

Neuro-Feedback Therapeutic Treatment For Autism Spectrum Disorders; Systematic Review

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ABSTRACT

Background: Neuro-feedback treatment is a modern equipment therapeutic technique that uses a tool to provide information on the brain's function to help people change their brain function. Neuro-feedback therapy helps to enhance behavioral or cognitive mechanisms associated with brain function.

Review question/objective: The goal of this study is to look at the effectiveness of neurofeedback therapy for people with autism spectrum disorders in a systematic way. The specific objectives are to identify how much the neurofeedback therapy showed the supporting evidence with autism spectrum disorders. The question in the review study is as follows: What is the efficacy of neuro-feedback therapy in the treatment of autism spectrum disorders in infants, adolescents and adults.

Methods: This review paper has included different study designed with and without control groups. The studies populations included different aged children, adolescents and adults with autism spectrum disorders the different sampling techniques were used. They received the sessions of neurofeedback treatment. Children were tested before and after neuro-feedback training and contrasted with the use of a cognitive evaluation method examination.

Conclusion: In the improvement of autism spectrum disorders, neuro-feedback therapy is effective.

Key word: Neurofeedback, Autism Spectrum Disorders

INTRODUCTION

Neurofeedback is a method of training that helps people to adjust their brain function by using an instrument that offers knowledge about the brain's function. The aim of neurofeedback is to enhance brain activity-related behavioral or cognitive processes. The neurofeedback approach, which has been around for a while, is gaining favor as a treatment for a variety of diseases [1]. Recent data suggests that the neuro feedback approach can be utilized to help people with autism spectrum disorders.

Neurofeedback is a type of biofeedback that teaches participants self-control of brain activities by measuring brain waves and providing a feedback signal. The audio and/or video input is generally given by neurofeedback. For desirable or undesirable brain activities, positive or negative feedback is provided [2].

The notion of neurofeedback is not new. For many decades, it has been the topic of study by scholars. Neurofeedback is a technique which helps subjects consciously regulate their brain waves. Electroencephalography (EEG) is, in fact, documented during treatment with neurofeedback. Then, using an online feedback loop in the form of audio, video or combination, its various components are extracted and fed to subjects. Therefore, electrophysiological components are shown separately. As an example, a changing bar graph can display the strength of a signal in a frequency band. During this procedure, the subject becomes aware of the changes that occur during training and will be able to track his or her development in order to reach maximum efficiency. For example, the individual may strive to improve brain patterns depending on changes in music or visual. The alpha, beta, delta, theta, and gamma treatment protocols for neurofeedback are generally focused on alpha, beta, delta, theta, and gamma therapy, or a mixture of them, such as alpha/theta ratio, beta/theta ratio [3]. The most commonly used protocols are alpha, beta, theta, and alpha/theta ratio. In this review research, we looked at the efficacy of neurofeedback therapy protocols for autism spectrum disorders.

Various Frequency Components

The frequency indicates how readily the waves, which are determined by the number of waves per second (Hz), oscillate, while the amplitude reflects the power of these waves, which is determined by the microvolt (μV). Delta (less than 4 Hz), theta (4-8 Hz), alpha (8-13 Hz), beta (13-30 Hz), and gamma (30-100 Hz) are all frequency components with different physiological functions. (Chart1). There are, however, differences in how different researches define the exact collection of frequency components [3, 4].

Table 1: Specific Brainwaves with their Characteristics

Common Brainwave Frequency	Frequency Range (Hz)	General Characteristics
Delta	1-4	Sleep, regeneration, challenging problem solving, unconsciousness, deep-unconsciousness

Theta	4-8	Creativity, insight, profound states, unconsciousness, optimum state of meditation, fear, distractibility, depression
Alpha	8-13	Alertness and peacefulness, readiness, meditation, deeply- relaxed
Lower alpha	8-10	Recalling
Upper alpha	10-13	Optimize cognitive performance
Sensory motor rhythm (SMR)	13-15	Mental alertness, physical relaxation
Beta	15-20	Thinking, concentration, sustained attention, anxiety, alertness, arousal
High beta	20-32	Intensity, hyper-alertness, tension
Gamma	32-100 or 40	Learning, cognitive processing, tasks to solve problems, mental sharpness, brain function, brain organization,

