7 avril 2014 v2c

Etudes sur le neurofeedback répertoriées dans la base PubMed

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[(1)] Sources : wikipedia.org et http://www.nlm.nih.gov/pubs/factsheets/medline.html

Mots clés recherchés dans le titre ou le résumé : neurofeedback, biofeedback EEG, ou neurothérapie, ainsi que quelques termes dérivés

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Critère de recherche (Search box) :
neurofeedback[Title/Abstract] OR EEG biofeedback[Title/Abstract] OR neurotherapy[Title/Abstract] OR electroencephalographic biofeedback[Title/Abstract] OR EEG feedback[Title/Abstract] OR SCP biofeedback[Title/Abstract] OR SCP self-regulation[Title/Abstract] OR SMR feedback[Title/Abstract] OR SMR biofeedback[Title/Abstract]

EEG: Electroencephalogram
SCP: Slow Cortical Potentials (bande de fréquences du signal cérébral 0Hz-1Hz)
SMR: Sensorimotor Rhythm (bande de fréquences du signal cérébral ~13Hz-~15Hz)

Paramètres d'affichage (Display settings) : Abstract – Sorted by Publication date

Résultat (trié par date de publication) : 555 publications

(Résultat au 7 avril 2014. Pour obtenir un résultat plus récent, voir le paragraphe précédent.)

Les publications qui traitent du **neurofeedback à usage thérapeutique ou en vue d'améliorer les performances humaines** sont signalées par une **étoile en tête du titre** (412 publications).

Pour les publications qui concernent le neurofeedback des ondes cérébrales par électroencéphalographie (tel qu'il est majoritairement pratiqué par les praticiens de neurofeedback en pratique privée), le terme **EEG** est mis en évidence en gras. Ce sont les publications les plus fréquentes et le terme EEG est souvent sous-entendu quand il n'est pas mentionné.

Pour les publications qui concernent les autres types de neurofeedback, c'est le terme **fMRI**[(1)], **LORETA**[(2)], **MEG**[(3)], (**f**)**NIRS**[(4)], ou **HEG**[(5)] qui est mis en évidence en gras.

Pour isoler plus facilement les publications qui traitent du neurofeedback utilisé dans le cadre du développement d'une Interface Cerveau/Machine (ICM), les termes **Brain-Computer Interface** (**BCI**), **Brain-Machine Interface** (**BMI)** et **Brain-Computer Communication** (**BCC**) ont été mis en évidence en gras.

Lorsque le texte intégral de l'article est disponible en libre accès sur internet, le lien correspondant est indiqué.

Pour quelques publications, le terme *neurothérapie* ou *EEG feedback* a été utilisé sans rapport avec le neurofeedback. Elles ont donc été exclues de cette liste a posteriori.

(1) fMRI: functional Magnetic Resonance Imaging
(2) LORETA: Low-Resolution Electromagnetic Tomography
(3) MEG: Magnetoencephalography
(4) (f)NIRS: (functional) Near-Infrared Spectroscopy
(5) HEG: Hemoencephalography

Liste des publications **(Cliquez sur le n° de page pour accéder au détail)**

Nat Rev Neurol. 2014 Mar;10(3):167-78. doi: 10.1038/nrneurol.2014.12. Epub 2014 Feb 18.

1. *Neuromodulatory treatments for chronic pain: efficacy and mechanisms.

Jensen MP[1], Day MA[1], Miró J[2].

[1]Department of Rehabilitation Medicine, University of Washington, Harborview Medical Center, 325 9th Avenue, Seattle, WA 98104-2499, USA.
[2]Department of Psychology, Universitat Rovira i Virgili, Carretera de Valls, s/n, 43007 Tarragona, Spain.

Abstract
Chronic pain is common, and the available treatments do not provide adequate relief for most patients. Neuromodulatory interventions that modify brain processes underlying the experience of pain have the potential to provide substantial relief for some of these patients. The purpose of this Review is to summarize the state of knowledge regarding the efficacy and mechanisms of noninvasive neuromodulatory treatments for chronic pain. The findings provide support for the efficacy and positive side-effect profile of hypnosis, and limited evidence for the potential efficacy of meditation training, noninvasive electrical stimulation procedures, and **neurofeedback** procedures. Mechanisms research indicates that hypnosis influences multiple neurophysiological processes involved in the experience of pain. Evidence also indicates that mindfulness meditation has both immediate and long-term effects on cortical structures and activity involved in attention, emotional responding and pain. Less is known about the mechanisms of other neuromodulatory treatments. On the basis of the data discussed in this Review, training in the use of self-hypnosis might be considered a viable 'first-line' approach to treat chronic pain. More-definitive research regarding the benefits and costs of meditation training, noninvasive brain stimulation and **neurofeedback** is needed before these treatments can be recommended for the treatment of chronic pain.

PMID: 24535464 [PubMed - in process]

Pediatrics. 2014 Mar;133(3):483-92. doi: 10.1542/peds.2013-2059. Epub 2014 Feb 17.

2. *In-School Neurofeedback Training for ADHD: Sustained Improvements From a Randomized Control Trial.

Steiner NJ, Frenette EC, Rene KM, Brennan RT, Perrin EC.

The Floating Hospital for Children at Tufts Medical Center, Department of Pediatrics, Boston, Massachusetts.

Abstract
OBJECTIVE: To evaluate sustained improvements 6 months after a 40-session, in-school computer attention training intervention using **neurofeedback** or cognitive training (CT) administered to 7- to 11-year-olds with attention-deficit/hyperactivity disorder (ADHD).

METHODS: One hundred four children were randomly assigned to receive **neurofeedback**, CT, or a control condition and were evaluated 6 months postintervention. A 3-point growth model assessed change over time across the conditions on the Conners 3-Parent Assessment Report (Conners 3-P), the Behavior Rating Inventory of Executive Function Parent Form

(BRIEF), and a systematic double-blinded classroom observation (Behavioral Observation of Students in Schools). Analysis of variance assessed community-initiated changes in stimulant medication.

RESULTS: Parent response rates were 90% at the 6-month follow-up. Six months postintervention, **neurofeedback** participants maintained significant gains on Conners 3-P (Inattention effect size [ES] = 0.34, Executive Functioning ES = 0.25, Hyperactivity/Impulsivity ES = 0.23) and BRIEF subscales including the Global Executive Composite (ES = 0.31), which remained significantly greater than gains found among children in CT and control conditions. Children in the CT condition showed delayed improvement over immediate postintervention ratings only on Conners 3-P Executive Functioning (ES = 0.18) and 2 BRIEF subscales. At the 6-month follow-up, **neurofeedback** participants maintained the same stimulant medication dosage, whereas participants in both CT and control conditions showed statistically and clinically significant increases (9 mg [P = .002] and 13 mg [P < .001], respectively).

CONCLUSIONS: **Neurofeedback** participants made more prompt and greater improvements in ADHD symptoms, which were sustained at the 6-month follow-up, than did CT participants or those in the control group. This finding suggests that **neurofeedback** is a promising attention training treatment for children with ADHD.

PMID: 24534402 [PubMed - in process]

Neurosci Biobehav Rev. 2014 Mar 29. pii: S0149-7634(14)00070-0. doi: 10.1016/j.neubiorev.2014.03.015. [Epub ahead of print]

3. *EEG-neurofeedback for optimising performance III: A review of methodological and theoretical considerations.

Gruzelier JH.

Goldsmiths, University of London. Electronic address: j.gruzelier@gold.ac.uk.

Abstract
In continuing this three-part review on validation of **EEG-neurofeedback** for optimal performance evidence is provided for feedback influences on the CNS, the integration of **EEG** with **fMRI** methodology as well as anatomical correlates. Whereas parts I and II reviewed the considerable behavioural outcome gains and evidence for their feedback causation, part III lays bare the not inconsiderable methodological and theoretical conundrums. Cardinal assumptions amongst practitioners about specificity of topography, behavioural outcome and frequency bands are critically examined. The hitherto mostly neglected nature of feedback learning is reviewed including evidence of within- and between-session and successive baseline learning; the enduring impact on the tonic **EEG**; implications for experimental design, individual differences and the trainer-participant interface; distinguishing between the learning and mastery of self-regulation; connectivity, ratio, unidirectional and multimodal feedback protocols. A thorough grounding in human neuroscience plus interpersonal skills are considered prerequisites for scientific advancement and ethically sound practice.

PMID: 24690579 [PubMed - as supplied by publisher]

Int J Psychophysiol. 2014 Mar 26. pii: S0167-8760(14)00078-6. doi: 10.1016/j.ijpsycho.2014.03.009. [Epub ahead of print]

4. *Immediate effects of alpha/theta and sensory-motor rhythm feedback on music performance.

Gruzelier JH[1], Hirst L[2], Holmes P[2], Leach J[3].

[1]Department of Psychology, Goldsmiths, University of London, Lewisham Way, New Cross, London SE14 6NW, UK. Electronic address: j.gruzelier@gold.ac.uk.
[2]Trinity/Laban Conservatoire of Music and Dance, London, UK.
[3]Department of Psychology, Goldsmiths, University of London, Lewisham Way, New Cross, London SE14 6NW, UK.

Abstract
This is one of a series of investigations comparing two **EEG-neurofeedback** protocols - Alpha/theta (A/T) and Sensory-Motor Rhythm (**SMR**) - for performance enhancement in the Arts, here with the focus on music. The original report (Egner and Gruzelier, 2003) established a beneficial outcome for elite conservatoire musicians following A/T training in two investigations. Subsequently this A/T advantage was replicated for both advanced instrumental and novice singing abilities, including improvisation, while **SMR** training benefited novice performance only (Gruzelier, Holmes et al., 2014). Here we report a replication of the latter study in university instrumentalists who as before were novice singers with one design change - post-training performances were conducted within the tenth final session instead of on a subsequent occasion. As before expert judges rated the domains of Creativity/Musicality, Communication/Presentation and Technique. The proximity to training of the music performances within the last session likely compromised gains from A/T learning, but perhaps reinforced the impact of **SMR** training efficacy. In support of validation there was evidence of strong within- and across-session A/T learning and positive linear trends for across-session **SMR**/theta and **SMR**/beta-2 ratio learning. In support of mediation learning correlated with music performance. The A/T outcome was markedly discrepant from previous studies and should dispel any impression that the hypnogogic state itself is transferred to the performance context. The effects of **SMR** ratio training are consistent with an impact on lower-order abilities required in novice performance such as sustained attention and memory, and benefiting all three domains of music assessment.

PMID: 24681246 [PubMed - as supplied by publisher]

PLoS One. 2014 Mar 18;9(3):e91837. doi: 10.1371/journal.pone.0091837. eCollection 2014.

5. *Neurofeedback as a treatment for major depressive disorder - a pilot study.

Peeters F[1], Oehlen M[1], Ronner J[2], van Os J[3], Lousberg R[1].

[1]Department of Psychiatry and Psychology, South Limburg Mental Health Research and Teaching Network, EURON, Maastricht University, Maastricht, The Netherlands.
[2]Department of Instrumentation, Faculty of Psychology and Neuroscience, Maastricht University, Maastricht, The Netherlands.
[3]Department of Psychiatry and Psychology, South Limburg Mental Health Research and Teaching Network, EURON, Maastricht University, Maastricht, The Netherlands; King's College London, King's Health Partners, Department of Psychosis Studies, Institute of Psychiatry, London, United Kingdom.

Abstract
BACKGROUND: There is growing interest in **neurofeedback** as a treatment for major depressive disorder. Reduction of asymmetry of alpha-activity between left and right prefrontal areas with **neurofeedback** has been postulated as effective in earlier studies. Unfortunately, methodological shortcomings limit conclusions that can be drawn from these studies. In a pilot-study, we investigated the effectiveness of reduction of asymmetry of alpha-activity with **neurofeedback** in depressed participants with the use of a stringent methodological approach.

METHODS: Nine participants meeting DSM-IV criteria for major depressive disorder were treated with a maximum of 30 **neurofeedback**-sessions, aimed at reducing asymmetry of alpha-activity, over a 10-week period. No changes in the use of antidepressants were allowed 6 weeks before and during the intervention. Changes in depressive symptomatology were assessed with the Quick Inventory of Depressive Symptoms, self-report version.

RESULTS: We observed response in 1 and remission in 4 out of a total of 9 participants. The effectiveness appeared largest in female participants. The mean asymmetry of alpha-activity decreased significantly over sessions in a quadratic fashion. This decrease was associated with clinical response.

CONCLUSIONS: This pilot study suggests that **neurofeedback** aimed at a reduction of frontal asymmetry of alpha-activity may be effective as a treatment for depression. However, this was an open label pilot study. Non-specific effects of the procedure and/or a beneficial natural course may have confounded the results. Randomized controlled trials will have to establish the efficacy of **neurofeedback** for depression.

TRIAL REGISTRATION: Nederlands Trial Register NTR1629.

PMID: 24642756 [PubMed - in process] PMCID: PMC3958393
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3958393

PLoS One. 2014 Mar 10;9(3):e91620. doi: 10.1371/journal.pone.0091620. eCollection 2014.

6. *Comparison of Real-Time Water Proton Spectroscopy and Echo-Planar Imaging Sensitivity to the BOLD Effect at 3 T and at 7 T.

Koush Y[1], Elliott MA[2], Scharnowski F[3], Mathiak K[4].

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[2]Center for Magnetic Resonance and Optical Imaging (CMROI), Department of Radiology, University of Pennsylvania, Philadelphia, Pennsylvania, United States of America.
[3]Department of Radiology and Medical Informatics, University of Geneva, Geneva, Switzerland; Institute of Bioengineering, Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland.
[4]Department of Psychiatry, Psychotherapy and Psychosomatics, RWTH Aachen University, Aachen, Germany; JARA Translational Brain Medicine, Jülich - Aachen, Germany.

Abstract
Gradient-echo echo-planar imaging (GE EPI) is the most commonly used approach to assess localized blood oxygen level dependent (BOLD) signal changes in real-time. Alternatively, real-time spin-echo single-voxel spectroscopy (SE SVS) has recently been introduced for spatially specific BOLD **neurofeedback** at 3 T and at 7 T. However, currently it is not known how **neurofeedback** based on real-time SE SVS compares to real-time GE EPI-based. We therefore compared both methods at high (3 T) and at ultra-high (7 T) magnetic field strengths. We evaluated standard quality measures of both methods for signals originating from the motor cortex, the visual cortex, and for a **neurofeedback** condition. At 3 T, the data quality of the real-time SE SVS and GE EPI R2* estimates were comparable. At 7 T, the data quality of the real-time GE EPI acquisitions was superior compared to those of the real-time SE SVS. Despite the somehow lower data quality of real-time SE SVS compared to GE EPI at 7 T, SE SVS acquisitions might still be an interesting alternative. Real-time SE SVS allows for a direct and subject-specific T2* estimation and thus for a physiologically more plausible **neurofeedback** signal.

PMID: 24614912 [PubMed - in process] PMCID: PMC3948886
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3948886

PLoS One. 2014 Mar 7;9(3):e91090. doi: 10.1371/journal.pone.0091090. eCollection 2014.

7. *Connectivity changes underlying neurofeedback training of visual cortex activity.

Scharnowski F[1], Rosa MJ[2], Golestani N[3], Hutton C[4], Josephs O[4], Weiskopf N[4], Rees G[5].

[1]Wellcome Trust Centre for Neuroimaging, UCL Institute of Neurology, University College London, London, United Kingdom; UCL Institute of Cognitive Neuroscience, University College London, London, United Kingdom; Institute of Bioengineering, Swiss Institute of Technology Lausanne (EPFL), Lausanne, Switzerland; Department of Radiology and Medical Informatics - CIBM, University of Geneva, Geneva, Switzerland.
[2]Department of Neuroscience, Institute of Psychiatry, King's College London, London, United Kingdom.
[3]UCL Institute of Cognitive Neuroscience, University College London, London, United Kingdom; University Medical School, University of Geneva, Geneva, Switzerland.
[4]Wellcome Trust Centre for Neuroimaging, UCL Institute of Neurology, University College London, London, United Kingdom.

[5]Wellcome Trust Centre for Neuroimaging, UCL Institute of Neurology, University College London, London, United Kingdom; UCL Institute of Cognitive Neuroscience, University College London, London, United Kingdom.

Abstract
Neurofeedback based on real-time functional magnetic resonance imaging (**fMRI**) is a new approach that allows training of voluntary control over regionally specific brain activity. However, the neural basis of successful **neurofeedback** learning remains poorly understood. Here, we assessed changes in effective brain connectivity associated with **neurofeedback** training of visual cortex activity. Using dynamic causal modeling (DCM), we found that training participants to increase visual cortex activity was associated with increased effective connectivity between the visual cortex and the superior parietal lobe. Specifically, participants who learned to control activity in their visual cortex showed increased top-down control of the superior parietal lobe over the visual cortex, and at the same time reduced bottom-up processing. These results are consistent with efficient employment of top-down visual attention and imagery, which were the cognitive strategies used by participants to increase their visual cortex activity.

PMID: 24609065 [PubMed - in process] PMCID: PMC3946642
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3946642

Clin EEG Neurosci. 2014 Mar 3. [Epub ahead of print]

8. *LORETA Neurofeedback in the Precuneus: Operant Conditioning in Basic Mechanisms of Self-Regulation.

Cannon RL, Baldwin DR, Diloreto DJ, Phillips ST, Shaw TL, Levy JJ.

Psychoeducational Network, Knoxville, TN, USA.

Abstract
Low-resolution brain electomagnetic tomography (**LORETA**) **neurofeedback** provides a mechanism to influence the electrical activity of the brain in intracranial space. The aim of this study was to determine the effects of **LORETA neurofeedback** (L**NF**B) in the precuneus as a mechanism for improving self-regulation in controls and a heterogeneous diagnostic group (DX). Thirteen participants completed between 10 and 20 sessions of L**NF**B training in a 3-voxel cluster in the left precuneus. The participants included 5 nonclinical university students, and 8 adults with heterogeneous psychiatric diagnoses. We assessed the effects of L**NF**B with neurophysiological measures as well as pre- and post-Personality Assessment Inventory (PAI) subscales and selected subtests from the Delis-Kaplan Executive Function System (DKEFS). There was a significant total relative power increase at the precuneus for baseline contrasts for the control group. The DX group did not reach significant levels. All participants showed improvements in executive functions and tended to report significantly less psychopathology. The basic neural mechanisms of self-regulation are poorly understood. The data obtained in this study demonstrate that L**NF**B in a heterogeneous population enhances executive functions while concordantly decreasing endorsement of psychological symptoms. The alpha frequency in the brain may represent integrative functioning relative to operant efficiency and self-regulatory mechanisms.

PMID: 24590872 [PubMed - as supplied by publisher]

Theor Med Bioeth. 2014 Feb;35(1):59-72. doi: 10.1007/s11017-014-9276-6.

9. *Mandatory neurotechnological treatment: ethical issues.

Focquaert F.

Department of Philosophy and Moral Sciences, Bioethics Institute Ghent, Ghent University, Blandijnberg 2, 9000, Ghent, Belgium, farah.focquaert@UGent.be.

Abstract
What if **neurofeedback** or other types of neurotechnological treatment, by itself or in combination with behavioral treatment, could achieve a successful "rewiring" of the psychopath's brain? Imagine that such treatments exist and that they provide a better long-term risk-minimizing strategy compared to imprisonment. Would it be ethical to offer such treatments as a condition of probation, parole, or (early) prison release? In this paper, I argue that it can be ethical to offer effective, non-invasive neurotechnological treatments to offenders as a condition of probation, parole, or (early) prison release provided that: (1) the status quo is in no way cruel, inhuman, degrading, or in some other way wrong, (2) the treatment option is in no way cruel, inhuman, degrading, or in some other way wrong, (3) the treatment is in the best interests of the offender, and (4) the offender gives his/her informed consent.

PMID: 24407528 [PubMed - in process]

Clin Psychol Rev. 2014 Feb 27;34(3):218-232. doi: 10.1016/j.cpr.2014.02.001. [Epub ahead of print]

10. *Pharmacological and psychosocial treatments for adolescents with ADHD: An updated systematic review of the literature.

Sibley MH[1], Kuriyan AB[2], Evans SW[3], Waxmonsky JG[4], Smith BH[5].

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[2]Florida International University, Miami, FL, USA.
[3]Ohio University, Athens, OH, USA.
[4]Pennsylvania State University Milton Hershey Medical Center, Hershey, PA, USA.
[5]University of Houston, Houston, TX, USA.

Abstract
Smith, Waschbusch, Willoughby, and Evans (2000) reviewed a small treatment literature on ADHD in adolescents and concluded that methylphenidate stimulant medication was a well-established treatment and behavior therapy (BT) demonstrated preliminary efficacy. This review extends and updates the findings of the prior one based on the previous 15years of research. Studies published since 1999 were identified and coded using standard criteria and effect sizes were calculated where appropriate. Highlights of the last 15years of research include an expansion of pharmacological treatment options and developmentally appropriate

psychosocial treatment packages for adolescents with ADHD. Additionally, nonstimulant medications (e.g., atomoxetine) are now approved for the treatment of ADHD in adolescence. The review concludes that medication and BT produce a similar range of therapeutic effects on the symptoms of adolescents with ADHD. However, results suggest that BT may produce greater overall benefits on measures of impairment. There was no evidence that cognitive enhancement trainings, such as working memory training or **neurofeedback** improved the functioning of adolescents with ADHD. Whether to use medication, BT, or their combination to treat an adolescent with ADHD is complicated and we provide evidence-informed guidelines for treatment selection. The reviewed evidence does not support current American Academy of Pediatrics and American Academy of Child and Adolescent Psychiatry professional guidelines, which state that stimulant medication is the preferred treatment for adolescents with ADHD. Recommendations for assessment, practice guidelines, and future research are discussed.

PMID: 24632046 [PubMed - as supplied by publisher]

Rev Neurol (Paris). 2014 Feb 24. pii: S0035-3787(14)00029-0. doi: 10.1016/j.neurol.2013.10.011. [Epub ahead of print]

11. *[Biofeedback and drug-resistant epilepsy: Back to an earlier treatment?]

[Article in French]

Micoulaud-Franchi JA[1], Lanteaume L[2], Pallanca O[3], Vion-Dury J[4], Bartolomei F[2].

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[2]Service de neurophysiologie clinique, CHU de la Timone, 264, rue Saint-Pierre, 13005 Marseille, France; Unité mixte Inserm épilepsie et cognition UMR 751, 27, boulevard Jean-Moulin, 13385 Marseille cedex 05, France.
[3]Centre médical veille-sommeil, SCMVS, 10, rue Edouard-Detaille, 75017 Paris, France; Service de neurophysiologie clinique, CHU de la Pitié-Salpêtrière, 48, boulevard de l'Hôpital, 75013 Paris, France.
[4]Unité de neurophysiologie, psychophysiologie et neurophénoménologie (UNPN), Solaris, pôle de psychiatrie universitaire, hôpital Sainte-Marguerite, 270, boulevard de Sainte-Marguerite, 13009 Marseille, France; UMR CNRS 7291, laboratoire de neurosciences cognitives (LNC), 31 Aix-Marseille université, site Saint-Charles, 3, place Victor-Hugo, 13331 Marseille cedex 3, France.

Abstract
Biofeedback is a complementary non-pharmacological and non-surgical therapeutic developed over the last thirty years in the management of drug-resistant epilepsy. Biofeedback allows learning cognitive and behavioral strategies via a psychophysiological feedback loop. Firstly, this paper describes the different types of biofeedback protocols used

for the treatment of drug-refractory epilepsy and their physiological justifications. Secondly, this paper analyzes the evidence of effectiveness, from a medical point of view, on reducing the numbers of seizures, and from a neurophysiological point of view, on the changing brain activity. Electroencephalography (**EEG**) biofeedback (**neurofeedback**) protocol on sensorimotor rhythms (**SMR**) has been investigated in many studies, the main limitation being small sample sizes and lack of control groups. The newer **neurofeedback** protocol on slow cortical potential (**SCP**) and galvanic skin response (GSR) biofeedback protocols have been used in a smaller number of studies. But, these studies are more rigorous with larger sized samples, matched control groups, and attempts to control the placebo effect. These protocols also open the way for innovative neurophysiological researches and may predict a renewal of biofeedback techniques. Biofeedback would have legitimacy in the field of clinical drug-resistant epilepsy at the interface between therapeutic and clinical neurophysiology.

PMID: 24576530 [PubMed - as supplied by publisher]

PLoS One. 2014 Feb 11;9(2):e88785. doi: 10.1371/journal.pone.0088785. eCollection 2014.

12. *Real-time FMRI neurofeedback training of amygdala activity in patients with major depressive disorder.

Young KD, Zotev V, Phillips R, Misaki M, Yuan H, Drevets WC, Bodurka J.

Laureate Institute for Brain Research, Tulsa, Oklahoma, United States of America.

Abstract

BACKGROUND: Amygdala hemodynamic responses to positive stimuli are attenuated in major depressive disorder (MDD), and normalize with remission. Real-time functional **MRI neurofeedback** (rt**fMRI**-nf) offers a non-invasive method to modulate this regional activity. We examined whether depressed participants can use rt**fMRI**-nf to enhance amygdala responses to positive autobiographical memories, and whether this ability alters symptom severity.

METHODS: Unmedicated MDD subjects were assigned to receive rt**fMRI**-nf from either left amygdala (LA; experimental group, n = 14) or the horizontal segment of the intraparietal sulcus (HIPS; control group, n = 7) and instructed to contemplate happy autobiographical memories (AMs) to raise the level of a bar representing the hemodynamic signal from the target region to a target level. This 40s Happy condition alternated with 40s blocks of rest and counting backwards. A final Transfer run without **neurofeedback** information was included.

RESULTS: Participants in the experimental group upregulated their amygdala responses during positive AM recall. Significant pre-post scan decreases in anxiety ratings and increases in happiness ratings were evident in the experimental versus control group. A whole brain analysis showed that during the transfer run, participants in the experimental group had increased activity compared to the control group in left superior temporal gyrus and temporal polar cortex, and right thalamus.

CONCLUSIONS: Using rt**fMRI**-nf from the left amygdala during recall of positive AMs, depressed subjects were able to self-regulate their amygdala response, resulting in improved

mood. Results from this proof-of-concept study suggest that rt**fMRI**-nf training with positive AM recall holds potential as a novel therapeutic approach in the treatment of depression.

PMID: 24523939 [PubMed - in process] PMCID: PMC3921228
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3921228

Indian J Psychol Med. 2014 Jan;36(1):40-4. doi: 10.4103/0253-7176.127246.

13. *Silent Epidemic: The Effects of Neurofeedback on Quality-of-Life.

Reddy RP[1], Rajeswaran J[1], Bhagavatula ID[2], Kandavel T[3].

[1]Department of Clinical Psychology, National Institute of Mental Health and Neurosciences, Bangalore, Karnataka, India.
[2]Department of Neurosurgery, National Institute of Mental Health and Neurosciences, Bangalore, Karnataka, India.
[3]Department of Biostatistics, National Institute of Mental Health and Neurosciences, Bangalore, Karnataka, India.

Abstract
BACKGROUND: The complex interaction of human, vehicle and environmental factors along with a lack of sustainable preventive programs has contributed to the "silent epidemic" of traumatic brain injuries (TBI). TBI poses a grave threat to the quality-of-life (QOL).

AIM: The aim of the present study was to examine the effects of **neurofeedback** in QOL in patients with TBI.

MATERIALS AND METHODS: Pre- and post-interventional study design was adopted. Sixty patients, 30 in the intervention group (IG) and 30 in waitlist group with the diagnosis of TBI in the age range of 18-49 years were assessed on QOL scale, after obtaining the informed consent. Patients in the IG were given 20 sessions of alpha-theta **neurofeedback** training (**NF**T), 5 sessions / week.

STATISTICS ANALYSIS: Descriptive statistics, Spearman's correlation, Mann-Whitney and Chi-squared test was used.

RESULTS AND CONCLUSION: Patients in the IG showed statistical improvements in QOL post post-**neurofeedback**. Results are encouraging for the incorporation of **NF**T into treatment programs for patients with TBI in improving QOL.

PMID: 24701008 [PubMed]
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3959017

Biol Psychol. 2014 Jan;95:126-34. doi: 10.1016/j.biopsycho.2013.02.020. Epub 2013 Mar 30.

14. *Enhancing sleep quality and memory in insomnia using instrumental sensorimotor rhythm conditioning.

Schabus M[1], Heib DP[2], Lechinger J[2], Griessenberger H[2], Klimesch W[3], Pawlizki A[4], Kunz AB[5], Sterman BM[6], Hoedlmoser K[7].

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Abstract
EEG recordings over the sensorimotor cortex show a prominent oscillatory pattern in a frequency range between 12 and 15 Hz (sensorimotor rhythm, **SMR**) under quiet but alert wakefulness. This frequency range is also abundant during sleep, and overlaps with the sleep spindle frequency band. In the present pilot study we tested whether instrumental conditioning of **SMR** during wakefulness can enhance sleep and cognitive performance in insomnia. Twenty-four subjects with clinical symptoms of primary insomnia were tested in a counterbalanced within-subjects-design. Each patient participated in a **SMR**- as well as a sham-conditioning training block. Polysomnographic sleep recordings were scheduled before and after the training blocks. Results indicate a significant increase of 12-15 Hz activity over the course of ten **SMR** training sessions. Concomitantly, the number of awakenings decreased and slow-wave sleep as well as subjective sleep quality increased. Interestingly, **SMR**-training enhancement was also found to be associated with overnight memory consolidation and sleep spindle changes indicating a beneficial cognitive effect of the **SMR** training protocol for **SMR** "responders" (16 out of 24 participants). Although results are promising it has to be concluded that current results are of a preliminary nature and await further proof before **SMR**-training can be promoted as a non-pharmacological approach for improving sleep quality and memory performance. [Note: this abstract should definitively have mentioned the word **neurofeedback**.]

PMID: 23548378 [PubMed - in process]

J Neuroeng Rehabil. 2014 Jan 28;11(1):9. [Epub ahead of print]

15. *An exploration of EEG features during recovery following stroke - implications for BCI-mediated neurorehabilitation therapy.

Leamy DJ, Kocijan J, Domijan K, Duffin J, Roche RA, Commins S, Collins R, Ward TE.

Abstract
BACKGROUND: Brain-Computer Interfaces (**BCI**) can potentially be used to aid in the recovery of lost motor control in a limb following stroke. **BCI**s are typically used by subjects with no damage to the brain therefore relatively little is known about the technical requirements for the design of a rehabilitative **BCI** for stroke.

METHODS: 32-channel electroencephalogram (**EEG**) was recorded during a finger-tapping task from 10 healthy subjects for one session and 5 stroke patients for two sessions approximately 6 months apart. An off-line **BCI** design based on Filter Bank Common Spatial Patterns (FBCSP) was implemented to test and compare the efficacy and accuracy of training a rehabilitative **BCI** with both stroke-affected and healthy data.

RESULTS: Stroke-affected **EEG** datasets have lower 10-fold cross validation results than healthy **EEG** datasets. When training a **BCI** with healthy **EEG**, average classification accuracy of stroke-affected **EEG** is lower than the average for healthy **EEG**. Classification accuracy of the late session stroke **EEG** is improved by training the **BCI** on the corresponding early stroke **EEG** dataset.

CONCLUSIONS: This exploratory study illustrates that stroke and the accompanying neuroplastic changes associated with the recovery process can cause significant inter-subject changes in the **EEG** features suitable for mapping as part of a **neurofeedback** therapy, even when individuals have scored largely similar with conventional behavioural measures. It appears such measures can mask this individual variability in cortical reorganization. Consequently we believe motor retraining **BCI** should initially be tailored to individual patients.

PMID: 24468185 [PubMed - as supplied by publisher]
See complete free article at:
http://www.jneuroengrehab.com/content/11/1/9

PLoS One. 2014 Jan 20;9(1):e85929. doi: 10.1371/journal.pone.0085929. eCollection 2014.

16. *Windowed correlation: a suitable tool for providing dynamic fMRI-based functional connectivity neurofeedback on task difficulty.

Zilverstand A, Sorger B, Zimmermann J, Kaas A, Goebel R.

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Abstract
The goal of **neurofeedback** training is to provide participants with relevant information on their ongoing brain processes in order to enable them to change these processes in a

meaningful way. Under the assumption of an intrinsic brain-behavior link, **neurofeedback** can be a tool to guide a participant towards a desired behavioral state, such as a healthier state in the case of patients. Current research in clinical neuroscience regarding the most robust indicators of pathological brain processes in psychiatric and neurological disorders indicates that **fMRI**-based functional connectivity measures may be among the most important biomarkers of disease. The present study therefore investigated the general potential of providing **fMRI neurofeedback** based on functional correlations, computed from short-window time course data at the level of single task periods. The ability to detect subtle changes in task performance with block-wise functional connectivity measures was evaluated based on imaging data from healthy participants performing a simple motor task, which was systematically varied along two task dimensions representing two different aspects of task difficulty. The results demonstrate that **fMRI**-based functional connectivity measures may provide a better indicator for an increase in overall (motor) task difficulty than activation level-based measures. Windowed functional correlations thus seem to provide relevant and unique information regarding ongoing brain processes, which is not captured equally well by standard activation level-based **neurofeedback** measures. Functional connectivity markers, therefore, may indeed provide a valuable tool to enhance and monitor learning within an **fMRI neurofeedback** setup.

PMID: 24465794 [PubMed - in process] PMCID: PMC3896435
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3896435

J Dev Behav Pediatr. 2014 Jan;35(1):18-27. doi: 10.1097/DBP.0000000000000009.

17. *Neurofeedback and cognitive attention training for children with attention-deficit hyperactivity disorder in schools.

Steiner NJ, Frenette EC, Rene KM, Brennan RT, Perrin EC.

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Abstract
OBJECTIVE: To evaluate the efficacy of 2 computer attention training systems administered in school for children with attention-deficit hyperactivity disorder (ADHD).

METHOD: Children in second and fourth grade with a diagnosis of ADHD (n = 104) were randomly assigned to **neurofeedback** (**NF**) (n = 34), cognitive training (CT) (n = 34), or control (n = 36) conditions. A 2-point growth model assessed change from pre-post intervention on parent reports (Conners 3-Parent [Conners 3-P]; Behavior Rating Inventory of Executive Function [BRIEF] rating scale), teacher reports (Swanson, Kotkin, Agler, M-Flynn and Pelham scale [SKAMP]; Conners 3-Teacher [Conners 3-T]), and systematic classroom observations (Behavioral Observation of Students in Schools [BOSS]). Paired t tests and an analysis of covariance assessed change in medication.

RESULTS: Children who received **NF** showed significant improvement compared with those in the control condition on the Conners 3-P Attention, Executive Functioning and Global Index, on all BRIEF summary indices, and on BOSS motor/verbal off-task behavior. Children

who received CT showed no improvement compared to the control condition. Children in the **NF** condition showed significant improvements compared to those in the CT condition on Conners 3-P Executive Functioning, all BRIEF summary indices, SKAMP Attention, and Conners 3-T Inattention subscales. Stimulant medication dosage in methylphenidate equivalencies significantly increased for children in the CT (8.54 mg) and control (7.05 mg) conditions but not for those in the **NF** condition (0.29 mg).

CONCLUSION: **Neurofeedback** made greater improvements in ADHD symptoms compared to both the control and CT conditions. Thus, **NF** is a promising attention training treatment intervention for children with ADHD.

PMID: 24399101 [PubMed - in process]

Postgrad Med. 2014 Jan;126(1):153-77. doi: 10.3810/pgm.2014.01.2735.

18. *Low dopamine function in attention deficit/hyperactivity disorder: should genotyping signify early diagnosis in children?

Gold MS, Blum K, Oscar-Berman M, Braverman ER.

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Abstract
Attention deficit/hyperactivity disorder (ADHD) is present in 8% to 12% of children, and 4% of adults worldwide. Children with ADHD can have learning impairments, poor selfesteem, social dysfunction, and an increased risk of substance abuse, including cigarette smoking. Overall, the rate of treatment with medication for patients with ADHD has been increasing since 2008, with ≥ 2 million children now being treated with stimulants. The rise of adolescent prescription ADHD medication abuse has occurred along with a concomitant increase of stimulant medication availability. Of adults presenting with a substance use disorder (SUD), 20% to 30% have concurrent ADHD, and 20% to 40% of adults with ADHD have a history of SUD. Following a brief review of the etiology of ADHD, its diagnosis and treatment, we focus on the benefits of early and appropriate testing for a predisposition to ADHD. We suggest that by genotyping patients for a number of known, associated dopaminergic polymorphisms, especially at an early age, misdiagnoses and/or over-diagnosis can be reduced. Ethical and legal issues of early genotyping are considered. As many as 30% of individuals with ADHD are estimated to either have secondary side-effects or are not responsive to stimulant medication. We also consider the benefits of non-stimulant medication and alternative treatment modalities, which include diet, herbal medications, iron supplementation, and **neurofeedback**. With the goals of improving treatment of patients with ADHD and SUD prevention, we encourage further work in both genetic diagnosis and novel treatment approaches.

PMID: 24393762 [PubMed - indexed for MEDLINE]

Biol Psychol. 2014 Jan;95:1-3. doi: 10.1016/j.biopsycho.2013.11.011. Epub 2013 Dec 8.

19. *Neurofeedback: introduction to the special issue.

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Extract
The Society of Applied Neuroscience (SAN, http://www.applied- neuroscience.org) was established in Europe as an international society to investigate the potential of **neurofeedback**, to promote research on validation and to encourage cross fertilisation in applied neuroscience. This special journal issue is one of four, an initiative encouraged by Elsevier, which is a themed issue on **neurofeedback** at the journal editor's invitation.

PMID: 24325817 [PubMed - in process]

Biol Psychol. 2014 Jan;95:108-15. doi: 10.1016/j.biopsycho.2013.11.013. Epub 2013 Dec 7.

20. *Evaluation of neurofeedback in ADHD: the long and winding road.

Arns M[1], Heinrich H[2], Strehl U[3].

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Abstract
Among the clinical applications of **neurofeedback**, most research has been conducted in ADHD. As an introduction a short overview of the general history of **neurofeedback** will be given, while the main part of the paper deals with a review of the current state of **neurofeedback** in ADHD. A meta-analysis on **neurofeedback** from 2009 found large effect sizes for inattention and impulsivity and medium effects sizes for hyperactivity. Since 2009 several new studies, including 4 placebo-controlled studies, have been published. These latest studies are reviewed and discussed in more detail. The review focuses on studies employing (1) semi-active, (2) active, and (3) placebo-control groups. The assessment of specificity of **neurofeedback** treatment in ADHD is discussed and it is concluded that standard protocols such as theta/beta, **SMR** and slow cortical potentials **neurofeedback** are well investigated and have demonstrated specificity. The paper ends with an outlook on future questions and tasks. It is concluded that future controlled clinical trials should, in a next step, focus on such known protocols, and be designed along the lines of learning theory.

PMID: 24321363 [PubMed - in process]

Biol Psychol. 2014 Jan;95:70-3. doi: 10.1016/j.biopsycho.2013.11.014. Epub 2013 Dec 7.

21. *The time-course of alpha neurofeedback training effects in healthy participants.

Dekker MK, Sitskoorn MM, Denissen AJ, van Boxtel GJ.

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Abstract
The time-course of alpha **neurofeedback** training (**NF**T) was investigated in 18 healthy participants who received 15 sessions of training (eyes open), each consisting of three training periods (data are from Van Boxtel et al., 2012). Here we report on the within- and between-session training effects using multilevel analyses. Over sessions, total alpha power (8-12 Hz) increased up to the tenth session, after which low alpha power (8-10 Hz) remained at the same level, while high alpha power (10-12 Hz) decreased. Within each training session, total alpha power increased from the first to the second period, and then decreased again. This decrease, however, was caused by a decrease in high alpha power only; low alpha power remained up to the end of training. These effects are discussed in terms of attention and motivation, and suggest different trainability for low and high alpha power.

PMID: 24321361 [PubMed - in process]

Brain Topogr. 2014 Jan;27(1):138-48. doi: 10.1007/s10548-013-0331-9. Epub 2013 Nov 16.

22. *Real-time neurofeedback using functional MRI could improve down-regulation of amygdala activity during emotional stimulation: a proof-of-concept study.

Brühl AB, Scherpiet S, Sulzer J, Stämpfli P, Seifritz E, Herwig U.

Department for Psychiatry, Psychotherapy and Psychosomatics, Psychiatric Hospital, University of Zürich, Lenggstrasse 31, PO-Box 1931, 8032, Zurich, Switzerland, annette.bruehl@puk.zh.ch.

Abstract
The amygdala is a central target of emotion regulation. It is overactive and dysregulated in affective and anxiety disorders and amygdala activity normalizes with successful therapy of the symptoms. However, a considerable percentage of patients do not reach remission within acceptable duration of treatment. The amygdala could therefore represent a promising target for real-time functional magnetic resonance imaging (rt**fMRI**) **neurofeedback**. rt**fMRI neurofeedback** directly improves the voluntary regulation of localized brain activity. At present, most rt**fMRI neurofeedback** studies have trained participants to increase activity of a target, i.e. up-regulation. However, in the case of the amygdala, down-regulation is supposedly more clinically relevant. Therefore, we developed a task that trained participants

to down-regulate activity of the right amygdala while being confronted with amygdala stimulation, i.e. negative emotional faces. The activity in the functionally-defined region was used as online visual feedback in six healthy subjects instructed to minimize this signal using reality checking as emotion regulation strategy. Over a period of four training sessions, participants significantly increased down-regulation of the right amygdala compared to a passive viewing condition to control for habilitation effects. This result supports the concept of using rt**fMRI neurofeedback** training to control brain activity during relevant stimulation, specifically in the case of emotion, and has implications towards clinical treatment of emotional disorders.

PMID: 24241476 [PubMed - in process]

Biol Psychol. 2014 Jan;95:96-107. doi: 10.1016/j.biopsycho.2013.11.001. Epub 2013 Nov 11.

23. *Replication of elite music performance enhancement following alpha/theta neurofeedback and application to novice performance and improvisation with SMR benefits.

Gruzelier JH[1], Holmes P[2], Hirst L[2], Bulpin K[3], Rahman S[3], van Run C[4], Leach J[5].

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Abstract
Alpha/theta (A/T) and sensory-motor rhythm (**SMR**) **neurofeedback** were compared in university instrumentalists who were novice singers with regard to prepared and improvised instrumental and vocal performance in three music domains: creativity/musicality, technique and communication/presentation. Only A/T training enhanced advanced playing seen in all three domains by expert assessors and validated by correlations with learning indices, strongest with Creativity/Musicality as shown by Egner and Gruzelier (2003). Here A/T gains extended to novice performance - prepared vocal, improvised vocal and instrumental - and were recognised by a lay audience who judged the prepared folk songs. **SMR** learning correlated positively with Technical Competence and Communication in novice performance, in keeping with **SMR neurofeedback**'s known impact on lower-order processes such as attention, working memory and psychomotor skills. The importance of validation through learning indices was emphasised in the interpretation of **neurofeedback** outcome.

PMID: 24231602 [PubMed - in process]

Biol Psychol. 2014 Jan;95:31-44. doi: 10.1016/j.biopsycho.2013.10.008. Epub 2013 Nov 6.

24. *Comparing tomographic EEG neurofeedback and EMG biofeedback in children with attention-deficit/hyperactivity disorder.

Maurizio S[1], Liechti MD[2], Heinrich H[3], Jäncke L[4], Steinhausen HC[5], Walitza S[6], Brandeis D[7], Drechsler R[8].

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[8]Department of Child and Adolescent Psychiatry, University of Zurich, Zurich, Switzerland. Electronic address: renate.drechsler@kjpd.uzh.ch.

Abstract
Two types of biofeedback (BF), tomographic electroencephalogram (**EEG**) **neurofeedback** (**NF**) and electromyographic biofeedback (EMG-BF), both with phasic and tonic protocols, were compared for treatment effects and specificity in attention-deficit/hyperactivity disorder (ADHD). Thirteen children with ADHD trained their brain activity in the anterior cingulate cortex (ACC), and twelve trained activity of arm muscles involved in fine motor skills. In each training session, resting state 24-channel **EEG** and training performances were recorded. Both groups showed similar behavioral improvements and artifact reduction in selected conditions, with no significant advantages despite medium effect sizes on primary outcomes for **NF**. Only the EMG-BF group, however, showed clear improvement in training regulation performance, and specific motor coordination effects. The **NF** group tended to present individual normalization of trained frequency bands in the ACC during rest across training. The results provide evidence for some specific effects in our small sample, albeit only to a small extent.

PMID: 24211870 [PubMed - in process]

Biol Psychol. 2014 Jan;95:45-53. doi: 10.1016/j.biopsycho.2013.10.010. Epub 2013 Nov 7.

25. Better than sleep: theta neurofeedback training accelerates memory consolidation.

Reiner M[1], Rozengurt R[2], Barnea A[3].

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[2]Gonda Multidisciplinary Brain Research Center, Bar-Ilan University, Israel.
[3]Bio Keshev - Private Practice for **Neurofeedback**, Givat Chaim Ichud 38935, Israel.

Abstract
Consistent empirical results showed that both night and day sleep enhanced memory consolidation. In this study we explore processes of consolidation of memory during awake hours. Since theta oscillations have been shown to play a central role in exchange of information, we hypothesized that elevated theta during awake hours will enhance memory consolidation. We used a **neurofeedback** protocol, to enhance the relative power of theta or beta oscillations. Participants trained on a tapping task, were divided into three groups: **neurofeedback** theta; **neurofeedback** beta; control. We found a significant improvement in performance in the theta group, relative to the beta and control groups, immediately after **neurofeedback**. Performance was further improved after night sleep in all groups, with a significant advantage favoring the theta group. Theta power during training was correlated with the level of improvement, indicating a clear relationship between memory consolidation, and theta **neurofeedback**.

PMID: 24211625 [PubMed - in process]

Int J Psychophysiol. 2014 Jan;91(1):10-5. doi: 10.1016/j.ijpsycho.2013.10.004. Epub 2013 Oct 18.

26. *Mobile EEG and its potential to promote the theory and application of imagery-based motor rehabilitation.

Kranczioch C[1], Zich C[2], Schierholz I[2], Sterr A[3].

[1]Neuropsychology Lab, Department of Psychology, European Medical School, Carl von Ossietzky University of Oldenburg, Oldenburg, Germany; Neurosensory Science Research Group, Carl von Ossietzky University of Oldenburg, Oldenburg, Germany.
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Abstract
Studying the brain in its natural state remains a major challenge for neuroscience. Solving this challenge would not only enable the refinement of cognitive theory, but also provide a better understanding of cognitive function in the type of complex and unpredictable situations that

constitute daily life, and which are often disturbed in clinical populations. With mobile **EEG**, researchers now have access to a tool that can help address these issues. In this paper we present an overview of technical advancements in mobile **EEG** systems and associated analysis tools, and explore the benefits of this new technology. Using the example of motor imagery (MI) we will examine the translational potential of MI-based **neurofeedback** training for neurological rehabilitation and applied research.

PMID: 24144637 [PubMed - in process]

Neuroimage. 2014 Jan 15;85 Pt 3:889-94. doi: 10.1016/j.neuroimage.2013.08.071. Epub 2013 Sep 12.

27. *Neuroenhancement: enhancing brain and mind in health and in disease.

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Abstract
Humans have long used cognitive enhancement methods to expand the proficiency and range of the various mental activities that they engage in, including writing to store and retrieve information, and computers that allow them to perform myriad activities that are now commonplace in the internet age. Neuroenhancement describes the use of neuroscience-based techniques for enhancing cognitive function by acting directly on the human brain and nervous system, altering its properties to increase performance. Cognitive neuroscience has now reached the point where it may begin to put theory derived from years of experimentation into practice. This special issue includes 16 articles that employ or examine a variety of neuroenhancement methods currently being developed to increase cognition in healthy people and in patients with neurological or psychiatric illness. This includes transcranial electromagnetic stimulation methods, such as transcranial direct current stimulation (tDCS) and transcranial magnetic stimulation (TMS), along with deep brain stimulation, **neurofeedback**, behavioral training techniques, and these and other techniques in conjunction with neuroimaging. These methods can be used to improve attention, perception, memory and other forms of cognition in healthy individuals, leading to better performance in many aspects of everyday life. They may also reduce the cost, duration and overall impact of brain and mental illness in patients with neurological and psychiatric illness. Potential disadvantages of these techniques are also discussed. Given that the benefits of neuroenhancement outweigh the potential costs, these methods could potentially reduce suffering and improve quality of life for everyone, while further increasing our knowledge about the mechanisms of human cognition.

PMID: 24036352 [PubMed - in process]

Ann N Y Acad Sci. 2014 Jan;1307(1):19-27. doi: 10.1111/nyas.12246. Epub 2013 Sep 13.

28. *The posterior cingulate cortex as a plausible mechanistic target of meditation: findings from neuroimaging.

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Abstract
There has been an increased interest in mindfulness and meditation training over the past decade. As evidenced by exponential growth in the number of publications since the beginning of the 21st century, progressively more is becoming known about both the clinical efficacy and underlying neurobiological mechanisms of mindfulness training. This paper briefly highlights psychological models of stress that converge between ancient and modern day (e.g., operant conditioning); identifies key brain regions that, with these models, are biologically plausible targets for mindfulness (e.g., posterior cingulate cortex); and discusses recent and emerging findings from neuroimaging studies of meditation therein, including new advances using real-time functional **magnetic resonance imaging neurofeedback** in neurophenomenological studies.

PMID: 24033438 [PubMed - in process]

Int J Psychophysiol. 2014 Jan;91(1):36-45. doi: 10.1016/j.ijpsycho.2013.08.011. Epub 2013 Sep 4.

29. *Brain-computer interfaces for EEG neurofeedback: peculiarities and solutions.

Huster RJ, Mokom ZN, Enriquez-Geppert S, Herrmann CS.

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Abstract
Neurofeedback training procedures designed to alter a person's brain activity have been in use for nearly four decades now and represent one of the earliest applications of brain-computer interfaces (**BCI**). The majority of studies using **neurofeedback** technology relies on recordings of the electroencephalogram (**EEG**) and applies **neurofeedback** in clinical contexts, exploring its potential as treatment for psychopathological syndromes. This clinical focus significantly affects the technology behind **neurofeedback BCI**s. For example, in contrast to other **BCI** applications, **neurofeedback BCI**s usually rely on **EEG**-derived features with only a minimum of additional processing steps being employed. Here, we highlight the peculiarities of **EEG**-based **neurofeedback BCI**s and consider their relevance for software implementations. Having reviewed already existing packages for the implementation of **BCI**s, we introduce our own solution which specifically considers the

relevance of multi-subject handling for experimental and clinical trials, for example by implementing ready-to-use solutions for pseudo-/sham-**neurofeedback**.

PMID: 24012908 [PubMed - in process]

Int J Psychophysiol. 2014 Jan;91(1):54-66. doi: 10.1016/j.ijpsycho.2013.08.007. Epub 2013 Aug 29.

30. *Smartphones as pocketable labs: visions for mobile brain imaging and neurofeedback.

Stopczynski A, Stahlhut C, Petersen MK, Larsen JE, Jensen CF, Ivanova MG, Andersen TS, Hansen LK.

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Abstract
Mobile brain imaging solutions, such as the Smartphone Brain Scanner, which combines low cost wireless **EEG** sensors with open source software for real-time neuroimaging, may transform neuroscience experimental paradigms. Normally subject to the physical constraints in labs, neuroscience experimental paradigms can be transformed into dynamic environments allowing for the capturing of brain signals in everyday contexts. Using smartphones or tablets to access text or images may enable experimental design capable of tracing emotional responses when shopping or consuming media, incorporating sensorimotor responses reflecting our actions into brain machine interfaces, and facilitating **neurofeedback** training over extended periods. Even though the quality of consumer neuroheadsets is still lower than laboratory equipment and susceptible to environmental noise, we show that mobile neuroimaging solutions, like the Smartphone Brain Scanner, complemented by 3D reconstruction or source separation techniques may support a range of neuroimaging applications and thus become a valuable addition to high-end neuroimaging solutions.

PMID: 23994206 [PubMed - in process]

Biol Psychol. 2014 Jan;95:74-85. doi: 10.1016/j.biopsycho.2013.05.020. Epub 2013 Jun 7.

31. *Effect of beta and gamma neurofeedback on memory and intelligence in the elderly.

Staufenbiel SM[1], Brouwer AM[2], Keizer AW[3], van Wouwe NC[4].

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Abstract
Recent research showed a correlation between cognitive decline and a decrease of **EEG** gamma activity. In the present double-blind randomized control study, we investigated whether gamma and beta **neurofeedback** protocols, that have been shown to modulate performance on cognitive control and memory in young adults, also leads to increased brain activity and cognitive performance in elderly. Twenty older adults either performed eight 30-min gamma **neurofeedback** session or beta **neurofeedback** session within a period of 21 days. Cognitive performance was determined before and after the training through an IQ and memory task and we added a subjective well-being questionnaire. Both **neurofeedback** training protocols resulted in a significant increase of the brain activity within each training session, suggesting that the aging brain is still trainable. However, we found no effects on cognitive performance or transfer of the feedback beyond the trainings. We discuss several possible reasons for the lack of training on rest measurements and cognition and ways to improve the feedback protocols for future studies.

PMID: 23751914 [PubMed - in process]

Biol Psychol. 2014 Jan;95:21-30. doi: 10.1016/j.biopsycho.2013.05.005. Epub 2013 May 25.

32. *Near-infrared spectroscopy based neurofeedback training increases specific motor imagery related cortical activation compared to sham feedback.

Kober SE[1], Wood G[2], Kurzmann J[3], Friedrich EV[4], Stangl M[5], Wippel T[6], Väljamäe A[7], Neuper C[8].

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Abstract
In the present study we implemented a real-time feedback system based on multichannel near-infrared spectroscopy (**NIRS**). Prior studies indicated that **NIRS**-based **neurofeedback** can enhance motor imagery related cortical activation. To specify these prior results and to confirm the efficacy of **NIRS**-based **neurofeedback**, we examined changes in blood oxygenation level collected in eight training sessions. One group got real feedback about their own brain activity (N=9) and one group saw a playback of another person's feedback recording (N=8). All participants performed motor imagery of a right hand movement. Real **neurofeedback** induced specific and focused brain activation over left motor areas. This focal brain activation became even more specific over the eight training sessions. In contrast, sham feedback led to diffuse brain activation patterns over the whole cortex. These findings can be useful when training patients with focal brain lesions to increase activity of specific brain areas for rehabilitation purpose.

PMID: 23714227 [PubMed - in process]

Biol Psychol. 2014 Jan;95:54-8. doi: 10.1016/j.biopsycho.2013.04.013. Epub 2013 May 20.

33. *Neurofeedback facilitation of implicit motor learning.

Ros T[1], Munneke MA[2], Parkinson LA[3], Gruzelier JH[4].

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[3]Brainhealth, The Diagnostic Clinic, London, UK.
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Abstract
BACKGROUND: Mu rhythm desynchronisation via **EEG-neurofeedback** (**NFB**) has been previously been shown to induce durable motor-cortical disinhibition for at least 20 min. It was hypothesised that the presentation of a novel procedural learning task immediately after this **NFB** protocol would boost motor performance.

METHOD: The protocol consisted of firstly activating the right primary motor cortex with a single session of Mu (8-12 Hz) suppression via **NFB** for a total of 30 min. Shortly after, and with their non-dominant (left) hand, subjects (n=10) performed the serial reaction time task (SRTT), which is used to assess reaction time improvement over multiple trials. During another occasion (1 week before/after), the same subjects were tested on a different sequence without prior **NFB**, as part of a counterbalanced control condition.

RESULTS: Compared to a "cross-over" condition without **NFB**, subjects who received **NFB** immediately prior to SRTT performance exhibited a significantly faster rate of learning, reflected in a greater reduction of reaction times across blocks (p=0.02). This occurred in the absence of explicit awareness of a repeating sequence. Moreover, no significant differences were observed between conditions in error rate or reaction time variability.

CONCLUSION: Our results suggest that a single **NFB** session may be directly used to facilitate the early acquisition of a procedural motor task, and are the first to demonstrate that **neurofeedback** effects could be exploited immediately after individual training sessions so as to boost behavioural performance and learning.

PMID: 23702458 [PubMed - in process]

Brain Topogr. 2014 Jan;27(1):149-57. doi: 10.1007/s10548-013-0295-9. Epub 2013 May 23.

34. *The effects of neurofeedback on oscillatory processes related to tinnitus.

Hartmann T, Lorenz I, Müller N, Langguth B, Weisz N.

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Abstract

Although widely used, no proof exists for the feasibility of **neurofeedback** for reinstating the disordered excitatory-inhibitory balance, marked by a decrease in auditory alpha power, in tinnitus patients. The current study scrutinizes the ability of **neurofeedback** to focally increase alpha power in auditory areas in comparison to the more common rTMS. Resting-state **MEG** was measured before and after **neurofeedback** (n = 8) and rTMS (n = 9) intervention respectively. Source level power and functional connectivity were analyzed with a focus on the alpha band. Only **neurofeedback** produced a significant decrease in tinnitus symptoms and-more important for the context of the study-a spatially circumscribed increase in alpha power in right auditory regions. Connectivity analysis revealed higher outgoing connectivity in a region ultimately neighboring the area in which power increases were observed. **Neurofeedback** decreases tinnitus symptoms and increases alpha power in a spatially circumscribed manner. In addition, compared to a more established brain stimulation-based intervention, **neurofeedback** is a promising approach to renormalize the excitatory-inhibitory imbalance putatively underlying tinnitus. This study is the first to demonstrate the feasibility of focally enhancing alpha activity in tinnitus patients by means of **neurofeedback**.

PMID: 23700271 [PubMed - in process]

Neuroimage. 2014 Jan 15;85 Pt 3:985-95. doi: 10.1016/j.neuroimage.2013.04.126. Epub 2013 May 11.

35. *Self-regulation of human brain activity using simultaneous real-time fMRI and EEG neurofeedback.

Zotev V, Phillips R, Yuan H, Misaki M, Bodurka J.

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Abstract

Neurofeedback is a promising approach for non-invasive modulation of human brain activity with applications for treatment of mental disorders and enhancement of brain performance. **Neurofeedback** techniques are commonly based on either electroencephalography (**EEG**) or real-time functional magnetic resonance imaging (rt**fMRI**). Advances in simultaneous **EEG-fMRI** have made it possible to combine the two approaches. Here we report the first implementation of simultaneous multimodal rt**fMRI** and **EEG neurofeedback** (rt**fMRI-EEG**-nf). It is based on a novel system for real-time integration of simultaneous rt**fMRI** and **EEG** data streams. We applied the rt**fMRI-EEG**-nf to training of emotional self-regulation in healthy subjects performing a positive emotion induction task based on retrieval of happy autobiographical memories. The participants were able to simultaneously regulate their BOLD **fMRI** activation in the left amygdala and frontal **EEG** power asymmetry in the high-beta band using the rt**fMRI-EEG**-nf. Our proof-of-concept results demonstrate the feasibility of simultaneous self-regulation of both hemodynamic (rt**fMRI**) and electrophysiological (**EEG**) activities of the human brain. They suggest potential applications of rt**fMRI-EEG**-nf in the development of novel cognitive neuroscience research paradigms and enhanced cognitive therapeutic approaches for major neuropsychiatric disorders, particularly depression.

PMID: 23668969 [PubMed - in process]

Biol Psychol. 2014 Jan;95:4-20. doi: 10.1016/j.biopsycho.2013.04.010. Epub 2013 May 1.

36. *Real-time fMRI brain computer interfaces: self-regulation of single brain regions to networks.

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Abstract
With the advent of brain computer interfaces based on real-time **fMRI** (rt**fMRI**-**BCI**), the possibility of performing **neurofeedback** based on brain hemodynamics has become a reality. In the early stage of the development of this field, studies have focused on the volitional control of activity in circumscribed brain regions. However, based on the understanding that the brain functions by coordinated activity of spatially distributed regions, there have recently been further developments to incorporate real-time feedback of functional connectivity and spatio-temporal patterns of brain activity. The present article reviews the principles of rt**fMRI neurofeedback**, its applications, benefits and limitations. A special emphasis is given to the discussion of novel developments that have enabled the use of this methodology to achieve self-regulation of the functional connectivity between different brain areas and of distributed brain networks, anticipating new and exciting applications for cognitive neuroscience and for the potential alleviation of neuropsychiatric disorders.

PMID: 23643926 [PubMed - in process]

Biol Psychol. 2014 Jan;95:86-95. doi: 10.1016/j.biopsycho.2013.04.005. Epub 2013 Apr 25.

37. *Beneficial outcome from EEG-neurofeedback on creative music performance, attention and well-being in school children.

Gruzelier JH, Foks M, Steffert T, Chen MJ, Ros T.

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Abstract
We earlier reported benefits for creativity in rehearsed music performance from alpha/theta (A/T) **neurofeedback** in conservatoire studies (Egner & Gruzelier, 2003) which were not found with **SMR**, Beta1, mental skills, aerobics or Alexander training, or in standby controls. Here the focus was the impact on novice music performance. A/T and **SMR** training were compared in 11-year old school children along with non-intervention controls with outcome measures not only of rehearsed music performance but also of creative improvisation, as well as sustained attention and phenomenology. Evidence of effective learning in the school setting was obtained for A/T and **SMR**/beta2 ratios. Preferential benefits from A/T for rehearsed music performance were replicated in children for technique and communication ratings. Benefits extended to creativity and communication ratings for creative improvisation which were shared with **SMR** training, disclosing an influence of **SMR** on unrehearsed music performance at a novice level with its greater cognitive demands. In a first application of A/T for improving sustained attention (TOVA), it was found to be more successful than **SMR** training, with a notable reduction in commission errors in the children, 15/33 of whom had attention indices in the ADHD range. Phenomenological reports were in favour of **neurofeedback** and well-being benefits. Implementing **neurofeedback** in the daily school setting proved feasible and holds pedagogic promise.

PMID: 23623825 [PubMed - in process]

Brain Topogr. 2014 Jan;27(1):20-32. doi: 10.1007/s10548-013-0285-y. Epub 2013 Apr 6.

38. *Neurofeedback in ADHD: further pieces of the puzzle.

Gevensleben H, Kleemeyer M, Rothenberger LG, Studer P, Flaig-Röhr A, Moll GH, Rothenberger A, Heinrich H.

Child & Adolescent Psychiatry, University Medicine Göttingen, Göttingen, Germany.

Abstract
Among the different neuromodulation techniques, **neurofeedback** (**NF**) is gaining increasing interest in the treatment of children with attention-deficit/hyperactivity disorder (ADHD). In this article, a methodological framework is summarised considering the training as a neuro-behavioural treatment. Randomised controlled trials are selectively reviewed. Results from two smaller-scale studies are presented with the first study comprising a tomographic analysis over the course of a slow cortical potential (**SCP**) training and a correlational analysis of regulation skills and clinical outcome in children with ADHD. In the second study, ADHD-related behaviour was studied in children with tic disorder who either conducted a **SCP** training or a theta/low-beta (12-15 Hz) training (single-blind, randomised design). Both studies provide further evidence for the specificity of **NF** effects in ADHD. Based on these findings, a refined model of the mechanisms contributing to the efficacy of **SCP** training is developed. Despite a number of open questions concerning core mechanisms, moderators and mediators, **NF** (theta/beta and **SCP**) training seems to be on its way to become a valuable and ethically acceptable module in the treatment of children with ADHD.

