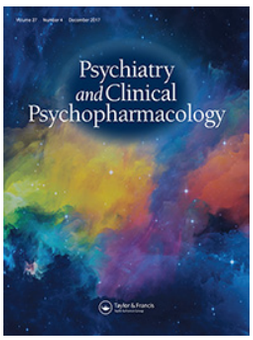

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Assessment of relationship between comorbid oppositional defiant disorder and recognition of emotional facial expressions in children with attention-deficit/hyperactivity disorder

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ABSTRACT

Objectives: Attention-deficit/hyperactivity disorder (ADHD) is the most frequent neurobehavioural disorder in childhood. ADHD is associated with impaired academic performance, cognitive, and emotional deficits. Moreover, comorbid oppositional defiant disorder (ODD) is leading to more severe impairment in social performance. Social cognition involves recognition, encoding, and interpretation of emotions from faces. Basic facial expressions that include sadness, happiness, anger, disgust, fear, and surprise are the easiest emotions to recognize. We aimed to demonstrate facial expression recognition impairments that might occur more frequently in children with co-occurring ADHD/ODD than patients with ADHD only. Thus, children with the co-occurrence of ODD may suffer more severely from social and behavioural difficulties.

Methods: Forty patients diagnosed with ADHD and/or co-occurring ADHD/ODD according to DSM-IV-TR criteria were compared with a parallel (by gender, age, and educational state) 11 healthy children as a control group in this study. Clear facial images of each emotion were used as well as two additional sets of photos include 50% blurred images and cropped eye images were added as distractors then all images represented with black and white tone for emotion recognition task via facial expression. Angry expressions presented as target expressions. DSM-IV-Based Screening and Rating Scale for Children and Adolescents with attention deficit and disruptive behaviour disorders, the Conners' Teachers Rating Scale/Revised Long Form and the Conners' Parent Rating Scale/Revised Long Form were used to provide diagnostic objectivity.

Results: Control group statistically performed better than ADHD group on recognition of emotional facial expressions. Results showed no statistically significant differences between the ADHD and ADHD/ODD group on recognition of emotional facial expressions. However, according to results of emotion recognition task via facial expressions, there were statistically significant differences between pure ADHD and comorbid ADHD+ODD groups in happy and neutral expressions. ADHD/ODD group tend to attribute more meaning to neutral facial expressions. Additionally there was statistically significant difference between control group and ADHD group according to recognition of angry expressions. There were statistically significant differences between the groups according to recognition of sad expressions in all clear, blurred, and eye photographs.

Conclusions: Difficulties in recognizing emotional facial expressions were observed in children with ADHD. A statistically significant association was established between presence of ADHD and impaired recognition of facial emotion expressions independent from the scores of the disruptive behaviour rating scale. Comorbid ODD was not associated with recognition of emotional facial expressions including angry expressions. Recognition of angry expressions was not found as a predictor for disruptive behaviour disorders.

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Introduction

Attention-deficit/hyperactivity disorder (ADHD) occurs in 3–5% of school-aged children and 50–70% continuous throughout young adulthood. ADHD is characterized by impaired symptoms of inattention, impulsivity, and hyperactivity [1,2]. The prevalence of oppositional defiant disorder (ODD) comorbidity on ADHD ranged from 40% to 80% [3]. In addition to a number of behavioural, attentional, and academic problems, children with ADHD have been reported to suffer from impairments in social interactions such as difficulty in emotion recognition [3,4].

Social competence refers to skills that facilitate interpersonal interactions including the expression and control of nonverbal communication. Successful social interaction is critically dependent upon our

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ability to understand other people's mind and their feelings. Social cognition involves recognition, encoding, and interpretation of emotions from faces [5,6]. Basic facial expressions which include the sadness, happiness, anger, disgust, fear, and surprise are the easiest emotions to recognize [7]. Recognition of basic emotions first emerges in early childhood and varies with age [8]. Five-month-old infants are able to discriminate facial expressions such as fear and sadness furthermore it has been shown that they are especially sensitive to anger expressions [9]. Similarly angry facial expressions are recognized more accurately and more quickly than happy expressions among a crowd by adults [10]. This finding indicates that angry faces are perceived as much threatening as fearful face stimuli. A significant correlation was observed between low rates of angry expressions' recognition and impaired perception of threatening face stimuli in children with hyperactivity [11].

