

Initial Orientation of Attention towards Emotional Faces in Children with Attention Deficit Hyperactivity Disorder

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Objective: Early recognition of negative emotions is considered to be of vital importance. It seems that children with attention deficit hyperactivity disorder have some difficulties recognizing facial emotional expressions, especially negative ones. This study investigated the preference of children with attention deficit hyperactivity disorder for negative (angry, sad) facial expressions compared to normal children.

Method: Participants were 35 drug naive boys with ADHD, aged between 6-11 years, and 31 matched healthy children. Visual orientation data were recorded while participants viewed face pairs (negative-neutral pairs) shown for 3000ms. The number of first fixations made to each expression was considered as an index of initial orientation.

Results: Group comparisons revealed no difference between attention deficit hyperactivity disorder group and their matched healthy counterparts in initial orientation of attention. A tendency towards negative emotions was found within the normal group, while no difference was observed between initial allocation of attention toward negative and neutral expressions in children with ADHD.

Conclusion: Children with attention deficit hyperactivity disorder do not have significant preference for negative facial expressions. In contrast, normal children have a significant preference for negative facial emotions rather than neutral faces.

Keywords: Attention, Attention deficit disorder with hyperactivity, Child, Eye movement, Facial expression

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Attention deficit hyperactivity disorder (ADHD) is a common neurobehavioral syndrome characterized by inattentiveness, and hyperactivity/impulsivity (1). Numerous studies have confirmed social incompetence in children with ADHD (2,3). These children have difficulties in interpretation of social situations, and are often rejected by their peers (2,4).

Recognition of emotional expressions, as the main component of nonverbal processing ability, is critical to effective social interactions (5). Adolescents and children with ADHD have impaired social and emotional capabilities and have difficulties appraising others' emotional states (6,7,8,9). A study done by Cadesky, Mota, and Schachar showed that children with ADHD made more mistakes in recognizing emotions, although their errors seemed to be random compared to children with conduct problems, which shows no bias in their emotional misrecognition. They stated that children with ADHD had deficits in encoding rather than specific bias in emotion interpretation (10). Singh et al. showed that children with ADHD had more difficulties in recognizing emotions, especially anger expression compared with

normal population (11).

In normal population, negative facial expressions compared to neutral ones attract attention preferentially and elicit enhanced event related potential (ERP) activity as early as 80-100ms (12, 13,14,15,16,17,18,19). From an evolutionary viewpoint, this preference is essential to detect potential dangers in our environment (15,20,21,22,23,24). ADHD children in comparison with healthy individuals are significantly less accurate in identifying emotional expressions, especially negative (fear, anger, sadness) expressions (10,11,25). This deficit seems to be related to their failure to attend to emotional cues due to impaired encoding of such signals. This is in line with cognitive-behavioral theories which propose that children with ADHD have impairments in selective attention and inhibition of irrelevant information (26,27,28,29).

Most studies conducted on emotion recognition in children with ADHD have focused on behavioral measures such as visual probe reaction time (RT) studies. These methods have some limitations: first, behavioral measures evaluate attention through an indirect way in which the results can be influenced by

other cognitive states. Second, these measures can only provide a snapshot of attention allocation at one point of time, and cannot detect sustained attention. The eye tracking methodology is probably the most direct way to assess selective attention which records the eye directions (30, 31). The current study evaluates attentional bias towards negative (anger, sadness) facial expressions using eye tracking system in children with ADHD compared to normal youth. We expected that ADHD group would exhibit delayed or no preference to negative facial expressions of emotion in comparison with normal children.

Materials and Method

Participants

35 boys aged between 6-11 years (8.35 ± 1.56) with the diagnosis of ADHD selected from among patients referred to child and adolescent psychiatrist office, and 31 normal boys of the same age (9.11 ± 1.54) selected from an elementary school in Tehran participated in the study. In addition to age, the groups were matched on Intelligence Quotient (IQ) using the Raven IQ test (ADHD group: 94.91 ± 11.13 , normal group: 96.43 ± 12.04) as well as WISC-R95. Children with IQ lower than 70 according to Raven test were excluded. Additionally, the vocabulary and blocks' subsets from WISC-R95, which are the most correlated subsets to verbal and performance IQs (32), were also employed to match the groups. The diagnosis of ADHD was first made by a child and adolescent psychiatrist according to DSM-IV (Statistical Manual of Mental Disorders, Fourth edition) criteria as a clinical assessment and then was confirmed by a fellow in child and adolescent psychiatry using the Persian version of K-SADS-PL interview (Schedule for Affective Disorders and Schizophrenia for School-Age Children-Present and Lifetime Version) (33). The two groups were right-handed and had normal or corrected to normal visual acuity. A gift of about 10 dollars was paid to the participants. The study protocol was approved by ethics committee of Tehran University of Medical Sciences (TUMS).