PMID: 23563906 [PubMed - in process]

Biol Psychol. 2014 Jan;95:59-69. doi: 10.1016/j.biopsycho.2013.02.019. Epub 2013 Mar 15.

39. *Modulation of frontal-midline theta by neurofeedback.

Enriquez-Geppert S[1], Huster RJ[2], Scharfenort R[3], Mokom ZN[3], Zimmermann J[4], Herrmann CS[5].

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Abstract
Cortical oscillations demonstrate a relationship with cognition. Moreover, they also exhibit associations with task performance and psychiatric mental disorders. This being the case, the modification of oscillations has become one of the key interests of neuroscientific approaches for cognitive enhancement. For such kind of alterations, **neurofeedback** (**NF**) of brain activity constitutes a promising tool. Concerning specific higher cognitive functions, frontal-midline theta (fm-theta) has been suggested as an important indicator of relevant brain processes. This paper presents a novel approach for an individualized, eight-session **NF** training to enhance fm-theta. An individual's dominant fm-theta frequency was determined based on experiments tapping executive functions. Effects of the actual **NF** training were compared to a pseudo-**NF** training. Participants of the pseudo-**NF** training experienced a comparable degree of motivation and commitment as the subjects of the actual **NF** training, but found the "training" slightly easier. In comparison to the pseudo-**NF** training, proper **NF** training significantly enhanced fm-theta amplitude in the actual training sessions, as well as during the whole course of training. However, unspecific changes in the alpha and beta frequency ranges found with both the actual **NF** and the pseudo-**NF** training groups emphasize the relevance of active control groups for **neurofeedback** studies.

PMID: 23499994 [PubMed - in process]

Tijdschr Psychiatr. 2013;55(11):841-52.

40. *[Neuromodulation as an intervention for addiction: overview and future prospects].

[Article in Dutch]

Luigjes J, Breteler R, Vanneste S, de Ridder D.

Abstract
BACKGROUND: In recent years several neuromodulation techniques have been introduced as interventions for addiction.

AIM: To review and discuss studies that have investigated the effects of treating addiction by means of electroencephalography (**EEG**) **neurofeedback**, real-time functional magnetic resonance imaging (rt-**fMRI**) **neurofeedback**, transcranial magnetic stimulation/transcranial direct current stimulation (TMS/tDCS) and deep brain stimulation (DBS).

METHOD: We reviewed the literature, focusing on Dutch studies in particular.

RESULTS: Studies using **EEG neurofeedback** were shown to have positive effects on drug use, treatment compliance, and cue reactivity in patients with cocaine and alcohol dependence. A pilot study investigating the effects of rt-**fMRI neurofeedback** on nicotine dependent patients showed that modulation of the anterior cingulate cortex can decrease smokers' craving for nicotine. In several studies decreased craving was found in alcohol dependent patients after TMS or tDCS stimulation of the anterior cingulate cortex or the dorsolateral prefrontal cortex. The first DBS pilot studies suggest that the nucleus accumbens is a promising target region for the treatment of alcohol and heroin dependence.

CONCLUSION: Neuromodulation provides us with a unique opportunity to directly apply neuroscientific knowledge to the treatment of addiction. However, more research is needed to ensure the efficacy, safety and feasibility of the various neuromodulation techniques that are now available.

PMID: 24242143 [PubMed - in process]
See complete free article in Dutch at:
http://www.tijdschriftvoorpsychiatrie.nl/en/issues/471/articles/9919

Przegl Lek. 2013;70(7):440-2.

41. *Neurofeedback therapy in patients with acute and chronic pain syndromes--literature review and own experience.

Kubik A, Biedroń A.

Instytut Neuromedica, Kraków. alicja.kubik@instytut-neuromedica.pl

Abstract
Pain management is based mainly on pharmacotherapy which has many limitations. Non-pharmacological techniques, like **neurofeedback** (**EEG**-biofeedback) are alternative methods of pain treatment. Data from literature confirm high efficacy of **neurofeedback** in pain syndromes treatment, chronic and acute as well. **Neurofeedback** plays an important role in management of post stroke, post traumatic headaches and in primary headaches like tension type headaches or migraine. Literature review and own experience indicate importance of number and frequency of performed **neurofeedback** trainings on treatment effectiveness. Satisfactory results have already been observed after 30 trainings however usually 40-60 training have to be performed. Effectiveness of such therapy in pain syndromes is usually good or less often acceptable (50% reduction of headaches). Children with tension type headaches (differently than adults) need reminder therapy every 6-12 months, otherwise recurrence of headaches is observed. Based on our own experience **neurofeedback** therapy seems to play role in neuropathic pain and cancer pain management.

PMID: 24167944 [PubMed - indexed for MEDLINE]

Tijdschr Psychiatr. 2013;55(10):773-82.

42. *[The role of sleep in ADHD: possibilities for prevention of ADHD?].

[Article in Dutch]

Arns M.

Abstract
BACKGROUND: Personalized medicine aims to provide the right treatment for the right person at the right time, as opposed to the currently employed ‘one-size-fits-all ' approach. This development relies on identification of ADHD subgroups using biomarkers. One

important ADHD subgroup is characterised by impaired vigilance regulation, as quantified by the **EEG** and this sub-group responds well to stimulant medication and **neurofeedback**. Recent insights suggest a clear association between reduced sleep duration and ADHD complaints in this sub-group of ADHD patients. A recently published model explains how different treatments e.g. chronobiological treatments and **neurofeedback** impact on this neural circuitry and mediate ADHD symptom improvement.

AIM: To test this recently published model predicting a relationship between solar intensity and ADHD prevalence.

METHOD: A literature survey on studies using identical methods to estimate the prevalence of ADHD in different geographical areas and compare those to worldwide solar intensity data.

RESULTS: A clear relationship between solar intensity and the worldwide prevalence of ADHD was found, explaining 34-57% of the variance in ADHD prevalence, where a lower prevalence of ADHD was found in areas with high solar-intensity.

CONCLUSION: The preventative effect of high solar intensity may be related to improvement of circadian clock disturbances. These findings likely apply to a substantial sub-group of ADHD patients and have major implications for our understanding of the etiology and possibly prevention of ADHD.

PMID: 24166337 [PubMed - in process]
See complete free article in Dutch at:
http://www.tijdschriftvoorpsychiatrie.nl/en/issues/470/articles/9898

Conf Proc IEEE Eng Med Biol Soc. 2013;2013:2016-9. doi: 10.1109/EMBC.2013.6609926.

43. Extraction of intended palpation times from facial EMGs in a mouse model of active sensing.

Schroeder JB, Ritt JT.

Abstract
The rodent whisker system is a common model for somatosensory neuroscience and sensorimotor integration. In support of ongoing efforts to assess neural stimulation approaches for future sensory prostheses, in which we deliver optogenetic stimulation to the somatosensory cortex of behaving mice, we must coordinate feedback in real time with active sensing whisker motions. Here we describe methods for extracting the times of whisker palpations from bilateral bipolar facial electromyograms (EMG). In particular, we show onset times extracted offline from EMG envelopes lead whisker motion onsets extracted from high speed video (HSV) by ≈ 16 ms. While HSV provides ground truth for sensing motions, it is not a feasible source of real time information suitable for **neurofeedback** experiments. As an alternative, we find the temporal derivative of the EMG envelope reliably predicts whisker motion onsets with short latency. Thus EMG, although providing noisy and partial information, can serve well as an input to control algorithms for testing neural processing of active sensing information, and providing stimulation for artificial touch experiments.

PMID: 24110113 [PubMed - in process]

Conf Proc IEEE Eng Med Biol Soc. 2013;2013:7400-3. doi: 10.1109/EMBC.2013.6611268.

44. *EEG brain mapping and brain connectivity index for subtypes classification of attention deficit hyperactivity disorder children during the eye-opened period.

Rodrak S, Wongsawat Y.

Abstract
Attention deficit hyperactivity disorder (ADHD) is one of the most prevalent neurological disorders. It is classified by the DSM-IV into three subtypes, i.e. 1) predominately inattentive type, 2) predominately hyperactive-impulsive type, and (3) combined type. In order to make the treatment via the **neurofeedback** or the occupational therapy, quantitative evaluations as well as ADHD subtype classification are the important problems to be solved to enhance an alternative way to treat ADHD. Hence, in this paper, we systematically classify all of these three subtypes by the 19-channel **EEG** data. Three brain mapping (Q**EEG**) techniques, i.e. absolute power of frequency bands, coherence, and phase lag, are employed to visualize each type of the ADHD. ADHD children with combined type have deficit in delta theta and alpha activity. For the inattentive type, there are excessive delta and theta absolute power in the frontal area as well as the excessive coherence in beta and high beta frequency bands. For the hyperactivity and impulsive type, the behavior is dominated by the slow wave. This information will give benefits to the psychiatrist, psychologist, **neurofeedback** therapist as well as the occupational therapist for quantitatively planning and analyzing the treatment.

PMID: 24111455 [PubMed - in process]

Conf Proc IEEE Eng Med Biol Soc. 2013;2013:6293-6. doi: 10.1109/EMBC.2013.6610992.

45. *EEG-based upper-alpha neurofeedback for cognitive enhancement in major depressive disorder: A preliminary, uncontrolled study.

Escolano C, Navarro-Gil M, Garcia-Campayo J, Minguez J.

Abstract
Conditioning of the upper-alpha rhythm to improve cognitive performance in healthy users by means of **neurofeedback** (**NF**) has been evaluated by several studies, however its effectiveness in people with severe cognitive deficits, such as depressive subjects, remains underexplored. This paper reports on a preliminary uncontrolled study to assess the effects of an upper-alpha **NF** intervention on patients with major depressive disorder (MDD). The **NF** effects on the **EEG** and cognitive performance were assessed. The **EEG** results showed that patients were able to modulate the upper-alpha rhythm in task-related **EEG** and during training, in both cases across the executions of the **NF** sessions, and pre and post within each session. The behavioral results showed the effectiveness of this intervention in a variety of cognitive functions such as working memory, attention, and executive functions.

PMID: 24111179 [PubMed - in process]

Conf Proc IEEE Eng Med Biol Soc. 2013;2013:433-6. doi: 10.1109/EMBC.2013.6609529.

46. *Design of an online EEG based neurofeedback game for enhancing attention and memory.

Thomas KP, Vinod AP, Guan C.

Abstract
Brain-Computer Interface (**BCI**) is an alternative communication and control channel between brain and computer which finds applications in neuroprosthetics, brain wave controlled computer games etc. This paper proposes an Electroencephalogram (**EEG**) based **neurofeedback** computer game that allows the player to control the game with the help of attention based brain signals. The proposed game protocol requires the player to memorize a set of numbers in a matrix, and to correctly fill the matrix using his attention. The attention level of the player is quantified using sample entropy features of **EEG**. The statistically significant performance improvement of five healthy subjects after playing a number of game sessions demonstrates the effectiveness of the proposed game in enhancing their concentration and memory skills.

PMID: 24109716 [PubMed - in process]

Evid Based Complement Alternat Med. 2013;2013:962741. Epub 2013 Sep 3.

47. *Efficacy of EMG- and EEG-Biofeedback in Fibromyalgia Syndrome: A Meta-Analysis and a Systematic Review of Randomized Controlled Trials.

Glombiewski JA, Bernardy K, Häuser W.

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Abstract
Objectives. Biofeedback (BFB) is an established intervention in the rehabilitation of headache and other pain disorders. Little is known about this treatment option for fibromyalgia syndrome (FMS). The aim of the present review is to integrate and critically evaluate the evidence regarding the efficacy of biofeedback for FMS. Methods. We conducted a literature search using Pubmed, clinicaltrials.gov (National Institute of Health), Cochrane Central Register of Controlled Trials, PsycI**NF**O, SCOPUS, and manual searches. The effect size estimates were calculated using a random-effects model. Results. The literature search produced 123 unique citations. One hundred sixteen records were excluded. The meta-analysis included seven studies (321 patients) on **EEG**-Biofeedback and EMG-Biofeedback. In comparison to control groups, biofeedback (BFB) significantly reduced pain intensity with a large effect size (g = 0.79; 95% CI: 0.22-1.36). Subgroup analyses revealed that only EMG-BFB and not **EEG**-BFB significantly reduced pain intensity in comparison to control groups (g = 0.86; 95% CI: 0.11-1.62). BFB did not reduce sleep problems, depression, fatigue, or health-related quality of life in comparison to a control group. Discussion. The interpretation of the results is limited because of a lack of studies on the long-term effects of EMG-BFB in FMS. Further research should focus on the long-term efficacy of BFB in fibromyalgia and on the identification of predictors of treatment response.

PMID: 24082911 [PubMed - as supplied by publisher] PMCID: PMC3776543

See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3776543

Adv Exp Med Biol. 2013;789:449-54. doi: 10.1007/978-1-4614-7411-1_60.

48. *NIRS-based neurofeedback learning systems for controlling activity of the prefrontal cortex.

Sakatani K, Takemoto N, Tsujii T, Yanagisawa K, Tsunashima H.

Department of Neurological Surgery, Division of Optical Brain Engineering, Nihon University School of Medicine, Tokyo, Japan, sakatani@med.nihon-u.ac.jp.

Abstract
The aim of this study was to develop a **NIRS**-based **neurofeedback** system to modulate activity in the prefrontal cortex (PFC). We evaluated the effectiveness of the system in terms of separability of changes in oxy-Hb and its derivative. Training with **neurofeedback** resulted in higher separability than training without **neurofeedback** or no training, suggesting that the **neurofeedback** system could enhance self-control of PFC activity. Interestingly, the dorsolateral PFC exhibited enhanced activity and high separability after **neurofeedback** training. These observations suggest that the **neurofeedback** system might be useful for training subjects to regulate emotions by self-control of dorsolateral PFC activity.

PMID: 23852528 [PubMed - in process]

Appl Neuropsychol Child. 2013;2(2):133-40. doi: 10.1080/21622965.2013.748383. Epub 2013 Jan 8.

49. *Interventions for executive function deficits in children and adolescents.

Riccio CA, Gomes H.

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Abstract
For children with neurodevelopmental or acquired disorders, deficits in executive function (EF) processes (i.e., attention, working memory, cognitive flexibility, and problem solving), are often evident. Moreover, EF deficits are associated with academic difficulties, behavioral and social difficulties, and long-term psychological maladjustment rendering prevention and intervention of EF deficits an important consideration. Many methods exist to address EF processes; this review will focus on pharmacological, cognitive/metacognitive, computerized, and **neurofeedback** approaches. Across research reviewed, results tend to vary depending on age, disorder, comorbid conditions, and outcome measures. Notably, there is limited research to suggest long-term maintenance of changes in symptom presentation, improved developmental trajectory, normalization of EF processes, or alteration to the associated neural connections. Implications for practice and future research for evidence-based interventions to address EF are discussed.

PMID: 23848245 [PubMed - indexed for MEDLINE]

Neuropsychobiology. 2013;67(4):210-23. doi: 10.1159/000347087. Epub 2013 Apr 27.

50. *Prediction of treatment response and the effect of independent component neurofeedback in obsessive-compulsive disorder: a randomized, sham-controlled, double-blind study.

Kopřivová J, Congedo M, Raszka M, Praško J, Brunovský M, Horáček J.

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Abstract

AIMS: The goal of this study was to assess the effect of independent component **neurofeedback** (**NFB**) on **EEG** and clinical symptoms in patients with obsessive-compulsive disorder (OCD). Subsequently, we explored predictors of treatment response and **EEG** correlates of clinical symptoms.

METHODS: In a randomized, double-blind, parallel design, 20 inpatients with OCD underwent 25 sessions of **NFB** or sham feedback (SFB). **NFB** aimed at reducing **EEG** activity in an independent component previously reported abnormal in this diagnosis. Resting-state **EEG** recorded before and after the treatment was analyzed to assess its posttreatment changes, relationships with clinical symptoms and treatment response.

RESULTS: Overall, clinical improvement in OCD patients was not accompanied by **EEG** change as assessed by standardized low-resolution electromagnetic tomography and normative independent component analysis. Pre- to posttreatment comparison of the trained component and frequency did not yield significant results; however, in the **NFB** group, the nominal values at the downtrained frequency were lower after treatment. The **NFB** group showed significantly higher percentage reduction of compulsions compared to the SFB group ($p = 0.015$). Pretreatment higher amount of delta (1-6 Hz) and low alpha oscillations as well as a lower amount of high beta activity predicted a worse treatment outcome. Source localization of these delta and high beta oscillations corresponded with previous **EEG** resting-state findings in OCD patients compared to healthy controls.

CONCLUSION: Independent component **NFB** in OCD proved useful in percentage improvement of compulsions. Based on our correlation analyses, we hypothesize that we targeted a network related to treatment resistance.

PMID: 23635906 [PubMed - in process]

Semin Pediatr Neurol. 2013 Dec;20(4):258-60. doi: 10.1016/j.spen.2013.10.007. Epub 2013 Oct 29.

51. *Notes from clinical practice: an MD's perspective on 9 years of neurofeedback practice.

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Extract
Neurofeedback is not well recognized in the allopathic medical community even though the American Academy of Pediatrics rates it as Level 1 “Best Support” Intervention for ADHD.4 For instance, I am the only physician in the Washington, DC area, who uses **neurofeedback** as a major tool in their practice. There is also ongoing resistance in medical insurance companies in recognizing **neurofeedback** as anything but “experimental” and therefore not covering under insurance.

PMID: 24365574 [PubMed - in process]

Appl Psychophysiol Biofeedback. 2013 Dec;38(4):285-91. doi: 10.1007/s10484-013-9233-6.

52. *Peripheral visual performance enhancement by neurofeedback training.

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Abstract
Peripheral visual performance is an important ability for everyone, and a positive inter-individual correlation is found between the peripheral visual performance and the alpha amplitude during the performance test. This study investigated the effect of alpha **neurofeedback** training on the peripheral visual performance. A **neurofeedback** group of 13 subjects finished 20 sessions of alpha enhancement feedback within 20 days. The peripheral visual performance was assessed by a new dynamic peripheral visual test on the first and last training day. The results revealed that the **neurofeedback** group showed significant enhancement of the peripheral visual performance as well as the relative alpha amplitude during the peripheral visual test. It was not the case in the non-**neurofeedback** control group, which performed the tests within the same time frame as the **neurofeedback** group but without any training sessions. These findings suggest that alpha **neurofeedback** training was effective in improving peripheral visual performance. To the best of our knowledge, this is the first study to show evidence for performance improvement in peripheral vision via alpha **neurofeedback** training.

PMID: 24101183 [PubMed - in process]

Nicotine Tob Res. 2013 Dec;15(12):2120-4. doi: 10.1093/ntr/ntt122. Epub 2013 Aug 9.

53. *Sustained reduction of nicotine craving with real-time neurofeedback: exploring the role of severity of dependence.

Canterberry M, Hanlon CA, Hartwell KJ, Li X, Owens M, LeMatty T, Prisciandaro JJ, Borckardt J, Saladin ME, Brady KT, George MS.

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Abstract
BACKGROUND: **Neurofeedback** delivered via real-time functional magnetic resonance imaging (rt**fMRI**) is a promising therapeutic technique being explored to facilitate self-regulation of craving in nicotine-dependent cigarette smokers. The current study examined the role of nicotine-dependence severity and the efficacy of multiple visits of **neurofeedback** from a single region of interest (ROI) in the anterior cingulate cortex (ACC) on craving reduction.

METHODS: Nine nicotine-dependent cigarette smokers participated in three rt**fMRI** visits that examined cue-induced craving and brain activation. Severity of nicotine dependence was assessed with the Fagerström Test for Nicotine Dependence. When viewing smoking-related images with instructions to "crave," patient-tailored ROIs were generated in the vicinity of the ACC. Activity levels from the ROI were fed back while participants viewed smoking cues with the instruction to reduce craving.

RESULTS: **Neurofeedback** from a single ROI in the ACC led to consistent decreases in self-reported craving and activation in the ACC across the three visits. Dependence severity predicted response to **neurofeedback** at Visit 3.

CONCLUSIONS: This study builds upon previous rt**fMRI** studies on the regulation of nicotine craving in demonstrating that feedback from the ACC can reduce activation to smoking cues across three separate visits. Individuals with lower nicotine-dependence severity were more successful in reducing ACC activation over time. These data highlight the need to consider dependence severity in developing more individualized **neurofeedback** methods.

PMID: 23935182 [PubMed - in process] PMCID: PMC3819983 [Available on 2014/12/1]

Clin Neurophysiol. 2013 Dec;124(12):2406-20. doi: 10.1016/j.clinph.2013.05.020. Epub 2013 Jul 1.

54. *Neurofeedback training improves attention and working memory performance.

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Abstract

OBJECTIVES: The present study aimed to investigate the effectiveness of the frontal-midline theta (fmθ) activity uptraining protocol on attention and working memory performance of older and younger participants.

METHODS: Thirty-two participants were recruited. Participants within each age group were randomly assigned to either the **neurofeedback** training (fmθ uptraining) group or the sham-**neurofeedback** training group.

RESULTS: There was a significant improvement in orienting scores in the older **neurofeedback** training group. In addition, there was a significant improvement in conflict scores in both the older and young **neurofeedback** training groups. However, alerting scores failed to increase. In addition, the fmθ training was found to improve working memory function in the older participants. The results further showed that fmθ training can modulate resting **EEG** for both **neurofeedback** groups.

CONCLUSIONS: Our study demonstrated that fmθ uptraining improved attention and working memory performance and theta activity in the resting state for normal aging adults. In addition, younger participants also benefited from the present protocol in terms of improving their executive function.

SIGNIFICANCE: The current findings contribute to a better understanding of the mechanisms underlying **neurofeedback** training in cognitive function, and suggest that the fmθ uptraining protocol is an effective intervention program for cognitive aging.

PMID: 23827814 [PubMed - indexed for MEDLINE]

Encephale. 2013 Dec;39(6):426-31. doi: 10.1016/j.encep.2013.04.009. Epub 2013 Jun 28.

55. *[Interactive rTMS protocols in psychiatry].

[Article in French]

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Abstract

BACKGROUND: The efficiency of repetitive transcranial magnetic stimulation (rTMS) in the treatment of psychiatric disorders is robust for major depressive episode (MDE) while results are encouraging for schizophrenia. However, rTMS protocols need to be optimized. Basic researches in TMS led to the concept of "state dependency TMS". This concept suggests that the neural circuits' activation states, before and during the stimulation, influence

the pulse effect. Indeed, TMS effect must be seen, not simply as a stimulus, but also as the result of an interaction between a stimulus and a level of brain activity. Those data suggest that rTMS efficiency could be increased in psychiatric disorders by triggering patients' neurocognitive activities during stimulation. Thus "interactive rTMS protocols" have been submitted.

OBJECTIVES: This article provides a review and a classification of different interactive protocols implemented in the treatment of MDE and schizophrenia. Protocols' interactions with cognitive activities and brain electrical activities will be discussed.

LITERATURE FINDINGS: Interactive rTMS protocols that manipulate cognitive activities have been developed for MDE treatments. They aim at regulating emotional states of depressed patients during the stimulation. The patients perform emotional tasks in order to activate cortical networks involving the left dorsolateral prefrontal cortex (DLPFC) into a state that may be more sensitive to the rTMS pulse effect. Simultaneous cognitive behavioral therapy ("CBT rTMS") and cognitive-emotional reactivation ("affective rTMS") have thus been tested during left DLPFC rTMS in MDE. Interactive rTMS protocols that manipulate brain electrical activities have been developed for MDE and schizophrenia treatments. Two categories of protocols should be identified. In the first set, personalized brain activity has been analyzed to determine the parameters of stimulation (i.e. frequency of stimulation) matching the patient ("personalized rTMS"). Personalized rTMS protocols can be made "online" or "offline" depending on whether the **EEG** activity is measured during or prior to rTMS. Online protocol is called "contingent rTMS": it consists in stimulating the brain only when a specific **EEG** pattern involving the intensity of alpha rhythm is recorded and recognized. Offline protocol is called "alpha rTMS", and relies on ascertaining frequency of stimulation in accordance with personalized alpha peak frequency prior to rTMS. In the second set, electrical brain activity is modulated before or during rTMS in order to stimulate the DLPFC in optimal conditions. Brain activity modulation may be obtained by transcranial direct current stimulation ("tDCS rTMS") or **EEG-biofeedack** ("**EEG-biofeedback** rTMS").

CONCLUSION: Interactive rTMS studies have various limitations, notably their exploratory character on a small sample of patients. Furthermore, their theoretical neurocognitive framework justification remains unclear. Nonetheless, interactive rTMS protocols allow us to consider a new field of rTMS, where cognitive and cerebral activities would no longer be considered as simple neural noise, leading to a kind of "first person rTMS", and certainly to innovative therapy in psychiatry.

PMID: 23810752 [PubMed - in process]

Front Neurosci. 2013 Dec 30;7:265. doi: 10.3389/fnins.2013.00265. eCollection 2013.

56. Decoding of single-trial auditory mismatch responses for online perceptual monitoring and neurofeedback.

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Abstract
Multivariate pattern classification methods are increasingly applied to neuroimaging data in the context of both fundamental research and in brain-computer interfacing approaches. Such methods provide a framework for interpreting measurements made at the single-trial level with respect to a set of two or more distinct mental states. Here, we define an approach in which the output of a binary classifier trained on data from an auditory mismatch paradigm can be used for online tracking of perception and as a **neurofeedback** signal. The auditory mismatch paradigm is known to induce distinct perceptual states related to the presentation of high- and low-probability stimuli, which are reflected in event-related potential (ERP) components such as the mismatch negativity (MMN). The first part of this paper illustrates how pattern classification methods can be applied to data collected in an MMN paradigm, including discussion of the optimization of preprocessing steps, the interpretation of features and how the performance of these methods generalizes across individual participants and measurement sessions. We then go on to show that the output of these decoding methods can be used in online settings as a continuous index of single-trial brain activation underlying perceptual discrimination. We conclude by discussing several potential domains of application, including **neurofeedback**, cognitive monitoring and passive brain-computer interfaces.

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See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3874475

Front Hum Neurosci. 2013 Dec 26;7:914. doi: 10.3389/fnhum.2013.00914. eCollection 2013.

57. *Neural substrates of cognitive control under the belief of getting neurofeedback training.

Ninaus M[1], Kober SE[1], Witte M[1], Koschutnig K[1], Stangl M[2], Neuper C[3], Wood G[1].

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Abstract
Learning to modulate one's own brain activity is the fundament of **neurofeedback** (**NF**) applications. Besides the neural networks directly involved in the generation and modulation of the neurophysiological parameter being specifically trained, more general determinants of **NF** efficacy such as self-referential processes and cognitive control have been frequently disregarded. Nonetheless, deeper insight into these cognitive mechanisms and their neuronal underpinnings sheds light on various open **NF** related questions concerning individual differences, brain-computer interface (**BCI**) illiteracy as well as a more general model of **NF** learning. In this context, we investigated the neuronal substrate of these more general regulatory mechanisms that are engaged when participants believe that they are receiving **NF**. Twenty healthy participants (40-63 years, 10 female) performed a sham **NF** paradigm during

fMRI scanning. All participants were novices to **NF**-experiments and were instructed to voluntarily modulate their own brain activity based on a visual display of moving color bars. However, the bar depicted a recording and not the actual brain activity of participants. Reports collected at the end of the experiment indicate that participants were unaware of the sham feedback. In comparison to a passive watching condition, bilateral insula, anterior cingulate cortex and supplementary motor and dorsomedial and lateral prefrontal areas were activated when participants actively tried to control the bar. In contrast, when merely watching moving bars, increased activation in the left angular gyrus was observed. These results show that the intention to control a moving bar is sufficient to engage a broad frontoparietal and cingulo-opercular network involved in cognitive control. The results of the present study indicate that tasks such as those generally employed in **NF** training recruit the neuronal correlates of cognitive control even when only sham **NF** is presented.

PMID: 24421765 [PubMed] PMCID: PMC3872730
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3872730

PLoS One. 2013 Dec 2;8(12):e81658. doi: 10.1371/journal.pone.0081658. eCollection 2013.

58. *Real-time fMRI pattern decoding and neurofeedback using FRIEND: an FSL-integrated BCI toolbox.

Sato JR, Basilio R, Paiva FF, Garrido GJ, Bramati IE, Bado P, Tovar-Moll F, Zahn R, Moll J.

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Abstract
The demonstration that humans can learn to modulate their own brain activity based on feedback of neurophysiological signals opened up exciting opportunities for fundamental and applied neuroscience. Although **EEG**-based **neurofeedback** has been long employed both in experimental and clinical investigation, functional **MRI** (**fMRI**)-based **neurofeedback** emerged as a promising method, given its superior spatial resolution and ability to gauge deep cortical and subcortical brain regions. In combination with improved computational approaches, such as pattern recognition analysis (e.g., Support Vector Machines, SVM), **fMRI neurofeedback** and brain decoding represent key innovations in the field of neuromodulation and functional plasticity. Expansion in this field and its applications critically depend on the existence of freely available, integrated and user-friendly tools for the neuroimaging research community. Here, we introduce FRIEND, a graphic-oriented user-friendly interface package for **fMRI neurofeedback** and real-time multivoxel pattern decoding. The package integrates routines for image preprocessing in real-time, ROI-based feedback (single-ROI BOLD level and functional connectivity) and brain decoding-based feedback using SVM. FRIEND delivers an intuitive graphic interface with flexible processing pipelines involving optimized procedures embedding widely validated packages, such as FSL and libSVM. In addition, a user-defined visual **neurofeedback** module allows users to easily design and run **fMRI neurofeedback** experiments using ROI-based or multivariate classification approaches. FRIEND is open-source and free for non-commercial use. Processing tutorials and extensive documentation are available.

PMID: 24312569 [PubMed - in process] PMCID: PMC3847114
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3847114

Ann Clin Psychiatry. 2013 Nov;25(4):289-96.

59. *Neurofeedback and traumatic brain injury: a literature review.

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Abstract
BACKGROUND: **Neurofeedback** is a form of biofeedback whereby a patient can learn to control measurements of brain activity such as those recorded by an electroencephalogram. It has been explored as a treatment for sequelae of traumatic brain injury, although the use of **neurofeedback** remains outside the realm of routine clinical practice.

METHODS: Google Scholar™ was used to find 22 examples of primary research. Measures of symptom improvement, neuropsychological testing, and changes in subjects' quantitative electroencephalogram were included in the analysis. A single reviewer classified each study according to a rubric devised by 2 societies dedicated to **neurofeedback** research.

RESULTS: All studies demonstrated positive findings, in that **neurofeedback** led to improvement in measures of impairment, whether subjective, objective, or both. However, placebo-controlled studies were lacking, some reports omitted important details, and study designs differed to the point where effect size could not be calculated quantitatively.

CONCLUSIONS: **Neurofeedback** is a promising treatment that warrants double-blind, placebo-controlled studies to determine its potential role in the treatment of traumatic brain injury. Clinicians can advise that some patients report improvement in a wide range of neuropsychiatric symptoms after undergoing **neurofeedback**, although the treatment remains experimental, with no standard methodology.

PMID: 24199220 [PubMed - in process]

Eur Eat Disord Rev. 2013 Nov;21(6):456-63. doi: 10.1002/erv.2250. Epub 2013 Sep 30.

60. *The potential of neurofeedback in the treatment of eating disorders: a review of the literature.

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Abstract

Neurofeedback is defined as the training of voluntary regulation of localised neural activity using real-time feedback through a brain-computer interface. It has shown initial success as a potential clinical treatment tool in proof of concept studies, but has yet to be evaluated with respect to eating disorders. This paper (i) provides a brief overview of the current status of eating disorder treatments; (ii) describes the studies to date that use **neurofeedback** involving electroencephalography, real-time **functional magnetic resonance imaging** or **near-infrared spectroscopy**; and (iii) considers the potential of these technologies as treatments for eating disorders.

PMID: 24115445 [PubMed - in process]

Exp Brain Res. 2013 Nov;231(3):351-65. doi: 10.1007/s00221-013-3699-6. Epub 2013 Sep 26.

61. Electroencephalography (EEG)-based neurofeedback training for brain-computer interface (BCI).

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Abstract

Electroencephalography has become a popular tool in basic brain research, but in recent years, several practical limitations have been highlighted. Some of the drawbacks pertain to the offline analyses of the neural signal that prevent the subjects from engaging in real-time error correction during learning. Other limitations include the complex nature of the visual stimuli, often inducing fatigue and introducing considerable delays, possibly interfering with spontaneous performance. By replacing the complex external visual input with internally driven motor imagery, we can overcome some delay problems, at the expense of losing the ability to precisely parameterize features of the input stimulus. To address these issues, we here introduce a nontrivial modification to brain-computer Interfaces (**BCI**). We combine the fast signal processing of motor imagery with the ability to parameterize external visual feedback in the context of a very simple control task: attempting to intentionally control the direction of an external cursor on command. By engaging the subject in motor imagery while providing real-time visual feedback on their instantaneous performance, we can take advantage of positive features present in both externally- and internally driven learning. We further use a classifier that automatically selects the cortical activation features that most likely maximize the performance accuracy. Under this closed loop coadaptation system, we saw a progression of the cortical activation that started in sensorymotor areas, when at chance performance motor imagery was explicitly used, migrated to BA6 under deliberate control and ended in the more frontal regions of prefrontal cortex, when at maximal performance accuracy, the subjects reportedly developed spontaneous mental control of the instructed direction. We discuss our results in light of possible applications of this simple **BCI** paradigm to study various cognitive phenomena involving the deliberate control of a directional signal in decision making tasks performed with intent.

PMID: 24068244 [PubMed - in process]

Acta Psychiatr Scand. 2013 Nov 25. doi: 10.1111/acps.12229. [Epub ahead of print]

62. *Plastic modulation of PTSD resting-state networks and subjective wellbeing by EEG neurofeedback.

Kluetsch RC, Ros T, Théberge J, Frewen PA, Calhoun VD, Schmahl C, Jetly R, Lanius RA.

Department of Psychosomatic Medicine and Psychotherapy, Central Institute of Mental Health, Medical Faculty Mannheim Heidelberg University, Mannheim, Germany.

Abstract
OBJECTIVE: Electroencephalographic (**EEG**) **neurofeedback** training has been shown to produce plastic modulations in salience network and default mode network functional connectivity in healthy individuals. In this study, we investigated whether a single session of **neurofeedback** training aimed at the voluntary reduction of alpha rhythm (8-12 Hz) amplitude would be related to differences in **EEG** network oscillations, functional **MRI** (**fMRI**) connectivity, and subjective measures of state anxiety and arousal in a group of individuals with post-traumatic stress disorder (PTSD).

METHOD: Twenty-one individuals with PTSD related to childhood abuse underwent 30 min of **EEG neurofeedback** training preceded and followed by a resting-state **fMRI** scan.

RESULTS: Alpha desynchronizing **neurofeedback** was associated with decreased alpha amplitude during training, followed by a significant increase ('rebound') in resting-state alpha synchronization. This rebound was linked to increased calmness, greater salience network connectivity with the right insula, and enhanced default mode network connectivity with bilateral posterior cingulate, right middle frontal gyrus, and left medial prefrontal cortex.

CONCLUSION: Our study represents a first step in elucidating the potential neurobehavioural mechanisms mediating the effects of **neurofeedback** treatment on regulatory systems in PTSD. Moreover, it documents for the first time a spontaneous **EEG** 'rebound' after **neurofeedback**, pointing to homeostatic/compensatory mechanisms operating in the brain.

PMID: 24266644 [PubMed - as supplied by publisher]

J Clin Child Adolesc Psychol. 2013 Nov 18. [Epub ahead of print]

63. *Evidence-Based Psychosocial Treatments for Children and Adolescents with Attention-Deficit/Hyperactivity Disorder.

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Abstract
The purpose of this research was to update the Pelham and Fabiano (2008) review of evidence-based practices for children and adolescents with attention-deficit/hyperactivity disorder. We completed a systematic review of the literature published between 2007 and 2013 to establish levels of evidence for psychosocial treatments for these youth. Our review included the identification of relevant articles using criteria established by the Society of Clinical Child and Adolescent Psychology (see Southam-Gerow & Prinstein, in press) using keyword searches and a review of tables of contents. We extend the conceptualization of treatment research by differentiating training interventions from behavior management and by reviewing the growing literature on training interventions. Consistent with the results of the previous review we conclude that behavioral parent training, behavioral classroom management, and behavioral peer interventions are well-established treatments. In addition, organization training met the criteria for a well-established treatment. Combined training programs met criteria for Level 2 (Probably Efficacious), **neurofeedback** training met criteria for Level 3 (Possibly Efficacious), and cognitive training met criteria for Level 4 (Experimental Treatments). The distinction between behavior management and training interventions provides a method for considering meaningful differences in the methods and possible mechanisms of action for treatments for these youth. Characteristics of treatments, participants, and measures, as well as the variability in methods for classifying levels of evidence for treatments, are reviewed in relation to their potential effect on outcomes and conclusions about treatments. Implications of these findings for future science and practice are discussed.

PMID: 24245813 [PubMed - as supplied by publisher]

Neurosci Biobehav Rev. 2013 Nov 15. pii: S0149-7634(13)00271-6. doi: 10.1016/j.neubiorev.2013.11.004. [Epub ahead of print]

64. *EEG-neurofeedback for optimising performance. II: Creativity, the performing arts and ecological validity.

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Abstract
As a continuation of a review of evidence of the validity of cognitive/affective gains following **neurofeedback** in healthy participants, including correlations in support of the gains being mediated by feedback learning (Gruzelier, 2013a), the focus here is on the impact on creativity, especially in the performing arts including music, dance and acting. The majority of research involves alpha/theta (A/T), sensory-motor rhythm (**SMR**) and heart rate variability (HRV) protocols. There is evidence of reliable benefits from A/T training with advanced musicians especially for creative performance, and reliable benefits from both A/T and **SMR** training for novice music performance in adults and in a school study with children with impact on creativity, communication/presentation and technique. Making the **SMR** ratio training context ecologically relevant for actors enhanced creativity in stage performance, with added benefits from the more immersive training context. A/T and HRV training have benefitted dancers. The **neurofeedback** evidence adds to the rapidly accumulating validation

of **neurofeedback**, while performing arts studies offer an opportunity for ecological validity in creativity research for both creative process and product.

PMID: 24239853 [PubMed - as supplied by publisher]

Neuroimage. 2013 Nov 11;88C:113-124. doi: 10.1016/j.neuroimage.2013.10.069. [Epub ahead of print]

65. *Self-regulation of the anterior insula: Reinforcement learning using real-time fMRI neurofeedback.

Lawrence EJ[1], Su L[2], Barker GJ[3], Medford N[4], Dalton J[3], Williams SC[3], Birbaumer N[5], Veit R[5], Ranganatha S[5], Bodurka J[6], Brammer M[3], Giampietro V[3], David AS[7].

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Abstract
The anterior insula (AI) plays a key role in affective processing, and insular dysfunction has been noted in several clinical conditions. Real-time functional **MRI neurofeedback** (rt**fMRI-NF**) provides a means of helping people learn to self-regulate activation in this brain region. Using the Blood Oxygenated Level Dependant (BOLD) signal from the right AI (RAI) as **neurofeedback**, we trained participants to increase RAI activation. In contrast, another group of participants was shown 'control' feedback from another brain area. Pre- and post-training affective probes were shown, with subjective ratings and skin conductance response (SCR) measured. We also investigated a reward-related reinforcement learning model of rt**fMRI-NF**. In contrast to the controls, we hypothesised a positive linear increase in RAI activation in participants shown feedback from this region, alongside increases in valence ratings and SCR to affective probes. Hypothesis-driven analyses showed a significant interaction between the RAI/control **neurofeedback** groups and the effect of self-regulation. Whole-brain analyses revealed a significant linear increase in RAI activation across four training runs in the group who received feedback from RAI. Increased activation was also observed in the caudate body and thalamus, likely representing feedback-related learning. No positive linear trend was observed in the RAI in the group receiving control feedback, suggesting that these data are not a general effect of cognitive strategy or control feedback. The control group did, however, show diffuse activation across the putamen, caudate and posterior insula which may indicate

the representation of false feedback. No significant training-related behavioural differences were observed for valence ratings, or SCR. In addition, correlational analyses based on a reinforcement learning model showed that the dorsal anterior cingulate cortex underpinned learning in both groups. In summary, these data demonstrate that it is possible to regulate the RAI using rt**fMRI-NF** within one scanning session, and that such reward-related learning is mediated by the dorsal anterior cingulate.

PMID: 24231399 [PubMed - as supplied by publisher]

PLoS One. 2013 Nov 6;8(11):e79184. doi: 10.1371/journal.pone.0079184. eCollection 2013.

66. *Prefrontal control of the amygdala during real-time fMRI neurofeedback training of emotion regulation.

Zotev V, Phillips R, Young KD, Drevets WC, Bodurka J.

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Abstract
We observed in a previous study (PLoS ONE 6:e24522) that the self-regulation of amygdala activity via real-time **fMRI neurofeedback** (rt**fMRI**-nf) with positive emotion induction was associated, in healthy participants, with an enhancement in the functional connectivity between the left amygdala (LA) and six regions of the prefrontal cortex. These regions included the left rostral anterior cingulate cortex (rACC), bilateral dorsomedial prefrontal cortex (DMPFC), bilateral superior frontal gyrus (SFG), and right medial frontopolar cortex (MFPC). Together with the LA, these six prefrontal regions thus formed the functional neuroanatomical network engaged during the rt**fMRI**-nf procedure. Here we perform a structural vector autoregression (SVAR) analysis of the effective connectivity for this network. The SVAR analysis demonstrates that the left rACC plays an important role during the rt**fMRI**-nf training, modulating the LA and the other network regions. According to the analysis, the rt**fMRI**-nf training leads to a significant enhancement in the time-lagged effect of the left rACC on the LA, potentially consistent with the ipsilateral distribution of the monosynaptic projections between these regions. The training is also accompanied by significant increases in the instantaneous (contemporaneous) effects of the left rACC on four other regions - the bilateral DMPFC, the right MFPC, and the left SFG. The instantaneous effects of the LA on the bilateral DMPFC are also significantly enhanced. Our results are consistent with a broad literature supporting the role of the rACC in emotion processing and regulation. Our exploratory analysis provides, for the first time, insights into the causal relationships within the network of regions engaged during the rt**fMRI**-nf procedure targeting the amygdala. It suggests that the rACC may constitute a promising target for rt**fMRI**-nf training along with the amygdala in patients with affective disorders, particularly posttraumatic stress disorder (PTSD).

PMID: 24223175 [PubMed - in process] PMCID: PMC3819266
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3819266

Neuroimage. 2013 Nov 6;88C:54-60. doi: 10.1016/j.neuroimage.2013.10.028. [Epub ahead of print]

67. *Targeted reinforcement of neural oscillatory activity with real-time neuroimaging feedback.

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Abstract
Biofeedback and brain-computer interfacing using **EEG** has been receiving continuous and increasing interest. However, the limited spatial resolution of low-density scalp recordings is a roadblock to the unequivocal monitoring and targeting of neuroanatomical regions and physiological signaling. This latter aspect is pivotal to the actual efficiency of **neurofeedback** procedures, which are expected to engage the modulation of well-identified components of neural activity within and between predetermined brain regions. Our group has previously contributed to demonstrate the principles of real-time magnetoencephalography (**MEG**) source imaging. Here we show how the technique was further developed to provide healthy subjects with region-specific **neurofeedback** to modulate successfully predetermined components of their brain activity in targeted brain regions. Overall, our results positively indicate that **neurofeedback** based on time-resolved **MEG** imaging has the potential to become an innovative therapeutic approach in neurology and neuropsychiatry.

PMID: 24211817 [PubMed - as supplied by publisher]

Neuroimage. 2013 Nov 1;81:422-30. doi: 10.1016/j.neuroimage.2013.05.010. Epub 2013 May 11.

68. *Connectivity-based neurofeedback: dynamic causal modeling for real-time fMRI.

Koush Y, Rosa MJ, Robineau F, Heinen K, W Rieger S, Weiskopf N, Vuilleumier P, Van De Ville D, Scharnowski F.

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Abstract
Neurofeedback based on real-time **fMRI** is an emerging technique that can be used to train voluntary control of brain activity. Such brain training has been shown to lead to behavioral effects that are specific to the functional role of the targeted brain area. However, real-time **fMRI**-based **neurofeedback** so far was limited to mainly training localized brain activity within a region of interest. Here, we overcome this limitation by presenting near real-time dynamic causal modeling in order to provide feedback information based on connectivity between brain areas rather than activity within a single brain area. Using a visual-spatial attention paradigm, we show that participants can voluntarily control a feedback signal that is based on the Bayesian model comparison between two predefined model alternatives, i.e. the

connectivity between left visual cortex and left parietal cortex vs. the connectivity between right visual cortex and right parietal cortex. Our new approach thus allows for training voluntary control over specific functional brain networks. Because most mental functions and most neurological disorders are associated with network activity rather than with activity in a single brain region, this novel approach is an important methodological innovation in order to more directly target functionally relevant brain networks.

PMID: 23668967 [PubMed - indexed for MEDLINE] PMCID: PMC3734349
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3734349

Integr Cancer Ther. 2013 Nov;12(6):475-87. doi: 10.1177/1534735413477192. Epub 2013 Apr 12.

69. *The effect of EEG biofeedback on reducing postcancer cognitive impairment.

Alvarez J, Meyer FL, Granoff DL, Lundy A.

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Abstract
BACKGROUND AND HYPOTHESES: Postcancer cognitive impairment (PCCI) is observed in a substantial number of breast cancer survivors, persisting for as long as 20 years in some subgroups. Although compensatory strategies are frequently suggested, no restorative interventions have yet been identified. This study examined the feasibility of **EEG biofeedback** ("**neurofeedback**") and its potential effectiveness in reducing PCCI as well as the fatigue, sleep disturbance, and psychological symptoms that frequently accompany PCCI.

STUDY DESIGN: This was a 6-month prospective study with a waitlist control period followed by an active intervention. Participants were female breast cancer survivors (n = 23), 6 to 60 months postchemotherapy, with self-reported cognitive impairment.

METHODS: Four self-report outcome measures (Functional Assessment of Cancer Therapy-Cognitive Function [FACT-Cog], Functional Assessment of Chronic Illness Therapy-Fatigue [FACIT-Fatigue], Pittsburgh Sleep Quality Index [PSQI], and Brief Symptom Inventory [BSI]-18) were administered 3 times during a 10-week waitlist control period, 3 times during a 10-week (20-session) **neurofeedback** training regimen, and once at 4 weeks post**neurofeedback**.

RESULTS: All 23 participants completed the study, demonstrating the feasibility of **EEG biofeedback** in this population. Initially, the sample demonstrated significant dysfunction on all measures compared with general population norms. Repeated-measures ANOVAs revealed strongly significant improvements ($P < .001$) on all 4 cognitive measures (perceived cognitive impairment, comments from others, perceived cognitive abilities, and impact on quality of life [QOL]), the fatigue scale, and the 4 psychological scales (somatization, depression, anxiety and global severity index) as well as on 3 of 8 sleep scales (quality, daytime dysfunction, and global). Two of the other sleep scales (latency and disturbance)

were significant at P < .01, and 1 (use of medication) at P < .05; 2 were not significant. Improvements were generally linear across the course of training, and were maintained at the follow-up testing. At the follow-up testing, the sample no longer differed significantly from normative populations on 3 of the 4 FACT-Cog measures (impairment, impact on QOL, and comments), FACIT-Fatigue, PSQI sleep quality and habitual efficiency, or any of the BSI-18 measures of psychological disturbance.

CONCLUSIONS: Data from this limited study suggest that **EEG biofeedback** has potential for reducing the negative cognitive and emotional sequelae of cancer treatment as well as improving fatigue and sleep patterns.

PMID: 23584550 [PubMed - in process]

Neuroimage. 2013 Nov 1;81:243-52. doi: 10.1016/j.neuroimage.2013.05.019. Epub 2013 May 16.

70. *Dynamic reconfiguration of human brain functional networks through neurofeedback.

Haller S, Kopel R, Jhooti P, Haas T, Scharnowski F, Lovblad KO, Scheffler K, Van De Ville D.

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Abstract
Recent **fMRI** studies demonstrated that functional connectivity is altered following cognitive tasks (e.g., learning) or due to various neurological disorders. We tested whether real-time **fMRI**-based **neurofeedback** can be a tool to voluntarily reconfigure brain network interactions. To disentangle learning-related from regulation-related effects, we first trained participants to voluntarily regulate activity in the auditory cortex (training phase) and subsequently asked participants to exert learned voluntary self-regulation in the absence of feedback (transfer phase without learning). Using independent component analysis (ICA), we found network reconfigurations (increases in functional network connectivity) during the **neurofeedback** training phase between the auditory target region and (1) the auditory pathway; (2) visual regions related to visual feedback processing; (3) insula related to introspection and self-regulation and (4) working memory and high-level visual attention areas related to cognitive effort. Interestingly, the auditory target region was identified as the hub of the reconfigured functional networks without a-priori assumptions. During the transfer phase, we again found specific functional connectivity reconfiguration between auditory and attention network confirming the specific effect of self-regulation on functional connectivity. Functional connectivity to working memory related networks was no longer altered consistent with the absent demand on working memory. We demonstrate that **neurofeedback** learning is mediated by widespread changes in functional connectivity. In contrast, applying learned self-regulation involves more limited and specific network changes in an auditory setup intended as a model for tinnitus. Hence, **neurofeedback** training might be used to promote recovery from neurological disorders that are linked to abnormal patterns of brain connectivity.

PMID: 23684872 [PubMed - indexed for MEDLINE]

Malays J Med Sci. 2013 Oct;20(5):5-15.

71. *Functional magnetic resonance imaging (FMRI) neurofeedback: implementations and applications.

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Abstract
Neurofeedback (**NFB**) allows subjects to learn how to volitionally influence the neuronal activation in the brain by employing real-time neural activity as feedback. **NFB** has already been performed with electroencephalography (**EEG**) since the 1970s. Functional **MRI** (**fMRI**), offering a higher spatial resolution, has further increased the spatial specificity. In this paper, we briefly outline the general principles behind **NFB**, the implementation of **fMRI**-**NFB** studies, the feasibility of **fMRI**-**NFB**, and the application of **NFB** as a supplementary therapy tool.

PMID: 24643368 [PubMed] PMCID: PMC3957350
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3957350

Clin Neurophysiol. 2013 Oct;124(10):2016-24. doi: 10.1016/j.clinph.2013.04.009. Epub 2013 May 22.

72. *Effects of non-pharmacological pain treatments on brain states.

Jensen MP1, Sherlin LH, Askew RL, Fregni F, Witkop G, Gianas A, Howe JD, Hakimian S.

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Abstract
OBJECTIVE: To (1) evaluate the effects of a single session of four non-pharmacological pain interventions, relative to a sham tDCS procedure, on pain and electroencephalogram- (**EEG**-) assessed brain oscillations, and (2) determine the extent to which procedure-related changes in pain intensity are associated with changes in brain oscillations.

METHODS: 30 individuals with spinal cord injury and chronic pain were given an **EEG** and administered measures of pain before and after five procedures (hypnosis, meditation, transcranial direct current stimulation [tDCS], **neurofeedback**, and a control sham tDCS procedure).

RESULTS: Each procedure was associated with a different pattern of changes in brain activity, and all active procedures were significantly different from the control procedure in at least three bandwidths. Very weak and mostly non-significant associations were found between changes in **EEG**-assessed brain activity and pain.

CONCLUSIONS: Different non-pharmacological pain treatments have distinctive effects on brain oscillation patterns. However, changes in **EEG**-assessed brain oscillations are not significantly associated with changes in pain, and therefore such changes do not appear useful for explaining the benefits of these treatments.

SIGNIFICANCE: The results provide new findings regarding the unique effects of four non-pharmacological treatments on pain and brain activity.

PMID: 23706958 [PubMed - indexed for MEDLINE] PMCID: PMC3759647 [Available on 2014/10/1]

Clin EEG Neurosci. 2013 Oct;44(4):265-72. doi: 10.1177/1550059413476031. Epub 2013 Mar 26.

73. *Neurofeedback training induces changes in white and gray matter.

Ghaziri J, Tucholka A, Larue V, Blanchette-Sylvestre M, Reyburn G, Gilbert G, Lévesque J, Beauregard M.

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Abstract

The main objective of this structural magnetic resonance imaging (**MRI**) study was to investigate, using diffusion tensor imaging, whether a **neurofeedback** training (**NF**T) protocol designed to improve sustained attention might induce structural changes in white matter (WM) pathways, purportedly implicated in this cognitive ability. Another goal was to examine whether gray matter (GM) volume (GMV) might be altered following **NF**T in frontal and parietal cortical areas connected by these WM fiber pathways. Healthy university students were randomly assigned to an experimental group (EXP), a sham group, or a control group. Participants in the EXP group were trained to enhance the amplitude of their β1 waves at F4 and P4. Measures of attentional performance and **MRI** data were acquired one week before (Time 1) and one week after (Time 2) **NF**T. Higher scores on visual and auditory sustained attention were noted in the EXP group at Time 2 (relative to Time 1). As for structural **MRI** data, increased fractional anisotropy was measured in WM pathways implicated in sustained attention, and GMV increases were detected in cerebral structures involved in this type of attention. After 50 years of research in the field of **neurofeedback**, our study constitutes the first empirical demonstration that **NF**T can lead to microstructural changes in white and gray matter.

PMID: 23536382 [PubMed - indexed for MEDLINE]

J Child Psychol Psychiatry. 2013 Oct 30. doi: 10.1111/jcpp.12143. [Epub ahead of print]

74. *Does EEG-neurofeedback improve neurocognitive functioning in children with attention-deficit/hyperactivity disorder? A systematic review and a double-blind placebo-controlled study.

Vollebregt MA, van Dongen-Boomsma M, Buitelaar JK, Slaats-Willemse D.

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Abstract
BACKGROUND: The number of placebo-controlled randomized studies relating to **EEG-neurofeedback** and its effect on neurocognition in attention-deficient/hyperactivity disorder (ADHD) is limited. For this reason, a double blind, randomized, placebo-controlled study was designed to assess the effects of **EEG-neurofeedback** on neurocognitive functioning in children with ADHD, and a systematic review on this topic was performed.

METHODS: Forty-one children (8-15 years) with a DSM-IV-TR diagnosis of ADHD were randomly allocated to **EEG-neurofeedback** or placebo-**neurofeedback** treatment for 30 sessions, twice a week. Children were stratified by age, electrophysiological state of arousal, and medication use. Neurocognitive tests of attention, executive functioning, working memory, and time processing were administered before and after treatment. Researchers, teachers, children and their parents, with the exception of the **neurofeedback**-therapist, were all blind to treatment assignment. Outcome measures were the changes in neurocognitive performance before and after treatment. Clinical trial registration: www.clinicaltrials.gov: NCT00723684.

RESULTS: No significant treatment effect on any of the neurocognitive variables was found. A systematic review of the current literature also did not find any systematic beneficial effect of **EEG-neurofeedback** on neurocognitive functioning.

CONCLUSION: Overall, the existing literature and this study fail to support any benefit of **neurofeedback** on neurocognitive functioning in ADHD, possibly due to small sample sizes and other study limitations.

PMID: 24168522 [PubMed - as supplied by publisher]

Front Hum Neurosci. 2013 Oct 24;7:680. doi: 10.3389/fnhum.2013.00680. eCollection 2013.

75. *Experiencing your brain: neurofeedback as a new bridge between neuroscience and phenomenology.

Bagdasaryan J, Quyen Mle V.

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Abstract
Neurophenomenology is a scientific research program aimed to combine neuroscience with phenomenology in order to study human experience. Nevertheless, despite several explicit implementations, the integration of first-person data into the experimental protocols of cognitive neuroscience still faces a number of epistemological and methodological challenges. Notably, the difficulties to simultaneously acquire phenomenological and neuroscientific data have limited its implementation into research projects. In our paper, we propose that **neurofeedback** paradigms, in which subjects learn to self-regulate their own neural activity, may offer a pragmatic way to integrate first-person and third-person descriptions. Here, information from first- and third-person perspectives is braided together in the iterative causal closed loop, creating experimental situations in which they reciprocally constrain each other. In real-time, the subject is not only actively involved in the process of data acquisition, but also assisted to directly influence the neural data through conscious experience. Thus, **neurofeedback** may help to gain a deeper phenomenological-physiological understanding of downward causations whereby conscious activities have direct causal effects on neuronal patterns. We discuss possible mechanisms that could mediate such effects and indicate a number of directions for future research.

PMID: 24187537 [PubMed] PMCID: PMC3807564
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3807564

Front Hum Neurosci. 2013 Oct 18;7:695. doi: 10.3389/fnhum.2013.00695. eCollection 2013.

76. *Learning to modulate one's own brain activity: the effect of spontaneous mental strategies.

Kober SE, Witte M, Ninaus M, Neuper C, Wood G.

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Abstract
Using **neurofeedback** (**NF**), individuals can learn to modulate their own brain activity, in most cases electroencephalographic (**EEG**) rhythms. Although a large body of literature reports positive effects of **NF** training on behavior and cognitive functions, there are hardly any reports on how participants can successfully learn to gain control over their own brain activity. About one third of people fail to gain significant control over their brain signals even after repeated training sessions. The reasons for this failure are still largely unknown. In this context, we investigated the effects of spontaneous mental strategies on **NF** performance. Twenty healthy participants performed either a **SMR** (sensorimotor rhythm, 12-15 Hz) based or a Gamma (40-43 Hz) based **NF** training over ten sessions. After the first and the last

training session, they were asked to write down which mental strategy they have used for self-regulating their **EEG**. After the first session, all participants reported the use of various types of mental strategies such as visual strategies, concentration, or relaxation. After the last **NF** training session, four participants of the **SMR** group reported to employ no specific strategy. These four participants showed linear improvements in **NF** performance over the ten training sessions. In contrast, participants still reporting the use of specific mental strategies in the last **NF** session showed no changes in **SMR** based **NF** performance over the ten sessions. This effect could not be observed in the Gamma group. The Gamma group showed no prominent changes in Gamma power over the **NF** training sessions, regardless of the mental strategies used. These results indicate that successful **SMR** based **NF** performance is associated with implicit learning mechanisms. Participants stating vivid reports on strategies to control their **SMR** probably overload cognitive resources, which might be counterproductive in terms of increasing **SMR** power.

PMID: 24151462 [PubMed] PMCID: PMC3798979
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3798979

Front Neurosci. 2013 Oct 17;7:170. doi: 10.3389/fnins.2013.00170. eCollection 2013.

77. *A toolbox for real-time subject-independent and subject-dependent classification of brain states from fMRI signals.

Rana M, Gupta N, Dalboni Da Rocha JL, Lee S, Sitaram R.

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Abstract
There is a recent increase in the use of multivariate analysis and pattern classification in prediction and real-time feedback of brain states from functional imaging signals and mapping of spatio-temporal patterns of brain activity. Here we present MANAS, a generalized software toolbox for performing online and offline classification of **fMRI** signals. MANAS has been developed using MATLAB, LIBSVM, and SVMlight packages to achieve a cross-platform environment. MANAS is targeted for neuroscience investigations and brain rehabilitation applications, based on **neurofeedback** and brain-computer interface (**BCI**) paradigms. MANAS provides two different approaches for real-time classification: subject dependent and subject independent classification. In this article, we present the methodology of real-time subject dependent and subject independent pattern classification of **fMRI** signals; the MANAS software architecture and subsystems; and finally demonstrate the use of the system with experimental results.

PMID: 24151454 [PubMed] PMCID: PMC3798026
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3798026

Neurosci Biobehav Rev. 2013 Oct 12. pii: S0149-7634(13)00224-8. doi: 10.1016/j.neubiorev.2013.09.015. [Epub ahead of print]

78. *EEG-neurofeedback for optimising performance. I: A review of cognitive and affective outcome in healthy participants.

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Abstract
A re-emergence of research on **EEG-neurofeedback** followed controlled evidence of clinical benefits and validation of cognitive/affective gains in healthy participants including correlations in support of feedback learning mediating outcome. Controlled studies with healthy and elderly participants, which have increased exponentially, are reviewed including protocols from the clinic: sensory-motor rhythm, beta1 and alpha/theta ratios, down-training theta maxima, and from neuroscience: upper-alpha, theta, gamma, alpha desynchronisation. Outcome gains include sustained attention, orienting and executive attention, the P300b, memory, spatial rotation, RT, complex psychomotor skills, implicit procedural memory, recognition memory, perceptual binding, intelligence, mood and well-being. Twenty-three of the controlled studies report **neurofeedback** learning indices along with beneficial outcomes, of which eight report correlations in support of a meditation link, results which will be supplemented by further creativity and the performing arts evidence in Part II. Validity evidence from optimal performance studies represents an advance for the **neurofeedback** field demonstrating that cross fertilisation between clinical and optimal performance domains will be fruitful. Theoretical and methodological issues are outlined further in Part III.

PMID: 24125857 [PubMed - as supplied by publisher]

Front Hum Neurosci. 2013 Oct 10;7:638. doi: 10.3389/fnhum.2013.00638. eCollection 2013.

79. *Modulation of functionally localized right insular cortex activity using real-time fMRI-based neurofeedback.

Berman BD, Horovitz SG, Hallett M.

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Abstract
The capacity for subjects to learn to volitionally control localized brain activity using **neurofeedback** is actively being investigated. We aimed to investigate the ability of healthy volunteers to quickly learn to use visual feedback during real-time functional **MRI** (rt**fMRI**) to modulate brain activity within their anterior right insular cortex (RIC) localized during a blink suppression task, an approach of possible interest in the use of rt**fMRI** to reduce urges. The RIC region of interest (RIC-ROI) was functionally localized using a blink suppression task, and blood-oxygen level dependent (BOLD) signal changes within RIC-ROI used to

create a constantly updating display fed back to the subject in the scanner. Subjects were instructed to use emotional imagery to try and increase activity within RIC-ROI during four feedback training runs (FB1-FB4). A "control" run (CNTRL) before training and a "transfer" run (XSFR) after training were performed without feedback to assess for baseline abilities and learning effects. Fourteen participants completed all **neurofeedback** training runs. At the group-level, increased BOLD activity was seen in the anterior RIC during all the FB runs, but a significant increase in the functionally defined RIC-ROI was only attained during FB2. In atlas-defined insular cortex ROIs, significant increases were seen bilaterally during the CNTRL, FB1, FB2, and FB4 runs. Increased activity within the insular cortices did not show lateralization. Training did, however, result in a significant increase in functional connectivity between the RIC-ROI and the medial frontal gyrus when comparing FB4 to FB1. Since **neurofeedback** training did not lead to an increase in BOLD signal across all feedback runs, we suggest that learning to control one's brain activity in this fashion may require longer or repeated rt**fMRI** training sessions.

PMID: 24133436 [PubMed] PMCID: PMC3794190
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3794190

Front Psychol. 2013 Oct 7;4:688. doi: 10.3389/fpsyg.2013.00688. eCollection 2013.

80. *Meditation and neurofeedback.