Several studies have shown that children with ADHD perform worse than healthy children on facial emotion recognition tasks [12]. Emotional recognition impairments have been reported more frequently in children with co-occurring ADHD than patients with behaviour disorders only and particularly more difficulties in recognizing angry and sad expressions have been underlined [13]. It is well-known that anger/irritability score is higher in patients with ODD than patients with ADHD [14]. Additionally more difficulties in perceiving and encoding of emotional expressions are leading to present much more higher anger/irritability score in patients with co-occurring ADHD/ODD [15].

The purpose of this study was to determine whether co-occurrence of ODD with ADHD causes more difficulties in encoding as well as recognition and interpretation of emotions or not and evaluate relations with disruptive behaviour. In present study, children with co-occurring ADHD/ODD were expected to be more insensitive to angry face symbols and this would possibly be related to deficits of children with ODD to assessing clues in angry expressions as a result of reduced empathy. Furthermore, children with co-occurring ADHD/ODD were also expected to interpret the emotions wrongly so these children may not feel empathy for another person.

Methods

Sample

Exclusion criteria for this study were presence of psychotic disorder, bipolar disorder, mental retardation, autism spectrum disorders, anxiety disorders, depression, substance abuse, severe medical/neurological diseases, and specific learning disability. Due to possible bias effects on outcomes of emotional lability, adolescents also excluded from this study. Additionally, patients who had a score of 25% or below in Raven Progressive Matrices Test (RPMT) and patients who did not volunteer to participate were excluded from the study.

In order to eliminate bias due to inattention, hyperactivity, and impulsivity, both of the compared groups had diagnosed with ADHD. In this study, comorbid ODD group was compared to the pure ADHD group.

Measures

Socio-demographic questionnaire: Includes socio-demographic data such as age, gender, educational state, socio-economical level (with Hollingshead-Redich scale), and place of residence as well as information including educational state of parents, medical history and family type (Table 1).

Schedule for Affective Disorders and Schizophrenia for School Aged Children –Present and Lifetime Version (K-SADS-PL-Turkish Version): An interview form that was created by Kaufman et al. in order to detect past and current psychopathologies in children and adolescents according to DSM-III-R (APA 1987) and DSM-IV (APA 1994) diagnostic criteria. The form has three sections as "introduction," "diagnosis," and "general evaluation." Severity of symptoms is rated as "absent," "subthreshold," and "threshold" [16].

DSM-IV-Based Screening and Rating Scale for Disorders of Attention Deficit and Disruptive Behaviors in Children and Adolescents (Parents and Teacher Forms) (SRS-ADDBD): This form was developed for the diagnosis of ADHD/disruptive behaviour disorders and consists of 26 items; each item has 4 ranging grades 0–3 depending on the severity of the symptom [17].

Raven Progressive Matrices Test: RPMT assesses analytical investigation, problem solving, regular thinking, abstraction, and mental process speed [18]. RPMT consists of a series of "shape puzzles" with increasing difficulty. In each test item, the subject is asked to identify the missing element that completes the pattern made of nine shapes. Test score above 95th percentile is defined as superior intelligence, below 5th percentile is defined as mental retardation [19]. In this study intelligence assessment performed clinically and supported with RPMT especially for its rapid and functional outcomes.

Conner's Parents Rating Scale- Revised/Long Form (CPRS-R/L): CPRS-R/L is consisted subscales of cognitive problems/inattention, oppositionality, hyperactivity, anxiety-shyness, perfectionism, social problems, and psychosomatic. DSM-IV index, ADHD index, and Global Index according to DSM-IV diagnostic criteria are used for contribution. Parents are requested to answer items while taking the last one month into consideration. Each item is answered as one the following four choices: Not true at all (rarely), somewhat true

Table 1. Distribution of sample group according to age and gender.

	ADHD ($n = 20$)	ADHD/ODD ($n = 20$)	Control ($n = 11$)	p
Age (years) median (min–max)	9.21 (4.42–12.08)	7.71 (6.08–11.33)[a]	11.32 (6.95–14.53)[b]	**.002**
Gender				
Male *n* (%)	12 (60.0)	18 (90.0)	7 (63.6)	.079
Female *n* (%)	8 (40.0)	2 (10.0)	4 (36.4)	

[a]Statistically significant differences observed with ADHD group by *post hoc* Bonferroni corrected Mann–Whitney U test.
[b]Statistically significant differences observed with ADHD + ODD group by *post hoc* Bonferroni corrected Mann–Whitney U test.

