Facial emotion recognition in children with autism spectrum disorder: Are emotional primes effective?

Ata Cantürk Dogrul[1], Banu Cangoz Tavat[2], Pınar Uran[3]
[1]Res. Assis., [2]Prof., Hacettepe University, Department of Psychology, Ankara, Turkey https://orcid.org/0000-0002-1699-886X
https://orcid.org/0000-0003-2213-3261
[3]Assoc. Prof., Izmir Democracy University School of Medicine, Department of Child and Adolescent Psychiatry, İzmir, Turkey
https://orcid.org/0000-0003-4560-9146

SUMMARY

Objective: This study investigated the facial emotion recognition problems in children with autism spectrum disorder and how different emotional primes (visual and vocal primes) affected this deficiency.

Method: Two separate experiments using the prime task were conducted in which only the prime modality was differentiated. Visual (Experiment-1) or vocal (Experiment-2) emotion primes were presented in the task. Then the participant decided whether the faces presented after primes had emotion.

Results: In both experiments, children with autism spectrum disorder showed impaired performance compared to healthy peers, and a happy face advantage was seen in both experiments independent of the group. Reaction time increased in autism spectrum disorder when the sad vocal prime was given. However, the priming effect was not seen in any modality in either group.

Discussion: Emotional priming has no effect on the recognition performance of healthy control and children with autism spectrum disorder. Sad vocal prime has a negative impact on children with autism spectrum disorder's ability to recognize faces. Happy and neutral tones as much as possible should be employed in the training and intervention programs for autism spectrum disorder, considering the effects of sad vocals.

Key Words: Autism spectrum disorder, facial emotion recognition, emotional priming, emotional prosody

INTRODUCTION

Diagnostic criteria of Autism Spectrum Disorder (ASD) are mainly explained within two dimensions: social communication-interaction problems and restricted-repetitive behaviors (1). Social communication-interaction problems in ASD include verbal and non-verbal communication deficiencies such as language abnormalities, weak eye contact, lack of social smile, and personal boundaries (2). Facial emotion recognition (FER), which is defined as the ability to distinguish emotions from facial expressions, has been a frequently researched subject for ASD (3) because understanding nonverbal emotional cues is crucial for successful social interaction (4). While the ability to FER in healthy individuals begins to develop in the first months of life (5), the aforementioned ability in individuals with ASD is controversial. Although the deficiency in FER is frequently reported in ASD (6), there are also studies showing that this skill is not impaired (7). However, this study has demonstra-ted that individuals with ASD are negatively affec-ted by the decrease in the intensity of emotion on the face. Also, some researchers have found emotion-specific impairments in FER. According to the study by Jones et al. (2011), individuals with ASD failed to recognize the emotional expression of ‘‘surprise’’ (8). It is thought that contradictory findings related to the FER in ASD arise from methodological problems such as age, intelligence, task selection, and stimulus type. (9).

While facial emotional stimuli were used in the early studies on emotion recognition, emotional human voices have started to be used in current

DOI: 10.5505/kpd.2024.55531

Cite this article as: Dogrul AC, Cangoz Tavat B, Uran P. Facial emotion recognition in children with autism spectrum disorder: Are emotional primes effective? Turkish J Clin Psych 2024; 27:139-149

The arrival date of article: 01.12.2023, **Acceptance date publication:** 27.02.2024

Turkish J Clinical Psychiatry 2024;27:139-149

studies (10,11). Vocals as speech sounds, like ''photographs'', may convey information such as trust, attraction, dominance, and emotional state (12). Emotional prosody consisting of pseudo-word or pseudo-sentences stimulating language grammar rules and phonotactic restrictions is prominent in emotion recognition studies with vocals (13,14,15).

There are findings indicating that emotional prosody recognition performance is impaired in ASD (16), as well as findings that do not impaired (17). Another study revealed that although children with ASD have no problem in perceiving prosody, they show atypical attention to the emotion in the voice compared to their peers (18). It was shown that based on an examination of distinct emotions, while children with high-function autism (HFA) fail to recognize the neutral and happy prosody compared to their typically developing peers, sad and angry prosody does not have problems in recognition (19).

The ability to recognize emotions is aided by clues from various sources, including the voice and the face (20). It is thought that an information processing system combines clues from various sources in one place to recognize emotions (21). Failure in emotion recognition from the face, vocal, and body movement in children with ASD show a perceptual problem (22), and they have difficulty combining emotional cues from different modalities (23). However, another study revealed that children between the ages of 7-10 have general difficulty in integrating vocals and faces, regardless of ASD (24).

Emotional priming paradigms are an effective tool for studying the interaction between emotional cues. Priming is the facilitating effect of the stimuli (prime) presented earlier on cognitive processes. The congruency effect, which indicates that priming is shown based on emotion, is a shortening reaction time and an increase in accuracy rate when the emotional valence of the prime and the target are similar (25). The emotional congruency effect applies to both the same (uni-modal) (26) and different modalities (cross-modal) (13). The fact that other modalities such as visual, auditory, and odor can create emotional congruency effects supports the view that it is a central system responsible for emotional information processing (21,26,27). A few studies show that emotional priming has less facilitating effect on children with ASD than on their healthy peers (28,29). Pell (2005) has demonstrated the emotional priming effect revealed by the congruence of vocal and face in healthy individuals (13,30). While no emotional priming effect was seen in adults with higher autism-like behaviors in a different study using the same paradigm (Facial Affective Decision Task: FADT), adults with lower autism-like behaviors responded faster to happy faces following a happy prime compared to a neutral prime (31).