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Extract
With its increasing popularity, many people in Western societies express an interest and motivation to meditate. However, for many it can often be quite difficult to maintain a disciplined and/or regular practice, for various reasons, ranging from a lack of time to general laziness. It is possible that machine assisted programs such as **neurofeedback** may help individuals develop their meditation practice more rapidly. Methods such as **neurofeedback** incorporate real-time feedback of electro-encephalography (**EEG**) activity to teach self-regulation, and may be potentially used as an aid for meditation.

PMID: 24109463 [PubMed] PMCID: PMC3791377
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3791377

BMC Neurosci. 2013 Oct 7;14:115. doi: 10.1186/1471-2202-14-115.

81. *EEG biofeedback improves attentional bias in high trait anxiety individuals.

Wang S, Zhao Y, Chen S, Lin G, Sun P, Wang T.

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Abstract
BACKGROUND: Emotion-related attentional bias is implicated in the aetiology and maintenance of anxiety disorders. Electroencephalogram (**EEG**) biofeedback can obviously improve the anxiety disorders and reduce stress level, and can also enhance attention performance in healthy subjects. The present study examined the effects and mechanisms of **EEG biofeedback** training on the attentional bias of high trait anxiety (HTA) individuals toward negative stimuli.

RESULTS: Event-related potentials were recorded while HTA (n=24) and nonanxious (n=21) individuals performed the color-word emotional Stroop task. During the emotional Stroop task, HTA participants showed longer reaction times and P300 latencies induced by negative words, compared to nonanxious participants.The **EEG biofeedback** significantly decreased the trait anxiety inventory score and reaction time in naming the color of negative words in the HTA group. P300 latencies evoked by negative stimuli in the **EEG biofeedback** group were significantly reduced after the alpha training, while no significant changes were observed in the sham biofeedback group after the intervention.

CONCLUSION: The prolonged P300 latency is associated with attentional bias to negative stimuli in the HTA group. **EEG biofeedback** training demonstrated a significant improvement of negative emotional attentional bias in HTA individuals, which may be due to the normalization of P300 latency.

PMID: 24099141 [PubMed - in process]
See complete free article at:
http://www.biomedcentral.com/1471-2202/14/115

Front Hum Neurosci. 2013 Oct 2;7:647. eCollection 2013.

82. *What about the "Self" is Processed in the Posterior Cingulate Cortex?

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Abstract
In the past decade, neuroimaging research has begun to identify key brain regions involved in self-referential processing, most consistently midline structures such as the posterior cingulate cortex (PCC). The majority of studies have employed cognitive tasks such as judgment about trait adjectives or mind wandering, that have been associated with increased PCC activity. Conversely, tasks that share an element of present-centered attention (being "on task"), ranging from working memory to meditation, have been associated with decreased PCC activity. Given the complexity of cognitive processes that likely contribute to these tasks, the specific contribution of the PCC to self-related processes still remains unknown. Building on this prior literature, recent studies have employed sampling methods that more precisely link subjective experience to brain activity, such as real-time **fMRI neurofeedback**. This recent work suggests that PCC activity may represent a sub-component cognitive process of self-reference - "getting caught up in" one's experience. For example, getting caught up in a drug craving or a particular viewpoint. In this paper, we will review evidence across a number of

different domains of cognitive neuroscience that converges in activation and deactivation of the PCC including recent neurophenomenological studies of PCC activity using real-time **fMRI neurofeedback**.

PMID: 24106472 [PubMed - as supplied by publisher] PMCID: PMC3788347
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3788347

Front Psychol. 2013 Oct 1;4:692. doi: 10.3389/fpsyg.2013.00692. eCollection 2013.

83. *EEG-Neurofeedback in psychodynamic treatment of substance dependence.

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Centre for Integrative Addiction Research (Grüner Kreis Society) Vienna, Austria ; Department of Psychology, Karl-Franzens-University Graz, Austria.

Extract
One means of further exploring the real time relationship between psychodynamic clinical processes and their manifestation in neuroprocessing is the integration of **neurofeedback** into psychodynamic sessions. Practically speaking, both interventions could be integrated, or at least inform one another. How this could be done is yet to be established.

PMID: 24098295 [PubMed] PMCID: PMC3787602
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3787602

Iran J Psychiatry Behav Sci. 2013 Fall;7(2):35-43.

84. *Effectiveness of EEG-Biofeedback on Attentiveness, Working Memory and Quantitative Electroencephalography on Reading Disorder.

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[2]Neuroscientist, Assistant Professor, Department of Psychology, School of Psychology,The University of Tabriz, Tabriz, Iran.

Abstract
Objective: Cognitive factors are the important correlates of reading disorder and their impairments are established in children with reading disorder. **Neurofeedback** as an intervention has been reported to be useful in improvement of cognitive deficits. The present study aimed to determine the effectiveness of this treatment on attentiveness and working memory and related electroencephalographic (**EEG**) changes in children with reading disorder. Methods: In this single subject study, six children with reading disorder aged 8-10 years old completed twenty 30-minunt sessions of treatment. Continuous performance task, the digit span subscale of the 3(rd) edition of Wechsler Intelligence Scale for Children

(WISC-III) and quantitative electroencephalography were used to evaluate the changes at pre and post-treatment. The data were evaluated by visual inspection of the graph, the mean percentage improvement and signal detection measures. Results: The results showed improvements in attention and working memory. Furthermore, **EEG** analysis did not show notable changes in the power of the targeted bands (delta, theta, and beta), rather the normalization of coherence was explicit in theta band at T3-T4, delta band at Cz-Fz, beta band at Cz-Fz, Cz-Pz and Cz-C4. Conclusions: These significant changes in coherence are possible indications of the connectivity between frontal and posterior association and integration between sensory and motor areas that explain the improvements in attention and working memory.

PMID: 24644508 [PubMed] PMCID: PMC3939990
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3939990

J Integr Neurosci. 2013 Sep;12(3):331-41. doi: 10.1142/S0219635213500192. Epub 2013 Jul 10.

85. *Implementation of a beam forming technique in real-time magnetoencephalography.

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Abstract
Real-time magnetoencephalography (rt**MEG**) is an emerging **neurofeedback** technology that could potentially benefit multiple areas of basic and clinical neuroscience. In the present study, we implemented voxel-based real-time coherence measurements in a rt**MEG** system in which we employed a beamformer to localize signal sources in the anatomical space prior to computing imaginary coherence. Our rt**MEG** experiment showed that a healthy subject could increase coherence between the parietal cortex and visual cortex when attending to a flickering visual stimulus. This finding suggests that our system is suitable for **neurofeedback** training and can be useful for practical brain-machine interface applications or **neurofeedback** rehabilitation.

PMID: 24070057 [PubMed - in process]

J Child Adolesc Psychopharmacol. 2013 Sep;23(7):448-57. doi: 10.1089/cap.2012.0090. Epub 2013 Jun 29.

86. *Effects of neurofeedback versus stimulant medication in attention-deficit/hyperactivity disorder: a randomized pilot study.

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Abstract
OBJECTIVE: The purpose of this pilot study was to compare the effects of 30 sessions of **neurofeedback** (**NF**) with stimulant medication on attention-deficit/hyperactivity disorder (ADHD) patients.

METHODS: Thirty-two medication-naïve ADHD patients, ages 7-16, from a neuropsychiatric clinic, were randomized to **NF** (n=16) or drug treatment (n=16). Other actions, such as parent management training, information, or support in school were given as needed, with no differences between the groups. All participants were assessed before treatment on two rating scales, each with parent and teacher forms. In addition, quantitative electroencephalogram (Q**EEG**) and event-related potentials (ERPs), which included behavioral data from a go/no go test were administered. **NF** training took place in the clinic over a period of 7-11 months, and was followed by a repeat of the same assessment tools. The mean time interval between pre- and postassesment was not significantly different in the two groups. The 18 symptoms of ADHD (American Psychiatric Association, Diagnostic and Statistical Manual of Mental Disorders, 4th ed. (DSM-IV)) were used as the primary outcome measure.

RESULTS: Analysis of covariance revealed a significant difference between the groups at evaluation in favor of medication, with a large effect size. This picture was confirmed by other outcome measures. The Q**EEG** spectral power in the theta and beta bands did not change in either group. In ERP, the P3 no go component increased significantly in 8 of 12 patients who had a clinically relevant medication effect, but did not increase in the medication nonresponders or the **NF** group.

CONCLUSIONS: Our study supports effects for stimulants, but not for **NF**. Effects of **NF** may require thorough patient selection, frequent training sessions, a system for excluding nonresponders, and active transfer training. The P3 no go ERP component may be a marker for treatment response.

PMID: 23808786 [PubMed - in process] PMCID: PMC3779016
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3779016

Biol Psychol. 2013 Sep;94(1):12-21. doi: 10.1016/j.biopsycho.2013.04.015. Epub 2013 May 9.

87. *Neurofeedback and standard pharmacological intervention in ADHD: a randomized controlled trial with six-month follow-up.

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Abstract

The present study is a randomized controlled trial that aims to evaluate the efficacy of **Neurofeedback** compared to standard pharmacological intervention in the treatment of attention deficit/hyperactivity disorder (ADHD). The final sample consisted of 23 children with ADHD (11 boys and 12 girls, 7-14 years old). Participants carried out 40 theta/beta training sessions or received methylphenidate. Behavioral rating scales were completed by fathers, mothers, and teachers at pre-, post-treatment, two-, and six-month naturalistic follow-up. In both groups, similar significant reductions were reported in ADHD functional impairment by parents; and in primary ADHD symptoms by parents and teachers. However, significant academic performance improvements were only detected in the **Neurofeedback** group. Our findings provide new evidence for the efficacy of **Neurofeedback**, and contribute to enlarge the range of non-pharmacological ADHD intervention choices. To our knowledge, this is the first randomized controlled trial with a six-month follow-up that compares **Neurofeedback** and stimulant medication in ADHD.

Republished in Biol Psychol. 2014 Jan;95:116-25.

PMID: 23665196 [PubMed - indexed for MEDLINE]

J Neurosci Methods. 2013 Sep 15;218(2):148-60. doi: 10.1016/j.jneumeth.2013.05.002. Epub 2013 May 15.

88. Real-time automated spectral assessment of the BOLD response for neurofeedback at 3 and 7T.

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Abstract

Echo-planar imaging is the dominant functional **MRI** data acquisition scheme for evaluating the BOLD signal. To date, it remains the only approach providing **neurofeedback** from spatially localized brain activity. Real-time functional single-voxel proton spectroscopy (fSVPS) may be an alternative for spatially specific BOLD **neurofeedback** at 7T because it allows for a precise estimation of the local T2* signal, EPI-specific artifacts may be avoided, and the signal contrast may increase. In order to explore and optimize this alternative **neurofeedback** approach, we tested fully automated real-time fSVPS spectral estimation procedures to approximate T2* BOLD signal changes from the unsuppressed water peak, i.e. lorentzian non-linear complex spectral fit (LNLCSF) in frequency and frequency-time domain. The proposed approaches do not require additional spectroscopic localizers in contrast to conventional T2* approximation based on linear regression of the free induction decay (FID). For methods comparison, we evaluated quality measures for signals from the motor and the visual cortex as well as a real-time feedback condition at high (3T) and at ultra-high (7T) magnetic field strengths. Using these methods, we achieved reliable and fast water peak spectral parameter estimations. At 7T, we observed an absolute increase of spectra line narrowing due to the BOLD effect, but quality measures did not improve due to artifactual line broadening. Overall, the automated fSVPS approach can be used to assess dynamic spectral changes in real-time, and to provide localized T2* **neurofeedback** at 3 and 7T.

PMID: 23685226 [PubMed - indexed for MEDLINE]

Front Public Health. 2013 Sep 13;1:31. eCollection 2013.

89. # *A Review of Traditional and Novel Treatments for Seizures in Autism Spectrum Disorder: Findings from a Systematic Review and Expert Panel.

Frye RE[1], Rossignol D[2], Casanova MF[3], Brown GL[4], Martin V[4], Edelson S[5], Coben R[6], Lewine J[7], Slattery JC[1], Lau C[1], Hardy P[8], Fatemi SH[9], Folsom TD[9], Macfabe D[10], Adams JB[11]

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Abstract

Despite the fact that seizures are commonly associated with autism spectrum disorder (ASD), the effectiveness of treatments for seizures has not been well studied in individuals with ASD. This manuscript reviews both traditional and novel treatments for seizures associated with ASD. Studies were selected by systematically searching major electronic databases and by a panel of experts that treat ASD individuals. Only a few anti-epileptic drugs (AEDs) have undergone carefully controlled trials in ASD, but these trials examined outcomes other than seizures. Several lines of evidence point to valproate, lamotrigine, and levetiracetam as the most effective and tolerable AEDs for individuals with ASD. Limited evidence supports the use of traditional non-AED treatments, such as the ketogenic and modified Atkins diet, multiple subpial transections, immunomodulation, and **neurofeedback** treatments. Although specific treatments may be more appropriate for specific genetic and metabolic syndromes associated with ASD and seizures, there are few studies which have documented the effectiveness of treatments for seizures for specific syndromes. Limited evidence supports l-carnitine, multivitamins, and N-acetyl-l-cysteine in mitochondrial disease and dysfunction, folinic acid in cerebral folate abnormalities and early treatment with vigabatrin in tuberous sclerosis complex. Finally, there is limited evidence for a number of novel treatments, particularly magnesium with pyridoxine, omega-3 fatty acids, the gluten-free casein-free diet, and low-frequency repetitive transcranial magnetic simulation. Zinc and l-carnosine are potential novel treatments supported by basic research but not clinical studies. This review demonstrates the wide variety of treatments used to treat seizures in individuals with ASD as well as the striking lack of clinical trials performed to support the use of these treatments.

Additional studies concerning these treatments for controlling seizures in individuals with ASD are warranted.

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See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3859980

Biomed Tech (Berl). 2013 Sep 7. pii: /j/bmte.2013.58.issue-s1-G/bmt-2013-4161/bmt-2013-4161.xml. doi: 10.1515/bmt-2013-4161. [Epub ahead of print]

90. *EEG Controlled Ni Lego Robot: Feasibility Study of Sensorimotor Alpha Rhythm Neurofeedback in Children.

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Abstract
We present a feasibility study of the novel system for **EEG** based **neurofeedback**. The proposed system can provide both continuous visual feedback on the computer screen and discrete reinforcement (movement of the NI LEGO Mindstorms robot) when the task is executed. We have tested the **NF** system on 31 children subjects (6-15 years). The subjects' task was to increase their alpha band power by using the continuous feedback. When the power level reached the predefined threshold, the command was sent to the robot to make a step which was considered a successful task execution. The preliminary results showed an overall increase of robot-activations during the course of the trials.

PMID: 24042802 [PubMed - as supplied by publisher]
See complete free article at:
http://www.degruyter.com/view/j/bmte.2013.58.issue-s1-G/bmt-2013-4161/bmt-2013-4161.xml;jsessionid=8BA9732A07807D9C33E1410E8C9F1525

Front Hum Neurosci. 2013 Sep 5;7:463. doi: 10.3389/fnhum.2013.00463. eCollection 2013.

91. *Cyborg psychiatry to ensure agency and autonomy in mental disorders. A proposal for neuromodulation therapeutics.

Micoulaud-Franchi JA, Fond G, Dumas G.

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Abstract
Neuromodulation therapeutics-as repeated Transcranial Magnetic Stimulation (rTMS) and **neurofeedback**-are valuable tools for psychiatry. Nevertheless, they currently face some limitations: rTMS has confounding effects on neural activation patterns, and **neurofeedback**

fails to change neural dynamics in some cases. Here we propose how coupling rTMS and **neurofeedback** can tackle both issues by adapting neural activations during rTMS and actively guiding individuals during **neurofeedback**. An algorithmic challenge then consists in designing the proper recording, processing, feedback, and control of unwanted effects. But this new neuromodulation technique also poses an ethical challenge: ensuring treatment occurs within a biopsychosocial model of medicine, while considering both the interaction between the patients and the psychiatrist, and the maintenance of individuals' autonomy. Our solution is the concept of Cyborg psychiatry, which embodies the technique and includes a self-engaged interaction between patients and the neuromodulation device.

PMID: 24046734 [PubMed] PMCID: PMC3763194
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3763194

J Clin Psychiatry. 2013 Aug;74(8):821-7. doi: 10.4088/JCP.12m08321.

92. *A randomized placebo-controlled trial of electroencephalographic (EEG) neurofeedback in children with attention-deficit/hyperactivity disorder.

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Reinier Postlaan 12, 6525 GC Nijmegen, The Netherlands m.vandongen-boomsma@karakter.com.

Abstract
OBJECTIVE: A double-blind, randomized, placebo-controlled study was designed to assess the efficacy and safety of electroencephalographic (**EEG**) **neurofeedback** in children with attention-deficit/hyperactivity disorder (ADHD). The study started in August 2008 and ended in July 2012 and was conducted at Karakter Child and Adolescent Psychiatry University Centre in Nijmegen, The Netherlands.

METHOD: Forty-one children (aged 8-15 years) with a DSM-IV-TR diagnosis of ADHD were randomly assigned to treatment with either **EEG neurofeedback** (n = 22) or placebo **neurofeedback** (n = 19) for 30 sessions, given as 2 sessions per week. The children were stratified by age, electrophysiologic state of arousal, and medication use. Everyone involved in the study, except the **neurofeedback** therapist and the principal investigator, was blinded to treatment assignment. The primary outcome was severity of ADHD symptoms on the ADHD Rating Scale IV, scored at baseline, during treatment, and at study end. Clinical improvement as measured by the Clinical Global Impressions-Improvement scale (CGI-I) was a secondary outcome.

RESULTS: While total ADHD symptoms improved over time in both groups ($F_{1,39} = 26.56$, $P < .001$), there was no significant treatment effect, ie, group × time interaction ($F_{1,39} = 0.36$, $P = .554$); the same was true for clinical improvement as measured by the CGI-I ($P = .092$). No clinically relevant side effects were observed. Among the children and their parents, guessing treatment assignment was not better than chance level ($P = .224$ for children, $P = .643$ for parents).

CONCLUSION: **EEG neurofeedback** was not superior to placebo **neurofeedback** in improving ADHD symptoms in children with ADHD.

TRIAL REGISTRATION: ClinicalTrials.gov identifier: NCT00723684.

PMID: 24021501 [PubMed - indexed for MEDLINE]

Front Hum Neurosci. 2013 Aug 23;7:499. doi: 10.3389/fnhum.2013.00499. eCollection 2013.

93. *Food related processes in the insular cortex.

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Abstract
The insular cortex is a multimodal brain region with regional cytoarchitectonic differences indicating various functional specializations. As a multisensory neural node, the insular cortex integrates perception, emotion, interoceptive awareness, cognition, and gustation. Regarding the latter, predominantly the anterior part of the insular cortex is regarded as the primary taste cortex. In this review, we will specifically focus on the involvement of the insula in food processing and on multimodal integration of food-related items. Influencing factors of insular activation elicited by various foods range from calorie-content to the internal physiologic state, body mass index or eating behavior. Sensory perception of food-related stimuli including seeing, smelling, and tasting elicits increased activation in the anterior and mid-dorsal part of the insular cortex. Apart from the pure sensory gustatory processing, there is also a strong association with the rewarding/hedonic aspects of food items, which is reflected in higher insular activity and stronger connections to other reward-related areas. Interestingly, the processing of food items has been found to elicit different insular activation in lean compared to obese subjects and in patients suffering from an eating disorder (anorexia nervosa (AN), bulimia nervosa (BN)). The knowledge of functional differences in the insular cortex opens up the opportunity for possible noninvasive treatment approaches for obesity and eating disorders. To target brain functions directly, real-time **functional magnetic resonance imaging neurofeedback** offers a state-of-the-art tool to learn to control the anterior insular cortex activity voluntarily. First evidence indicates that obese adults have an enhanced ability to regulate the anterior insular cortex.

PMID: 23986683 [PubMed] PMCID: PMC3750209
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3750209

Swiss Med Wkly. 2013 Aug 22;143:w13838. doi: 10.4414/smw.2013.13838.

94. *A randomised controlled trial of combined EEG feedback and methylphenidate therapy for the treatment of ADHD.

Li L, Yang L, Zhuo CJ, Wang YF.

Institute of Mental Health, Peking University, Beijing, China; drlili@bjmu.edu.cn.

Abstract
PURPOSE: To evaluate the efficacy of combined methylphenidate and **EEG** feedback treatment for children with ADHD.

METHODS: Forty patients with ADHD were randomly assigned to the combination group (methylphenidate therapy and **EEG** feedback training) or control group (methylphenidate therapy and non-feedback attention training) in a 1:1 ratio using the double-blind method. These patients, who met the DSM-IV diagnostic criteria and were aged between 7 and 16 years, had obtained optimal therapeutic effects by titrating the methylphenidate dose prior to the trial. The patients were assessed using multiple parameters at baseline, after 20 treatment sessions, after 40 treatment sessions, and in 6-month follow-up studies.

RESULTS: Compared to the control group, patients in the combination group had reduced ADHD symptoms and improved in related behavioural and brain functions.

CONCLUSION: The combination of **EEG** feedback and methylphenidate treatment is more effective than methylphenidate alone. The combined therapy is especially suitable for children and adolescents with ADHD who insufficiently respond to single drug treatment or experience drug side effects.

PMID: 23986461 [PubMed - in process]
See complete free article at:
http://www.smw.ch/content/smw-2013-13838

Front Hum Neurosci. 2013 Aug 15;7:478. doi: 10.3389/fnhum.2013.00478. eCollection 2013.

95. *Control beliefs can predict the ability to up-regulate sensorimotor rhythm during neurofeedback training.

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Abstract
Technological progress in computer science and neuroimaging has resulted in many approaches that aim to detect brain states and translate them to an external output. Studies from the field of brain-computer interfaces (**BCI**) and **neurofeedback** (**NF**) have validated the coupling between brain signals and computer devices; however a cognitive model of the processes involved remains elusive. Psychological parameters usually play a moderate role in predicting the performance of **BCI** and **NF** users. The concept of a locus of control, i.e., whether one's own action is determined by internal or external causes, may help to unravel inter-individual performance capacities. Here, we present data from 20 healthy participants

who performed a feedback task based on **EEG** recordings of the sensorimotor rhythm (**SMR**). One group of 10 participants underwent 10 training sessions where the amplitude of the **SMR** was coupled to a vertical feedback bar. The other group of ten participants participated in the same task but relied on sham feedback. Our analysis revealed that a locus of control score focusing on control beliefs with regard to technology negatively correlated with the power of **SMR**. These preliminary results suggest that participants whose confidence in control over technical devices is high might consume additional cognitive resources. This higher effort in turn may interfere with brain states of relaxation as reflected in the **SMR**. As a consequence, one way to improve control over brain signals in **NF** paradigms may be to explicitly instruct users not to force mastery but instead to aim at a state of effortless relaxation.

PMID: 23966933 [PubMed] PMCID: PMC3744034
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3744034

Front Hum Neurosci. 2013 Aug 9;7:453. doi: 10.3389/fnhum.2013.00453. eCollection 2013.

96. *The morphology of midcingulate cortex predicts frontal-midline theta neurofeedback success.

Enriquez-Geppert S, Huster RJ, Scharfenort R, Mokom ZN, Vosskuhl J, Figge C, Zimmermann J, Herrmann CS.

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Abstract
Humans differ in their ability to learn how to control their own brain activity by **neurofeedback**. However, neural mechanisms underlying these inter-individual differences, which may determine training success and associated cognitive enhancement, are not well-understood. Here, it is asked whether **neurofeedback** success of frontal-midline (fm) theta, an oscillation related to higher cognitive functions, could be predicted by the morphology of brain structures known to be critically involved in fm-theta generation. Nineteen young, right-handed participants underwent **magnetic resonance imaging** of T1-weighted brain images, and took part in an individualized, eight-session **neurofeedback** training in order to learn how to enhance activity in their fm-theta frequency band. Initial training success, measured at the second training session, was correlated with the final outcome measure. We found that the inferior, superior, and middle frontal cortices were not associated with training success. However, volume of the midcingulate cortex as well as volume and concentration of the underlying white matter structures act as predictor variables for the general responsiveness to training. These findings suggest a neuroanatomical foundation for the ability to learn to control one's own brain activity.

PMID: 23950741 [PubMed] PMCID: PMC3739027
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3739027

Front Hum Neurosci. 2013 Aug 7;7:452. doi: 10.3389/fnhum.2013.00452. eCollection 2013.

97. *Improving the neural mechanisms of cognition through the pursuit of happiness.

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Abstract
This paper reviews evidence on the neural basis of how positive mood states can modulate cognition, particularly during creative problem-solving. Studies performed over the past few decades demonstrate that individuals in a positive mood engage in a broader scope of attention, enhancing their access to distant and unusual semantic associations, and increasing task-shifting and problem-solving capacities. In this review, we summarize these behavioral studies; we then present recent findings on the changes in brain activation patterns that are induced by a positive mood when participants engage in problem-solving tasks and show how these relate to task performance. Additionally, we integrate findings on the neuromodulatory influence of positive mood on cognition as mediated by dopaminergic signaling in the prefrontal cortex and we describe how this system can go awry during pathological states of elevated mood as in mania. Finally, we describe current and future research directions using psychotherapeutic and real-time **fMRI neurofeedback** approaches to up-regulate positive mood and facilitate optimal creative cognitive performance. We conclude with some speculations on the clinical implications of this emerging area of research.

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See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3735982

Front Hum Neurosci. 2013 Aug 6;7:440. doi: 10.3389/fnhum.2013.00440. eCollection 2013.

98. *Effortless awareness: using real time neurofeedback to investigate correlates of posterior cingulate cortex activity in meditators' self-report.

Garrison KA, Santoyo JF, Davis JH, Thornhill TA 4th, Kerr CE, Brewer JA.

Yale Therapeutic Neuroscience Clinic, Department of Psychiatry, Yale University School of Medicine New Haven, CT, USA.

Abstract
Neurophenomenological studies seek to utilize first-person self-report to elucidate cognitive processes related to physiological data. Grounded theory offers an approach to the qualitative analysis of self-report, whereby theoretical constructs are derived from empirical data. Here we used grounded theory methodology (GTM) to assess how the first-person experience of meditation relates to neural activity in a core region of the default mode network-the posterior cingulate cortex (PCC). We analyzed first-person data consisting of meditators' accounts of their subjective experience during runs of a real time **fMRI neurofeedback** study of meditation, and third-person data consisting of corresponding feedback graphs of PCC activity during the same runs. We found that for meditators, the subjective experiences of "undistracted awareness" such as "concentration" and "observing sensory experience," and "effortless doing" such as "observing sensory experience," "not efforting," and "contentment,"

correspond with PCC deactivation. Further, the subjective experiences of "distracted awareness" such as "distraction" and "interpreting," and "controlling" such as "efforting" and "discontentment," correspond with PCC activation. Moreover, we derived several novel hypotheses about how specific qualities of cognitive processes during meditation relate to PCC activity, such as the difference between meditation and "trying to meditate." These findings offer novel insights into the relationship between meditation and mind wandering or self-related thinking and neural activity in the default mode network, driven by first-person reports.

PMID: 23964222 [PubMed] PMCID: PMC3734786
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3734786

Neuroimage. 2013 Aug 1;76:386-99. doi: 10.1016/j.neuroimage.2013.03.033. Epub 2013 Mar 27.

99. *Real-time fMRI neurofeedback: progress and challenges.

Sulzer J, Haller S, Scharnowski F, Weiskopf N, Birbaumer N, Blefari ML, Bruehl AB, Cohen LG, DeCharms RC, Gassert R, Goebel R, Herwig U, LaConte S, Linden D, Luft A, Seifritz E, Sitaram R.

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Abstract
In February of 2012, the first international conference on real time functional magnetic resonance imaging (rt**fMRI**) **neurofeedback** was held at the Swiss Federal Institute of Technology Zurich (ETHZ), Switzerland. This review summarizes progress in the field, introduces current debates, elucidates open questions, and offers viewpoints derived from the conference. The review offers perspectives on study design, scientific and clinical applications, rt**fMRI** learning mechanisms and future outlook.

PMID: 23541800 [PubMed - indexed for MEDLINE]

Holist Nurs Pract. 2013 Jul-Aug;27(4):246-50. doi: 10.1097/HNP.0b013e3182971b7c.

100. *Neurofeedback: an integrative treatment of substance use disorders.

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Abstract

Substance use disorders are exceedingly complicated as is the treatment. To increase positive outcomes, an understanding of all facets, bio/psycho/social/spiritual,economic, and interdisciplinary aspects, are essential to successful treatment. **Neurofeedback** has been applied successfully as an integrative treatment of SUDs for more than 30 years. Highlighted research that includes the Peniston Alpha-Theta protocol and Scott-Kaiser modifications of the Peniston protocol has shown that SUD treatment when combined with conventional treatment has the potential to improve measurable parameters and significantly increase positive outcomes.

PMID: 23774725 [PubMed - indexed for MEDLINE]

Clin EEG Neurosci. 2013 Jul;44(3):193-202. doi: 10.1177/1550059412458262.

101. *Neurofeedback training aimed to improve focused attention and alertness in children with ADHD: a study of relative power of EEG rhythms using custom-made software application.

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Abstract

Neurofeedback is a nonpharmacological treatment for attention-deficit hyperactivity disorder (ADHD). We propose that operant conditioning of electroencephalogram (**EEG**) in **neurofeedback** training aimed to mitigate inattention and low arousal in ADHD, will be accompanied by changes in **EEG** bands' relative power. Patients were 18 children diagnosed with ADHD. The **neurofeedback** protocol ("Focus/Alertness" by Peak Achievement Trainer) has a focused attention and alertness training mode. The **neurofeedback** protocol provides one for Focus and one for Alertness. This does not allow for collecting information regarding changes in specific **EEG** bands (delta, theta, alpha, low and high beta, and gamma) power within the 2 to 45 Hz range. Quantitative **EEG** analysis was completed on each of twelve 25-minute-long sessions using a custom-made MatLab application to determine the relative power of each of the aforementioned **EEG** bands throughout each session, and from the first session to the last session. Additional statistical analysis determined significant changes in relative power within sessions (from minute 1 to minute 25) and between sessions (from session 1 to session 12). Analysis was of relative power of theta, alpha, low and high beta, theta/alpha, theta/beta, and theta/low beta and theta/high beta ratios. Additional secondary measures of patients' post-**neurofeedback** outcomes were assessed, using an audiovisual selective attention test (IVA + Plus) and behavioral evaluation scores from the Aberrant Behavior Checklist. Analysis of data computed in the MatLab application, determined that theta/low beta and theta/alpha ratios decreased significantly from session 1 to session 12, and from minute 1 to minute 25 within sessions. The findings regarding **EEG** changes resulting from brain wave self-regulation training, along with behavioral evaluations, will help elucidate neural mechanisms of **neurofeedback** aimed to improve focused attention and alertness in ADHD.

PMID: 23820311 [PubMed - indexed for MEDLINE]

Dev Sci. 2013 Jul;16(4):574-83. doi: 10.1111/desc.12054. Epub 2013 May 28.

102. *Plasticity during childhood and adolescence: innovative approaches to investigating neurocognitive development.

Cohen Kadosh K, Linden DE, Lau JY.

Department of Experimental Psychology, University of Oxford, Oxford, OX1 3UD, UK. kathrin.cohenkadosh@psy.ox.ac.uk

Abstract
Adolescence is a period of profound change, which holds substantial developmental milestones, but also unique challenges to the individual. In this opinion paper, we highlight the potential of combining two recently developed behavioural and neural training techniques (cognitive bias modification and **functional magnetic neuroimaging**-based **neurofeedback**) into a research approach that could help make the most of increased levels of plasticity during childhood and adolescence. We discuss how this powerful combination could be used to explore changing brain-behaviour relationships throughout development in the context of emotion processing, a cognitive domain that exhibits continuous development throughout the second decade of life. By targeting both behaviour and brain response, we would also be in an excellent position to define sensible time windows for enhancing plasticity, thereby allowing for targeted intervention approaches that can help improve emotion processing in both typically and atypically developing populations.

PMID: 23786475 [PubMed - indexed for MEDLINE]

Psychiatry Res. 2013 Jul 30;213(1):79-81. doi: 10.1016/j.pscychresns.2013.03.003. Epub 2013 May 15.

103. *Reduction of cue-induced craving through realtime neurofeedback in nicotine users: the role of region of interest selection and multiple visits.

Hanlon CA, Hartwell KJ, Canterberry M, Li X, Owens M, Lematty T, Prisciandaro JJ, Borckardt J, Brady KT, George MS.

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Abstract
This multi-visit, real-time **functional magnetic resonance imaging** feedback study demonstrates that treatment-seeking smokers can effectively modulate their behavioral and brain responses to smoking cues. They are more effective at decreasing activity in functionally defined regions involved in "craving" (e.g. ventral anterior cingulate cortex (vACC)) rather than increasing activity in regions involved in "resisting" (e.g. dorsal medial prefrontal cortex (dmPFC)).

PMID: 23683344 [PubMed - in process]

J Atten Disord. 2013 Jul;17(5):420-36. doi: 10.1177/1087054713482580. Epub 2013 Apr 16.

104. *A proposed multisite double-blind randomized clinical trial of neurofeedback for ADHD: need, rationale, and strategy.

Kerson C; Collaborative **Neurofeedback** Group: Arnold LE, Arns M, Conners K, deBeus R, Hirshberg L, Kerson C, Kraemer H, Lofthouse N, Lubar J, McBurnett K, Monastra V.

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Abstract
OBJECTIVE: Additional treatments with persisting benefit are needed for ADHD. Because ADHD often shows excessive theta electroencephalogram (**EEG**) power, low beta, and excessive theta-beta ratio (TBR), a promising treatment is **neurofeedback** (**NF**) downtraining TBR. Although several nonblind randomized clinical trials (RCTs) show a medium-large benefit for **NF**, a well-blinded, sham-controlled RCT is needed to differentiate specific from nonspecific effects.

METHOD: Experts in **NF**, ADHD, clinical trials, and statistics collaborated to design a double-blind multisite RCT.

RESULTS/CONCLUSION: At four sites, 180 children aged 7 to 10 years with rigorously diagnosed ADHD and TBR ≥ 5 will be randomized to active TBR-**NF** versus sham **NF** of equal duration, intensity, and appearance. Sham, utilizing prerecorded **EEG**s with participant artifacts superimposed, will keep participants and staff blind. Treatment fidelity will be trained/monitored by acknowledged **NF** leaders. Multidomain assessments before, during, and after treatment (follow-up to 2 years) will also include tests of blinding and sham inertness.

PMID: 23590978 [PubMed - indexed for MEDLINE]

Clin Neurophysiol. 2013 Jul;124(7):1262-3. doi: 10.1016/j.clinph.2013.02.013. Epub 2013 Mar 20.

105. *Boosting neural activity in cortical motor areas through neurofeedback in Parkinson's Disease.

Suppa A.

Comment on
Bereitschaftspotential augmentation by **neuro-feedback** training in Parkinson's disease. [Clin Neurophysiol. 2013]

PMID: 23523112 [PubMed - indexed for MEDLINE]

PLoS One. 2013 Jul 11;8(7):e68261. doi: 10.1371/journal.pone.0068261. Print 2013.

106. *Decoding speech perception by native and non-native speakers using single-trial electrophysiological data.

Brandmeyer A, Farquhar JD, McQueen JM, Desain PW.

Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, Nijmegen, The Netherlands. a.brandmeyer@donders.ru.nl

Abstract
Brain-computer interfaces (**BCI**s) are systems that use real-time analysis of neuroimaging data to determine the mental state of their user for purposes such as providing **neurofeedback**. Here, we investigate the feasibility of a **BCI** based on speech perception. Multivariate pattern classification methods were applied to single-trial **EEG** data collected during speech perception by native and non-native speakers. Two principal questions were asked: 1) Can differences in the perceived categories of pairs of phonemes be decoded at the single-trial level? 2) Can these same categorical differences be decoded across participants, within or between native-language groups? Results indicated that classification performance progressively increased with respect to the categorical status (within, boundary or across) of the stimulus contrast, and was also influenced by the native language of individual participants. Classifier performance showed strong relationships with traditional event-related potential measures and behavioral responses. The results of the cross-participant analysis indicated an overall increase in average classifier performance when trained on data from all participants (native and non-native). A second cross-participant classifier trained only on data from native speakers led to an overall improvement in performance for native speakers, but a reduction in performance for non-native speakers. We also found that the native language of a given participant could be decoded on the basis of **EEG** data with accuracy above 80%. These results indicate that electrophysiological responses underlying speech perception can be decoded at the single-trial level, and that decoding performance systematically reflects graded changes in the responses related to the phonological status of the stimuli. This approach could be used in extensions of the **BCI** paradigm to support perceptual learning during second language acquisition.

PMID: 23874567 [PubMed - in process] PMCID: PMC3708957
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3708957

PLoS One. 2013 Jul 3;8(7):e67692. doi: 10.1371/journal.pone.0067692. Print 2013.

107. Electric Field Encephalography as a tool for functional brain research: a modeling study.

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Abstract
We introduce the notion of Electric Field Encephalography (EFEG) based on measuring electric fields of the brain and demonstrate, using computer modeling, that given the

appropriate electric field sensors this technique may have significant advantages over the current **EEG** technique. Unlike **EEG**, EFEG can be used to measure brain activity in a contactless and reference-free manner at significant distances from the head surface. Principal component analysis using simulated cortical sources demonstrated that electric field sensors positioned 3 cm away from the scalp and characterized by the same signal-to-noise ratio as **EEG** sensors provided the same number of uncorrelated signals as scalp **EEG**. When positioned on the scalp, EFEG sensors provided 2-3 times more uncorrelated signals. This significant increase in the number of uncorrelated signals can be used for more accurate assessment of brain states for non-invasive brain-computer interfaces and **neurofeedback** applications. It also may lead to major improvements in source localization precision. Source localization simulations for the spherical and Boundary Element Method (BEM) head models demonstrated that the localization errors are reduced two-fold when using electric fields instead of electric potentials. We have identified several techniques that could be adapted for the measurement of the electric field vector required for EFEG and anticipate that this study will stimulate new experimental approaches to utilize this new tool for functional brain research.

PMID: 23844066 [PubMed - indexed for MEDLINE] PMCID: PMC3700999
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3700999

Trends Cogn Sci. 2013 Jun;17(6):295-302. doi: 10.1016/j.tics.2013.04.009. Epub 2013 May 7.

108. *Learned regulation of brain metabolism.

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Institute of Medical Psychology and Behavioral Neurobiology, University of Tuebingen, Silcherstrasse 5, D-72076 Tübingen, Germany.

Abstract
Self-regulation and voluntary control of circumscribed brain regions using real-time functional **MRI** (rt-**fMRI**) allows the establishment of a causal functional link between localized brain activity and behavior and cognition. A long tradition of research has clearly shown the brain's ability to learn volitional control of its own activity and effects on behavior. Yet, the underlying neural mechanism of self-regulation is still not fully understood. Here, we propose that self-regulation of brain activity is akin to skill learning and thus may depend on an intact subcortical motor system. We elaborate on the critical role of the basal ganglia in skill learning and **neurofeedback**, and clarify that brain-self-regulation need not be an explicit and conscious process as often mistakenly held.

Published by Elsevier Ltd.

PMID: 23664452 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2013 Jun;38(2):133-41. doi: 10.1007/s10484-013-9218-5.

109. *Neurofeedback training for opiate addiction: improvement of mental health and craving.

Dehghani-Arani F, Rostami R, Nadali H.

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Abstract
Psychological improvements in patients with substance use disorders have been reported after **neurofeedback** treatment. However, **neurofeedback** has not been commonly accepted as a treatment for substance dependence. This study was carried out to examine the effectiveness of this therapeutic method for opiate dependence disorder. The specific aim was to investigate whether treatment leads to any changes in mental health and substance craving. In this experimental study with a pre-post test design, 20 opiate dependent patients undergoing Methadone or Buprenorphine maintenance treatment were examined and matched and randomized into two groups. While both experimental and control groups received their usual maintenance treatment, the experimental group received 30 sessions of **neurofeedback** treatment in addition. The **neurofeedback** treatment consisted of sensory motor rhythm training on Cz, followed by an alpha-theta protocol on Pz. Data from the general health questionnaire and a heroin craving questionnaire were collected before and after treatment. Multivariate analysis of covariance showed that the experimental group achieved improvement in somatic symptoms, depression, and total score in general mental health; and in anticipation of positive outcome, desire to use opioid, and relief from withdrawal of craving in comparison with the control group. The study supports the effectiveness of **neurofeedback** training as a therapeutic method in opiate dependence disorder, in supplement to pharmacotherapy.

PMID: 23605225 [PubMed - indexed for MEDLINE] PMCID: PMC3650238
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3650238

Appl Psychophysiol Biofeedback. 2013 Jun;38(2):101-8. doi: 10.1007/s10484-013-9214-9.

110. *Steps toward developing an EEG biofeedback treatment for chronic pain.

Jensen MP, Gertz KJ, Kupper AE, Braden AL, Howe JD, Hakimian S, Sherlin LH.

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Abstract
Chronic pain, usually refractory to analgesics, is a significant problem for many individuals with spinal cord injury (SCI). Preliminary studies suggest that electroencephalography (**EEG**) biofeedback (also known as **neurofeedback**, **NF**) has the potential to help patients with otherwise refractory chronic pain. However, there remain many unanswered questions about the effects and mechanisms of this treatment. We studied 13 individuals with SCI and chronic pain with **NF**. Ten of the 13 individuals completed 4 sessions each of three different **neurofeedback** protocols assigned in random order for a total of 12 **NF** sessions. All three protocols had similar immediate effects on pain intensity. In addition, the participants

reported modest pre- to post-treatment decreases in worst pain and pain unpleasantness following completion of the 12 **NF** sessions. These improvements were maintained at 3-month follow-up. The majority of the participants felt they benefited from and were satisfied with the treatment. No significant effects on measures of other outcome domains (sleep quality, pain interference and fatigue) were observed, although there was a non-significant trend for an increase in fatigue. Finally, pre- to post-treatment changes in **EEG** bandwidth activity, consistent with the training protocols, were observed in θ and α but not β frequencies. The findings provide preliminary support for the potential efficacy of **NF** for the treatment of SCI-related pain, and suggest that further clinical studies are warranted.

PMID: 23532434 [PubMed - indexed for MEDLINE]

Int J Psychophysiol. 2013 Jun 14. pii: S0167-8760(13)00181-5. doi: 10.1016/j.ijpsycho.2013.06.010. [Epub ahead of print]

111. *Validation of a neurofeedback paradigm: Manipulating frontal EEG alpha-activity and its impact on mood.

Peeters F, Ronner J, Bodar L, van Os J, Lousberg R.

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Abstract
It is claimed that **neurofeedback** (**NF**) is an effective treatment for a variety of psychiatric disorders. **NF**, within an operant conditioning framework, helps individuals to regulate cortical electroencephalographic (**EEG**) activity while receiving feedback from a visual or acoustic signal. For example, changing asymmetry between left and right frontal brain alpha activity by **NF**, is claimed to be an efficacious treatment for major depressive disorder. However, the specificity of this intervention in occasioning electrophysiological changes at target locations and target wave-frequencies, and its relation to changes in mood, has not been established. During a single session of **NF**, it was tested if the balance between left and right frontal alpha-activity could be changed, regardless of direction, in 40 healthy females. Furthermore, we investigated whether this intervention was electrophysiologically specific and if it was associated with changes in mood. Participants were able to decrease or increase frontal alpha-asymmetry during the intervention. However, no changes in mood were observed. Changes in **EEG** activity were specific in terms of location and wave-frequency.

PMID: 23773999 [PubMed - as supplied by publisher]

J Neurosci. 2013 May 29;33(22):9488-97. doi: 10.1523/JNEUROSCI.5911-12.2013.

112. The day-after effect: long term, Hebbian-like restructuring of resting-state fMRI patterns induced by a single epoch of cortical activation.

Harmelech T, Preminger S, Wertman E, Malach R.

Department of Neurobiology, Weizmann Institute of Science, Rehovot 76100, Israel.

Abstract
During rest, the cerebral cortex displays rich, coordinated patterns of spontaneous activity. The mechanism that shapes these patterns is largely unknown. Here we demonstrate that a Hebbian-like, sustained process plays a role in focusing these coherent patterns. Human subjects used an **fMRI**-based **neurofeedback** (**NF**) paradigm to intensely activate the dorsal anterior cingulate cortex for a single epoch (30 min). Resting-state correlations between all of the cortical voxels' BOLD time courses (functional connectivity) were mapped before, immediately after, and one day after the **NF** session. We found that the single epoch of cortical activation induced a lasting restructuring of the functional connections according to a Hebbian-like rule. Therefore, the change (increase and decrease) in functional connectivity strength of cortical voxels during rest reflected the level of their prior coactivation during the **NF** epoch. Interestingly, the effect was significantly enhanced 1 d after the **NF** activation epoch. The effect was evident in each subject individually, indicating its potential as a diagnostic window into the personal history of prior brain activations of both healthy and abnormal individuals.

PMID: 23719815 [PubMed - indexed for MEDLINE]
See complete free article at:
http://www.jneurosci.org/content/33/22/9488.long

PLoS One. 2013 May 17;8(5):e64590. doi: 10.1371/journal.pone.0064590. Print 2013.

113. *Cross-brain neurofeedback: scientific concept and experimental platform.

Duan L, Liu WJ, Dai RN, Li R, Lu CM, Huang YX, Zhu CZ.

State Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University, Beijing, PR China.

Abstract
The present study described a new type of multi-person **neurofeedback** with the neural synchronization between two participants as the direct regulating target, termed as "cross-brain **neurofeedback**." As a first step to implement this concept, an experimental platform was built on the basis of **functional near-infrared spectroscopy**, and was validated with a two-person **neurofeedback** experiment. This novel concept as well as the experimental platform established a framework for investigation of the relationship between multiple participants' cross-brain neural synchronization and their social behaviors, which could provide new insight into the neural substrate of human social interactions.

PMID: 23691253 [PubMed - indexed for MEDLINE] PMCID: PMC3656856
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3656856

Int J Psychophysiol. 2013 May 15. pii: S0167-8760(13)00127-X. doi: 10.1016/j.ijpsycho.2013.05.004. [Epub ahead of print]

114. *Application of alpha/theta neurofeedback and heart rate variability training to young contemporary dancers: State anxiety and creativity.

Gruzelier JH, Thompson T, Redding E, Brandt R, Steffert T.

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Abstract
As one in a series on the impact of **EEG-neurofeedback** in the performing arts, we set out to replicate a previous dance study in which alpha/theta (A/T) **neurofeedback** and heart rate variability (HRV) biofeedback enhanced performance in competitive ballroom dancers compared with controls. First year contemporary dance conservatoire students were randomised to the same two psychophysiological interventions or a choreology instruction comparison group or a no-training control group. While there was demonstrable **neurofeedback** learning, there was no impact of the three interventions on dance performance as assessed by four experts. However, HRV training reduced anxiety and the reduction correlated with improved technique and artistry in performance; the anxiety scale items focussed on autonomic functions, especially cardiovascular activity. In line with the putative impact of hypnogogic training on creativity A/T training increased cognitive creativity with the test of unusual uses, but not insight problems. Methodological and theoretical implications are considered.

PMID: 23684733 [PubMed - as supplied by publisher]

Transl Psychiatry. 2013 Apr 30;3:e250. doi: 10.1038/tp.2013.24.

115. *Orbitofrontal cortex neurofeedback produces lasting changes in contamination anxiety and resting-state connectivity.

Scheinost D, Stoica T, Saksa J, Papademetris X, Constable RT, Pittenger C, Hampson M.

Department of Biomedical Engineering, Yale University, New Haven, CT, USA.

Abstract
Anxiety is a core human emotion but can become pathologically dysregulated. We used functional magnetic resonance imaging (**fMRI**) **neurofeedback** (**NF**) to noninvasively alter patterns of brain connectivity, as measured by resting-state **fMRI**, and to reduce contamination anxiety. Activity of a region of the orbitofrontal cortex associated with contamination anxiety was measured in real time and provided to subjects with significant but subclinical anxiety as a **NF** signal, permitting them to learn to modulate the target brain region. **NF** altered network connectivity of brain regions involved in anxiety regulation: subjects exhibited reduced resting-state connectivity in limbic circuitry and increased connectivity in the dorsolateral prefrontal cortex. **NF** has been shown to alter brain connectivity in other contexts, but it has been unclear whether these changes persist; critically, we observed changes in connectivity several days after the completion of **NF** training,

demonstrating that such training can lead to lasting modifications of brain functional architecture. Training also increased subjects' control over contamination anxiety several days after the completion of **NF** training. Changes in resting-state connectivity in the target orbitofrontal region correlated with these improvements in anxiety. Matched subjects undergoing a sham feedback control task showed neither a reorganization of resting-state functional connectivity nor an improvement in anxiety. These data suggest that **NF** can enable enhanced control over anxiety by persistently reorganizing relevant brain networks and thus support the potential of **NF** as a clinically useful therapy.

PMID: 23632454 [PubMed - indexed for MEDLINE] PMCID: PMC3641411
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3641411

Int J Psychophysiol. 2013 Apr;88(1):1-16. doi: 10.1016/j.ijpsycho.2013.02.001. Epub 2013 Feb 13.

116. *Boosting brain functions: Improving executive functions with behavioral training, neurostimulation, and neurofeedback.

Enriquez-Geppert S1, Huster RJ, Herrmann CS.

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Abstract
Cognitive enhancement is a popular topic, attracting attention both from the general public and the scientific research community. Higher cognitive functions are involved in various aspects of everyday life and have been associated with manifest behavioral and psychiatric mental impairments when deteriorated. The improvement of these so-called executive functions (EFs) is of high individual, social, and economic relevances. This review provides a synopsis of two lines of research, investigating the enhancement of capabilities in executive functioning: a) computerized behavioral trainings, and b) approaches for direct neuromodulation (**neurofeedback** and transcranial electrostimulation). Task switching, memory updating, response inhibition, and dual task performance are addressed in terms of cognitive functions. It has been shown that behavioral cognitive training leads to enhanced performance in task switching, memory updating, and dual tasks. Similarly, direct neurocognitive modulation of brain regions that are crucially involved in specific EFs also leads to behavioral benefits in response inhibition, task switching, and memory updating. Response inhibition performance has been shown to be improved by neurostimulation of the right inferior frontal cortex, whereas neurostimulation of the dorsolateral prefrontal cortex exerts effects on task switching and memory updating. Due to a lack of consistency in experimental methods and findings, a comparison of different training approaches concerning their effectiveness is not yet possible. So far, current data suggest that training gains may indeed generalize to untrained tasks aiming at the same cognitive process, as well as across cognitive domains within executive control.

PMID: 23415793 [PubMed - indexed for MEDLINE]

Stroke. 2013 Apr;44(4):1091-8. doi: 10.1161/STROKEAHA.111.674507. Epub 2013 Feb 12.

117. *Near-infrared spectroscopy-mediated neurofeedback enhances efficacy of motor imagery-based training in poststroke victims: a pilot study.

Mihara M, Hattori N, Hatakenaka M, Yagura H, Kawano T, Hino T, Miyai I.

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Abstract

BACKGROUND AND PURPOSE: Despite the findings that motor imagery and execution are supposed to share common neural networks, previous studies using imagery-based rehabilitation have revealed inconsistent results. In the present study, we investigated whether feedback of cortical activities (**neurofeedback**) using **near-infrared spectroscopy** could enhance the efficacy of imagery-based rehabilitation in stroke patients.

METHODS: Twenty hemiplegic patients with subcortical stroke received 6 sessions of mental practice with motor imagery of the distal upper limb in addition to standard rehabilitation. Subjects were randomly allocated to REAL and SHAM groups. In the REAL group, cortical hemoglobin signals detected by **near-infrared spectroscopy** were fed back during imagery. In the SHAM group, irrelevant randomized signals were fed back. Upper limb function was assessed using the finger and arm subscales of the Fugl-Meyer assessment and the Action Research Arm Test.

RESULTS: The hand/finger subscale of the Fugl-Meyer assessment showed greater functional gain in the REAL group, with a significant interaction between time and group ($F(2,36)=15.5$; $P<0.001$). A significant effect of **neurofeedback** was revealed even in severely impaired subjects. Imagery-related cortical activation in the premotor area was significantly greater in the REAL group than in the SHAM group ($T(58)=2.4$; $P<0.05$).

CONCLUSIONS: Our results suggest that **near-infrared spectroscopy**-mediated **neurofeedback** may enhance the efficacy of mental practice with motor imagery and augment motor recovery in poststroke patients with severe hemiparesis.

PMID: 23404723 [PubMed - indexed for MEDLINE]
See complete free article at:
http://stroke.ahajournals.org/content/44/4/1091.long

Psychiatr Clin North Am. 2013 Mar;36(1):163-8. doi: 10.1016/j.psc.2013.01.005.

118. *Neurofeedback: an emerging technology for treating central nervous system dysregulation.

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Stone Mountain Center, 310 River Road Exd, New Paltz, NY 12561, USA.

Abstract

Neurofeedback is a machine-mediated noninvasive treatment modality based on the analysis and "feeding back" of electroencephalogram brainwaves, which has shown efficacy with a variety of central nervous system-based problems. It has special application where patients have adverse reaction to psychopharmacologic treatments and psychotherapy, cognitive behavioral therapy, and dialectical behavior therapy have proved ineffective. Treatment modalities include active forms based on operant conditioning, involving a subject's response to stimuli. **Neurofeedback** is strong in clinical confirmations of efficacy (case studies) and has thus far limited controlled studies in the peer-reviewed journals.

PMID: 23538085 [PubMed - indexed for MEDLINE]

Int J Psychophysiol. 2013 Mar 25. pii: S0167-8760(13)00061-5. doi: 10.1016/j.ijpsycho.2013.03.011. [Epub ahead of print]

119. *EEG-neurofeedback and psychodynamic psychotherapy in a case of adolescent anhedonia with substance misuse: Mood/theta relations.

Unterrainer HF, Chen MJ, Gruzelier JH.

Centre for Integrative Addiction Research (Grüner Kreis Society), Vienna, Austria; Department of Psychology, Karl-Franzens-University, Graz, Austria. Electronic address: human.unterrainer@uni-graz.at.

Abstract
There is substantial evidence confirming the efficacy of **neurofeedback** with applications in clinical, educational and optimal performance domains. However, a psychodynamically informed **NF**-approach needs exploration. A male (19y), college student whose first year was being seriously compromised after severe, 18-month, polydrug misuse, was treated with 11 sessions including a 2-month follow-up of **neurofeedback** combined with short-term psychodynamic psychotherapy. Pre/post-treatment and follow-up assessment with the Brief Psychiatric Rating Scale (BPRS) and the Montgomery-Asberg Depression Rating Scale confirmed that levels of psychopathology dropped almost to zero. Correlational evidence disclosed that **SMR**/theta training was positively associated with reduction in psychopathological ratings, largely due to theta amplitude reduction; the strongest relation being with reduced BPRS activation. Alpha/theta training was not correlated with clinical improvement. The combined treatment was found to be highly effective with the student who learned to deal with feelings of anhedonia and alienation. There was no relapse during the follow-up phase. Further research is recommended.

PMID: 23535499 [PubMed - as supplied by publisher]

J Child Neurol. 2013 Mar 12. [Epub ahead of print]

120. *The Application and Efficacy of Combined Neurofeedback Therapy and Imagery Training in Adolescents With Tourette Syndrome.

Zhuo C, Li L.

Department of Psychiatry, Tianjin Anning Hospital, Dongli District, Tianjin, China.

Abstract
We aimed to examine the effectiveness of combined **neurofeedback** therapy and imagery training in adolescent patients with refractory Tourette syndrome. Two patients, aged respectively 14 and 16 years, had been treated with haloperidol and tiapride; however, this medication was ineffective and accompanied by intolerable side effects. In this study, the patients completed 80 sessions of **neurofeedback** treatment followed by imagery training. The patients were assessed with behavior rating scales both before and after the treatment as well as during follow-up examinations to evaluate the effect of the combined therapy. Patients showed significant improvement in motor tic and vocal tic symptoms, exemplified by a reduction in the frequency and intensity of tics, indicating that **neurofeedback**, together with imagery training, has a positive therapeutic effect on adolescent patients with medication-refractory Tourette syndrome.

PMID: 23481449 [PubMed - as supplied by publisher]

Neuroimage. 2013 Mar 1;75C:176-184. doi: 10.1016/j.neuroimage.2013.02.041. [Epub ahead of print]

121. *Neurofeedback-mediated self-regulation of the dopaminergic midbrain.

Sulzer J, Sitaram R, Blefari ML, Kollias S, Birbaumer N, Stephan KE, Luft A, Gassert R.

Rehabilitation Engineering Laboratory, Department of Health Sciences and Technology, ETH Zurich, CH-8092, Switzerland.

Abstract
The dopaminergic system is involved in reward encoding and reinforcement learning. Dopaminergic neurons from this system in the substantia nigra/ventral tegmental area complex (SN/VTA) fire in response to unexpected reinforcing cues. The goal of this study was to investigate whether individuals can gain voluntary control of SN/VTA activity, thereby potentially enhancing dopamine release to target brain regions. **Neurofeedback** and mental imagery were used to self-regulate the SN/VTA. Real-time functional magnetic resonance imaging (rt**fMRI**) provided abstract visual feedback of the SN/VTA activity while the subject imagined rewarding scenes. Skin conductance response (SCR) was recorded as a measure of emotional arousal. To examine the effect of **neurofeedback**, subjects were assigned to either receiving feedback directly proportional (n=15, veridical feedback) or inversely proportional (n=17, inverted feedback) to SN/VTA activity. Both groups of subjects were able to up-regulate SN/VTA activity initially without feedback. Veridical feedback improved the ability to up-regulate SN/VTA compared to baseline while inverted feedback did not. Additional dopaminergic regions were activated in both groups. The ability to self-regulate SN/VTA was differentially correlated with SCR depending on the group, suggesting an association between

emotional arousal and **neurofeedback** performance. These findings indicate that SN/VTA can be voluntarily activated by imagery and voluntary activation is further enhanced by **neurofeedback**. The findings may lead the way towards a non-invasive strategy for endogenous control of dopamine.

PMID: 23466940 [PubMed - as supplied by publisher]

Am J Psychiatry. 2013 Mar 1;170(3):275-89. doi: 10.1176/appi.ajp.2012.12070991.

122. *Nonpharmacological interventions for ADHD: systematic review and meta-analyses of randomized controlled trials of dietary and psychological treatments.

Sonuga-Barke EJ, Brandeis D, Cortese S, Daley D, Ferrin M, Holtmann M, Stevenson J, Danckaerts M, van der Oord S, Döpfner M, Dittmann RW, Simonoff E, Zuddas A, Banaschewski T, Buitelaar J, Coghill D, Hollis C, Konofal E, Lecendreux M, Wong IC, Sergeant J; European ADHD Guidelines Group.

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Abstract

OBJECTIVE: Nonpharmacological treatments are available for attention deficit hyperactivity disorder (ADHD), although their efficacy remains uncertain. The authors undertook meta-analyses of the efficacy of dietary (restricted elimination diets, artificial food color exclusions, and free fatty acid supplementation) and psychological (cognitive training, **neurofeedback**, and behavioral interventions) ADHD treatments.

METHOD: Using a common systematic search and a rigorous coding and data extraction strategy across domains, the authors searched electronic databases to identify published randomized controlled trials that involved individuals who were diagnosed with ADHD (or who met a validated cutoff on a recognized rating scale) and that included an ADHD outcome.

RESULTS: Fifty-four of the 2,904 nonduplicate screened records were included in the analyses. Two different analyses were performed. When the outcome measure was based on ADHD assessments by raters closest to the therapeutic setting, all dietary (standardized mean differences=0.21-0.48) and psychological (standardized mean differences=0.40-0.64) treatments produced statistically significant effects. However, when the best probably blinded assessment was employed, effects remained significant for free fatty acid supplementation (standardized mean difference=0.16) and artificial food color exclusion (standardized mean difference=0.42) but were substantially attenuated to nonsignificant levels for other treatments.

CONCLUSIONS: Free fatty acid supplementation produced small but significant reductions in ADHD symptoms even with probably blinded assessments, although the clinical significance of these effects remains to be determined. Artificial food color exclusion

produced larger effects but often in individuals selected for food sensitivities. Better evidence for efficacy from blinded assessments is required for behavioral interventions, **neurofeedback**, cognitive training, and restricted elimination diets before they can be supported as treatments for core ADHD symptoms.

PMID: 23360949 [PubMed - indexed for MEDLINE]
See complete free article at:
http://ajp.psychiatryonline.org/article.aspx?articleid=1566975

Crit Rev Biomed Eng. 2013;41(3):269-79.

123. *Brain-computer interfaces for neurorehabilitation.

Sreedharan S[1], Sitaram R[2], Paul JS[3], Kesavadas C[4].

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Abstract
Brain-computer interfaces (**BCI**s) enable control of computers and other assistive devices, such as neuro-prostheses, which are used for communication, movement restoration, neuro-modulation, and muscle stimulation, by using only signals measured directly from the brain. A **BCI** creates a new output channel for the brain to a computer or a device. This requires retrieval of signals of interest from the brain, and its use for neuro-rehabilitation by means of interfacing the signals to a computerized device. Brain signals such as action potentials from single neurons or nerve fibers, extracellular local field potentials (LFPs), electrocorticograms, electroencephalogram and its components such as the event-related brain potentials, real-time **functional magnetic resonance imaging**, **near-infrared spectroscopy**, and magneto-encephalogram have been used. **BCI**s are envisaged to be useful for communication, control and self-regulation of brain function. **BCI**s employ **neurofeedback** to enable operant conditioning to allow the user to learn using it. Paralytic conditions arising from stroke or other diseases are being targeted for **BCI** application. **Neurofeedback** strategies ranging from sensory feedback to direct brain stimulation are being employed. Existing **BCI**s are limited in their throughput in terms of letters per minute or commands per minute, and need extensive training to use the **BCI**. Further, they can cause rapid fatigue due to use and have limited adaptability to changes in the patient's brain state. The challenge before **BCI** technology for neuro-rehabilitation today is to enable effective clinical use of **BCI**s with minimal effort to set up and operate.

PMID: 24579648 [PubMed - in process]

Fiziol Cheloveka. 2013 Jan-Feb;39(1):103-16.

124. *[Voluntary alpha-power increasing training impact on the heart rate variability].

[Article in Russian]

Bazanova OM, Balioz NV, Muravleva KB, Skoraia MV.