(sometimes), quite true (mostly), and completely true (almost always) [20].

Conner's Teachers Rating Scale-Revised/Long Form (CTRS-R/L): CTRS-R/L includes 38 items, 6 subscales, and additionally 3 assistant scales based on the ADHD symptoms in DSM-IV: ADHD index, Conner's Global Index and DSM-IV Symptoms Index. Teachers are requested to evaluate children/adolescent's behaviours while taking the last one month into consideration. For each item, four answer choices represented as mention above [21].

Sub-parameters can use in the SRS-ADDBD, CTRS-R/L, and CPRS-R/L scales for evaluate the diagnosis of ODD. A pattern of negativistic, hostile, and defiant behaviour lasting at least six months, during which four (or more) of the following are present: often loses temper, often argues with adults, often actively defies or refuses to comply with adults' requests or rules, often deliberately annoys people, often blames others for his or her mistakes or misbehaviour, often touchy or easily annoyed by others, often angry and resentful, often spiteful or vindictive. ODD causes significant problems at school or home. It occurs on its own, rather than as part of the course of another mental health problem, such as a substance use disorder, depression, or bipolar disorder [22].

Task to Recognize Emotions from Facial Expressions: In order to evaluate nonverbal social processing skills of the children; happy, sad, angry, and neutral facial expressions of 3 male and 3 female adults were used. Diagnostic Analysis of Nonverbal Accuracy, which was inspired from Nowicki and Duke, was revised using photographs that present facial expressions of adults from Turkey [23]. Clear facial images of each emotion were used for recognition tasks as well as two additional sets of photos include 50% blurred images and cropped eye images were added as distractors then all images represented with black and white tone (Figure 1). Completion time of test was measured. Meanwhile our healthy control group was used as comparisons to confirm the validity of tasks and reliable outcomes have obtained.

Statistical analysis

All the data were analysed with SPSS (Statistical Package for the Social Sciences) software for Windows Version 22.0. Individual and aggregate data were summarized using descriptive statistics including mean, standard deviations, median (min–max), frequencies, and percentages. Evaluation of categorical variables performed by Chi-Square test. Normality of data distribution was verified by Shapiro–Wilk test. Comparison of the variables with normal distribution was made with Student t test. For the continuous variables that were not normally distributed, the Mann–Whitney U test was conducted to compare between groups. Comparisons between multiple groups were made by Kruskal–Wallis test followed by *post hoc* Bonferroni's correction. *P*-values of <.05 were considered statistically significant.

This study was performed with the Institutional Review Board protocol approval date 25/02/2014 and number 50687469-1491-107-14/1648.4-393 in Gulhane Military Medical Academy Department of Child and Adolescent Psychiatry between January 2014 and April 2014. The study included 40 children aged between 6 and 12 years old who were either newly diagnosed with ADHD or combined type ADHD according to DSM-IV-TR diagnostic criteria. A health group which consisting of 11 children and 10 adults (11 males, 10 females) were included to our study. Health adults were only used for comparisons to confirm the validity of recognition of emotions from facial expressions tasks. Children were enrolled in the study after obtainment of written informed consent from their family. In order to eliminate possible effects, participants did not receive psycho-stimulant drugs at least a day prior to evaluations.

Results

The study included 51 children and adolescents. Mean age of the participants was 9.28 ± 2.35 and median was 9.16 (4.42–14.53) years. The participants included in this study were 37 (72.5%) male and 14 (27.5%) female. Twenty patients (39.2%) diagnosed with ADHD and 20 patients (39.2%) diagnosed with co-occurring ADHD/ODD were compared with a parallel (by gender, age, and educational state) 11 healthy children (21.6%) as a control group in this study. In our study, mean age of the participants detected in pure ADHD group ($n = 20$) was 9.34 ± 2.21 years, in comorbid ADHD + ODD group ($n = 20$) was 8.16 ± 1.65 years and in healthy control group was ($n = 11$) was 11.37 ± 2.35 years. There was statistically significant difference between groups according to mean age ($p < .002$). *Post hoc* comparisons between ADHD + ODD and