In people with ADHD, most research has been performed on neurofeedback therapy. Attention deficit hyperactivity disorder (ADHD) is a developmental disorder characterized by inattention, hyperactivity, and impulsivity [5]. EEG patterns show increased theta power and decreased beta power over frontal and central midline cortical brain areas in 85 to 90% of patients with ADHD [6]. Neurofeedback in ADHD helps to reduce theta power and raise beta power in these circumstances. A recent meta-analysis on the effectiveness of EEG biofeedback in ADHD [7] was published, although neurofeedback treatment for autistic spectrum disorders has also been studied. Neurofeedback's benefits for people with autism are also discussed. Finally, we review the most recent neurofeedback and autism research and discuss some potential future research topics.

Neurofeedback response rates have been reported to range between 54% and 76% in individuals with autism [8, 9, and 10]. This means that in more than half of the individuals with autism who took part in a scientific study, EEG behavior was effectively improved over the course of neurofeedback therapy. Simultaneously, a sizable number of clients have been unable to respond to neurofeedback over time. As a result, it may be interesting to speculate on why some people respond well to neurofeedback treatment while others do not. While the exact reason why some people respond to neurofeedback is unknown at this time, it's possible that respondents and non-responders differ in some psychological characteristics, such as attention span, cognitive flexibility, or reward sensitivity. Alternatively, there could be physiological differences between the mean theta powers levels of two clients trained to lower theta power throughout the course of 40 neurofeedback sessions. The mean values of theta power per session of a neurofeedback responder are shown in the upper half of the figure, while the mean values of theta power per session of a neurofeedback non-responder are shown in the lower portion of the image.

METHOD

The current qualitative review included both published and unpublished studies. Current review of children, adolescents and adults aged 8 years or older living with an autism spectrum disorders. The emphasis of this systematic review has been well established in the literature on the efficacy of neurofeedback therapy for autism spectrum disorders. Neurofeedback, based only on autism spectrum disorders, has been studied in existing systematic evaluations and conditions of other disorders have been omitted from the latest one.

Review studies investigating neurofeedback, therapy but not limited to the single device, the LENS, and mixed alpha / theta and alpha / beta protocols were discussed in the study. There was no exclusion dependent on the therapy's frequency, severity or duration. Every method / protocol of neurofeedback was included in the experimental interventions. The control group may consist of no treatment, any alternative treatment or other neurofeedback method / protocol.

Types of studies

The current study consider both experimental and epidemiological research designs, including RCTs, non-RCTs, quasi-experimental, before and after trials, prospective and retrospective cohort trials, case control studies, and cross-sectional analytical investigations. Only researches done in English were considered for this study.

DISCUSSION

Neurofeedback's therapy efficacy in autism disorder has been documented in around 8 scientific publications currently. Table 2 summarizes the studies that have looked into the effects of neurofeedback on autism. Some research [11, 12, and 13] found that neurofeedback had an effect on one or more participants. While other studies compared the neurofeedback group to the non-neurofeedback or other treatment group of individuals [8, 14, 9, 10]. Furthermore, in all of the investigations to far, the subjects were either children or teenagers. There have been no reports of neurofeedback in adults with autism as of yet. In all the studies that were released, about 88 percent of the participants were male. In terms of the autistic spectrum, people diagnosed with autism were included in most research. One research concentrated exclusively on PDD-NOS participants [9], while two other studies primarily involved people with Asperger syndrome [11, 13].

Autistic symptoms such as social interaction problems and communication deficiencies have been demonstrated to benefit by neurofeedback [8, 9, and 12]. There were also improvements in self-esteem, empathy, and resilience, as well as reductions in anxiety, tempers tantrums, and mood swings [11]. Parents who completed questionnaires [14, 11, & 12] all attested to the good effects of neurofeedback. In one study, neurofeedback had no effect on the decrease of autistic symptoms. According to the explanation for why some studies showed positive effects of neurofeedback on the reduction of autism symptoms while other studies were not known at the time, discrepancies in neurofeedback protocols and sample characteristics between studies may have been responsible for the study's disparate results[15]. Another theory is that it is to blame for

