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The Effectiveness of Neurofeedback on Improving Social Interactions and Activity of Daily Living in Children with Autism Spectrum Disorder: A Narrative Review

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Abstract

Context: Impairment in social interactions and daily activities of autism spectrum disorder (ASD) patients is one of the negative and important consequences of ASD. Recently, the use of non-pharmacological methods to improve behavior and rehabilitation in patients with ASD has attracted the attention of researchers and specialist physicians. According to the mentioned topic, This study aimed to evaluate the effectiveness of neurofeedback (NF) in improving social interactions and activity of daily living (ADL) in children with ASD.

Evidence Acquisition: This narrative review obtained the desired results by collecting previous similar studies related to the study's primary purpose. First, 182 articles were extracted through the search of MeSH (medical subject headings) terms associated with the particular objectives of the study in international reliable databases. Then, twenty-five studies were selected as final studies considering the inclusion and exclusion criteria.

Results: The results of the present study showed that NF can help to improve the performance of children with ASD through brain waves as a new treatment method based on conditioning and reinforcement. NF helps identify cognitive problems and improve cognitive processes in autistic children by improving self-regulation of the brain. In addition, NF leads to better cognitive performance by increasing beta waves and decreasing theta waves. On the other hand, increasing beta waves increases alertness, concentration, and metabolism, which can improve cognitive and social functioning.

Conclusions: Based on the results, NF has a positive and significant effect in improving social interactions and ADL in children with autism spectrum disorder. Therefore, this method should be used to improve behavioral disorders and strengthen the ADL of patients with ASD, considering the side effects of pharmacological intervention methods.

Keywords: Neurofeedback, Mental Disorders, Autism Spectrum Disorder, Social Interactions, Children

1. Context

Autism spectrum disorder (ASD) is a group of disorders described in the neurodevelopmental class based on the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5). Autism spectrum disorder begins during development and before the age of three, and various genetic and environmental factors are involved in the occurrence of this disorder (1). Two general diagnostic criteria are involved for this disorder, and two diagnostic criteria have been proposed for this disorder, which include (A) the presence of persistent deficits in communication and social interactions in various situations and (B) repetitive and limited patterns of interests, behavior, and activities (2). Regarding functional level, these patients are divided into two categories: High performance and low performance. High-performance people are usually normal regarding intelligence and grammatical and linguistic functions, but they have problems in daily life and living independently (3).

Upon the increase of ASD patients, the families of the patients should spend more money and time to provide health, rehabilitation, and educational services for these patients. As a result, the social damage resulting from this problem will be more significant (4, 5). The problem with cognitive skills is one of the problems faced by

people with ASD. Mental disability is seen in 80% of these people (IQ less than 70) (6). Another major problem for people with ASD is socializing and interacting with others appropriately and usefully at different stages of life, which also reduces their quality of life (7). Crozier and Tincani and Mathew (2006) reported that impairment in social skills is the most recognized characteristic of ASD. According to this study, on the one hand, these patients have a strong desire to be alone and avoid others. On the other hand, they desire to communicate with others but do not know how to start and continue it, and they have problems establishing communication with others (8).

The impairment in performing Activities of Daily Living (ADL) is one of the other problems of patients with ASD. Individuals develop these skills in a predictable sequence, which is part of their individual performance area, and defects in work, self-help, leisure, and health skills are usually associated with ADL impairments (9).

Treatment methods and interventions that have been proposed in children with ASD include biopharmaceuticals, complementary interventions, psycho-educational interventions, and combined selective interventions (10-15). Parents and educators of patients with ASD should evaluate which of the therapeutic-educational methods is more effective and appropriate for the patients based on the disorder created. The neurofeedback (NF) method is one of the therapeutic methods to improve social skills and ADL in patients with ASD, which has received much attention from researchers (16-20).

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On the one hand, improving social interactions and ADL levels in autistic patients by non-pharmacological methods such as NF is essential. On the other hand, no review study has been conducted on the mentioned topic. Therefore, the main goal of this study was to determine the effectiveness of NF in improving social skills and ADL in autism patients with ASD in the form of a narrative review.

2. Evidence Acquisition

This narrative review was based on three follow-up steps to achieve the results. The first step: Searching valid scientific databases worldwide by MeSH (Medical Subject Headings), which included “Autism Spectrum Disorder," “Neurofeedback," “Social Interactions," “Daily Life Activities," “Children," “Social Interaction," “Social Behavior," “Social Communication," “Psychopharmacological Treatment," “Developmental Disorders," “Non-pharmacological Interventions," “Therapy," “Outcomes," “Cognitive Training Programs" and “Clinical Evaluation." Second steps: A total of 182 published articles and authentic scientific reports were received, and twenty-five studies were finally selected as final studies considering inclusion and exclusion criteria. Research on nonpharmacological methods (excluding Neurofeedback) and unrelated variables, including focus, active memory, electroencephalogram, balance, reading disorder, cognitive deficits, attraction, etc., were excluded during the screening process of received studies. Third step: The results of the final selected studies were evaluated and extracted by the researchers, and then the findings were discussed.