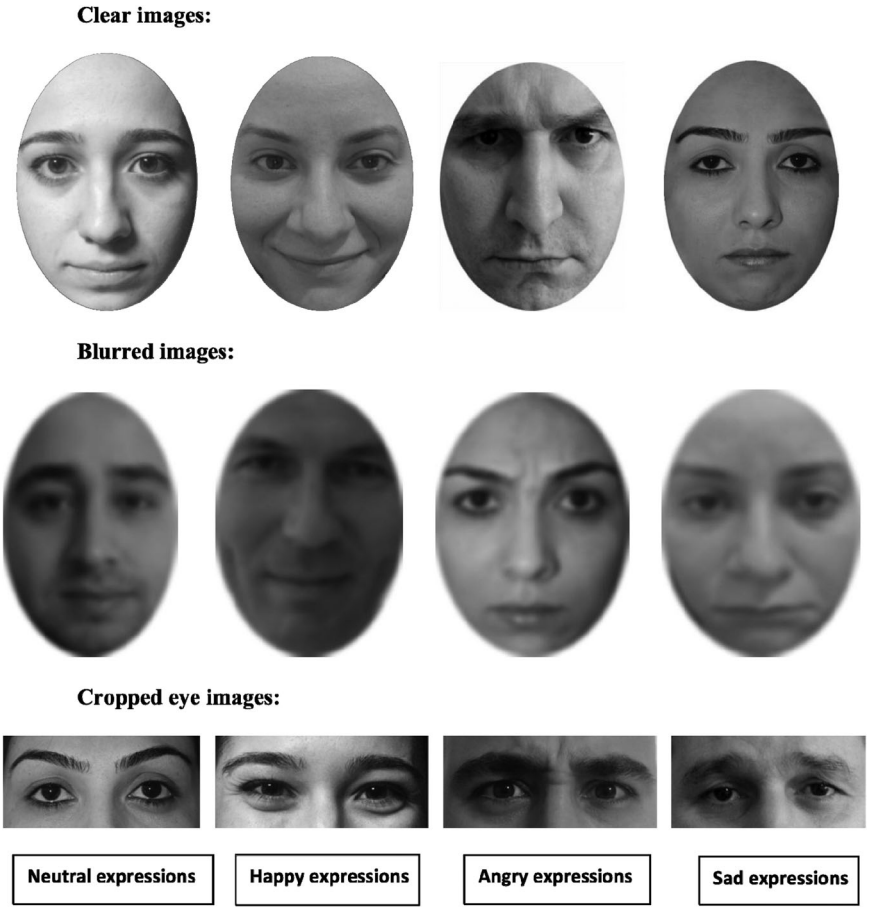

Figure 1. Image samples for emotion recognition task via facial expression.

control groups revealed a statistically significant difference. The average age of the control group was statistically significantly higher than ADHD + ODD. The groups were similar in terms of gender ($p = .079$). Our study sample was found to have medium socioeconomic status.

There were statistically significant differences between pure ADHD and comorbid ADHD + ODD groups according to "Hyperactivity/Impulsivity" and "Oppositionality" subscales of parents SRS-ADDBD inventory. Additionally, comparison for CPRS-R/L scores showed that comorbid ADHD + ODD group had statistically significantly higher scores for "oppositionality," "Hyperactivity," "Social problems," Conners' global index "total score" and "Anxiety/impulsivity," "DSM-IV hyperactivity-impulsivity," and "total score" ($p < .05$) (Table 2).

There were statistically significant differences between pure ADHD and comorbid ADHD + ODD groups according to "Hyperactivity/Impulsivity" and "Oppositionality" subscales of teachers SRS-ADDBD inventory. Additionally comparison for CPRS-R/L

Table 2. Comparison of ADHD and comorbid ADHD/ODD groups according to the distribution of parents' scale scores.