differences in the sample's character and, as a result, in the degree of nonspecific effect control (e.g. the attention obtained by trainees in addition to their training). The section headed 'Performance of neurofeedback study' offers more information on the effects of non-specific factors and related design difficulties. In comparison to parental reports and communication abilities, teachers have not noticed as much change in social interactions. At the same time, only three research [10, 15, and 11] included instructor findings. Teachers observed behavioral changes in adolescents with autism following neurofeedback in one of these three studies [11]. Teachers saw the same changes in behavior as parents in four of the five situations stated in this research, such as increased self-esteem and flexibility. In one of the cases discussed in this study, the instructor did not notice any changes in conduct, but the participant's parents did. Two more studies that looked at teacher reports found no change in the actions of children and adolescents after receiving neurofeedback [10, 15].

Table 2: A summary of the researches on the effects of neurofeedback in children and adolescents with autism

Authors and Year of Publication	n	Study Design	Age (Years)	Treatment	Number of Session
Sichel, Fehmi, & Goldstein, 1995	1	Case study	8	Decrease 4-8 Hz; increase 12-15 Hz; P3, Pz, and P4	31
Jarusiewicz, 2002	24	Pretest posttest control group	4-13	Decrease 2-7 Hz and 22-30 Hz; increase 10-13 Hz; C4	20-69
Scolnick, 2005	5	Case study	12-16	Decrease 2-10 Hz and 22-30 Hz; increase 8-11 Hz, 12-15 Hz or 15- 18 Hz; Fz, Cz, Pz, C4 or T6	24-31
Coben & Padolsky, 2007	49	Pretest posttest control group	3-14	Decrease hyper-connectivity	20
Kouijzer, de Moor, Gerrits, Congedo, & van Schie, 2009	14	Pretest posttest control group	8-12	Decrease 4-7 Hz; increase 12-15 Hz; C4	40
Kouijzer, van Schie, de Moor, Gerrits, & Buitelaar, 2010	20	Randomized pretest posttest control group	8-12	Decrease 3-7 Hz and slight variations; Fz, Cz or F4	40
Thompson, Thompson, & Reid, 2010	159	Case study	5-58	Decrease 3-7 Hz; increase 12-15 Hz; Cz or CFz	40-60
Kouijzer, van Schie, Gerrits, Buitelaar, & de Moor, under review	38	Randomized pretest posttest control group	12-18	Decrease 2-7 Hz and slight variations; Cz or CFz	34-40

With blinded
active
comparator

CURRENT VIEW

Neuro-feedback has been proven to help children and adolescents with autism improve their cognitive functions [8, 9, 10, and 15]. These effects were measured using a set of neuropsychological tasks that provide a more realistic assessment of therapy's effects than asking parents or teachers about their child's or student's behavior. Cognitive flexibility is a cognitive trait that has been demonstrated to improve following neurofeedback therapy. Those who got neurofeedback improved their cognitive flexibility in three investigations, whereas participants in control groups did not [9, 10, and 15]. Cognitive flexibility is defined as the ability to shift thinking or action in response to changing circumstances [16]. One of the most common characteristics of ordinary birth is a lack of flexibility. Many persons with autism, for example, struggle to transition from one circumstance to the next or fear when something unexpected happens. The positive benefits of neurofeedback on cognitive flexibility were found in studies that employed the trail creating exercise, which allows participants to link letters of the alphabet and numbers in an alternating manner (1-A-2-B-3-C, etc.) on paper. At this point, it is unknown if neurofeedback contributes to changes in real-life cognitive flexibility. Future research can look into whether neurofeedback works in real-life situations. In addition to increases in cognitive flexibility, studies have found gains in other cognitive domains [9]. More gains in concentration, inhibition, and planning have been observed, indicating a more general increase in executive functions [8], who found a general increase in executive functions followed by improvements in visual perception and language functioning, support the neurofeedback treatment result.

The results of neurofeedback training can also be measured using QEEG, which is a more objective method. Because neurofeedback focuses on adjusting the brain's electrical activity, QEEG testing can be utilized to see if the EEG was indeed impacted structurally by the treatment. The majority of studies looking into the effects of neurofeedback in children and adolescents with autism compared pre- and post-treatment QEEGs and showed that EEG activity improved following neurofeedback.

