Emotion Recognition in Children With Autism Spectrum Disorder. Does Level of Sensory Responsiveness Matter?

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ABSTRACT

Current research reveals an important role of cognitive strategies in the development of the ability to recognize emotions in persons with autism spectrum disorder (ASD). Therefore, a closer look at the relationship between emotion recognition deficits in that group and the underlying sensory integration processes may prove relevant for explaining the origins of this deficit. In order to verify the existence and scope of the relationship between emotion recognition and the level of sensory responsiveness in children with ASD, a study was carried out among a group of 63 children with an ASD diagnosis, aged between 3 years and 7 months to 9 years and 3, months using the Emotion Recognition subscale from the Theory of Mind Mechanism Scale and the Sensory Experiences Questionnaire. The obtained results revealed that only the level of sensory hyporesponsiveness was a predictor of the level of emotion recognition in the sample. Confirming the role of the level of sensory hyporesponsiveness in explaining the deficit in emotion recognition provides a better understanding of the genesis of this deficit. It also justifies the need to include sensory hyporesponsiveness therapy in the educational and rehabilitation process aimed at improving the children with ASD's emotion recognition abilities.

KEYWORDS

autism spectrum disorder
emotion recognition
sensory responsiveness
sensory hyporesponsiveness
middle childhood

INTRODUCTION

The history of research into emotion recognition deficits in individuals with autism spectrum disorders (ASD) is as long as the history of research into the functioning of this group. As early as the 1940s, the pioneers of research on the functioning of individuals with ASD—Leo Kanner (1943) and Hans Asperger (1944)—drew attention to the difficulties experienced by this group in terms of establishing emotional contact with others. Today, researchers emphasize the neurophysiological background of the deficit in the recognition of the emotional states of others that is found in individuals with ASD (Dapretto et al., 2006). A relationship between difficulties in emotion recognition and the severity of ASD symptoms is also indicated (Williams & Gray, 2013). However, it is worth pointing out that as far as the level of emotion recognition development is concerned, individuals with ASD are a heterogeneous group. Evidence suggests that the deficit in this skill is deeper and more extensive in children than in adults with this disorder. So far, it has been demonstrated that children with ASD can correctly recognize situation-driven emotions, although they are not as good at recognizing other people's belief-driven emotional states (Baron-Cohen, 1991). Meanwhile, results from more recent studies reveal difficulties experienced by children with ASD in recognizing essential emotions by observing facial expression, body posture, or tone of voice (Franco et al., 2014; Fridenson-Hayo et al., 2016).

At the same time, researchers note that adults with ASD perform just as well as typically-developing adults when it comes to tasks requiring the recognition of emotional states, even if they need significantly more time. Some authors speculate that the longer response times observed in individuals with ASD may be a result of their use of certain compensatory cognitive strategies, similar to those that help them navigate through social situations (Gev et al., 2016; Matsumoto et al., 2016). Such strategies include looking at the facial regions relevant to the expression of emotions (mouth, eyes) or following the gaze of another person (Bradshaw et al., 2011; Freeth et al., 2011; Chakraborty & Chakrabarti, 2016; Pedreño et al., 2017).

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The above analyses lead to the conclusion that cognitive processes have a particularly important role in the development of the ability of individuals with ASD to recognize the emotional states of others. Therefore, confirming the relationship between the development of this ability and the course of sensory processing, which is fundamental to other processes as well, is of particular importance. These processes are responsible for integrating individual sensory perceptions into a coherent picture of reality. They also enable a person to formulate an adequate response to the perceived situation (the so-called adaptive response) and thus to actively participate in the perceived reality (Ayres, 1991; Dunn, 1997). At the same time, the course of these processes in individuals with ASD is not typical. The vast majority of people with ASD (92%) experience atypical sensory processing (Green et al., 2016). Moreover, the propensity for such atypical sensory experiences is fairly stable during early development (between 2 and 8 years of age, McCormick et al., 2016; Perez Repetto et al., 2017). It is also worth noting that individuals with ASD are more likely than those developing typically to suffer from sensory hypersensitivity (Tavassoli et al., 2014), particularly to auditory stimuli (Baranek et al., 2007), as well as difficulties in shifting attention between stimuli belonging to different modalities (Marco et al., 2011), audiovisual speech processing (Irwin & Brancazio, 2014), and integration of tactile and visual stimuli (Greenfield et al., 2015; Ropar et al., 2018).