			ADHD ($n = 20$)	ADHD/ODD ($n = 20$)	p
SRS-ADDBD (parent)	Inattention		18.00 ± 3.71	19.75 ± 4.77	.203
	Hyperactivity/impulsivity		16 (8.25–21.0)	22.5 (15.75–24.0)	**.010**
	Oppositionality		9.65 ± 5.65	15.95 ± 4.50	**<.001**
Conner's (parent)	Oppositionality		13.30 ± 7.31	20.20 ± 5.12	**.001**
	Cognitive problems/inattention		24.25 ± 5.16	23.45 ± 6.64	.673
	Hyperactivity		13.40 ± 7.25	18.00 ± 4.28	**.020**
	Anxiety/shyness		9.90 ± 4.83	9.75 ± 5.10	.924
	Perfectionism		6.5 (3.0–8.75)	6.5 (5–8)	.512
	Social problems		3.50 ± 2.74	6.35 ± 3.42	**.006**
	Psychosomatic		3.5 (2–7)	4 (1.5–6.0)	.925
	ADHD index		27.5 (18.75–32)	29 (22.0–31.5)	.398
	DSM-IV index	Inattention	21 (14.25–22.0)	20 (16.25–21.5)	.820
		Hyperactivity/impulsivity	14.95 ± 6.76	20.45 ± 3.98	**.004**
		Total	33.70 ± 9.92	39.40 ± 6.61	**.040**
	Global index	Anxiety/impulsivity	12.15 ± 4.38	16.05 ± 2.78	**.002**
		Emotional variability	4.25 ± 2.73	5.05 ± 2.23	.317
		Total	16.40 ± 6.51	21.10 ± 3.75	**.009**

Note: Normal distributed data presented with mean ± standard deviation, data which not normally distributed presented with median (25–75%).

scores showed that comorbid ADHD + ODD group had statistically significantly higher scores for "oppositionality," "Hyperactivity," "Social problems," "ADHD index-hyperactivity," Conners' global index "total score," "emotional variability" and "Anxiety/impulsivity," "DSM-IV hyperactivity-impulsivity," and "total score" ($p < .05$) (Table 3).

According to results of emotion recognition task via facial expressions, there were statistically significant differences between control group and ADHD groups (pure ADHD group and ADHD + ODD group) in happy ("eye" and "clear"), sad ("total," "clear," "eye," and "blurred"), angry ("total"), and neutral ("total," "clear," and "eye") expressions (Table 4). But there was statistically significant difference between pure ADHD group and ADHD + ODD group in only "neutral-clear" expressions. And this statistically significant differences in recognition of facial expressions' numbers among "neutral-clear" expressions originated from comorbid ADHD + ODD group (Table 4).

As for the comparison of neutral-clear images, comorbid ADHD + ODD group showed statistically significantly lower performance than did the control and pure ADHD group. When distractors, clear, and negative photographs were compared, control group showed statistically significant differences from the case groups. Comorbid ADHD + ODD and pure ADHD group had more difficulties to recognize those expressions than pure ADHD group (Table 4).

Discussion

Impaired interpersonal relationships have been reported in ADHD. These difficulties are commonly thought to develop secondary to an impairment of nonverbal language. Ability to recognize facial

Table 3. Comparison of ADHD and comorbid ADHD/ODD groups according to the distribution of teachers' scale scores.

			ADHD ($n = 20$) mean ± SD	ADHD/ODD ($n = 20$) mean ± SD	p
SRS-ADDBD (teacher)	Inattention		16.75 ± 5.74	19.35 ± 4.34	.114
	Hyperactivity/impulsivity		13 (7.25–19)	22 (11.5–24.0)	**.014**
	Oppositionality		4.5 (3–8.5)	15 (10–18)	**<.001**
Conner's (teacher)	Oppositionality		1 (1–5.5)	5.5 (3–8)	**.007**
	Cognitive problems/inattention		10.70 ± 4.23	11.55 ± 4.44	.539
	Hyperactivity		8.25 ± 4.71	12.45 ± 4.52	**.007**
	Anxiety/shyness		5.20 ± 1.96	5.70 ± 3.31	.565
	Perfectionism		2 (0–3)	1.5 (0–3)	.968
	Social problems		4.40 ± 3.10	8.75 ± 4.00	**<.001**
	ADHD index-inattention		11.60 ± 4.50	13.40 ± 2.01	.114
	ADHD index-hyperactivity		7.5 (3.25–11)	12 (8–14)	**.013**
	DSM-IV index	Inattention	16.70 ± 5.18	18.40 ± 4.12	.258
		Hyperactivity/impulsivity	12.40 ± 7.21	18.75 ± 6.58	**.006**
		Total	29.10 ± 10.57	37.15 ± 8.43	**.011**
	Global index	Anxiety/impulsivity	8.60 ± 3.68	11.25 ± 2.97	**.017**
		Emotional variability	3.85 ± 2.28	6.15 ± 4.65	**.023**
		Total	14 (7.25–16.75)	15.5 (14–19.75)	**.038**

Note: Normal distributed data presented with mean ± standard deviations, data which not normally distributed presented with median (25–75%).

