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## Broad autism phenotype: theory of mind and empathy skills in unaffected siblings of children with autism spectrum disorder

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### ABSTRACT

**OBJECTIVE:** Difficulties in social communication is core symptoms of autism spectrum disorder (ASD), and it is often present in first-degree relatives in varying degrees. However, these subclinical autistic traits, which are thought to be related to genetic susceptibility factors, may be heterogeneous in family members. This prospective, the aim of this study was to compare unaffected siblings of children with ASD in terms of theory of mind, empathy skills, and broad autism phenotype (BAP).

**METHODS:** Forty-one children who were diagnosed Autistic Disorder, Asperger Disorder and Pervasive Developmental Disorder-not otherwise specified according to Diagnostic and Statistical Manual of Mental Disorders, 4th Edition and their unaffected siblings and 43 controls of typically developing children were included. The Schedule for Affective Disorders and Schizophrenia for School-age Children – Present and Lifetime Version was conducted all children with the aim of excluding a psychiatric diagnosis. False-belief tasks and Emotion Recognition Scales were used to evaluate theory of mind and empathy skills. The Social Communication Questionnaire was administered by the clinician in order to evaluate subthreshold autistic symptoms.

**RESULTS:** Unaffected siblings of ASD children exhibited worse performance in theory of mind and emotion recognition tasks. Additionally, these children had more autistic symptoms and there was a correlation with autism symptoms and social cognition tasks.

**DISCUSSION:** In compatible with BAP, the results indicated that the siblings of children with ASD showed a neurocognitive profile associated with ASD at a slight level, and they had more subsyndromal autism symptoms compared with healthy children. The findings also indicated that there was a weakness in skills of empathy and theory of mind ability of siblings of ASD.

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Autism spectrum disorder;  
siblings; theory of mind;  
empathy; social skills

## Introduction

Autism spectrum disorders (ASD) are neuropsychiatric disorders that start in the first years of life and are observed in the form of deficit in reciprocal social interaction and communication, stereotypical behaviours, and limited areas of interest [1]. It was considered rare in the period when it was first identified. In recent years, it was estimated that average ASD prevalence ranged between 0.8% and 1.6% [2] and the ratio of males to females was 4:1 [3]. To date, various different factors have been proposed to explain the etiopathogenesis of autism, but a distinct prenatal or postnatal cause has yet to be determined. Studies of twins indicated high inheritance in ASD [4]. Although genetic bases of this disorder have become definite, it is still not known how there is a genetic transition. This may result from the clinical and etiologic heterogeneity of ASD.

There is an increase in the number of typically developing children with a sibling identified as being

on the ASD in recent years. Studies of families and twins indicated that there may be behavioural phenotypes that qualitatively resemble the core symptoms but are defined more broadly in relatives of individuals with ASD compared with the general population [5]. In other words, it was thought that some familial characteristics observed in the relatives of children with ASD may reflect slight phenotype expressions [6]. In the literature, subclinical features seen in the relatives of individuals with ASD have been described as broad autism phenotype (BAP) [7]. BAP has gathered pace with evaluations conducted on relatives of individuals with ASD. The features of BAP consist of social skills, communication, and repetitive stereotype behavioural patterns in parallel with the core symptoms of ASD. As in ASD, BAP features are seen more frequently in male relatives [5, 8–10]. It was reported that ASD-like symptoms were seen in 25% of first-degree relatives of children with autism [11]. Additionally, there is a significant heterogeneity of subclinical autistic

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traits among family members of the individual with ASD [12].

In a prospective study of unaffected siblings of children with ASD and children who had no history of ASD in their families, it was stated that children who had siblings with ASD showed autism symptoms at significantly higher levels in the 12th-month compared with the control group [13]. It was also shown in evaluations of the same groups made at age 3 years that siblings had much greater social communication deficit, lower cognitive skills, and far more internalizing problems compared with the control group [13].

One of the most significant risk factors in unaffected relatives of children with ASD is social cognition deficit [14]. Social cognition is defined as the mutual interaction of cognition and social behaviour, and it is related to specific brain networks, the medial frontal cortex, temporoparietal junction, superior temporal sulcus, and temporal poles [15]. Emotion recognition is an important aspect of social cognition. It was shown that there was an inability to recognize emotions in unaffected first-degree relatives of children with ASD [16,17].