The precise effects of EEG were determined by the neurofeedback approach used. After limiting theta power and rewarding beta power, participants' theta to beta ratios reduced, i.e. changed in the direction of normality on a post-treatment measurement [12, 11, and 13]. Similarly, neurofeedback directed at decreasing delta and theta power resulted in lowered delta power in future QEEG measurements [10], while neurofeedback focused at decreasing delta and theta power resulted in decreased delta power in subsequent QEEG measurements [15]. Coben & Padolsky (2007) used neurofeedback to successfully reduce hyper-connectivity in the majority of their subjects. Only one study [9] failed to show that neurofeedback has an effect on EEGs in children and adolescents with autism. Only if the favourable benefits of neurofeedback on autistic symptoms, cognitive flexibility, and EEG behaviour reported after neurofeedback are sustained

after the end of care are clinically important. That is, if patients return to pre-treatment levels after the last neurofeedback session, they can continue with neurofeedback training for the rest of their life and profit from the results. However, present evidence suggests that neurofeedback has long-term impacts on autistic symptoms and leads to long-term development in cognitive functioning in people with autism. Following the end of the last neurofeedback session, Kouijzer and colleagues measured autistic symptoms and cognitive function for six months, ten months, fifteen months, and twelve months. The effects of EEG theta activity were found to be preserved six months after the completion of neurofeedback in one study [10], but the initial changes in EEG delta activity detected immediately after treatment returned to baseline after six months in another study [15]. The explanation for why EEG improvements were long-lasting in one study but not in the other could be due to the various samples employed in both experiments. Participants in the first trial ranged in age from 8 to 12 years old and had a wide range of behavioral disorders, whereas those in the second study ranged in age from 12 to 18 years old and had mostly internalizing issues. EEG alterations in younger participants or participants with both externalizing and internalizing behavior difficulties may be more likely to persist over time than EEG changes in older participants or people with internalizing behavior problems. The good impacts on cognitive flexibility abilities that co-occurred after neurofeedback were shown to be sustained six months later, despite the fact that the improvements in EEG activity were not sustained. This research suggests that long-term EEG alterations aren't required for systemic gains in cognitive flexibility. A drop in slow wave power may be required to start improving cognitive flexibility, but other mechanisms are needed to keep the ability to switch activities going.

CONCLUSION

Neuro-feedback is a tool that is used in a number of psychiatric conditions, such as autism, to modify brain activity that deviates from normality. Latest studies indicate that neurofeedback can offer a helpful therapy for the autism spectrum of individuals. Indeed, multiple studies have shown that people with autism may modify their brain activity by the use of neurofeedback in particular frequency bands, and that neurofeedback training can be followed by sustained improvements in the symptoms of autism, cognitive functioning, and long-term changes in EEG.

RECOMMENDATION

Any treatment procedure can be tested in an experimental setting to see how beneficial it is in a specific demographic. Such experimental research should adhere to a variety of guidelines in order to prevent study outcomes from being influenced by factors other than the treatment itself. Campbell and Stanley (1963) recommended the use of a pretest-posttest control group design to control characteristics that could cause results to be mistaken with experimental therapy results, such as maturation. In a randomized pretest posttest control group design, participants are randomly allocated to one of two study groups: the treatment group, which receives the therapy of interest, and the control group, which does not. Participants in both classes are examined at the same time before and after therapy.

Several experts have stated that the findings of prior studies studying the impacts of neurofeedback were not the result of neurofeedback per se, but rather reflected nonspecific effects of neurofeedback. Beneficial effects induced by sources other than interest-bearing therapy are known as non-specific therapeutic effects.

As indicated in this chapter, some people with autism respond well to neurofeedback and are able to change their EEG behavior during sessions, whereas others do not respond and do not elicit EEG changes. Importantly, a recent study discovered that the benefits of neurofeedback are limited to persons with autism who respond to it. As a result, it's critical that neurofeedback responders are identified early on, preferably before therapy begins. Future research should define the demographic, psychological, and physiological characteristics of those who react to neurofeedback.

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