What is Neurofeedback?

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Neurofeedback and Epilepsy

In 1992, Andrews and Schonfeld [24] reported the largest study, using a behavioral approach, which included EEG biofeedback for 83 subjects with medically uncontrolled seizures. Seizure types were not described. Patients were trained to identify preseizure warnings and triggers, perform diaphragmatic breathing techniques, and use EEG biofeedback to induce therapeutic alpha activity (8–12 cps at 50 mV). Sixty-nine of the eighty-three subjects (83%) achieved total seizure control, which was defined as no seizures during the time of this multifaceted behavioral treatment.
Kamiya’s experiment had two parts.

In the first part, a subject was asked to keep his eyes closed and when a tone sounded to say whether he thought he was in alpha. He was then told whether he was correct or wrong. Initially the subject would get about fifty percent correct, but some subjects would eventually develop the ability to better distinguish between states. In the second part of the study, subjects were asked to go into alpha when a bell rang once and not go into the state when the bell rang twice. Once again some subjects were able to enter the state on command. Alpha states were connected with relaxation, and alpha training had the possibility to alleviate stress and stress-related conditions.
Joe Kamiya, PhD
Alpha Theta Neurofeedback
Alcoholics

**Alpha Theta Training**
- Enhanced percentages of alpha and theta waves
- Reduction in depression
- 2 out of 10 relapsed in 36 months
- Significant decrease in all clinical scales

**Traditional Psychotherapy**
- Significant decrease in avoidant and psychotic thinking
- 8 out of 10 relapse in 36 months
Anxiety – before and after neurofeedback
Pre-post QEEG - Anxiety

Z Scored FFT Summary Information

Delta Absolute Power

Theta

Alpha

Beta

High Beta

Z Scored FFT Summary Information

Delta Absolute Power

Theta

Alpha

Beta

High Beta
Pre-post QEEG ADHD
Efficacy of Neurofeedback treatment in ADHD: The effects on Inattention, Impulsivity and Hyperactivity: A meta-analysis.

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Effect Sizes

• An effect size of 0.8 means that the score of the average person in the experimental group is 0.8 standard deviations above the average person in the control group, and hence exceeds the scores of 79% of the control group.
Another way to interpret effect sizes is to compare them to the effect sizes of differences that are familiar.

Small Effect Size = .2
  • difference between the heights of 15 year old and 16 year old girl.

Medium Effect Size = .5
  • difference between heights of 14 year old and 18 year old girls.

Large Effect Size = .8
  • difference between the heights of 13 year old and 18 year old girls.
ADHD meta-analysis

**Impulsivity**

N = 718

Neurofeedback vs. No Treatment
The average effect size was 0.6862.

Neurofeedback vs. Methylphenidate
The average effect size was -0.0393
Inattention
N = 324

Neurofeedback vs No Treatment

The average effect size for Inattention after excluding one study was 1.0238
Hyperactivity

N = 375

Neurofeedback vs. No Treatment

The average effect size for Hyperactivity was 0.7082
But what about autism spectrum, anxiety, and other disorders?

• An Effective Neurofeedback Intervention to Improve Social Interactions in Children with Autism Spectrum Disorder.

• Friedrich EV¹, Sivanathan A², Lim T², Suttie N³, Louchart S³,⁴, Pillen S⁵, Pineda JA⁵.

• Author information

• Abstract

• Neurofeedback training (NFT) approaches were investigated to improve behavior, cognition and emotion regulation in children with autism spectrum disorder (ASD). Thirteen children with ASD completed pre-/post-assessments and 16 NFT-sessions. The NFT was based on a game that encouraged social interactions and provided feedback based on imitation and emotional responsiveness. Bidirectional training of EEG mu suppression and enhancement (8-12 Hz over somatosensory cortex) was compared to the standard method of enhancing mu. Children learned to control mu rhythm with both methods and showed improvements in (1) electrophysiology: increased mu suppression, (2) emotional responsiveness: improved emotion recognition and spontaneous imitation, and (3) behavior: significantly better behavior in every-day life. Thus, these NFT paradigms improve aspects of behavior necessary for successful social interactions.
Autism Spectrum