This study examines the effects of uni-modal (visual-visual) and cross-modal (auditory-visual) emotional stimulus interactions on FER in children with ASD, with two separate experiments using the FADT. Emojis were used as emotional prime in Experiment 1; vocals were used as emotional prime in Experiment 2. Thus, the effects of prime on emotional face photographs presented as targets in both experiments were separately investigated. It was hypothesized that the effect of uni-modal congruency would be seen in both groups, while cross-modal congruency would only be seen in healthy controls. Thus, the cross-modal emotion recognition skills of children with ASD and with typical development will be examined using a different task. The modality priorities and/or advantages that will be revealed by examining the cross-modal (auditory-facial) skills of ASD characterized by FER deficiencies, will contribute to the literature, especially in terms of regulation the programs to be developed in their education.

METHOD

Participants

Due to the cognitive and behavioral problems associated with ASD and the demands of the task to be performed in the experiments, strict evaluation criteria were applied in the selection of participants. Since most of the children with ASD who are candidates to participate in the research will be eliminated in the screening tests due to strict evaluation criteria, the evaluation was made among 350 children diagnosed with ASD were educated in special education and rehabilitation centers in the province of Ankara, Turkey. All children with ASD were previously diagnosed with ASD according to DSM 5 and have a medical board report. Healthy controls were reached through social media announcements. The sample of Experiment 1 consists of 34 volunteer children (15 healthy, 19 with ASD) aged between 6 and 12. Six children with ASD were eliminated due to their scores in the following screening tests and were excluded from the analyzes of Experiment 1. The sample of Experiment 2 consists of 38 volunteer children (16 healthy controls, 22 with ASD) aged between 6 and 12 who did not participate in Experiment 1. 10 children with ASD were eliminated from the analysis of Experiment 2 because of their scores of the screening tests. Children with mild to moderate autism symptoms according to Childhood Autism Rating Scale were included in the study. According to the Schedule for Affective Disorders and Schizophrenia for School Aged Children Present and Lifetime Version (KSADS-PL), a semi-structured psychiatric interview applied by a child and adolescent psychiatrist, children who did not have any psychiatric diagnosis other than ASD were included in the study. Participants' general intelligence and receptive language skills were evaluated with the Raven Standard Progressive Matrices and Peabody Picture Vocabulary Test. Participants who scored below the Turkish norms in these tests were not included in the study. No participants have abnormal vision or hearing problem. Participants did not use any psychiatric drugs that could affect cognitive processes in the 48 hours before the experiment.

Diagnostic and descriptive measures

Sociodemographic Questionnaire: It was completed by the parents of the children participating in the study. Information about the participants' age, gender, years of education, socioeconomic level, health status, and other demographic characteristics that may affect the results of the research were obtained.

Schedule for Affective Disorders and Schizophrenia for School-Age Children–Present and Lifetime Version (K-SADS-PL): It is a semi-structured interview developed to determine the past and present psychopathologies of children and adolescents. It was first developed by Kaufman et al. (32). Its Turkish adaptation studies were performed by Gökler et al. in 2004 (33).

Childhood Autism Rating Scale (CARS): It is used to measure the presence and severity of autism (34). It consists of 15 items containing behavioral ratings in categories such as object use, adaptation to change, and imitation. The highest score on the scale is 60. Children with a score of 15-29.5 are thought to have not autistic traits, while those with a score of 30-36.5 are thought to have mild-moderate autistic traits, and those with a score of 37-60 are thought to have severe autistic traits. The reliability and validity study of the Turkish version of the scale were conducted by İncekaş Gassaloğlu, et al. in 2016 (35). In this study, the Cronbach alpha value of the total score of the scale was .95 ($p < .01$), the test-retest reliability correlation coefficient was reported as .98 ($p < .01$), and the inter-rater reliability coefficient was .97 ($p < .01$).

Raven's Standart Progressive Matrices (RSPM): It is a general intelligence test independent of culture and language (36). The test consists of five separate sets, 12 items in each set, a total of 60 items. The items have an increasing difficulty level. The scores are calculated over the total score and the completion time of the test, and the highest score is 60. The norms in the Turkish standardization study of the RSPM for children aged 6-12 were taken as reference (37).

Peabody Picture Vocabulary Test: It was developed by Dunn (1959) to measure the language development of individuals between the ages of 3-17 (38). The test, which is widely used in the world and in our country, includes a total of 100 pictures. In the test, the participant is asked to find and show the most appropriate picture for the word presented orally. Each correct answer is 1 point, and the highest score that can be obtained from the test is 100. The Turkish adaptation of the test was carried out by Katz, et al. (39) (as cited in Oner, 1997).

Figure 1. Examples of target face photos.

Experimental Task

The task in both experiments was prepared with E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA). Experiments 1 and 2 differ only in terms of stimuli that are presented as prime (emojis in Experiment 1; vocals in Experiment 2). The FADT consists of a total of 144 trials, 72 of which are “YES” (emotional target face) and 72 of which are “NO” (non-emotional target face). “YES” trials include 24 emotionally congruent (e.g., happy prime-happy target face or sad prime-sad target face), 24 emotionally incongruent (e.g., happy prime-sad target face or sad prime-happy target face), and 24 neutral (neutral prime-happy target face or neutral prime-sad target face) trials. “NO” trials, on the other hand, consist of 72 target faces that do not express emotion, coming after happy (24), sad (24), and neutral (24) prime stimuli. 144 trials were divided into six blocks, and primes and targets were chosen as pseudorandom so that they are not repeated in blocks. In Experiment 2, vocal primes were presented at most four times in all trials and only once in each block. The gender of the model in the target face photograph was matched with the gender of the vocal primes. The order of presentation of the blocks was determined by semi-balancing.