The neural foundations of the relationship between atypical sensory processing and cognitive processing in individuals with ASD have been explored in detail by the proponents of the concepts of the calibration process (Gori, 2015), the extended sensory temporal binding window (Brock et al., 2002; Martínez-Sanchis, 2014; Greenfield et al., 2015; Ropar et al., 2018), the disrupted mechanism of neural oscillation (Beker et al., 2018), and the variability of neural activity (Haigh, 2018).

The above analyses of the relationship between sensory processing and perception, together with the aforementioned findings suggesting a greater contribution of cognitive analyses to the recognition of facial expressions of emotion in individuals with ASD as compared to typically developing individuals, support the idea that the atypical course of sensory processing in these individuals may determine their difficulties in recognizing the emotional states of others (Gev et al., 2016; Matsumoto et al., 2016).

To date, researchers have been able to confirm the predictive role of the processing of stimuli of most modalities (visual, auditory, tactile, gustatory, and olfactory) for the development of the ability to recognize facial expressions of basic emotions in children with ASD (Efranian et al., 2018). In high-functioning adults with ASD, it has been noted that hyperresponsiveness to sensory stimuli makes it possible to make some inferences about their difficulty in recognizing emotions (especially negative ones, Meng et al., 2021). Researchers speculate that hyperresponsiveness to sensory stimuli in individuals with ASD may result in increased perception and strong, negative cognitive assessment of facial expressions of negative emotions (Meng et al., 2021). The contribution of abnormal sensory processing to the genesis of abnormal behavioral and emotional responses has also been proven (Fabbri-Destro et al., 2022). However, no studies have been reported that would precisely indicate a relationship between the level of responsiveness to sensory stimuli and the level of development of more advanced stages of recognition of emotions (situation-driven, desire-driven, or belief-driven emotions) in children with ASD.

The current analyses aimed to determine whether the level of sensory responsiveness would predict the level of development of emotion recognition (also on advanced levels) in children with ASD. It has been demonstrated that the level of development of the ability to recognize the facial expression of basic emotions in children with ASD can be deduced from their responsiveness to sensory stimuli (Efranian et al., 2018). On the other hand, the level of hyperresponsiveness to sensory stimuli in adults with ASD is a predictor of difficulty in recognizing the facial expressions of negative emotions (Meng et al., 2021). Therefore, the hypothesis tested in the current study (H1) was the following: The level of sensory responsiveness predicts the level of emotion recognition in children with ASD (also on advanced levels)

METHOD

Participants

The study involved a group of 63 children with a diagnosis of ASD, aged from 3 years and 7 months to 9 years and 3 months (M = 5;9, SD = 1.59).

There was a disproportion between girls (17.5%, 11 participants) and boys (82.5%, 52 participants). The children who participated in the study lived in medium-sized and large cities (30.16%, 19 participants and 23.80%, 15 participants, respectively), rural areas (28.58%, 18 participants), and small towns (12.70%, 8 participants). For three children, no information was obtained on their place of residence. The participants attended inclusive kindergartens or inclusive groups within kindergartens (79.37%, 50 participants), kindergartens for children with special educational needs (7.93%, 5 participants), schools for children with special educational needs (6.34%, 4 participants), and inclusive schools or inclusive groups within schools (3.18%, 2 participants). One of the participating children attended a therapeutic school (1.59%) and another attended a special care educational facility (1.59%). The vast majority of participants were diagnosed with autism, or infantile or early childhood autism (87.31%, 55 participants). The children also had diagnoses of Asperger's syndrome (7.93%, 5 participants) and atypical autism (4.76%, 3 participants). The parents of the children were mostly persons with higher (mothers: 52.3%, fathers: 30.2%) and secondary education (mothers: 34.9%, fathers: 36.5%). However, some parents had vocational (mothers: 6.3%, fathers: 25.4%) and primary education (mothers: 1.16%, one person). No information on the level of education was obtained from three mothers and five fathers of the children.