- Neurofeedback training produces normalization in behavioural and electrophysiological measures of high-functioning autism.
- Pineda JA\textsuperscript{1}, Carrasco K, Datko M, Pillen S, Schalles M.
- Author information
- Abstract
- Autism spectrum disorder (ASD) is a neurodevelopmental condition exhibiting impairments in behaviour, social and communication skills. These deficits may arise from aberrant functional connections that impact synchronization and effective neural communication. Neurofeedback training (NFT), based on operant conditioning of the electroencephalogram (EEG), has shown promise in addressing abnormalities in functional and structural connectivity. We tested the efficacy of NFT in reducing symptoms in children with ASD by targeting training to the mirror neuron system (MNS) via modulation of EEG mu rhythms. The human MNS has provided a neurobiological substrate for understanding concepts in social cognition relevant to behavioural and cognitive deficits observed in ASD. Furthermore, mu rhythms resemble MNS phenomenology supporting the argument that they are linked to perception and action. Thirty hours of NFT on ASD and typically developing (TD) children were assessed. Both groups completed an eyes-open/-closed EEG session as well as a mu suppression index assessment before and after training. Parents filled out pre- and post-behavioural questionnaires. The results showed improvements in ASD subjects but not in TDs. This suggests that induction of neuroplastic changes via NFT can normalize dysfunctional mirroring networks in children with autism, but the benefits are different for TD brains.
Depression

- Real-Time Functional Magnetic Resonance Imaging Amygdala Neurofeedback Changes Positive Information Processing in Major Depressive Disorder.

- Young KD¹, Misaki M², Harmer CJ³, Victor T², Zotev V², Phillips R², Siegle GJ⁴, Drevets WC⁵, Bodurka J⁶.

- Author information

- Abstract

- BACKGROUND:

In participants with major depressive disorder who are trained to upregulate their amygdalar hemodynamic responses during positive autobiographical memory recall with real-time functional magnetic resonance imaging neurofeedback (rtfMRI-nf) training, depressive symptoms diminish. This study tested whether amygdalar rtfMRI-nf also changes emotional processing of positive and negative stimuli in a variety of behavioral and imaging tasks.

- METHODS:

Patients with major depressive disorder completed two rtfMRI-nf sessions (18 received amygdalar rtfMRI-nf, 16 received control parietal rtfMRI-nf). One week before and following rtfMRI-nf training, participants performed tasks measuring responses to emotionally valenced stimuli including a backward-masking task, which measures the amygdalar hemodynamic response to emotional faces presented for traditionally subliminal duration and followed by a mask, and the Emotional Test Battery in which reaction times and performance accuracy are measured during tasks involving emotional faces and words.

- RESULTS:

During the backward-masking task, amygdalar responses increased while viewing masked happy faces but decreased to masked sad faces in the experimental versus control group following rtfMRI-nf. During the Emotional Test Battery, reaction times decreased to identification of positive faces and during self-identification with positive words and vigilance scores increased to positive faces and decreased to negative faces during the faces dot-probe task in the experimental versus control group following rtfMRI-nf.

- CONCLUSIONS:

rtfMRI-nf training to increase the amygdalar hemodynamic response to positive memories was associated with changes in amygdalar responses to happy and sad faces and improved processing of positive stimuli during performance of the Emotional Test Battery. These results may suggest that amygdalar rtfMRI-nf training alters responses to emotional stimuli in a manner similar to antidepressant pharmacotherapy.
Anxiety

- Frontal alpha asymmetry neurofeedback for the reduction of negative affect and anxiety.
- Mennella R¹, Patron E², Palomba D³.
- Author information
- Abstract

Frontal alpha asymmetry has been proposed to underlie the balance between approach and withdrawal motivation associated to each individual's affective style. Neurofeedback of EEG frontal alpha asymmetry represents a promising tool to reduce negative affect, although its specific effects on left/right frontal activity and approach/withdrawal motivation are still unclear. The present study employed a neurofeedback training to increase frontal alpha asymmetry (right - left), in order to evaluate discrete changes in alpha power at left and right sites, as well as in positive and negative affect, anxiety and depression. Thirty-two right-handed females were randomly assigned to receive either the neurofeedback on frontal alpha asymmetry, or an active control training (N = 16 in each group). The asymmetry group showed an increase in alpha asymmetry driven by higher alpha at the right site (p < 0.001), as well as a coherent reduction in both negative affect and anxiety symptoms (ps < 0.05), from pre-to post-training. No training-specific modulation emerged for positive affect and depressive symptoms. These findings provide a strong rationale for the use of frontal alpha asymmetry neurofeedback for the reduction of negative affect and anxiety in clinical settings.
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