

Attentional Bias towards Emotional Scenes in Boys with Attention Deficit Hyperactivity Disorder

Ebrahim Pishyareh, PhD²
 Mehdi Tehrani-Doost, MD^{1,2}
 Javad Mahmoodi-Gharaie, MD¹
 Anahita Khorrami, MD²
 Mitra Joudi, MD¹
 Mehrnoosh Ahmadi, MD¹

1 Department of Psychiatry, Roozbeh Psychiatry Hospital, Tehran University of Medical Sciences, Tehran, Iran
 2 Institute for Cognitive Science Studies (ICSS), Tehran, Iran

Corresponding author:

Mehdi Tehrani-Doost, M.D.
 Associate Professor in Child & Adolescent Psychiatry
 Department of Psychiatry, Tehran University of Medical Sciences
 Roozbeh Psychiatry Hospital
 South Kargar Avenue, Tehran 1333715914, Iran
 Tel: +98-21-55412222
 Fax: +98-21-55419113
 Email: tehranid@sina.tums.ac.ir

Objective: Children with attention-deficit / hyperactivity disorder (ADHD) react explosively and inappropriately to emotional stimuli. It could be hypothesized that these children have some impairment in attending to emotional cues. Based on this hypothesis, we conducted this study to evaluate visual directions of children with ADHD towards paired emotional scenes.

Method: thirty boys between the ages of 6 and 11 years diagnosed with ADHD were compared with 30 age-matched normal boys. All participants were presented paired emotional and neutral scenes in the four following categories: pleasant-neutral; pleasant-unpleasant; unpleasant-neutral; and neutral – neutral. Meanwhile, their visual orientations towards these pictures were evaluated using the eye tracking system. The number and duration of first fixation and duration of first gaze were compared between the two groups using the MANOVA analysis. The performance of each group in different categories was also analyzed using the Friedman test.

Results: With regards to duration of first gaze, which is the time taken to fixate on a picture before moving to another picture, ADHD children spent less time on pleasant pictures compared to normal group, while they were looking at pleasant – neutral and unpleasant – pleasant pairs. The duration of first gaze on unpleasant pictures was higher while children with ADHD were looking at unpleasant – neutral pairs ($P < 0.01$).

Conclusion: based on the findings of this study it could be concluded that children with ADHD attend to unpleasant conditions more than normal children which leads to their emotional reactivity.

Key words: Attention, Attention deficit disorder with hyperactivity, Emotion, Psychophysiology

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Attention deficit hyperactivity disorder (ADHD) is a common neurodevelopmental disorder in children and adolescents characterized by inattention, hyperactivity, and impulsivity (1). Youth with ADHD, especially the combined type, have some interpersonal problems characterized as negative and conflictual (2). Consequently, they are often rejected by others. Of the suggested explanations for the social deficits seen in children with ADHD is that they are unable to inhibit and regulate their emotional and behavioral responses. This deficit leads to explosive and inappropriate reaction to other's emotions (3).

Based on the review of literature, it can be stated that emotions play an important role in social interaction (4). Emotional competence has been defined as including three components: 1- Understanding emotional cues; 2- Expression of emotions; 3- Regulating emotions (5). One of the basic components of emotional competence is recognizing the emotional expressions. It has been shown that individuals with ADHD have some problems with understanding

other's emotional states (6, 7, 8 & 9). They also have some impairment in recognizing emotional faces especially negative expressions (10, 11). Using an emotional facial expression task, Pelc found that Children with ADHD have more difficulties in recognizing angry and sad emotions (12). The deficit in emotion recognition has been found in boys at risk of ADHD (13). In this study, it was found that these children confused the emotions of happy, sad, and angry with the "scared" emotion as well as anger with "sadness". It was also found that these boys need more time to recognize emotions (13). It has also been found that youth with ADHD have difficulty matching emotional stories with basic emotional faces (14). In the few studies conducted on emotional processing in ADHD, the main focus was on behavioral measures. There is just one study evaluating facial emotional recognition using the event related potentials (Williams 2008). In this study, it was found that adolescents with ADHD had poorer performance on detecting negative emotions and delayed latencies reflected on brain signals while they were looking at emotional faces

(Williams 2008). Thus, it could be concluded that individuals with ADHD have some deficits in detecting emotional states; and this difficulty can lead to inappropriate reaction to emotions.

Recognizing the emotional stimuli is based on orienting and sustaining attention to them. It can be hypothesized that children and adolescents with ADHD have some impairment in orienting to emotional stimuli, so they may recognize these cues less accurately which leads to inappropriate reaction. Most studies have used emotional faces and behavioral measures to evaluate the ability to recognize emotions (10, 11). However, it can be assumed that these people might also have some problems with detecting emotional cues from scenes. This means that individuals with ADHD might have some impairment in attending to emotional situations other than seen in human faces. We hypothesized that these children have attentional bias to negative scenes compared to positive ones.