Research Tools

The Sensory Experiences Questionnaire (SEQ) by Baranek (1999), translated into Polish by Krzysztofik et al. (2016, translation consultation by M. Wiśniewska), is a tool designed to measure the level of sensory responsiveness in children with ASD aged 1 to 8 years. The level of sensory responsiveness is assessed in terms of a total score and specific scores for patterns of sensory responsiveness (hyporespon-

siveness = HYPO, hyperresponsiveness = HYPER, sensory seeking = SEEK, social context = SOCIAL, nonsocial context = NONSOCIAL) and sensory modalities (auditory = AUD, visual = VIS, tactile = TACT, gustatory and olfactory = GUST AND OLF, vestibular and proprioceptive = VEST and PRO). The child's parent/guardian provides answers concerning the frequency of a particular behavior on a 5-point Likert scale. The tool also contains items requiring descriptive answers analyzed qualitatively. Cronbach's α coefficients in the current sample showed satisfactory values for the total score (.83) and for individual dimensions (HYPER = .81, HYPO = .67, SEEK =.78, SOCIAL = .61, NONSOCIAL = .80) and modalities (VIS = .64, TACT = .66). However, three subscales showed insufficient values (AUD = .53, VEST and PRO = .23, GUST and OLF = .43).

The Theory of Mind Mechanism Scale (SToMM, Krzysztofik, 2016) was constructed based on the concept and educational program of mind-reading skills proposed by Howlin et al. (1999). This tool is used to assess the level of development of three elements of the Theory of Mind Mechanism: emotion recognition, understanding beliefs, and ability to pretend play. The current study used the emotion recognition subscale (SToMM_E). Its tasks are organized into five levels: 1 = recognition of facial expressions in photographs of adults and children, 2 = recognition of emotions in schematic drawings, 3 = identification of situation-driven emotions, 4 = identification of desire-driven emotions, and 5 = identification of belief-driven emotions. The child is asked to answer (verbally or by pointing to the appropriate symbol) a question asked by the investigator. The child's score can range from 0 to 5 points. A score of 0 indicates the lowest level of emotion recognition and 5 indicates the highest. Cronbach's α internal consistency coefficient for this subscale in the sample was .91.

The sociodemographic datasheet consisted of questions to the child's parent/caregiver concerning the type of educational establishment the child attends, the child's method of communication, the presence of comorbid disorders, and the family's place of residence.

Procedure

The sample was recruited on the basis of written consent obtained from parents/guardians of the children. The study was carried out in 26 different educational and therapeutic institutions (therapeutic centers, special and integrational schools and kindergartens as well as public schools and kindergartens with integrational classes/sections) located in four regions in central, eastern and southern Poland (Lubelskie, Mazowieckie, Świętokrzyskie, and Podkarpackie voivodeships).

Parents or caregivers of the participating children had the opportunity to read detailed written information about the conditions of the study before giving their consent for participation. They were assured of the anonymity of the study and that the results would only be used for scientific purposes. After providing written consent for participation, the parents/caregivers of the children were asked to complete the SEQ and the sociodemographic datasheet, which were handed to them either in person by the researcher or through a therapist or teacher.

The participating children were invited to individual research sessions during which their level of development of emotion recognition was assessed. The sessions were held in educational or therapeutic establishments, in a room familiar to the child. Each child was prepared by a therapist or teacher to participate in the study. No other people were present during the session other than the investigator and the participating child, except in a few cases when a support teacher was present. The sessions lasted approximately 20 minutes and were held in a form of play. After a session was finished, the children received a toy (a yo-yo, a sensory ball, a squeeze toy etc.) as a reward for their participation.

The research project was approved by the Research Ethics Committee Institute of Psychology at the John Paul II Catholic University of Lublin, Poland.

RESULTS

Data Analysis

IBM SPSS 25 version with the PROCESS extension (Hayes, 2018) was used for the statistical analysis.

