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Emotion Recognition Skill in Specific Learning Disorder and Attention-Deficit Hyperactivity Disorder

ABSTRACT

Objective: Social difficulties can affect both academic and relational-social functioning in common neurodevelopmental disorders such as attention-deficit hyperactivity disorder and specific learning disorder. It is known that social cognitive skills directly affect social functioning. The aim in this study is to examine the social cognitive skill of facial emotion recognition in children with attention-deficit hyperactivity disorder and specific learning disorder and to investigate whether literacy learning is related to emotion recognition.

Methods: In the study, we compared the emotion recognition skill of 41 children with attention-deficit hyperactivity disorder, 50 with specific learning disorder, and 43 typically developed children using the Reading Mind in the Eyes Test. In addition, we evaluated the relationship between children's emotion recognition ability and literacy learning time.

Results: Attention-deficit hyperactivity disorder and specific learning disorder groups did not show a statistically significant difference in terms of Reading Mind in the Eyes Test scores, but both groups had lower scores than their typically eveloped peers ($P < .001$). In addition, we found that low Reading Mind in the Eyes Test scores were associated with late learning in reading and writing ($P < .001$, $r = -.033$).

Conclusion: This study found that the specific learning disorder and attention-deficit hyperactivity disorder groups showed similar but poorer impact recognition skills than their typically developed peers. In addition, we showed that literacy learning speed is related to emotion recognition.

Keywords: Attention-deficit and hyperactivity disorder, emotion recognition, specific learning disorder

Introduction

In recent years, research on facial emotion recognition (ER), which is one of the social cognition skills in children and adolescents, has found more place in the literature.[1-4] Emotion recognition skills have an important place in the emotional and social development of children and are related to social functionality.[1] Understanding facial expression is essential to accurately interpreting the person being communicated with, to be able to direct their actions based on that information, and to respond appropriately in social situations.[5] Therefore, deficiencies in ER may put the child and adolescent in a difficult situation psychosocially.[1] Deficiency in ER skills is typically observed in individuals with autism spectrum disorder (ASD).[6] Studies show that deficits in social cognitive skills such as ER may also be present in neurodevelopmental disorders other than autism.[2-4] Neurodevelopmental diseases are discussed with the concept of neurodiversity in the current literature.[7,8] The overlaps in the similar etiological origins and symptom clusters of these diseases and the fact that developmental changes are thought to be lifespan development form the basis for this concept.[7,8] Attention-deficit hyperactivity disorder (ADHD) has been a disease that has been more studied and considered with ASD in this concept.[8] The ER skill, which is also the subject of our study, is one of the areas that can be regarded as the symptom intersection cluster for ASD and ADHD. Attention-deficit

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hyperactivity disorder is a chronic neurobiological disorder characterized by attention deficit, hyperactivity, and impulsivity that are inappropriate for the developmental level of the individual.[9] Functional disabilities in social, academic, and familial aspects have been observed in children diagnosed with ADHD.[9] Within this wide spectrum of symptoms, social incompetence is significant, such as not being able to listen to the other person, interrupting frequently, initiating speech at inappropriate times, not continuing with the appropriate subject, and difficulties in friendships.[9] Numerous studies have found a lower ability to understand emotions from the faces of others in children diagnosed with ADHD compared to their typically developing peers.[3,4] There are various studies that focus on the neurobiological factors of the weakness of ER skills in children with ADHD.[10,11] Executive function deficiencies such as working memory deficits are studied in this regard.[12] However, functional deficits in the anterior cingulate cortex and medial prefrontal cortex areas, which are thought to be responsible for forming representations about the mental states of others, are also possible topics of discussion in terms of neurobiological origin.[10,11] In specific learning disorder (SLD), another neurodevelopmental disorder that is also diagnosed frequently, we have much more limited information about ER skills. Specific learning disorder is characterized by the individual having lower academic skills than is appropriate for their age and development and involves a wide range of effects, including deficiencies in reading and writing, calculation, visuospatial abilities, and motor coordination.[2] In studies examining the social cognitive skills of children with SLD, it has been found that these children had a poorer understanding of non-verbal cues and empathy skills than their typically developed (TD) peers.[13] In the limited number of studies focusing on facial ER, it has been observed that the ability of children with SLD to understand emotions from the faces of others is less than the developmentally expected level.[2] Some issues related to executive functions, such as visual perceptual processing defects, symbolic processing defects, and cognitive differences, may cause difficulties in perceiving and processing facial emotions in this group of children.[2] Indeed, difficulties in perceiving visual cues and processing and integrating information affect facial ER.[14]

In ADHD and SLD, which are common neurodevelopmental diseases, ER skill deficiencies can increase the social and emotional difficulties that children currently face in their daily lives.[1,2,13] Considering that both maintaining peer relations and academic skills require being able to establish social relations, not being able to understand what the other person is feeling or thinking correctly will put the child at a disadvantage in this regard.