FADT Stimuli

A total of 48 color photographs (383 x 500 pixels) of two white-skinned female and two white-skinned male models, including 3 happy, 3 sad, and 6 non-emotional (not representing a known emotion), were selected from a set of emotional face photographs developed by Pell in 2002 (40) and later used in other studies (13,30,31). According to the procedures in Pell’s study, college students aged 19 to 26 (68 females and 15 males; M = 19.9, SD = 1.6) and children aged 7 to 10 (17 girls and 15 males; M = 8.3, SD = .89) independently rated the images in terms of emotion recognition and emotional valence. These volunteers did not take part in the main experiments. In the emotion recognition task has 7 options (anger, disgust, fear, sad, happy, surprised, non-emotional face) accurate recognition rate of over 75% were considered valid. Emotional valence was measured on a 5-point scale ranging from -2 (very negative) to +2 (very positive). Scores between -0.75 and -2 points were considered sad, and scores between +0.75 and +2 were considered happy. According to these evaluations, 3 out of 48 photographs were eliminated. Consequently, 45 face photographs were chosen to serve as targets in FADT (Figure 1). Non-copy-

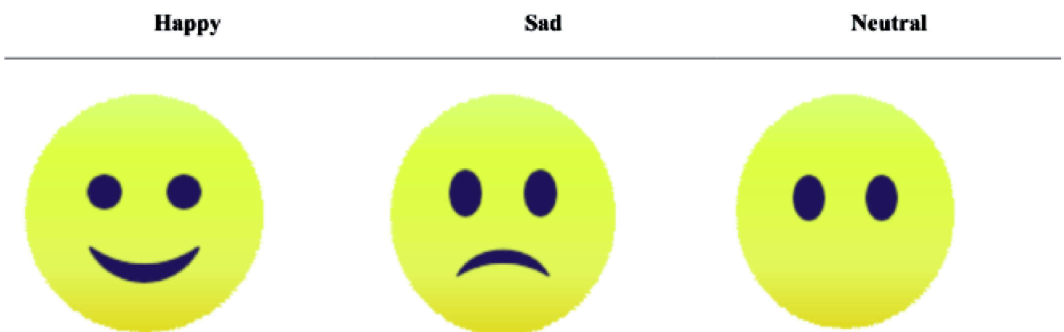
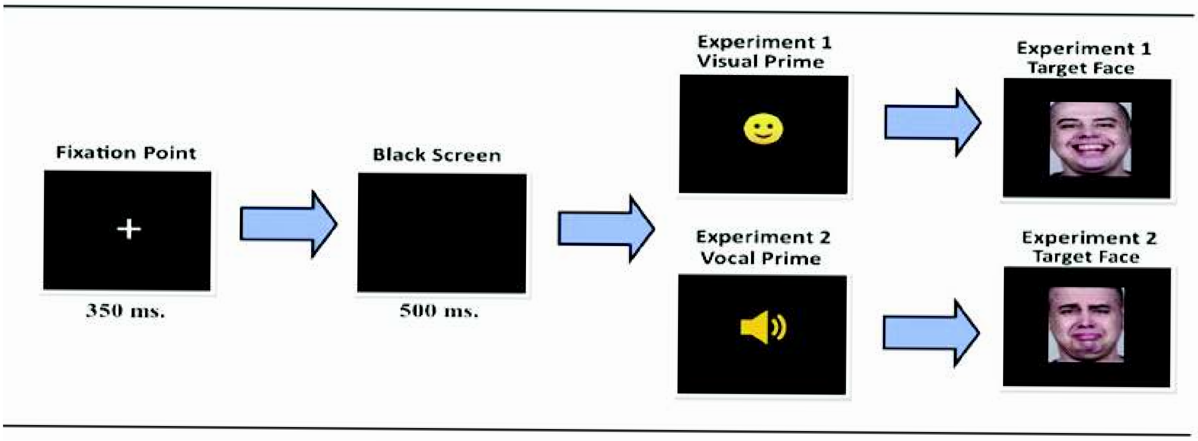


Figure 2. Visual prime stimuli (emoji primes) used in Experiment 1.

Figure 3. A schematic representation of a trial sequence in Experiment 1 and Experiment 2.



righted emojis were used as primes (Figure 2) in experiment 1. 83 vocal primes which consist of pseudo-sentences in Turkish were used in experiment 2. Vocal primes was developed by following the steps in the study by Pell et al (41).

Procedure

The procedure of Experiments 1 and 2 are identical except for the prime stimuli (emojis in Experiment 1; vocals in Experiment 2). Screening tests, which lasted approximately 90 minutes, were administered to the participants in the first session. and Experiment 1 or 2 was administered in the second session, approximately one week later. Before the experiments, the participants were shown facial emotional cards corresponding to six basic emotions that were not used in the main experiment, and they were asked to recognize them. Participants were seated in a fixed and upright position at approximately 60 cm from the laptop screen (1920x1080 pixels – 15.6 inches). The participants were instructed that they would see some emojis or hearing sounds on the screen, not to focus on them, and then to decide (YES/NO) whether the faces that would appear on the screen contained emotions. In the practice trials, at least 7 out of 12 trials were required to be answered correctly. In FADT, each trial was first presented with a focusing screen (350 ms), then a blank screen (500 ms) and emotional emoji primes in Experiment 1 and emotional vocal primes in Experiment 2 (average 2009 ms). In order that the position where the emojis were presented in Experiment 1 would not be blank while the vocals were presented in Experiment 2, A representative sound sign indivating the vocal, had the same color and size with emojis was used in place of emojis. The average duration of the vocals in Experiment 2 is 2009 ms. In Experiment 1, each emoji presented instead of the vocals in Experiment 2, remained on the screen for the average time of the vocals (2009 ms). Thus, Experiment 1 and 2 were tried to be matched except for the modality of the prime stimuli. In each trial, the target face was presented on the screen after the prime. Target faces are displayed on the screen until the participant reacts or for 5000 ms. (Figure 3).

