ORIGINAL RESEARCH

Evaluation of self-esteem in children with attention-deficit/hyperactivity disorder based on event-related potential

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Abstract

Background: Self-esteem, the value we place on ourselves, has been associated with effects on health, and life satisfaction. Many studies reported that children with attention-deficit/hyperactivity disorder (ADHD) suffer from low self-esteem has been associated with negative life outcomes. The present study investigated neural correlation of self-esteem in this group compared with typically developing children using the event-related potentials (ERP).

Materials and Methods: A total number of 10 children with ADHD were compared with 10 typically developing children matched with their age, gender and IQs. We employed the event-related potential (ERP) technique to explore neural manifestations of implicit self-esteem using the Go/Nogo association task (GNAT). Participants generated a response (Go) or withheld a response (Nogo) to self-words and good or bad attributed.

Result: ERP results showed delayed N200 response in frontal areas in bad condition in normal children compared to ADHD children ($p < 0.05$), indicating positive self-esteem.

Conclusion: The present study provides neural evidence for probably low self-esteem in ADHD children.

Keywords: ADHD, Event-related potentials (ERP), N200 component, Self-esteem

Introduction

ADHD is a common neurodevelopmental disorder which is characterized with inattentiveness, hyperactivity/impulsivity (1, 2). These children have difficulties in social and emotional functions, and are often rejected by their peers (3, 4). ADHD affects many aspects of life, such as problem of lack of self-control with broad implications in the development, learning ability, social adaptation (5, 6), school difficulties (7, 8) and increased risk for development of low self-esteem (9). Indeed, many studies have reported negative relationships between ADHD and self-esteem (10).

The concept of self-esteem refers to a person's evaluation of himself or herself (11). People like to defend their self-esteem when it is threatened (12). Low self-esteem has been associated with negative life outcomes, including substance abuse (13), unhappiness, depression, eating disorders, worsened recovery after illnesses (14), fearfulness, shyness, loneliness (15), enhanced sensitivity to cues of social standing (16), more susceptible to interpersonal distress, posttraumatic stress disorder (PTSD), social phobia (17-19), and more manifestation of psychiatric symptoms (20). In contrast, high self-esteem may increase motivation to engage in self-care behaviors that ultimately reduce symptoms or may directly improve mood, thereby reducing symptoms (21). High self-esteem has been associated with positive characteristics such as initiative, strong coping skills, persistence in the face of challenges, happiness, longevity (22), positive emotions, and even physical health (23).

Previous work has shown that self-esteem modulates neural responses to social feedback in the dorsal anterior cingulate cortex (dACC), dorsal medial prefrontal cortex (dMPFC), posterior superior temporal sulcus (pSTS), anterior insula (24), ventral anterior cingulate cortex (vACC), and MPFC (25). Individual differences in self-esteem are reflected in both structural and functional fronto-striatal circuits linking areas underlying self-referential cognition to ones involved in positive evaluation. On the other hand, few studies reported the mental flexibility network such as fronto-parietal circuits, includes the lateral frontal lobe, the anterior cingulate cortex, dorsolateral and anterior prefrontal cortex, lateral cerebellum, anterior insula gyrus, caudate nucleus and inferior parietal lobe regions, altered in children with ADHD (26, 27).

Neural studies that examine self-esteem in ADHD are rare. Event-related brain potentials (ERP) is a research tool with high temporal resolution for investigating neurocognitive functions (28). In ERP studies, the Go/No-go Association Task (GNAT), a measure of implicit social cognition developed by Brian Nosek (29), used to study neural mechanisms behind response inhibition. GNAT is a classical measure of implicit attitude, or the strength of association between a target and good vs. bad attributes. Augmented and delayed fronto-central N200 component, indicating response inhibition, frequently has been observed in Nogo responses in comparison with Go responses. A self-esteem GNAT involves at least two blocks. In one block (self + good condition), participants respond to self and good stimuli (Go), but ignore bad stimuli (Nogo) (Press if a self word + good word); in the other block (self + bad condition), participants respond to self and bad stimuli (Go), but ignore self and good stimuli (Nogo) (Press if a self word + bad word) (30).