Deficit of theory of mind (ToM) is one of the basic problems in ASD. ToM abilities refer to an awareness of the fact that human behaviours result from implicit mental states that are not always compatible with objective reality [18]. Even though it was considered that genetic and environmental factors might be effective, it was shown in a study of healthy siblings of children with ASD and siblings of healthy children that there was no difference between the groups in terms of ToM skills [19]. This finding was contra to the observations of ToM inability in parents of children with Asperger syndrome [20]. Although there are studies investigated autistic traits, social cognition, and ToM skills in parents of children with ASD, very few studies in the literature concerning the evaluation of unaffected siblings terms of ToM skills and emotion recognition.

The aim of this study was to compare the unaffected siblings of children with ASD with healthy children in terms of ToM, empathy skills, and BAP. Among our hypotheses was that siblings of children with ASD would have difficulty in ToM and empathy skills, and would show subclinical autism symptoms. We thought that these children would have more difficulty in ToM and empathy skills as autism symptoms increased. To our knowledge, no studies have evaluated unaffected siblings of children with ASD in this regard in Turkey.

## Methods

### Design, setting, and recruitment

It was determined that 49 children who were diagnosed as having ASD between September 2013 and March

2014, and followed up Dokuz Eylül University Faculty of Medicine outpatient clinic of Child and Adolescent Psychiatry Department, had 49 siblings aged 8–18 years. ASD was diagnosed from child and adolescent psychiatrist in accordance with the criteria of the text revised Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV-TR). In determining process all family were informed and asked to participate in the study. Six of the 49 siblings were excluded from the study group because their families rejected participation in the study, and 2 were excluded because they were assessed as having a psychiatric disorder. Forty-one children who met the inclusion criteria and accepted to participate were included in the study. Twenty-three of the children with ASD had an autistic disorder, 3 children had Asperger syndrome, and 16 children had pervasive developmental disorder-not otherwise specified (PDD-NOS). The inclusion criteria of the study group were as follows: (1) normal intelligence quotient level clinically; (2) aged between 8 and 18 years; (3) having siblings with an autistic disorder, Asperger syndrome or PDD-NOS as per the diagnostic criteria of DSM-IV-TR; (4) the sibling with ASD had no genetic disorder; (5) the children and their parents voluntarily accepted to participate in the study. To determine genetic disorder in ASD children, paediatric neurology consultation was requested for all children. Non-ASD siblings who were diagnosed as having an axis I psychiatric disorder in accordance with the DSM-IV-TR criteria were excluded from the study. In the study group, all children with ASD were taken from simplex family.

Fifty children aged between 8 and 18 years who were healthy in terms of general medicine were identified for the control group and evaluated for psychiatric disorders and any chronic medical disease. Five of the 50 children were excluded from the study because their families rejected participation in the study, 1 was excluded because an axis I disorder was diagnosed, and 1 was excluded because their mental capability was evaluated as low according to the clinical observation. It was also asked for family history of ASD to parents of the comparison group.

After taking the inclusion and exclusion criteria into consideration, a total of 84 children-adolescents and their families were included in the study. Ethics committee approval was granted by local Ethical Committee.

### Procedure

With the aim of excluding any psychiatric disorders that may be present, the Schedule for Affective Disorders and Schizophrenia for School-age Children – Present and Lifetime Version (K-SADS-PL) was used in all children. The diagnosis interview was made with the children with ASD and their parents by a physician and the Childhood Autism Assessment

Scale form was completed after the interview. The parents were interviewed in order to evaluate subthreshold autistic symptoms by a physician and the Social Communication Questionnaire (SCQ) was administered. False-Belief tests, and Comprehension Test (CT) and Unexpected Outcomes Test (UOT) as part of the Emotion Recognition Scales were applied to the study and control group with the aim of evaluating the ToM and empathy skills. Written informed consent was acquired from all parents and children.