Table 4. Comparison of pure ADHD group with ADHD + ODD group according to the emotional facial expression recognition tasks.

		ADHD ($n = 20$) Median (25–75%)	ADHD/ODD ($n = 20$) Median (25–75%)	Control ($n = 11$) Median (25–75%)	p
Happy	Clear	6 (5.25–6.0)	6 (6–6)	6 (6–6)	.192
	Eye	4.5 (3.25–5.75)	4 (2–5)	5 (5–6)[b]	**.012**
	Blurred	6 (5.25–6.0)	6 (6–6)	6 (6–6)	.218
	Total	16 (15–17)	15 (14–16)	17 (17–18)[b]	**.004**
Sad	Clear	3 (2–3)	2 (1.0–3.75)	5 (5–6)[ab]	**<.001**
	Eye	3 (2–3)	2 (1.0–3.75)	5 (4–6)[ab]	**<.001**
	Blurred	2 (1–3)	2 (1–3)	5 (4–6)[ab]	**<.001**
	Total	7 (6–8)	7 (5–9)	15 (14–16)[ab]	**<.001**
Angry	Clear	5 (4–6)	5 (5–6)	5 (5–6)	.116
	Eye	5 (4.25–6.0)	5 (5–6)	6 (5–6)	.651
	Blurred	4.5 (3.25–6.0)	4 (4–5)	6 (5–6)	.069
	Total	14 (11–16)	15 (13–16)	16 (15–18)[ab]	**.012**
Neutral	Clear	5.5 (4.25–6.0)	4 (1.25–5.0)[ac]	6 (5–6)	**.003**
	Eye	4 (3–4.75)	3 (2–4)	5 (4–5)[b]	**.026**
	Blurred	5 (4–6)	4.5 (2.25–5.75)	5 (5–6)	.133
	Total	14 (11.5–16.0)	11.5 (7.25–14.75)	16 (13–17)[b]	**.001**
Clear images		18.5 (18–19)	17.5 (15–19)	22 (22–23)[ab]	**<.001**
Distracter images (Eye + Blurred)		33.5 (29.25–36.0)	30 (26.25–35.75)	41 (38–43)[ab]	**<.001**
Negative images (Sad + Angry)		21.5 (17.25–24.0)	21 (18–24)	30 (30–33)[ab]	**<.001**

[a]Statistically significant differences observed with ADHD group by *post hoc* Bonferroni corrected Mann–Whitney U test.
[b]Statistically significant differences observed with ADHD + ODD group by *post hoc* Bonferroni corrected Mann–Whitney U test.

expressions of emotion is essential for perceiving non-verbal languages and it has been demonstrated to be central to social behavioural organization of individuals [24].

In this study, although a statistically significant difference between the control group, ADHD group and ADHD + ODD group, we can say that this clinically not important difference, because all age groups are prepubescent and maximum age is 14.53 year in the groups.

In our study, social problem scores (hyperactivity-impulsivity and oppositional scores) were statistically higher in patients with co-occurring ADHD/ODD. Pardini et al. found a positive correlation between high ADHD scores and ODD scores [25]. In another study, ODD cases were determined to have less success in the sub-scale that is used for assessment of social skills [26]. Thus suggests poor interpretation of emotional cues, rather than an inability to capture these social cues in cases with ODD.

There were statistically significant differences between healthy control group and pure ADHD/comorbid ADHD + ODD groups regarding recognition of happy, sad, neutral, clear, distractors, and negative emotions in our study. According to results of emotion recognition task via facial expressions, there were statistically significant differences between pure ADHD and comorbid ADHD + ODD groups in happy ("total" and "clear"), sad ("total," "clear," "eye," and "blurred"), angry ("total" and "eye"), and neutral ("total," "clear," and "eye") expressions ($p < .05$) (Table 4). The statistically significant differences in recognition of facial expressions; numbers among sad ("clear," "eye," and "blurred") and angry ("total") expressions originated from control group ($p < .05$). The statistically significant differences in recognition of facial expressions; numbers among neutral ("clear") expressions originated from comorbid ADHD + ODD group. The statistically significant differences in recognition of facial expressions ($p < .05$); numbers among happy ("total" and "clear") and neutral ("total" and "eye") expressions observed between control and comorbid ADHD + ODD group (Table 4).