Abstract
In order to study the effect of the alpha **EEG** power increasing training at heart rate variability (HRV) as the index of the autonomic regulation of cognitive functions there were follow tasks: (1) to figure out the impact of biofeedback in the voluntary increasing the power in the individual high-frequency alpha-band effect on heart rate variability and related characteristics of cognitive and emotional spheres, (2) to determine the nature of the relationship between alpha activity indices and heart rate variability, depending on the alpha-frequency **EEG** pattern at rest (3) to examine how the individual alpha frequency **EEG** pattern is reflected in changes HRV as a result of biofeedback training. Psychometric indicators of cognitive performance, the characteristics of the alpha-**EEG** activity and heart rate variability (HRV) as LF/HF and pNN50 were recorded in 27 healthy men aged 18-34 years, before, during, and after 10 sessions of training of voluntary increase in alpha power in the individual high-frequency alpha band with eyes closed. To determine the biofeedback effect on the alpha power increasing training, data subjects are compared in 2 groups: experimental (14) with the real and the control group (13 people)--with mock biofeedback. The follow up effect of trainings was studied through month over the 10 training sessions. Results showed that alpha biofeedback training enhanced the fluency and accuracy in cognitive performance, decreased anxiety and frontal EMG, increased resting frequency, width and power in individual upper alpha range only in participants with low baseline alpha frequency. While mock biofeedback increased resting alpha power only in participants with high baseline resting alpha frequency and did change neither cognitive performance, nor HRV indices. Biofeedback training eliminated the alpha power decrease in response to arithmetic task in both with high and low alpha frequency participants and this effect was followed up over the month. Mock biofeedback training has no such effect. The positive correlation between the alpha-peak frequency and pNN50 in patients with initially low, but negative--those with high baseline alpha frequency explains the multidirectional biofeedback effects on HRV in low and high alpha frequency subjects. The individual alpha-frequency **EEG** pattern determines the effectiveness of the alpha **EEG biofeedback** training in changing heart rate variability, which provides a basis for predicting the results and develop individual approaches to the biofeedback technology implementation that can be used in clinical practice for treatment and rehabilitation of psychosomatic syndromes and in educational training.

PMID: 23668077 [PubMed - indexed for MEDLINE]

Brain Topogr. 2013 Jan 16. [Epub ahead of print]

125. Neuromodulation, Agency and Autonomy.

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Abstract

Neuromodulation consists in altering brain activity to restore mental and physical functions in individuals with neuropsychiatric disorders and brain and spinal cord injuries. This can be achieved by delivering electrical stimulation that excites or inhibits neural tissue, by using electrical signals in the brain to move computer cursors or robotic arms, or by displaying brain activity to subjects who regulate that activity by their own responses to it. As enabling prostheses, deep-brain stimulation and brain-computer interfaces (**BCI**s) are forms of extended embodiment that become integrated into the individual's conception of himself as an autonomous agent. In **BCI**s and **neurofeedback**, the success or failure of the techniques depends on the interaction between the learner and the trainer. The restoration of agency and autonomy through neuromodulation thus involves neurophysiological, psychological and social factors.

PMID: 23322211 [PubMed - as supplied by publisher]

IEEE Trans Neural Syst Rehabil Eng. 2013 Jan 9. [Epub ahead of print]

126. Real-Time Mental Arithmetic Task Recognition From EEG Signals.

Wang Q, Sourina O.

Abstract
EEG-based monitoring the state of the users brain functioning and giving her/him the visual/audio/tactile feedback is called **neurofeedback** technique, and it could allow the user to train the corresponding brain functions. It could provide an alternative way of treatment for some psychological disorders such as Attention Deficit Hyperactivity Disorder (ADHD), where concentration function deficit exists, Autism Spectrum Disorder (ASD), or dyscalculia where the difficulty in learning and comprehending the arithmetic exists. In this paper, a novel method for multifractal analysis of **EEG** signals named generalized Higuchi fractal dimension spectrum (GHFDS) was proposed and applied in mental arithmetic task recognition from **EEG** signals. Other features such as power spectrum density (PSD), autoregressive model (AR) and statistical features were analyzed as well. The usage of the proposed fractal dimension spectrum of **EEG** signal in combination with other features improved the mental arithmetic task recognition accuracy in both multi-channel and one-channel subject-dependent algorithms up to 97.87% and 84.15% correspondingly. Based on the channel ranking, four channels were chosen which gave the accuracy up to 97.11%. Reliable real-time **neurofeedback** system could be implemented based on the algorithms proposed in this paper.

PMID: 23314778 [PubMed - as supplied by publisher]

Curr Opin Psychiatry. 2013 Jan;26(1):27-32. doi: 10.1097/YCO.0b013e32835a0b63.

127. *Integrative neuroimaging in mood disorders.

Keedwell PA, Linden DE.

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Abstract

PURPOSE OF REVIEW: Neuroimaging has become a central technique of biological psychiatry and is uniquely suited to assess functional and structural brain changes in psychiatric patients in vivo. In this review, we highlight several recent developments that may enable the transition of psychiatric neuroimaging from laboratory to clinic.

RECENT FINDINGS: We describe recent trends in refining imaging techniques for brain microstructure (diffusion imaging) and neurochemistry (magnetic resonance spectroscopy of neurotransmitters and metabolites) and their application to patients with mood disorders and individuals at risk, such as first-degree relatives. We also survey recent progress in imaging-guided deep brain stimulation (DBS), imaging-based (**neurofeedback**) therapies and studies looking at their convergent anatomical targets. These new interventional techniques, which aim to modulate brain circuits of emotion and motivation highlighted by functional imaging studies, have shown promising effects in several small studies.

SUMMARY: The mapping of brain patterns associated with risk to develop mood disorders may pave the way for diagnostic/prognostic applications of neuroimaging. The neuromodulation techniques of DBS and **neurofeedback**, which target dysfunctional or compensatory circuits identified by functional imaging, may take neuroimaging into a new, therapeutic domain.

PMID: 23108231 [PubMed - in process]

Int J Psychophysiol. 2013 Jan 25. pii: S0167-8760(12)00667-8. doi: 10.1016/j.ijpsycho.2012.11.007. [Epub ahead of print]

128. *Differential effects on mood of 12-15 (SMR) and 15-18 (beta1) Hz neurofeedback.

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Abstract
The common assumption in **EEG-neurofeedback** is one of functional specificity of the trained spectral bands, though it has been posited that only a nonspecific generalised learning process may be engaged. Earlier we reported differential effects on attention in healthy participants measured with continuous performance tests and the P300, following training of the sensory-motor rhythm band (**SMR**, 12-15Hz) compared with the adjacent beta1 (15-18hz) band. Here previously unreported results are presented with phenomenological data from an activation checklist in support of the putative calming effect of **SMR neurofeedback**. While within sessions both protocols induced tiredness, this was paralleled by an increase in calmness only following **SMR** training. The differential effect on mood was theoretically consistent and extends evidence of cognitive functional specificity with **neurofeedback** to affective processes.

PMID: 23357178 [PubMed - as supplied by publisher]

Neuroimage. 2013 Jan 15;65:324-35. doi: 10.1016/j.neuroimage.2012.09.046. Epub 2012 Sep 26.

129. *Mind over chatter: plastic up-regulation of the fMRI salience network directly after EEG neurofeedback.

Ros T, Théberge J, Frewen PA, Kluetsch R, Densmore M, Calhoun VD, Lanius RA.

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Abstract
Neurofeedback (**NFB**) involves a **brain-computer interface** that allows users to learn to voluntarily control their cortical oscillations, reflected in the electroencephalogram (**EEG**). Although **NFB** is being pioneered as a noninvasive tool for treating brain disorders, there is insufficient evidence on the mechanism of its impact on brain function. Furthermore, the dominant rhythm of the human brain is the alpha oscillation (8-12 Hz), yet its behavioral significance remains multifaceted and largely correlative. In this study with 34 healthy participants, we examined whether during the performance of an attentional task, the functional connectivity of distinct **fMRI** networks would be plastically altered after a 30-min session of voluntary reduction of alpha rhythm (n=17) versus a sham-feedback condition (n=17). We reveal that compared to sham-feedback, **NFB** induced an increase of connectivity within regions of the salience network involved in intrinsic alertness (dorsal anterior cingulate), which was detectable 30 min after termination of training. The increase in salience network (default-mode network) connectivity was negatively (positively) correlated with changes in 'on task' mind-wandering as well as resting state alpha rhythm. Crucially, we observed a causal dependence between alpha rhythm synchronization during **NFB** and its subsequent change at resting state, not exhibited by the SHAM group. Our findings provide neurobehavioral evidence for the brain's exquisite functional plasticity, and for a temporally direct impact of **NFB** on a key cognitive control network, suggesting a promising basis for its use to treat cognitive disorders under physiological conditions.

PMID: 23022326 [PubMed - in process]

Conf Proc IEEE Eng Med Biol Soc. 2012;2012:4643-7. doi: 10.1109/EMBC.2012.6347002.

130. *Double-blind single-session neurofeedback training in upper-alpha for cognitive enhancement of healthy subjects.

Escolano C, Olivan B, Lopez-del-Hoyo Y, Garcia-Campayo J, Minguez J.

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Abstract
This paper reports on a single-session **neurofeedback** (**NF**) training procedure on the user-specific upper alpha band for cognitive enhancement in healthy users. A double-blind study

was designed using a **NF** group and an active control group. Control group performed as the **NF** group but received sham feedback, minimizing the non-specific factors of training. This design aimed to (i) investigate upper alpha as a **NF** parameter, (ii) evaluate the **NF** effects on upper alpha during the execution of a cognitive task, and (iii) evaluate the effects on cognitive performance by means of a cognitive task and a battery of psychological tests. Results of **EEG** analysis show the key role of the feedback: only the **NF** group enhanced upper alpha during the training, and it led to a desynchronization increase during the execution of the cognitive task. Regarding the behavioral results, a strong learning effect was observed, with the **NF** group performing better in almost all measurements but many of them without statistical significance.

PMID: 23366963 [PubMed - indexed for MEDLINE]

Conf Proc IEEE Eng Med Biol Soc. 2012;2012:4635-8. doi: 10.1109/EMBC.2012.6347000.

131. Upper alpha neurofeedback training over the motor cortex increases SMR desynchronization in motor tasks.

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Abstract
Desynchronization of sensorimotor rhythms (**SMR**) is a distinctive feature that provides a discriminative pattern for **BCI** operation. However, individuals such as **BCI** illiterates can not produce these discriminable patterns with sufficient reliability. Additionally, **SMR** desynchronization can become deteriorated or extinct in patients with spinal cord injury or a cerebrovascular accident. In all these situations **BCI** usage is compromised. This paper proposes an intervention based on **neurofeedback** training of the upper alpha band to improve **SMR** desynchronization. The feasibility of this intervention is demonstrated in a preliminary study in which five healthy subjects were trained to increase their upper alpha band power. Such increases produced higher **SMR** desynchronization and better discrimination between rest and execution states of a motor task.

PMID: 23366961 [PubMed - indexed for MEDLINE]

Conf Proc IEEE Eng Med Biol Soc. 2012;2012:4112-5. doi: 10.1109/EMBC.2012.6346871.

132. *EEG-based Brain-Computer Interface to support post-stroke motor rehabilitation of the upper limb.

Cincotti F, Pichiorri F, Aricò P, Aloise F, Leotta F, de Vico Fallani F, Millán Jdel R, Molinari M, Mattia D.

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Abstract

Brain-Computer Interfaces (**BCI**s) process brain activity in real time, and mediate non-muscular interaction between and individual and the environment. The subserving algorithms can be used to provide a quantitative measurement of physiological or pathological cognitive processes - such as Motor Imagery (MI) - and feed it back the user. In this paper we propose the clinical application of a **BCI**-based rehabilitation device, to promote motor recovery after stroke. The **BCI**-based device and the therapy exploiting its use follow the same principles that drive classical neuromotor rehabilitation, and (i) provides the physical therapist with a monitoring instrument, to assess the patient's participation in the rehabilitative cognitive exercise; (ii) assists the patient in the practice of MI. The device was installed in the ward of a rehabilitation hospital and a group of 29 patients were involved in its testing. Among them, eight have already undergone a one-month training with the device, as an add-on to the regular therapy. An improved system, which includes analysis of Electromyographic (EMG) patterns and Functional Electrical Stimulation (FES) of the arm muscles, is also under clinical evaluation. We found that the rehabilitation exercise based on **BCI**-mediated **neurofeedback** mechanisms enables a better engagement of motor areas with respect to motor imagery alone and thus it can promote neuroplasticity in brain regions affected by a cerebrovascular accident. Preliminary results also suggest that the functional outcome of motor rehabilitation may be improved by the use of the proposed device.

PMID: 23366832 [PubMed - indexed for MEDLINE]

Conf Proc IEEE Eng Med Biol Soc. 2012;2012:1057-60. doi: 10.1109/EMBC.2012.6346116.

133. *Nonlinear dynamics measures applied to EEG recordings of patients with attention deficit/hyperactivity disorder: quantifying the effects of a neurofeedback treatment.

Cerquera A, Arns M, Buitrago E, Gutiérrez R, Freund J.

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Abstract
This work presents the application of nonlinear dynamics measures to electroencephalograms (**EEG**) acquired from patients with Attention Deficit/Hyperactivity Disorder (ADHD) before and after a **neurofeedback** therapy, with the aim to assess the effects of the **neurofeedback** in a quantitative way. The database contains **EEG** registers of seven patients acquired in eyes-closed and eyes-opened conditions, in pre-and post-treatment phases. Five measures were applied: largest Lyapunov exponent, Lempel-Ziv complexity, Hurst exponent, and multiscale entropy on two different scales. The purpose is to test whether these measures are apt to detect and quantify differences from **EEG** registers between pre- and post-treatment. The results indicate that these measures could have a potential utility for detection of quantitative changes in specific **EEG** channels. In addition, the performance of some of these measures improved when the bandwidth was reduced to 3-30 Hz.

PMID: 23366077 [PubMed - indexed for MEDLINE]

Rinsho Shinkeigaku. 2012;52(11):1185-7.

134. *[A new neuroscientific approach using decoded neurofeedback (DecNef)].

[Article in Japanese]

Shibata K.

Brain Information Communication Research Laboratory Group, Advanced Telecommunication Research Institute International.

Abstract
Neurofeedback is defined as a method to read out information from the brain and feed the information back to the brain. This technology has developed in the past ten years and attracted considerable attention as potential treatments for rehabilitation and psychiatric disease. We recently invented the decoded **neurofeedback** (DecNef) method, a new **neurofeedback** technique using **functional magnetic resonance imaging**. With DecNef, subjects were trained to regulate their brain activation pattern in a specific area and lead the pattern to a target state. We found that the DecNef training for several days leads to perceptual improvement that corresponds to the induced target state. DecNef enables us to test cause-and-effect relationships between neural activation in a target brain area and changes in perception, cognition, and behavior. In this sense, this method can be a powerful tool in cognitive and systems neuroscience. In addition, the concept of DecNef, leading a neural activation pattern to a specific state, can be applied for a variety of fields including engineering and medical treatment.

PMID: 23196557 [PubMed - in process]

Rinsho Shinkeigaku. 2012;52(11):1174-7.

135. *[Contribution of brain function analysis to the evolution of neurorehabilitation].

[Article in Japanese]

Miyai I, Mihara M, Hattori N, Hatakenaka M, Kawano T, Yagura H.

Neurorehabilitation Research Institute, Morinomiya Hospital.

Abstract
Recent studies of functional neuroimaging and clinical neurophysiology have implied that functional recovery after stroke is associated with use-dependent plasticity of the damaged brain. However the property of the reorganized neural network depends on site and size of the lesion, which makes it difficult to assess what the adaptive plasticity is. From clinical point of view there is accumulating randomized controlled trials for the benefit of task-oriented rehabilitative intervention including constraint-induced movement therapy, robotics, and body-weight supported treadmill training. However dose-matched control intervention is usually as effective as a specific intervention. This raises a question regarding the specificity of a task-oriented intervention. Second question is whether such intervention goes beyond the biological destiny of human. Specifically there is no known strategy enhancing recovery of severely impaired hand. To augment functional gain, several methods of neuro-modulation

may bring break-through on the assumption that they induce greater adaptive plasticity. Such neuro-modulative methods include neuropharmacological modulation, brain stimulation using transcranial magnetic stimulation and direct current stimulation, peripheral nerve stimulation, **neurofeedback** using real-time **fMRI** and real-time **fNIRS**, and **brain-machine interface**. A preliminary randomized controlled trial regarding real-time feedback of premotor activities revealed promising results for recovery of paretic hand in patients with stroke.

PMID: 23196554 [PubMed - in process]

Front Neurosci. 2012;6:189. doi: 10.3389/fnins.2012.00189. Epub 2012 Dec 26.

136. Volitional control of neuromagnetic coherence.

Sacchet MD, Mellinger J, Sitaram R, Braun C, Birbaumer N, Fetz E.

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Abstract
Coherence of neural activity between circumscribed brain regions has been implicated as an indicator of intracerebral communication in various cognitive processes. While neural activity can be volitionally controlled with **neurofeedback**, the volitional control of coherence has not yet been explored. Learned volitional control of coherence could elucidate mechanisms of associations between cortical areas and its cognitive correlates and may have clinical implications. Neural coherence may also provide a signal for **brain-computer interfaces** (**BCI**). In the present study we used the Weighted Overlapping Segment Averaging method to assess coherence between bilateral magnetoencephalograph sensors during voluntary digit movement as a basis for **BCI** control. Participants controlled an onscreen cursor, with a success rate of 124 of 180 (68.9%, sign-test $p < 0.001$) and 84 out of 100 (84%, sign-test $p < 0.001$). The present findings suggest that neural coherence may be volitionally controlled and may have specific behavioral correlates.

PMID: 23271991 [PubMed] PMCID: PMC3530077
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3530077

Front Neurosci. 2012;6:181. doi: 10.3389/fnins.2012.00181. Epub 2012 Dec 19.

137. Communication and control by listening: toward optimal design of a two-class auditory streaming brain-computer interface.

Hill NJ, Moinuddin A, Häuser AK, Kienzle S, Schalk G.

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Abstract
Most **brain-computer interface** (**BCI**) systems require users to modulate brain signals in response to visual stimuli. Thus, they may not be useful to people with limited vision, such as

those with severe paralysis. One important approach for overcoming this issue is auditory streaming, an approach whereby a **BCI** system is driven by shifts of attention between two simultaneously presented auditory stimulus streams. Motivated by the long-term goal of translating such a system into a reliable, simple yes-no interface for clinical usage, we aim to answer two main questions. First, we asked which of two previously published variants provides superior performance: a fixed-phase (FP) design in which the streams have equal period and opposite phase, or a drifting-phase (DP) design where the periods are unequal. We found FP to be superior to DP ($p = 0.002$): average performance levels were 80 and 72% correct, respectively. We were also able to show, in a pilot with one subject, that auditory streaming can support continuous control and **neurofeedback** applications: by shifting attention between ongoing left and right auditory streams, the subject was able to control the position of a paddle in a computer game. Second, we examined whether the system is dependent on eye movements, since it is known that eye movements and auditory attention may influence each other, and any dependence on the ability to move one's eyes would be a barrier to translation to paralyzed users. We discovered that, despite instructions, some subjects did make eye movements that were indicative of the direction of attention. However, there was no correlation, across subjects, between the reliability of the eye movement signal and the reliability of the **BCI** system, indicating that our system was configured to work independently of eye movement. Together, these findings are an encouraging step forward toward **BCI**s that provide practical communication and control options for the most severely paralyzed users.

PMID: 23267312 [PubMed] PMCID: PMC3525941
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3525941

Med Hypotheses. 2012 Dec;79(6):790-8. doi: 10.1016/j.mehy.2012.08.031. Epub 2012 Sep 20.

138. *Self-regulation of brain oscillations as a treatment for aberrant brain connections in children with autism.

Pineda JA, Juavinett A, Datko M.

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Abstract
Autism is a highly varied developmental disorder typically characterized by deficits in reciprocal social interaction, difficulties with verbal and nonverbal communication, and restricted interests and repetitive behaviors. Although a wide range of behavioral, pharmacological, and alternative medicine strategies have been reported to ameliorate specific symptoms for some individuals, there is at present no cure for the condition. Nonetheless, among the many incompatible observations about aspects of the development, anatomy, and functionality of the autistic brain, it is widely agreed that it is characterized by widespread aberrant connectivity. Such disordered connectivity, be it increased, decreased, or otherwise compromised, may complicate healthy synchronization and communication among and within different neural circuits, thereby producing abnormal processing of sensory inputs necessary for normal social life. It is widely accepted that the innate properties of brain electrical activity produce pacemaker elements and linked networks that oscillate synchronously or

asynchronously, likely reflecting a type of functional connectivity. Using phase coherence in multiple frequency **EEG** bands as a measure of functional connectivity, studies have shown evidence for both global hypoconnectivity and local hyperconnectivity in individuals with ASD. However, the nature of the brain's experience-dependent structural plasticity suggests that these abnormal patterns may be reversed with the proper type of treatment. Indeed, **neurofeedback** (**NF**) training, an intervention based on operant conditioning that results in self-regulation of brain electrical oscillations, has shown promise in addressing marked abnormalities in functional and structural connectivity. It is hypothesized that **neurofeedback** produces positive behavioral changes in ASD children by normalizing the aberrant connections within and between neural circuits. **NF** exploits the brain's plasticity to normalize aberrant connectivity patterns apparent in the autistic brain. By grounding this training in known anatomical (e.g., mirror neuron system) and functional markers (e.g., mu rhythms) of autism, **NF** training holds promise to support current treatments for this complex disorder. The proposed hypothesis specifically states that **neurofeedback**-induced alpha mu (8-12Hz) rhythm suppression or desynchronization, a marker of cortical activation, should induce neuroplastic changes and lead to normalization in relevant mirroring networks that have been associated with higher-order social cognition.

PMID: 22999736 [PubMed - in process]

Curr Treat Options Neurol. 2012 Dec;14(6):594-607. doi: 10.1007/s11940-012-0197-2.

139. *Updates on treatment of attention-deficit/hyperactivity disorder: facts, comments, and ethical considerations.

Rothenberger A, Rothenberger LG.

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Abstract
OPINION STATEMENT: Within the last 2 years the bulk of information on evidence based treatments in ADHD was reviewed quite intensively and new empirical studies could be added. This update reports comprehensively about actual and essential facts in the field related to brain development and sensitive periods, predictors of treatment, safety of medication, value of naturalistic studies, new drugs and complementary medicine, behavioral interventions including **neurofeedback** and psychosocial treatment, treatment of comorbidity, and ethical considerations including preventive aspects. The updated combination of well selected evidence based treatments (ie, pharma plus non-pharma) seems to be clinically and ethically recommended as also suggested by the European and American guidelines on ADHD.

PMID: 22968494 [PubMed] PMCID: PMC3501189
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3501189

J Atten Disord. 2012 Dec 20. [Epub ahead of print]

140. *One Size Fits All? Slow Cortical Potentials Neurofeedback: A Review.

Mayer K, Wyckoff SN, Strehl U.

PMID: 23264371 [PubMed - as supplied by publisher]

BMC Cancer. 2012 Dec 6;12(1):581. doi: 10.1186/1471-2407-12-581.

141. *Neurofeedback to improve neurocognitive functioning of children treated for a brain tumor: design of a randomized controlled double-blind trial.

de Ruiter MA, Meeteren AY, van Mourik R, Janssen TW, Greidanus JE, Oosterlaan J, Grootenhuis MA.

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Abstract
BACKGROUND: Neurotoxicity caused by treatment for a brain tumor is a major cause of neurocognitive decline in survivors. Studies have shown that **neurofeedback** may enhance neurocognitive functioning. This paper describes the protocol of the PRISMA study, a randomized controlled trial to investigate the efficacy of **neurofeedback** to improve neurocognitive functioning in children treated for a brain tumor.

METHODS/DESIGN: Efficacy of **neurofeedback** will be compared to placebo training in a randomized controlled double-blind trial. A total of 70 brain tumor survivors in the age range of 8 to 18 years will be recruited. Inclusion also requires caregiver-reported neurocognitive problems and being off treatment for more than two years. A group of 35 healthy siblings will be included as the control group. On the basis of a q**EEG** patients will be assigned to one of three treatment protocols. Thereafter patients will be randomized to receive either **neurofeedback** training (n=35) or placebo training (n=35). Neurocognitive tests, and questionnaires administered to the patient, caregivers, and teacher, will be used to evaluate pre- and post-intervention functioning, as well as at 6-month follow-up. Siblings will be administered the same tests and questionnaires once.

DISCUSSION: If **neurofeedback** proves to be effective for pediatric brain tumor survivors, this can be a valuable addition to the scarce interventions available to improve neurocognitive and psychosocial functioning.

TRIAL REGISTRATION: ClinicalTrials.gov NCT00961922.

PMID: 23217162 [PubMed - in process] PMCID: PMC3530427
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3530427

J Neurosci. 2012 Dec 5;32(49):17830-41. doi: 10.1523/JNEUROSCI.6334-11.2012.

142. *Improving Visual Perception through Neurofeedback.

Scharnowski F, Hutton C, Josephs O, Weiskopf N, Rees G.

Wellcome Trust Centre for Neuroimaging, UCL Institute of Neurology, and UCL Institute of Cognitive Neuroscience, University College London, London WC1N 3AR, United Kingdom, Institute of Bioengineering, Swiss Institute of Technology (EPFL), CH-1015 Lausanne, Switzerland, and Department of Radiology and Medical Informatics, Center for Biomedical Imaging (CIBM), University of Geneva, CH-1211 Geneva 14, Switzerland.

Abstract
Perception depends on the interplay of ongoing spontaneous activity and stimulus-evoked activity in sensory cortices. This raises the possibility that training ongoing spontaneous activity alone might be sufficient for enhancing perceptual sensitivity. To test this, we trained human participants to control ongoing spontaneous activity in circumscribed regions of retinotopic visual cortex using **real-time functional MRI**-based **neurofeedback**. After training, we tested participants using a new and previously untrained visual detection task that was presented at the visual field location corresponding to the trained region of visual cortex. Perceptual sensitivity was significantly enhanced only when participants who had previously learned control over ongoing activity were now exercising control and only for that region of visual cortex. Our new approach allows us to non-invasively and non-pharmacologically manipulate regionally specific brain activity and thus provide "brain training" to deliver particular perceptual enhancements.

PMID: 23223302 [PubMed - in process] PMCID: PMC3520425 [Available on 2013/6/5]
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3520425

Neuroimage. 2012 Dec;63(4):1775-81. doi: 10.1016/j.neuroimage.2012.08.061. Epub 2012 Aug 30.

143. Recovery of the default mode network after demanding neurofeedback training occurs in spatio-temporally segregated subnetworks.

Van De Ville D, Jhooti P, Haas T, Kopel R, Lovblad KO, Scheffler K, Haller S.

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Abstract
The default mode (DM) network is a major large-scale cerebral network that can be identified with functional magnetic resonance imaging (**fMRI**) during resting state. Most studies consider functional connectivity networks as stationary phenomena. Consequently, the transient behavior of the DM network and its subnetworks is still largely unexplored. Most functional connectivity **fMRI** studies assess the steady state of resting without any task. To specifically investigate the recovery of the DM network during the transition from activation to rest, we implemented a cognitively demanding real-time **fMRI neurofeedback** task that targeted down-regulation of the primary auditory cortex. Each of twelve healthy subjects performed 16 block-design **fMRI** runs (4 runs per day repeated on 4 days) resulting 192 runs

in total. The analysis included data-driven independent component analysis (ICA) and high-resolution latency estimation between the four components that corresponded to subnetworks of the DM network. These different subnetworks reemerged after regulation with an average time lag or 3.3s and a time lag of 4.4s between the first and fourth components; i.e., the DM recovery first shifts from anterior to posterior, and then gradually focuses on the ventral part of the posterior cingulate cortex, which is known to be implicated in internally directed cognition. In addition, we found less reactivation in the early anterior subnetwork as regulation strength increased, but more reactivation with larger regulation for the late subnetwork that encompassed the ventral PCC. This finding confirms that the level of task engagement influences inversely the subsequent recovery of regions related to attention compared to those related to internally directed cognition.

PMID: 22960086 [PubMed - in process]

Span J Psychol. 2012 Nov;15(3):930-41.

144. *Clinical efficacy of a new automated hemoencephalographic neurofeedback protocol.

Dias AM, Van Deusen AM, Oda E, Bonfim MR.

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Abstract
Among the ongoing attempts to enhance cognitive performance, an emergent and yet underrepresented venue is brought by hemoencefalographic **neurofeedback** (**HEG**). This paper presents three related advances in **HEG neurofeedback** for cognitive enhancement: a) a new **HEG** protocol for cognitive enhancement, as well as b) the results of independent measures of biological efficacy (**EEG** brain maps) extracted in three phases, during a one year follow up case study; c) the results of the first controlled clinical trial of **HEG**, designed to assess the efficacy of the technique for cognitive enhancement of an adult and neurologically intact population. The new protocol was developed in the environment of a software that organizes digital signal algorithms in a flowchart format. Brain maps were produced through 10 brain recordings. The clinical trial used a working memory test as its independent measure of achievement. The main conclusion of this study is that the technique appears to be clinically promising. Approaches to cognitive performance from a metabolic viewpoint should be explored further. However, it is particularly important to note that, to our knowledge, this is the world's first controlled clinical study on the matter and it is still early for an ultimate evaluation of the technique.

PMID: 23156903 [PubMed - indexed for MEDLINE]

Med Sci Monit. 2012 Nov;18(11):CS94-104.

145. *Evaluation of a neurotherapy program for a child with ADHD with Benign Partial Epilepsy with Rolandic Spikes (BPERS) using event-related potentials.

Pąchalska M, Kropotov ID, Mańko G, Lipowska M, Rasmus A, Łukaszewska B, Bogdanowicz M, Mirski A.

Andrzej Frycz Modrzewski Cracow University, Cracow, Poland. neuropsychologia23@o2.pl

Abstract
BACKGROUND: We hypothesized that there would be a good response to **relative beta training**, applied to regulate the dynamics of brain function in a patient with benign partial epilepsy with Rolandic Spikes (BPERS), associated with neuropsychiatric deficits resembling the symptoms of attention deficit-hyperactivity disorder (ADHD).

CASE REPORT: The patient, E.Z., age 9.3, was suffering from neuropsychiatric symptoms, cognitive dysfunction, especially attention deficits, and behavioral changes, rendering him unable to function independently in school and in many situations of everyday life. He was treated for epilepsy, but only slight progress was made. The patient took part in 20 sessions of **relative beta training** combined with behavioral training. We used standardized neuropsychological testing, as well as ERPs before the experiment and after the completion of the **neurotherapy** program. Neuropsychological testing at baseline showed multiple cognitive deficits. Over the course of **neurotherapy**, E.Z.'s verbal and non-verbal IQ increased significantly. His cognitive functions also improved, including immediate and delayed logical and visual recall on the WMS-III, maintaining attention on the WMS-III, and executive functions, but remained below norms. Physiologically, the patient showed substantial changes after **neurotherapy**, including fewer spikes and an increased P300 NOGO component.

CONCLUSIONS: The cognitive deficits characteristic for ADHD in a child with BPERS may be unresponsive to antiepileptic treatment, but are reversible after a carefully selected **neurotherapy** program, combined with antiepileptic treatment. Event Related Potentials (ERPs) in the GO/NOGO task can be used to assess functional brain changes induced by neurotherapeutical programs.

PMID: 23111748 [PubMed - in process]
See complete free article at:
http://www.medscimonit.com/download/index/idArt/883531

IEEE Trans Neural Syst Rehabil Eng. 2012 Nov;20(6):823-35. doi: 10.1109/TNSRE.2012.2214789. Epub 2012 Sep 24.

146. Asynchronous BCI based on motor imagery with automated calibration and neurofeedback training.

Kus R, Valbuena D, Zygierewicz J, Malechka T, Graeser A, Durka P.

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Abstract

A new multiclass **brain-computer interface** (**BCI**) based on the modulation of sensorimotor oscillations by imagining movements is described. By the application of advanced signal processing tools, statistics and machine learning, this **BCI** system offers: 1) asynchronous mode of operation, 2) automatic selection of user-dependent parameters based on an initial calibration, 3) incremental update of the classifier parameters from feedback data. The signal classification uses spatially filtered signals and is based on spectral power estimation computed in individualized frequency bands, which are automatically identified by a specially tailored AR-based model. Relevant features are chosen by a criterion based on Mutual Information. Final recognition of motor imagery is effectuated by a multinomial logistic regression classifier. This **BCI** system was evaluated in two studies. In the first study, five participants trained the ability to imagine movements of the right hand, left hand and feet in response to visual cues. The accuracy of the classifier was evaluated across four training sessions with feedback. The second study assessed the information transfer rate (ITR) of the **BCI** in an asynchronous application. The subjects' task was to navigate a cursor along a computer rendered 2-D maze. A peak information transfer rate of 8.0 bit/min was achieved. Five subjects performed with a mean ITR of 4.5 bit/min and an accuracy of 74.84%. These results demonstrate that the use of automated interfaces to reduce complexity for the intended operator (outside the laboratory) is indeed possible. The signal processing and classifier source code embedded in BCI2000 is available from https://www.brain-project.org/downloads.html.

PMID: 23033330 [PubMed - in process]

J Neurosci Methods. 2012 Nov 15;211(2):203-9. doi: 10.1016/j.jneumeth.2012.08.020. Epub 2012 Aug 28.

147. *Fuzzy Synchronization Likelihood-wavelet methodology for diagnosis of autism spectrum disorder.

Ahmadlou M, Adeli H, Adeli A.

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Abstract

This paper presents a methodology for investigation of functional connectivity in patients with autism spectrum disorder (ASD) using Fuzzy Synchronization Likelihood (Fuzzy SL). Fuzzy SLs between and within brain regions are calculated in all **EEG** sub-bands produced by the wavelet decomposition as well as in the full-band **EEG**. Then, discriminative Fuzzy SLs between and within different regions and different **EEG** sub-bands or full-band **EEG** for distinguishing autistic children from healthy control children are determined based on Analysis of Variation (ANOVA). Finally, the selected features are used as input to an Enhanced Probabilistic Neural Network classifier to make an accurate diagnosis of ASD based on the detected differences in the regional functional connectivity of autistic and healthy **EEG**s. The methodology is validated using **EEG** data obtained from 9 autistic and 9 healthy children. The ANOVA test showed high ability of the regional Fuzzy SLs in low frequency bands, delta and theta, as well as alpha band for discriminating the two groups. A high classification accuracy of 95.5% was achieved for distinguishing autistic **EEG**s from healthy **EEG**s. It is concluded that the methodology presented in this paper can be used as an effective tool for diagnosis of the autism. Further, the regional Fuzzy SLs discovered in this

research can be used as reliable markers in **neurofeedback** treatments to improve neuronal plasticity and connectivity in autistic patients.

PMID: 22968137 [PubMed - in process]

Adv Mind Body Med. 2012 Fall;26(2):8-12.

148. *Alpha brain-wave neurofeedback training reduces psychopathology in a cohort of male and female Canadian aboriginals.

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Abstract
OBJECTIVE: The study was conducted to determine if alpha brain-wave **neurofeedback** training can have positive psychological results by reducing anxiety and other psychopathology.

METHOD: The cohort participated in alpha brain-wave **neurofeedback** training for 76 minutes (day 1) to 120 or more minutes (days 5-7) daily for 7 days. Electroencephalogram (**EEG**) electrodes were attached to the head with conductive gel according to the 10-20 International Electrode Placement System. During training, participants were seated in a comfortable armchair within a soundproof and lightproof room. Brain-wave signals were amplified for processing by analog-to-digital converters and polygraphs, then filtered to the pure delta, theta, alpha, beta, and gamma bands as well as subbands of these bands of the **EEG**. For 2-minute epochs, trainees sat with their eyes closed in the dark listening to their feedback tones as the filtered alpha brain-wave **EEG** signals controlled the loudness of the tones. Then a "ding" sounded and the tones stopped. For 8 seconds, a monitor lit up with dimly illuminated, static numbers, indicating the strength of their alpha brain waves, after which the feedback tones resumed and the process was repeated.

PARTICIPANTS: 40 adult volunteers were recruited from the aboriginal population (First Nations, Métis, and Inuit) of Canada. The cohort ranged in age from 25 to 60 years and included males and females.

SETTING: The study was conducted at Biocybernaut Institute of Canada in Victoria, British Columbia.

PRIMARY OUTCOME MEASURES: Data was obtained to determine the effectiveness of this training by giving four psychological tests (Minnesota Multi-Phasic Personality Inventory, and the trait forms of the Multiple Affect Adjective Check List, Clyde Mood Scale, and Profile of Mood States) on the first day prior to commencing training and on the seventh day upon completion of the training. **EEG** data was also compiled throughout the training and analyzed as a factor of the training process.

RESULTS: Postintervention data showed positive results with reduction of psychopathology when compared to the data from testing prior to the training. Analysis of this data showed improvement in several areas of psychopathology.

CONCLUSION: Alpha brain-wave **neurofeedback** training daily for 7 days does have positive psychological results in adult male and female Canadian aboriginals as measured by data from four psychological tests on the participants.

PMID: 23341412 [PubMed - indexed for MEDLINE]

IEEE Trans Neural Syst Rehabil Eng. 2012 Oct 9. [Epub ahead of print]

149. Functional Alteration of the DMN by Learned Regulation of the PCC Using Real-Time fMRI.

Zhang G, Zhang H, Li X, Zhao X, Yao L, Long Z.

Abstract
The default mode network (DMN) is a network of brain regions that are active during rest and suppressed during a cognitively demanding task. Previous studies have shown that the DMN can be altered by development, aging, disorder, cognitive tasks and off-line training. However, it's unclear whether activity in the DMN can be altered by real-time training. Recently, real-time functional magnetic resonance imaging (rt**fMRI**), as a novel **neurofeedback** technique, has been applied to train subjects to voluntarily control activities in specific brain regions. In the current study, it was found that by using rt**fMRI** to guide training, subjects were able to learn to decrease activity in the posterior cingulate cortex (PCC), which is a key hub in the DMN, using motor imagery strategy. After the real-time training, activity in the medial prefrontral cortex/ anterior cingulate cortex (MPFC/ACC) of the resting state DMN was decreased. By contrast, the control group without **neurofeedback** produced increased activity in the MPFC/ACC of the DMN during the post-training resting state. These findings suggest that this rt**fMRI** technique has great potential to be used in the regulation of the DMN and may be a novel approach for studying functional plasticity of the cortex.

PMID: 23070370 [PubMed - as supplied by publisher]

Clin EEG Neurosci. 2012 Oct;43(4):315-22. doi: 10.1177/1550059412451880.

150. *The effectiveness of neurofeedback training on EEG coherence and neuropsychological functions in children with reading disability.

Nazari MA, Mosanezhad E, Hashemi T, Jahan A.

Department of Psychology, University of Tabriz, Iran.

Abstract
Neurofeedback training (**NF**T) is an effective intervention in regulating electroencephalogram (**EEG**) abnormalities leading to improvements in behavioral deficits, which exist in children with reading disabilities. This single-subject study explores our

evaluation of the improvements in the reading ability and phonological awareness deficit, as well as the changes in the **EEG** in children with reading disabilities as a result of **NF**T. Participants were 6 children, aged between 8 and 10 years, who completed twenty 30-minute sessions of **NF**T and follow-up measurement sessions 2 months subsequent to the completion of the training sessions. The results showed significant improvement in reading and phonological awareness skills. Furthermore, **EEG** analysis did not show notable changes in the power of the targeted bands (delta, theta, and beta), rather there was normalization of coherence of the theta band at T3-T4, delta band at Cz-Fz, and beta band at Cz-Fz, Cz-Pz, and Cz-C4. These significant changes in coherence possibly indicate integration of sensory and motor areas that explains the improvements in reading skills and phonological awareness.

PMID: 23185091 [PubMed - in process]

Curr Psychiatry Rep. 2012 Oct;14(5):536-42. doi: 10.1007/s11920-012-0301-z.

151. *Current status of neurofeedback for attention-deficit/hyperactivity disorder.

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Abstract
As conventional treatments offer incomplete benefit for over 33 % of children with attention-deficit/hyperactivity disorder (ADHD) and many refuse to try them, additional treatments are needed. One of the most promising is **neurofeedback** (**NF**, **EEG biofeedback**), which trains the brain with real-time video/audio information about its electrical activity measured from scalp electrodes. Since 2010, data from 8 randomized controlled studies of **NF** have been published with overall mean effect sizes of: 0.40 (all measures), 0.42 (ADHD measures), 0.56 (inattention), and 0.54 (hyperactivity/ impulsivity). Unfortunately, the benefit reported from randomized studies has not been observed in the few small blinded studies conducted. Main study strengths include randomization, evidence-based diagnostic assessments, multi-domain treatment outcomes, use of some type of blinding, and sham control conditions. Main study limitations include lack of large samples, abnormal **EEG** participant selection, double-blinding, and testing of blind validity and sham inertness. Most recently, a collaborative **NF** research group has been planning a definitive double-blind well-controlled trial.

PMID: 22890816 [PubMed - indexed for MEDLINE]

Neurosci Biobehav Rev. 2012 Oct 23. pii: S0149-7634(12)00173-X. doi: 10.1016/j.neubiorev.2012.10.006. [Epub ahead of print]

152. *Neurofeedback in ADHD and insomnia: Vigilance stabilization through sleep spindles and circadian networks.

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Department of Experimental Psychology, Utrecht University, Utrecht, The Netherlands; Research Institute Brainclinics, Bijleveldsingel 34, 6524 AD Nijmegen, The Netherlands. Electronic address: martijn@brainclinics.com.

Abstract
In this review article an overview of the history and current status of **neurofeedback** for the treatment of ADHD and insomnia is provided. Recent insights suggest a central role of circadian phase delay, resulting in sleep onset insomnia (SOI) in a sub-group of ADHD patients. Chronobiological treatments, such as melatonin and early morning bright light, affect the suprachiasmatic nucleus. This nucleus has been shown to project to the noradrenergic locus coeruleus (LC) thereby explaining the vigilance stabilizing effects of such treatments in ADHD. It is hypothesized that both Sensori-Motor Rhythm (**SMR**) and Slow-Cortical Potential (**SCP**) **neurofeedback** impact on the sleep spindle circuitry resulting in increased sleep spindle density, normalization of SOI and thereby affect the noradrenergic LC, resulting in vigilance stabilization. After SOI is normalized, improvements on ADHD symptoms will occur with a delayed onset of effect. Therefore, clinical trials investigating new treatments in ADHD should include assessments at follow-up as their primary endpoint rather than assessments at outtake. Furthermore, an implication requiring further study is that **neurofeedback** could be stopped when SOI is normalized, which might result in fewer sessions.

PMID: 23099283 [PubMed - as supplied by publisher]

Int J Psychophysiol. 2012 Oct;86(1):83-7. doi: 10.1016/j.ijpsycho.2012.07.182. Epub 2012 Aug 1.

153. *Individual alpha neurofeedback training effect on short term memory.

Nan W, Rodrigues JP, Ma J, Qu X, Wan F, Mak PI, Mak PU, Vai MI, Rosa A.

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Abstract
Memory performance has been reported to be associated with electroencephalogram (**EEG**) alpha activity. This study aimed to improve short term memory performance by individual alpha **neurofeedback** training (**NF**T). With appropriate protocol designed for **NF**T, the experimental results showed that the participants were able to learn to increase the relative amplitude in individual alpha band during **NF**T and short term memory performance was significantly enhanced by 20 sessions of **NF**T. More importantly, further analysis revealed that the improvement of short term memory was positively correlated with the increase of the relative amplitude in the individual upper alpha band during training. In addition, effective strategies for individual alpha training varied among individuals and the most successful mental strategies were related to positive thinking.

PMID: 22864258 [PubMed - in process]

Clin Neurophysiol. 2012 Oct;123(10):1989-2005. doi: 10.1016/j.clinph.2012.03.016. Epub 2012 May 17.

154. *First clinical trial of tomographic neurofeedback in attention-deficit/hyperactivity disorder: evaluation of voluntary cortical control.

Liechti MD, Maurizio S, Heinrich H, Jäncke L, Meier L, Steinhausen HC, Walitza S, Drechsler R, Brandeis D.

Department of Child and Adolescent Psychiatry, University of Zürich, Zürich, Switzerland.

Abstract

OBJECTIVE: **Tomographic neurofeedback** (t**NF**) training was evaluated as a treatment for attention-deficit/hyperactivity disorder (ADHD). To investigate the specificity of the treatment, outcomes were related to learning during t**NF**.

METHODS: Thirteen children with ADHD trained over 36 lessons to regulate their brain activity in the anterior cingulate cortex (ACC) using both theta-beta frequency and slow cortical potential (**SCP**) protocols. Thirty-channel electroencephalogram (**EEG**) was used to calculate low-resolution electromagnetic t**NF** and to assess the course of the training. Pre- and post-assessments included questionnaires, tests of attention, **EEG** recordings, and cognitive event-related potentials.

RESULTS: Despite behavioural improvement and **EEG** artefact reduction, only partial learning was found for ACC parameters. Successful regulation was observed only for a simple feedback variant of **SCP** training, but with ACC-specific effects. Over training, resting **EEG** analysis indicated individual frequency normalisation rather than unidirectional changes across subjects.

CONCLUSIONS: These results indicate that clinical improvement after ACC-t**NF** training can parallel artefact reduction without substantial learning of improved cortical control. However, individual normalisation of resting **EEG** activity and partial **SCP** control proved possible in this specific brain region affected in ADHD using t**NF**. Further studies are needed to clarify which critical aspects mediate region-specific learning in **neurofeedback**.

SIGNIFICANCE: This study is the first to systematically investigate t**NF** in children suffering from a psychiatric disorder.

PMID: 22608481 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2012 Sep;37(3):171-80. doi: 10.1007/s10484-012-9191-4.

155. *The effects of QEEG-informed neurofeedback in ADHD: an open-label pilot study.

Arns M, Drinkenburg W, Leon Kenemans J.

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Abstract
In ADHD several **EEG** biomarkers have been described before, with relevance to treatment outcome to stimulant medication. This pilot-study aimed at personalizing **neurofeedback** treatment to these specific sub-groups to investigate if such an approach leads to improved clinical outcomes. Furthermore, pre- and post-treatment **EEG** and ERP changes were investigated in a sub-group to study the neurophysiological effects of **neurofeedback**. Twenty-one patients with ADHD were treated with Q**EEG**-informed **neurofeedback** and post-treatment effects on inattention (ATT), hyperactivity/impulsivity (HI) and comorbid depressive symptoms were investigated. There was a significant improvement for both ATT, HI and comorbid depressive complaints after Q**EEG**-informed **neurofeedback**. The effect size for ATT was 1.78 and for HI was 1.22. Furthermore, anterior individual alpha peak frequency (iAPF) demonstrated a strong relation to improvement on comorbid depressive complaints. Pre- and post-treatment effects for the **SMR neurofeedback** sub-group exhibited increased N200 and P300 amplitudes and decreased **SMR EEG** power post-treatment. This pilot study is the first study demonstrating that it is possible to select **neurofeedback** protocols based on individual **EEG** biomarkers and suggests this results in improved treatment outcome specifically for ATT, however these results should be replicated in further controlled studies. A slow anterior iAPF at baseline predicts poor treatment response on comorbid depressive complaints in line with studies in depression. The effects of **SMR neurofeedback** resulted in specific ERP and **EEG** changes.

PMID: 22446998 [PubMed - indexed for MEDLINE] PMCID: PMC3419351
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3419351

Conscious Cogn. 2012 Sep;21(3):1345-54. doi: 10.1016/j.concog.2012.06.009. Epub 2012 Jul 15.

156. Psychophysics of EEG alpha state discrimination.

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Abstract
Nearly all research in **neurofeedback** since the 1960s has focused on training voluntary control over **EEG** constructs. By contrast, **EEG** state discrimination training focuses on awareness of subjective correlates of **EEG** states. This study presents the first successful replication of **EEG** alpha state discrimination first reported by Kamiya (1962). A 150-s baseline was recorded in 106 participants. During the task, low (<30th percentile of the baseline) and high alpha events (>70th percentile) triggered a prompt. Participants indicated "high" or "low" with a keypress response and received immediate feedback. Seventy-five

percent of participants achieved significant discrimination within nine sessions, with a significant learning curve effect. Performance was significantly related to physical properties of the **EEG** signal, including magnitude, duration, and absolute vs. relative amplitude. These results are consistent with a conceptualization of **EEG** state discrimination as a sensory modality, although it is also intricately related to voluntary control of these states.

PMID: 22800733 [PubMed - indexed for MEDLINE] PMCID: PMC3424312 [Available on 2013/9/1]
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3424312

Biomed Tech (Berl). 2012 Aug 30. pii: /j/bmte.2012.57.issue-s1-F/bmt-2012-4444/bmt-2012-4444.xml. doi: 10.1515/bmt-2012-4444. [Epub ahead of print]

157. *Patient Adaptive Neurofeedback for ADHD Therapy.

Schmidt T, Henrich D.

PMID: 22945072 [PubMed - as supplied by publisher]

Biomed Tech (Berl). 2012 Aug 30. pii: /j/bmte.2012.57.issue-s1-F/bmt-2012-4526/bmt-2012-4526.xml. doi: 10.1515/bmt-2012-4526. [Epub ahead of print]

158. Modulating attentional states by EEG-based neurofeedback.

Grosse-Wentrup M.

[For **BCI**]

PMID: 22944996 [PubMed - as supplied by publisher]

Appl Psychophysiol Biofeedback. 2012 Aug 30. [Epub ahead of print]

159. *Developing a Performance Brain Training™ Approach for Baseball: A Process Analysis with Descriptive Data.

Sherlin LH, Larson NC, Sherlin RM.

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Abstract
Neurofeedback may be useful for improving sports performance but few studies have examined this potential. Here we present data of five development players from a major league baseball team. The aims were to evaluate the feasibility of conducting sessions within a professional organization, assess changes in quantitative electroencephalograph (Q**EEG**), NeuroPerformance Profile™, and report qualitative self-report data before and after brain

training. The **EEG** was recorded with 19 electrodes for 20 min of baseline conditions and approximately 21 min of a continuous performance test. The fast Fourier transform analysis provided average cross-spectral matrices for bands delta (1-3.5 Hz), theta (4-7.5 Hz), alpha (8-12 Hz), low beta (13-16 Hz), beta 1 (13-21 Hz), beta 2 (22-32 Hz), and gamma (32-45 Hz) from the pre and post intervention evaluations in the baseline condition of eyes open. The continuous performance test metrics included the errors of omission, errors of commission, response time and response time variability. The 9 scales of the NeuroPerformance Profile™ were examined. The Q**EEG** data, CPT data and NeuroPerformance Profile™ data were all compared between the pre and post 15 sessions of brain training using a within subject paired t test design corrected for multiple comparisons using false discovery rate method. Following brain training, comparative Q**EEG**, CPT and NeuroPerformance Profile™ analyses illustrated significant differences. The Q**EEG** findings of all participants illustrated significant changes within the training parameters but also across other frequency bands and electrode sites. Overall, the positive findings in both objective and subjective measures suggest further inquiry into the utility of brain training for performance enhancement with the specific application of sport is warranted. Particularly Q**EEG** and CPT gains were noted in the areas that correspond to client self-report data demonstrating improvement in attention, decreased intrusive thought patterns and improvements in sleep patterns.

PMID: 22932915 [PubMed - as supplied by publisher]

Appl Psychophysiol Biofeedback. 2012 Aug 18. [Epub ahead of print]

160. *Is EEG-biofeedback an Effective Treatment in Autism Spectrum Disorders? A Randomized Controlled Trial.

Kouijzer ME, van Schie HT, Gerrits BJ, Buitelaar JK, de Moor JM.

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Abstract

EEG-biofeedback has been reported to reduce symptoms of autism spectrum disorders (ASD) in several studies. However, these studies did not control for nonspecific effects of **EEG-biofeedback** and did not distinguish between participants who succeeded in influencing their own **EEG** activity and participants who did not. To overcome these methodological shortcomings, this study evaluated the effects of **EEG-biofeedback** in ASD in a randomized pretest-posttest control group design with blinded active comparator and six months follow-up. Thirty-eight participants were randomly allocated to the **EEG-biofeedback**, skin conductance (SC)-**biofeedback** or waiting list group. **EEG**- and SC-**biofeedback** sessions were similar and participants were blinded to the type of feedback they received. Assessments pre-treatment, post-treatment, and after 6 months included parent ratings of symptoms of ASD, executive function tasks, and 19-channel **EEG** recordings. Fifty-four percent of the participants significantly reduced delta and/or theta power during **EEG-biofeedback** sessions and were identified as **EEG**-regulators. In these **EEG**-regulators, no statistically significant reductions of symptoms of ASD were observed, but they showed significant improvement in cognitive flexibility as compared to participants who managed to regulate SC. **EEG-biofeedback** seems to be an applicable tool to regulate **EEG** activity and has specific effects on cognitive flexibility, but it did not result in significant reductions in symptoms of ASD. An important finding was that no nonspecific effects of **EEG-biofeedback** were demonstrated.

PMID: 22903518 [PubMed - as supplied by publisher]

Magn Reson Imaging. 2012 Aug 16. [Epub ahead of print]

161. Spatially aggregated multiclass pattern classification in functional MRI using optimally selected functional brain areas.

Zheng W, Ackley ES, Martínez-Ramón M, Posse S.

Department of Neurology, School of Medicine, University of New Mexico, Albuquerque, NM, USA.

Abstract
In previous works, boosting aggregation of classifier outputs from discrete brain areas has been demonstrated to reduce dimensionality and improve the robustness and accuracy of functional magnetic resonance imaging (**fMRI**) classification. However, dimensionality reduction and classification of mixed activation patterns of multiple classes remain challenging. In the present study, the goals were (a) to reduce dimensionality by combining feature reduction at the voxel level and backward elimination of optimally aggregated classifiers at the region level, (b) to compare region selection for spatially aggregated classification using boosting and partial least squares regression methods and (c) to resolve mixed activation patterns using probabilistic prediction of individual tasks. Brain activation maps from interleaved visual, motor, auditory and cognitive tasks were segmented into 144 functional regions. Feature selection reduced the number of feature voxels by more than 50%, leaving 95 regions. The two aggregation approaches further reduced the number of regions to 30, resulting in more than 75% reduction of classification time and misclassification rates of less than 3%. Boosting and partial least squares (PLS) were compared to select the most discriminative and the most task correlated regions, respectively. Successful task prediction in mixed activation patterns was feasible within the first block of task activation in real-time **fMRI** experiments. This methodology is suitable for sparsifying activation patterns in real-time **fMRI** and for **neurofeedback** from distributed networks of brain activation.

PMID: 22902471 [PubMed - as supplied by publisher] PMCID: PMC3505582 [Available on 2014/2/16]
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3505582

Neurosci Bull. 2012 Aug;28(4):456-67. doi: 10.1007/s12264-012-1254-2.

162. Low-frequency fluctuation in continuous real-time feedback of finger force: a new paradigm for sustained attention.

Dong ZY, Liu DQ, Wang J, Qing Z, Zang ZX, Yan CG, Zang YF.

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Abstract
OBJECTIVE: Behavioral studies have suggested a low-frequency (0.05 Hz) fluctuation of sustained attention on the basis of the intra-individual variability of reaction-time. Conventional task designs for functional magnetic resonance imaging (**fMRI**) studies are not appropriate for frequency analysis. The present study aimed to propose a new paradigm, real-time finger force feedback (RT-FFF), to study the brain mechanisms of sustained attention and **neurofeedback**.

METHODS: We compared the low-frequency fluctuations in both behavioral and **fMRI** data from 38 healthy adults (19 males; mean age, 22.3 years). Two **fMRI** sessions, in RT-FFF and sham finger force feedback (S-FFF) states, were acquired (TR 2 s, Siemens Trio 3-Tesla scanner, 8 min each, counter-balanced). Behavioral data of finger force were obtained simultaneously at a sampling rate of 250 Hz.

RESULTS: Frequency analysis of the behavioral data showed lower amplitude in the low-frequency band (0.004-0.104 Hz) but higher amplitude in the high-frequency band (27.02-125 Hz) in the RT-FFF than the S-FFF states. The mean finger force was not significantly different between the two states. **fMRI** data analysis showed higher fractional amplitude of low-frequency fluctuation (fALFF) in the S-FFF than in the RT-FFF state in the visual cortex, but higher fALFF in RT-FFF than S-FFF in the middle frontal gyrus, the superior frontal gyrus, and the default mode network.

CONCLUSION: The behavioral results suggest that the proposed paradigm may provide a new approach to studies of sustained attention. The **fMRI** results suggest that a distributed network including visual, motor, attentional, and default mode networks may be involved in sustained attention and/or real-time feedback. This paradigm may be helpful for future studies on deficits of attention, such as attention deficit hyperactivity disorder and mild traumatic brain injury.

PMID: 22833043 [PubMed - indexed for MEDLINE]

J Neurosci Methods. 2012 Aug 15;209(2):290-8. doi: 10.1016/j.jneumeth.2012.06.025. Epub 2012 Jul 1.

163. Building virtual reality fMRI paradigms: a framework for presenting immersive virtual environments.

Mueller C, Luehrs M, Baecke S, Adolf D, Luetzkendorf R, Luchtmann M, Bernarding J.

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Abstract
The advantage of using a virtual reality (VR) paradigm in **fMRI** is the possibility to interact with highly realistic environments. This extends the functions of standard **fMRI** paradigms, where the volunteer usually has a passive role, for example, watching a simple movie paradigm without any stimulus interactions. From that point of view the combined usage of

VR and real-time **fMRI** offers great potential to identify underlying cognitive mechanisms such as spatial navigation, attention, semantic and episodic memory, as well as **neurofeedback** paradigms. However, the design and the implementation of a VR stimulus paradigm as well as the integration into an existing MR scanner framework are very complex processes. To support the modeling and usage of VR stimuli we developed and implemented a VR stimulus application based on C++. This software allows the fast and easy presentation of VR environments for **fMRI** studies without any additional expert knowledge. Furthermore, it provides for the reception of real-time data analysis values a bidirectional communication interface. In addition, the internal plugin interface enables users to extend the functionality of the software with custom programmed C++ plugins. The VR stimulus framework was tested in several performance tests and a spatial navigation study. According to the post-experimental interview, all subjects described immersive experiences and a high attentional load inside the artifical environment. Results from other VR spatial memory studies confirm the neuronal activation that was detected in parahippocampal areas, cuneus, and occipital regions.

PMID: 22759716 [PubMed - in process]

BMC Psychiatry. 2012 Aug 10;12:107. doi: 10.1186/1471-244X-12-107.

164. *Neurofeedback for the treatment of children and adolescents with ADHD: a randomized and controlled clinical trial using parental reports.

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Abstract

BACKGROUND: A randomized and controlled clinical study was performed to evaluate the use of **neurofeedback** (**NF**) to treat attention-deficit/hyperactivity disorder (ADHD) in children and adolescents.

METHODS: The ADHD population was selected from an outpatient clinic for Child and Adolescent Mental Health in Norway. Ninety-one of the 275 children and adolescents ranging in age from 6 to 18 years (10.5 years) participated in 30 sessions of an intensive **NF** program. The reinforcement contingency was based on the subjects' production of cortical beta1 activity (15-18 Hz). The ADHD participants were randomized into three groups, with 30 in the **NF** group, 31 controls in a group that was given methylphenidate, and 30 in a group that received **NF** and methylphenidate. ADHD core symptoms were reported by parents using the parent form of the Clinician's Manual for Assessment by Russell A. Barkley.

RESULTS: Ninety-one children and adolescents were effectively randomized by age, sex, intelligence and distribution of ADHD core symptoms. The parents reported significant effects of the treatments, but no significant differences between the treatment groups were observed.

CONCLUSIONS: **NF** was as effective as methylphenidate at treating the attentional and hyperactivity symptoms of ADHD, based on parental reports.

TRIAL REGISTRATION: Current Controlled Trials NCT01252446.

PMID: 22877086 [PubMed - indexed for MEDLINE] PMCID: PMC3441233
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3441233

Exp Brain Res. 2012 Aug;221(1):69-74. doi: 10.1007/s00221-012-3148-y. Epub 2012 Jun 23.

165. *The efficacy of EEG neurofeedback aimed at enhancing sensory-motor rhythm theta ratio in healthy subjects.

de Zambotti M, Bianchin M, Magazzini L, Gnesato G, Angrilli A.

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Abstract
Scientific evidence supporting the reliability of **neurofeedback** (**NF**) in modifying the electroencephalographic (**EEG**) pattern is still limited. Several studies in **NF** research and clinical setting have been focused to increase sensory-motor rhythm (**SMR**) and simultaneously decrease theta activity with the aim of increasing attention performance and reducing hyperactive and impulsive behaviors. The goal of the present study was to assess the efficacy of **NF** training to enhance the **SMR**/theta ratio across sixteen sessions of training in eight healthy volunteers. Results suggested an increase of **SMR**/theta across weeks of training. Theta activity was strongly and steadily inhibited since the first session of training with slight decreases in the following weeks; instead, **SMR** was strongly inhibited at the beginning and progressively increased across sessions. These results suggest that individuals are able to inhibit theta activity easily while they fail to increase **SMR** in the first sessions. On the other hand, a separate analysis performed on the baseline preceding **NF** revealed a decreasing trend of **SMR**/theta ratio across the 8 weeks of training. Results point to the importance of providing **EEG** data in addition to behavioral modification, during **NF** training, to avoid possible misinterpretation of results.

PMID: 22729458 [PubMed - indexed for MEDLINE]

Gait Posture. 2012 Jul 27. [Epub ahead of print]

166. *Vibrotactile neurofeedback balance training in patients with Parkinson's disease: Reducing the number of falls.

Rossi-Izquierdo M, Ernst A, Soto-Varela A, Santos-Pérez S, Faraldo-García A, Sesar-Ignacio A, Basta D.

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Abstract

The aim of this study was to assess effectiveness of balance training with a vibrotactile **neurofeedback** system in improving overall stability in patients with Parkinson's disease (PD). Ten patients diagnosed with idiopathic PD were included. Individualization of the rehabilitation program started with a body sway analysis of stance and gait tasks (Standard Balance Deficit Test, SBDT) by using the diagnostic tool of the applied device (Vertiguard(®)-RT). Those tasks with the poorest outcome as related to age- and gender-related controls were included in the training program (not more than six tasks). Improvement of postural stability was assessed by performing SBDT, Sensory Organization Test (SOT) of Computerized Dynamic Posturography (CDP), Dizziness Handicap Inventory (DHI), activity-specific balance confidence scale and recording the number of falls over the past three months. Furthermore, scores of SOT and DHI of 10 PD patients previously trained in an earlier study (by using CDP) were compared with results of those in the present study. After **neurofeedback** training (**NF**T), there was a statistically significant improvement in body sway (calculated over all training tasks), number of falls, and scores of SOT, DHI and ABC. In comparison with CDP-training, a statistically significant higher increase of SOT score was observed for patients after **NF**T with the Vertiguard-RT device compared to CDP training. Our results showed that a free-field vibrotactile **NF**T with Vertiguard(®)-RT device can improve balance in PD patients in everyday life conditions very effectively, which might led in turn to a reduction of falls.

PMID: 22841586 [PubMed - as supplied by publisher]

PLoS One. 2012;7(6):e38115. doi: 10.1371/journal.pone.0038115. Epub 2012 Jun 4.

167. *Real-time self-regulation of emotion networks in patients with depression.

Linden DE, Habes I, Johnston SJ, Linden S, Tatineni R, Subramanian L, Sorger B, Healy D, Goebel R.