Statistical Analysis

Power analysis was performed with G-Power (42) to determine an adequate sample size. In order to obtain .80 power as a result of the analysis, the required number of participants was determined as 28 for each experiment at .05 alpha level and medium effect size.

Statistical Package for Social Sciences (SPSS) 23.0 licensed program was used in the analysis of all data. The significance level for all analyzes was determined as $p < .05$. In order to examine whether there is a difference between the groups in the study in terms of the scores they got from the screening tests (RPSM, PPVT, and CARS), independent samples t-test analysis was performed. Trials with reaction times below 300 ms and above 5000 ms were excluded from the data set. Only emotion-expressing face trials (YES trials) were included in the analysis, and reaction time analyzes were conducted on correct trials. To examine the congruency effect for both experiments, two separate 2 (Group: ASD vs Control) x 3 Prime (Happy

Table 1. Comparison of healthy and ASD participants in Experiment 1 in terms of screening test scores with t test

N = 28	Group	n	M – SD	t	df	p	Cohen s d
RPSM*	Control	15	32.33 – 10.11	1.69	26	.102	.64
	ASD	13	26.38 – 8.11				
PPVT*	Control	15	80.66 – 6.28	2.29	17.44	.030	.85
	ASD	13	72.46 – 12.10				
CARS*	Control	15	18.10 – 2.22	-20.83	26	.000	8.06
	ASD	13	33.00 – 1.38				

*RSPM: Raven's Standart Progressive Matrices; PPVT: Peabody Picture Vocabulary Test; CARS: Childhood Autism Rating Scale.

vs Neutral vs Sad) x 2 (Target: Happy vs Sad) ANOVAs were conducted seperately for accuracy rate and reaction time. Post-hoc analyzes (Bonferroni correction) were performed to identify the source of significant differences.

RESULTS

Sociodemographic features and screening tests

Experiment 1

After screening tests and practice trials, 13 children with ASD (12 boys, 1 girl; M = 8.23, SD = 1.87) aged 6-12 years and 15 healthy controls (8 boys, 7 girls; M = 9.00, SD = 1.81) matched for age, intelligence, and receptive language skills, a total of 28 children were included in the analysis. The results of the independent samples t-test, which were conducted to determine whether there is a significant difference between the groups in terms of age, years of education, RPSM, PPVT, and CARS scores, are summarized in Table 1. However, receptive language skills of children with ASD were found to be lower than healthy children, t(17,44) = 2.29, p < .05, and they had a receptive language age score from PPVT compatible with their biological age.

Experiment 2

After screening tests and practice trials, 12 children with ASD (11 boys, 1 girl; M = 9.25, SD = 1.71) aged 6-12 years and 16 healthy children (8 boys, 8 girls; M = 10.06, SD = 1.73) matched for age, intelligence, and receptive language skills were included in the analyses. There was no difference in terms of age between the ASD and control groups, t(26) = 1.23, p > .05. The screening test scores of the participants in Experiment 2 are summarized in Table 2.

Reaction time and accuracy rate

Experiment 1

For reaction time, the group variable's main effect is statistically significant, F(1, 26) = 21.84, p< .001, ηp2 = 0.45. The reaction time of healthy participants (M = 1450, SE = 85) was significantly faster than those with ASD (M = 2031, SE = 91). There is a statistically significant main effect of the target variable on the reaction time, F(1,26) = 25.02, p< .001, ηp2 = 0.49. In other words, happy faces (M = 1647, SE = 59) were recognized faster than sad faces (M = 1833, SE = 69). However, the main effect of the prime on the reaction time was not statistically significant, F(2,52) = .07, p > .05, ηp2 = 0.003. None of the interaction effects are statistically significant. Considering the accuracy rates, the

Table 2. Comparison of healthy and ASD participants in Experiment 2 in terms of screening test scores with t test

N = 28	Group	n	M – SD	t	df	p	Cohen s d
RPSM*	Control	15	33.81 – 4.98	1.68	26	.104	.63
	ASD	13	30.33 – 5.92				
PPVT*	Control	15	79.31 – 8.35	2.29	26	.319	.38
	ASD	13	75.75 – 10.18				
CARS*	Control	15	18.37 – 2.32	-20.83	21.09	.000	7.61
	ASD	13	31.87 – 0.95				

*RSPM: Raven's Standart Progressive Matrices; PPVT: Peabody Picture Vocabulary Test; CARS: Childhood Autism Rating Scale.

main effect of the group is statistically significant, $F(1, 26) = 24.49$, $p < .001$, $\eta p2 = 0.48$. The FADT accuracy rate of healthy participants (M = 92.7, SE = 3.3) was higher than those with ASD (M = 68.4, SE = 3.6). The main effect of the target on the accuracy rate is statistically significant, $F(1,26) = 4.42$, $p < .05$, $\eta p2 = 0.14$. It is seen that happy faces (M = 85.3, SE = 2.4) are recognized more accurately than sad ones (M = 75.7, SE = 4.0). The main effect of the prime on the accuracy rate is not statistically significant, $F(2,52) = .84$, $p > .05$, $\eta p2 = 0.03$. None of the interaction effects are statistically significant.

Experiment 2

The group main effect for reaction time is statistically significant, $F(1, 26) = 16.20$, $p < .001$, $\eta p2 = 0.38$. Healthy participants (M = 1412, SE = 28) responded faster than those with ASD (M = 2012, SE = 113). The main effect of prime is also statistically significant, $F(2,52) = .3.57$, $p < .05$, $\eta p2 = 0.12$. According to post-hoc comparisons, while happy primes (M = 1679, SE = 73) were recognized faster than sad ones (M = 1760, SE = 80), there was no significant difference between the neutral (M = 1696, SE = 77) primes and emotional primes (happy and sad).