As for the comparison of sad expressions in clear, blurred, eye photographs, and angry expressions in total photographs, control group showed statistically higher performance than did the other groups. Regarding ability to recognize happy faces in total, clear photographs, and neutral faces in total, eye photographs, control group showed statistically higher performance than did the comorbid ADHD + ODD group. As for the comparison of neutral-clear images, comorbid ADHD + ODD group showed statistically lower performance than did the control and pure ADHD group. When distractors, clear and negative photographs were compared, control group showed statistically significant differences from the case groups. Comorbid ADHD + ODD and pure ADHD group had more difficulties to recognize those expressions than control group (Table 4).

These outcomes are found consistent with published data related to disruptive behavioural disorders. Researches which compared cases with pure ADHD and co-occurring ADHD/ODD in terms of emotional functionality have particularly focused on emotional dysregulation [25,27]. Comparative studies including healthy controls have shown that cases with disruptive behavioural disorders are performed worse in recognition of emotion expressions [13,28].

Numerous researches have reported that children with ADHD impaired to recognize negative or unpleasant emotional expressions such as anger or sadness [29,30]. Children with ADHD spent more time to recognize expressions involving negative emotions in our study. This finding was interpreted as either they had more tendencies towards negative emotional expressions, or they had difficulty recognizing it [31].

In our study, pure ADHD and co-occurring ADHD/ODD groups were found statistically equivalent for the recognition of emotion expressions. However, both groups were found inadequate when compared with the healthy control group. Similarly, Faraone et al. observed that healthy control group performed better than did the ADHD group on interpersonal interactions in social environment [4].

It has been shown that comorbid ADHD/ODD cases tend to attribute more meaning to neutral facial expressions. Interpreting uncertain facial expressions as negative content may arise to potentially aggressive behaviour [32]. Supportively, research on behaviour disorder cases reported that responses of amygdala to faces with fearful expressions were also observed against neutral facial expressions [13].

In our study, according to correlation analysis between sub-tests of CTRS-R/L, CPRS-R/L and the outcomes of the emotional facial expressions' recognition tasks, there was no statistically significant relationship between recognizing negative expressions including anger and impulsive, aggressive behaviours, defiance, and social problem scores. These findings suggest that beyond recognition of others' emotions, disruptive behavioural problems may be related to biased or hostile interpretation of others' emotions.

Studies with healthy populations show some evidence to suggest that angry and sad faces are more easily distinguished in the crowd [33]. In our study, there was no statistically significant difference between comorbid ADHD/ODD group and control group regarding recognition of angry faces, which suggest that sensitivity to angry and sad expressions are independent from disruptive behaviour. Similarly Cadesky et al. demonstrated that children with comorbid

behavioural disorder had inadequacy in correctly recognizing emotions except angry expressions [34].

Children's emotional development is shaped by scanning their parent's faces and they can use this information as an emotional reference. This type of behaviour helps them to regulate their impulses for their own needs. It has been shown that parents of the children with ODD are less caring compared to parents of the children with pure ADHD [35]. In this respect, when children are examined for their skills of recognizing emotions, their parents' recognition skills should also be examined at the same time in further studies.

This present study has certain limitations. In our study, we have examined limited number of samples and held a cross-sectional examination on whether emotion was recognized or not among the study groups; representation and regulation of emotions which are the other steps of emotion processing, are beyond the scope of this study and they were not evaluated.

In conclusion, a statistically significant association could be established between the presence of ADHD and impaired recognition of facial emotion expressions independent from the scores of the disruptive behaviour rating scale. Furthermore, angry face recognition rates were not decreased in any case. Statistically there was no significant relationship between ADHD/ODD groups according to impairment of recognize angry expressions. Recognition of angry expressions was not found as a predictor of disruptive behaviours. Consequently further researches should be performed with larger study groups to achieve more assuring results.

In this respect, children with co-occurring ADHD/ODD distinguish the angry emotions as like children with pure ADHD, but may not interpret the angry emotions as pure ADHD. In this context we don't carry through expected result. Researchers should perform the child–mother attachment and family dynamics to enlighten cause of this pattern.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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