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Abstract

Many patients show no or incomplete responses to current pharmacological or psychological therapies for depression. Here we explored the feasibility of a new brain self-regulation technique that integrates psychological and neurobiological approaches through **neurofeedback** with functional magnetic resonance imaging (**fMRI**). In a proof-of-concept study, eight patients with depression learned to upregulate brain areas involved in the generation of positive emotions (such as the ventrolateral prefrontal cortex (VLPFC) and insula) during four **neurofeedback** sessions. Their clinical symptoms, as assessed with the 17-item Hamilton Rating Scale for Depression (HDRS), improved significantly. A control group that underwent a training procedure with the same cognitive strategies but without **neurofeedback** did not improve clinically. Randomised blinded clinical trials are now needed to exclude possible placebo effects and to determine whether **fMRI**-based **neurofeedback** might become a useful adjunct to current therapies for depression.

PMID: 22675513 [PubMed - indexed for MEDLINE] PMCID: PMC3366978

See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3366978

Neurotherapeutics. 2012 Jul;9(3):588-98. doi: 10.1007/s13311-012-0136-7.

168. *Evidence-based information on the clinical use of neurofeedback for ADHD.

Moriyama TS, Polanczyk G, Caye A, Banaschewski T, Brandeis D, Rohde LA.

National Institute of Developmental Psychiatry for Children and Adolescents-INCT-CNPq, São Paulo, Brazil. taismoriyama@gmail.com

Abstract
Neurofeedback (**NF**) is a training to enhance self-regulatory capacity over brain activity patterns and consequently over brain mental states. Recent findings suggest that **NF** is a promising alternative for the treatment of attention-deficit/hyperactivity disorder (ADHD). We comprehensively reviewed literature searching for studies on the effectiveness and specificity of **NF** for the treatment of ADHD. In addition, clinically informative evidence-based data are discussed. We found 3 systematic review on the use of **NF** for ADHD and 6 randomized controlled trials that have not been included in these reviews. Most nonrandomized controlled trials found positive results with medium-to-large effect sizes, but the evidence for effectiveness are less robust when only randomized controlled studies are considered. The direct comparison of **NF** and sham-**NF** in 3 published studies have found no group differences, nevertheless methodological caveats, such as the quality of the training protocol used, sample size, and sample selection may have contributed to the negative results. Further data on specificity comes from electrophysiological studies reporting that **NF** effectively changes brain activity patterns. No safety issues have emerged from clinical trials and **NF** seems to be well tolerated and accepted. Follow-up studies support long-term effects of **NF**. Currently there is no available data to guide clinicians on the predictors of response to **NF** and on optimal treatment protocol. In conclusion, **NF** is a valid option for the treatment for ADHD, but further evidence is required to guide its use.

PMID: 22930416 [PubMed - in process] PMCID: PMC3441929 [Available on 2013/7/1]
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3441929

Neurotherapeutics. 2012 Jul;9(3):569-87. doi: 10.1007/s13311-012-0131-z.

169. *Clinical utility of EEG in attention-deficit/hyperactivity disorder: a research update.

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Abstract
Psychiatric research applications of electroencephalography (**EEG**), the earliest approach to imaging human cortical brain activity, are attracting increasing scientific and clinical interest.

For more than 40 years, **EEG** research has attempted to characterize and quantify the neurophysiology of attention-deficit/hyperactivity disorder (ADHD), most consistently associating it with increased frontocentral theta band activity and increased theta to beta (θ/β) power ratio during rest compared to non-ADHD controls. Recent reports suggest that while these **EEG** measures demonstrate strong discriminant validity for ADHD, significant **EEG** heterogeneity also exists across ADHD-diagnosed individuals. In particular, additional studies validating the use of the θ/β power ratio measure appear to be needed before it can be used for clinical diagnosis. In recent years, the number and the scientific quality of research reports on **EEG**-based **neurofeedback** (**NF**) for ADHD have grown considerably, although the studies reviewed here do not yet support **NF** training as a first-line, stand-alone treatment modality. In particular, more research is needed comparing **NF** to placebo control and other effective treatments for ADHD. Currently, after a long period of relative stasis, the neurophysiological specificity of measures used in **EEG** research is rapidly increasing. It is likely, therefore, that new **EEG** studies of ADHD using higher density recordings and new measures drawn from viewing **EEG** as a 3-dimensional functional imaging modality, as well as intensive re-analyses of existing **EEG** study data, can better characterize the neurophysiological differences between and within ADHD and non-ADHD subjects, and lead to more precise diagnostic measures and effective **NF** approaches.

PMID: 22814935 [PubMed - in process] PMCID: PMC3441927 [Available on 2013/7/1]
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3441927

Neuromodulation. 2012 Jul;15(4):350-60. doi: 10.1111/j.1525-1403.2012.00447.x. Epub 2012 Apr 11.

170. *Noninvasive and invasive neuromodulation for the treatment of tinnitus: an overview.

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Abstract
OBJECTIVE: Nonpulsatile tinnitus is an auditory phantom percept characterized as a tone, or a noise-like sound such as a hissing or buzzing sound or polyphonic, in the absence of any objective physical sound source. Although advances have been made in symptomatic pharmacologic and nonpharmacologic treatments, these treatments are unable to eliminate the tinnitus sensation in most patients. A novel approach using noninvasive and invasive neuromodulation has emerged as an interesting and promising modality for tinnitus relief.

METHODOLOGY: We review noninvasive neuromodulation techniques including transcranial magnetic stimulation, transcranial direct current stimulation, transcutaneous electrical nerve stimulation, and cortical **neurofeedback**, as well as invasive neuromodulation techniques including auditory cortex stimulation, dorsolateral prefrontal cortex stimulation, subcutaneous occipital nerve stimulation, and deep brain stimulation, as potential treatments of tinnitus.

CONCLUSION: Although the different techniques introduced revealed promising results, further research is needed to better understand how these techniques work and how the brain

responds to neuromodulation. More sophisticated stimulation regimens and parameters should be developed to dynamically stimulate various regions at different frequencies and intensities, physiologically tailored to the patient's brain state in an attempt to maximize efficacy.

PMID: 22494273 [PubMed - indexed for MEDLINE]

PLoS One. 2012;7(3):e32234. doi: 10.1371/journal.pone.0032234. Epub 2012 Mar 2.

171. *Neurofeedback using real-time near-infrared spectroscopy enhances motor imagery related cortical activation.

Mihara M, Miyai I, Hattori N, Hatakenaka M, Yagura H, Kawano T, Okibayashi M, Danjo N, Ishikawa A, Inoue Y, Kubota K.

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Abstract
Accumulating evidence indicates that motor imagery and motor execution share common neural networks. Accordingly, mental practices in the form of motor imagery have been implemented in rehabilitation regimes of stroke patients with favorable results. Because direct monitoring of motor imagery is difficult, feedback of cortical activities related to motor imagery (**neurofeedback**) could help to enhance efficacy of mental practice with motor imagery. To determine the feasibility and efficacy of a real-time **neurofeedback** system mediated by near-infrared spectroscopy (**NIRS**), two separate experiments were performed. Experiment 1 was used in five subjects to evaluate whether real-time cortical oxygenated hemoglobin signal feedback during a motor execution task correlated with reference hemoglobin signals computed off-line. Results demonstrated that the **NIRS**-mediated **neurofeedback** system reliably detected oxygenated hemoglobin signal changes in real-time. In Experiment 2, 21 subjects performed motor imagery of finger movements with feedback from relevant cortical signals and irrelevant sham signals. Real **neurofeedback** induced significantly greater activation of the contralateral premotor cortex and greater self-assessment scores for kinesthetic motor imagery compared with sham feedback. These findings suggested the feasibility and potential effectiveness of a **NIRS**-mediated real-time **neurofeedback** system on performance of kinesthetic motor imagery. However, these results warrant further clinical trials to determine whether this system could enhance the effects of mental practice in stroke patients.

PMID: 22396753 [PubMed - indexed for MEDLINE] PMCID: PMC3292558
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3292558

Schizophr Bull. 2012 Jun;38(4):678-82. doi: 10.1093/schbul/sbs006. Epub 2012 Feb 9.

172. *Taking back the brain: could neurofeedback training be effective for relieving distressing auditory verbal hallucinations in patients with schizophrenia?

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Abstract
Progress in identifying the neural correlates of auditory verbal hallucinations (AVHs) experienced by patients with schizophrenia has not fulfilled its promise to lead to new methods of treatments. Given the existence of a large number of such patients who have AVHs that are refractory to traditional treatments, there is the urgent need for the development of new effective interventions. This article proposes that the technique of **neurofeedback** may be an appropriate method to allow the translation of pure research findings from AVH-research into a clinical intervention. **Neurofeedback** is a method through which individuals can self-regulate their neural activity in specific neural regions/frequencies, following operant conditioning of their intentional manipulation of visually presented real-time feedback of their neural activity. Four empirically testable hypotheses are proposed as to how **neurofeedback** may be employed to therapeutic effect in patients with AVHs.

PMID: 22323675 [PubMed - indexed for MEDLINE] PMCID: PMC3406539 [Available on 2013/6/18]
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3406539

J Neuropsychiatry Clin Neurosci. 2012 Spring;24(2):237-40. doi: 10.1176/appi.neuropsych.11020041.

173. *Neurotherapy of traumatic brain injury/posttraumatic stress symptoms in OEF/OIF veterans.

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Abstract
The Flexyx **Neurotherapy** System (FNS), a novel variant of **EEG biofeedback**, was adapted for intervention with seven treatment-refractory Afghanistan/Iraq war veterans, and brought about significant decreases in bothersome neurobehavioral and posttraumatic stress symptoms. FNS may help ameliorate mixed trauma spectrum syndromes.

PMID: 22772672 [PubMed - indexed for MEDLINE]

J Atten Disord. 2012 May 29. [Epub ahead of print]

174. *Nonpharmacological Treatments for ADHD: A Meta-Analytic Review.

Hodgson K, Hutchinson AD, Denson L.

Abstract
Objective: The authors replicated and expanded on Fabiano et al.'s meta-analysis of behavioral treatments for ADHD, systematically comparing the efficacy of 7 nonpharmacological interventions. Method: A total of 14 controlled treatment studies conducted post-1994-evaluating behavior modification, **neurofeedback** therapy, multimodal psychosocial treatment, school-based programs, working memory training, parent training, and self-monitoring-were identified, primarily by searching electronic English-language databases. The results were meta-analyzed: mean-weighted effect sizes for the treatment outcomes of 625 participants (382 treatment, 243 controls) were calculated, and moderator analyses examined contributions of gender, ADHD subtype, and treatment "dosage" to outcome. Results: Behavior modification and **neurofeedback** treatments were most supported by this evidence. Interventions were generally more efficacious for girls, and least efficacious for the "combined" ADHD subtype. The authors found no dose or age effects. Conclusion: Based on the small, published literature, this study supports some nonpharmacological interventions for ADHD, and indicates directions for more evaluation research into psychological treatments. (J. of Att. Dis. 2012; XX(X) 1-XX).

PMID: 22647288 [PubMed - as supplied by publisher]

Atten Disord. 2012 May 22. [Epub ahead of print]

175. *EEG Neurofeedback for ADHD: Double-Blind Sham-Controlled Randomized Pilot Feasibility Trial.

Arnold LE, Lofthouse N, Hersch S, Pan X, Hurt E, Bates B, Kassouf K, Moone S, Grantier C.

Abstract
Objective: Preparing for a definitive randomized clinical trial (RCT) of **neurofeedback** (**NF**) for ADHD, this pilot trial explored feasibility of a double-blind, sham-controlled design and adherence/palatability/relative effect of two versus three treatments/week. Method: Unmedicated 6- to 12-year-olds with Diagnostic and Statistical Manual of Mental Disorders (4th ed.; DSM-IV) ADHD were randomized to active **NF** versus sham-**NF** and to 2X versus 3X/week treatment frequency. Frequency switch was allowed after Treatment 24. Results: In two school years, 39 participants were recruited and 34 (87%) completed all 40 treatments. Child/parent guesses about assigned treatment were no better than chance. At Treatment 24, 38% chose 2X/week and 62% chose 3X/week. Both active **NF** and sham yielded large pre-post improvement on parent ratings but **NF** no more than sham. Conclusion: Blinding appears to work, and sham does not prevent recruitment/retention. Treatment frequency of 3X/week seems preferred over 2X/week and was as effective. A large double-blind RCT is feasible and necessary to test specific **NF** effectiveness. (J. of Att. Dis. 2012; XX(X) 1-XX).

PMID: 22617866 [PubMed - as supplied by publisher]

J Orthop Sci. 2012 May;17(3):331-5. doi: 10.1007/s00776-012-0209-9. Epub 2012 Apr 11.

176. *Neural mechanisms underlying deafferentation pain: a hypothesis from a neuroimaging perspective.

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Abstract
Deafferentation pain following nerve injury annoys patients, and its management is a challenge in clinical practice. Although the mechanisms underlying deafferentation pain remain poorly understood, progress in the development of multidimensional neuroimaging techniques is casting some light on these issues. Deafferentation pain likely results from reorganization of the nervous system after nerve injury via processes that interact with the substrates for pain perception (the pain matrix). Therapeutic effects of motor cortex stimulation on deafferentation pain suggest that the core mechanisms underlying deafferentation pain also interact with the motor system. Therefore, simultaneous neuroimaging and brain stimulation, an emerging neuroimaging technique, was developed to investigate complicated interactions among motor, somatosensory, and pain systems. In healthy participants, parts of the pain matrix (the anterior cingulate cortex, parietal operculum, and thalamus) show activity during both somatosensory stimulation and brain stimulation to the motor cortex. This finding indicates that motor, somatosensory, and pain systems communicate among each other via the neural network. A better understanding of the plastic mechanisms influencing such cross-talk among these systems will help develop therapeutic interventions using brain stimulation and **neurofeedback**.

PMID: 22491886 [PubMed - indexed for MEDLINE] PMCID: PMC3359448
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3359448

Arch Phys Med Rehabil. 2012 May;93(5):882-8. doi: 10.1016/j.apmr.2011.10.028. Epub 2012 Mar 9.

177. *Feasibility and test-retest reliability of an electroencephalography-based brain mapping system in children with cerebral palsy: a preliminary investigation.

Lee NG, Kang SK, Lee DR, Hwang HJ, Jung JH, You JS, Im CH, Kim DA, Lee JA, Kim KS.

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Abstract
OBJECTIVE: To investigate the feasibility and test-retest reliability of a novel electroencephalography (**EEG**)-based brain mapping system in healthy children and children with cerebral palsy (CP).

DESIGN: Correlation statistics.

SETTING: University brain mapping and neurorehabilitation laboratory.

PARTICIPANTS: A convenience sample of children (N=12; 5 healthy children, mean ± SD, 12.6±0.89y; 7 children with CP, mean ± SD, 9.71±1.1y) participated in the study.

INTERVENTIONS: Not applicable.

MAIN OUTCOME MEASURES: Mu band (8-12Hz) power values in event-related spectral perturbation maps during reach and grasp hand movements were repeatedly measured on 2 separate occasions (2h apart). Intraclass correlation coefficient (ICC(1,2)) tests were computed to determine test-retest reliability at the standard level of significance (P<.004). In addition, the feasibility of the system was determined by evaluating potential differences in the cortical activation areas obtained from topographical maps during actual reach and grasp motor tasks between healthy children and children with CP.

RESULTS: The test-retest reliability results showed excellent reliability between the repeated measures, ranging from .93 (P=.000) to .99 (P=.000). Our **EEG** brain mapping system was capable of distinguishing differences in the cortical activity power (mu band power spectra) between healthy children and children with CP.

CONCLUSIONS: To our knowledge, this study is the first evidence demonstrating the feasibility and reliability of the **EEG** brain mapping system. Clinically, this system provides important insights into neuroplasticity associated with motor recovery after treatment and can also be used as real-time **neurofeedback** or noninvasive neuromodulation in the course of neurologic rehabilitation.

PMID: 22405955 [PubMed - indexed for MEDLINE]

Neuroimage. 2012 May 15;61(1):21-31. doi: 10.1016/j.neuroimage.2012.02.053. Epub 2012 Mar 3.

178. *Investigation of fMRI neurofeedback of differential primary motor cortex activity using kinesthetic motor imagery.

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Abstract

Functional **MRI neurofeedback** (**fMRI NF**) is an emerging technique that trains subjects to regulate their brain activity while they manipulate sensory stimulus representations of **fMRI** signals in "real-time". Here we report an **fMRI NF** study of brain activity associated with kinesthetic motor imagery (kMI), analyzed using partial least squares (PLS), a multivariate analysis technique. Thirteen healthy young adult subjects performed kMI involving each hand

separately, with **NF** training targeting regions of interest (ROIs) in the left and right primary motor cortex (M1). Throughout, subjects attempted to maximize a laterality index (LI) of brain activity-the difference in activity between the contralateral ROI (relative to the hand involved in kMI) and the ipsilateral M1 ROI-while receiving real-time updates on a visual display. Six of 13 subjects were successful in increasing the LI value, whereas the other 7 were not successful and performed similarly to 5 control subjects who received sham **NF** training. Ability to suppress activity in the ipsilateral M1 ROI was the primary driver of successful **NF** performance. Multiple PLS analyses depicted activated networks of brain regions involved with imagery, self-awareness, and feedback processing, and additionally showed that activation of the task positive network was correlated with task performance. These results indicate that **fMRI NF** of kMI is capable of modulating brain activity in primary motor regions in a subset of the population. In the future, such methods may be useful in the development of **NF** training methods for enhancing motor rehabilitation following stroke.

PMID: 22401758 [PubMed - indexed for MEDLINE]

Neurosci Lett. 2012 May 10;516(1):156-60. doi: 10.1016/j.neulet.2012.03.087. Epub 2012 Apr 5.

179. *Which attention-deficit/hyperactivity disorder children will be improved through neurofeedback therapy? A graph theoretical approach to neocortex neuronal network of ADHD.

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Abstract

Neurofeedback training is increasingly used for ADHD treatment. However some ADHD patients are not treated through the long-time **neurofeedback** trainings with common protocols. In this paper a new graph theoretical approach is presented for **EEG**-based prediction of ADHD patients' responses to a common **neurofeedback** training: rewarding **SMR** activity (12-15 Hz) with inhibiting theta activity (4-8 Hz) and beta2 activity (18-25 Hz). Eyes closed **EEG**s of two groups before and after **neurofeedback** training were studied: ADHD patients with (15 children) and without (15 children) positive response to **neurofeedback** training. Employing a recent method to measure synchronization, fuzzy synchronization likelihood, functional connectivity graphs of the patients' brains were constructed in the full-band **EEG**s and 6 common **EEG** sub-bands produced by wavelet decomposition. Then, efficiencies of the brain networks in synchronizability and high speed information transmission were computed based on mean path length of the graphs, before and after **neurofeedback** training. The results were analyzed by ANOVA and showed synchronizability of the neocortex activity network at beta band in ADHDs with positive response is obviously less than that of ADHDs resistant to **neurofeedback** therapy, before treatment. The accuracy of linear discriminant analysis (LDA) in distinguishing these patients based on this feature is so high (84.2%) that this feature can be considered as reliable characteristics for prediction of responses of ADHDs to the **neurofeedback** trainings. Also

difference between flexibility of the neocortex in beta band before and after treatment is obviously larger in the ADHDs with positive response in comparison to those with negative response which may be a neurophysiologic reason for dissatisfaction of the last group to the **neurofeedback** therapy.

PMID: 22503723 [PubMed - indexed for MEDLINE]

Expert Rev Neurother. 2012 Apr;12(4):447-60. doi: 10.1586/ern.12.22.

180. *Neurofeedback in children with ADHD: validation and challenges.

Gevensleben H, Rothenberger A, Moll GH, Heinrich H.

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Abstract
Neurofeedback (**NF**), a type of neurobehavioral training, has gained increasing attention in recent years, especially concerning the treatment of children with ADHD. Promising results have emerged from recent randomized controlled studies, and thus, **NF** is on its way to becoming a valuable addition to the multimodal treatment of ADHD. In this review, we summarize the randomized controlled trials in children with ADHD that have been published within the last 5 years and discuss issues such as the efficacy and specificity of effects, treatment fidelity and problems inherent in placebo-controlled trials of **NF**. Directions for future **NF** research are outlined, which should further address specificity and help to determine moderators and mediators to optimize and individualize **NF** training. Furthermore, we describe methodological (tomographic **NF**) and technical ('tele-**NF**') developments that may also contribute to further improvements in treatment outcome.

PMID: 22449216 [PubMed - indexed for MEDLINE]

Clin EEG Neurosci. 2012 Apr;43(2):133-44. doi: 10.1177/1550059411429531. Epub 2012 Mar 27.

181. *Schizophrenia and the efficacy of qEEG-guided neurofeedback treatment: a clinical case series.

Surmeli T, Ertem A, Eralp E, Kos IH.

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Abstract
Schizophrenia is sometimes considered one of the most devastating of mental illnesses because its onset is early in a patient's life and its symptoms can be destructive to the patient, the family, and friends. Schizophrenia affects 1 in 100 people at some point during their lives, and while there is no cure, it is treatable with antipsychotic medications. According to the

Clinical Antipsychotic Trials for Interventions Effectiveness (CATIE), about 74% of the patients who have discontinued the first medication prescribed within a year will have a relapse afterward. This shows an enormous need for developing better treatment methods and better ways to manage the disease, since current therapies do not have sufficient impact on negative symptoms, cognitive dysfunction, and compliance to treatment. In this clinical case series, we investigate the efficacy of quantitative electroencephalography (q**EEG**)-guided **neurofeedback** (**NF**) treatment in this population, and whether this method has an effect on concurrent medical treatment and on the patients. Fifty-one participants (25 males and 26 females) ranging from 17 to 54 years of age (mean: 28.82 years and SD: 7.94 years) were included. Signed consent was received from all patients. Most of the participants were previously diagnosed with chronic schizophrenia, and their symptoms did not improve with medication. All 51 patients were evaluated using q**EEG**, which was recorded at baseline and following treatment. Before recording the q**EEG**, participants were washed out for up to 7 half-lives of the medication. After Food and Drug Administration (FDA)-approved Nx-Link Neurometric analysis, q**EEG**s suggested a diagnosis of chronic schizophrenia for all participants. This was consistent with the clinical judgment of the authors. The participants' symptoms were assessed by means of the Positive and Negative Syndrome Scale (PANSS). Besides the PANSS, 33 out of 51 participants were also evaluated by the Minnesota Multiphasic Personality Inventory (MMPI) and the Test of Variables of Attention (TOVA), both at baseline and following treatment. Each participant was prescribed an **NF** treatment protocol based on the results of their q**EEG** neurometric analysis. Each session was 60 minutes in duration, with 1 to 2 sessions per day. When 2 sessions were administered during a single day, a 30-minute rest was given between the sessions. Changes in the PANSS, MMPI, and TOVA were analyzed to evaluate the effectiveness of **NF** treatment. The mean number of sessions completed by the participants was 58.5 sessions within 24 to 91 days. Three dropped out of treatment between 30 and 40 sessions of **NF**, and one did not show any response. Of the remaining 48 participants 47 showed clinical improvement after **NF** treatment, based on changes in their PANSS scores. The participants who were able to take the MMPI and the TOVA showed significant improvements in these measures as well. Forty were followed up for more than 22 months, 2 for 1 year, 1 for 9 months, and 3 for between 1 and 3 months after completion of **NF**. Overall **NF** was shown to be effective. This study provides the first evidence for positive effects of **NF** in schizophrenia.

PMID: 22715481 [PubMed - indexed for MEDLINE]

Neurophysiol Clin. 2012 Apr;42(3):79-94. doi: 10.1016/j.neucli.2011.12.002. Epub 2012 Jan 14.

182. *[Towards a new approach of neurophysiology in clinical psychiatry: functional magnetic resonance imaging neurofeedback applied to emotional dysfunctions].

[Article in French]

Micoulaud-Franchi JA, Fakra E, Cermolacce M, Vion-Dury J.

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Abstract
Emotions color in a singular way our everyday life and constitute important determinants of human cognition and behavior. Emotional regulation is an essential process involved in neuropathophysiology and therapeutic efficacy in many psychiatric disorders. Yet, traditional psychiatric therapeutic has focused on symptomatic rather than neurophysiological criteria. Therefore, it was proposed to teach patients to modify their own brain activity directly, in order to obtain a therapeutic effect. These techniques, which are named **neurofeedback**, were originally developed using electroencephalography. Recent technical advances in **fMRI** enable real-time acquisition, and open opportunities to its utilization in **neurofeedback**. This seems particularly interesting in emotion regulation, which, at a neurofunctional level, lies on cortico-limbic pathways that, in great parts, were previously identified by traditional **fMRI** paradigms. This emotion regulation plays a central role in the etiopathogeny psychiatric, especially depressive and anxious, disorders. It is possible to devise new therapeutic strategies and research approach for addressing directly the neurophysiological processes of emotion regulation by integrating the neurofunctional activities of a subject. These prospects seem to be in line with the neurophenomenology project, which proposes to establish a link between subjective experiences and objective neurophysiological measures.

PMID: 22500698 [PubMed - indexed for MEDLINE]

Addict Biol. 2012 Mar 28. doi: 10.1111/j.1369-1600.2012.00449.x. [Epub ahead of print]

183. *Volitional reduction of anterior cingulate cortex activity produces decreased cue craving in smoking cessation: a preliminary real-time fMRI study.

Li X, Hartwell KJ, Borckardt J, Prisciandaro JJ, Saladin ME, Morgan PS, Johnson KA, Lematty T, Brady KT, George MS.

Department of Psychiatry, Medical University of South Carolina, Charleston, SC, USA Department of Psychiatry, Ralph H. Johnson VA Medical Center, Charleston, SC, USA Department of Academic Radiology, University of Nottingham, Nottingham, UK Department of Anesthesiology, Systems Neuroscience and Pain Laboratory, Standford University, Palo Alto, CA, USA.

Abstract
Numerous research groups are now using analysis of blood oxygen level-dependent (BOLD) functional magnetic resonance imaging (**fMRI**) results and relaying back information about regional activity in their brains to participants in the scanner in 'real time'. In this study, we explored the feasibility of self-regulation of frontal cortical activation using real-time **fMRI** (rt**fMRI**) **neurofeedback** in nicotine-dependent cigarette smokers during exposure to smoking cues. Ten cigarette smokers were shown smoking-related visual cues in a 3 Tesla **MRI** scanner to induce their nicotine craving. Participants were instructed to modify their craving using rt**fMRI** feedback with two different approaches. In a 'reduce craving' paradigm, participants were instructed to 'reduce' their craving, and decrease the anterior cingulate cortex (ACC) activity. In a separate 'increase resistance' paradigm, participants were asked to increase their resistance to craving and to increase middle prefrontal cortex (mPFC) activity. We found that participants were able to significantly reduce the BOLD signal in the ACC

during the 'reduce craving' task (P = 0.028). There was a significant correlation between decreased ACC activation and reduced craving ratings during the 'reduce craving' session (P = 0.011). In contrast, there was no modulation of the BOLD signal in mPFC during the 'increase resistance' session. These preliminary results suggest that some smokers may be able to use **neurofeedback** via rt**fMRI** to voluntarily regulate ACC activation and temporarily reduce smoking cue-induced craving. Further research is needed to determine the optimal parameters of **neurofeedback** rt**fMRI**, and whether it might eventually become a therapeutic tool for nicotine dependence.

PMID: 22458676 [PubMed - indexed for MEDLINE] PMCID: PMC3389595 [Available on 2014/7/1]

IEEE Trans Neural Syst Rehabil Eng. 2012 Jan 23. [Epub ahead of print]

184. Semi-Blind Independent Component Analysis of fMRI Based on Real-Time fMRI System.

Ma X, Zhang H, Zhao X, Yao L, Long Z.

Abstract
Real-time functional magnetic resonance imaging (**fMRI**) is a type of **neurofeedback** tool that enables researchers to train individuals to actively gain control over their brain activation. Independent component analysis (ICA) based on data-driven model is seldom used in real-time **fMRI** studies due to large time cost, though it has been very popular to offline analysis of **fMRI** data. The feasibility of performing real-time ICA (rtICA) processing has been demonstrated by previous study. However, rtICA was only applied to analyze single-slice data rather than full-brain data. In order to improve the performance of rtICA, we proposed semi-blind real-time ICA (sb-rtICA) for our real-time **fMRI** system by adding regularization of certain estimated time courses using the experiment paradigm information to rtICA. Both simulated and real-time **fMRI** experiment were conducted to compare the two approaches. Results from simulated and real full-brain **fMRI** data demonstrate that sb-rtICA outperforms rtICA in robustness, computational time and spatial detection power. Moreover, in contrast to rtICA, the first component estimated by sb-rtICA tends to be the target component in more sliding windows.

PMID: 22275721 [PubMed - as supplied by publisher]

Neurosci Res. 2012 Jan 20. [Epub ahead of print]

185. *Real-time fMRI-based neurofeedback reinforces causality of attention networks.

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Abstract

In this study, we investigated the efficacy of a real-time functional magnetic resonance imaging (rt**fMRI**)-based **neurofeedback** method for the modulation of the effective connectivity (EC) of causality between attention-related neuronal activities. In participants who received the feedback of attention-related neuronal activity, the EC estimated from Granger causality analysis was reinforced within the task-related network, such as between the bilateral cingulate gyri and frontal cortices, whereas the EC between the task-related network and task-unrelated resting-state network, including the inferior parietal lobule, was diminished. On the other hand, only marginal changes were observed in participants who received "sham" feedback. This "dynamic" characteristic measure of EC based on causality may be useful for evaluating the efficacy of methods designed to modulate brain networks, including rt**fMRI**-based **neurofeedback**.

PMID: 22285603 [PubMed - as supplied by publisher]

Behav Brain Res. 2012 Jan 2;229(1):29-40. [Epub ahead of print]

186. Trial-to-trial variability differentiates motor imagery during observation between low versus high responders: A functional near-infrared spectroscopy study.

Holper L, Kobashi N, Kiper D, Scholkmann F, Wolf M, Eng K.

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Abstract
Trial-to-trial variability is a well-known issue in brain signals measured using functional near-infrared spectroscopy (**fNIRS**). We aimed to investigate whether trial-to-trial variability does provide information about individual performance. Seventeen subjects observed a virtual reality grasping task in first-person view while either imagining (motor imagery during observation, MIO) or imitating (motor execution, ME) the movements. Each condition was performed with the display in one of two positions, a conventional vertical position and a mirrored horizontal position which placed the virtual arm in the correct position relative to the viewpoint. Averaged oxy-hemoglobin concentration Δ[O(2)Hb] showed that the responses could be differentiated into two distinct groups: low responders (LR) and high responders (HR). Within groups, two main sources of trial-to-trial variability were identified: (a) the Δ[O(2)Hb] amplitude, with largest amplitudes in ME conditions (group HR) and smallest amplitudes in MIO conditions (group LR), and (b) the sign of Δ[O(2)Hb], with positive responses occurring most frequently during ME (group HR) and negative responses most frequently during MIO (group LR). Furthermore, the trial-to-trial dynamics differed between groups and could be described in group LR as inverted polynomial U-shaped curve in the mirror conditions (ME-mirror, MIO-mirror). Last, trial-to-trial variability was significantly dependent on task modality, i.e. ME (group HR) versus MIO (group LR), and/or the mirrored display positions (group LR). Our results show a relationship of trial-to-trial variability to individual MI performance, which may be of significance for neurorehabilitation applications.

Although the sources of trial-to-trial variability remain unknown, we suggest that they may contribute to future **neurofeedback** applications.

PMID: 22227507 [PubMed - as supplied by publisher]

J Alzheimers Dis. 2012 Jan 1;28(2):357-67.

187. *Neurofeedback in healthy elderly human subjects with electroencephalographic risk for cognitive disorder.

Becerra J, Fernández T, Roca-Stappung M, Díaz-Comas L, Galán L, Bosch J, Espino M, Moreno AJ, Harmony T.

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Abstract
In normal elderly subjects, the best electroencephalogram (**EEG**)-based predictor of cognitive impairment is theta **EEG** activity abnormally high for their age. The goal of this work was to explore the effectiveness of a **neurofeedback** (**NFB**) protocol in reducing theta **EEG** activity in normal elderly subjects who present abnormally high theta absolute power (AP). Fourteen subjects were randomly assigned to either the experimental group or the control group; the experimental group received a reward (tone of 1000 Hz) when the theta AP was reduced, and the control group received a placebo treatment, a random administration of the same tone. The results show that the experimental group exhibits greater improvement in **EEG** and behavioral measures. However, subjects of the control group also show improved **EEG** values and in memory, which may be attributed to a placebo effect. However, the effect of the **NFB** treatment was clear in the EG, although a placebo effect may also have been present.

PMID: 22002790 [PubMed - in process]

Prax Kinderpsychol Kinderpsychiatr. 2011;60(8):666-76.

188. *[The usage of neurofeedback in children with ADHD: the method and its evaluation].

[Article in German]
Gevensleben H, Moll GH, Rothenberger A, Heinrich H.

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Abstract
Neurofeedback is a computer-based behavior training, which is gaining increasing interest in the treatment of children with attention-deficit/hyperactivity disorder (ADHD). This article gives an introduction to **neurofeedback** and summarizes the state of research, discussing inter alia methodical aspects (e. g., requirements to a control training). Evaluation studies conducted so far indicate clinical efficacy. For example, **neurofeedback** training was superior to a computerized attention training in a randomized controlled trial (medium effect size).

Follow-up investigations suggest that treatment effects remain stable (at least six months). At the clinical level, comparable improvements could be obtained for the **neurofeedback** protocols theta/beta training and training of slow cortical potentials. Neurophysiological findings document different mechanisms of theta/beta training and slow cortical potential training. Future studies should further elucidate the specificity of training effects related to the kind of training and certain disorders and address how to optimize and individualize **neurofeedback** training.

PMID: 22145423 [PubMed - indexed for MEDLINE]

PLoS One. 2011;6(9):e24522. Epub 2011 Sep 8.

189. *Self-regulation of amygdala activation using real-time FMRI neurofeedback.

Zotev V, Krueger F, Phillips R, Alvarez RP, Simmons WK, Bellgowan P, Drevets WC, Bodurka J.

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Abstract
Real-time functional magnetic resonance imaging (rt**fMRI**) with **neurofeedback** allows investigation of human brain neuroplastic changes that arise as subjects learn to modulate neurophysiological function using real-time feedback regarding their own hemodynamic responses to stimuli. We investigated the feasibility of training healthy humans to self-regulate the hemodynamic activity of the amygdala, which plays major roles in emotional processing. Participants in the experimental group were provided with ongoing information about the blood oxygen level dependent (BOLD) activity in the left amygdala (LA) and were instructed to raise the BOLD rt**fMRI** signal by contemplating positive autobiographical memories. A control group was assigned the same task but was instead provided with sham feedback from the left horizontal segment of the intraparietal sulcus (HIPS) region. In the LA, we found a significant BOLD signal increase due to rt**fMRI neurofeedback** training in the experimental group versus the control group. This effect persisted during the Transfer run without **neurofeedback**. For the individual subjects in the experimental group the training effect on the LA BOLD activity correlated inversely with scores on the Difficulty Identifying Feelings subscale of the Toronto Alexithymia Scale. The whole brain data analysis revealed significant differences for Happy Memories versus Rest condition between the experimental and control groups. Functional connectivity analysis of the amygdala network revealed significant widespread correlations in a fronto-temporo-limbic network. Additionally, we identified six regions--right medial frontal polar cortex, bilateral dorsomedial prefrontal cortex, left anterior cingulate cortex, and bilateral superior frontal gyrus--where the functional connectivity with the LA increased significantly across the rt**fMRI neurofeedback** runs and the Transfer run. The findings demonstrate that healthy subjects can learn to regulate their amygdala activation using rt**fMRI neurofeedback**, suggesting possible applications of rt**fMRI neurofeedback** training in the treatment of patients with neuropsychiatric disorders.

PMID: 21931738 [PubMed - in process] PMCID: PMC3169601
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3169601/?tool=pubmed

Otol Neurotol. 2011 Dec;32(9):1492-9.

190. *Efficacy of a vibrotactile neurofeedback training in stance and gait conditions for the treatment of balance deficits: a double-blind, placebo-controlled multicenter study.

Basta D, Rossi-Izquierdo M, Soto-Varela A, Greters ME, Bittar RS, Steinhagen-Thiessen E, Eckardt R, Harada T, Goto F, Ogawa K, Ernst A.

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Abstract

OBJECTIVE: Vestibular rehabilitation strategies mostly require a long-lasting training in stance conditions, which is finally not always successful. The individualized training in everyday-life conditions with an intuitive tactile **neurofeedback** stimulus seems to be a more promising approach. Hence, the present study was aimed at investigating the efficacy of a new vibrotactile **neurofeedback** system for vestibular rehabilitation.

STUDY DESIGN: Double-blinded trial.

PATIENTS: One hundred five patients who experience one of the following balance disorders for more than 12 months were included in the study: canal paresis, otolith disorder, removal of an acoustic neuroma, microvascular compression syndrome, Parkinson's disease, and presbyvertigo.

INTERVENTIONS: Vibrotactile **neurofeedback** training was performed daily (15 min) over 2 weeks with the Vertiguard system in those 6 tasks of the Standard Balance Deficit Test with the most prominent deviations from the normative values.

MAIN OUTCOME MEASURES: Trunk and ankle sway, dizziness handicap inventory, and vestibular symptom score were measured in the verum and placebo group before the training, on the last training day and 3 months later.

RESULTS: A significant reduction in trunk and ankle sway as well as in the subjective symptom scores were observed in the verum group. Such an effect could not be found in any of the outcome parameters of the placebo group.

CONCLUSION: The vibrotactile **neurofeedback** training applied in the present study is a highly efficient method for the reduction of body sway in different balance disorders. Because the rehabilitation program is easy to perform, not exhausting, and time saving, elderly patients and those with serious, long-lasting balance problems also can participate successfully.

PMID: 22089958 [PubMed - in process]

Appl Psychophysiol Biofeedback. 2011 Dec;36(4):281-8.

191. *Neurofeedback training for Tourette syndrome: an uncontrolled single case study.

Messerotti Benvenuti S, Buodo G, Leone V, Palomba D.

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Abstract
Gilles de la Tourette syndrome (TS) is characterized by motor and vocal tic manifestations, often accompanied by behavioral, cognitive and affective dysfunctions. Electroencephalography of patients with TS has revealed reduced Sensorimotor Rhythm (**SMR**) and excessive fronto-central Theta activity, that presumably underlie motor and cognitive disturbances in TS. Some evidence exists that **neurofeedback** (**NFB**) training aimed at enhancing **SMR** amplitude is effective for reducing tics. The present report is an uncontrolled single case study where a **NFB** training protocol, involving combined **SMR** uptraining/Theta downtraining was delivered to a 17-year-old male with TS. After sixteen **SMR**-Theta sessions, six additional sessions were administered with **SMR** uptraining alone. **SMR** increase was better obtained when **SMR** uptraining was administered alone, whereas Theta decrease was observed after both trainings. The patient showed a reduction of tics and affective symptoms, and improvement of cognitive performance after both trainings. Overall, these findings suggest that Theta decrease might account for some clinical effects seen in conjunction with **SMR** uptraining. Future studies should clarify the feasibility of **NFB** protocols for patients with TS beyond **SMR** uptraining alone.

PMID: 21915704 [PubMed - in process]

J Neural Eng. 2011 Dec;8(6):066009. Epub 2011 Oct 26.

192. *Detection of movement intention from single-trial movement-related cortical potentials.

Niazi IK, Jiang N, Tiberghien O, Nielsen JF, Dremstrup K, Farina D.

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Abstract
Detection of movement intention from neural signals combined with assistive technologies may be used for effective **neurofeedback** in rehabilitation. In order to promote plasticity, a causal relation between intended actions (detected for example from the **EEG**) and the corresponding feedback should be established. This requires reliable detection of motor intentions. In this study, we propose a method to detect movements from **EEG** with limited latency. In a self-paced asynchronous **BCI** paradigm, the initial negative phase of the movement-related cortical potentials (MRCPs), extracted from multi-channel scalp **EEG** was used to detect motor execution/imagination in healthy subjects and stroke patients. For MRCP detection, it was demonstrated that a new optimized spatial filtering technique led to better accuracy than a large Laplacian spatial filter and common spatial pattern. With the optimized spatial filter, the true positive rate (TPR) for detection of movement execution in healthy

subjects (n = 15) was 82.5 ± 7.8%, with latency of -66.6 ± 121 ms. Although TPR decreased with motor imagination in healthy subject (n = 10, 64.5 ± 5.33%) and with attempted movements in stroke patients (n = 5, 55.01 ± 12.01%), the results are promising for the application of this approach to provide patient-driven real-time **neurofeedback**.

PMID: 22027549 [PubMed - in process]

Auris Nasus Larynx. 2011 Dec;38(6):735-8. Epub 2011 May 17.

193. *Neurofeedback for subjective tinnitus patients.

Crocetti A, Forti S, Del Bo L.

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Abstract

OBJECTIVE: Previous studies report that enhanced power in the delta range (1.5-4Hz) and reduced power in the alpha frequency band (8-12Hz) were most pronounced in the temporal regions. These studies referred to the 8-12Hz activity as tau activity, and they created a new **neurofeedback** protocol to treat tinnitus using a temporally generated tau rhythm (8-12Hz) and slow waves in the delta range (3-4Hz) for feedback. This study aims to repeat this protocol and to evaluate its effect on tinnitus.

METHODS: Fifteen normal-hearing patients with tinnitus were treated with the **neurofeedback** protocol. The Tinnitus Handicap Inventory and Visual Analogue Scales were administered before and after treatment and at 1, 3 and 6 months post-treatment.

RESULTS: After therapy, all questionnaires scores were significant improved, and the improvements persisted throughout the followup period. Moreover, an increasing trend in the tau/delta ratio was observed; specifically, the trend was more stable respect of the pre-recording measure. However, only in some subjects may the signal alone be enough to develop the correct behaviors.

CONCLUSION: Further studies are necessary to characterize the tinnitus subjects who recovered from and adapted to this psychophysical condition and, therefore, responded to **neurofeedback** therapy.

PMID: 21592701 [PubMed - in process]

Science. 2011 Dec 9;334(6061):1413-5.

194. Perceptual learning incepted by decoded fMRI neurofeedback without stimulus presentation.

Shibata K, Watanabe T, Sasaki Y, Kawato M.

Advanced Telecommunications Research Institute International Computational Neuroscience Laboratories, Keihanna Science City, Kyoto 619-0288, Japan.

Abstract

It is controversial whether the adult primate early visual cortex is sufficiently plastic to cause visual perceptual learning (VPL). The controversy occurs partially because most VPL studies have examined correlations between behavioral and neural activity changes rather than cause-and-effect relationships. With an online-feedback method that uses decoded functional magnetic resonance imaging (**fMRI**) signals, we induced activity patterns only in early visual cortex corresponding to an orientation without stimulus presentation or participants' awareness of what was to be learned. The induced activation caused VPL specific to the orientation. These results suggest that early visual areas are so plastic that mere inductions of activity patterns are sufficient to cause VPL. This technique can induce plasticity in a highly selective manner, potentially leading to powerful training and rehabilitative protocols.

PMID: 22158821 [PubMed - indexed for MEDLINE]

Rinsho Shinkeigaku. 2011 Nov;51(11):924-6.

195. *Neurorehabilitative intervention with neurofeedback system using functional near-infrared spectroscopy.

Mihara M.

Neurorehabilitation Research Insitute, Morinomiya Hospital.

Abstract
Recent advance in **Brain-Machine interface** (**BMI**) technology, including analysis of brain signal, enable a real-time interaction between patients and environment bypassing their damaged neuromuscular systems. Although most of researches have focused on substituting output function, it has been growing interest in applying this technology for restoring their brain. Several studies have proved that feedback of cortical activities (**neurofeedback**) enable regulating brain activation voluntarily. According to this notion, we have developed a real-time **neurofeedback** system mediated by near-infrared spectroscopy (**NIRS**) as a **neurofeedback** tool in neurorehabilitation. First, we have evaluated whether real-time cortical oxygenated hemoglobin (OxyHb) feedback signals correlated with reference OxyHb signals analyzed off-line during a motor execution task. Our results showed high correlation between results from two analyses. Second, we investigated whether the self-assessment scores for kinesthetic motor imagery and motor imagery related cortical activation was enhanced by **neurofeedback**. Our experiment with right handed healthy subjects revealed significant improvement of the imagery scale, and enhanced cortical activations including the contralateral premotor area. These results suggest that the **neurofeedback** technique may improve the efficacy of mental practice with motor imagery.

PMID: 22277419 [PubMed - in process]

J Atten Disord. 2011 Nov 16. [Epub ahead of print]

196. *A Review of Neurofeedback Treatment for Pediatric ADHD.

Lofthouse N, Arnold LE, Hersch S, Hurt E, Debeus R.

The Ohio State University, Columbus, USA.

Abstract
Objective: The aim of this paper was to review all randomized published trials and unpublished conference presentations on the **neurofeedback** (**NF**) treatment of pediatric ADHD, and their relevance, strengths, and limitations. Method: Via PsychInfo and Medline searches and contacts with **NF** researchers 14 studies were identified and reviewed. Results: The majority were conducted from 1994 to 2010, with 5- to 15-year-olds, usually male and White with the combined type of ADHD. Most studies used theta/beta **NF** with a unipolar-electrode placement at Cz and demonstrated, where reported, an overall ADHD mean effect size of d = 0.69, a medium effect. Main study strengths, within some studies, include use of randomization, treatment control conditions, Diagnostic and Statistical Manual of Mental Disorders criteria, evidence-based assessment of ADHD, standard treatment outcome measures, multidomain assessment, and, for some studies, moderate sample size, some type of blind and the identification of medication as a concomitant treatment. Main study limitations (and directions for future research) include the lack of adequate blinding of participants, raters and **NF** trainers, a sham-**NF**/blinded control treatment condition, posttreatment follow-up, generalizability, specific details about delivery of **NF**, identification and control of comorbidity, and the identification, measurement, and control of concomitant treatments and potential side effects. Conclusion: Based on the results and methodologies of published studies, this review concludes that **NF** for pediatric ADHD can be currently considered as "probably efficacious." (J. of Att. Dis. 2011; XX(X) 1-XX).

PMID: 22090396 [PubMed - as supplied by publisher]

J Neurosci. 2011 Nov 9;31(45):16309-17.

197. *Real-time functional magnetic resonance imaging neurofeedback for treatment of Parkinson's disease.

Subramanian L, Hindle JV, Johnston S, Roberts MV, Husain M, Goebel R, Linden D.

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Abstract
Self-regulation of brain activity in humans based on real-time feedback of functional magnetic resonance imaging (**fMRI**) signal is emerging as a potentially powerful, new technique. Here, we assessed whether patients with Parkinson's disease (PD) are able to alter local brain activity to improve motor function. Five patients learned to increase activity in the supplementary motor complex over two **fMRI** sessions using motor imagery. They attained as much activation in this target brain region as during a localizer procedure with overt movements. Concomitantly, they showed an improvement in motor speed (finger tapping) and clinical ratings of motor symptoms (37% improvement of the motor scale of the Unified Parkinson's Disease Rating Scale). Activation during **neurofeedback** was also observed in other cortical motor areas and the basal ganglia, including the subthalamic nucleus and globus pallidus, which are connected to the supplementary motor area (SMA) and crucial nodes in the pathophysiology of PD. A PD control group of five patients, matched for clinical severity and medication, underwent the same procedure but did not receive feedback about their SMA activity. This group attained no control of SMA activation and showed no motor improvement. These findings demonstrate that self-modulation of cortico-subcortical motor

circuits can be achieved by PD patients through **neurofeedback** and may result in clinical benefits that are not attainable by motor imagery alone.

PMID: 22072682 [PubMed - indexed for MEDLINE]

Hum Brain Mapp. 2011 Oct 22. doi: 10.1002/hbm.21427. [Epub ahead of print]

198. *Acquired self-control of insula cortex modulates emotion recognition and brain network connectivity in schizophrenia.

Ruiz S, Lee S, Soekadar SR, Caria A, Veit R, Kircher T, Birbaumer N, Sitaram R.

Institute of Medical Psychology and Behavioral Neurobiology, University of Tübingen, Germany; Department of Psychiatry, Faculty of Medicine, Pontificia Universidad Catolica de Chile, Santiago, Chile; Graduate School of Neural and Behavioral Sciences, International Max Planck Research School, Tübingen, Germany. smruiz@med.puc.cl.

Abstract
Real-time functional magnetic resonance imaging (rt**fMRI**) is a novel technique that has allowed subjects to achieve self-regulation of circumscribed brain regions. Despite its anticipated therapeutic benefits, there is no report on successful application of this technique in psychiatric populations. The objectives of the present study were to train schizophrenia patients to achieve volitional control of bilateral anterior insula cortex on multiple days, and to explore the effect of learned self-regulation on face emotion recognition (an extensively studied deficit in schizophrenia) and on brain network connectivity. Nine patients with schizophrenia were trained to regulate the hemodynamic response in bilateral anterior insula with contingent rt**fMRI neurofeedback**, through a 2-weeks training. At the end of the training stage, patients performed a face emotion recognition task to explore behavioral effects of learned self-regulation. A learning effect in self-regulation was found for bilateral anterior insula, which persisted through the training. Following successful self-regulation, patients recognized disgust faces more accurately and happy faces less accurately. Improvements in disgust recognition were correlated with levels of self-activation of right insula. Rt**fMRI** training led to an increase in the number of the incoming and outgoing effective connections of the anterior insula. This study shows for the first time that patients with schizophrenia can learn volitional brain regulation by rt**fMRI** feedback training leading to changes in the perception of emotions and modulations of the brain network connectivity. These findings open the door for further studies of rt**fMRI** in severely ill psychiatric populations, and possible therapeutic applications. Hum Brain Mapp, 2011. © 2011 Wiley Periodicals, Inc.

PMID: 22021045 [PubMed - as supplied by publisher]

Neuroimage. 2011 Oct 14. [Epub ahead of print]

199. *Real-time fMRI and its application to neurofeedback.

Weiskopf N.

Abstract
Real-time **fMRI** (rt**fMRI**) allows immediate access to experimental results by analyzing data as fast as they are acquired. It was devised soon after the inception of **fMRI** and has undergone a rapid development since then. The availability of results during the ongoing experiment facilitates a variety of applications such as quality assurance or fast functional localization. Rt**fMRI** can also be used as a **brain-computer interface** (**BCI**) with high spatial resolution and whole-brain coverage, overcoming limitations of **EEG** based **BCI**s. This review will focus on the application of rt**fMRI BCI**s to **neurofeedback**, i.e., the online feedback of the blood oxygen level dependent (BOLD) response. I will motivate its development and place its beginnings into the contemporary scientific context by providing an account of our early work at the University of Tübingen, followed by a review of the accomplishments and the current state of rt**fMRI neurofeedback**. Rt**fMRI neurofeedback** has been used to train self-regulation of the local BOLD response in various different brain areas and to study consequential behavioral effects. Behavioral effects such as modulation of pain, reaction time, linguistic or emotional processing have been shown in healthy and/or patient populations. Rt**fMRI neurofeedback** presents a new paradigm for studying the relation between brain behavior and physiology, because the latter can be regarded as the independent variable (unlike in conventional neuroimaging studies where behavior is the independent variable). The initial results in patient populations improving pain, tinnitus, depression or modulating perception in schizophrenia are encouraging and merit further controlled clinical studies.

PMID: 22019880 [PubMed - as supplied by publisher]

Med Sci Monit. 2011 Oct;17(10):CS120-8.

200. *Evaluation of differentiated neurotherapy programs for a patient after severe TBI and long term coma using event-related potentials.

Pachalska M, Łukowicz M, Kropotov JD, Herman-Sucharska I, Talar J.

Andrzej Frycz Modrzewski Cracow University, Cracow, Poland and Center for Cognition and Communication, New York, NY, USA. neuropsychologia23@o2.pl

Abstract
BACKGROUND: This article examines the effectiveness of differentiated rehabilitation programs for a patient with frontal syndrome after severe TBI and long-term coma. We hypothesized that there would be a small response to relative beta training, and a good response to rTMS, applied to regulate the dynamics of brain function.

CASE REPORT: M. L-S, age 26, suffered from anosognosia, executive dysfunction, and behavioral changes, after a skiing accident and prolonged coma, rendering him unable to function independently in many situations of everyday life. Only slight progress was made after traditional rehabilitation. The patient took part in 20 sessions of relative beta training (program A) and later in 20 sessions of rTMS (program B); both programs were combined with behavioral training. We used standardized neuropsychological testing, as well as ERPs

before the experiment, after the completion of program A, and again after the completion of program B. As hypothesized, patient M.L-S showed small improvements in executive dysfunction and behavioral disorders after the conclusion of program A, and major improvement after program B. Similarly, in physiological changes the patient showed small improvement after relative beta training and a significant improvement of the P300 NOGO component after the rTMS program.

CONCLUSIONS: The rTMS program produced larger physiological and behavioral changes than did relative beta training. A combination of different neurotherapeutical approaches (such as **neurofeedback**, rTMS, tDCS) can be suggested for similar severe cases of TBI. ERPs can be used to assess functional brain changes induced by neurotherapeutical programs.

PMID: 21959618 [PubMed - indexed for MEDLINE]

J Rehabil Med. 2011 Oct;43(10):951-7.

201. *Effects of neurofeedback training with an electroencephalogram-based brain-computer interface for hand paralysis in patients with chronic stroke: a preliminary case series study.

Shindo K, Kawashima K, Ushiba J, Ota N, Ito M, Ota T, Kimura A, Liu M.

Department of Rehabilitation Medicine, Keio University Tsukigase Rehabilitation Center, 380-2 Tsukigase. krugreims@yahoo.co.jp

Abstract
OBJECTIVE: To explore the effectiveness of neurorehabilitative training using an electroencephalogram-based **brain-computer interface** for hand paralysis following stroke.

DESIGN: A case series study.

SUBJECTS: Eight outpatients with chronic stroke demonstrating moderate to severe hemiparesis.

METHODS: Based on analysis of volitionally decreased amplitudes of sensory motor rhythm during motor imagery involving extending the affected fingers, real-time visual feedback was provided. After successful motor imagery, a mechanical orthosis partially extended the fingers. **Brain-computer interface** interventions were carried out once or twice a week for a period of 4-7 months, and clinical and neurophysiological examinations pre- and post-intervention were compared.

RESULTS: New voluntary electromyographic activity was measured in the affected finger extensors in 4 cases who had little or no muscle activity before the training, and the other participants exhibited improvement in finger function. Significantly greater suppression of the sensory motor rhythm over both hemispheres was observed during motor imagery. Transcranial magnetic stimulation showed increased cortical excitability in the damaged hemisphere. Success rates of **brain-computer interface** training tended to increase as the session progressed in 4 cases.

CONCLUSION: **Brain-computer interface** training appears to have yielded some improvement in motor function and brain plasticity. Further controlled research is needed to clarify the role of the **brain-computer interface** system.

PMID: 21947184 [PubMed - indexed for MEDLINE]

Med Biol Eng Comput. 2011 Sep;49(9):985-95. Epub 2011 Jun 24.

202. An EEG-based real-time cortical functional connectivity imaging system.

Hwang HJ, Kim KH, Jung YJ, Kim DW, Lee YH, Im CH.

Department of Biomedical Engineering, Hanyang University, 17 Haengdang-dong, Seongdong-gu, Seoul, 133-791, South Korea.

Abstract
In the present study, we introduce an **EEG**-based, real-time, cortical functional connectivity imaging system capable of monitoring and tracing dynamic changes in cortical functional connectivity between different regions of interest (ROIs) on the brain cortical surface. The proposed system is based on an **EEG**-based dynamic neuroimaging system, which is capable of monitoring spatiotemporal changes of cortical rhythmic activity at a specific frequency band by conducting real-time cortical source imaging. To verify the implemented system, we performed three test experiments in which we monitored temporal changes in cortical functional connectivity patterns in various frequency bands during structural face processing, finger movements, and working memory task. We also traced the changes in the number of connections between all possible pairs of ROIs whose correlations exceeded a predetermined threshold. The quantitative analysis results were consistent with those of previous off-line studies, thereby demonstrating the possibility of imaging cortical functional connectivity in real-time. We expect our system to be applicable to various potential applications, including real-time diagnosis of psychiatric diseases and **EEG neurofeedback**.

PMID: 21701853 [PubMed - in process]

Conf Proc IEEE Eng Med Biol Soc. 2011 Aug;2011:5778-81.

203. *Stability of MEG for real-time neurofeedback.

Foldes ST, Vinjamuri RK, Wang W, Weber DJ, Collinger JL.

Abstract
Movement-related field potentials can be extracted and processed in real-time with magnetoencephalography (**MEG**) and used for brain machine interfacing (**BMI**). However, due to its immense sensitivity to magnetic fields, **MEG** is prone to a low signal to noise ratio. It is therefore important to collect enough initial data to appropriately characterize motor-related activity and to ensure that decoders can be built to adequately translate brain activity into **BMI**-device commands. This is of particular importance for therapeutic **BMI** applications where less time spent collecting initial open-loop data means more time for performing **neurofeedback** training which could potentially promote cortical plasticity and rehabilitation. This study evaluated the amount of hand-grasp movement and rest data needed to characterize sensorimotor modulation depth and build classifier functions to decode brain

states in real-time. It was determined that with only five minutes of initial open-loop **MEG** data, decoders can be built to classify brain activity as grasp or rest in real-time with an accuracy of 84±6%.

PMID: 22255653 [PubMed - in process]

Conf Proc IEEE Eng Med Biol Soc. 2011 Aug;2011:4596-9.

204. *Single-trial classification of feedback potentials within neurofeedback training with an EEG brain-computer interface.

Lopez-Larraz E, Iterate I, Escolano C, Garcia I, Montesano L, Minguez J.

Abstract
Neurofeedback therapies are an emerging technique used to treat neuropsychological disorders and to enhance cognitive performance. The feedback stimuli presented during the therapy are a key factor, serving as guidance throughout the entire learning process of the brain rhythms. Online decoding of these stimuli could be of great value to measure the compliance and adherence of the subject to the training. This paper describes the modeling and classification of performance feedback potentials with a **Brain-Computer Interface** (**BCI**), under a real **neurofeedback** training with five subjects. LDA and SVM classification techniques are compared and are both able to provide an average performance of approximately 80%.

PMID: 22255361 [PubMed - in process]

Conf Proc IEEE Eng Med Biol Soc. 2011 Aug;2011:2327-30.

205. *EEG-based upper alpha neurofeedback training improves working memory performance.

Escolano C, Aguilar M, Minguez J.

Abstract
Neurofeedback (**NF**) training has revealed its therapeutical effects to treat a variety of neurological and psychological disorders, and has demonstrated its feasibility to improve certain cognitive aptitudes in healthy users. Although promising results of **NF** training exist in recent literature, the reliability of its effects remains questioned due to a lack of deep studies examining its impact on the human electrophysiology. This paper presents a **NF** training aimed at improving working memory performance in healthy users by the enhancement of upper alpha band. A user-specific training was used (upper alpha was determined for each user using the individual alpha frequency) to reduce the unspecific factors of training the entire classical alpha band as traditional **NF** usually does. **EEG** assessments in active and passive open-eyes state were conducted pre/post the **NF** training. The **EEG** analyses reveal the UA enhancement during the active tasks which is independent of other frequency bands. UA was also enhanced in the passive state but independence could not be obtained in lower alpha band. Finally, significant improvement in working memory was obtained with regard to a control group.

PMID: 22254807 [PubMed - in process]

Eur Child Adolesc Psychiatry. 2011 Aug 13. [Epub ahead of print]

206. *Neurofeedback in ADHD: a single-blind randomized controlled trial.

Bakhshayesh AR, Hänsch S, Wyschkon A, Rezai MJ, Esser G.

Department of Psychology, Faculty of Humanities, Yazd University, Yazd, Iran.

Abstract
Neurofeedback treatment has been demonstrated to reduce inattention, impulsivity and hyperactivity in children with attention deficit/hyperactivity disorder (ADHD). However, previous studies did not adequately control confounding variables or did not employ a randomized reinforcer-controlled design. This study addresses those methodological shortcomings by comparing the effects of the following two matched **biofeedback** training variants on the primary symptoms of ADHD: **EEG neurofeedback** (**NF**) aiming at theta/beta ratio reduction and EMG **biofeedback** (BF) aiming at forehead muscle relaxation. Thirty-five children with ADHD (26 boys, 9 girls; 6-14 years old) were randomly assigned to either the therapy group (**NF**; n = 18) or the control group (BF; n = 17). Treatment for both groups consisted of 30 sessions. Pre- and post-treatment assessment consisted of psychophysiological measures, behavioural rating scales completed by parents and teachers, as well as psychometric measures. Training effectively reduced theta/beta ratios and EMG levels in the **NF** and BF groups, respectively. Parents reported significant reductions in primary ADHD symptoms, and inattention improvements in the **NF** group were higher compared to the control intervention (BF, d (corr) = -.94). **NF** training also improved attention and reaction times on the psychometric measures. The results indicate that **NF** effectively reduced inattention symptoms on parent rating scales and reaction time in neuropsychological tests. However, regarding hyperactivity and impulsivity symptoms, the results imply that non-specific factors, such as behavioural contingencies, self-efficacy, structured learning environment and feed-forward processes, may also contribute to the positive behavioural effects induced by **neurofeedback** training.

PMID: 21842168 [PubMed - as supplied by publisher]

Neuroimage. 2011 Aug 4. [Epub ahead of print]

207. Signal quality and Bayesian signal processing in neurofeedback based on real-time fMRI.

Koush Y, Zvyagintsev M, Dyck M, Mathiak KA, Mathiak K.

Department of Psychiatry, Psychotherapy and Psychosomatics, RWTH Aachen University, Germany; JARA, Translational Brain Medicine, Germany.

Abstract
Real-time **fMRI** allows analysis and visualization of the brain activity online, i.e. within one repetition time. It can be used in **neurofeedback** applications where subjects attempt to control an activation level in a specified region of interest (ROI) of their brain. The signal

derived from the ROI is contaminated with noise and artifacts, namely with physiological noise from breathing and heart beat, scanner drift, motion-related artifacts and measurement noise. We developed a Bayesian approach to reduce noise and to remove artifacts in real-time using a modified Kalman filter. The system performs several signal processing operations: subtraction of constant and low-frequency signal components, spike removal and signal smoothing. Quantitative feedback signal quality analysis was used to estimate the quality of the **neurofeedback** time series and performance of the applied signal processing on different ROIs. The signal-to-noise ratio (SNR) across the entire time series and the group event-related SNR (eSNR) were significantly higher for the processed time series in comparison to the raw data. Applied signal processing improved the t-statistic increasing the significance of blood oxygen level-dependent (BOLD) signal changes. Accordingly, the contrast-to-noise ratio (CNR) of the feedback time series was improved as well. In addition, the data revealed increase of localized self-control across feedback sessions. The new signal processing approach provided reliable **neurofeedback**, performed precise artifacts removal, reduced noise, and required minimal manual adjustments of parameters. Advanced and fast online signal processing algorithms considerably increased the quality as well as the information content of the control signal which in turn resulted in higher contingency in the **neurofeedback** loop.

PMID: 21839842 [PubMed - as supplied by publisher]

Curr Neurol Neurosci Rep. 2011 Aug;11(4):443-50.

208. *Biofeedback and epilepsy.

Nagai Y.