The main effect of the target is also statistically significant, $F(1,26) = 4.54$, $p < .05$, $\eta p2 = 0.14$. Happy faces (M = 1658, SE = 84) were recognized faster than sad faces (M = 1766, SE = 73). None of the interaction effects were statistically significant except for the Group*Prime interaction effect, $F(2,52) = 6.23$, $p < .05$, $\eta p2 = 0.19$. According to the post-hoc comparisons of the Group*Prime interaction effect; happy, sad and neutral primes did not differ in reaction times in the healthy group ($p > .05$). In the group with ASD, happy (M = 1949, SE = 110) and neutral (M = 1961, SE = 117) primes were recognized faster than sad (M = 2126, SE = 120) primes ($p = .003$), while no significant difference was found between happy and neutral primes ($p = 1.00$).

The main effect of the group variable on the accuracy rate is statistically significant, $F(1, 26) = 16.21$, $p < .001$, $\eta p2 = 0.38$. However, the target, $F(1,26) = .58$, $p > .05$, $\eta p2 = 0.02$, and prime, $F(2,52) = .63$, $p > .05$, $\eta p2 = 0.02$, main effects were not statistically significant. None of the interaction effects are statistically significant.

DISCUSSION

In this study, the effects of different types of primes on the facial affective decision in children with ASD and healthy controls were investigated in two separate experiments using uni-modal (Experiment 1; emoji and face) and cross-modal (vocal and face) stimuli. The findings showed that children with ASD detected emotionally expressive human faces less quickly and accurately than healthy children. In the literature, this finding is repeatedly reproduced (6,43). Besides, the existence of problems with emotion recognition in autism was suggested by a meta-analysis that examined the findings of 48 distinct articles (44). Additionally, the impact of various presentation modalities on ASD's difficulty in recognizing emotions is frequently studied. Another recent meta-analysis that compiled studies on human faces, non-human faces (symbolic, animal, etc.), and emotion recognition from speech and music in ASD, showed a general difficulty in correct emotion recognition (45). It is known that this difficulty is not caused by participant characteristics such as the presentation time of the stimulus or IQ. When visual and auditory modalities are examined: general emotion disorders (emotion-general) in emotion recognition from the human face, emotion-specific impairments in speech prosody and emotion recognition from music, and no impairment in non-human faces were observed. Children with ASD are less likely than their healthy peers to identify the emotion in a human face reliably; however, they are more likely to identify the emotion on a dog's face. Since the target stimulus in the task (FADT) was the human face in both experiments, there may have been a difference between the groups. It is insufficient to explain the nature of facial emotion recognition disorder seen in ASD only with behavioral studies. Despite controlling for confounding factors such as age, intelligence, language skills, and co-psychiatric diagnosis, children with ASD performed less successfully in FADT than healthy children (Figure 4). This may be because of aspects of the ASD phenotype that relate to facial recognition.

According to a heuristic model presented by Schultz in 2005 (46), deficiencies in the amygdala and fusiform face region, which mediate the development of social skills in the early years of life, lead to ASD. The failure in FADT can be explained by less activation in the fusiform facial area (47,48) and lower amygdala activation in emotion recognition tasks in ASD (49,50). Additionally, electroencephalography (EEG) and eye-tracking (ET) investigations showed that individuals with ASD had abnormal gaze patterns and brain activity toward facial expressions (51).

In both experiments, children with ASD and healthy controls aged 6-12 years recognized happy human faces faster than sad ones. The fact that happy target faces were recognized faster than sad faces in FADT regardless of group and prime is consistent with the findings of studies using FADT (30,31). Leppänen and Hietanen (52) assert that happy facial expressions can be recognized more quickly than neutral and sad ones due to their perceptual advantages, including requiring more physical changes, being able to be recognized from a single symptom (such as teeth), and not necessarily requiring analysis of the entire face. Electrophysiology studies also supported the perceptual advantage of happy faces. Although faces with negative valence such as sad, fear, and anger were temporally processed in the early stage (enhanced N170), perceptual advantages of happy faces facilitate the categorization (reduced P3b) and decision (reduced slow positive wave) in the later stages (53). These findings are consistent with the hypothesis that faces with negative valance (angry, fearful) should be processed faster than happy expressions due to their adaptive characteristics. Accordingly, negative expression processing is prioritized in the early stage of recognition, while categorization is performed later, including allocating controlled attention resources and decision. Due to the similarity of the perceptual characteristics and emotional valences of the negative faces, discrimination in the categorization stage takes longer than happy faces. This result may be an advantage for happy faces about recognition.

In addition, FADT requires deciding whether the target face contains emotion ("YES/NO"). "YES" is the correct response for emotional faces and "NO" for non-emotional faces. However, it was observed that the participants tended to decide "YES" for happy and "NO" for sad. For this reason, the performance measurement that requires a YES/NO decision should not be preferred in emotion recognition studies using human faces to be conducted with children with ASD.

There are conflicting findings in the literature regarding the priming effect in children with ASD. While Kamio et al. (28) did not find an emotional priming effect in the group with ASD, Prehn-Kristensen et al. (54) found an effect using the eye-tracking approach. Given the abnormal gaze pattern associated with ASD, this effect is crucial for understanding how to interpret the result of the priming study. In our investigation, there was no evidence of a priming effect (prime*target interaction effect) in either group. This finding suggests that the participants may not have paid enough attention to the stimuli presented.