The aim of the present study is to gain better understanding of the neurobiological basis of children with ADHD in self-esteem. Based on literature mentioned above, we expected that Nogo menus Go responses to self+good during the self + bad condition, would elicit a larger and delayed N200 component in normal children compared to ADHD ones.

Materials and Methods

Subjects

Ten boys between the ages of 7 and 11 years old (9.51 ± 0.6) diagnosed with ADHD were compared with ten healthy boys (9.92 ± 0.08 years old) matched on age, sex, and years of education. Normal children were recruited from elementary schools in Tehran, Iran. Children with ADHD (combined type) were selected from drug naive patients that were referred to a child and adolescent psychiatrist clinic. Diagnosis was made by a child and adolescent psychiatrist based on DSM-IV-TR (Statistical Manual of Mental Disorders, Fourth edition) (31) criteria as a clinical assessment. The two groups were right-handed

and had normal visual acuity. In addition, Intelligence Quotient (IQ) of all participants were evaluated according to the WISC-R IQ test (ADHD group: 99 ± 6.75, normal group: 111 ± 6.25).

Task and stimuli
The pictures were viewed for 1000 ms followed by a white fixation point for 1000 ms with ±100 ms randomization. The stimuli were being presented at the middle of the screen. The task was designed using the Evoke software (version 3.1). The task included one practice and two experimental blocks. Each block comprised with 96 trials. We selected 99 Persian words as stimuli: 3 self-words including self, myself, I; as well as 48 positive attribute words and 48 negative attribute words. Most attributes were selected from the Anderson Word List (32). Then these words translated to Persian language and confirmed with four expert psychologists. In each block, two identical categories of stimuli were presented. In the self + good block (condition), participants were instructed to press the space bar if a stimulus conveyed self-words + positive-words, but to do nothing if a stimulus was bad-words, and vice versa in the self + bad block. Before each block, pilot trials were run to enable participants to become familiar with the task. For each trial, the stimulus was randomly selected from two categories of stimuli, with equal numbers of stimuli from each category. The attribute words were presented without repetition.

The parents completed a consent form before starting the examination. During the ERP session participants were being seated in a comfortable chair in a dimly lit room at a distance of 60 cm from a 17-inch LG computer screen. The participants were told to always look at the center of the screen, if possible without making eye movements, and to blink only during the intervals. To ensure that they attend to stimuli, they monitored by camera in other room during task performance.

Electrophysiological recording and analysis
Continuous EEG signals were recorded by 32 Ag/AgCl electrodes mounted in an electrode cap (Waveguard, ANT, Netherlands) according to the international 10-20 standard system with additional intermediate positions.

ASA 4.7.1 software was used for data acquisition. Electrode impedances were maintained below 10 kΩ. The sampling rate was 512 sec–1. EEG data was analyzed offline using the EEGLAB software (version 11.0.4.3b). Raw data was filtered with a band-pass filter of 1 to 45 Hz and referenced to the average between electrodes. The eye movement artifacts were removed using the independent component analysis (ICA). In addition, the remaining artifacts with deflection amplitudes of ± 100 μV from the baseline were eliminated (primarily through automatic artifact reduction). Artifact-free EEG recordings were then segmented into epochs ranging from 250 ms pre-stimulus to 800 ms post-stimulus. Each channel baseline was corrected by the pre-stimulus voltage subtraction.

We investigated N200 component. This component is an index of response inhibition particularly in the fronto-central region during Go/Nogo paradigm. Following inspection of the grand average of ERPs and based on the literature, we decided to quantify the peak amplitudes of N200 component within specified latency windows between 250-400 ms in Fz, FCz, F3, F4, FC3, FC4 electrodes (30).

Statistical analysis
Mean values of the amplitude and latency were statistically analyzed using repeated-measure analysis of variance (ANOVA) comprising the following core factors: 2 conditions (self-good, self- bad), 2 response types (Go, Nogo) as the within subjects factors, and groups (patients and controls) as the between subject factor. Greenhouse-Geisser was used for the degrees of freedom. Throughout the experiment, differences with $p < 0.05$ were considered significant. Follow-up independent sample t-test was used to break down between-subject and interaction effects.

Results
In behavioral level, we performed an ANOVA on reaction time to self on Go trials in two conditions (good vs. bad) in two groups. Inconsistent with our expectation, current results not revealed any significant main or interaction effect ($p > 0.05$).