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Abstract
Biofeedback is a noninvasive behavioral treatment that enables a patient to gain volitional control over a physiological process. As a treatment for epilepsy, **biofeedback** interventions were explored from as early as the 1970s, concentrating on sensory motor rhythm (**SMR**) as a neurophysiologic parameter. Whereas **SMR biofeedback** aims to modulate frequency components of the electroencephalography (**EEG**), slow cortical potential (**SCP**) **biofeedback** (which was introduced in the 1990s) focuses on the regulation of the amplitude of cortical potential changes (DC shift). In its application to epilepsy, **biofeedback** using galvanic skin response (GSR), an electrodermal measure of sympathetic activity, is a relatively new cost-effective methodology. The present article first reviews **biofeedback** using **SMR** and **SCP**, for which efficacy and neural mechanisms are relatively well characterized. Then recent data regarding promising applications of GSR **biofeedback** will be introduced and discussed in detail.

PMID: 21465147 [PubMed - in process]

J Child Neurol. 2011 Aug;26(8):1045-51. Epub 2011 May 16.

209. *Clinical neurofeedback: case studies, proposed mechanism, and implications for pediatric neurology practice.

Legarda SB, McMahon D, Othmer S, Othmer S.

Georgetown University Medical Center, Departments of Pediatrics and Neurology, Washington, DC, USA.

Abstract
Trends in alternative medicine use by American health care consumers are rising substantially. Extensive literature exists reporting on the effectiveness of **neurofeedback** in the treatment of autism, closed head injury, insomnia, migraine, depression, attention deficit hyperactivity disorder, epilepsy, and posttraumatic stress disorder. We speculated that **neurofeedback** might serve as a therapeutic modality for patients with medically refractory neurological disorders and have begun referring patients to train with clinical **neurofeedback** practitioners. The modality is not always covered by insurance. Confident their child's medical and neurological needs would continue to be met, the parents of 3 children with epilepsy spectrum disorder decided to have their child train in the modality. The children's individual progress following **neurofeedback** are each presented here. A proposed mechanism and practice implications are discussed.

PMID: 21576401 [PubMed - in process]

Ann Indian Acad Neurol. 2011 Jul;14(3):148-52.

210. *Nonpharmacological treatment of epilepsy.

Saxena VS, Nadkarni VV.

Department of Neurology, Gita Bhawan Hospital and Research Centre, Indore, India.

Abstract
Nonpharmacological treatment of epilepsy includes surgery, vagal nerve stimulation, ketogenic diet, and other alternative/complementary therapies, e.g., yoga, Ayurveda, electroencephalography (**EEG**) **biofeedback** technique, aerobic exercise, music therapy, transcranial magnetic stimulation, acupuncture, and herbal remedies (traditional Chinese medicine). Alternative therapies, despite the term, should not be considered as an alternative to antiepileptic medication; they complement accepted drug treatment. Alternative therapies like yoga, through techniques that relax the body and mind, reduce stress, improve seizure control, and also improve quality of life. Ketogenic diet is a safe and effective treatment for intractable epilepsies; it has been recommended since 1921. The diet induces ketosis, which may control seizures. The most successful treatment of epilepsy is with modern antiepileptic drugs, which can achieve control of seizures in 70-80% cases. Patients opt for alternative therapies because they may be dissatisfied with antiepileptic drugs due to their unpleasant side effects, the long duration of treatment, failure to achieve control of seizures, cultural beliefs and, in the case of women, because they wish to get pregnant. Surgical treatment may lead to physical and psychological sequelae and is an option only for a minority of patients. This article presents supportive evidence from randomized controlled trials done to assess the benefit of non-pharmacological treatment.

PMID: 22028523 [PubMed] PMCID: PMC3200033
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3200033/?tool=pubmed

Appl Psychophysiol Biofeedback. 2011 Jul 26. [Epub ahead of print]

211. *Neurofeedback for Insomnia: A Pilot Study of Z-Score SMR and Individualized Protocols.

Hammer BU, Colbert AP, Brown KA, Ilioi EC.

Department of Psychophysiology, Helfgott Research Institute, National College of Natural Medicine, 049 SW Porter Street, Portland, OR, 97201-4848, USA, barbhammer37@yahoo.com.

Abstract
Insomnia is an epidemic in the US. **Neurofeedback** (**NFB**) is a little used, psychophysiological treatment with demonstrated usefulness for treating insomnia. Our objective was to assess whether two distinct Z-Score **NFB** protocols, a modified sensorimotor (**SMR**) protocol and a sequential, quantitative **EEG** (sQ**EEG**)-guided, individually designed (IND) protocol, would alleviate sleep and associated daytime dysfunctions of participants with insomnia. Both protocols used instantaneous Z scores to determine reward condition administered when awake. Twelve adults with insomnia, free of other mental and uncontrolled physical illnesses, were randomly assigned to the **SMR** or IND group. Eight completed this randomized, parallel group, single-blind study. Both groups received fifteen 20-min sessions of Z-Score **NFB**. Pre-post assessments included sQ**EEG**, mental health, quality of life, and insomnia status. ANOVA yielded significant post-treatment improvement for the combined group on all primary insomnia scores: Insomnia Severity Index (ISI $p < .005$), Pittsburgh Sleep Quality Inventory (PSQI $p < .0001$), PSQI Sleep Efficiency ($p < .007$), and Quality of Life Inventory ($p < .02$). Binomial tests of baseline **EEG**s indicated a significant proportion of excessively high levels of Delta and Beta power ($p < .001$) which were lowered post-treatment (paired z-tests $p < .001$). Baseline **EEG**s showed excessive sleepiness and hyperarousal, which improved post-treatment. Both Z-Score **NFB** groups improved in sleep and daytime functioning. Post-treatment, all participants were normal sleepers. Because there were no significant differences in the findings between the two groups, our future large scale studies will utilize the less burdensome to administer Z-Score **SMR** protocol.

PMID: 21789650 [PubMed - as supplied by publisher]

Neuroimage. 2011 Jul 23. [Epub ahead of print]

212. Self-modulation of primary motor cortex activity with motor and motor imagery tasks using real-time fMRI-based neurofeedback.

Berman BD, Horovitz SG, Venkataraman G, Hallett M.

Department of Neurology, University of Colorado Denver, Denver, CO, USA; Human Motor Control Section, National Institute of Neurological Disorders and Stroke (NINDS), National Institutes of Health, Bethesda, MD, USA.

Abstract
Advances in **fMRI** data acquisition and processing have made it possible to analyze brain activity as rapidly as the images are acquired allowing this information to be fed back to subjects in the scanner. The ability of subjects to learn to volitionally control localized brain activity within motor cortex using such real-time **fMRI**-based **neurofeedback** (**NF**) is actively being investigated as it may have clinical implications for motor rehabilitation after central nervous system injury and brain-computer interfaces. We investigated the ability of fifteen healthy volunteers to use **NF** to modulate brain activity within the primary motor cortex (M1) during a finger tapping and tapping imagery task. The M1 hand area ROI (ROI(m)) was functionally localized during finger tapping and a visual representation of BOLD signal changes within the ROI(m) fed back to the subject in the scanner. Surface EMG was used to assess motor output during tapping and ensure no motor activity was present during motor imagery task. Subjects quickly learned to modulate brain activity within their ROI(m) during the finger-tapping task, which could be dissociated from the magnitude of the tapping, but did not show a significant increase within the ROI(m) during the hand motor imagery task at the group level despite strongly activating a network consistent with the performance of motor imagery. The inability of subjects to modulate M1 proper with motor imagery may reflect an inherent difficulty in activating synapses in this area, with or without **NF**, since such activation may lead to M1 neuronal output and obligatory muscle activity. Future real-time **fMRI**-based **NF** investigations involving motor cortex may benefit from focusing attention on cortical regions other than M1 for feedback training or alternative feedback strategies such as measures of functional connectivity within the motor system.

PMID: 21803163 [PubMed - as supplied by publisher]

Dev Med Child Neurol. 2011 Jul 14. doi: 10.1111/j.1469-8749.2011.04043.x. [Epub ahead of print]

213. *Neurofeedback in autism spectrum disorders.

Holtmann M, Steiner S, Hohmann S, Poustka L, Banaschewski T, Bölte S.

LWL-University Hospital for Child and Adolescent Psychiatry, Psychotherapy and Psychosomatics of the Ruhr University Bochum, Hamm, Germany Department of Child and Adolescent Psychiatry and Psychotherapy, Central Institute of Mental Health, Mannheim, Germany Department of Women's and Children's Health, Karolinska Institutet Centre of Neurodevelopmental Disorders, Karolinska Institutet, Stockholm, Sweden.

Abstract
Aim To review current studies on the effectiveness of **neurofeedback** as a method of treatment of the core symptoms of autism spectrum disorders (ASD). Method Studies were selected based on searches in PubMed, Ovid MEDLINE, EMBASE, ERIC, and CINAHL using combinations of the following keywords: '**Neurofeedback**' OR '**EEG Biofeedback**' OR '**Neurotherapy**' OR 'Mu-Rhythm' OR '**SMR**' AND 'Autism' OR 'Autism Spectrum Disorder' OR 'Pervasive Developmental Disorder'. Results The existing evidence does not support the use of **neurofeedback** in the treatment of ASD. Studies with outcomes in favour of

neurofeedback might be showing an improvement in comorbid attention-deficit-hyperactivity disorder symptoms rather than a true improvement in core ASD symptoms. Interpretation Limitations of this review are those inherent in the studies available, including small sample size, short duration, variable diagnostic criteria, and insufficient control interventions, all causing a lack of generalizability.

PMID: 21752020 [PubMed - as supplied by publisher]

HNO. 2011 Jul 8. [Epub ahead of print]

214. *[Vibrotactile neurofeedback training with the Vertiguard® RT system : A placebo-controlled double-blinded pilot study on vestibular rehabilitation.]

[Article in German]

Basta D, Ernst A.

HNO-Klinik im Unfallkrankenhaus Berlin, Warener Str. 7, 12683, Berlin, Deutschland, dietmar.basta@ukb.de.

Abstract

BACKGROUND: The success of **neurofeedback** training for vestibular rehabilitation depends largely on the type of feedback signal as well as on the specific parameters. Ideal training should be based on the individual balance deficits in patients in everyday situations. The present study is therefore aimed at investigating the therapeutic outcome of a new vibrotactile **neurofeedback** system for the first time in a pilot study.

PATIENTS AND METHODS: A total of 36 patients performed daily vibrotactile **neurofeedback** training (for 10 days) based on a sway analysis on the first day. The reduction of body sway and vertigo symptom scale (VSS) scores were calculated after the training and compared with those of the placebo group.

RESULTS: All five patient groups (characterized by different vestibular disorders) which performed the training with the correct feedback signal showed reduced body sway and VSS score (n=30). This effect was not visible in the placebo group.

CONCLUSIONS: Individualized vibrotactile **neurofeedback** training as presented here with the Vertiguard® system appeared to improve balance during daily activities in all patient groups investigated, but not in controls. Future studies should investigate the efficacy of this new method in a larger sample as well as its long term effects.

PMID: 21735279 [PubMed - as supplied by publisher]

Clin EEG Neurosci. 2011 Jul;42(3):195-201.

215. *Obsessive compulsive disorder and the efficacy of qEEG-guided neurofeedback treatment: a case series.

Sürmeli T, Ertem A.

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neuropsychiatry@yahoo.com

Abstract
While **neurofeedback** (**NF**) has been extensively studied in the treatment of many disorders, there have been only three published reports, by D.C. Hammond, on its clinical effects in the treatment of obsessive compulsive disorder (OCD). In this paper the efficacy of q**EEG**-guided **NF** for subjects with OCD was studied as a case series. The goal was to examine the clinical course of the OCD symptoms and assess the efficacy of q**EEG** guided **NF** training on clinical outcome measures. Thirty-six drug resistant subjects with OCD were assigned to 9-84 sessions of Q**EEG**-guided **NF** treatment. Daily sessions lasted 60 minutes where 2 sessions with half-hour applications with a 30 minute rest given between sessions were conducted per day. Thirty-three out of 36 subjects who received **NF** training showed clinical improvement according to the Yale-Brown obsessive-compulsive scale (Y-BOCS). The Minnesota multiphasic inventory (MMPI) was administered before and after treatment to 17 of the subjects. The MMPI results showed significant improvements not only in OCD measures, but all of the MMPI scores showed a general decrease. Finally, according to the physicians' evaluation of the subjects using the clinical global impression scale (CGI), 33 of the 36 subjects were rated as improved. Thirty-six of the subjects were followed for an average of 26 months after completing the study. According to follow-up interviews conducted with them and/or their family members 19 of the subjects maintained the improvements in their OCD symptoms. This study provides good evidence for the efficacy of **NF** treatment in OCD. The results of this study encourage further controlled research in this area.

PMID: 21870473 [PubMed - in process]

Clin Pediatr (Phila). 2011 Jul;50(7):615-22. Epub 2011 May 10.

216. *Computer-based attention training in the schools for children with attention deficit/hyperactivity disorder: a preliminary trial.

Steiner NJ, Sheldrick RC, Gotthelf D, Perrin EC.

Floating Hospital for Children, Boston, MA, USA. nsteiner@tuftsmedicalcenter.org

Abstract
Objective. This study examined the efficacy of 2 computer-based training systems to teach children with attention deficit/hyperactivity disorder (ADHD) to attend more effectively. Design/methods. A total of 41 children with ADHD from 2 middle schools were randomly assigned to receive 2 sessions a week at school of either **neurofeedback** (**NF**) or attention training through a standard computer format (SCF), either immediately or after a 6-month wait (waitlist control group). Parents, children, and teachers completed questionnaires pre- and postintervention. Results. Primary parents in the **NF** condition reported significant ($P < .05$) change on Conners's Rating Scales-Revised (CRS-R) and Behavior Assessment Scales for Children (BASC) subscales; and in the SCF condition, they reported significant ($P < .05$) change on the CRS-R Inattention scale and ADHD index, the BASC Attention Problems Scale, and on the Behavioral Rating Inventory of Executive Functioning (BRIEF). Conclusion. This randomized control trial provides preliminary evidence of the effectiveness

of computer-based interventions for ADHD and supports the feasibility of offering them in a school setting.

PMID: 21561933 [PubMed - in process]

Curr Opin Psychiatry. 2011 Jul;24(4):291-300.

217. *Complementary medicine for children and young people who have attention deficit hyperactivity disorder.

Skokauskas N, McNicholas F, Masaud T, Frodl T.

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Abstract

PURPOSE OF REVIEW: Despite effectiveness of medication in treating children and young people who have attention deficit hyperactivity disorder (ADHD), concerns about the effects of medication on children's developing brains, adverse side-effects, possibility of long-term use, and compliance issues have all contributed to the continuing search for alternative therapies. This article reviews the latest scientific evidence of the effectiveness and safety of these treatments in ADHD.

RECENT FINDINGS: Although there is evidence from a large randomized controlled study that **neurofeedback** has positive effects on reducing children's symptoms of ADHD, most recent randomized controlled trials have generally yielded negative results. Some positive results exist from a pilot study of repetitive transcranial magnetic stimulation. However, the sample size was far too small to enable any conclusions to be drawn about the evidence. Findings from the recent randomized controlled trials of supplements of essential fatty acids in children who have ADHD clearly demonstrated lack of superiority compared with placebo.

SUMMARY: Notwithstanding efforts made to increase the scientific rigor of previous studies, more recent studies have generally been unsuccessful in demonstrating adequate treatment effects of complementary medicine on children who have ADHD. Currently, there is no proof that complementary medicine provides a better alternative for children who have ADHD than treatments that are currently available within multimodal therapy.

PMID: 21602686 [PubMed - in process]

Science. 2011 Jun 24;332(6037):1568-71. Epub 2011 May 26.

218. Selective attention from voluntary control of neurons in prefrontal cortex.

Schafer RJ, Moore T.

Department of Neurobiology, Stanford University School of Medicine, Stanford, CA 94305, USA.

Abstract

Animals can learn to voluntarily control neuronal activity within various brain areas through operant conditioning, but the relevance of that control to cognitive functions is unknown. We found that rhesus monkeys can control the activity of neurons within the frontal eye field (FEF), an oculomotor area of the prefrontal cortex. However, operantly driven FEF activity was primarily associated with selective visual attention, and not oculomotor preparation. Attentional effects were untrained and were observed both behaviorally and neurophysiologically. Furthermore, selective attention correlated with voluntary, but not spontaneous, fluctuations in FEF activity. Our results reveal a specific association of voluntarily driven neuronal activity with "top-down" attention and suggest a basis for the use of **neurofeedback** training to treat disorders of attention.

Comment in Science. 2011 Jun 24;332(6037):1512-3.

PMID: 21617042 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2011 Jun 9. [Epub ahead of print]

219. *EEG Biofeedback Treatment Improves Certain Attention and Somatic Symptoms in Fibromyalgia: A Pilot Study.

Caro XJ, Winter EF.

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Abstract
Fibromyalgia (FMS) is a chronic, painful disorder often associated with measurable deficiencies in attention. Since **EEG biofeedback** (**EEG**-BF) has been used successfully to treat attention problems, we reasoned that this modality might be helpful in the treatment of attention problems in FMS. We also speculated that improvement in central nervous system (CNS) function might be accompanied by improvement in FMS somatic symptoms. We studied fifteen FMS patients with attention problems, demonstrated by visual and auditory continuous performance testing (CPT), while completing 40 or more **EEG**-BF sessions. Training consisted of a "**SMR** protocol" that augmented 12-15 Hz brainwaves (sensory motor rhythm; **SMR**), while simultaneously inhibiting 4-7 Hz brainwaves (theta) and 22-30 Hz brainwaves (high beta). Serial measurements of pain, fatigue, psychological distress, morning stiffness, and tenderness were also obtained. Sixty-three FMS patients who received standard medical care, but who did not receive **EEG**-BF, served as controls. Visual, but not auditory, attention improved significantly ($P < 0.008$). **EEG**-BF treated subjects also showed improvement in tenderness, pain and fatigue. Somatic symptoms did not change significantly in controls. Visual attention parameters and certain somatic features of FMS appear to improve with an **EEG**-BF **SMR** protocol. **EEG**-BF training in FMS deserves further study.

PMID: 21656150 [PubMed - as supplied by publisher]

Neuroscientist. 2011 Jun 7. [Epub ahead of print]

220. Real-Time fMRI: A Tool for Local Brain Regulation.

Caria A, Sitaram R, Birbaumer N.

Institute of Medical Psychology & Behavioral Neurobiology, Eberhard-Karls-University of Tübingen, Germany; Università di Trento, Trento, Italy.

Abstract
Real-time **fMRI** permits simultaneous measurement and observation of brain activity during an ongoing task. One of the most challenging applications of real-time **fMRI** in neuroscientific and clinical research is the possibility of acquiring volitional control of localized brain activity using real-time **fMRI** -based **neurofeedback** protocols. Real-time **fMRI** allows the experimenter to noninvasively manipulate brain activity as an independent variable to observe the effects on behavior. Real-time **fMRI neurofeedback** studies demonstrated that learned control of the local brain activity leads to specific changes in behavior. Here, the authors describe the implementation and application of real-time **fMRI** with particular emphasis on the self-regulation of local brain activity and the investigation of brain-function relationships. Real-time **fMRI** represents a promising new approach to cognitive neuroscience that could complement traditional neuroimaging techniques by providing more causal insights into the functional role of circumscribed brain regions in behavior.

PMID: 21652587 [PubMed - as supplied by publisher]

Int J Behav Med. 2011 Jun 3. [Epub ahead of print]

221. *Quantification of Adverse Events Associated with Functional MRI Scanning and with Real-Time fMRI-Based Training.

Hawkinson JE, Ross AJ, Parthasarathy S, Scott DJ, Laramee EA, Posecion LJ, Rekshan WR, Sheau KE, Njaka ND, Bayley PJ, Decharms RC.

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Abstract
BACKGROUND: Although functional magnetic resonance imaging (**fMRI**) is in widespread research use, the safety of this approach has not been extensively quantitatively evaluated. Real-time **fMRI** (rt**fMRI**)-based training paradigms use **fMRI neurofeedback** and cognitive strategies to alter regional brain activation, and are currently being evaluated as a novel approach to treat neurological and psychiatric conditions.

PURPOSE: The purpose of this study is to determine the incidence and severity of any adverse events that might be caused by changes in brain activation brought about through **fMRI** or through rt**fMRI**-based training paradigms.

METHOD: Quantitative adverse event self-report data were obtained from 641 functional imaging scans in 114 chronic pain patients participating in a research clinical trial examining repeated **fMRI** scans and rt**fMRI**-based training. Participants recorded potential adverse events during non-scanning baseline, **fMRI** scanning, or rt**fMRI**-based training sessions.

RESULTS: There were no significant increases in the number of reported adverse events following **fMRI** or rt**fMRI** scanning sessions compared to baseline non-scanning sessions in

a chronic pain trial (N = 88). There were no reported adverse events of any kind for over 90% of sessions during the course of rt**fMRI**-based training. When adverse events were reported, they were almost exclusively mild or moderate in severity and similar to those observed in a non-scanning baseline session. There was no increase in adverse events reported by participants receiving feedback from any of four brain regions during repeated rt**fMRI**-based training scans compared to non-scanning baseline sessions. For chronic pain patients completing the rt**fMRI**-based training paradigm including up to a total of nine scan sessions (N = 69), neither the number nor severity of reported events increased during the **fMRI** or rt**fMRI** scanning portions of the paradigm. There were no significant increases in the number of reported adverse events in participants who withdrew from the study.

CONCLUSION: Repeated **fMRI** scanning and rt**fMRI** training, consisting of repeated **fMRI** scanning in conjunction with cognitive strategies and real-time feedback from several regions of interest in multiple brain systems to control brain region activation, were not associated with an increase in adverse event number or severity. These results demonstrate the safety of repetitive **fMRI** scanning paradigms similar to those in use in many laboratories worldwide, as well as the safety rt**fMRI**-based training paradigms.

PMID: 21633905 [PubMed - as supplied by publisher]

Epilepsy Res. 2011 Jun;95(1-2):136-43. Epub 2011 May 7.

222. Do surface DC-shifts affect epileptic hippocampal EEG activity?

Fritz NE, Fell J, Burr W, Axmacher N, Elger CE, Helmstaedter C.

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Abstract
Despite considerable research on **EEG-feedback** of slow cortical potentials (**SCP**s) for seizure control in epilepsy, the underlying mechanisms and the direct effects on intracerebral pathological activity within the focal area remain unclear. Intrahippocampal **EEG** recordings from four patients with temporal lobe epilepsy and implanted electrodes were analyzed with regard to spike activity and power in 10 frequency bands (0.5-148Hz) during **SCP feedback** based on surface recordings (position Cz). Trials with positive, negative and indifferent **SCP**s were contrasted. Three of the four patients showed changes in spike activity during **SCP**s, but these were inconsistent between patients, and resulted in increased and decreased activity in both positive and negative **SCP**s. Spectral analysis revealed that in all patients, positive surface shifts showed a bi-hemispheric higher power in the high-frequency activity above 40Hz. Two patients showed a higher power also during negative shifts, both in high-frequency activity and one in most other frequency bands. Feedback-related power effects did not differ between focal and non-focal side. The inconsistent change in spiking activity and the lack of decrease of power in pathology associated frequency bands during **SCP**s show that these **SCP**s do not decrease pathological activity within the epileptic focus. A possible relation of higher power in high-frequency activity during positive **SCP**s to cognitive processes, such as memory functions, is discussed.

PMID: 21550209 [PubMed - in process]

Georgian Med News. 2011 May;(194):24-8.

223. *The psychological aspects of burning mouth syndrome.

Kenchadze R, Iverieli M, Okribelashvili N, Geladze N, Khachapuridze N.

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Abstract
It should be emphasized that at the present stage there is no consensus achieved regarding the etiopathogenesis of BMS. Almost all researchers point to lots of factors, simultaneously participating in genesis and development of BMS and at the same time most of them agreed on one - psychological factors play a crucial role in formation and maintenance of painful sensations. The aim of the study was the identification of psychological or psychiatric deviations (changes) among the patients with BMS to perform an adequate differentiated therapy. Clinico-psychological examination (dentist, neurologist, psychiatrist) was carried out in 39 patients from 46 to 70 years of age. Among them women - 36 and men - 3. To identify clinical types of BMS a classification of P.J. Lamey (1996) was used and as a result, depression, insomnia, cancerophobia, severe neurologic disorders, phobic syndrome were revealed. Three main categories - a chronic somatoform dysfunction (23 cases), chronic vegetative disorders (8), and chronic pain phenomenon (12) were identified. Only in one case was revealed a paranoid syndrome. Alongside with the well-known scheme of treatment (antidepressants, anticonvulsants, or neuroleptics) Psychotherapy was conducted, while **EEG-feedback** (**Biofeedback**, **Neurofeedback**) method was used for the first time. A number of important decisions were made the most important of which are the following: BMS - must be regarded as a psychosomatic problem rather than a psychiatric disorder. In addition to psychotherapy, using of **EEG - feedback** method greatly improved patients' condition and in 4 cases BMS clinical manifestations were evened-out completely.

PMID: 21685517 [PubMed - in process]

Nervenarzt. 2011 May;82(5):590-6.

224. *[Psychobiosocial interventions for autism].

[Article in German]
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Abstract
A multitude of interventions is offered for the treatment of autism spectrum disorders (ASD). However, only few have demonstrated scientific evidence, and even the evaluated methods need further examination of their mechanisms and scope. This article provides a brief summary of the premises and principles of successful psychobiosocial ASD intervention. ABA, TEACCH, PECS, social skills and cognitive training are described as examples for

established approaches to ASD. Training of μ-suppression using **neurofeedback** and reanimation of the fusiform gyrus and amygdala using computer-aided facial affect recognition training are introduced as neurobiologically based ASD interventions.

PMID: 21523442 [PubMed - in process]

Span J Psychol. 2011 May;14(1):374-84.

225. *A new neurofeedback protocol for depression.

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Abstract
CONTEXT: **Neurofeedback** represents an exciting complementary option in the treatment of depression that builds upon a huge body of research on electroencephalographic correlates of depression.

OBJECTIVE: The objectives of this article are threefold: review the literature on **neurofeedback** protocols for depression; introduce a new protocol, which aims to synthesize the best qualities of the currently available protocols; and present the results of a small clinical experiment with the new protocol.

METHOD: Structured survey of the literature; software development; clinical trial with one subject, submitted to ten sessions of **neurofeedback** (one hour each).

RESULTS: Currently there are twenty-one articles in **neurofeedback** for depression, among which only six present original experimental results. All of them report positive results with the technique. The most used protocols focus on Alpha inter-hemispheric asymmetry, and Theta/Beta ratio within the left prefrontal cortex. Our new protocol integrates both dimensions in a single circuit, adding to it a third programming line, which divides Beta frequencies and reinforces the decrease of Beta-3, in order to reduce anxiety. The favorable outcome of our clinical experiment, suggests that new research with this protocol is worthwhile.

PMID: 21568194 [PubMed - indexed for MEDLINE]

Brain Nerve. 2011 Apr;63(4):385-392.

226. *[Biofeedback Treatment for Epilepsy].

[Article in Japanese]
Nagai Y, Matsuura M.

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Abstract
Abstract Anti-epileptic drugs are the mainstay in the management of epilepsy. However, approximately 30% of patients continue to have seizures despite optimal drug therapy. Behavioural interventions that include **biofeedback** have become increasingly popular over the last 3 decades, and the results have mostly been encouraging. **Biofeedback** is a non-

invasive behavioural treatment that enables a patient to gain volitional control over a physiological process. In epilepsy, targeted parameters for **biofeedback** include electroencephalographic (**EEG**) measures of cortical activity, such as different **EEG** frequencies or cortical potentials (i.e., **neurofeedback**), and peripheral autonomic activity, such as Galvanic Skin Response (GSR). In this review, **biofeedback** using Sensory Motor Rhythm (**SMR**), Slow Cortical Potentials (**SCP**), and GSR are discussed. **SMR biofeedback** was established in the 1970s and is the most prominent methodology for **biofeedback** treatment of epilepsy in published literature. The technique is now regaining its popularity. **SCP biofeedback** was introduced in the 1990s. In contrast to **SMR biofeedback**, which modulates the frequency components of **EEG**, **SCP biofeedback** focuses on the regulation of potential changes (amplitude of DC shift). The clinical trials conducted using **SCP biofeedback** were larger than those conducted using **SMR biofeedback**, and their overall outcomes were promising. GSR **biofeedback** is a relatively new methodology in its application to epilepsy and focuses on the modulation of electrodermal measures of sympathetic activity. Compared to the **neurofeedback** approach, GSR **biofeedback** is much easier to implement, and evidence suggests that its clinical benefits can be achieved more rapidly. Although the **biofeedback** treatment may never achieve the status of an alternative to pharmacotherapy for epilepsy, current research findings strongly suggest that **biofeedback** has the potential to become a potent adjunctive non-pharmacological approach to reduce seizure frequency in patient with drug-resistant epilepsy. Further research, especially a well-controlled large clinical trial, is necessary and anticipated.

PMID: 21441642 [PubMed - as supplied by publisher]

Brain Stimul. 2011 Apr;4(2):122-3. Epub 2010 Sep 8.

227. One step more toward new therapeutic options in brain stimulation: two models of EEG-based rTMS--from "EEG-contingent rTMS" to "EEG-biofeedback rTMS".

Micoulaud-Franchi JA, Vion-Dury J.

PMID: 21511215 [PubMed - indexed for MEDLINE]

Eur Child Adolesc Psychiatry. 2011 Apr;20(4):197-207.

228. *European clinical guidelines for Tourette syndrome and other tic disorders. Part III: behavioural and psychosocial interventions.

Verdellen C, van de Griendt J, Hartmann A, Murphy T; ESSTS Guidelines Group.

HSK Group/Expertise Centre Tics, Hambakenwetering 5B, 5231 DD Den Bosch, The Netherlands. c.verdellen@hsk.nl
Erratum in Eur Child Adolesc Psychiatry. 2011 Jul;20(7):377.

Abstract
This clinical guideline provides recommendations for the behavioural and psychosocial interventions (BPI) of children and adolescents with tic disorders prepared by a working group of the European Society for the Study of Tourette Syndrome (ESSTS). A systematic

literature search was conducted to obtain an update on the efficacy of BPI for tics. Relevant studies were identified using computerised searches of the Medline and PsycI**NF**O databases and the Cochrane Library for the years 1950-2010. The search identified no meta-analyses, yet twelve (systematic) reviews and eight randomised controlled trials provided evidence for the current review. Most evidence was found for habit reversal training (HRT) and the available but smaller evidence also supports the efficacy of exposure with response prevention (ERP). Both interventions are considered first line behavioural treatments for tics for both children and adults and should be offered to a patient, taking into account his preference. Treatments that are considered second line or add-on behavioural treatments are contingency management, function based interventions and relaxation training. **Neurofeedback** is still experimental. Almost no research was identified that examined the efficacy of psychosocial interventions, e.g., psychoeducation and group work. Based on clinical practice, this guideline recommends behavioural treatment as first line offer to patients in most cases. It should be embedded within a psychoeducational and supportive context and can be combined with drug treatment.

PMID: 21445725 [PubMed - indexed for MEDLINE]

J Neural Eng. 2011 Mar 24;8(2):025008. [Epub ahead of print]

229. Bristle-sensors-low-cost flexible passive dry EEG electrodes for neurofeedback and BCI applications.

Grozea C, Voinescu CD, Fazli S.

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Abstract
In this paper, we present a new, low-cost dry electrode for **EEG** that is made of flexible metal-coated polymer bristles. We examine various standard **EEG** paradigms, such as capturing occipital alpha rhythms, testing for event-related potentials in an auditory oddball paradigm and performing a sensory motor rhythm-based event-related (de-) synchronization paradigm to validate the performance of the novel electrodes in terms of signal quality. Our findings suggest that the dry electrodes that we developed result in high-quality **EEG** recordings and are thus suitable for a wide range of **EEG** studies and **BCI** applications. Furthermore, due to the flexibility of the novel electrodes, greater comfort is achieved in some subjects, this being essential for long-term use.

PMID: 21436526 [PubMed - as supplied by publisher]

Cogn Affect Behav Neurosci. 2011 Mar;11(1):44-51.

230. *Upregulation of emotion areas through neurofeedback with a focus on positive mood.

Johnston S, Linden DE, Healy D, Goebel R, Habes I, Boehm SG.

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Abstract
Real-time **functional magnetic resonance imaging** can be used to feed back signal changes from the brain to participants such that they can train to modulate activation levels in specific brain areas. Here we present the first study combining up-regulation of brain areas for positive emotions with psychometric measures to assess the effect of successful self-regulation on subsequent mood. We localized brain areas associated with positive emotions through presentation of standardized pictures with positive valence. Participants up-regulated activation levels in their target area during specific periods, alternating with rest. Participants attained reliable self-control of the target area by the last of three seven-minute runs. This training effect was supported by an extensive network outside the targeted brain region, including higher sensory areas, paralimbic and orbitofrontal cortex. Self-control of emotion areas was not accompanied by clear changes in self-reported emotions; trend-level improvements on depression scores were counteracted by increases on measures of fatigue, resulting in no overall mood improvement. It is possible that benefits of self-control of emotion networks may only appear in people who display abnormal emotional homeostasis. The use of only a single, short, training session, overlap between positive and negative emotion networks and aversive reactions to the scanning environment may have prevented the detection of subtle changes in mood.

PMID: 21264651 [PubMed - in process]

Georgian Med News. 2011 Mar;(192):47-57.

231. *Changes in cognitive evoked potentials during non pharmacological treatment in children with attention deficit/hyperactivity disorder.

Bakhtadze SZ, Dzhanelidze MT, Khachapuridze NS.

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Abstract
Attention deficit/hyperactivity disorder (ADHD) is one of the most widely spread condition of school aged children affecting 5% of children of this age. The unified consensus of the precise diagnosis of this condition is still absent. This fact encourages the researchers to seek the alternative neurometric tools which will help the clinicians in diagnosis making process of ADHD. The neurophysiologic approaches especially event-related potentials (ERPs) are mostly important from this point of view. The later response of ERPs (P3) reflects the most important parts of executive functioning frequently affected in ADHD children - the process of mental effortfullness to select the appropriate behavior and decision making. Besides the diagnosis the treatment of ADHD is also the point of concern of neurologists and neurophyschologists. In recent years **EEG biofeedback** (**Neurofeedback**-**NF**) have become the alternative treatment as in some cases pharmacological drugs are non effective. The positive impact of **NF** was based on improvement detected by various questionnaires which are less valid but its effectiveness on ERPs parameters is still unknown. Thus we aimed to study the changes of ERPs after **NF** therapy.

METHODS: We have studied 93 children with ADHD of combined subtype (ADHDcom) without any kind of pharmacological treatment. Age range 9-12 years. The children were divided into two subgroups: The first ADHDcom-1 (48 children) were children where **NF**

treatment was carried out and the second subgroup of ADHDcom-2 (45 children) were non treated children.

RESULTS: We have observed statistically significant improvement of parameters of later response like P3 in ADHD-1 compared with ADHD-2 whereas **NF** was non effective for earlier component like N1.

CONCLUSIONS: **NF** can positively affect on the P3 parameters which is very important in ADHD children as P3 reflects the speed of information processing as well as selection of appropriate action and decision making which are frequently affected in ADHD children.

PMID: 21525539 [PubMed - indexed for MEDLINE]

J Altern Complement Med. 2011 Feb;17(2):109-15. Epub 2011 Feb 8.

232. *Neurofeedback-enhanced gamma brainwaves from the prefrontal cortical region of meditators and non-meditators and associated subjective experiences.

Rubik B.

Institute for Frontier Science , Oakland, CA; Graduate College, Interdisciplinary Studies, Union Institute and University, Cincinnati, OH; Integrative Health Studies, California Institute for Integral Studies, San Francisco, CA; and Integrative Health, Saybrook Graduate School and Research Center, San Francisco, CA.

Abstract
Abstract Objectives: This study had two aims: (1) to explore the inner experiences associated with increased production of gamma brainwaves in an initial **neurofeedback** experience; and (2) to measure and compare **neurofeedback**-enhanced increased output from the prefrontal cortical region of meditators and non-meditators, using the Peak Brain Happiness Trainer(™) **neurofeedback** system. Design: This was a controlled pilot study; it involved a single session per subject. Setting: The research was conducted in a nonprofit laboratory in the United States. Subjects: There were 12 adults in 2 groups (N = 12): 6 practitioners of Transcendental Meditation(™) and six controls. Measures: The measures were self-assessed inner experiences and measurements of clarified gamma output at the prefrontal cortical region. Results: (1) Self-assessed descriptions were comparable for both groups; (2) the associations of 16 supplied descriptors with the initial **neurofeedback** experience were comparable for both groups and showed highest scores for "happy" ($p < 0.0001$) and "loving" ($p < 0.0001$), and lowest scores for "stressed" ($p < 0.0001$) and "disappointed" ($p < 0.0001$); (3) baseline measures were comparable for both groups; (4) both groups were able to increase gamma brainwaves using **neurofeedback** ($p < 0.01$); and (5) meditators produced greater increases over controls ($p = 0.02$). Conclusions: The inner experience associated with increased clarified gamma amplitude from the prefrontal cortex apparently involves positive emotions of happiness and love, along with reduced stress. Meditators achieved greater increases in the gamma band from the prefrontal cortical region over controls during an initial **neurofeedback** session.

PMID: 21303197 [PubMed - in process]

J Neural Transm. 2011 Feb;118(2):275-84. Epub 2010 Dec 17.

233. *ADHD and EEG-neurofeedback: a double-blind randomized placebo-controlled feasibility study.

Lansbergen MM, van Dongen-Boomsma M, Buitelaar JK, Slaats-Willemse D.

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Abstract
Electroencephalography (**EEG**)-**neurofeedback** has been shown to offer therapeutic benefits to patients with attention-deficit/hyperactivity disorder (ADHD) in several, mostly uncontrolled studies. This pilot study is designed to test the feasibility and safety of using a double-blind placebo feedback-controlled design and to explore the initial efficacy of individualized **EEG-neurofeedback** training in children with ADHD. Fourteen children (8-15 years) with ADHD defined according to the DSM-IV-TR criteria were randomly allocated to 30 sessions of **EEG-neurofeedback** (n = 8) or placebo feedback (n = 6). Safety measures (adverse events and sleep problems), ADHD symptoms and global improvement were monitored. With respect to feasibility, all children completed the study and attended all study visits and training sessions. No significant adverse effects or sleep problems were reported. Regarding the expectancy, 75% of children and their parent(s) in the active **neurofeedback** group and 50% of children and their parent(s) in the placebo feedback group thought they received placebo feedback training. Analyses revealed significant improvements of ADHD symptoms over time, but changes were similar for both groups. This pilot study shows that it is feasible to conduct a rigorous placebo-controlled trial to investigate the efficacy of **neurofeedback** training in children with ADHD. However, a double-blind design may not be feasible since using automatic adjusted reward thresholds may not work as effective as manually adjusted reward thresholds. Additionally, implementation of active learning strategies may be an important factor for the efficacy of **EEG-neurofeedback** training. Based on the results of this pilot study, changes are made in the design of the ongoing study.

PMID: 21165661 [PubMed - in process]
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3051071/?tool=pubmed

Clin EEG Neurosci. 2011 Jan;42(1):59-61.

234. *QEEG-guided neurofeedback for recurrent migraine headaches.

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Abstract
Seventy-one patients with recurrent migraine headaches, aged 17-62, from one neurological practice, completed a quantitative electroencephalogram (Q**EEG**) procedure. All Q**EEG**

results indicated an excess of high-frequency beta activity (21-30 Hz) in 1-4 cortical areas. Forty-six of the 71 patients selected **neurofeedback** training while the remaining 25 chose to continue on drug therapy. **Neurofeedback** protocols consisted of reducing 21-30 Hz activity and increasing 10 Hz activity (5 sessions for each affected site). All the patients were classified as migraine without aura. For the **neurofeedback** group the majority (54%) experienced complete cessation of their migraines, and many others (39%) experienced a reduction in migraine frequency of greater than 50%. Four percent experienced a decrease in headache frequency of < 50%. Only one patient did not experience a reduction in headache frequency. The control group of subjects who chose to continue drug therapy as opposed to **neurofeedback** experienced no change in headache frequency (68%), a reduction of less than 50% (20%), or a reduction greater than 50% (8%). Q**EEG**-guided **neurofeedback** appears to be dramatically effective in abolishing or significantly reducing headache frequency in patients with recurrent migraine.

PMID: 21309444 [PubMed - indexed for MEDLINE]

Comput Intell Neurosci. 2011;2011:327953. doi: 10.1155/2011/327953. Epub 2011 May 17.

235. rtMEG: a real-time software interface for magnetoencephalography.

Sudre G, Parkkonen L, Bock E, Baillet S, Wang W, Weber DJ.

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Abstract
To date, the majority of studies using magnetoencephalography (**MEG**) rely on off-line analysis of the spatiotemporal properties of brain activity. Real-time **MEG** feedback could potentially benefit multiple areas of basic and clinical research: **brain-machine interfaces**, **neurofeedback** rehabilitation of stroke and spinal cord injury, and new adaptive paradigm designs, among others. We have developed a software interface to stream **MEG** signals in real time from the 306-channel Elekta Neuromag **MEG** system to an external workstation. The signals can be accessed with a minimal delay (≤45 ms) when data are sampled at 1000 Hz, which is sufficient for most real-time studies. We also show here that real-time source imaging is possible by demonstrating real-time monitoring and feedback of alpha-band power fluctuations over parieto-occipital and frontal areas. The interface is made available to the academic community as an open-source resource.

PMID: 21687573 [PubMed - in process] PMCID: PMC3113367 Free PMC Article
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http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3113367/?tool=pubmed

Front Psychol. 2011;2:73. Epub 2011 Apr 26.

236. *Alpha rhythms in audition: cognitive and clinical perspectives.

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Abstract
Like the visual and the sensorimotor systems, the auditory system exhibits pronounced alpha-like resting oscillatory activity. Due to the relatively small spatial extent of auditory cortical areas, this rhythmic activity is less obvious and frequently masked by non-auditory alpha-generators when recording non-invasively using magnetoencephalography (**MEG**) or electroencephalography (**EEG**). Following stimulation with sounds, marked desynchronizations can be observed between 6 and 12 Hz, which can be localized to the auditory cortex. However knowledge about the functional relevance of the auditory alpha rhythm has remained scarce so far. Results from the visual and sensorimotor system have fuelled the hypothesis of alpha activity reflecting a state of functional inhibition. The current article pursues several intentions: (1) Firstly we review and present own evidence (**MEG**, **EEG**, s**EEG**) for the existence of an auditory alpha-like rhythm independent of visual or motor generators, something that is occasionally met with skepticism. (2) In a second part we will discuss tinnitus and how this audiological symptom may relate to reduced background alpha. The clinical part will give an introduction into a method which aims to modulate neurophysiological activity hypothesized to underlie this distressing disorder. Using **neurofeedback**, one is able to directly target relevant oscillatory activity. Preliminary data point to a high potential of this approach for treating tinnitus. (3) Finally, in a cognitive neuroscientific part we will show that auditory alpha is modulated by anticipation/expectations with and without auditory stimulation. We will also introduce ideas and initial evidence that alpha oscillations are involved in the most complex capability of the auditory system, namely speech perception. The evidence presented in this article corroborates findings from other modalities, indicating that alpha-like activity functionally has an universal inhibitory role across sensory modalities.

PMID: 21687444 [PubMed] PMCID: PMC3110491 Free PMC Article
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http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3110491/?tool=pubmed

Hum Brain Mapp. 2011 Jan;32(1):22-31. doi: 10.1002/hbm.20997.

237. *Modulation of subgenual anterior cingulate cortex activity with real-time neurofeedback.

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Abstract
The advent of real-time **neurofeedback** techniques has allowed us to begin to map the controllability of sensory and cognitive and, more recently, affective centers in the brain. The subgenual anterior cingulate cortex (sACC) is thought to be involved in generation of affective states and has been implicated in psychopathology. In this study, we examined whether individuals could use real-time **fMRI neurofeedback** to modulate sACC activity. Following a localizer task used to identify an sACC region of interest, an experimental group of eight women participated in four scans: (1) a pretraining scan in which they were asked to decrease activity in the sACC without **neurofeedback**; (2) two training scans in which sACC **neurofeedback** was presented along with instructions to decrease sACC activity; and (3) a

neurofeedback-free post-training scan. An additional nine women in a yoked feedback control group saw sACC activity from the participants in the experimental group. Activity in the sACC was significantly reduced during **neurofeedback** training in the experimental group, but not in the control group. This training effect in the experimental group, however, did not generalize to the **neurofeedback**-free post-training scan. A psychophysiological interaction analysis showed decreased correlation in the experimental group relative to the sham control group between activity in the sACC and the posterior cingulate cortex during **neurofeedback** training relative to **neurofeedback**-free scans. The finding that individuals can down-modulate the sACC shows that a primary emotion center in which functional abnormality has been strongly implicated in affective disorders can be controlled with the aid of **neurofeedback**.

PMID: 21157877 [PubMed - indexed for MEDLINE] PMCID: PMC3049174 Free PMC Article
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Neuropsychobiology. 2011;63(1):43-51. Epub 2010 Nov 9.

238. Is alpha wave neurofeedback effective with randomized clinical trials in depression? A pilot study.

Choi SW, Chi SE, Chung SY, Kim JW, Ahn CY, Kim HT.

Department of Industrial and Advertising Psychology, Daejeon University, Daejeon, Korea.

Abstract
Frontal asymmetric activation has been proposed to be the underlying mechanism for depression. Some case studies have reported that the enhancement of a relative right frontal alpha activity by an asymmetry **neurofeedback** training leads to improvement in depressive symptoms. In the present study, we examined whether a **neurofeedback** training designed to increase the relative activity of the right frontal alpha band would have an impact on symptoms of depressive subjects suffering from emotional, behavioral, and cognitive problems. Our results indicated that the asymmetry **neurofeedback** training increased the relative right frontal alpha power, and it remained effective even after the end of the total training sessions. In contrast to the training group, the placebo control group did not show a difference. The **neurofeedback** training had profound effects on emotion and cognition. First, we replicated earlier findings that enhancing the left frontal activity led to alleviation of depressive symptoms. Moreover, cognitive tests revealed that the asymmetry training improved performance of executive function tests, whereas the placebo treatment did not show improvement. We preliminarily concluded that the asymmetry training is important for controlling and regulating emotion, and it may facilitate the left frontal lobe function.

PMID: 21063132 [PubMed - indexed for MEDLINE]

Conf Proc IEEE Eng Med Biol Soc. 2010;2010:4238-41.

239. Characteristics of motor imagery based EEG-brain computer interface using combined cue and neuro-feedback.

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Abstract
In this paper, we evaluated **BCI** algorithm using CSP for finding out about realistic possibility of **BCI** based on CSP. **BCI** algorithm that was comprised of CSP and least square linear classifier was evaluated in 10 persons. According to the result of the experiment, the effect of combined cue and **neurofeedback** is evaluated. In case of combined cue, the correlation of combined cue and visual cue is higher than other conditions. And in case of **neurofeedback**, some subject is exceptional but general trend shows the performance improvement by **neurofeedback**.

PMID: 21096902 [PubMed - indexed for MEDLINE]

Conf Proc IEEE Eng Med Biol Soc. 2010;2010:158-61.

240. Demand driven deep brain stimulation: regimes and autoregressive hidden Markov implementation.

Brittain JS, Probert-Smith P, Aziz TZ.

Centre of Excellence in Personalized Healthcare, Institute of Biomedical Engineering, Old Road Campus Research Building, University of Oxford, Headington, OX3 7DQ, UK. john-stuart.aziz@nds.ox.ac.uk

Abstract
Deep brain stimulation is an increasingly prevalent surgical option in the treatment of a multitude of neurological conditions, most notably Parkinson's disease. The development of a **neurofeedback** device is driven primarily by stimulator habituation, surgical risk factors, the cost of battery replacement, and reported neuropsychiatric side-effects under prolonged chronic administration. Here we present two distinct regimes for stimulation delivery in chronic and acute symptomatic conditions, presented in the context of Parkinsonian bradykinesias and tremor. Implementation strategies are discussed with a focus on vector-autoregressive hidden Markov models for tremor prediction. Detection of simple motor actions versus tremor are compared in a preliminary performance analysis.

PMID: 21096527 [PubMed - indexed for MEDLINE]

Prog Brain Res. 2011;192:263-72.

241. *Real-time functional magnetic imaging-brain-computer interface and virtual reality promising tools for the treatment of pedophilia.

Renaud P, Joyal C, Stoleru S, Goyette M, Weiskopf N, Birbaumer N.
Université du Québec en Outaouais, Institut Philippe-Pinel de Montréal, Montréal, Québec, Canada.

Abstract
This chapter proposes a prospective view on using a real-time functional magnetic imaging (rt-**fMRI**) **brain-computer interface (BCI)** application as a new treatment for pedophilia. **Neurofeedback** mediated by interactive virtual stimuli is presented as the key process in this new **BCI** application. Results on the diagnostic discriminant power of virtual characters depicting sexual stimuli relevant to pedophilia are given. Finally, practical and ethical implications are briefly addressed.

PMID: 21763528 [PubMed - in process]

J Neuroeng Rehabil. 2010 Dec 14;7(1):60.

242. *Applying a brain-computer interface to support motor imagery practice in people with stroke for upper limb recovery: a feasibility study.

Prasad G, Herman P, Coyle D, McDonough S, Crosbie J.

Intelligent Systems Research Centre (ISRC), University of Ulster, Magee Campus, Derry, N, Ireland, UK. g.prasad@ulster.ac.uk

Abstract
BACKGROUND: There is now sufficient evidence that using a rehabilitation protocol involving motor imagery (MI) practice in conjunction with physical practice (PP) of goal-directed rehabilitation tasks leads to enhanced functional recovery of paralyzed limbs among stroke sufferers. It is however difficult to confirm patient engagement during an MI in the absence of any on-line measure. Fortunately an **EEG**-based **brain-computer interface** (**BCI**) can provide an on-line measure of MI activity as a **neurofeedback** for the **BCI** user to help him/her focus better on the MI task. However initial performance of novice **BCI** users may be quite moderate and may cause frustration. This paper reports a pilot study in which a **BCI** system is used to provide a computer game-based **neurofeedback** to stroke participants during the MI part of a protocol.

METHODS: The participants included five chronic hemiplegic stroke sufferers. Participants received up to twelve 30-minute MI practice sessions (in conjunction with PP sessions of the same duration) on 2 days a week for 6 weeks. The **BCI neurofeedback** performance was evaluated based on the MI task classification accuracy (CA) rate. A set of outcome measures including action research arm test (ARAT) and grip strength (GS), was made use of in assessing the upper limb functional recovery. In addition, since stroke sufferers often experience physical tiredness, which may influence the protocol effectiveness, their fatigue and mood levels were assessed regularly.

RESULTS: Positive improvement in at least one of the outcome measures was observed in all the participants, while improvements approached a minimal clinically important difference (MCID) for the ARAT. The on-line CA of MI induced sensorimotor rhythm (**SMR**) modulation patterns in the form of lateralized event-related desynchronization (ERD) and event-related synchronization (ERS) effects, for novice participants was in a moderate range of 60-75% within the limited 12 training sessions. The ERD/ERS change from the first to the last session was statistically significant for only two participants.

CONCLUSIONS: Overall the crucial observation is that the moderate **BCI** classification performance did not impede the positive rehabilitation trends as quantified with the rehabilitation outcome measures adopted in this study. Therefore it can be concluded that the **BCI** supported MI is a feasible intervention as part of a post-stroke rehabilitation protocol combining both PP and MI practice of rehabilitation tasks. Although these findings are promising, the scope of the final conclusions is limited by the small sample size and the lack of a control group.

PMID: 21156054 [PubMed - in process] PMCID: PMC3017056 Free PMC Article
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J Neuroeng Rehabil. 2010 Dec 2;7(1):57.

243. *Testing the potential of a virtual reality neurorehabilitation system during performance of observation, imagery and imitation of motor actions recorded by wireless functional near-infrared spectroscopy (fNIRS).

Holper L, Muehlemann T, Scholkmann F, Eng K, Kiper D, Wolf M.

Biomedical Optics Research Laboratory, Division of Neonatology, Department of Obstetrics and Gynecology, University Hospital Zurich, Frauenklinikstrasse 10, 8091 Zurich, Switzerland. holper@ini.phys.ethz.ch

Abstract
BACKGROUND: Several neurorehabilitation strategies have been introduced over the last decade based on the so-called simulation hypothesis. This hypothesis states that a neural network located in primary and secondary motor areas is activated not only during overt motor execution, but also during observation or imagery of the same motor action. Based on this hypothesis, we investigated the combination of a virtual reality (VR) based neurorehabilitation system together with a wireless functional near infrared spectroscopy (**fNIRS**) instrument. This combination is particularly appealing from a rehabilitation perspective as it may allow minimally constrained monitoring during neurorehabilitative training.

METHODS: **fNIRS** was applied over F3 of healthy subjects during task performance in a virtual reality (VR) environment: 1) 'unilateral' group (N = 15), contralateral recording during observation, motor imagery, observation & motor imagery, and imitation of a grasping task

performed by a virtual limb (first-person perspective view) using the right hand; 2) 'bilateral' group (N = 8), bilateral recording during observation and imitation of the same task using the right and left hand alternately.

RESULTS: In the unilateral group, significant within-condition oxy-hemoglobin concentration Δ[O2Hb] changes (mean ± SD μmol/l) were found for motor imagery (0.0868 ± 0.5201 μmol/l) and imitation (0.1715 ± 0.4567 μmol/l). In addition, the bilateral group showed a significant within-condition Δ[O2Hb] change for observation (0.0924 ± 0.3369 μmol/l) as well as between-conditions with lower Δ[O2Hb] amplitudes during observation compared to imitation, especially in the ipsilateral hemisphere ($p < 0.001$). Further, in the bilateral group, imitation using the non-dominant (left) hand resulted in larger Δ[O2Hb] changes in both the ipsi- and contralateral hemispheres as compared to using the dominant (right) hand.

CONCLUSIONS: This study shows that our combined VR-**fNIRS** based neurorehabilitation system can activate the action-observation system as described by the simulation hypothesis during performance of observation, motor imagery and imitation of hand actions elicited by a VR environment. Further, in accordance with previous studies, the findings of this study revealed that both inter-subject variability and handedness need to be taken into account when recording in untrained subjects. These findings are of relevance for demonstrating the potential of the VR-**fNIRS** instrument in **neurofeedback** applications.

PMID: 21122154 [PubMed - in process] PMCID: PMC3014953 Free PMC Article
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http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3014953/?tool=pubmed

PLoS One. 2010 Nov 11;5(11):e15474.

244. Speeded near infrared spectroscopy (NIRS) response detection.

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Abstract
The hemodynamic response measured by Near Infrared Spectroscopy (**NIRS**) is temporally delayed from the onset of the underlying neural activity. As a consequence, **NIRS** based **brain-computer-interfaces** (**BCI**s) and **neurofeedback** learning systems, may have a latency of several seconds in responding to a change in participants' behavioral or mental states, severely limiting the practical use of such systems. To explore the possibility of reducing this delay, we used a multivariate pattern classification technique (linear support vector machine, SVM) to decode the true behavioral state from the measured neural signal and systematically evaluated the performance of different feature spaces (signal history, history gradient, oxygenated or deoxygenated hemoglobin signal and spatial pattern). We found that the latency to decode a change in behavioral state can be reduced by 50% (from 4.8 s to 2.4 s), which will enhance the feasibility of **NIRS** for real-time applications.

PMID: 21085607 [PubMed - in process] PMCID: PMC2978722 Free PMC Article

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http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2978722/?tool=pubmed

Magn Reson Med. 2010 Nov 3. [Epub ahead of print]

245. Multiecho coarse voxel acquisition for neurofeedback fMRI.

Kuo AY, Chiew M, Tam F, Cunningham C, Graham SJ.

Department of Medical Biophysics, University of Toronto, Toronto, Ontario, Canada.

Abstract
"Real-time" functional magnetic resonance imaging (**fMRI**) is starting to be used in **neurofeedback** applications, enabling individuals to regulate their brain activity for therapeutic purposes. These applications use two-dimensional multislice echo planar or spiral readouts to image the entire brain volume, often with a much smaller region of interest within the brain monitored for **feedback** purposes. Given that such brain activity should be sampled rapidly, it is worthwhile considering alternative functional magnetic resonance imaging pulse sequences that trade spatial resolution for temporal resolution. We developed a prototype sequence localizing a column of magnetization by outer volume saturation, from which densely sampled transverse relaxation time decays are obtained at coarse voxel locations using an asymmetric gradient echo train. For 5 × 20 × 20 mm3 voxels, 256 echoes are sampled at ~1 msec and then combined in weighted summation to increase functional magnetic resonance imaging signal contrast. This multiecho coarse voxel pulse sequence is shown experimentally at 1.5 T to provide the same signal contrast to noise ratio as obtained by spiral imaging for a primary motor cortex region of interest, but with potential for enhanced temporal resolution. A **neurofeedback** experiment also illustrates measurement and calculation of functional magnetic resonance imaging signals within 1 sec, emphasizing the future potential of the approach. Magn Reson Med, 2010. © 2010 Wiley-Liss, Inc.

PMID: 21049480 [PubMed - as supplied by publisher]

Z Kinder Jugendpsychiatr Psychother. 2010 Nov;38(6):409-19; quiz 419-20.

246. *[Neurofeedback training in children with ADHD: behavioral and neurophysiological effects].

[Article in German]
Gevensleben H, Moll GH, Heinrich H.

Kinder- und Jugendpsychiatrie, Universitätsmedizin Göttingen.

Abstract
In a multicentre randomised controlled trial, we evaluated the clinical efficacy of **neurofeedback** (**NF**) training in children with ADHD and investigated the mechanisms underlying a successful training. We used an attention skills training, coupled with the training setting and demands made upon participants, as the control condition. At the behavioural level, **NF** was superior to the control group concerning core ADHD symptomatology as well as associated domains. For the primary outcome measure

(improvement in the FBB-HKS total score), the effect size was .60. The same pattern of results was obtained at the 6-month follow-up. Thus, **NF** may be seen as a clinically effective module in the treatment of children with ADHD. At the neurophysiological level (**EEG**, ERPs), specific effects for the two **NF** protocols, theta/beta training, and training of slow cortical potentials were demonstrated. For example, for theta/beta training, a decrease of theta activity in the **EEG** was associated with a reduction of ADHD symptomatology. **SCP** training was accompanied inter alia by an increase in the contingent negative variation in the attention network test; thus, children were able to allocate more resources for preparation. **EEG**- and ERP-based predictors were also found. The present article reviewed the findings of the original papers related to the trial and outlines future research topics.

PMID: 21128217 [PubMed - indexed for MEDLINE]

Neurosci Behav Physiol. 2010 Nov;40(9):951-4. Epub 2010 Oct 19.

247. Changes in the power levels of cortical EEG rhythms in cats during training using acoustic feedback signals.

Fokina YO, Kulichenko AM, Pavlenko VB.

Department of Human and Animal Physiology and Biophysics, Vernadskii National University of Taurida, Simferopol, Ukraine.

Abstract
Chronic experiments on two conscious cats were performed to study the dynamics of the ratios of spectral power levels of beta and theta rhythms and neuron activity in the dopaminergic system of the ventral tegmentum during **EEG feedback** sessions. Training was performed using a model in which the level of sound signals presented to the animals decreased as the spectral power ratios of the **EEG** beta and theta rhythms recorded in the frontal leads increased. In a control series, the changes in the sound signal level were independent of the ongoing **EEG**. These experiments showed that the ratio of the spectral power levels of the beta and theta rhythms changed during **feedback** sessions, with increases in the spectral power of the beta rhythm and decreases in the spectral power of the theta rhythm. These changes were accompanied by increases in the activity of presumptive dopaminergic neurons in the ventral tegmentum.

PMID: 20954005 [PubMed - in process]

Appl Psychophysiol Biofeedback. 2010 Oct 29. [Epub ahead of print]

248. Predicting Successful Learning of SMR Neurofeedback in Healthy Participants: Methodological Considerations.

Weber E, Köberl A, Frank S, Doppelmayr M.

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Abstract

Neurofeedback (**NF**) is a tool that has proven helpful in the treatment of various disorders such as epilepsy or attention deficit disorder (ADHD). Depending on the respective application, a high number of training sessions might be necessary before participants can voluntarily modulate the electroencephalographic (**EEG**) rhythms as instructed. In addition, many individuals never learn to do so despite numerous training sessions. Thus, we are interested in determining whether or not performance during the early training sessions can be used to predict if a participant will learn to regulate the **EEG** rhythms. Here, we propose an easy to use, but accurate method for predicting the performance of individual participants. We used a sample set of sensorimotor rhythm (**SMR** 12-15 Hz) **NF** training sessions (experiment 1) to predict the performance of the participants of another study (experiment 2). We then used the data obtained in experiment 2 to predict the performance of participants in experiment 1. We correctly predicted the performance of 12 out of 13 participants in the first group and all 14 participants in the second group; however, we were not able to make these predictions before the end of the eleventh training session.

PMID: 21053066 [PubMed - as supplied by publisher]

J Neuroimaging. 2010 Oct 26. doi: 10.1111/j.1552-6569.2010.00529.x. [Epub ahead of print]

249. Intermittent "Real-time" fMRI Feedback Is Superior to Continuous Presentation for a Motor Imagery Task: A Pilot Study.

Johnson KA, Hartwell K, Lematty T, Borckardt J, Morgan PS, Govindarajan K, Brady K, George MS.

From the CNS Division, Department of Psychiatry (KH, TL, KB), Brain Stimulation Laboratory, Department of Psychiatry (KAJ, JB, MSG), Center for Advanced Imaging Research (KAJ, PSM, KG, MSG), and Department of Radiology (PSM), Medical University of South Carolina, Charleston, SC; Ralph H. Johnson VA Medical Center, Charleston, SC (KH, KB, MSG); and Systems Neuroscience and Pain Laboratory, Department of Anesthesiology, Stanford University, Palo Alto, CA (KAJ).

Abstract

BACKGROUND: Real-time functional **MRI feedback** (RT**fMRI**f) is a developing technique, with unanswered methodological questions. Given a delay of seconds between neural activity and the measurable hemodynamic response, one issue is the optimal method for presentation of **neurofeedback** to subjects. The primary objective of this preliminary study was to compare the methods of continuous and intermittent presentation of **neural feedback** on targeted brain activity.

METHODS: Thirteen participants performed a motor imagery task and were instructed to increase activation in an individually defined region of left premotor cortex using RT**fMRI**f. The **fMRI** signal change was compared between real and false **feedback** for scans with either continuous or intermittent **feedback** presentation.

RESULTS: More individuals were able to increase their **fMRI** signal with intermittent **feedback**, while some individuals had decreased signal with continuous **feedback**. The evaluation of **feedback** itself activated an extensive amount of brain regions, and false **feedback** resulted in brain activation outside of the individually defined region of interest.

CONCLUSIONS: As implemented in this study, intermittent presentation of **feedback** is more effective than continuous presentation in promoting self-modulation of brain activity. Furthermore, it appears that the process of evaluating **feedback** involves many brain regions that can be isolated using intermittent presentation.