On the other hand, one of the findings that has to be discussed is that the main effect of the prime was not statistically significant in Experiment 1 and was statistically significant in Experiment 2. Emojis may not have been able to enough activate the emotion in Experiment 1 because they were symbolic faces. In addition, the emotions on primes were represented invariably by the same emoji in the trials, unlike vocal primes, which may have caused a decrease in the reaction via affective habituation (55,56,57). In Experiment 2, happy vocal primes may have attracted participants' attention more than sad vocals, causing participants to react more quickly. In other words, children in this age group benefited from natural human voices as cues, while they did not benefit from using unnatural symbolic stimuli (emojis).

Another important finding is that happy and neutral vocals are recognized faster than sad ones (Group*prime interaction effect) in children with ASD. Unlike healthy children, children with ASD were negatively affected by sad human voices. In other words, children with ASD benefited from happy and neutral human voices as cues but not happy symbolic visual stimuli (emojis). Wang and Tsao (19) revealed that children with HFA could not recognize the happy and neutral prosody compared to healthy peers, but they had no difficulty recognizing the sad and angry prosody. Therefore, while children with ASD participating in this study may not have well recognized the happy and neutral prosody prime presented in Experiment 2, they may have been able to recognize the sad prosody correctly. If the negative effects of sad prosody found in our study related to its accurate recognition, it may imply that sad prosody disrupts FER rather than primes.

Limitations

Although the implementation of strict screening tests and diagnostic criteria for the participants increased the sample quality, the small sample size is a limitation of this study. Comorbid conditions such as intelligence, ADHD, anxiety, and learning disorder in ASD were checked with screening tests and semi-structured interviews. However, although children with ASD scored in line with the norms in the receptive language skill screened by PPVT in Experiment 1, there is a statistically significant difference between them and healthy children. In addition, comorbid conditions (anxiety, ADHD, etc.) screened with KSADS-PL provide information about the presence or absence of the disorder. It should be kept in mind that this semi-structured interview is not functional in determining the level of disorder.

Future goals and clinical applications

The unique contribution of our study is to draw attention to the advantage of happy (cheerful, soft, affectionate, warm) and neutral tones over sad tones when communicating with children with ASD in daily life. Additionally, it is advised that training and intervention programs for children with ASD employ happy and neutral tones as much as possible, considering the effects of sad vocals. Besides, sad prosody disadvantage may have resulted from the efforts of individuals with ASD to direct their attention to positive stimuli to cope with high anxiety. Although these children did not meet the diagnostic criteria for anxiety disorder in our study, they may have experienced more performance anxiety than healthy controls under experimental conditions due to the set shifting and self-regulation difficulties often seen in individuals with ASD. These relations should be further investigated in a larger sample in future studies.

Authors notes: This paper was produced from the master's thesis of the corrensponding author.

Acknowledgments: The authors sincerely thank the children who participated in the study and their parents for their contributions.

Funding: No funds, grants, or other support was received.

Competing interests: The authors have no relevant financial or non-financial interests to disclose.

Correspondence address: Res. Assis. Ata Canturk Dogrul, Hacettepe University, Department of Psychology, Ankara, Turkey dogrulata@gmail.com

REFERENCES

1. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders (5th edn). APA, 2013.

2. Nazeer A, Ghaziuddin M. Autism spectrum disorders: clinical features and diagnosis. Pediatr Clin North Am. 2012 ;59(1):19-25. doi:10.1016/j.pcl.2011.10.007

3. Wieckowski AT, Flynn LT, Richey JA, Gracanin D, White SW. Measuring change in facial emotion recognition in individuals with autism spectrum disorder: A systematic review. Autism. 2020;24(7):1607–28. doi:10.1177/1362361320925334

4. Carton JS, Kessler EA, Pape CL. Nonverbal decoding skills and relationship well-being in adults. J Nonverbal Behav. 1999;23(1):91–100. doi:10.1023/A:1021339410262

5. Rump KM, Giovannelli JL, Minshew NJ, Strauss MS. The development of emotion recognition in individuals with autism. Child Dev. 2009;80(5):1434–47. doi: 10.1111/j.1467-8624.2009.01343.x

6. Harms MB, Martin A, Wallace GL. Facial emotion recognition in autism spectrum disorders: a review of behavioral and neuroimaging studies. Neuropsychol Rev. 2010;20(3):290–322. doi:10.1007/s11065-010-9138-6

7. Wong N, Beidel DC, Sarver DE, Sims V. Facial emotion recognition in children with high functioning autism and children with social phobia. Child Psychiatry Hum Dev. 2012;43(5):775–94. doi:10.1007/s10578-012-02

8. Jones CRG, Pickles A, Falcaro M, Marsden AJS, Happé F, Scott SK, Sauter D, Tregay J, Phillips RJ, Baird G, Simonoff E, Charman T. A multimodal approach to emotion recognition ability in autism spectrum disorders. J Child Psychol Psychiatry. 2011;52(3):275–85. doi:10.1111/j.1469-7610.2010.02328.x

9. Bal E, Harden E, Lamb D, Van Hecke AV, Denver JW, Porges SW. Emotion recognition in children with autism spectrum disorders: relations to eye gaze and autonomic state. J Autism Dev Disord. 2010;40(3):358–70. doi:10.1007/s10803-009-0884-3

10. Cowen AS, Laukka P, Elfenbein HA, Liu R, Keltner D. The primacy of categories in the recognition of 12 emotions in speech prosody across two cultures. Nat Hum Behav. 2019;3(4):369–82. doi:10.1038/s41562-019-0533-6

11. Martins AT, Faísca L, Vieira H, Gonçalves G. Emotional Recognition and Empathy both in Deaf and Blind Adults. J Deaf Stud Deaf Educ. 2019;24(2):119–27. doi:10.1093/deafed/eny046