Based on this hypothesis, we conducted this study to evaluate the orientation of children with ADHD towards negative, positive, and neutral scenes compared to normal children using the eye tracking system. This study was done only on boys since ADHD is more prevalent in boys than in girls.

Materials and Method

Participants

Thirty boys between the ages of 6 and 11 years diagnosed with ADHD were compared with thirty age-matched normal boys. The diagnosis of ADHD was first made by a child and adolescent psychiatrist based on DSM-IV criteria and then confirmed using the Persian version of K-SADS-PL interview (Schedule for Affective Disorders and Schizophrenia for School-age Children Present and Lifetime Version) by a fellow in child and adolescent psychiatry. The reliability and validity of this instrument was evaluated in a study done by Shahrivar et al. (15). ADHD children with a co morbid psychiatric disorder were excluded from the study. The control children recruited from the mainstream schools had no history of major psychiatric problems based on K-SADS interview. The two groups had IQs of above 80 and normal or corrected to normal visual acuity.

Stimuli

A collection of pictures showing neutral, pleasant and unpleasant scenes were selected from the International Affective Picture System - IAPS. The selected pictures were used in a pilot study on 25 normal children to evaluate their arousals and valences. There were no significant differences between the obtained scores in this pilot study and that of the IAPS manual. The pictures were divided in three categories of pleasant, unpleasant, and neutral based on their contents and valence according to IAPS manual. The pictures whose valence score was below 4.5 were considered as unpleasant, between 4.5 and 6 as neutral, and above 6 as pleasant. Then the pictures were paired

in four groups: pleasant – neutral (16 pairs); unpleasant-neutral (18 pairs); pleasant-unpleasant (17 pairs); and neutral – neutral (7 pairs). To prevent the directional bias, the pairs were repositioned in terms of left or right direction. Therefore, there were 116 trials in each block which was repeated twice with a short pause.

Instrument

Stimuli were presented on a 19 – inch monitor with a resolution of 1400 by 900 pixels. The participants' visual directions were recorded by an Eye Link II video base tracker (SR research Ltd, Mississauga, Ontario, Canada). The system had a head mounted tracking device which used infrared to detect corneal reflection and the changes in pupil size. The sampling rate of the eye tracker was 250HZ. The right eye was used to follow the participant's gaze. An eye position remaining within a 50 pixel area for more than 100 ms was considered as fixation. The mean number and duration of first fixation on each emotion were considered as variables. Another variable was the duration of first gaze which is the time taken to fixate on one picture before moving to another picture.

Procedure

After selecting the participants, a consent form was completed by their parents. Then they were examined in a quiet dark room. There was a 55 cm distance between the participants' eyes and the monitor. A chin-rest was also used to minimize the unwanted head movements. Before presenting the pictures, the child was asked to fixate on a black spot at the center of the screen for 3000 ms, and then he was asked to follow the spot through nine random places. This procedure was done for calibration. Then, the paired pictures were presented for 3000 ms while the participant's visual directions were recorded. Each trial was followed by a black spot for drift correction. The two blocks of 116 trials with a 15-minute break were used in the study.

Statistical Analysis

Data collection was done using the Eye Link Data viewer. Data Analysis was done using the SPSS software 16.0. The multivariate analysis (MANOVA) was used to compare the two groups in terms of number and duration of first fixation on each emotion and the duration of first gaze. The P Value less than 0.05 were considered as significant. Since the categories were not consistent, the Friedman test was used to find the visual orientation towards different pictures within groups.

Results

There were no significant differences between the two groups in terms of age and IQ (table1). With regards to the number of first fixation on each emotion, no significant difference was observed between the

Table 1. Demographic characteristics of two groups

Variables	Normal (N=30) Mean±SD	ADHD (N=30) Mean±SD	t	P-Value
Age (by month)	106.27±17.02	101.63±17.63	1.03	0.30
I.Q.	100.73±9.39	99.43±5.99	0.63	0.52

Table2. Comparison of duration of first gaze on pictures between the two groups

Variables	Normal (N=30) Mean±SD	ADHD (N=30) Mean±SD	F	P-Value
Duration of first gaze on pleasant in pleasant – neutral	563.15±197.76	466.71±130.97	4.95	.03
Duration of first gaze on pleasant in pleasant – unpleasant	395.5±186.53	317.32±106.58	3.97	.05
Duration of first gaze on neutral in unpleasant – neutral	327.68±132.37	275.39±98.6	3.01	.08
Duration of first gaze on neutral in pleasant – neutral	166.31±70.5	168.58±49.7	.02	.88
Duration of first gaze on unpleasant in unpleasant – neutral	314.52±109.17	327.05±103.41	.20	.65
Duration of first gaze on unpleasant in pleasant – unpleasant	334.90±124.8	344.93±94.05	.12	.72