PMID: 20977537 [PubMed - as supplied by publisher]

Eur Arch Psychiatry Clin Neurosci. 2010 Oct 9. [Epub ahead of print]

250. Social reinforcement can regulate localized brain activity.

Mathiak KA, Koush Y, Dyck M, Gaber TJ, Alawi E, Zepf FD, Zvyagintsev M, Mathiak K.

Department of Psychiatry and Psychotherapy, RWTH Aachen University, Pauwelsstr. 30, 52074, Aachen, Germany, kamathiak@ukaachen.de.

Abstract
Social learning is essential for adaptive behavior in humans. **Neurofeedback** based on functional magnetic resonance imaging (**fMRI**) trains control over localized brain activity. It can disentangle learning processes at the neural level and thus investigate the mechanisms of operant conditioning with explicit social reinforcers. In a pilot study, a computer-generated face provided a positive **feedback** (smiling) when activity in the anterior cingulate cortex (ACC) increased and gradually returned to a neutral expression when the activity dropped. One female volunteer without previous experience in **fMRI** underwent training based on a social reinforcer. Directly before and after the **neurofeedback** runs, neural responses to a cognitive interference task (Simon task) were recorded. We observed a significant increase in activity within ACC during the **neurofeedback** blocks, correspondent with the a-priori defined anatomical region of interest. In the course of the **neurofeedback** training, the subject learned to regulate ACC activity and could maintain the control even without direct **feedback**. Moreover, ACC was activated significantly stronger during Simon task after the **neurofeedback** training when compared to before. Localized brain activity can be controlled by social reward. The increased ACC activity transferred to a cognitive task with the potential to reduce cognitive interference. Systematic studies are required to explore long-term effects on social behavior and clinical applications.

PMID: 20936298 [PubMed - as supplied by publisher]

Nonlinear Biomed Phys. 2010 Sep 30;4(1):4.

251. *QEEG characteristics and spectrum weighted frequency for children diagnosed as autistic spectrum disorder.

Pop-Jordanova N, Zorcec T, Demerdzieva A, Gucev Z.

Pediatric Clinic, Faculty of Medicine, University of Skopje, Macedonia. npopjordanova@gmail.com.

Abstract

BACKGROUND: Autistic spectrum disorders are a group of neurological and developmental disorders associated with social, communication, sensory, behavioral and cognitive impairments, as well as restricted, repetitive patterns of behavior, activities, or interests.The aim of this study was a) to analyze Q**EEG** findings of autistic patients and to compare the results with data base; and b) to introduce the calculation of spectrum weighted frequency (brain rate) as an indicator of general mental arousal in these patients.

RESULTS: Results for Q-**EEG** shows generally increased delta-theta activity in frontal region of the brain. Changes in Q**EEG** pattern appeared to be in a non-linear correlation with maturational processes.Brain rate measured in CZ shows slow brain activity (5. 86) which is significantly lower than normal and corresponds to low general mental arousal.Recent research has shown that autistic disorders have as their basis disturbances of neural connectivity. **Neurofeedback** seems capable of remediating such disturbances when these data are considered as part of treatment planning.

CONCLUSIONS: Prognosis of this pervasive disorder depends on the intellectual abilities: the better intellectual functioning, the possibilities for life adaptation are higherQ**EEG** shows generally increased delta-theta activity in frontal region of the brain which is related to poor cognitive abilities.Brain rate measured in CZ shows slow brain activity related to under arousal. Pharmacotherapy combined with behavior therapy, social support and especially **neurofeedback** technique promise slight improvements.

PMID: 20920283 [PubMed - in process] Free Article
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http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2959057/?tool=pubmed.

J Neurosci Methods. 2010 Sep 25. [Epub ahead of print]

252. Bilateral adaptation and neurofeedback for brain computer interface system.

Li J, Zhang L.

MOE-Microsoft Key Laboratory for Intelligent Computing and Intelligent Systems, Department of Computer Science and Engineering, Shanghai Jiao Tong University, Shanghai 200240, China.

Abstract

Brain computer interface (**BCI**) provides an alternative communication pathway between human brain and external devices without the participation of peripheral nerves and muscles. Although the **BCI** techniques have been developing quickly in recent decades, there still exist a number of unsolved problems, such as instability, unreliability and low transmission rate in real time applications of **BCI**. In the present study, we design a bilateral training framework for both human and the **BCI** system to improve recognition accuracy and to reduce the impact caused by non-stationary **EEG** signal. The statistical analysis is used to test whether there is an obvious improvement in recognition performance after using the bilateral adaptation strategy. The statistical analysis indicates that our algorithm is significantly different from the

existing method in both conditions of trials (p=0.0073) and sliding time windows (p=0.00077). The results of statistical analysis reconfirm that performance using our algorithm is distinctly improved. The online experiments also demonstrate that the proposed algorithm achieves higher prediction accuracy and reliability compared with the existing method. The objective of our research is to transfer this strategy to some practical applications (e.g., electrical wheelchair control) for the better performance.

PMID: 20875456 [PubMed - as supplied by publisher]

Neuroimage. 2010 Sep 17. [Epub ahead of print]

253. *Neurofeedback training of the upper alpha frequency band in EEG improves cognitive performance.

Zoefel B, Huster RJ, Herrmann CS.

Otto-Von-Guericke-University, Institute for Biology, Madeburg, Germany.

Abstract
In this study, the individually determined upper alpha frequency band in **EEG** (electroencephalogram) was investigated as a **neurofeedback** parameter. Fourteen subjects were trained on five sessions within 1week by means of **feedback** dependent on the current upper alpha amplitude. On the first and fifth session, cognitive ability was tested by a mental rotation test. As a result, eleven of the fourteen subjects showed significant training success. Individually determined upper alpha was increased independently of other frequency bands. The enhancement of cognitive performance was significantly larger for the **neurofeedback** group than for a control group who did not receive **feedback**. Thus, enhanced cognitive control went along with an increased upper alpha amplitude that was found in the **neurofeedback** group only.

PMID: 20850552 [PubMed - as supplied by publisher]
See complete free article at:
http://www.sciencedirect.com/science/article/pii/S105381191001181X

Clin Neurophysiol. 2010 Sep 13. [Epub ahead of print]

254. *Neurofeedback in children with ADHD: Specific event-related potential findings of a randomized controlled trial.

Wangler S, Gevensleben H, Albrecht B, Studer P, Rothenberger A, Moll GH, Heinrich H.

Dept. of Child and Adolescent Mental Health, University of Erlangen-Nürnberg, Schwabachanlage 6+10, D-91054 Erlangen, Germany.

Abstract

OBJECTIVE: In a randomized controlled trial, we could demonstrate clinical efficacy of **neurofeedback** (**NF**) training for children with ADHD (Gevensleben et al., 2009a). The present investigation aimed at learning more about the neuronal mechanisms of **NF** training.

METHODS: Children with ADHD either completed a **NF** training or a computerized attention skills training (ratio 3:2). **NF** training consisted of one block of theta/beta training and one block of slow cortical potential (**SCP**) training, each comprising 18 training units. At three times (pre-training, between the two training blocks and at post-training), event-related potentials (ERP) were recorded during the Attention Network Test. ERP analysis focused on the P3, reflecting inter alia attentional resources for stimulus evaluation, and the contingent negative variation (CNV), primarily related to cognitive preparation.

RESULTS: After **NF** training, an increase of the CNV in cue trials could be observed, which was specific for the **SCP** training. A larger pre-training CNV was associated with a larger reduction of ADHD symptomatology for **SCP** training.

CONCLUSIONS: CNV effects reflect neuronal circuits underlying resource allocation during cognitive preparation. These distinct ERP effects are closely related to a successful **NF** training in children with ADHD. In future studies, neurophysiological recordings could help to optimize and individualize **NF** training.

SIGNIFICANCE: The findings contribute to a better understanding of the mechanisms underlying **NF** training in children with ADHD.

PMID: 20843737 [PubMed - as supplied by publisher]

Clin Neurophysiol. 2010 Sep 10. [Epub ahead of print]

255. *Neurofeedback training in ADHD: More news on specificity.

Brandeis D.

Department of Child and Adolescent Psychiatry, University of Zürich, Switzerland, and Zürich Center for Integrative Human Physiology (ZIHP), Zürich, Switzerland; Department of Child and Adolescent Psychiatry and Psychotherapy, Central Institute of Mental Health, Mannheim, Germany; Neumünsterallee 9 CH 8032 Zürich, Switzerland Tel.: +41 43 499 2763.

PMID: 20833584 [PubMed - as supplied by publisher]

Eur Child Adolesc Psychiatry. 2010 Sep;19(9):715-24. Epub 2010 May 25.

256. *Neurofeedback training in children with ADHD: 6-month follow-up of a randomised controlled trial.

Gevensleben H, Holl B, Albrecht B, Schlamp D, Kratz O, Studer P, Rothenberger A, Moll GH, Heinrich H.

Child and Adolescent Psychiatry, University of Göttingen, v.Siebold-Str. 5, Göttingen, Germany.

Abstract

Neurofeedback (**NF**) could help to improve attentional and self-management capabilities in children with attention-deficit/hyperactivity disorder (ADHD). In a randomised controlled trial, **NF** training was found to be superior to a computerised attention skills training (AST) (Gevensleben et al. in J Child Psychol Psychiatry 50(7):780-789, 2009). In the present paper, treatment effects at 6-month follow-up were studied. 94 children with ADHD, aged 8-12 years, completed either 36 sessions of **NF** training (n = 59) or a computerised AST (n = 35). Pre-training, post-training and follow-up assessment encompassed several behaviour rating scales (e.g., the German ADHD rating scale, FBB-HKS) completed by parents. Follow-up information was analysed in 61 children (ca. 65%) on a per-protocol basis. 17 children (of 33 dropouts) had started a medication after the end of the training or early in the follow-up period. Improvements in the **NF** group (n = 38) at follow-up were superior to those of the control group (n = 23) and comparable to the effects at the end of the training. For the FBB-HKS total score (primary outcome measure), a medium effect size of 0.71 was obtained at follow-up. A reduction of at least 25% in the primary outcome measure (responder criterion) was observed in 50% of the children in the **NF** group. In conclusion, behavioural improvements induced by **NF** training in children with ADHD were maintained at a 6-month follow-up. Though treatment effects appear to be limited, the results confirm the notion that **NF** is a clinically efficacious module in the treatment of children with ADHD.

PMID: 20499120 [PubMed - in process]

Neurosci Lett. 2010 Aug 16;480(2):112-6. Epub 2010 Jun 11.

257. *Acting performance and flow state enhanced with sensory-motor rhythm neurofeedback comparing ecologically valid immersive VR and training screen scenarios.

Gruzelier J, Inoue A, Smart R, Steed A, Steffert T.

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Abstract

Actors were trained in sensory-motor rhythm (**SMR**) **neurofeedback** interfaced with a computer rendition of a theatre auditorium. Enhancement of **SMR** led to changes in the lighting while inhibition of theta and high beta led to a reduction in intrusive audience noise. Participants were randomised to a virtual reality (VR) representation in a ReaCTor, with surrounding image projection seen through glasses, or to a 2D computer screen, which is the conventional **neurofeedback** medium. In addition there was a no-training comparison group. Acting performance was evaluated by three experts from both filmed, studio monologues and Hamlet excerpts on the stage of Shakespeare's Globe Theatre. **Neurofeedback** learning reached an asymptote earlier as did identification of the required mental state following training in the ReaCTor training compared with the computer screen, though groups reached

the same asymptote. These advantages were paralleled by higher ratings of acting performance overall, well-rounded performance, and especially the creativity subscale including imaginative expression, conviction and characterisation. On the Flow State scales both **neurofeedback** groups scored higher than the no-training controls on self-ratings of sense of control, confidence and feeling at-one. This is the first demonstration of enhancement of artistic performance with eyes-open **neurofeedback** training, previously demonstrated only with eyes-closed slow-wave training. Efficacy is attributed to psychological engagement through the ecologically relevant learning context of the acting-space, putatively allowing transfer to the real world otherwise achieved with slow-wave training through imaginative visualisation. The immersive VR technology was more successful than a 2D rendition.

PMID: 20542087 [PubMed - in process]

Ugeskr Laeger. 2010 Aug 16;172(33):2221-5.

258. *[Neurofeedback as ADDH therapy]

[Article in Danish]
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Abstract
The article is a review of the past two decades of research on Attention Deficit Hyperactive Disorder (ADHD) and the documented effect of training with **EEG biofeedback**, often called **neurofeedback**. Research during the past twenty years seems to confirm that 70-80% of patients benefit from **neurofeedback** training. Research from the last ten years, using control groups, comparison between different kinds of treatment and psychometric testing, has to some degree confirmed the early findings. Due to the lack of placebo studies or studies comprising false **feedback**, **neurofeedback** can only be characterized as probably effective.

PMID: 20727288 [PubMed - indexed for MEDLINE]

Neuroimage. 2010 Aug 1. [Epub ahead of print]

259. Computing moment-to-moment BOLD activation for real-time neurofeedback.

Hinds O, Ghosh S, Thompson TW, Yoo JJ, Whitfield-Gabrieli S, Triantafyllou C, Gabrieli JD.

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Abstract
Estimating moment-to-moment changes in blood oxygenation level dependent (BOLD) activation levels from functional magnetic resonance imaging (**fMRI**) data has applications for learned regulation of regional activation, brain state monitoring, and **brain-machine interfaces**. In each of these contexts, accurate estimation of the BOLD signal in as little time as possible is desired. This is a challenging problem due to the low signal-to-noise ratio of

fMRI data. Previous methods for real-time **fMRI** analysis have either sacrificed the ability to compute moment-to-moment activation changes by averaging several acquisitions into a single activation estimate or have sacrificed accuracy by failing to account for prominent sources of noise in the **fMRI** signal. Here we present a new method for computing the amount of activation present in a single **fMRI** acquisition that separates moment-to-moment changes in the **fMRI** signal intensity attributable to neural sources from those due to noise, resulting in a **feedback** signal more reflective of neural activation. This method computes an incremental general linear model fit to the **fMRI** time series, which is used to calculate the expected signal intensity at each new acquisition. The difference between the measured intensity and the expected intensity is scaled by the variance of the estimator in order to transform this residual difference into a statistic. Both synthetic and real data were used to validate this method and compare it to the only other published real-time **fMRI** method.

PMID: 20682350 [PubMed - as supplied by publisher]
See complete free article at:
http://www.sciencedirect.com/science/article/pii/S1053811910010335

Neurosci Lett. 2010 Jul 19;479(1):49-53. Epub 2010 May 15.

260. *The effectiveness of EEG-feedback on attention, impulsivity and EEG: a sham feedback controlled study.

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Abstract

EEG-feedback, also called **neurofeedback**, is a training procedure aimed at altering brain activity, and is used as a treatment for disorders like Attention Deficit/Hyperactivity Disorder (ADHD). Studies have reported positive effects of **neurofeedback** on attention and other dependent variables. However, double-blind studies including a sham **neurofeedback** control group are lacking. The inclusion of such group is crucial to control for unspecific effects. The current work presents a sham-controlled, double-blind evaluation. The hypothesis was that **neurofeedback** enhances attention and decreases impulsive behavior. Participants (n=27) were students selected on relatively high scores on impulsivity/inattention questionnaires (Barrat Impulsivity Scale and Broadbent CFQ). They were assigned to a **neurofeedback** treatment or a sham group. (sham)**Neurofeedback** training was planned for 15 weeks consisting of a total of 30 sessions, each lasting 22 min. Before and after 16 sessions (i.e., interim analyses), q**EEG** was recorded and impulsivity and inattention was assessed using a stop signal task and reversed continuous performance task and two questionnaires. Results of the interim analyses showed that participants were blind with respect to group inclusion, but no trend towards an effect of **neurofeedback** on behavioral measures was observed. Therefore in line with ethical guidelines the experiment was ceased. These results implicate a possible lack of effect of **neurofeedback** when one accounts for non-specific effects. However, the specific form of **feedback** and application of the sham-controlled double-blind design may have diminished the effect of **neurofeedback**.

PMID: 20478360 [PubMed - indexed for MEDLINE]

J Neurother. 2010 Jul;14(3):195-216.

261. *Neurofeedback Effects on Evoked and Induced EEG Gamma Band Reactivity to Drug-related Cues in Cocaine Addiction.

Horrell T, El-Baz A, Baruth J, Tasman A, Sokhadze G, Stewart C, Sokhadze E.

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Abstract

INTRODUCTION: Preoccupation with drug and drug-related items is a typical characteristic of cocaine addicted individuals. It has been shown in multiple accounts that prolonged drug use has a profound effect on the **EEG** recordings of drug addicts when compared to controls during cue reactivity tests. Cue reactivity refers to a phenomenon in which individuals with a history of drug abuse exhibit excessive psychophysiological responses to cues associated with their drug of choice. One of the aims of this pilot study was to determine the presence of an attentional bias to preferentially process drug-related cues using evoked and induced gamma reactivity measures in cocaine addicts before and after biobehavioral treatment based on **neurofeedback**. Another aim was to show that central **SMR** amplitude increase and frontal theta control is possible in an experimental outpatient drug users group over 12 **neurofeedback** sessions.

METHOD: Ten current cocaine abusers participated in this pilot research study using **neurofeedback** combined with Motivational Interviewing sessions. Eight of them completed all planned pre- and post -**neurofeedback** cue reactivity tests with event-related **EEG** recording and clinical evaluations. Cue reactivity test represented a visual oddball task with images from the International Affective Picture System and drug-related pictures. Evoked and induced gamma responses to target and non-target drug cues were analyzed using wavelet analysis.

RESULTS: Outpatient subjects with cocaine addiction completed the biobehavioral intervention and successfully increased **SMR** while keeping theta practically unchanged in 12 sessions of **neurofeedback** training. The addition of Motivational Interviewing helped retain patients in the study. Clinical evaluations immediately after completion of the treatment showed decreased self-reports on depression and stress scores, and urine tests collaborated reports of decreased use of cocaine and marijuana. Effects of **neurofeedback** resulted in a lower **EEG** gamma reactivity to drug-related images in a post-**neurofeedback** cue reactivity test. In particular, evoked gamma showed decreases in power to non-target and to a lesser extent target drug-related cues at all topographies (left, right, frontal, parietal, medial, inferior); while induced gamma power decreased globally to both target and non-target drug cues. Our findings supported our hypothesis that gamma band cue reactivity measures are sufficiently sensitive functional outcomes of **neurofeedback** treatment. Both evoked and induced gamma measures were found capable to detect changes in responsiveness to both target and non-target drug cues.

CONCLUSION: Our study emphasizes the utility of cognitive neuroscience methods based on **EEG** gamma band measures for the assessment of the functional outcomes of **neurofeedback**-based biobehavioral interventions for cocaine use disorders. This approach may have significant potential for identifying both physiological and clinical markers of treatment progress. The results confirmed our prediction that **EEG** changes achieved with **neurofeedback** training will be accompanied by positive **EEG** outcomes in a cue reactivity and clinical improvements.

PMID: 20976131 [PubMed]PMCID: PMC2957125 [Available on 2011/7/1]
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2957125

Appl Psychophysiol Biofeedback. 2010 Jul 8. [Epub ahead of print]

262. *Neurofeedback Intervention in Fibromyalgia Syndrome; a Randomized, Controlled, Rater Blind Clinical Trial.

Kayıran S, Dursun E, Dursun N, Ermutlu N, Karamürsel S.

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Abstract

We designed a randomized, rater blind study to assess the efficacy of **EEG biofeedback** (**Neurofeedback**-**NFB**) in patients with fibromyalgia syndrome (FMS). Eighteen patients received twenty sessions of **NFB**-sensory motor rhythm (**SMR**) treatment (**NFB** group) during 4 weeks, and eighteen patients were given 10 mg per day escitalopram treatment (control group) for 8 weeks. Visual Analog Scales for pain and fatigue, Hamilton and Beck Depression and Anxiety Inventory Scales, Fibromyalgia Impact Questionnaire and Short Form 36 were used as outcome measures which were applied at baseline and 2nd, 4th, 8th, 16th, 24th weeks. Mean amplitudes of **EEG** rhythms (delta, theta, alpha, **SMR**, beta1 and beta2) and theta/**SMR** ratio were also measured in **NFB** group. All post-treatment measurements showed significant improvements in both of the groups (for all parameters $p < 0.05$). **NFB** group displayed greater benefits than controls (for all parameters $p < 0.05$). Therapeutic efficacy of **NFB** was found to begin at 2nd week and reached to a maximum effect at 4th week. On the other hand, the improvements in SSRI treatment were also detected to begin at 2nd week but reached to a maximum effect at 8th week. No statistically significant changes were noted regarding mean amplitudes of **EEG** rhythms ($p > 0.05$ for all). However, theta/**SMR** ratio showed a significant decrease at 4th week compared to baseline in the **NFB** group ($p < 0.05$). These data support the efficacy of **NFB** as a treatment for pain, psychological symptoms and impaired quality of life associated with fibromyalgia.

PMID: 20614235 [PubMed - as supplied by publisher]

Cleve Clin J Med. 2010 Jul;77 Suppl 3:S60-7.

263. *Biofeedback in the treatment of epilepsy.

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Abstract

This review traces the application of electroencephalographic (**EEG**) operant conditioning, or **biofeedback**, from animal research to its emergence as an alternative treatment for the major types of seizure disorder. Initial animal studies focusing on brain mechanisms that mediate learned behavioral inhibition revealed a uniquely correlated 12- to 15-Hz **EEG** rhythm localized to sensorimotor cortex. We labeled this the sensorimotor rhythm, or **SMR**. The similarity of the **SMR** to the known **EEG** spindle pattern during quiet sleep led to the novel idea of attempting to increase the **SMR** using **EEG** operant conditioning. The hypothesis was that this might produce a corresponding increase in sleep spindle activity, thus establishing a common **EEG** marker for the state of motor inhibition. Results supported this hypothesis but led also to the accidental discovery of an anticonvulsant effect on drug-induced seizures in cats and monkeys. Continuing animal studies identified a pattern of neurophysiologic responses correlated with the **SMR** in primary motor pathways. These and other findings were indicative of reduced motor excitability. Simultaneously, we undertook studies in human epileptic subjects that documented a significant reduction in seizure incidence and severity, together with **EEG** pattern normalization. This work expanded internationally, resulting in numerous well-controlled group and single-case studies summarized in recent meta-analyses. Exciting new findings in **functional neuroimaging**/**EEG** correlation studies provide a rational model for the basis of these clinical effects. In recognition of the diversity of clinical applications of **EEG biofeedback** and the complexity of seizure disorders, this review also details specific methods used in our **EEG biofeedback** program.

PMID: 20622079 [PubMed - in process] Free Article
See complete free article at: http://www.ccjm.org/content/77/Suppl_3/S60.long.

Clin EEG Neurosci. 2010 Jul;41(3):170-7.

264. *Effectiveness of neurofeedback training as a treatment for opioid-dependent patients.

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Abstract

Neurofeedback (**NF**) training has been employed as a therapeutic method in substance-dependence disorder over the last three decades. The purpose of the present study was to examine the effectiveness of this method on improvement of comorbid neuro-psychological syndromes in opioid-dependence disorder. Psychopathological and craving dimensions and brain activity signals of 20 opioid dependent patients were measured using Symptom Checklist-90-Revised (SCL-90-R), Heroin Craving Questionnaire (HCQ), and Quantitative Electroencephalography (Q**EEG**). All the patients were undergoing pharmacotherapy. They were assigned to two groups that were matched based on SCL-90-R scores, education and age. The experimental group received 30 sessions of **NF** training in addition to their medicine. The control group received only the usual pharmacotherapy. The probable changes were monitored by reappraisal of all the patients after the treatment. We hypothesized that patients in the experimental group would show more reduction in their comorbid syndromes. The

Multivariate Analysis of Covariance (MANCOVA) showed that the experimental group, in comparison with control group, showed significantly more improvement in all three outcome measures. In the SCL-90-R, improvement was noted with the hypochondriacs, obsession, interpersonal sensitivity, aggression, psychosis, and general symptomatic indexes. In the HCQ, improvement was found in the anticipation of positive outcome, desire to use substance, and total average score. Finally, the Q**EEG** showed positive changes in frontal, central and parietal delta, frontal and central theta, parietal alpha and frontal and central Sensory Motor Rhythm (**SMR**) amplitudes. This study suggests that **NF** can be used as a therapeutic method to ameliorate abnormalities related to opioid-dependence disorders. The results emphasize the importance of neuropsychological interventions in treatment of substance-dependence disorders.

PMID: 20722354 [PubMed - indexed for MEDLINE]

Neuroimage. 2010 Jun 30. [Epub ahead of print]

265. Decoding fMRI brain states in real-time.

Laconte SM.

Abstract

This article reviews a technological advance that originates from two areas of ongoing neuroimaging innovation-(1) the use of multivariate supervised learning to decode brain states and (2) real-time functional magnetic resonance imaging (rt**fMRI**). The approach uses multivariate methods to train a model capable of decoding a subject's brain state from **fMRI** images. The decoded brain states can be used as a control signal for a **brain computer interface** (**BCI**) or to provide **neurofeedback** to the subject. The ability to adapt the stimulus during the **fMRI** experiment adds a new level of flexibility for task paradigms and has potential applications in a number of areas, including performance enhancement, rehabilitation, and therapy. Multivariate approaches to real-time **fMRI** are complementary to region-of-interest (ROI)-based methods and provide a principled method for dealing with distributed patterns of brain responses. Specifically, a multivariate approach is advantageous when network activity is expected, when mental strategies could vary from individual to individual, or when one or a few ROIs are not unequivocally the most appropriate for the investigation. Beyond highlighting important developments in rt**fMRI** and supervised learning, the article discusses important practical issues, including implementation considerations, existing resources, and future challenges and opportunities. Some possible future directions are described, calling for advances arising from increased experimental flexibility, improvements in predictive modeling, better comparisons across rt**fMRI** and other **BCI** implementations, and further investigation of the types of **feedback** and degree to which interface modulation is obtainable for various tasks.

PMID: 20600972 [PubMed - as supplied by publisher]

Appl Psychophysiol Biofeedback. 2010 Jun;35(2):125-34.

266. *An exploratory study on the effects of tele-neurofeedback and tele-biofeedback on objective and subjective sleep in patients with primary insomnia.

Cortoos A, De Valck E, Arns M, Breteler MH, Cluydts R.

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Abstract

Insomnia is a sleeping disorder, usually studied from a behavioural perspective, with a focus on somatic and cognitive arousal. Recent studies have suggested that an impairment of information processes due to the presence of cortical hyperarousal might interfere with normal sleep onset and/or consolidation. As such, a treatment modality focussing on CNS arousal, and thus influencing information processing, might be of interest. Seventeen insomnia patients were randomly assigned to either a tele-**neurofeedback** (n = 9) or an electromyography tele-**biofeedback** (n = 8) protocol. Twelve healthy controls were used to compare baseline sleep measures. A polysomnography was performed pre and post treatment. Total Sleep Time (TST), was considered as our primary outcome variable. Sleep latency decreased pre to post treatment in both groups, but a significant improvement in TST was found only after the **neurofeedback** (**NFB**) protocol. Furthermore, sleep logs at home showed an overall improvement only in the **neurofeedback** group, whereas the sleep logs in the lab remained the same pre to post training. Only **NFB** training resulted in an increase in TST. The mixed results concerning perception of sleep might be related to methodological issues, such as the different locations of the training and sleep measurements.

PMID: 19826944 [PubMed - indexed for MEDLINE]

Epilepsy Res. 2010 Jun;90(1-2):75-82. Epub 2010 Apr 11.

267. Does arousal interfere with operant conditioning of spike-wave discharges in genetic epileptic rats?

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Abstract

One of the ways in which **brain computer interfaces** can be used is **neurofeedback** (**NF**). Subjects use their brain activation to control an external device, and with this technique it is also possible to learn to control aspects of the brain activity by operant conditioning. Beneficial effects of **NF** training on seizure occurrence have been described in epileptic patients. Little research has been done about differentiating **NF** effectiveness by type of epilepsy, particularly, whether idiopathic generalized seizures are susceptible to **NF**. In this experiment, seizures that manifest themselves as spike-wave discharges (SWDs) in the **EEG** were reinforced during 10 sessions in 6 rats of the WAG/Rij strain, an animal model for absence epilepsy. **EEG**'s were recorded before and after the training sessions. Reinforcing SWDs let to decreased SWD occurrences during training; however, the changes during training were not persistent in the post-training sessions. Because behavioural states are

known to have an influence on the occurrence of SWDs, it is proposed that the reinforcement situation increased arousal which resulted in fewer SWDs. Additional tests supported this hypothesis. The outcomes have implications for the possibility to train SWDs with operant learning techniques.

PMID: 20388587 [PubMed - indexed for MEDLINE]

Pain Med. 2010 Jun;11(6):912-9.

268. *Neurotherapy of fibromyalgia?

Nelson DV, Bennett RM, Barkhuizen A, Sexton GJ, Jones KD, Esty ML, Ochs L, Donaldson CC.

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Abstract

OBJECTIVE: To evaluate the efficacy of a novel variant of electroencephalograph **biofeedback**, the Low Energy **Neurofeedback** System (LENS), that utilizes minute pulses of electromagnetic stimulation to change brainwave activity for the amelioration of fibromyalgia (FM) symptoms.

DESIGN: Randomized, double-blind, placebo-controlled clinical trial.

SETTING: Tertiary referral academic medical center, outpatient.

PATIENTS: Thirty-four patients diagnosed with FM according to 1990 American College of Rheumatology classification criteria.

INTERVENTIONS: Active or sham LENS, depending on randomization, for 22 treatment sessions.

OUTCOME MEASURES: Primary outcome measure was the Fibromyalgia Impact Questionnaire total score. Secondary outcome measures included number of tender points (TPs) and pressure required to elicit TPs on physical examination, quantitative sensory testing heat pain threshold, and self-reported cognitive dysfunction, fatigue, sleep problems, global psychological distress, and depression obtained at baseline, immediate post-treatment, and 3- and 6-month follow-up.

RESULTS: Participants who received the active or sham interventions improved (Ps < 0.05) on the primary and a variety of secondary outcome measures, without statistically significant between group differences in evidence at post-treatment or 3- or 6-month follow-up. Individual session self-reported ratings of specific symptoms (cognitive dysfunction, fatigue, pain, and sleep, and overall activity level) over the course of the 22 intervention sessions indicated significant linear trends for improvement for the active intervention condition only (Ps < 0.05).

CONCLUSION: LENS cannot be recommended as a single modality treatment for FM. However, further study is warranted to investigate the potential of LENS to interact synergistically with other pharmacologic and nonpharmacologic therapies for improving symptoms in FM.

PMID: 20624243 [PubMed - in process]

Neuroreport. 2010 Mar 31;21(5):328-32.

269. Neurofeedback training on sensorimotor rhythm in marmoset monkeys.

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Abstract

Neurofeedback research in a model closely related to humans is recommended to rule out placebo effects and unspecific factors bridging the gap between nonvalidated empirical and standardized controlled research. In this article, telemetric sensorimotor rhythm (**SMR**; 11-14 Hz) **feedback** training in the marmoset monkey is applied to examine the monkey's capability to voluntary control their brain activity. Four monkeys, provided with two epidural bioelectric electrodes above the sensorimotor cortex, were trained with positive reinforcement on **SMR** measured by online analyses of 1.28 s electroencephalogram epochs in 30-min sessions. These monkeys learned within five sessions to increase their alpha activity. The first evidence of nonhuman primates having an operant control over the **SMR** is provided, an initial step for a much-needed scientific basis to **neurofeedback**.

PMID: 20186109 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2010 Mar;35(1):29-30.

270. *Using QEEG-guided neurofeedback for epilepsy versus standardized protocols: enhanced effectiveness?

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Abstract

This article briefly reviews some of the past **EEG** treatments of epilepsy and discusses how Q**EEG** may potentially enhance effectiveness of this approach. Several cases are presented in support of this approach.

PMID: 20012556 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2010 Mar;35(1):63-81.

271. *Neurofeedback outcomes in clients with Asperger's syndrome.

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Abstract

This paper summarizes data from a review of **neurofeedback** (**NFB**) training with 150 clients with Asperger's Syndrome (AS) and 9 clients with Autistic Spectrum Disorder (ASD) seen over a 15 year period (1993-2008) in a clinical setting. The main objective was to investigate whether electroncephalographic **(EEG) biofeedback**, also called **neurofeedback** (**NFB**), made a significant difference in clients diagnosed with AS. An earlier paper (Thompson et al. 2009) reviews the symptoms of AS, highlights research findings and theories concerning this disorder, discusses Q**EEG** patterns in AS (both single and 19-channel), and details a hypothesis, based on functional neuroanatomy, concerning how **NFB**, often paired with **biofeedback** (BFB), might produce a change in symptoms. A further aim of the current report is to provide practitioners with a detailed description of the method used to address some of the key symptoms of AS in order to encourage further research and clinical work to refine the use of **NFB** plus BFB in the treatment of AS. All charts were included for review where there was a diagnosis of AS or ASD and pre- and post-training testing results were available for one or more of the standardized tests used. Clients received 40-60 sessions of **NFB**, which was combined with training in metacognitive strategies and, for most older adolescent and adult clients, with BFB of respiration, electrodermal response, and, more recently, heart rate variability. For the majority of clients, **feedback** was contingent on decreasing slow wave activity (usually 3-7 Hz), decreasing beta spindling if it was present (usually between 23 and 35 Hz), and increasing fast wave activity termed sensorimotor rhythm (**SMR**) (12-15 or 13-15 Hz depending on assessment findings). The most common initial montage was referential placement at the vertex (CZ) for children and at FCz (midway between FZ and CZ) for adults, referenced to the right ear. Metacognitive strategies relevant to social understanding, spatial reasoning, reading comprehension, and math were taught when the **feedback** indicated that the client was relaxed, calm, and focused. Significant improvements were found on measures of attention (T.O.V.A. and IVA), core symptoms (Australian Scale for Asperger's Syndrome, Conners' Global Index, SNAP version of the DSM-IV criteria for ADHD, and the ADD-Q), achievement (Wide Range Achievement Test), and intelligence (Wechsler Intelligence Scales). The average gain for the Full Scale IQ score was 9 points. A decrease in relevant **EEG** ratios was also observed. The ratios measured were (4-8 Hz)(2)/(13-21 Hz)(2), (4-8 Hz)/(16-20 Hz), and (3-7 Hz)/(12-15 Hz). The positive outcomes of decreased symptoms of Asperger's and ADHD (including a decrease in difficulties with attention, anxiety, aprosodias, and social functioning) plus improved academic and intellectual functioning, provide preliminary support for the use of **neurofeedback** as a helpful component of effective intervention in people with AS.

PMID: 19908142 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2010 Mar;35(1):83-105.

272. *Neurofeedback for autistic spectrum disorder: a review of the literature.

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Abstract

There is a need for effective interventions to address the core symptoms and problems associated with autistic spectrum disorder (ASD). Behavior therapy improves communication and behavioral functioning. Additional treatment options include psychopharmacological and biomedical interventions. Although these approaches help children with autistic problems, they may be associated with side effects, risks or require ongoing or long-term treatment. **Neurofeedback** is a noninvasive approach shown to enhance neuroregulation and metabolic function in ASD. We present a review of the literature on the application of **Neurofeedback** to the multiple problems associated with ASD. Directions for future research are discussed.

PMID: 19856096 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2010 Mar;35(1):25-7. Epub 2009 Oct 15.

273. *Recent advances in quantitative EEG as an aid to diagnosis and as a guide to neurofeedback training for cortical hypofunctions, hyperfunctions, disconnections, and hyperconnections: improving efficacy in complicated neurological and psychological disorders.

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Abstract

Recent advances in Q**EEG**-databases have enabled improvements in interpretation, which in turn have led to more effective **neurofeedback** interventions. These improvements relate mostly to evaluations conducted in the high frequency beta range (21-30 Hz) evaluation and in single Hz bins, which more specifically address which frequencies need to be trained to most quickly and effectively normalize their dysfunctions and remediate their difficulties. Use of the modular activation/coherence model (Walker et al. in J Neurother 11: 25-44, 2007) provides a framework for correcting the slow or fast modular dysfunctions, as well as normalizing connectivity using coherence training.

PMID: 19830549 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2010 Mar;35(1):37-8.

274. *Conclusion: QEEG-guided neurofeedback in context and in practice.

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PMID: 19774458 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2010 Mar;35(1):31-6. Epub 2009 Sep 4.

275. *The need for individualization in neurofeedback: heterogeneity in QEEG patterns associated with diagnoses and symptoms.

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Abstract

Very diverse assessment procedures are utilized by **neurofeedback** practitioners, many of which are not based on careful examination of raw **EEG** data followed by scientifically objective quantitative **EEG** (Q**EEG**) database comparisons. Research is reviewed demonstrating the great heterogeneity in the **EEG** patterns associated with various diagnoses and symptoms. The fact that most patients qualify for dual diagnoses, with co-morbid psychiatric and medical conditions present, complicates the ability of clinicians to estimate what electrophysiological patterns may be associated with symptoms. In such cases treatment planning is characterized by a great deal of guesswork and experimentation. Peer reviewed publications have documented that **neurofeedback** treatment can sometimes be associated with both transient side effects as well as more serious negative effects. It is believed that the lack of comprehensive and objective assessment of brain functioning may increase the risk of **neurofeedback** either being ineffective or causing iatrogenic harm. Q**EEG** provides reliable, non-invasive, objective, culture-free and relatively low cost evaluation of brain functioning, permitting individualization of treatment and added liability protection.

PMID: 19760143 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2010 Mar;35(1):5-11. Epub 2009 Aug 27.

276. *Improvements in spelling after QEEG-based neurofeedback in dyslexia: a randomized controlled treatment study.

Breteler MH, Arns M, Peters S, Giepmans I, Verhoeven L.

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Erratum in:

Appl Psychophysiol Biofeedback. 2010 Jun;35(2):187.

Abstract
Phonological theories of dyslexia assume a specific deficit in representation, storage and recall of phonemes. Various brain imaging techniques, including q**EEG**, point to the importance of a range of areas, predominantly the left hemispheric temporal areas. This study attempted to reduce reading and spelling deficits in children who are dyslexic by means of **neurofeedback** training based on neurophysiological differences between the participants and gender and age matched controls. Nineteen children were randomized into an experimental group receiving q**EEG** based **neurofeedback** (n = 10) and a control group (n = 9). Both groups also received remedial teaching. The experimental group improved considerably in spelling (Cohen's d = 3). No improvement was found in reading. An indepth study of the changes in the q**EEG** power and coherence protocols evidenced no fronto-central changes, which is in line with the absence of reading improvements. A significant increase of alpha coherence was found, which may be an indication that attentional processes account for the improvement in spelling. Consideration of subtypes of dyslexia may refine the results of future studies.

PMID: 19711183 [PubMed - indexed for MEDLINE]PMCID: PMC2837193 Free PMC Article
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Appl Psychophysiol Biofeedback. 2010 Mar;35(1):13-23. Epub 2009 Aug 1.

277. *The relative efficacy of connectivity guided and symptom based EEG biofeedback for autistic disorders.

Coben R, Myers TE.

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Abstract
Autism is a neurodevelopmental disorder characterized by deficits in communication, social interaction, and a limited range of interests with repetitive stereotypical behavior. Various abnormalities have been documented in the brains of individuals with autism, both anatomically and functionally. The connectivity theory of autism is a recently developed theory of the neurobiological cause of autisic symptoms. Different patterns of hyper- and hypo-connectivity have been identified with the use of quantitative electroencephalogray (Q**EEG**), which may be amenable to **neurofeedback**. In this study, we compared the results of two published controlled studies examining the efficacy of **neurofeedback** in the treatment of autism. Specifically, we examined whether a symptom based approach or an assessment/connectivity guided based approach was more effective. Although both methods demonstrated significant improvement in symptoms of autism, connectivity guided **neurofeedback** demonstrated greater reduction on various subscales of the Autism Treatment Evaluation Checklist (ATEC). Furthermore, when individuals were matched for severity of symptoms, the amount of change per session was significantly higher in the Coben and Padolsky (J Neurother 11:5-23, 2007) study for all five measures of the ATEC. Our findings

suggest that an approach guided by Q**EEG** based connectivity assessment may be more efficacious in the treatment of autism. This permits the targeting and amelioration of abnormal connectivity patterns in the brains of people who are autistic.

PMID: 19649702 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2010 Mar;35(1):39-61. Epub 2009 Jul 1.

278. *Functional neuroanatomy and the rationale for using EEG biofeedback for clients with Asperger's syndrome.

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Abstract

This paper reviews the symptoms of Asperger's Syndrome (AS), a disorder along the autism continuum, and highlights research findings with an emphasis on brain differences. Existing theories concerning AS are described, including theory of mind (Hill and Frith in Phil Trans Royal Soc Lond, Bull 358:281-289, 2003), mirror neuron system (Ramachandran and Oberman in Sci Am 295(5):62-69, 2006), and Porges' (Ann N Y Acad Sci 1008:31-47, 2003, The neurobiology of autism, Johns Hopkins University Press, Baltimore, 2004) polyvagal theory. (A second paper, Outcomes using **EEG biofeedback** Training in Clients with Asperger's Syndrome, summarizes clinical outcomes obtained with more than 150 clients.) Patterns seen with Q**EEG** assessment are then presented. Single channel assessment at the vertex (CZ) reveals patterns similar to those found in Attention-Deficit/Hyperactivity Disorder. Using 19-channel data, significant differences (z-scores > 2) were found in the amplitude of both slow waves (excess theta and/or alpha) and fast waves (beta) at various locations. Differences from the norm were most often found in mirror neuron areas (frontal, temporal and temporal-parietal). There were also differences in coherence patterns, as compared to a normative database (Neuroguide). Low Resolution Electromagnetic Tomography Analysis (Pascual-Marqui et al. in Methods Find Exp Clin Pharmacol 24C:91-95, 2002) suggested the source of the abnormal activity was most often the anterior cingulate. Other areas involved included the amygdala, uncus, insula, hippocampal gyrus, parahippocampal gyrus, fusiform gyrus, and the orbito-frontal and/or ventromedial areas of the prefrontal cortex. Correspondence between symptoms and the functions of the areas found to have abnormalities is evident and those observations are used to develop a rationale for using **EEG biofeedback**, called **neurofeedback** (**NFB**), intervention. **NFB** training is targeted to improve symptoms that include difficulty reading and mirroring emotions, poor attention to the outside world, poor self-regulation skills, and anxiety. Porges' polyvagal theory is used to emphasize the need to integrate **NFB** with **biofeedback** (BFB), particularly heart rate variability training. We term this emerging understanding the Systems Theory of Neural Synergy. The name underscores the fact that **NFB** and BFB influence dynamic circuits and emphasizes that, no matter where we enter the nervous system with an intervention, it will seek its own new balance and equilibrium.

PMID: 19568927 [PubMed - indexed for MEDLINE]

Eur Radiol. 2010 Mar;20(3):696-703. Epub 2009 Sep 16.

279. *Real-time fMRI feedback training may improve chronic tinnitus.

Haller S, Birbaumer N, Veit R.

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Abstract

OBJECTIVES: Tinnitus consists of a more or less constant aversive tone or noise and is associated with excess auditory activation. Transient distortion of this activation (repetitive transcranial magnetic stimulation, rTMS) may improve tinnitus. Recently proposed operant training in real-time functional magnetic resonance imaging (rt**fMRI**) **neurofeedback** allows voluntary modification of specific circumscribed neuronal activations. Combining these observations, we investigated whether patients suffering from tinnitus can (1) learn to voluntarily reduce activation of the auditory system by rt**fMRI neurofeedback** and whether (2) successful learning improves tinnitus symptoms.

METHODS: Six participants with chronic tinnitus were included. First, location of the individual auditory cortex was determined in a standard **fMRI** auditory block-design localizer. Then, participants were trained to voluntarily reduce the auditory activation (rt**fMRI**) with visual **biofeedback** of the current auditory activation.

RESULTS: Auditory activation significantly decreased after rt**fMRI neurofeedback**. This reduced the subjective tinnitus in two of six participants.

CONCLUSION: These preliminary results suggest that tinnitus patients learn to voluntarily reduce spatially specific auditory activations by rt**fMRI neurofeedback** and that this may reduce tinnitus symptoms. Optimized training protocols (frequency, duration, etc.) may further improve the results.

PMID: 19760238 [PubMed - indexed for MEDLINE]

Harv Ment Health Lett. 2010 Mar;26(9):4-5.

280. *Neurofeedback for attention deficit hyperactivity disorder. The evidence base for this therapy is weak, although a new, well-designed study addresses some concerns.

[No authors listed]

PMID: 20480625 [PubMed - indexed for MEDLINE]

Neuroimage. 2010 Feb 15;49(4):3404-13. Epub 2009 Nov 24.

281. *Enhancing cognitive control through neurofeedback: a role of gamma-band activity in managing episodic retrieval.

Keizer AW, Verment RS, Hommel B.

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Abstract
Neural synchronization has been proposed to be the underlying mechanism for exchanging and integrating anatomically distributed information and has been associated with a myriad of cognitive domains, including visual feature binding, top-down control, and long-term memory. Moreover, it seems that separate frequency bands have different functions in these cognitive processes. Here we studied whether **neurofeedback** training designed either to increase local gamma band activity (GBA+; 36-44 Hz), or local beta band activity (BBA+; 12-20 Hz), would have an impact on performance of behavioral tasks measuring short-term and long-term episodic binding. Our results show that GBA-enhancing **neurofeedback** training increased occipital GBA within sessions, and occipital and frontal GBA across sessions. Both groups showed an increase of GBA coherence between frontal and occipital areas, but the BBA+ group increased BBA coherence between these areas as well. **Neurofeedback** training had profound effects on behavior. First, we replicated earlier findings that enhancing GBA led to greater flexibility in handling (selectively retrieving) episodic bindings, which points to a role of GBA in top-down control of memory retrieval. Moreover, the long-term memory task revealed a double dissociation: GBA-targeted training improved recollection, whereas BBA-targeted training improved familiarity memory. We conclude that GBA is important for controlling and organizing memory traces of relational information in both short-term binding and long-term memory, while frontal-occipital coherence in the beta band may facilitate familiarity processes.

PMID: 19925870 [PubMed - indexed for MEDLINE]

Behav Brain Funct. 2010 Feb 2;6:9.

282. *Neurofeedback and biofeedback with 37 migraineurs: a clinical outcome study.

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Abstract
BACKGROUND: Traditional peripheral **biofeedback** has grade A evidence for effectively treating migraines. Two newer forms of **neurobiofeedback**, **EEG biofeedback** and hemoencephalography **biofeedback** were combined with thermal handwarming **biofeedback** to treat 37 migraineurs in a clinical outpatient setting.

METHODS: 37 migraine patients underwent an average of 40 **neurofeedback** sessions combined with thermal **biofeedback** in an outpatient **biofeedback** clinic. All patients were on at least one type of medication for migraine; preventive, abortive or rescue. Patients kept daily headache diaries a minimum of two weeks prior to treatment and throughout treatment showing symptom frequency, severity, duration and medications used. Treatments were conducted an average of three times weekly over an average span of 6 months. Headache diaries were examined after treatment and a formal interview was conducted. After an average of 14.5 months following treatment, a formal interview was conducted in order to ascertain duration of treatment effects.

RESULTS: Of the 37 migraine patients treated, 26 patients or 70% experienced at least a 50% reduction in the frequency of their headaches which was sustained on average 14.5 months after treatments were discontinued.

CONCLUSIONS: All combined neuro and **biofeedback** interventions were effective in reducing the frequency of migraines with clients using medication resulting in a more favorable outcome (70% experiencing at least a 50% reduction in headaches) than just medications alone (50% experience a 50% reduction) and that the effect size of our study involving three different types of **biofeedback** for migraine (1.09) was more robust than effect size of combined studies on thermal **biofeedback** alone for migraine (.5). These non-invasive interventions may show promise for treating treatment-refractory migraine and for preventing the progression from episodic to chronic migraine.

PMID: 20205867 [PubMed - in process]PMCID: PMC2826281 Free PMC Article
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2826281/?tool=pubmed.

Eur J Neurosci. 2010 Feb;31(4):770-8.

283. Endogenous control of waking brain rhythms induces neuroplasticity in humans.

Ros T, Munneke MA, Ruge D, Gruzelier JH, Rothwell JC.

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Abstract

This study explores the possibility of noninvasively inducing long-term changes in human corticomotor excitability by means of a **brain-computer interface**, which enables users to exert internal control over the cortical rhythms recorded from the scalp. We demonstrate that self-regulation of electroencephalogram rhythms in quietly sitting, naive humans significantly affects the subsequent corticomotor response to transcranial magnetic stimulation, producing durable and correlated changes in neurotransmission. Specifically, we show that the intrinsic suppression of alpha cortical rhythms can in itself produce robust increases in corticospinal excitability and decreases in intracortical inhibition of up to 150%, which last for at least 20 min. Our observations may have important implications for therapies of brain disorders associated with abnormal cortical rhythms, and support the use of electroencephalogram-based **neurofeedback** as a noninvasive tool for establishing a causal link between rhythmic cortical activities and their functions.

PMID: 20384819 [PubMed - indexed for MEDLINE]

Neurosci Lett. 2010 Jan 18;469(1):34-8. Epub 2009 Nov 24.

284. Optimization of SSVEP brain responses with application to eight-command Brain-Computer Interface.

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Abstract
This study pursues the optimization of the brain responses to small reversing patterns in a Steady-State Visual Evoked Potentials (SSVEP) paradigm, which could be used to maximize the efficiency of applications such as **Brain-Computer Interfaces** (**BCI**). We investigated the SSVEP frequency response for 32 frequencies (5-84 Hz), and the time dynamics of the brain response at 8, 14 and 28 Hz, to aid the definition of the optimal neurophysiological parameters and to outline the onset-delay and other limitations of SSVEP stimuli in applications such as our previously described four-command **BCI** system. Our results showed that the 5.6-15.3 Hz pattern reversal stimulation evoked the strongest responses, peaking at 12 Hz, and exhibiting weaker local maxima at 28 and 42 Hz. After stimulation onset, the long-term SSVEP response was highly non-stationary and the dynamics, including the first peak, was frequency-dependent. The evaluation of the performance of a frequency-optimized eight-command **BCI** system with dynamic **neurofeedback** showed a mean success rate of 98%, and a time delay of 3.4s. Robust **BCI** performance was achieved by all subjects even when using numerous small patterns clustered very close to each other and moving rapidly in 2D space. These results emphasize the need for SSVEP applications to optimize not only the analysis algorithms but also the stimuli in order to maximize the brain responses they rely on.

PMID: 19931592 [PubMed - indexed for MEDLINE]

Benefits Q. 2010;26(1):53-4.

285. *Welfare plan exclusions standard of review--abuse of discretion--exclusion of neurofeedback.

[No authors listed]

PMID: 20608118 [PubMed - indexed for MEDLINE]

Clin EEG Neurosci. 2010 Jan;41(1):32-41.

286. *Post WISC-R and TOVA improvement with QEEG guided neurofeedback training in mentally retarded: a clinical case series of behavioral problems.

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Abstract

According to the DSM-IV, Mental Retardation is significantly sub-average general intellectual functioning accompanied by significant limitations in adaptive functioning in at least two of the following skill areas: communication, self-care, home living, social/interpersonal skills, use of community resources, self-direction, functional academic skills, work, leisure, health and safety. In pilot work, we have seen positive clinical effects of **Neurofeedback** (**NF**) applied to children with Trisomy 21 (Down Syndrome) and other forms of mental retardation. Given that many clinicians use **NF** in Attention Deficit Hyperactivity Disorder and Generalized Learning Disability cases, we studied the outcomes of a clinical case series using Quantitative **EEG** (Q**EEG**) guided **NF** in the treatment of mental retardation. All 23 subjects received **NF** training. The Q**EEG** data for most subjects had increased theta, alpha, and coherence abnormalities. A few showed increased delta over the cortex. Some of the subjects were very poor in reading and some had illegible handwriting, and most subjects had academic failures, impulsive behavior, and very poor attention, concentration, memory problems, and social skills. This case series shows the impact of Q**EEG**-guided **NF** training on these clients' clinical outcomes. Fourteen out of 23 subjects formerly took medications without any improvement. Twenty-three subjects ranging from 7-16 years old attending private learning centers were previously diagnosed with mental retardation (severity of degree: from moderate to mild) at various university hospitals. Evaluation measures included Q**EEG** analysis, WISC-R (Wechsler Intelligence Scale for Children-Revised) IQ test, TOVA (Test of Variables of Attention) test, and DPC-P (Developmental Behaviour Checklist) were filled out by the parents. **NF** trainings were performed by Lexicor Biolex software. NX-Link was the commercial software reference database used to target the treatment protocols, along with the clinical judgment of the first author. Q**EEG** signals were sampled at 128 samples per second per channel and electrodes were placed according to the International 10-20 system. Between 80 and 160 **NF** training sessions were completed, depending on the case. None of the subjects received any special education during **NF** treatment. Two subjects with the etiology of epilepsy were taking medication, and the other 21 subjects were medication-free at the baseline. Twenty-two out of 23 patients who received **NF** training showed clinical improvement according to the DPC-P with Q**EEG** reports. Nineteen out of 23 patients showed significant improvement on the WISC-R, and the TOVA. For the WISC-R test, 2 showed decline on total IQ due to the decline on some of the subtests, 2 showed no improvement on total IQ although improvement was seen on some of the subtests, however even these cases showed improvement on Q**EEG** and DPC-P. This study provides the first evidence for positive effects of **NF** treatment in mental retardation. The results of this study encourage further research.

PMID: 20307014 [PubMed - indexed for MEDLINE]

Hist Human Sci. 2010;23(1):107-26.

287. Taking care of one's brain: how manipulating the brain changes people's selves.

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Abstract

The increasing attention to the brain in science and the media, and people's continuing quest for a better life, have resulted in a successful self-help industry for brain enhancement. Apart from brain books, foods and games, there are several devices on the market that people can use to stimulate their brains and become happier, healthier or more successful. People can, for example, switch their brain state into relaxation or concentration with a light-and-sound machine, they can train their brain waves to cure their Attention Deficit Hyperactivity Disorder (ADHD) or solve their sleeping problems with a **neurofeedback** device, or they can influence the firing of their neurons with electric or magnetic stimulation to overcome their depression and anxieties. Working on yourself with a brain device can be seen as a contemporary form of Michel Foucault's "technologies of the self." Foucault described how since antiquity people had used techniques such as reading manuscripts, listening to teachers, or saying prayers to "act on their selves" and control their own thoughts and behaviours. Different techniques, Foucault stated, are based on different precepts and constitute different selves. I follow Foucault by stating that using a brain device for self-improvement indeed constitutes a new self. Drawing on interviews with users of brain devices and observations of the practices in brain clinics, I analyse how a new self takes shape in the use of brain devices; not a monistic (neuroscientific) self, but a "layered" self of all kinds of entities that exchange and control each other continuously.

PMID: 20518157 [PubMed - indexed for MEDLINE]

Int J Psychophysiol. 2010 Jan;75(1):25-32. Epub 2009 Nov 3.

288. *The effect of gamma enhancing neurofeedback on the control of feature bindings and intelligence measures.

Keizer AW, Verschoor M, Verment RS, Hommel B.

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Abstract

Neural synchronization in the gamma band has been associated with feature binding and intelligence. Using **neurofeedback**, we aimed at changing the power of the gamma band and investigated whether these changes would influence behavioral measures of feature binding and intelligence. The results show that people are indeed able to alter the power in the gamma band if provided with **neurofeedback**. Moreover, the increase of gamma band power was related to a decrease of binding costs and an increase in intelligence, suggesting that the control of feature binding and intelligence share a common underlying mechanism.

PMID: 19895855 [PubMed - indexed for MEDLINE]

Nervenarzt. 2010 Jan;81(1):16-23.

289. [Functional magnetic resonance imaging in psychiatry and psychotherapy]

[Article in German]

Derntl B, Habel U, Schneider F.

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Abstract
Technical improvements, functional magnetic resonance imaging (**fMRI**) has become the most popular and versatile imaging method in psychiatric research. The scope of this manuscript is to briefly introduce the basics of MR physics, the blood oxygenation level-dependent (BOLD) contrast as well as the principles of MR study design and functional data analysis. The presentation of exemplary studies on emotion recognition and empathy in schizophrenia patients will highlight the importance of MR methods in psychiatry. Finally, we will demonstrate insights into new developments that will further boost MR techniques in clinical research and will help to gain more insight into dysfunctional neural networks underlying cognitive and emotional deficits in psychiatric patients. Moreover, some techniques such as **neurofeedback** seem promising for evaluation of therapy effects on a behavioral and neural level.

PMID: 20057981 [PubMed - indexed for MEDLINE]

Neuroimage. 2010 Jan 1;49(1):1066-72. Epub 2009 Jul 29.

290. *Neurofeedback: A promising tool for the self-regulation of emotion networks.

Johnston SJ, Boehm SG, Healy D, Goebel R, Linden DE.

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Abstract
Real-time functional magnetic resonance imaging (**fMRI**) affords the opportunity to explore the feasibility of self-regulation of functional brain networks through **neurofeedback**. We localised emotion networks individually in thirteen participants using **fMRI** and trained them to upregulate target areas, including the insula and amygdala. Participants achieved a high degree of control of these networks after a brief training period. We observed activation increases during periods of upregulation of emotion networks in the precuneus and medial prefrontal cortex and, with increasing training success, in the ventral striatum. These findings demonstrate the feasibility of **fMRI**-based **neurofeedback** of emotion networks and suggest a possible development into a therapeutic tool.

PMID: 19646532 [PubMed - indexed for MEDLINE]

Tijdschr Psychiatr. 2010;52(1):41-50.

291. *[Neurofeedback and attention deficit hyperactivity disorder: what is it and is it working?]

[Article in Dutch]
van As J, Hummelen JW, Buitelaar JK.

jvas@centrummaliebaan.nl

Comment in Tijdschr Psychiatr. 2010;52(4):277-8; author reply 278-9.

Abstract

BACKGROUND:
Neurofeedback (**NF**) is a method of treatment that is being used increasingly in the Netherlands, particularly in psychological practices. Many psychiatric and somatic symptoms are currently being treated with the help of **NF**. In particular, **NF** is being used more and more to treat attention deficit hyperactivity disorder (ADHD). Despite its growing popularity, **NF** is still a relatively unknown treatment method in psychiatric practices.

AIM: To investigate the scientific evidence for treating adhd with **NF**.

METHOD: We searched the literature for reports on controlled trials that investigated the effectiveness of **NF** on ADHD.
RESULTS: Six controlled trials were located. The studies reported that **NF** had a positive effect on adhd, but all the studies were marred by methodological shortcomings.

CONCLUSION: On the basis of currently available research results, no firm conclusion can be drawn about the effectiveness of treating adhd by means of **NF**. In view of the fact that **NF** is being used more and more as a method of treatment, there is an urgent need for scientific research in this field to be well planned and carefully executed.

PMID: 20054796 [PubMed - indexed for MEDLINE] Free Article (in Dutch)

Appl Psychophysiol Biofeedback. 2009 Dec;34(4):309-28.

292. *Identifying indices of learning for alpha neurofeedback training.

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Abstract

Neurofeedback has been around for decades and has applications for both clinical and healthy populations yet there is no standard method for measuring learning or a way of defining successful learning. Thus the aim of this study was to focus on alpha **neurofeedback** and examine changes in three different measures: amplitude, percent time, and integrated alpha, across four methods: within sessions, across sessions, within sessions compared to baseline, and across sessions compared to baseline. Participants completed 10 weekly sessions of eyes open alpha (8-12 Hz) **neurofeedback** training (**NF**T) at Pz. Whilst all three measures showed changes within sessions, the inclusion of baselines revealed that such changes represented a return to baseline levels rather than an increase in alpha. Changes across sessions were only evident in amplitude and inclusion of baseline showed that **NF**T did not elicit any changes beyond baseline levels. Given this a case is made for incorporating baseline measures when attempting to identify evidence of learning. It is also suggested that both amplitude and percent time measures are used independently rather than incorporate them into

a more conservative and less sensitive integrated measure. Finally, focusing on within sessions changes may be a more useful approach in identifying changes resulting from **NF**T.

PMID: 19760142 [PubMed - indexed for MEDLINE]

Nanoethics. 2009 Dec;3(3):217-230. Epub 2009 Dec 1.

293. The Mind and the Machine. On the Conceptual and Moral Implications of Brain-Machine Interaction.

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Abstract

Brain-machine interfaces are a growing field of research and application. The increasing possibilities to connect the human brain to electronic devices and computer software can be put to use in medicine, the military, and entertainment. Concrete technologies include cochlear implants, Deep Brain Stimulation, **neurofeedback** and neuroprosthesis. The expectations for the near and further future are high, though it is difficult to separate hope from hype. The focus in this paper is on the effects that these new technologies may have on our 'symbolic order'-on the ways in which popular categories and concepts may change or be reinterpreted. First, the blurring distinction between man and machine and the idea of the cyborg are discussed. It is argued that the morally relevant difference is that between persons and non-persons, which does not necessarily coincide with the distinction between man and machine. The concept of the person remains useful. It may, however, become more difficult to assess the limits of the human body. Next, the distinction between body and mind is discussed. The mind is increasingly seen as a function of the brain, and thus understood in bodily and mechanical terms. This raises questions concerning concepts of free will and moral responsibility that may have far reaching consequences in the field of law, where some have argued for a revision of our criminal justice system, from retributivist to consequentialist. Even without such a (unlikely and unwarranted) revision occurring, brain-machine interactions raise many interesting questions regarding distribution and attribution of responsibility.

PMID: 20234874 [PubMed]PMCID: PMC2837217 Free PMC Article
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http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2837217/?tool=pubmed.

Eur Arch Psychiatry Clin Neurosci. 2009 Nov;259 Suppl 2:S143-7.

294. *Brain imaging: on the way toward a therapeutic discipline.

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Abstract
Brain imaging has proven its importance as an essential tool of neuroscientific research, especially in psychiatry. Several of these methods at hand promise to enhance our understanding of function and dysfunction of neural processes and their disturbances in mental disorders in the near future. But the convincing success of imaging tools in research has not yet answered the demand to lead to new therapies or to new and useful tools in the diagnosis and treatment of single subjects. This article tries to point out how new methodological developments are promising to lead to a further step in this way. This therapeutic option is based on technical developments like high-field magnetic resonance imaging (**MRI**) or the further development of **neurofeedback**. This concept might make brain imaging such as realtime **fMRI** a therapeutic option at least in specialized institutions in the foreseeable future, especially since MR-scanners are already widely available nowadays.

PMID: 19876672 [PubMed - indexed for MEDLINE]

Int J Psychophysiol. 2009 Nov;74(2):149-57. Epub 2009 Aug 25.

295. *Distinct EEG effects related to neurofeedback training in children with ADHD: a randomized controlled trial.

Gevensleben H, Holl B, Albrecht B, Schlamp D, Kratz O, Studer P, Wangler S, Rothenberger A, Moll GH, Heinrich H.