This research aimed to examine how facial ER differs in children with SLD and ADHD compared to their TD peers.

MAIN POINTS

- *Children with specific learning disorder (SLD) and attention-deficit hyperactivity disorder (ADHD) have statistically significantly poorer emotion recognition than their typically developing peers.*
- *There was no difference in emotional recognition skills between children with SLD and ADHD.*
- *Poor emotion recognition was correlated with poor literacy learning skills.*

As far as we know, there is no study in the literature comparing SLD and ADHD in the context of facial ER. Attention-deficit hyperactivity disorder is a group that has been studied more in terms of ER, and we predict that it will be poorer than their peers.[1,3] In the light of the literature, we thought that we would obtain similar results in children with SLD, which is a less studied disorder in terms of ER, than in children with ADHD. As the first hypothesis of our study, we thought that the facial ER skills of children with neurodevelopmental disorders SLD and ADHD would be similar but worse than their TD peers. It is known that the most common problem in SLD is below what is expected for their age in terms of academic skills. It is discussed in the literature that the ability to understand emotions can be effective in academic development.[15,16] Research shows that learning may be about understanding the other person's feelings and thoughts.[15,16] Our second hypothesis is that for individuals who have difficulty recognizing facial emotions, the time to learn to read and write will be slower.

Methods

Participants

The participants in the study were volunteer participants aged 6–14 years old who applied to Cerrahpaşa Faculty of Medicine Child and Adolescent Psychiatry Outpatient Clinic. The study was approved by the ethics committee of Cerrahpaşa Faculty of Medicine (February 8, 2017-52674). In the first stage, 81 children diagnosed with SLD, 72 children diagnosed with ADHD, and 44 TD children after clinical interview in the child and adolescent psychiatry outpatient clinic were included. Wechsler Intelligence Scale for Children-Revised (WISC-R) was applied to children with SLD during the diagnosis process, and children with a total score of 85 and above were included in the initial evaluation. In the ADHD and TD groups, children who were thought to have normal mental development based on clinical interview and anamnesis from their parents were included. The purpose of the research was explained to the parents and children, and they were included if they agreed to participate in the study. Informed consent was obtained from the parents and children who agreed to participate. A semi-structured diagnostic interview, the Kiddie Schedule for Affective Disorders and Schizophrenia (K-SADS), was conducted with parents and children. The parents who filled out the sociodemographic data form for the participants were deemed suitable for inclusion, and the Child Version of Reading Mind in Eyes Test (RMET) was administered to the children by the researcher. Intellectual disability, autism spectrum disorder, mood disorder, psychosis, anxiety disorder, depressive disorder, eating disorder, and obsessive-compulsive disorder were used as exclusion criteria, because these disorders may affect facial ER.[17] In addition, children with chronic physical diseases, such as epilepsy and syndromic diseases, were excluded from the study sample.

Based on the diagnostic interviews conducted in the SLD group, 15 children with ADHD comorbidity, 7 children with other psychiatric comorbidities, and 3 children with chronic physical diseases were excluded from the sample. Thirteen children with comorbid psychiatric disorders and 5 children with chronic physical diseases in the ADHD group were also excluded from the study statistics. During the RMET, the data of 4 children from the SLD group, 8 from the ADHD group, and 1 from the healthy control group were not included in the statistical calculation in order not to affect the reliability of the study since they scored below 9 points. Two cases from