## Measures

### *The Schedule for Affective Disorders and Schizophrenia for School-age Children – Present and Lifetime Version*

K-SADS-PL is a semi-structured interview form designed for the identification of past or present psychopathologies of children and adolescents in accordance with the diagnostic scales of DSM-III-R and DSM-IV [21]. The form consists of three sections: sociodemographic data are questioned in the first section, psychiatric symptoms in the past and present are questioned in the second section, and general functioning of children is evaluated in the third section. Affective disorders, psychotic disorders, anxiety disorders, elimination disorders, disruptive behaviour disorders, alcohol and substance use disorders, eating disorders and tic disorders may be evaluated during the interview. The Turkish translation of K-SADS-PL and validity and reliability were performed previously [22].

### *The Childhood Autism Rating Scale*

The Childhood Autism Rating Scale (CARS) is widely used in the diagnosis of autism and the distinction of these children from children with other developmental disorders. The scale is filled based on data obtained in the interview with the family and through observation of the child. The Turkish validity and reliability study of the scale has been conducted and the cut-off score was determined as 30 [23]. Additionally, the Cronbach's alpha value of total score of the scale was determined as 0.95 [23]. Test-retest reliability ( $r = 0.98$ ,  $p < .01$ ) and inter-rater reliability ( $r = 0.97$ ,  $p < .01$ ) were determined for total score of the scale [23].

### *Social Communication Questionnaire*

SCQ is a 40-item scale that investigates autistic symptoms and is completed by the primary caregiver. The SCQ may be applied to all individuals whose chronological ages are 4 years and over provided that their mental ages are at least 2 years [24]. The Turkish validity and reliability study of the scale has been conducted and the cut-off score of the Turkish version was

determined as 15 [25]. The Cronbach's alpha value for the total score of the scale was 0.80 [25]. The intra-class correlation coefficient, which is conducted to assess test-retest reliability of scale, varied between 0.87 and 0.96 ( $p < .0001$ ) [25].

## Emotion Recognition Scales

### *Comprehension Test*

CT is an 11-item test that was developed for evaluating the skill of a person in estimating emotional responses given in a case or condition [26]. The items were created by sampling from emotions and affective causes. The emotions in the items consist of anger, fear, disgust, astonishment, worry, exultation, belittlement, social varieties of basic emotions (pride, shame, pity, and embarrassment), and a variety of intensities of basic emotions (such as the difference in horror and fear). According to pilot studies that were conducted on young children, adolescents, and adults, it was determined that CT had an acceptable internal consistency (Cronbach's  $\alpha = 0.85$ ) [27]. Inter-rater reliability of scale was determined ( $r = 0.84$ ) [26]. The responses were scored between 0 and 2 and the total scores were calculated as 0–24.

### *Unexpected Outcomes Test*

The UOT is a 12-item measure of reasoning about the emotional states of others, which is essentially related to empathic ability [27]. UOT items define a situation that causes an emotional response in a character of a story, but the emotional response is unexpected and incompatible with the content, which leads to the emotion. The person to whom the test is applied is requested to give additional situational information to resolve the distinct incompatibility. According to pilot studies conducted on adolescents and adults, it was determined that UOT had an acceptable internal consistency (Cronbach's  $\alpha = 0.82$ ) [27]. Inter-rater reliability of scale was determined ( $r = 0.85$ ) [26]. The responses were scored between 0 and 2 and total scores were calculated as 0–24.

### *ToM tasks*

False-belief tests were primarily developed by Wimmer and Perner with the aim of evaluating ToM [28]. Baron-Cohen et al. produced another version of this test named "Sally and Ann" [29]. In our study, the false-belief tests that evaluate first- and second-order ToM skills were used. For first-order ToM skills, a character in a story has a false belief relevant to a situation, and for second-order skills, the character has a false-belief relevant to the belief of somebody else. In both false-belief tests, there are questions of reality relevant to each story, a memory question, and a question of ToM investigating the false belief of a character

about another character [30]. Dolls and some other visual materials were used to present the action sequences in the stories.

### Sociodemographic data form

This form was created by the authors based on the literature with the aim of collecting information of the socio-demographic characteristics of children and adolescents. In the form, there are questions investigating information regarding age, sex, age of sibling with ASD, socio-economic level, academic status, and family.