12. Rezlescu C, Penton T, Walsh V, Tsujimura H, Scott SK, Banissy MJ. Dominant voices and attractive faces: The contribution of visual and auditory information to integrated person impressions. J Nonverbal Behav. 2015;39(4):355–70. doi:10.1007/s10919-015-0214-8

13. Pell MD. Nonverbal emotion priming: Evidence from the 'Facial Affect Decision Task'. J Nonverbal Behav. 2005;29(1):45–73. doi:10.1007/s10919-004-0889-8,

14. Castro SL, Lima CF. Recognizing emotions in spoken language: A validated set of Portuguese sentences and pseudosentences for research on emotional prosody. Behav Res Methods. 2010;42(1):74–81. doi:10.3758/BRM.42.1.74

15. Paulmann S, Uskul AK. Cross-cultural emotional prosody recognition: evidence from Chinese and British listeners. Cogn Emot. 2014;28(2):230–44. doi:10.1080/02699931.2013.812033

16. Rosenblau G, Kliemann D, Dziobek I, Heekeren HR. Emotional prosody processing in autism spectrum disorder. Soc Cogn Affect Neurosci. 2017;12(2):224–39. doi:10.1093/scan/nsw1181.

17. Brennand R, Schepman A, Rodway P. Vocal emotion perception in pseudo-sentences by secondary-school children with Autism Spectrum Disorder. Res Autism Spectr Disord. 2011;5(4):1567–73. doi:10.1016/j.rasd.2011.03.002

18. Brooks PJ, Ploog BO. Attention to emotional tone of voice in speech perception in children with autism. Res Autism Spectr Disord. 2013;7(7):845–57. doi:10.1016/j.rasd.2013.03.003

19. Wang JE, Tsao FM. Emotional prosody perception and its association with pragmatic language in school-aged children with high-function autism. Res Dev Disabil. 2015;37:162–70. doi: 10.1016/j.ridd.2014.11.013,

20. de Gelder B, Vroomen J. The perception of emotion by ear and by eye. Cogn and Emot. 2000;14(3):289–311. doi: 10.1080/026999300378824

21. Borod JC, Pick LH, Hall S, Sliwinski M, Madigan N, Obler LK, Welkowitz J, Canino E, Erhan HM, Goral M, Morrison C, Tabert M. Relationships among facial, prosodic, and lexical channels of emotional perceptual processing. Cogn and Emot. 2000;14(2):193–211. doi: 10.1080/026999300378932

22. Philip RCM, Whalley HC, Stanfield AC, Sprengelmeyer R, Santos IM, Young AW, Atkinson AP, Calder AJ, Johnstone EC, Lawrie SM, Hall J. Deficits in facial, body movement and vocal emotional processing in autism spectrum disorders. Psychol Med. 2010;40(11):1919–29. doi:10.1017/S0033291709992364

23. Charbonneau G, Bertone A, Lepore F, Nassim M, Lassonde M, Mottron L, Collignon O. Multilevel alterations in the processing of audio-visual emotion expressions in autism spectrum disorders. Neuropsychologia. 2013;51(5):1002–10. doi:10.1016/j.neuropsychologia.2013.02.009

24. West MJ, Angwin AJ, Copland DA, Arnott WL, Nelson NL. Cross-modal emotion recognition and autism-like traits in typically developing children. J Exp Child Psychol. 2020;191:104737. doi:10.1016/j.jecp.2019.104737

25. Fazio RH, Sanbonmatsu DM, Powell MC, Kardes FR. On the automatic activation of attitudes. J Pers Soc Psychol. 1986;50(2):229–38. doi:10.1037/0022-3514.50.2.229

26. Carroll NC, Young AW. Priming of emotion recognition. Q J Exp Psychol A. 2005;58A(7):1173–97. doi:10.1080/02724980443000539

27. Hermans D, Baeyens F, Eelen P. Odours as affective-processing context for word evaluation: A case of cross-modal affective priming. Cogn and Emot. 1998;12(4):601–13. doi:10.1080/026999398379583

28. Kamio Y, Wolf J, Fein D. Automatic processing of emotional faces in high-functioning pervasive developmental disorders: An affective priming study. J Autism Dev Disord. 2006;36(2):155–67. doi:10.1007/s10803-005-0056-z

29. Clark TF, Winkielman P, McIntosh DN. Autism and the

extraction of emotion from briefly presented facial expressions: stumbling at the first step of empathy. Emotion. 2008;8(6):803–9. doi:10.1037/a0014124.

30. Pell MD, Jaywant A, Monetta L, Kotz SA. Emotional speech processing: Disentangling the effects of prosody and semantic cues. Cogn and Emot. 2011;25(5):834–53. doi:10.1080/02699931.2010.516915

31. West MJ, Copland DA, Arnott WL, Nelson NL, Angwin AJ. Effects of prosodic and semantic cues on facial emotion recognition in relation to autism-like traits. J Autism Dev Disord. 2018;48(8):2611–8. doi:10.1007/s10803-018-3522-0

32. Kaufman J, Birmaher B, Brent D, Rao U, Flynn C, Moreci P, Williamson D, Ryan N. Schedule for Affective Disorders and Schizophrenia for School-Age Children-Present and Lifetime Version (K-SADS-PL): initial reliability and validity data. J Am Acad Child Adolesc Psychiatry. 1997;36(7):980–8. doi: 00004583-199707000-00021

33. Gokler B, Unal F, Pehlivanturk B, Kultur E, Akdemir D, Taner Y. Reliability and validity of schedule for affective disorders and schizophrenia for school age children-present and lifetime version-Turkish version (K-SADS-PL-T). Turkish Journal of Child and Adolescent Mental Health. 2004;11:109-116.