The analyses began with the level of sensory responsiveness and emotion recognition in the group of children with ASD.

In terms of the level of general responsiveness and responsiveness in particular dimensions and modalities, the children obtained mean results (between 1.91 and 2.66) similar to the theoretical mean for the SEQ. They indicate that the level of sensory responsiveness in the children had average values. It is worth noting that the highest level of sensory responsiveness was observed for the modalities concerning vestibular and proprioceptive stimuli, gustation and olfaction, as well as in the dimension of sensory seeking. The lowest level of responsiveness in the children was observed in the dimension of hyporesponsiveness to sensory stimuli and the tactile modality (see Table 1).

The development of the children's ability to recognize emotions was between Levels 2 and 3, that is, between the ability to recognize emotions in schematic drawings and the ability to identify situation-driven emotions (see Table 1).

Next, the relationships between the variables were analyzed. The results indicate that of the five modalities and five dimensions of sensory responsiveness, only the level of hyporesponsiveness to sensory stimuli contributed to explaining the level of development of emotion recognition in the children. This dimension of sensory responsiveness explained 7% of the variability in emotion recognition scores (R^2 = 0.07). The higher the level of hyporesponsiveness to sensory stimuli, the lower the level of development of emotion recognition in the children (ß = –0.27, see Table 2).

DISCUSSION

The analyses partially confirmed H1. Only the level of sensory hyporesponsiveness predicted the level of emotion recognition in the group.

Hitherto, researchers revealed a predictive role of sensory processing in the visual, auditory, tactile, gustatory, and olfactory modalities for the level of development of the ability to recognize facial expressions

TABLE 1.
Sensory Responsiveness and Emotion Recognition in the Sample

		M	*SD*
SEQ	TS	2.27	0.50
	HYPER	2.15	0.66
	HYPO	1.91	0.70
	SEEK	2.47	0.66
	SOCIAL	2.11	0.56
	NONSOCIAL	2.33	0.54
	VIS	2.24	0.67
	AUD	2.21	0.75
	TACT	1.98	0.59
	VEST and PRO	2.66	0.69
	GUST and OLF	2.40	0.68
SToMM	SToMM_E	3.24	0.57

Note. SEQ = Sensory Experiences Questionnaire, TS = total score, HYPER = hyperresponsiveness, HYPO = hyporesponsiveness, SEEK = sensory seeking, SOCIAL = social context, NONSOCIAL = nonsocial context, VIS = visual, AUD = auditory, TACT = tactile, VEST and PRO = vestibular and proprioceptive, GUST and OLF = gustatory and olfactory, SToMM_E = emotion recognition subscale from the Theory of Mind Mechanism Scale.

TABLE 2.
Regressions for Emotion Recognition

Explained variable: emotion recognition $R^2 = 0.07$, $F = 4.80$ $p = .032$				
	ß	*t*	*p*	95%CI
Constant	4.77 (B)	6.39	.001	3,28: 6.27
Hyporesponsiveness	−0.27	−2.19	.032	−1.53: −0.07

Note. R^2 = model fit coefficient, *t* = test statistic; β = standardized regression coefficient; *p* = statistical significance.

of basic emotions in children with ASD (Efranian et al., 2018). It has also been confirmed that difficulties experienced by high-functioning adults with ASD in recognizing negative emotions remain related to their hyperresponsiveness to sensory stimuli (Meng et al., 2021). This relationship is explained on the grounds that hyperresponsiveness to sensory stimuli in individuals with ASD may result in increased perception and strong, negative cognitive assessment of facial expressions of negative emotions (Meng et al., 2021).

The results of the current study reveal that the development of the ability of children with ASD to recognize basic emotions (joy, sadness, fear, and anger) both in terms of the facial expression of such emotions and their association with situational context, desire, and belief is conditional upon the level of hyporesponsiveness to sensory stimuli. The level of emotion recognition in the participating children was not found to be affected by their level of hyperresponsiveness to sensory stimuli or their level of responsiveness to visual, auditory, tactile, gustatory, or olfactory stimuli, as reported by other researchers (Efranian et al., 2018; Meng et al., 2021).