### Statistical analyses

The data were evaluated using the IBM SPSS statistics software version 22. The measured variables were expressed as mean  $\pm$  standard deviation and the categorical variables defined as percentage and number. The distribution of numeric variables was evaluated using the Kolmogorov–Smirnov test and by evaluating histograms. The comparison of normal distribution of numeric variables was evaluated using the Student's *t* test, and non-normally distributed numeric variables were evaluated using the Mann–Whitney *U* test. The categorical variables were evaluated using the Pearson's Chi-square test and the Fisher's exact test. The Pearson's test was used to identify the direction and level of the association in numeric variables, and the Spearman's correlation test was used for non-normally distributed numeric variables. Effect size was measured with Cohen's *d*. Cohen's *d*-values of 0.2 or below reflect a small effect size, around 0.50 reflect a moderate effect size, and 0.80 and above reflect a large effect size [31].

**Table 1.** Sociodemographic attributes.

	Study group ( <i>n</i> = 41)	Control group ( <i>n</i> = 43)	<i>p</i>
Age (mean $\pm$ SD)	12.2 $\pm$ 2.8	12.3 $\pm$ 2.8	.684 <sup>a</sup>
Sex			
Male	20 (48.8%)	22 (51.2%)	.827 <sup>b</sup>
Female	21 (51.2%)	21 (48.8%)	
Educational level			
Primary school	29 (70.7%)	28 (65.1%)	.528 <sup>b</sup>
High school	12 (29.3%)	15 (34.9%)	
Academic success			
Very good	27 (65.9%)	24 (55.8%)	.681 <sup>b</sup>
Good	13 (31.7%)	18 (41.9%)	
Average	1 (2.4%)	1 (2.3%)	
Age of mother (mean $\pm$ SD)	38.5 $\pm$ 5.6	40.4 $\pm$ 5.2	.171 <sup>a</sup>
Marriage age of mother (mean $\pm$ SD)	22.8 $\pm$ 3.9	23.1 $\pm$ 4.7	.925 <sup>a</sup>
Age of father (mean $\pm$ SD)	43.6 $\pm$ 6.7	44.9 $\pm$ 5.3	.195 <sup>a</sup>
Marriage age of father (mean $\pm$ SD)	27.9 $\pm$ 5.1	27.6 $\pm$ 4.1	.861 <sup>a</sup>
Marital status			
Together	40 (97.6%)	40 (93%)	.616 <sup>b</sup>
Divorced/living separate	1 (2.4%)	3 (7%)	
Family income (mean $\pm$ SD) TL	3550 $\pm$ 2864	3551 $\pm$ 2895	.871 <sup>a</sup>

Note: TL: Turkish Lira

<sup>a</sup>Mann–Whitney *U* test.

<sup>b</sup>Chi-square test.

The value of statistical significance was determined as  $p < .05$ .

### Results

The mean age was 12.2  $\pm$  2.8 years in the study group and 12.3  $\pm$  2.8 years in the control group. The study group consisted of 48.8% boys (*n* = 20) and 51.2% girls (*n* = 21); the control group comprised 51.2% boys (*n* = 22) and 48.8% girls (*n* = 21). No statistically significant difference was determined between the study and control groups in terms of age, sex, educational level, academic success, age of parents and their ages at the time of marriage, marital status of parents, educational level and occupational status of parents, and family income ( $p < .05$ , Table 1).

The total score of SCQ was 4.82  $\pm$  2.84 in the study group, and 0.67  $\pm$  0.86 in the control group. It is thought that the relevant function area was problematic when the SCQ scores increased. The scores of SCQ were compared using the Mann–Whitney *U* test because there was no normal distribution. The higher scores of SCQ in the study group were statistically significant (Mann–Whitney *U* test,  $z = -6.46$ ,  $p < .0001$ , Cohen's *d* = 1.97).

A statistically significant difference was determined between the study and control groups in terms of total scores of CT and UOT (Table 2). In CT and UOT, the responses given by the study and control groups were evaluated by two blinded physicians as *appropriate*, *response given but insufficient*, and *not appropriate*. Two points were given to questions evaluated as “appropriate,” 1 point was given to questions evaluated as “response given but insufficient,” and 0 was given to questions evaluated as “not appropriate.”