3. Results

High-Functioning Autism (HFA) is one of the autism spectrum disorders. In this situation, people with HFA have better cognitive performance than other autistic children, and mostly, their intelligence quotient (IQ) score is more than seventy. However, children with HFA have poorer communication and social skills compared to healthy children (21, 22). Joint attention skills (JAT) are a significant deficiency in children with ASD, in addition to stereotyped behaviors or special interests and communication deficits that affect verbal and non-verbal strategies. Deficits in JAT are associated with poor attitudes about the mind, communication, and self-regulation (23, 24). JAT is a condition in which two people actively focus on a thing, event, or situation. In normally developing children, JAT is often completed by the end of eighteen months (24). According to the theory of Sigman and McGovern (2005), it is considered a critical deficit in children with ASD of any spectrum (25, 26). Children with autism spectrum disorders have deficits in JAT, but their mechanisms are unclear. A hypothesized mechanism underlying the social disorders associated with HFA is a defect in the Mirror Neuron System (MNS) and has been proposed in the form of Broken Mirrors theory. Deficits in MNS activity may explain abnormal social skills common in ASD, such as impaired JAT, understanding others' goals, and

empathy (27, 28). This disorder likely stems from the inability to form and coordinate social representations of oneself and others.

Electroencephalogram (EEG) showed that MNS activity in children with ASD shows abnormalities compared to children with normal development (29). However, few studies have focused on operationalizing such solutions to improve MNS defects potentially. Direct recording of neural activity using electromagnetic methods has shown activation patterns associated with mirror neurons (30, 31).

In the first studies on the effect of NF on autism symptoms, Jansiewicz et al. (2006) evaluated the effectiveness of NF training on children with ASD. In the mentioned research, twenty-four 24 children with ASD were divided into two equal groups of 12 people regarding gender, age, and severity of the disorder. NF was taught to one group (experimental group), and this intervention was not performed for the other group (control group). The study showed that NF training caused a 26% reduction in autism symptoms compared to the control group (3% reduction) (21). Scolnick (2005) reported that their EEG performance, concentration, and attention improved after 24 sessions of NF, and their anxiety and unpleasant social behaviors decreased (32). Despite some conflicting results about the effect of NF on the performance of people with ASD, the results of Kouijzer et al. (2013) (33), Coben et al. (2010) (34), Thompson et al. (2010) (35), showed that NF can help improve the performance of children with ASD through brain waves as a new treatment method based on conditioning and reinforcement. Accordingly, many parents and physicians are looking for low-risk and effective treatment methods such as NF to reduce the symptoms of ASD. Mohammadi et al. (2019) reported that the effectiveness of NF in improving cognitive and social skills in 7-12-year-old children with ASD was significant ($P < 0.001$) (36). In addition, similar results by Carrick et al. (2018) concluded that the NF method affects the brain activities, motor sensors, and daily behavior of people with ASD (37). However, the results of Marlats et al. (2019) showed that the effectiveness of NF on mild cognitive impairment in adults is not significant (38). Although the studies of Carrick et al. (2018) and Marlats et al. (2019) were similar regarding subject matter and objectives, the difference in the results could be due to the difference in the population (37, 38).

Regarding the effect of NF, there are disorders in the growth process of neuronal networks in the brains of children with ASD. Thus, structural or pathological changes are not seen in evaluating the brain tissue of these patients. NF can be an exercise to restore the neuronal network function of autistic patients (39). The attitude towards the situation is that autistic children have an over-excited nervous system, which causes the child not to pay attention and perform properly. Therefore, the first step for improving the performance of autistic children is to remove their nervous system from the aforementioned critical state (36). NF helps identify cognitive problems and improve cognitive processes in autistic children by improving self-regulation of the brain. In addition, NF leads to better cognitive performance by increasing beta waves and decreasing theta waves. On the other hand, increasing beta waves increases alertness, concentration, and metabolism, which can improve cognitive and social function (40).

Activity of Daily Living (ADL) is one of the life dimensions of patients with ASD that can be affected due to the consequences of this disease. Orsmond et al. (2007) found that adolescents with more independence in ADL participate more in community and creative activities (41). Mirzaie et al. (2018) showed that ADL provides opportunities to participate in two-person and group activities, especially in the early years of life. In addition, ADL affects the child's development and can affect the development of language, the creation of social skills, and the achievement of academic skills in the future (42). According to the results of the studies mentioned above, it is logical that effective treatment methods on social skills also affect ADL activity. In general, NF can affect cognitive restructuring, muscle relaxation training, life skills training, and coping with anxiety-provoking situations. Mohammadi et al. (2019) concluded that NF has a significant effect on ADL improvement in autistic children ($P < 0.001$) (36).

In addition to the positive and significant impact of NF on the social skills and cognitive performance of autistic patients, this treatment method improves other disorders and similar diseases, including children with attention-deficit/hyperactivity disorder, generalized anxiety disorder, multiple sclerosis, reading disorder, social cognitive deficits, and attention deficit hyperactivity disorder has a positive and significant effect (43-48). According to the results, NF therapy is an effective treatment method for mental disorders.

4. Conclusions

Based on previous studies, NF has a positive and significant effect in improving social interactions and daily life activities in children with ASD. Therefore, considering the side effects of pharmacological intervention methods, it is suggested to use educational

methods and other non-pharmacological methods, such as NF, to treat behavioral disorders and strengthen daily functioning for patients with ASD.

Footnotes

Authors' Contribution: M.H.S: Presenting the idea, designing the study, writing and revision of the manuscript; M.S: Collection and recording of data, writing, and revision of the manuscript.

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