Stimuli

A compilation of 6 Caucasian faces (3 female and 3 male) in jpg format expressing negative emotion (anger, sadness) and neutral expressions was collected from Cohn Kanade AU-coded Facial Expressions Database (34). This database has more than 2000 image sequences in which the subjects were instructed by an experimenter to perform a series of 23 facial displays that included single or combinations of action units. The final frame of each image has been coded using the FACS (facial action coding system) describing expressions in terms of action units (AU) (35). The subjects used in this study were S037, S044, S050, S052, S055, S130. The photos were in black and white colors. Full-blown expressions were used only. The photos were resized to 397×425 pixels (14×5.5 cm) using the Microsoft Paint. No changes in contrast,

resolution, or illumination were made. The task was designed using the Experiment Builder 1.6.121 (SR Research Ltd, Mississauga, Ontario, Canada). Each emotion was paired with the same person's neutral expression producing 12 pairs (2 emotions \times 6 persons). The pictures in each trial were presented in two opposing sides (right and left). The right image location was 745×383 pixels and the left was 273×383 pixels. The distance between the innermost edges of images was 3cm. The face pairs were counterbalanced during the task. Additionally, 2 blocks were designed while the second block was the repetition of the first one. A set of 48 face pairs (6 persons \times 2 emotions \times 2 counterbalance \times 2 blocks) was compiled. Although, as this study was a part of a more comprehensive study, we had 252 trials divided into 2 blocks, but only 48 face pairs were negative-neutral. This study was designed according to routine standard designs of emotion recognition studies. (for example see references 31,44,45.)

Instruments

Stimuli were presented on a 19" AOC monitor with 1440 by 900 pixels screen resolution connected to a 2.60 GHz Pentium Dual core CPU computer. Participants' visual directions were recorded using the Eye Link II tracker (SR Research Ltd, Mississauga, Ontario, Canada) connected to another computer with the same characteristics. This device is head-mounted and uses infrared to detect corneal reflection and the changes in pupil size. The right eye was used to follow the participants' gaze. The sampling rate of the eye tracker was 250Hz. An eye position remaining within a 50pixel area for more than 100ms was considered as fixation (36).

Procedure

Upon receiving the consent form, the participants were examined using the eye tracker system in a quiet dark room dimly lit by the light of a monitor. There was a 55cm distance between a participant's eyes and center of the monitor. A chin-rest was used to minimize unwanted head movements and to maintain the distance constantly. Prior to turning the lights off, the examiner instructed the participant to fixate on the cross and look at the faces freely while they were being presented. The same instruction appeared on the monitor after starting the task. 9-point calibration was done before running the task to follow the participant's eye movements. At the beginning of the task, a white fixation cross appeared at the center of a black screen (location: 511×383). This helped us to ensure that the participant is attending consciously to a predefined location at the start point of each trial. This cross was being presented constantly during the face pair presentation. When the eye was being fixated, the experimenter would initiate the task. The pair of faces was being displayed on a black background for 3000ms; and during this time the participant looked at the monitor freely. Thereafter, the fixation cross appeared

again and this process was repeated for the next trials. There was a short break of about 10 minutes between the 2 blocks, and then the second block, which was the repetition of the first block, started after recalibration. It took about 30min to complete the task thoroughly.

Data analysis

Data collection was done using EyeLink® Data Viewer. The number of first fixations on each expression (negative versus neutral) was expected to show initial allocation of attention and thus preference for that expression. The p value less than 0.05 was considered as statistically significant.