The first- and second-order false-belief tests consisted of three questions; the question of reality relevant to the story told by the practitioner, the memory question, and the question of belief. The responses given by the study and control group were evaluated as *true* or *false*. One point was given for true responses and wrong responses were scored as 0. First-order, second-order, and total scores of the study group were significantly lower (Table 3).

In the study group, there were no significant gender differences in scores of ToM and Emotion Recognition Scales ( $p > .05$ ).

**Table 2.** Comparison of Perception Test and UOT total scores.

	Study group ( <i>n</i> = 41) Mean $\pm$ SD	Control group ( <i>n</i> = 43) Mean $\pm$ SD	Effect size (Cohen's <i>d</i> )	<i>p</i>
Comprehension Test	10.7 $\pm$ 2.6	14 $\pm$ 2.3	1.37	<.001
Unexpected Outcomes Test	11.4 $\pm$ 3.3	16.4 $\pm$ 2.0	−1.78	<.001

Note: Student's *t* test.

## Correlations

In order to assess relation between subclinical autistic traits and social cognition in the study group, the correlations between total scores of SCQ and emotion recognition scales and ToM tasks were examined via Spearman's correlation test. A statistically significant correlation was determined in the study group in terms of SCQ scores, CT, UOT, and ToM tasks (Table 4).

## Discussion

This exploratory study was the first to examine ToM and emotion recognition together in siblings of children with ASD. In this paper, the findings indicated that this specific group of children, who had no psychiatric disorders, showed more subthreshold autism symptoms compared with healthy children, and there was also a weakness in their skills of empathy and ToM.

In our study, SCQ, which is an efficient instrument for measuring autistic symptoms, was used to evaluate subthreshold autism symptoms in the two groups. The total SCQ score of the study group was significantly higher. In a study that compared healthy brothers of children with ASD with a control group, Social Responsiveness Scale (SRS) scores of the brothers were determined as significantly higher [32]. In that paper, the higher SRS scores of the brothers led the authors to propose that specific genes that cause ASD in these children may lead to social disabilities more commonly, even if no ASD has been diagnosed [32]. In a study, which is conducted in Turkey, the parents of children with ASD and parents of typically developing children were assessed in terms of subclinical autistic traits and results showed that parents of children with ASD had high scores in Autism Spectrum Quotient (AQ) [12]. Another study from Turkey showed that parents of children with ASD had higher scores in social skills subscale of AQ, but not in total score [33]. The findings in our study are compatible with the findings of previous studies [10,32,34–36], which indicated that quantitative autistic characteristics increased in first-degree relatives of children with ASD.

In another study that aimed to define BAP in the early developmental period, the 6-month-old infant siblings of children with ASD smiled at their parents

less per day compared with the siblings of healthy children [37]. In the same study, it was also determined that these children reacted to common attention stimuli later when aged 18 months, and the common attention starting ratios of these children in their 15th-month were lower [37]. In our study, the SCQ lifetime form was used. When one considers that the SCQ lifetime forms were completed based on the whole developmental story of the individuals, it may be said that SCQ scores of unaffected siblings of children with ASD were higher in the pre-school period compared with healthy children, and autism symptoms were much more frequent in these children in the early period.

The higher ratio of physical morphologic differences in healthy siblings of children with ASD [38] supports the view that the genetic constitution associated with ASD is transferred to siblings in another way, and this transfer manifests itself with both physical properties and subthreshold psychosocial symptoms. Even if the mechanism of this genetic transfer is not known completely, future familial studies will help to find more enlightening data on this subject. The findings in our study support the view that the siblings of children with ASD have difficulties in the social arena, even if the sibling with ASD does not meet ASD and other psychiatric disorders criteria. It was thought that the genetic constitution of ASD created a genetic vulnerability in the siblings of these children, which caused subthreshold symptoms.