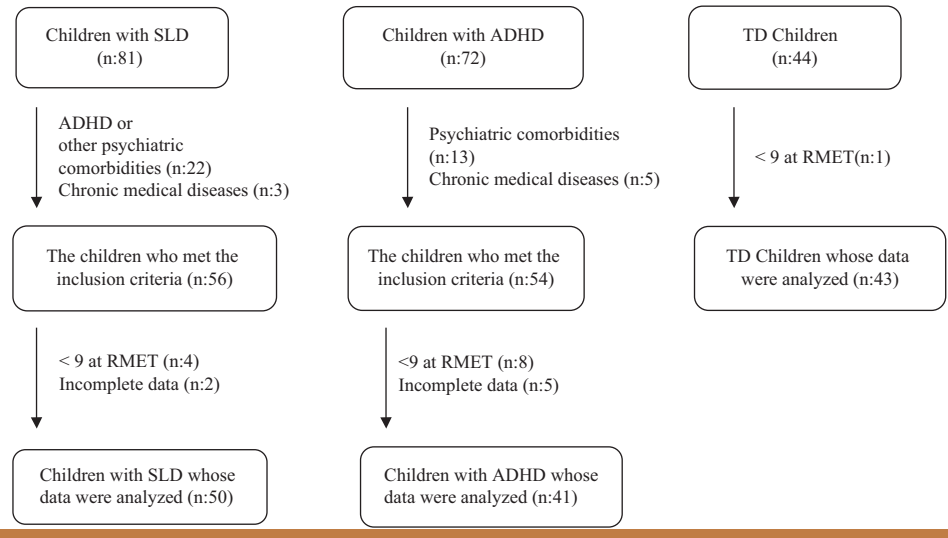

Figure 1. Data collection and exclusion flowchart.

the SLD group and 5 cases from the ADHD group with incomplete data were excluded from the study. Sample statistics were carried out for 50 SLD participants, 41 ADHD participants, and 43 TD healthy controls (Figure 1).

Materials

Sociodemographic Data Form: Using the sociodemographic data form created by the researchers, information regarding the age and gender of the child, the time taken to learn to read and write, the ages and education levels of the parents, and family income was collected.

Schedule for Affective Disorders and Schizophrenia for School-Age Children (6-18 Years)-Present and Lifetime Version, the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, K-SADS-PL-DSM-5: The K-SADS-PL is a semi-structured interview chart that is used to evaluate psychiatric symptoms in children and adolescents and to determine their past and current psychopathology. The Affective Disorders and Schizophrenia Interview Schedule, first prepared by Chambers et al[18], was arranged by Kaufman et al[19] as the "Present and Lifetime version" according to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition diagnostic criteria. Additionally, the interview is valid and reliable for Turkish.[20] It was seen that the concordance of the diagnoses made with the interview with the K-SADS was very good in terms of eating disorders, selective mutism, and autism spectrum disorders ($\kappa = 0.92$-1.0), good in terms of obsessive-compulsive disorder, oppositional/defiant disorder, social anxiety disorder, generalized anxiety disorder, depressive disorders, destructive mood dysregulation disorder, and ADHD ($\kappa = 0.67$-0.80). Inter-rater reliability was very good ($\kappa = 1.0$) for selective mutism, good for oppositional/defiant disorder, disruptive mood dysregulation disorder, ADHD, and depressive disorders ($\kappa = 0.63$-0.73). Test–retest reliability was also found to be very good for autism spectrum disorders ($\kappa = 0.82$) and good for ADHD, oppositional/defiant disorder, generalized anxiety disorder, and depressive disorders ($\kappa = 0.62$-0.78).

Reading Mind in Eyes Test: The RMET, also known as the Eyes Test, was developed by Baron-Cohen et al.[21] The eye test is thought to be able to measure the theory of mind as it requires the subject to understand "mental states" and match them to the eyes, which are part of the face. The test comprises pictures of the eyes and eye circles of female and male actors; for each item, there are words referring to 4 mental and emotional states. Three of the 4 words are distractors, and one is the correct answer. The subject is asked to look at the photograph and determine which word out of 4 describes what the person in the photograph is thinking or feeling. The choice includes basic emotions such as happy, sad, angry, or afraid, as well as more "complex" emotions such as arrogance, suspicion, and planning. Baron-Cohen also created a children's version of the Eye Test consisting of 28 pictures. The expressions of emotion in this test, which consists of 25 photographs selected from the pictures used in the adult version and 3 new photographs, are expressed in simpler words that children can understand. In the Turkish population, a study conducted by Girli with 235 children and adolescents between the ages of 6 and 16 found this scale to be both valid and reliable.[22] The scale was adapted to include 28 items, and the internal consistency coefficient was 0.72 for the child form. Scores greater than 9 indicate that the correct answers are above the level of chance. The maximum score is 28, and higher scores indicate better social cognition and theory of mind skills.