Results

Independent samples t-test was done to make sure that the Wechsler IQ of the groups matched. No significant difference was observed between the groups (Table1). We performed a 2×2 multivariate analysis of variances (MANOVA) with the groups as between factor and facial expression (negative relative to neutral) as within subjects in order to compare groups on number of first fixations toward each expression. No significant difference was observed between the groups (Table2). Paired t-test was done separately in within each group to compare number of first fixations toward each face expression (negative, neutral). Paired t-test was significant within the normal group ($t=2.049$, $df=30$, $p=0.049$). This difference was not significant within the ADHD group ($t=1.564$, $df=34$, $p=0.127$).

Discussion

In the present study, we investigated whether children with ADHD have the same preference for negative facial expressions as the normal children. Results revealed no significant difference between the two groups in initial allocation of attention to negative emotions in comparison with neutral expressions. However, within the normal group there was a significant difference between numbers of first fixations on negative relative to neutral expressions, indicating an initial attentional orientation to negative emotions. In contrast, such difference was not observed in the ADHD group.

Our results which are in line with previous studies suggest attentional preference for negative facial expressions in normal population (37). Amanda Holmes et al. ,using ERP and reaction time(RT) data, found an attentional orienting toward threatening(angry) relative to happy and neutral faces in normal population (38).

Studies assessing emotion recognition ability of children and adolescents with ADHD propose misinterpreting of negative facial expressions especially threat-related (anger,fear) emotions (39,6,11,10) which show an impairment in recognition of potential signals for threat in environment. Karin Pelc et al. using an emotional facial expressions decoding task found that children with ADHD have more difficulties in recognizing angry and sad facial emotions (25). ADHD children's deficit in identifying emotional expressions, especially negative ones (10,11,25) seems to be related to their failure to attend to emotional cues due to impaired encoding of such signals. This failure is in line with cognitive-behavioral theories which propose children with ADHD have impairments in selective attention and inhibition of irrelevant information (26,27,28,29).

We did not find any significant difference between ADHD and control group in allocation of attention toward negative emotions. However, the insignificant difference between orientation of attention toward negative and neutral expressions within the ADHD group show that these children may have some impairment in differentiating between negative and neutral expressions which might be due to their failure to recognize negative expressions preferentially.

However, we could not find significant differences between the two groups as well as within ADHD group due to our insufficient number of trials displaying negative-neutral face pairs (48 face pairs) which is due to the fact that this study is part of a more comprehensive study with about 252 trials with different emotions. Additionally, the fact that the two negative emotions of anger and sadness were not separated in this study, might have resulted in low detection power; as the score of negative orientation was sum of the score of orientation to either angry or sad faces.

Table 1 Group comparison of intelligence quotient

Variables	ADHD (n=35) M (SD)	Normal (n=31) M (SD)	F	t	df	p
Intelligence						
Blocks	11.37 (2.7)	11.23(2.56)	0.299	-0.201	63	0.834
Vocabulary	12.14 (2.04)	12.2 (1.86)	0.086	0.117	63	0.907

Table2 Comparison of number of first fixations in the two groups

Variables	ADHD (n=35) M (SD)	Normal (n=31) M (SD)	F(1,64)	P
Number of 1st fixations				
Negative	22.82 (3.45)	22.68 (3.84)	0.028	0.86
Neutral	21.1 (3.45)	20.29 (4.26)	0.859	0.35

For some reasons, we used boys only in our study : 1st, the prevalence of ADHD among girls is much lower than in boys (41); 2nd, girls are less symptomatic generally (42); 3rd, girls' emotion recognition abilities are expected to be different from boys'. (43).

In future it would be interesting to do a separate eye-tracking study with negative-neutral face pairs and increased trials to assess if ADHD children have poorer negative expression recognition compared with normal children. It would also be beneficial to have a group of girls with ADHD in the future studies to compare their emotion recognition abilities with the boys group. Some studies have indicated that attention deficits in boys with ADHD might account for their difficulty in recognizing facial expressions of emotion (40). Therefore, effective treatment for attention deficits might be helpful and it would probably improve their facial emotion recognition ability. Thus, it can also be of interest if these children's initial orientation will be assessed after Ritalin prescription and be compared with ADHD group before Ritalin consumption.

Conclusions

The present study shows that ADHD children do not have significant preference for negative facial expressions. In contrast, normal children have a significant preference in their initial orientations for negative facial emotions rather than neutral faces. This finding might be useful in future planning of ADHD treatments. Training ADHD children with emotion regulation tasks might have beneficial effects on the prognosis of this disorder.

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