ToM skills are insufficient in children with ASD and there are findings in the literature concerning the genetic basis of this skill; accordingly, this skill in the siblings of children with ASD was evaluated in our study. The siblings of children with ASD gave significantly more wrong responses to both first- and second-order false-belief tests. It was also determined that total ToM skill scores of these children were significantly lower compared with the control group. This finding suggests that there is an inability in ToM skills of siblings of children with ASD. When reviewed in terms of development, ToM skills occur approximately at the age of 5 years [39]. The lower age limit of our study and control group included was determined as 8 years and it was expected that the ToM skills of these healthy children in both the groups should be developed. Baron-Cohen and Hammer stated that the

**Table 3.** Comparison of theory of mind scores in the study and control group.

	Study group (n = 41) Mean ± SD	Control group (n = 43) Mean ± SD	Effect size (Cohen's <i>d</i> )	<i>p</i> <sup>a</sup>
First-order ToM	2.6 ± 0.6	2.9 ± 0.2	0.67	.021
Second-order ToM	2.5 ± 0.6	2.8 ± 0.3	0.63	.009
Total ToM	5.1 ± 1.1	5.7 ± 0.5	0.7	.02

<sup>a</sup>Mann-Whitney *U* test.

**Table 4.** The correlation of SCQ and Emotion Recognition Scales and theory of mind tasks in the study group.

	Social Communication Questionnaire	
	rho <sup>a</sup>	<i>p</i>
Comprehension Test	-.406	<0.001
Unexpected Outcomes Test	-.519	<0.001
Total ToM Scores	-.358	0.011

<sup>a</sup>Spearman's correlation analysis.

parents of children with Asperger syndrome had difficulty in ToM tests compared with the parents of healthy children [20]. In contrast, Ozonoff et al. compared the healthy siblings of children with autism with the healthy siblings of children with learning disorders; no significant difference was determined between the two groups in terms of ToM tests [40]. Our study is compatible with a study conducted on the first-degree relatives of children with autism in which difficulties in ToM skills were reported in the parents of these children [20]. When it is also assumed that ToM skills and social cognition are correlated, these persons may have difficulties in interpersonal relations, daily activities, and understanding complicated social situations in their lives; therefore, their interpersonal interactions may be adversely affected.

There is increasing recent evidence to show that autism is a disorder characterized by inability in empathy skills, as well as ToM [27]. It was shown that the emotion recognition skills of children who had autism and other pervasive developmental disorders were also insufficient [41]. Furthermore, children with high functional autism showed less inability in the emotion recognition skills compared with those with low function [42], and the siblings of children with autism showed an inability in emotion recognition skills compared with the control group [43]. In a study that included siblings of children with Asperger syndrome, eye tests were used to evaluate empathy skills/social cognition, and it was determined that they showed significantly worse performance compared with the control group [44].

In our study, it was thought that there was an inability in the empathy skills of siblings of children with ASD, as well as a defect of ToM, because there was a significant difference between the study and control group in both ToM tasks and emotion recognition tests.

Although results of SCQ, ToM, and Emotion Recognition Scales were significant between the two groups, we did not find any gender differences in the study group. This finding seems contra with previous studies which stated BAP features are seen more frequently in male relatives [5, 8–10]. This may be due to small sample size of study group when divide it as a male and female.

Despite the fact that the intelligence levels of these children were not measured, all children were included by considering factors such as clinical observation and educational success, and we tried to minimize the effect of intelligence level on emotion recognition skills. Even if it was stated in studies that ToM ability was damaged in schizophrenia and emotion recognition skills were not exclusive to autism, the measurement of both ToM and emotion recognition skills may be a useful tool to evaluate developmental levels and social cognition of children with ASD and their first-degree relatives, and may also be specific to this group.

The limitations of the study should also be considered in the evaluation of our findings. First, due to the relatively small sample size, and second, the intelligence level of the children was not measured with a psychometric test.

Consequently, we suggest that unaffected siblings of children with ASD have difficulties in emotion recognition and theory of mind abilities. Additionally, it may be thought that those children showed a neurocognitive profile associated with ASD at a slight level. The correlation of SCQ scores with social cognition tasks showed the profile of these children was correlated with BAP. As a future direction, it is important to investigate genetic and neurobiological markers, which may be associated with BAP cluster among families of individuals with ASD.

### Disclosure statement

No potential conflict of interest was reported by the authors.

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