The current study focused on preschool children with ASD and may have revealed some patterns specific only to this age group. Therefore, it might be the case that the ability to recognize emotions is determined by the level of sensory hyporesponsiveness only in preschool children with ASD. In adults, the level of sensory hyperresponsiveness acquires predictive significance for emotion recognition, as suggested by other authors (Meng et al., 2021), which is related to their increased perception of emotions and strong cognitive response to facial expressions of negative emotions. An analysis of research reports on the difficulties experienced by children with ASD in recognizing emotions suggests that they are still unable to use cognitive analyses (Franco et al., 2014; Fridenson-Hayo et al., 2016). As can be concluded from the current results, the factor impeding the development of their ability to recognize other people's emotions is their insufficient—and not excessive (as is the case of adults)—level of responsiveness to sensory stimuli. This is because low levels of sensory responsiveness make it impossible to perceive the active stimulus and respond to it appropriately. This level of sensory responsiveness may be more decisive for the recognition of other people's emotions by children with ASD than by adults with ASD, as children are not yet able to intentionally direct their attention to the elements of a situation that are relevant to understanding it, including emotions. It seems that the level of sensory hyporesponsiveness loses its predictive function for emotion recognition in adults with ASD, while this predictive function is acquired by the level of sensory hyperresponsiveness associated with the cognitive evaluation of facial expressions of emotion (Meng et al., 2021).

The level of development of emotion recognition skills in the current study, in terms of recognizing facial expressions of emotion as well as recognizing emotion on the basis of the person's situational context, desires, and beliefs, was not shown to be related to the level of responsiveness to auditory, visual, tactile, gustatory, or olfactory stimuli. Instead, it is determined by the level of hyporesponsiveness to sensory stimuli, regardless of modality. In an earlier study (Efranian et al., 2018), the level of responsiveness to stimuli of the above modalities showed predictive functions for the ability to recognize facial expressions of emotion in children with ASD. Therefore, it can be assumed that it is the sensory modality that is affected by the abnormality of significance for the prediction of the ability to recognize facial expressions of emotion. In contrast, what is significant for the prediction of more advanced levels of emotion recognition (situation-driven, desire-driven, and belief-driven emotions) is the type of abnormal sensory processing—hyporesponsiveness—regardless of which modality it involves.

The relationships between the level of sensory responsiveness and the level of development of emotion recognition described in the current study suggest that it is worthwhile to plan therapeutic activities in such a way that they simultaneously include emotion recognition

training and sensory integration therapy aimed specifically at the symptoms of sensory hyporesponsiveness.

The limitation of the current study are a lack of a control group of typical developing children and a lack of information on children's attendance in emotion recognition training. It is worth repeating the study using a control group, as well as providing information about the children's previous experiences with emotion recognition therapy or training. In this way, the obtained results will be more reliable.

Moreover, the wide age range of the surveyed children (between 3 and 9 years old) caused the studied group to include children at the age corresponding to two various developmental periods. It can be assumed that such a situation should not significantly affect the variance in results. Such an assumption can be justified by the delay of about five years in the theory of mind development observed in children with ASD (Happé, 1995). If emotion recognition is one of the manifestations of the theory of mind (Howlin et al., 1999) we can expect similar delays in this ability. However, it is worth confirming such a supposition in the future by conducting separate analyses for two subgroups of children (e.g., aged 6 or younger and older). In the current study, such analyses were not possible due to the small size of the subgroups extracted in this way.

Despite the limitations, the current study confirmed the role of the sensory hyporesponsiveness level in explaining the level of emotion recognition in children with ASD. Such a conclusion is important for the discussion on the conditions of emotion recognition development in this group.

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There is no potential conflict of interest including financial, personal or other relationships with other people or organizations within three years of beginning the submitted work that could inappropriately influence, or be perceived to influence, their work.

The research project was approved by the Research Ethics Committee Institute of Psychology at the John Paul II Catholic University of Lublin, Poland.

DATA AVAILABILITY

The Author declares that data will be made available upon reasonable request.

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