Table3. Comparison of duration of first gaze on pictures among different emotional pairs of pictures within the two groups

Variables	ADHD (N=30)		Normal (N=30)	
	Mean Rank	P	Mean Rank	P
Duration of first gaze on neutral in neutral – unpleasant condition	1.23	.003	1.50	1.00
Duration of first gaze on unpleasant in neutral - unpleasant condition	1.77		1.50	
Duration of first gaze on pleasant in pleasant - neutral condition	2.00	.0001	2.00	.0001
Duration of first gaze on neutral in pleasant – neutral condition	1.00		1.00	
Duration of first gaze on pleasant in pleasant - unpleasant condition	1.37	.14	1.57	.46
Duration of first gaze on unpleasant in pleasant – unpleasant condition	1.63		1.43	

ADHD and normal children. Further, no significant difference was found between the two groups in the duration of first fixation (Table 2).

There was a significant difference between the two groups when the duration of first gaze was considered as a variable. Children with ADHD spent less time on pleasant pictures while they were looking at the pleasant – neutral pairs (F=4.95, P=0.03). This time was also less on pleasant pictures while looking at the pleasant – unpleasant pairs in ADHD children compared to normal group (F=3.97, P=0.05) (Table2).

Within the ADHD group, the duration of first gaze on unpleasant pictures while looking at the unpleasant-neutral pairs was significantly longer compared to neutral pictures using the Friedman analysis in each group (x²=8.53, P=0.03). This duration was not different in the normal group.

On the other hand, both groups spent significantly more time in their first gazes on pleasant pictures while looking at pleasant-neutral pairs (x²=30, P<0.001)

Discussion

This study was conducted to assess the ADHD boys' attentions towards emotional scenes using the eye tracking system compared with normal boys. Children were examined in terms of their visual orientations while they were looking at paired pictures of pleasant-neutral, pleasant-unpleasant, pleasant – neutral and neutral – neutral groups. The variables are the number and the duration of first fixation and duration of first gaze on pictures. In this study, it was found that the duration of first gaze on pleasant pictures was lower in the ADHD group compared to normal children. It

means that these children are less likely to attend to pleasant pictures. It could be interpreted that children with ADHD do not spent much time to look at pleasant pictures, so they may not recognize pleasant pictures properly compared to normal children. This is in line with Pelc's study which showed that boys at risk of ADHD have confusion in recognizing happy faces (12). The findings of a recent study which has not yet been published also showed that these children have difficulty detecting happy faces compared to normal children (Noorazar, Tehrani-Doost, Khorrami, Farhadbeigi, 2012, unpublished). In this study, we also found that boys with ADHD spend more time on unpleasant pictures on their first gazes compared to neutral ones. This difference was not significant in the normal group. This is also in accordance with Pelc and Noorazar's studies in which they found that boys at risk of ADHD spent more time on recognizing emotional faces (12 & Noorazar, Tehrani-Doost, Khorrami, Farhadbeigi, unpublished). It could be interpreted that children with attention deficit/hyperactivity disorder have a tendency to look at unpleasant pictures and spend more time on them. Another interpretation is that these children need more time to recognize negative emotions compared to positive ones .

Based on these findings, we can conclude that children with ADHD orient preferably to unpleasant situations compared to normal children, so the induction of negative emotions could be increased based on their increased attentions to negative scenes. This preference in orientation cannot be interpreted by their inattentiveness per se because they should have had

impairment in orienting to all emotional scenes. Therefore, their interest to unpleasant emotional situations may be due to another component which is different from core symptoms of ADHD. This finding could be considered as another interpretation to emotional reactivity seen in ADHD children which is different from their inability to regulate their emotions (3, 18). The Barkley's theory explains dysregulation of emotions after their expressions in individuals with ADHD. However, these findings explain how these children attend to and recognize emotions. Apparently, if people have different attention to emotional cues they will express their emotions differently. This is in line with other studies showing that ADHD children differ from normal children in recognizing emotional cues in faces (10, 11, and 14.)

Based on this hypothesis, it could be concluded that the increased reactivity of ADHD children may be due to their increased attention to unpleasant and negative situations. This study is the first research on evaluating ADHD children's orientation towards emotional scenes using the eye tracking system, so we were not able to compare these findings to those of other studies'. Findings of this study should be reassessed by other studies with larger samples to confirm the mentioned hypothesis. It is not clear whether this emotional deficit is based on oppositional symptoms accompanying ADHD or is due to ADHD per se. To answer this question we need to evaluate this hypothesis in a large group of children with ADHD, to assess the oppositional symptoms and their association with these findings. It should again be mentioned that this study was conducted only on boys with ADHD. Therefore, further studies to examine this hypothesis in ADHD girls compared to boys are recommended.

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