Statistical Analysis

The data obtained from the research were evaluated using the International Business Machines Statistical Package for the Social Sciences 22.0 package program (IBM SPSS Corp.; Armonk, NY, USA). The normality of the data was evaluated using the Kolmogorov–Smirnov test. The Mann–Whitney *U*-test was used to compare numerical variables. The non-parametric Kruskal–Wallis test was used in the triple comparison of non-categorical variables that were not normally distributed. The Fisher–Freeman–Halton test is used to compare categorical variables with 3 or more categories. The Dunn–Bonferroni post hoc test was applied for advanced paired comparisons in the case of differences. For the comparison of the correlation of numerical data, Spearman's Rho test was used because the data were not normally distributed. Statistically, values of $P > .05$ were accepted as significant, and the *P*-value was reported directly to indicate the level of significance of the findings.

Table 1. Descriptive Statistics for Sociodemographic Data and Clinical Features

			SLD (n = 50)	ADHD (n = 41)	TD (n = 43)	*P*
Gender	(n, %)	Female	13 (26%)	6 (14.6%)	19 (44.2%)	.011*
	(n, %)	Male	37 (74%)	35 (85.4%)	24 (55.8%)	
Age	Median (min-max)	Month	112.0 (80-160)	120.0 (74-158)	112.0 (73-164)	.927**
Age of mother	Median (min-max)	Year	36 (26-50)	37 (27-50)	38 (27-48)	.288**
Age of father	Median (min-max)	Year	40.5 (29-55)	41.0 (32-57)	42.0 (34-54)	.327**
Educational status of mother	(n, %)	Until high school	27 (38%)	20 (28.2%)	24 (33.8%)	.822*
	(n, %)	High school and above	23 (36.5%)	21 (33.3%)	19 (30.2%)	
Educational status of father	(n, %)	Until high school	30 (38.5%)	27(34.6)	21 (26.9%)	.269*
	(n, %)	High school and above	20 (35.7%)	14 (25.0%)	22 (39.3%)	
Literacy learning time	(n, %)	First year first term	17 (34%)	34 (82.9%)	41(95.3%)	<.001*
	(n, %)	First year second term	11 (22%)	2 (4.9%)	1 (2.3%)	
	(n, %)	Second year	8 (16%)	3 (7.3%)	-	
	(n, %)	Third year	4 (8%)	-	-	
	(n, %)	Fourth year or later	2 (4%)	-	-	
	(n, %)	Not yet	8 (16%)	2 (4.9%)	1 (2.3%)	
Family income	(n, %)	Low	15 (30%)	7 (17%)	14 (32.6%)	.124*
		Moderate	31 (62%)	29 (70.7%)	20 (46.5%)	
		High	8 (8%)	5 (20.9%)	9 (20.9%)	

*Fisher–Freeman–Halton test; **Kruskal–Wallis test.
SLD, specific learning disorder; ADHD, attention-deficit hyperactivity disorder; TD, typically developed.

Results

Sample Characteristics

The general sociodemographic characteristics of the sample of 134 children in total are summarized in Table 1. There was no difference between the groups in any characteristics apart from gender.

Facial Emotion Recognition: Comparison Between Groups

When the total RMET scores (Table 2) were compared between the SLD, ADHD, and TD groups, it was found that the scores of the TD groups were significant (H = 2, $P < .001$, Kruskal–Wallis). In post hoc comparisons, the RMET scores of the TD group were significantly higher than for the SLD group ($P < .001$) and for the ADHD group ($P < .001$). No significant difference was observed between the ADHD and SLD groups in terms of total RMET score ($P = 1$) (Table 3).

Literacy Learning Time and Facial Emotion Recognition

A significant negative correlation was found between the time of acquisition of literacy skills and RMET total scores ($P < .001$). Additionally, considering all the SLD, ADHD, and TD groups, it was observed that reading and learning delay was negatively correlated with RMET scores.

When comparing the literacy learning time by dividing the literacy learning time into first-grade first-term learners, first-grade second-term learners, and later learners, a significant negative relationship was found between RMET total score and literacy learning time ($r = -0.033$, $P = .001$). In the comparison made using this model, the *P*-values for this correlation were $P = .586$, $r = -0.079$; $P = .010$, $r = -0.406$; and $P = .115$, $r = 0.247$ for the SLD, ADHD, and TD groups, respectively, meaning the relationship was only significant for the ADHD group.

Table 2. Facial Emotion Recognition Scores

RMET Scores	Median	(Min-Max)	Mean (SD)
SLD	15	9-26	15.34 (4.34)
ADHD	16	9-22	15.90 (3.47)
TD	19	14-26	19.48 (2.91)

SLD, specific learning disorder; ADHD, attention-deficit hyperactivity disorder; TD, typically developed; RMET, Reading Mind in Eyes Test; SD, standard deviation.