Also, in investigation of amplitude of N200 responses using repeated-measure ANOVA, we observed no significant main effect or interaction in factors of condition, response-type, and groups (p > 0.05).

In investigation of latency of N200 responses and inhibition responses evaluation, firstly we computed Nogo minus Go waves latencies in both of conditions (good, and bad) in two groups. Then we conduct 2×2 ANOVA test, condition (good vs bad) × group (Normal vs ADHD). Current results showed a significant interaction effect of condition × group [F(1,18) = 5.216, p = 0.035]. Thus, we used independent sample test for response compare (No/go menus Go) between group in each condition separately. Results showed a significant different in bad condition between groups (t (18) = 3.274, p = 0.001), but in good condition not revealed significant different between ADHD and normal groups (t(18) =-1.342, p-value = 0.3).

Also, in section of grand average, we observed different between latencies of Go and No/go response waves only in bad condition. In normal children, mean of N200 latency for No/go response was 341.82 ± 0.32 ms, and for Go response was 324.15 ± 0.1 ms. In ADHD children, mean of N200 latency for Nogo response was 337.1±0.91 ms, and for Go response was 335.92 ± 0.4 ms in bad condition.
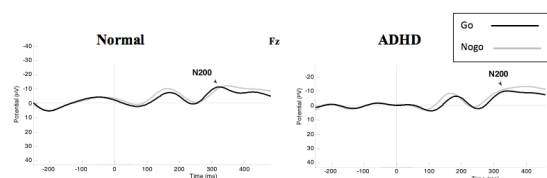

Figure 1. Grand-average of the N200 components in ERPs recorded from the Fz electrode during response to presentations of self-bad condition in Normal and ADHD children.

Discussion

The aim of this study was to evaluate self-esteem by the N200 component in patients with ADHD compared normal children during Go/No-go Association Task (GNAT). We expected to observe difference N200 features in children with ADHD compared to normal. During bad condition, the results revealed delayed Nogo response in normal children compared to ADHD ones, indicating positive self-esteem in normal children compared to ADHD ones. Thus, this study supported our hypothesis that children with ADHD were difference from normal children in self-esteem. Consistent with current results Wu et al. (2014) showed delayed Nogo N200 negativity in the self + bad condition as compared with the self + good condition, suggesting the manifestation of implicit self-esteem on brain activity suggesting that activated self-association is positive in healthy subjects (30). One study showed the difficult task elicited a greater N2 (300–450 ms) component than the easy task, but only in the low self-esteem undergraduate students. The authors speculate that the difficult math might have induced more negative emotions in subjects with low self-esteem, and that low self-esteem individuals might be more susceptible to interpret the difficult task as threatening (33). Other studies using go/no-go, task and other conflict tasks, reported the frontal-central N2 has repeatedly been shown to be strongly associated with conflict conditions (34). Inconsistent to our hypothesis, current study not revealed any different N200 amplitude between groups. Low sample size maybe is possible reason for inconsistent results. It needs more consideration with further research. However, lack of different in No/go response (self+good) compared to Go response (self+bad) latency during bad condition in ADHD group, but not for healthy ones, supported our hypothesis that children with ADHD were difference from normal children in self-esteem and probably they have low self-esteem based on neural deficit. Consistent with these results, many studies showed that ADHD group have low self-esteem compared to normal (10, 35). However, few studies reported that children and adolescents with ADHD often overestimate their abilities, perceptions of self and self-concepts. Thus, as a protection mechanism, they enhance the appreciation of happiness that they feel with their lives (36). ADHD children shows more difficulties on attention and executive functions, worse are the performance in schoolwork and everyday tasks, which can impact the development of self-esteem and causes more guilty feelings, which in turn are associated with academic failure and increased risk for development of low self-esteem (9, 37).

In summary, based on our findings and previous studies, we interpret that ADHD children have probably some impairments in neural resources of positive view to self, which can lead to many difficulties in these children in future. These findings might provide initial evidence for future planning of interventional approaches for increasing self-esteem in children with ADHD and prohibition and reducing of more difficult in future.

Conflict of interest
Authors declare no conflict of interest.

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