34. Schopler E, Reichler RJ, DeVellis RF, Daly K. Toward objective classification of childhood autism: Childhood Autism Rating Scale (CARS). J Autism Dev Disord. 1980;10(1):91–103. doi:10.1007/BF02408436

35. İncekaş Gassaloğlu S, Baykara B, Avcil S, Demiral Y. Validity and reliability analysis of Turkish version of Childhood Autism Rating Scale. Turk Psikiyatri Derg. 2016;27(4):266–74. doi: 10.5080/u11197

36. Raven JC. Guide to Progressive Matrices (1938) (rev. ed.). London: HK Lewis, 1938/1956.

37. Düzen NE, Şahin N, Raven J, Raven CJ. Chapter 12: The Standard Progressive Matrices in Turkey. In Uses and Abuses of Intelligence: Studies Advancing Spearman and Raven's Quest for NonArbitrary Metrics (1st ed.), United Kingdom: Royal Fireworks Press, 2008, pp. 336-352.

38. Dunn LM. Peabody Picture Vocabulary Test. Circle Pines, MN: American Guidance Service ,1959.

39. Katz J, Önen F, Demir N, Uzlukaya A, Uludağ P. A Turkish Peabody Picture Vocabulary Test. Hacettepe University Journal of Social Sciences. 1974;6(1-2):129 – 140.

40. Pell MD. Evaluation of nonverbal emotion in face and voice: some preliminary findings on a new battery of tests. Brain Cogn. 2002;48(2–3):499–504.

41. Pell MD, Paulmann S, Dara C, Alasseri A, Kotz SA. Factors in the recognition of vocally expressed emotions: A comparison of four languages. J Phon. 2009;37(4):417–35. doi:10.1016/j.wocn.2009.07.005

42. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 2007;39(2):175–91. doi:10.3758/BF03193146

43. Kennedy DP, Adolphs R. Perception of emotions from facial expressions in high-functioning adults with autism. Neuropsychologia. 2012;50(14):3313–9. doi:10.1016/j.neuropsychologia.2012.09.038

44. Uljarevic M, Hamilton A. Recognition of emotions in autism: a formal meta-analysis. J Autism Dev Disord. 2013;43(7):1517–26. doi:10.1007/s10803-012-1695-5

45. Leung FYN, Sin J, Dawson C, Ong JH, Zhao C, Veić A, Liu F. Emotion recognition across visual and auditory modalities in autism spectrum disorder: A systematic review and meta-analysis. Dev Rev. 2022;63:101000. doi: 10.1016/j.dr.2021.101000

46. Schultz RT. Developmental deficits in social perception in autism: the role of the amygdala and fusiform face area. Int J Dev Neurosci. 2005;23(2–3):125–41. doi:10.1016/j.ijdevneu.2004.12.012

47. Schultz RT, Gauthier I, Klin A, Fulbright RK, Anderson AW, Volkmar F, Skudlarski P, Lacadie C, Cohen DJ, Gore JC. Abnormal ventral temporal cortical activity during face discrimination among individuals with autism and Asperger syndrome. Arch Gen Psychiatry. 2000 Apr;57(4):331-40. doi: 10.1001/archpsyc.57.4.331. PMID: 10768694.

48. Wang AT, Dapretto M, Hariri AR, Sigman M, Bookheimer SY. Neural correlates of facial affect processing in children and adolescents with autism spectrum disorder. J Am Acad Child Adolesc Psychiatry. 2004;43(4):481–90. doi: 10.1097/00004583-200404000-00015

49. Baron-Cohen S, Ring HA, Wheelwright S, Bullmore ET, Brammer MJ, Simmons A, Williams SCR. Social intelligence in the normal and autistic brain: an fMRI study. Eur J Neurosci. 1999;11(6):1891–8. doi:10.1046/j.1460-9568.1999.00621.x

50. Pierce K, Müller RA, Ambrose J, Allen G, Courchesne E. Face processing occurs outside the fusiform 'face area' in autism: evidence from functional MRI. Brain. 2001;124(Pt 10):2059–73. doi:10.1093/brain/124.10.2059

51. Black MH, Chen NTM, Iyer KK, Lipp OV, Bölte S, Falkmer M, et al. Mechanisms of facial emotion recognition in autism spectrum disorders: Insights from eye tracking and electroencephalography. Neurosci Biobehav Rev. 2017;80:488–515. doi:10.1016/j.neubiorev.2017.06.016

52. Leppänen JM, Hietanen JK. Positive facial expressions are recognized faster than negative facial expressions, but why? Psychol Res. 2004;69(1–2):22–9. doi: 10.1007/s00426-003-0157-2

53. Calvo MG, Beltrán D. Recognition advantage of happy faces: Tracing the neurocognitive processes. Neuropsychologia. 2013;51(11):2051–61. doi: 10.1016/j.neuropsychologia.2013.07.010

54. Prehn-Kristensen A, Lorenzen A, Grabe F, Baving L. Negative emotional face perception is diminished on a very early level of processing in autism spectrum disorder. Soc Neurosci. 2019;14(2):191–4. doi:10.1080/17470919.2018.1441904

55. Dijksterhuis A, Smith PK. Affective habituation: Subliminal exposure to extreme stimuli decreases their extremity. Emotion. 2002;2(3):203–14. doi:10.1037/1528-3542.2.3.203

56. Leventhal AM, Martin RL, Seals RW, Tapia E, Rehm LP. Investigating the dynamics of affect: Psychological mechanisms of affective habituation to pleasurable stimuli. Motiv and Emot. 2007;31(2):145–57. doi:10.1007/s11031-007-9059-8

57. Rieth CA, Huber DE. Priming and habituation for faces: Individual differences and inversion effects. J Exp Psychol Hum Percept Perform. 2010;36(3):596–618. doi:10.1037/a0018737