Table 3. Post hoc Comparisons of SLD, ADHD, and TD Groups

	P
SLD–ADHD	1.00
SLD–TD	<.001
ADHD–TD	<.001

SLD, specific learning disorder; ADHD, attention-deficit hyperactivity disorder; TD, typically developed.

Discussion

This study aimed to understand the difference in ER skills of children with SLD compared to their typically developing peers and children with ADHD. Our research found that, in accordance with the literature, SLD and ADHD groups had poorer facial ER skills than their TD peers.[1-3] No statistical significant differences were observed when comparing the SLD and ADHD groups with each other. In the literature, it is known that both SLD and ADHD are among neurodevelopmental disorders, including ASD, and they are frequently seen together.[8,23] In the context of neurodiversity, it was an expected result that there was no significant statistical difference in terms of ER between the SLD and ADHD groups, which we evaluated separately, considering similar symptom clusters and etiological connections. It is a topic discussed in the current literature that a better understanding of neurodevelopmental disorders and developing intervention strategies can be through new approaches.[7,8,24] By including symptom networks and underlying mechanisms, the multidimensional approach can transform overlapping areas and differentiation in this large cluster into a form that clinicians and researchers can use more functionally.[8,24] Emotion recognition deficiencies can also find their place in this context.

Regarding the sociodemographic variables, the groups were uniform in terms of children's ages, parents' ages and education levels, and family income (Table 1). Only gender data showed a statistically significant difference between the groups. More males were in the ADHD and SLD groups than the control group. Indeed, the male gender is more common in these neurodevelopmental diagnostic groups.[25,26] In order to understand whether gender caused the observed difference in emotion recognition between the groups, the RMET scores between males and females were compared, and it was found that gender did not affect facial ER in our study. Previously, studies have shown that females have better social cognition,[22] but other studies did not detect any difference between the genders.[27,28] Research has shown that this situation may vary according to their diagnosis, socioeconomic status, and age group.[6,27]

In our study, a highly significant relationship was found between children's literacy learning timing and their ability to recognize facial emotions. Evaluating the SLD, ADHD, and health control groups together, it was observed that children who learned to read and write late had poorer ER than those children who learned on time. To the best of our knowledge, the literature related to literacy learning time and ER is limited. Considering that learning processes are based on social interaction, the individual's difficulty in understanding emotions may affect learning and school success in various areas.[15,16] Some studies showed emotion recognition and academic achievement through executive functions.[15] Late literacy learning is very common in children with SLD.[29] In order to enhance the clarity of the results, we evaluated all 3 groups separately. There were few children in the SLD group who learned to read on time. Additionally, in the TD group, the number of children who did not learn to read on time was quite low. Statistical evaluation in these 2 groups was inappropriate due to the scarcity and disproportionality of the values. In the ADHD group, although the number was still not very high, significant differences were observed both in the correlation analysis and in the comparison of groups with different time to literacy learning, as understanding the emotions of others was negatively related to the time to learning to read.

Our study has some limitations. The sample size of our study was limited, the number of men and women in the groups was not equal, the IQ scores of the ADHD and TD groups were not measured, and the reading learning time data were learned by asking the parents. Our results should be interpreted with these limitations in mind.

Conclusion

Specific learning disorder comes with social and academic challenges, albeit at different levels, like ADHD and ASD from other neurodevelopmental diseases. In this study, we found that the concept of ER, which we think may be one of the mechanisms associated with social and academic difficulties, is statistically similar to ADHD in SLD children. Both groups had worse ER skills than their TD peers. When we evaluated all the participants, we saw that those who had difficulty recognizing emotions also had problems learning to read and write. Our study showed that ER skills may be found in the consociate symptom cluster of 2 neurodevelopmental disorders such as ADHD and SLD, and it is one of the findings that can distinguish them from their healthy peers. We think that ER is an area that should also be considered in therapeutic intervention studies for SLD and ADHD. Future studies may contribute to the field by evaluating executive functions, examining and controlling for environmental and familial variables, and producing intervention strategies.

Ethics Committee Approval: *Ethical committee approval was received from the Ethics Committee of İstanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine (Date: 08.02.2017, no: 52674).*

Informed Consent: *Written informed consent was obtained from all participants who participated in this study.*

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