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Abstract
In a randomized controlled trial, **neurofeedback** (**NF**) training was found to be superior to a computerised attention skills training concerning the reduction of ADHD symptomatology (Gevensleben et al., 2009). The aims of this investigation were to assess the impact of different **NF** protocols (theta/beta training and training of slow cortical potentials, **SCP**s) on the resting **EEG** and the association between distinct **EEG** measures and behavioral improvements. In 72 (of initially 102) children with ADHD, aged 8-12, **EEG** changes after either a **NF** training (n=46) or the control training (n=26) could be studied. The combined **NF** training consisted of one block of theta/beta training and one block of **SCP** training, each block comprising 18 units of 50 minutes (balanced order). Spontaneous **EEG** was recorded in a two-minute resting condition before the start of the training, between the two training blocks and after the end of the training. Activity in the different **EEG** frequency bands was analyzed. In contrast to the control condition, the combined **NF** training was accompanied by a reduction of theta activity. Protocol-specific **EEG** changes (theta/beta training: decrease of posterior-midline theta activity; **SCP** training: increase of central-midline alpha activity) were associated with improvements in the German ADHD rating scale. Related **EEG**-based predictors were obtained. Thus, differential **EEG** patterns for theta/beta and **SCP** training provide further evidence that distinct neuronal mechanisms may contribute to similar behavioral improvements in children with ADHD.

PMID: 19712709 [PubMed - indexed for MEDLINE]

Mov Disord. 2009 Oct 15;24(13):2015-9.

296. *Complementary and alternative medicine use in Gilles de la Tourette syndrome.

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Abstract
The aim of this study was to describe the use of complementary and alternative medicine (CAM) in patients with Tourette syndrome (TS) and explore associations with CAM use. In recent years CAM use has increased, but rates of CAM use in TS patients are not reported. Consecutive TS patients or their parent(s), seen in an academic movement disorder center, completed a questionnaire regarding their use of CAM. One hundred TS patients or parents completed the questionnaire, mean age 21.5 +/- 13.5, 76 males, 87 Caucasians. Sixty four patients had used at least one CAM modality. CAM treatments used were prayer (28), vitamins (21), massage (19), dietary supplements (15), chiropractic manipulations (12), meditation (10), diet alterations (nine), yoga (nine), acupuncture (eight), hypnosis (seven), homeopathy (six), and **EEG biofeedback** (six). Fifty six percent of patients using CAM reported some improvement. Users paid out of pocket for 47% of treatments pursued, and 19% of these payers received partial reimbursement by third party payer. Users and non-users did not differ in age, gender, race, income, educational level, general health, tic severity, medication use for TS, current satisfaction from medications or experience of side effects from medications. CAM use was associated with the presence of affective disorder (P = 0.004), but not with either ADHD or OCD. Among CAM users, 80% initiated CAM without informing their doctor. CAM is commonly used in children and adults with TS, and often without the neurologist's knowledge. Physicians should inquire about CAM to understand the spectrum of interventions that patients with TS use.

PMID: 19705358 [PubMed - indexed for MEDLINE]

Ann Clin Psychiatry. 2009 Oct-Dec;21(4):213-36.

297. *Novel and emerging treatments for autism spectrum disorders: a systematic review.

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Abstract
BACKGROUND: Currently, only one medication (risperidone) is FDA-approved for the treatment of autism spectrum disorders (ASD). Perhaps for this reason, the use of novel, unconventional, and off-label treatments for ASD is common, with up to 74% of children with ASD using these treatments; however, treating physicians are often unaware of this usage.

METHODS: A systematic literature search of electronic scientific databases was performed to identify studies of novel and emerging treatments for ASD, including nutritional supplements, diets, medications, and nonbiological treatments. A grade of recommendation ("Grade") was then assigned to each treatment using a validated evidence-based guideline as outlined in this review: A: Supported by at least 2 prospective randomized controlled trials (RCTs) or 1 systematic review. B: Supported by at least 1 prospective RCT or 2 nonrandomized controlled trials. C: Supported by at least 1 nonrandomized controlled trial or 2 case series. D: Troublingly inconsistent or inconclusive studies or studies reporting no improvements. Potential adverse effects for each treatment were also reviewed.

RESULTS: Grade A treatments for ASD include melatonin, acetylcholinesterase inhibitors, naltrexone, and music therapy. Grade B treatments include carnitine, tetrahydrobiopterin, vitamin C, alpha-2 adrenergic agonists, hyperbaric oxygen treatment, immunomodulation and anti-inflammatory treatments, oxytocin, and vision therapy. Grade C treatments for ASD include carnosine, multivitamin/mineral complex, piracetam, polyunsaturated fatty acids, vitamin B6/magnesium, elimination diets, chelation, cyproheptadine, famotidine, glutamate antagonists, acupuncture, auditory integration training, massage, and **neurofeedback**.

CONCLUSIONS: The reviewed treatments for ASD are commonly used, and some are supported by prospective RCTs. Promising treatments include melatonin, antioxidants, acetylcholinesterase inhibitors, naltrexone, and music therapy. All of the reviewed treatments are currently considered off-label for ASD (ie, not FDA-approved) and some have adverse effects. Further studies exploring these treatments are needed. Physicians treating children with an ASD should make it standard practice to inquire about each child's possible use of these types of treatments.

PMID: 19917212 [PubMed - indexed for MEDLINE]

Clin EEG Neurosci. 2009 Oct;40(4):245-61.

298. "All that spikes is not fits", mistaking the woods for the trees: the interictal spikes--an "EEG chameleon" in the interface disorders of brain and mind: a critical review.

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Abstract

Recent research into mammalian cortical neurophysiology, after 6 decades of Berger's seminal work on electroencephalography, has shifted the older concept of interictal epileptiform activity (IEA) away from that of a mere electrographic graphoelement of relevance to diagnostic implications in epilepsy. Instead, accumulating information has stressed the neuropsychological implications, cognitive and/or behavioral consequence of these electrophysiological events, which are the phenotypic expression of aberrations of actual biophysical cellular function. We feel that this review is germane to neuropsychiatry, however, a rather neglected area of research. There is a great scope for brain-behavior-**EEG** research in the future that can be complimented by other techniques of "neurobehavioral electrophysiology". This review does not address the "pearls, perils and pitfalls" in the use of

EEG in epilepsy, but critically and systematically reappraises the published electroencephalographic correlates of human behavior. We reiterate that epileptiform and other paroxysmal **EEG** dysrhythmias unrelated to clinical seizures do have neuropsychological, cognitive and/or behavioral implications as seen in the various neuropsychiatric and neurobehavioral disorders discussed in this article. IEA and **EEG** dysrhythmias should neither be ignored as irrelevant nor automatically attributed to epilepsy. The relevance of these **EEG** aberrations in the disorders of the brain-mind interface extend beyond epilepsy, and may be an electrophysiological endophenotype of aberrant neuronal behavior indicative of underlying morpho-functional brain abnormalities. Magnetoencephalography (**MEG**), data fusion models (**EEG-fMRI**-BOLD), transcranial magnetic stimulation (TMS), evoked potentials (EP); intracranial electrophysiology, and **EEG neurofeedback** complemented by current functional neuroimaging techniques (**fMRI** and PET) would certainly help in further understanding the broader relationship between brain and behavior.

PMID: 19780346 [PubMed - indexed for MEDLINE]

Zh Vyssh Nerv Deiat Im I P Pavlova. 2009 Sep-Oct;59(5):593-7.

299. [Changes in the power of cat EEG rhythms during training with acoustic feedback signals]

[Article in Russian]
Fokina IuO, Kulichenko AM, Pavlenko VB.

Abstract
Dynamics of power relation between beta and theta rhythms and activity of dopaminergic neurons in the ventral tegmentum were studied in chronic **EEG biofeedback** experiments in two waking cats. **EEG biofeedback** training was based on a developed scheme, in which the level of a presented sound signal decreased if the ratio of power of beta and theta rhythms recorded in the frontal area increased (due to the increase in the beta-rhythm power and decrease in the power of the theta rhythm). These changes were accompanied by the increase in the activity of tegmental neurons presumably dopaminergic.

PMID: 19947535 [PubMed - indexed for MEDLINE]

BMC Neurosci. 2009 Jul 24;10:87.

300. *Optimizing microsurgical skills with EEG neurofeedback.

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Abstract
BACKGROUND: By enabling individuals to self-regulate their brainwave activity in the field of optimal performance in healthy individuals, **neurofeedback** has been found to improve cognitive and artistic performance. Here we assessed whether two distinct **EEG**

neurofeedback protocols could develop surgical skill, given the important role this skill plays in medicine.

RESULTS: National Health Service trainee ophthalmic microsurgeons (N = 20) were randomly assigned to either Sensory Motor Rhythm-Theta (**SMR**) or Alpha-Theta (AT) groups, a randomized subset of which were also part of a wait-list 'no-treatment' control group (N = 8). **Neurofeedback** groups received eight 30-minute sessions of **EEG** training. Pre-post assessment included a skills lab surgical procedure with timed measures and expert ratings from video-recordings by consultant surgeons, together with state/trait anxiety self-reports. **SMR** training demonstrated advantages absent in the control group, with improvements in surgical skill according to 1) the expert ratings: overall technique ($d = 0.6$, $p < 0.03$) and suture task ($d = 0.9$, $p < 0.02$) (judges' intraclass correlation coefficient = 0.85); and 2) with overall time on task ($d = 0.5$, $p = 0.02$), while everyday anxiety (trait) decreased ($d = 0.5$, $p < 0.02$). Importantly the decrease in surgical task time was strongly associated with **SMR EEG** training changes ($p < 0.01$), especially with continued reduction of theta (4-7 Hz) power. AT training produced marginal improvements in technique and overall performance time, which were accompanied by a standard error indicative of large individual differences. Notwithstanding, successful within session elevation of the theta-alpha ratio correlated positively with improvements in overall technique ($r = 0.64$, $p = 0.047$).

CONCLUSION: **SMR**-Theta **neurofeedback** training provided significant improvement in surgical technique whilst considerably reducing time on task by 26%. There was also evidence that AT training marginally reduced total surgery time, despite suboptimal training efficacies. Overall, the data set provides encouraging evidence of optimized learning of a complex medical specialty via **neurofeedback** training.

PMID: 19630948 [PubMed - indexed for MEDLINE]PMCID: PMC2723116 Free PMC Article
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http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2723116/?tool=pubmed.

Clin EEG Neurosci. 2009 Jul;40(3):180-9.

301. *Efficacy of neurofeedback treatment in ADHD: the effects on inattention, impulsivity and hyperactivity: a meta-analysis.

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Abstract

Since the first reports of **neurofeedback** treatment in Attention Deficit Hyperactivity Disorder (ADHD) in 1976, many studies have investigated the effects of **neurofeedback** on different symptoms of ADHD such as inattention, impulsivity and hyperactivity. This technique is also used by many practitioners, but the question as to the evidence-based level of this treatment is still unclear. In this study selected research on **neurofeedback** treatment for ADHD was collected and a meta-analysis was performed. Both prospective controlled studies and studies employing a pre- and post-design found large effect sizes (ES) for **neurofeedback** on impulsivity and inattention and a medium ES for hyperactivity.

Randomized studies demonstrated a lower ES for hyperactivity suggesting that hyperactivity is probably most sensitive to nonspecific treatment factors. Due to the inclusion of some very recent and sound methodological studies in this meta-analysis, potential confounding factors such as small studies, lack of randomization in previous studies and a lack of adequate control groups have been addressed, and the clinical effects of **neurofeedback** in the treatment of ADHD can be regarded as clinically meaningful. Three randomized studies have employed a semi-active control group which can be regarded as a credible sham control providing an equal level of cognitive training and client-therapist interaction. Therefore, in line with the AAPB and ISNR guidelines for rating clinical efficacy, we conclude that **neurofeedback** treatment for ADHD can be considered "Efficacious and Specific" (Level 5) with a large ES for inattention and impulsivity and a medium ES for hyperactivity.

PMID: 19715181 [PubMed - indexed for MEDLINE]

Clin EEG Neurosci. 2009 Jul;40(3):173-9.

302. *Meta-analysis of EEG biofeedback in treating epilepsy.

Tan G, Thornby J, Hammond DC, Strehl U, Canady B, Arnemann K, Kaiser DA.

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Abstract

About one third of patients with epilepsy do not benefit from medical treatment. For these patients electroencephalographic **(EEG) biofeedback** is a viable alternative. **EEG biofeedback**, or **neurofeedback**, normalizes or enhances **EEG** activity by means of operant conditioning. While dozens of scientific reports have been published on **neurofeedback** for seizure disorder, most have been case series with too few subjects to establish efficacy. The purpose of this paper is to meta-analyze existing research on **neurofeedback** and epilepsy. We analyzed every **EEG biofeedback** study indexed in MedLine, PsychInfo, and PsychLit databases between 1970 and 2005 on epilepsy that provided seizure frequency change in response to **feedback**. Sixty-three studies have been published, 10 of which provided enough outcome information to be included in a meta-analysis. All studies consisted of patients whose seizures were not controlled by medical therapies, which is a very important factor to keep in mind when interpreting the results. Nine of 10 studies reinforced sensorimotor rhythms (**SMR**) while 1 study trained slow cortical potentials (**SCP**). All studies reported an overall mean decreased seizure incidence following treatment and 64 out of 87 patients (74%) reported fewer weekly seizures in response to **EEG biofeedback**. Treatment effect was mean log (post/pre) where pre and post represent number of seizures per week prior to treatment and at final evaluation, respectively. Due to prevalence of small groups, Hedges's g was computed for effect size. As sample heterogeneity was possible (Q test, p=.18), random effects were assumed and the effect of intervention was -0.233, SE = 0.057, z = -4.11, p<.001. Based on this meta-analysis, **EEG** operant conditioning was found to produce a significant reduction on seizure frequency. This finding is especially noteworthy given the patient group, individuals who had been unable to control their seizures with medical treatment.

PMID: 19715180 [PubMed - indexed for MEDLINE]

J Child Psychol Psychiatry. 2009 Jul;50(7):780-9. Epub 2009 Jan 12.

303. *Is neurofeedback an efficacious treatment for ADHD? A randomised controlled clinical trial.

Gevensleben H, Holl B, Albrecht B, Vogel C, Schlamp D, Kratz O, Studer P, Rothenberger A, Moll GH, Heinrich H.

Child & Adolescent Psychiatry, University of Göttingen, Germany.

Comment in Evid Based Ment Health. 2010 Feb;13(1):21.
J Child Psychol Psychiatry. 2009 Jul;50(7):767-8.

Abstract

BACKGROUND: For children with attention deficit/hyperactivity disorder (ADHD), a reduction of inattention, impulsivity and hyperactivity by **neurofeedback** (**NF**) has been reported in several studies. But so far, unspecific training effects have not been adequately controlled for and/or studies do not provide sufficient statistical power. To overcome these methodological shortcomings we evaluated the clinical efficacy of **neurofeedback** in children with ADHD in a multisite randomised controlled study using a computerised attention skills training as a control condition.

METHODS: 102 children with ADHD, aged 8 to 12 years, participated in the study. Children performed either 36 sessions of **NF** training or a computerised attention skills training within two blocks of about four weeks each (randomised group assignment). The combined **NF** treatment consisted of one block of theta/beta training and one block of slow cortical potential (**SCP**) training. Pre-training, intermediate and post-training assessment encompassed several behaviour rating scales (e.g., the German ADHD rating scale, FBB-HKS) completed by parents and teachers. Evaluation ('placebo') scales were applied to control for parental expectations and satisfaction with the treatment.

RESULTS: For parent and teacher ratings, improvements in the **NF** group were superior to those of the control group. For the parent-rated FBB-HKS total score (primary outcome measure), the effect size was .60. Comparable effects were obtained for the two **NF** protocols (theta/beta training, **SCP** training). Parental attitude towards the treatment did not differ between **NF** and control group.

CONCLUSIONS: Superiority of the combined **NF** training indicates clinical efficacy of **NF** in children with ADHD. Future studies should further address the specificity of effects and how to optimise the benefit of **NF** as treatment module for ADHD.

PMID: 19207632 [PubMed - indexed for MEDLINE]

PLoS One. 2009 Jun 15;4(6):e5915.

304. Scale-free music of the brain.

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Abstract
BACKGROUND: There is growing interest in the relation between the brain and music. The appealing similarity between brainwaves and the rhythms of music has motivated many scientists to seek a connection between them. A variety of transferring rules has been utilized to convert the brainwaves into music; and most of them are mainly based on spectra feature of **EEG**.

METHODOLOGY/PRINCIPAL FINDINGS: In this study, audibly recognizable scale-free music was deduced from individual Electroencephalogram (**EEG**) waveforms. The translation rules include the direct mapping from the period of an **EEG** waveform to the duration of a note, the logarithmic mapping of the change of average power of **EEG** to music intensity according to the Fechner's law, and a scale-free based mapping from the amplitude of **EEG** to music pitch according to the power law. To show the actual effect, we applied the deduced sonification rules to **EEG** segments recorded during rapid-eye movement sleep (REM) and slow-wave sleep (SWS). The resulting music is vivid and different between the two mental states; the melody during REM sleep sounds fast and lively, whereas that in SWS sleep is slow and tranquil. 60 volunteers evaluated 25 music pieces, 10 from REM, 10 from SWS and 5 from white noise (WN), 74.3% experienced a happy emotion from REM and felt boring and drowsy when listening to SWS, and the average accuracy for all the music pieces identification is 86.8%(kappa = 0.800, P<0.001). We also applied the method to the **EEG** data from eyes closed, eyes open and epileptic **EEG**, and the results showed these mental states can be identified by listeners.

CONCLUSIONS/SIGNIFICANCE: The sonification rules may identify the mental states of the brain, which provide a real-time strategy for monitoring brain activities and are potentially useful to **neurofeedback** therapy.

PMID: 19526057 [PubMed - indexed for MEDLINE]PMCID: PMC2691588 Free PMC Article
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http://www.ncbi.nlm.nih.gov/pmc/articles/pmid/19526057/?tool=pubmed.

Hum Brain Mapp. 2009 May;30(5):1605-14.

305. *Self-regulation of regional cortical activity using real-time fMRI: the right inferior frontal gyrus and linguistic processing.

Rota G, Sitaram R, Veit R, Erb M, Weiskopf N, Dogil G, Birbaumer N.

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Abstract
Neurofeedback of functional magnetic resonance imaging (**fMRI**) can be used to acquire selective control over activation in circumscribed brain areas, potentially inducing behavioral changes, depending on the functional role of the targeted cortical sites. In the present study, we used **fMRI-neurofeedback** to train subjects to enhance regional activation in the right inferior frontal gyrus (IFG) to influence speech processing and to modulate language-related

performance. Seven subjects underwent real-time **fMRI-neurofeedback** training and succeeded in achieving voluntary regulation of their right Brodmann's area (BA) 45. To examine short-term behavioral impact, two linguistic tasks were carried out immediately before and after the training. A significant improvement of accuracy was observed for the identification of emotional prosodic intonations but not for syntactic processing. This evidence supports a role for the right IFG in the processing of emotional information and evaluation of affective salience. The present study confirms the efficacy of **fMRI-biofeedback** for noninvasive self-regulation of circumscribed brain activity.

PMID: 18661503 [PubMed - indexed for MEDLINE]

J Neurosci Methods. 2009 Apr 30;179(1):150-6. Epub 2009 Jan 29.

306. Neurofeedback-based motor imagery training for brain-computer interface (BCI).

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Abstract

In the present study, we propose a **neurofeedback**-based motor imagery training system for **EEG**-based **brain-computer interface** (**BCI**). The proposed system can help individuals get the feel of motor imagery by presenting them with real-time brain activation maps on their cortex. Ten healthy participants took part in our experiment, half of whom were trained by the suggested training system and the others did not use any training. All participants in the trained group succeeded in performing motor imagery after a series of trials to activate their motor cortex without any physical movements of their limbs. To confirm the effect of the suggested system, we recorded **EEG** signals for the trained group around sensorimotor cortex while they were imagining either left or right hand movements according to our experimental design, before and after the motor imagery training. For the control group, we also recorded **EEG** signals twice without any training sessions. The participants' intentions were then classified using a time-frequency analysis technique, and the results of the trained group showed significant differences in the sensorimotor rhythms between the signals recorded before and after training. Classification accuracy was also enhanced considerably in all participants after motor imagery training, compared to the accuracy before training. On the other hand, the analysis results for the control **EEG** data set did not show consistent increment in both the number of meaningful time-frequency combinations and the classification accuracy, demonstrating that the suggested system can be used as a tool for training motor imagery tasks in **BCI** applications. Further, we expect that the motor imagery training system will be useful not only for **BCI** applications, but for functional brain mapping studies that utilize motor imagery tasks as well.

PMID: 19428521 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2009 Mar;34(1):37-51. Epub 2009 Feb 6.

307. Event-related potential study of novelty processing abnormalities in autism.

Sokhadze E, Baruth J, Tasman A, Sears L, Mathai G, El-Baz A, Casanova MF.

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Abstract

To better understand visual processing abnormalities in autism we studied the attention orienting related frontal event potentials (ERP) and the sustained attention related centro-parietal ERPs in a three stimulus oddball experiment. The three stimulus oddball paradigm was aimed to test the hypothesis that individuals with autism abnormally orient their attention to novel distracters as compared to controls. A dense-array 128 channel EGI electroencephalographic (**EEG**) system was used on 11 high-functioning children and young adults with autism spectrum disorder (ASD) and 11 age-matched, typically developing control subjects. Patients with ASD showed slower reaction times but did not differ in response accuracy. At the anterior (frontal) topography the ASD group showed significantly higher amplitudes and longer latencies of early ERP components (e.g., P100, N100) to novel distracter stimuli in both hemispheres. The ASD group also showed prolonged latencies of late ERP components (e.g., P2a, N200, P3a) to novel distracter stimuli in both hemispheres. However, differences were more profound in the right hemisphere for both early and late ERP components. Our results indicate augmented and prolonged early frontal potentials and a delayed P3a component to novel stimuli, which suggest low selectivity in pre-processing and later-stage under-activation of integrative regions in the prefrontal cortices. Also, at the posterior (centro-parietal) topography the ASD group showed significantly prolonged N100 latencies and reduced amplitudes of the N2b component to target stimuli. In addition, the latency of the P3b component was prolonged to novel distracters in the ASD group. In general, the autistic group showed prolonged latencies to novel stimuli especially in the right hemisphere. These results suggest that individuals with autism over-process information needed for the successful differentiation of target and novel stimuli. We propose the potential application of ERP evaluations in a novelty task as outcome measurements in the biobehavioral treatment (e.g., **EEG biofeedback**, TMS) of autism.

PMID: 19199028 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2009 Mar;34(1):59-68. Epub 2009 Feb 6.

308. *Traumatic brain injury rehabilitation: QEEG biofeedback treatment protocols.

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Abstract

Interventions for improvement of cognitive problems in patients with traumatic brain injury (TBI) include **electroencephalography biofeedback**, also known as **neurofeedback**. Quantitative electroencephalography (Q**EEG**) patterns are assessed in TBI patients and then compared to a database obtained from a normative population. Deviations in Q**EEG** patterns

from the normative group are the basis for an intervention plan. While Q**EEG** patterns, obtained under an eyes closed, resting condition, provide information about deviations at rest, Q**EEG** patterns obtained while the patient engages in cognitive tasks reflect specific deficiencies in brain functioning. This paper reviews and assesses Q**EEG** patterns collected under both resting conditions as well as cognitive tasks. The article provides a theoretical and empirical base for Q**EEG** interventions with TBI.

PMID: 19199027 [PubMed - indexed for MEDLINE]

Cogn Process. 2009 Feb;10 Suppl 1:S101-9. Epub 2008 Dec 11.

309. *A theory of alpha/theta neurofeedback, creative performance enhancement, long distance functional connectivity and psychological integration.

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Abstract

Professionally significant enhancement of music and dance performance and mood has followed training with an **EEG-neurofeedback** protocol which increases the ratio of theta to alpha waves using auditory **feedback** with eyes closed. While originally the protocol was designed to induce hypnogogia, a state historically associated with creativity, the outcome was psychological integration, while subsequent applications focusing on raising the theta-alpha ratio, reduced depression and anxiety in alcoholism and resolved post traumatic stress syndrome (PTSD). In optimal performance studies we confirmed associations with creativity in musical performance, but effects also included technique and communication. We extended efficacy to dance and social anxiety. Diversity of outcome has a counterpart in wide ranging associations between theta oscillations and behaviour in cognitive and affective neuroscience: in animals with sensory-motor activity in exploration, effort, working memory, learning, retention and REM sleep; in man with meditative concentration, reduced anxiety and sympathetic autonomic activation, as well as task demands in virtual spatial navigation, focussed and sustained attention, working and recognition memory, and having implications for synaptic plasticity and long term potentiation. Neuroanatomical circuitry involves the ascending mescencephalic-cortical arousal system, and limbic circuits subserving cognitive as well as affective/motivational functions. Working memory and meditative bliss, representing cognitive and affective domains, respectively, involve coupling between frontal and posterior cortices, exemplify a role for theta and alpha waves in mediating the interaction between distal and widely distributed connections. It is posited that this mediation in part underpins the integrational attributes of alpha-theta training in optimal performance and psychotherapy, creative associations in hypnogogia, and enhancement of technical, communication and artistic domains of performance in the arts.

PMID: 19082646 [PubMed - indexed for MEDLINE]

Cogn Process. 2009 Feb;10 Suppl 1:S71-9. Epub 2008 Oct 31.

310. Neurophysical substrates of arousal and attention.

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Abstract

The study of arousal and attention could be of prominent importance for elucidating both fundamental and practical aspects of the mind-brain puzzle. Defined as "general activation of mind" (Kahnemann in Attention and effort. Prentice-Hall, New Jersey, 1973), or "general operation of consciousness" (Thacher and John in Functional neuroscience: foundations of cognitive processing. Erlbaum, Hillsdale, 1977), arousal can be considered as a starting point of fundamental research on consciousness. Similar role could be assigned to attention, which can be defined by substituting the attributes "general" with "focused". Concerning the practical applications, the empirically established correlation between neuronal oscillations and arousal/attention levels is widely used in research and clinics, including **neurofeedback**, **brain-computer communication**, etc. However, the neurophysical mechanism underlying this correlation is still not clear enough. In this paper, after reviewing some present classical and quantum approaches, a transition probability concept of arousal based on field-dipole quantum interactions and information entropy is elaborated. The obtained analytical expressions and numerical values correspond to classical empirical results for arousal and attention, including the characteristic frequency dependence and intervals. Simultaneously, the fundamental (substrate) role of **EEG** spectrum has been enlightened, whereby the attention appears to be a bridge between arousal and the content of consciousness. Finally, some clinical implications, including the brain-rate parameter as an indicator of arousal and attention levels, are provided.

PMID: 18975019 [PubMed - indexed for MEDLINE]

Clin EEG Neurosci. 2009 Jan;40(1):5-10.

311. *QEEG guided neurofeedback therapy in personality disorders: 13 case studies.

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Abstract

According to DSM-IV, personality disorder constitutes a class only when personality traits are inflexible and maladaptive and cause either significant functional impairment or subjective distress. Classical treatment of choice for personality disorders has been psychotherapy and/or psychopharmacotherapy. Our study is to determine if subjects with antisocial personality disorders will benefit from quantitative **EEG** (q**EEG**) guided **neurofeedback** treatment. Thirteen subjects (9 male, 4 female) ranged in age from 19 to 48 years. All the subjects were free of medications and illicit drugs. We excluded subjects with other mental disorders by clinical assessment. Psychotherapy or psychopharmacotherapy or any other treatment model was not introduced to any of the subjects during or after **neurofeedback** treatment. For the

subject who did not respond to **neurofeedback**, training was applied with 38 sessions of **LORETA neurofeedback** training without success. Evaluation measures included q**EEG** analysis with Nx Link data base, MMPI, T.O.V.A tests and SA-45 questionaries at baseline, and at the end of **neurofeedback** treatment. Lexicor q**EEG** signals were sampled at 128 Hz with 30 minutes-**neurofeedback** sessions completed between 80-120 sessions depending on the case, by Biolex **neurofeedback** system. At baseline and after every 20 sessions, patients were recorded with webcam during the interview. Twelve out of 13 subjects who received 80-120 sessions of **neurofeedback** training showed significant improvement based on SA-45 questionaries, MMPI, T.O.V.A. and q**EEG**/Nx Link data base (Neurometric analysis) results, and interviewing by parent/family members. **Neurofeedback** can change the view of psychiatrists and psychologists in the future regarding the treatment of personality disorders. This study provides the first evidence for positive effects of **neurofeedback** treatment in antisocial personality disorders. Further study with controls is warranted.

PMID: 19278127 [PubMed - indexed for MEDLINE]

Conf Proc IEEE Eng Med Biol Soc. 2009;2009:5377-80.

312. Neurofeedback of two motor functions using supervised learning-based real-time functional magnetic resonance imaging.

Papageorgiou TD, Curtis WA, McHenry M, LaConte SM.

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Abstract

This study examines the effects of **neurofeedback** provided by support vector machine (SVM) classification-based real-time functional magnetic resonance imaging (rt-**fMRI**) during two types of motor tasks. This approach also enables the examination of the neural regions associated with predicting mental states in different domains of motor control, which is critical to further our understanding of normal and impaired function. Healthy volunteers (n = 13) performed both a simple button tapping task, and a covert rate-of-speech counting task. The average prediction accuracy was approximately 95% for the button tapping task and 86% for the speech task. However, subsequent offline analysis revealed that classification of the initial runs was significantly lower - 75% ($p<0.001$) for button and 72% ($p<0.005$) for speech. To explore this effect, a group analysis was performed using the spatial maps derived from the SVM models, which showed significant differences between the two **fMRI** runs. One possible explanation for the difference in spatial patterns and the asymmetry in the prediction accuracies is that when subjects are actively engaged in the task (i.e. when they are trying to control a computer interface), they are generating stronger BOLD responses in terms of both intensity and spatial extent.

PMID: 19964387 [PubMed - indexed for MEDLINE]

Conf Proc IEEE Eng Med Biol Soc. 2009;2009:5385-8.

313. EEG-based real-time dynamic neuroimaging.

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Abstract

In the present paper, an electroencephalography (**EEG**)-based real-time dynamic neuroimaging system, which was recently developed by the authors, is introduced and its potential applications are presented. The real-time system could monitor spatiotemporal changes of cortical rhythmic activity on a subject's cortical surface, not on the subject's scalp surface, with a high temporal resolution. The developed system can be potentially applied to various practical applications such as **neurofeedback** based motor imagery training, real-time diagnosis of psychiatric brain diseases, online monitoring of **EEG** experiments, and neurorehabilitation, of which some examples are presented herein.

PMID: 19963902 [PubMed - indexed for MEDLINE]

Conf Proc IEEE Eng Med Biol Soc. 2009;2009:845-8.

314. *Integrated real-time neurofeedback system to raise the frontal lobe activity: design and implementation.

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Abstract

The anti-social behaviors of the people who are characteristic of abnormal action have seriously affected our society. Recent years, with the development of brain science, the features of human's abnormal action have been identified by means of the low frontal lobe activities. However, in many countries, the corresponding systems for identification and treatment are in an insufficient situation. Thus, in this paper, an integrated portable and real-time **neurofeedback** system assisted by **EEG** has been developed. The algorithm for this system has been developed and its performance has been verified by the **fMRI** experiment. Through the experiment, we ensured that the subjects controlled and checked their frontal lobe activities by themselves via the integrated real-time **neurofeedback** system. And then, the potential human's abnormal action could be not only early detected, but also eased via **neurofeedback** system. Therefore, we expected that our system can be more benefit to individuals and society.

PMID: 19963734 [PubMed - indexed for MEDLINE]

Int J Neurosci. 2009;119(3):404-41.

315. Differentiating a network of executive attention: LORETA neurofeedback in anterior cingulate and dorsolateral prefrontal cortices.

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Abstract

INTRODUCTION: This study examines the differential effects of space-specific neuro-operant learning, utilizing low-resolution electromagnetic tomographic (**LORETA**) **neurofeedback** in three regions of training (ROTs), namely, the anterior cingulate gyrus (AC) and right and left dorsolateral prefrontal cortices (RPFC and LPFC respectively).

METHODS: This study was conducted with 14 nonclinical students with a mean age of 22. We utilized electrophysiological measurements and subtests of the WAIS-III for premeasures and postmeasures.

RESULTS: The data indicate that the AC shares a significant association with the RPFC and LPFC; however, each of the ROTs exhibits different cortical effects in all frequencies when trained exclusively.

DISCUSSION: **LORETA neurofeedback** (L**NFB**) appears to enhance the functioning and strengthening of networks of cortical units physiologically related to each ROT; moreover, significant changes are mapped for each frequency domain, showing the associations within this possible attentional network.

PMID: 19116846 [PubMed - indexed for MEDLINE]

Int Rev Neurobiol. 2009;86:107-17.

316. Neurofeedback and brain-computer interface clinical applications.

Birbaumer N, Ramos Murguialday A, Weber C, Montoya P.

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Abstract

Most of the research devoted to **BMI** development consists of methodological studies comparing different online mathematical algorithms, ranging from simple linear discriminant analysis (LDA) (Dornhege et al., 2007) to nonlinear artificial neural networks (ANNs) or support vector machine (SVM) classification. Single cell spiking for the reconstruction of hand movements requires different statistical solutions than electroencephalography (**EEG**)-rhythm classification for communication. In general, the algorithm for **BMI** applications is computationally simple and differences in classification accuracy between algorithms used for a particular purpose are small. Only a very limited number of clinical studies with neurological patients are available, most of them single case studies. The clinical target

populations for **BMI**-treatment consist primarily of patients with amyotrophic lateral sclerosis (ALS) and severe CNS damage including spinal cord injuries and stroke resulting in substantial deficits in communication and motor function. However, an extensive body of literature started in the 1970s using **neurofeedback** training. Such training implemented to control various **EEG**-measures provided solid evidence of positive effects in patients with otherwise pharmacologically intractable epilepsy, attention deficit disorder, and hyperactivity ADHD. More recently, the successful introduction and testing of real-time **fMRI** and a **NIRS**-**BMI** opened an exciting field of interest in patients with psychopathological conditions.

PMID: 19607994 [PubMed - indexed for MEDLINE]

Prog Brain Res. 2009;177:275-92.

317. Another kind of 'BOLD Response': answering multiple-choice questions via online decoded single-trial brain signals.

Sorger B, Dahmen B, Reithler J, Gosseries O, Maudoux A, Laureys S, Goebel R.

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Abstract

The term 'locked-in'syndrome (LIS) describes a medical condition in which persons concerned are severely paralyzed and at the same time fully conscious and awake. The resulting anarthria makes it impossible for these patients to naturally communicate, which results in diagnostic as well as serious practical and ethical problems. Therefore, developing alternative, muscle-independent communication means is of prime importance. Such communication means can be realized via **brain-computer interfaces** (**BCI**s) circumventing the muscular system by using brain signals associated with preserved cognitive, sensory, and emotional brain functions. Primarily, **BCI**s based on electrophysiological measures have been developed and applied with remarkable success. Recently, also blood flow-based neuroimaging methods, such as functional magnetic resonance imaging (**fMRI**) and functional near-infrared spectroscopy (**fNIRS**), have been explored in this context. After reviewing recent literature on the development of especially hemodynamically based **BCI**s, we introduce a highly reliable and easy-to-apply communication procedure that enables untrained participants to motor-independently and relatively effortlessly answer multiple-choice questions based on intentionally generated single-trial **fMRI** signals that can be decoded online. Our technique takes advantage of the participants' capability to voluntarily influence certain spatio-temporal aspects of the blood oxygenation level-dependent (BOLD) signal: source location (by using different mental tasks), signal onset and offset. We show that healthy participants are capable of hemodynamically encoding at least four distinct information units on a single-trial level without extensive pretraining and with little effort. Moreover, real-time data analysis based on simple multi-filter correlations allows for automated answer decoding with a high accuracy (94.9%) demonstrating the robustness of the presented method. Following our 'proof of concept', the next step will involve clinical trials with LIS patients, undertaken in close collaboration with their relatives and caretakers in order to elaborate individually tailored communication protocols. As our procedure can be easily transferred to **MRI**-equipped clinical sites, it may constitute a simple and effective possibility for online detection of residual consciousness and for LIS patients to communicate

basic thoughts and needs in case no other alternative communication means are available (yet)--especially in the acute phase of the LIS. Future research may focus on further increasing the efficiency and accuracy of **fMRI**-based **BCI**s by implementing sophisticated data analysis methods (e.g., multivariate and independent component analysis) and **neurofeedback** training techniques. Finally, the presented **BCI** approach could be transferred to portable **fNIRS** systems as only this would enable hemodynamically based communication in daily life situations.

PMID: 19818908 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2008 Dec;33(4):211-21. Epub 2008 Oct 3.

318. Alterations in Event Related Potentials (ERP) associated with tinnitus distress and attention.

Delb W, Strauss DJ, Low YF, Seidler H, Rheinschmitt A, Wobrock T, D'Amelio R.

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Abstract
Tinnitus related distress corresponds to different degrees of attention paid to the tinnitus. Shifting attention to a signal other than the tinnitus is therefore particularly difficult for patients with high tinnitus related distress. As attention effects on Event Related Potentials (ERP) have been shown this should be reflected in ERP measurements (N100, phase locking). In order to prove this hypothesis single sweep ERP recordings were obtained in 41 tinnitus patients as well as 10 control subjects during a period of time when attention was shifted to a tone (attended) and during a second phase (unattended) when they did not focus attention to the tone. Whereas tinnitus patients with low distress showed a significant reduction in both N100 amplitude and phase locking when comparing the attended and unattended measurement condition a group of patients with high tinnitus related distress did not show such ERP alterations. Using single sweep ERP measurements the results of our study show, that attention in high tinnitus related distress patients is captured by their tinnitus significantly more than in low distress patients. Furthermore our results provide the basis for future **neurofeedback** based tinnitus therapies aiming at maximizing the ability to shift attention away from the tinnitus.

PMID: 18836827 [PubMed - indexed for MEDLINE]

Zhongguo Dang Dai Er Ke Za Zhi. 2008 Dec;10(6):726-7.

319. *[Electroencephalographic biofeedback for the treatment of attention deficit hyperactivity disorder in children]

[Article in Chinese]
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Abstract
OBJECTIVE: Attention deficit hyperactivity disorder (ADHD) is a common behavioral disorder in children. When the children fulfill cognition tasks, brain theta wave activity increases and beta wave activity weakens. This study aimed to explore the efficacy of electroencephalographic **(EEG) biofeedback** therapy for ADHD in children by assessing the changes of the ratio of brain theta to beta waves and the integrated visual and auditory continuous performance test (IVA-CPT).

METHODS: **EEG biofeedback** therapy was performed in 30 children with ADHD. The ratio of brain theta to beta waves was measured before and after therapy. IVA-CPT was used to assess the effectiveness of **biofeedback** therapy.

RESULTS: After two courses of treatment, the mean ratio of brain theta to beta waves in the 30 children with ADHD was significantly reduced from 12.32+/-4.35 (before treatment) to 6.54+/-1.27 ($p<0.01$). IVA-CPT demonstrated that the values of six indexes measured, including integrate reaction control quotient, integrate attention quotient, auditory and visual reaction control quotients, auditory and visual attention control quotients, were significantly increased after **biofeedback** therapy ($p<0.01$).

CONCLUSIONS: **EEG biofeedback** can reduce the ratio of brain theta to beta waves and lead to significant decreases in inattention and hyperactivity and it is effective for treatment of ADHD in children.

PMID: 19102840 [PubMed - indexed for MEDLINE]

J Neurosci Methods. 2008 Nov 15;175(2):165-86. Epub 2008 Aug 5.

320. An open-source hardware and software system for acquisition and real-time processing of electrophysiology during high field MRI.

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Abstract
Simultaneous recording of electrophysiology and functional magnetic resonance imaging (**fMRI**) is a technique of growing importance in neuroscience. Rapidly evolving clinical and scientific requirements have created a need for hardware and software that can be customized for specific applications. Hardware may require customization to enable a variety of recording types (e.g., electroencephalogram, local field potentials, or multi-unit activity) while meeting the stringent and costly requirements of **MRI** safety and compatibility. Real-time signal processing tools are an enabling technology for studies of learning, attention, sleep, epilepsy, **neurofeedback**, and neuropharmacology, yet real-time signal processing tools are difficult to develop. We describe an open-source system for simultaneous electrophysiology and **fMRI** featuring low-noise (<0.6microV p-p input noise), electromagnetic compatibility for **MRI** (tested up to 7T), and user-programmable real-time signal processing. The hardware distribution provides the complete specifications required to build an **MRI**-compatible

electrophysiological data acquisition system, including circuit schematics, print circuit board (PCB) layouts, Gerber files for PCB fabrication and robotic assembly, a bill of materials with part numbers, data sheets, and vendor information, and test procedures. The software facilitates rapid implementation of real-time signal processing algorithms. This system has been used in human **EEG/fMRI** studies at 3 and 7T examining the auditory system, visual system, sleep physiology, and anesthesia, as well as in intracranial electrophysiological studies of the non-human primate visual system during 3T **fMRI**, and in human hyperbaric physiology studies at depths of up to 300 feet below sea level.

PMID: 18761038 [PubMed - indexed for MEDLINE]PMCID: PMC2855223 Free PMC Article
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http://www.ncbi.nlm.nih.gov/pmc/articles/pmid/18761038/?tool=pubmed (HS?).

Eur Arch Psychiatry Clin Neurosci. 2008 Nov;258 Suppl 5:71-5.

321. Brain imaging and psychotherapy: methodological considerations and practical implications.

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Abstract

The development of psychotherapy has been based on psychological theories and clinical effects. However, an investigation of the neurobiological mechanisms of psychological interventions is also needed in order to improve indication and prognosis, inform the choice of parallel pharmacotherapy, provide outcome measures and potentially even aid the development of new treatment protocols. This neurobiological investigation can be informed by animal models, for example of learning and conditioning, but will essentially need the non-invasive techniques of **functional neuroimaging** in order to assess psychotherapy effects on patients' brains, which will be reviewed here. Most research so far has been conducted in obsessive compulsive disorder (OCD), anxiety disorders and depression. Effects in OCD were particularly exciting in that both cognitive behavioural therapy and medication with a selective serotonin inhibitor led to a reduction in blood flow in the caudate nucleus. In phobia, brief courses of behavioural therapy produced marked reductions of paralimbic responses to offensive stimuli in line with the clinical improvement. Findings in depression are less consistent, with both increases and decreases in prefrontal metabolism being reported. However, they are important in pointing to different mechanisms for the clinical effects of pharmacotherapy (more "bottom up") and psychotherapy (more "top down"). For the future it would be desirable if the findings of psychotherapy changes to brain activation patterns were confirmed in larger groups with homogenous imaging protocols. **Functional imaging** has already made great contributions to the understanding of the neural correlates of psychopathology. For example, evidence converges to suggest that the subgenual cingulate is crucial for mood regulation. One current clinical application of these findings is deep brain stimulation in areas highlighted by such imaging studies. I will discuss their initial application in depression and OCD, and suggest potential alternative options based on recent developments in **neurofeedback** technology.

PMID: 18985299 [PubMed - indexed for MEDLINE]

J Neurosci Methods. 2008 Oct 30;175(1):154-62. Epub 2008 Aug 19.

322. A new concept of a unified parameter management, experiment control, and data analysis in fMRI: application to real-time fMRI at 3T and 7T.

Hollmann M, Mönch T, Mulla-Osman S, Tempelmann C, Stadler J, Bernarding J.

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Abstract

In functional **MRI** (**fMRI**) complex experiments and applications require increasingly complex parameter handling as the experimental setup usually consists of separated soft- and hardware systems. Advanced real-time applications such as **neurofeedback**-based training or **brain computer interfaces** (**BCI**s) may even require adaptive changes of the paradigms and experimental setup during the measurement. This would be facilitated by an automated management of the overall workflow and a control of the communication between all experimental components. We realized a concept based on an XML software framework called Experiment Description Language (EDL). All parameters relevant for real-time data acquisition, real-time **fMRI** (rt**fMRI**) statistical data analysis, stimulus presentation, and activation processing are stored in one central EDL file, and processed during the experiment. A usability study comparing the central EDL parameter management with traditional approaches showed an improvement of the complete experimental handling. Based on this concept, a feasibility study realizing a dynamic rt**fMRI**-based **brain computer interface** showed that the developed system in combination with EDL was able to reliably detect and evaluate activation patterns in real-time. The implementation of a centrally controlled communication between the subsystems involved in the rt**fMRI** experiments reduced potential inconsistencies, and will open new applications for adaptive **BCI**s.

PMID: 18773922 [PubMed - indexed for MEDLINE]

Sleep. 2008 Oct;31(10):1401-8.

323. *Instrumental conditioning of human sensorimotor rhythm (12-15 Hz) and its impact on sleep as well as declarative learning.

Hoedlmoser K, Pecherstorfer T, Gruber G, Anderer P, Doppelmayr M, Klimesch W, Schabus M.

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Abstract

STUDY OBJECTIVES: To test whether instrumental conditioning of sensorimotor rhythm (**SMR**; 12-15 Hz) has an impact on sleep parameters as well as declarative memory performance in humans.

DESIGN: Randomized, parallel group design

SETTING: 10 instrumental conditioning sessions, pre- and posttreatment investigation including sleep evaluations

PARTICIPANTS: 27 healthy subjects (13 male) Interventions: **SMR**-conditioning (experimental group) or randomized-frequency conditioning (control group); declarative memory task before and after a 90-min nap

MEASUREMENT AND RESULTS: The experimental group was trained to enhance the amplitude of their **SMR**-frequency range, whereas the control group participated in a randomized-frequency conditioning program (i.e., every session a different 3-Hz frequency bin between 7 and 20 Hz). During pre- and posttreatment the subjects had to attend the sleep laboratory to take a 90-min nap (2:00-3:30 pm) and to perform a declarative memory task before and after sleep. The experimental design was successful in conditioning an increase in relative 12-15 Hz amplitude within 10 sessions (d = 0.7). Increased **SMR** activity was also expressed during subsequent sleep by eliciting positive changes in different sleep parameters (sleep spindle number [d = 0.6], sleep onset latency [d = 0.7]); additionally, this increased 12-15 Hz amplitude was associated with enhancement in retrieval score computed at immediate cued recall (d = 0.9).

CONCLUSION: Relative **SMR** amplitude increased over 10 instrumental conditioning sessions (in the experimental group only) and this "shaping of one's own brain activity" improved subsequent declarative learning and facilitated the expression of 12-15 Hz spindle oscillations during sleep. Most interestingly, these electrophysiological changes were accompanied by a shortened sleep onset latency. [Note: this abstract should definitively have mentioned the word **EEG biofeedback**.]

PMID: 18853937 [PubMed - indexed for MEDLINE] PMCID: PMC2572745
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2572745

Clin EEG Neurosci. 2008 Oct;39(4):203-5.

324. *Power spectral frequency and coherence abnormalities in patients with intractable epilepsy and their usefulness in long-term remediation of seizures using neurofeedback.

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Abstract

Medically intractable seizures appear to be highly correlated with focal slow activity (delta or theta). They also correlate highly with decreases in the coherence of theta. Normalization of focal slowing and of decreased theta coherence will probably be the **neurofeedback** approaches most likely to decrease or eliminate seizures in future cases. **Neurofeedback** has been used for over 35 years to reduce the incidence and severity of seizures. With power training to decrease theta and increase the sensorimotor rhythm (12-15 Hz), an average of 82% of patients experienced a significant reduction in seizure frequency, and occasional remissions were seen. Recent improvements using Q**EEG** to guide **neurofeedback** training have made it possible to eliminate seizures in most patients, even those with intractable seizures. Following our previous study in 2005, we report an additional 25 patients so treated. We also report an analysis of the frequency of Q**EEG** abnormalities in this patient group. All of the intractable epileptic patients had one or more slow foci (excessive theta or delta compared with the normal database). One third had a relative deficiency of beta power. One fourth had a deficiency of absolute delta. Eighteen percent had excessive absolute alpha power, 18% had deficient absolute alpha power, 18% percent had excessive absolute beta power, and 18% percent had deficient absolute beta power. Hypocoherence of theta was found in 75%, and decreases in alpha coherence were noted in 42%. Hypocoherence of beta was found in 50%, and hypocoherence of delta was found in 25%. Increases in alpha coherence were noted in 33%. Seventeen percent had no coherence abnormalities. When most of the power and coherence abnormalities were normalized with **neurofeedback** training, all the patients became seizure-free; 76% no longer required an anticonvulsant for seizure control.

PMID: 19044219 [PubMed - indexed for MEDLINE]

Curr Psychiatry Rep. 2008 Oct;10(5):432-8.

325. *Quantitative electroencephalography and attention-deficit/hyperactivity disorder: implications for clinical practice.

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Abstract

Although behavioral symptoms of inattention, impulsivity, and hyperactivity serve as a foundation for the accurate diagnosis of attention-deficit/hyperactivity disorder (ADHD), the low interrater reliability and specificity of behavioral rating scales and the absence of comprehensive screening for medical conditions that mimic ADHD have created a barrier to the effective treatment of ADHD. Recently published studies using quantitative electroencephalographic techniques have identified abnormal patterns of cortical activation through power spectral analysis, in event-related cortical potentials, and in slow cortical potentials that may serve as a basis for overcoming these barriers. This paper reviews the initial evidence indicating that power spectral analysis and event-related cortical potentials may be useful in differentiating ADHD from other psychiatric disorders, helping in medication selection, evaluating medication response, and improving the rate of treatment initiation and maintenance. Studies examining **electroencephalogram biofeedback** (**neurotherapy**) are reviewed using published efficacy guidelines.

PMID: 18803918 [PubMed - indexed for MEDLINE]

HNO. 2008 Oct;56(10):990-5.

326. *[Modern rehabilitation for vestibular disorders using neurofeedback training procedures]

[Article in German]
Basta D, Ernst A.

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Abstract
The conservative therapy of long-lasting vestibular disorders has been changed over the last few years by the introduction of **neuro(bio-)feedback** procedures. A technical **neurofeedback** system applies an additional (acoustic, galvanic, vibrotactile) stimulus to the patient while performing vestibular exercises. This stimulus is dependent on the extent of postural deviation of the patient from a normal (ideal) position in space. The **neurofeedback** system is body worn and continuously registers any postural deviation from the normal position so that it can apply suitable stimuli to the patient. This new way of rehabilitating patients with vertigo seems to be a promising addition in the therapy of long-lasting, complex vestibular disorders as recent studies have demonstrated.

PMID: 18806973 [PubMed - indexed for MEDLINE]

J Neural Transm. 2008 Oct;115(10):1445-56. Epub 2008 Sep 2.

327. *Slow cortical potential neurofeedback in attention deficit hyperactivity disorder: is there neurophysiological evidence for specific effects?

Doehnert M, Brandeis D, Straub M, Steinhausen HC, Drechsler R.

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Abstract
This study compared changes in quantitative **EEG** (Q**EEG**) and CNV (contingent negative variation) of children suffering from ADHD treated by **SCP** (slow cortical potential) **neurofeedback** (**NF**) with the effects of group therapy (GT) to separate specific from non-specific neurophysiological effects of **NF**. Twenty-six children (age: 11.1 +/- 1.15 years) diagnosed as having ADHD were assigned to **NF** (N = 14) or GT (N = 12) training groups. Q**EEG** measures at rest, CNV and behavioral ratings were acquired before and after the trainings and statistically analyzed. For children with ADHD-combined type in the **NF** group, treatment effects indicated a tendency toward improvement of selected Q**EEG** markers. We could not find the expected improvement of CNV, but CNV reduction was less pronounced in good **NF** performers. Q**EEG** changes were associated with some behavioral scales. Analyses of subgroups suggested specific influences of **SCP** training on brain functions. To conclude, **SCP neurofeedback** improves only selected attentional brain functions as measurable with

Q**EEG** at rest or CNV mapping. Effects of **neurofeedback** including the advantage of **NF** over GT seem mediated by both specific and non-specific factors.

PMID: 18762860 [PubMed - indexed for MEDLINE]

PLoS One. 2008 Aug 13;3(8):e2967.

328. Towards zero training for brain-computer interfacing.

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Abstract

Electroencephalogram (**EEG**) signals are highly subject-specific and vary considerably even between recording sessions of the same user within the same experimental paradigm. This challenges a stable operation of **Brain-Computer Interface** (**BCI**) systems. The classical approach is to train users by **neurofeedback** to produce fixed stereotypical patterns of brain activity. In the machine learning approach, a widely adapted method for dealing with those variances is to record a so called calibration measurement on the beginning of each session in order to optimize spatial filters and classifiers specifically for each subject and each day. This adaptation of the system to the individual brain signature of each user relieves from the need of extensive user training. In this paper we suggest a new method that overcomes the requirement of these time-consuming calibration recordings for long-term **BCI** users. The method takes advantage of knowledge collected in previous sessions: By a novel technique, prototypical spatial filters are determined which have better generalization properties compared to single-session filters. In particular, they can be used in follow-up sessions without the need to recalibrate the system. This way the calibration periods can be dramatically shortened or even completely omitted for these 'experienced' **BCI** users. The feasibility of our novel approach is demonstrated with a series of online **BCI** experiments. Although performed without any calibration measurement at all, no loss of classification performance was observed.

PMID: 18698427 [PubMed - indexed for MEDLINE]PMCID: PMC2500157 Free PMC Article
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http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2500157/?tool=pubmed.

Methods. 2008 Aug;45(4):279-88. Epub 2008 Aug 3.

329. *EEG applications for sport and performance.

Thompson T, Steffert T, Ros T, Leach J, Gruzelier J.

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Abstract

One approach to understanding processes that underlie skilled performing has been to study electrical brain activity using electroencephalography (**EEG**). A notorious problem with **EEG**

is that genuine cerebral data is often contaminated by artifacts of non-cerebral origin. Unfortunately, such artifacts tend to be exacerbated when the subject is in motion, meaning that obtaining reliable data during exercise is inherently problematic. These problems may explain the limited number of studies using **EEG** as a methodological tool in the sports sciences. This paper discusses how empirical studies have generally tackled the problem of movement artifact by adopting alternative paradigms which avoid recording during actual physical exertion. Moreover, the specific challenges that motion presents to obtaining reliable **EEG** data are discussed along with practical and computational techniques to confront these challenges. Finally, as **EEG** recording in sports is often underpinned by a desire to optimise performance, a brief review of **EEG-biofeedback** and peak performance studies is also presented. A knowledge of practical aspects of **EEG** recording along with the advent of new technology and increasingly sophisticated processing models offer a promising approach to minimising, if perhaps not entirely circumventing, the problem of obtaining reliable **EEG** data during motion.

PMID: 18682293 [PubMed - indexed for MEDLINE]

Prilozi. 2008 Jul;29(1):239-52.

330. *Simultaneous EEG and EMG biofeedback for peak performance in musicians.

Markovska-Simoska S, Pop-Jordanova N, Georgiev D.

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Abstract

The aim of this study was to determine the effects of alpha **neurofeedback** and EMG **biofeedback** protocols for improvement of musical performance in violinists. The sample consisted of 12 music students (10 violinists and 2 viola players) from the Faculty of Music, Skopje (3 males, mean age of 20 +/- 0 and 9 females, mean age = 20.89 +/- 2.98). Six of them had a low alpha peak frequency (APF) (< 10 Hz), and six a high APF (> 10 Hz). The sample was randomized in two groups. The students from the experimental group participated in 20 sessions of **biofeedback** (alpha/EMG), combined with music practice, while the students from the control group did only music practice. Average absolute power, interhemispheric coherence in the alpha band, alpha peak frequency (APF), individual alpha band width (IABW), amount of alpha suppression (AAS) and surface forehead integrated EMG power (IEMG), as well as a score on musical performance and inventories measuring anxiety, were assessed. Alpha-**EEG**/EMG-**biofeedback** was associated with a significant increase in average alpha power, APF and IABW in all the participants and with decreases in IEMG only in high-APF musicians. The **biofeedback** training success was positively correlated with the alpha power, IcoH, APF, IABW and baseline level of APF and IABW. Alpha-**EEG**/EMG **biofeedback** is capable of increasing voluntary self-regulation and the quality of musical performance. The efficiency of **biofeedback** training depends on the baseline **EEG** alpha activity status, in particular the APF.

PMID: 18709013 [PubMed - indexed for MEDLINE]

Int J Imaging Syst Technol. 2008 Jun 13;18(1):69-78.

331. Neurofeedback fMRI-mediated learning and consolidation of regional brain activation during motor imagery.

Yoo SS, Lee JH, O'Leary H, Panych LP, Jolesz FA.

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Abstract
We report the long-term effect of real-time functional **MRI** (rt**fMRI**) training on voluntary regulation of the level of activation from a hand motor area. During the performance of a motor imagery task of a right hand, blood-oxygenation-level-dependent (BOLD) signal originating from a primary motor area was presented back to the subject in real-time. Demographically matched individuals also received the same procedure without valid **feedback** information. Followed by the initial rt**fMRI** sessions, both groups underwent two-week long, daily-practice of the task. Off-line data analysis revealed that the individuals in the experimental group were able to increase the level of BOLD signal from the regulatory target to a greater degree compared to the control group. Furthermore, the learned level of activation was maintained after the two-week period, with the recruitment of additional neural circuitries such as the hippocampus and the limbo-thalamo-cortical pathway. The activation obtained from the control group, in the absence of proper **feedback**, was indifferent across the training conditions. The level of BOLD activity from the target regulatory region was positively correlated with a self evaluative score within the experimental group, while the majority of control subjects had difficulty adopting a strategy to attain the desired level of functional regulation. Our results suggest that rt**fMRI** helped individuals learn how to increase region-specific cortical activity associated with a motor imagery task, and the level of increased activation in motor areas was consolidated after the two-week self-practice period, with the involvement of neural circuitries implicated in motor skill learning.

PMID: 19526048 [PubMed]PMCID: PMC2630170 Free PMC Article
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http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2630170/?tool=pubmed.

Appl Psychophysiol Biofeedback. 2008 Jun;33(2):101-24. Epub 2008 Jun 13.

332. *Efficacy of traumatic brain injury rehabilitation: interventions of QEEG-guided biofeedback, computers, strategies, and medications.

Thornton KE, Carmody DP.

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Abstract
The onset of cognitive rehabilitation brought with it a hope for an effective treatment for the traumatic brain injured subject. This paper reviews the empirical reports of changes in cognitive functioning after treatment and compares the relative effectiveness of several

treatments including computer interventions, cognitive strategies, **EEG biofeedback**, and medications. The cognitive functions that are reviewed include auditory memory, attention and problem solving. The significance of the change in cognitive function is assessed in two ways that include effect size and longevity of effect. These analyses complement the previously published meta-reviews by adding these two criteria and include reports of **EEG biofeedback**, which is shown to be an effective intervention for auditory memory.

PMID: 18551365 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2008 Mar;33(1):1-28. Epub 2008 Jan 24.

333. *EEG biofeedback as a treatment for substance use disorders: review, rating of efficacy, and recommendations for further research.

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Abstract

Electroencephalographic **(EEG) biofeedback** has been employed in substance use disorder (SUD) over the last three decades. The SUD is a complex series of disorders with frequent comorbidities and **EEG** abnormalities of several types. **EEG biofeedback** has been employed in conjunction with other therapies and may be useful in enhancing certain outcomes of therapy. Based on published clinical studies and employing efficacy criteria adapted by the Association for Applied Psychophysiology and **Biofeedback** and the International Society for **Neurofeedback** and Research, alpha theta training-either alone for alcoholism or in combination with beta training for stimulant and mixed substance abuse and combined with residential treatment programs, is probably efficacious. Considerations of further research design taking these factors into account are discussed and descriptions of contemporary research are given.

PMID: 18214670 [PubMed - indexed for MEDLINE]PMCID: PMC2259255 Free PMC Article
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http://www.ncbi.nlm.nih.gov/pmc/articles/pmid/18214670/?tool=pubmed.

J Pain. 2008 Mar;9(3):193-9. Epub 2007 Dec 21.

334. *New insights into neuromodulatory approaches for the treatment of pain.

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Abstract

Two lines of evidence about the association between the experience of pain and brain state (measured via electroencephalogram or **EEG**) have recently come to light. First, research from a number of sources suggests a link between brain **EEG** activity and the experience of pain. Specifically, this research suggests that the subjective experience of pain is associated with relatively lower amplitudes of slower wave (delta, theta, and alpha) activity and relatively higher amplitudes of faster wave (beta) activity. Second, there has been a recent increase in interest in interventions that impact the cortical neuromodulation of pain, including behavioral treatments (such as self-hypnosis training and **neurofeedback**) and both invasive and noninvasive brain stimulation. Although a direct causal link between experience of pain and brain activity as measured by **EEG** has not been established, the targeting of pain treatment at a cortical level by trying to affect **EEG** rhythms directly is an intriguing possibility. PERSPECTIVE: Preliminary evidence suggests the possibility, which has not yet been adequately tested or proven, that the experience of chronic pain is linked to cortical activity as assessed via an electroencephalogram. Support for this hypothesis would have important implications for understanding the mechanisms that underlie a number of pain treatments, and for developing new innovative treatments for chronic pain management.

PMID: 18096437 [PubMed - indexed for MEDLINE]

Neuroreport. 2008 Feb 12;19(3):315-7.

335. Alpha neurofeedback improves the maintaining ability of alpha activity.

Cho MK, Jang HS, Jeong SH, Jang IS, Choi BJ, Lee MG.

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Abstract
The effects of alpha-**neurofeedback** (A**NF**) on electroencephalographic alpha-activity were investigated. Each session consisted of a 2.5-min eye-opened state and 17.5-min of A**NF**, which was divided into 16 1.25-min bins. Alpha amplitudes were gradually increased as the session was repeated. The maximum value at the start of A**NF** gradually decreased as time passed, but the slowdown of alpha-activity during each session was decreased as the session was repeated. The correlation between alpha-activity at the end of A**NF** and at the following session's eye-opened state was highly significant. These results showed that A**NF** enhances the ability of alpha-activity to maintain itself rather than the increase of alpha-amplitude during intrasession and that the maintained alpha-activity during former training remained until the next session.

PMID: 18303573 [PubMed - indexed for MEDLINE]

Hum Brain Mapp. 2008 Feb;29(2):157-66.

336. Atlas-based multichannel monitoring of functional MRI signals in real-time: automated approach.

Lee JH, O'Leary HM, Park H, Jolesz FA, Yoo SS.

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Abstract

We report an automated method to simultaneously monitor blood-oxygenation-level-dependent (BOLD) MR signals from multiple cortical areas in real-time. Individual brain anatomy was normalized and registered to a pre-segmented atlas in standardized anatomical space. Subsequently, using real-time **fMRI** (rt**fMRI**) data acquisition, localized BOLD signals were measured and displayed from user-selected areas labeled with anatomical and Brodmann's Area (BA) nomenclature. The method was tested on healthy volunteers during the performance of hand motor and internal speech generation tasks employing a trial-based design. Our data normalization and registration algorithm, along with image reconstruction, movement correction and a data display routine were executed with enough processing and communication bandwidth necessary for real-time operation. Task-specific BOLD signals were observed from the hand motor and language areas. One of the study participants was allowed to freely engage in hand clenching tasks, and associated brain activities were detected from the motor-related neural substrates without prior knowledge of the task onset time. The proposed method may be applied to various applications such as **neurofeedback**, **brain-computer-interface**, and functional mapping for surgical planning where real-time monitoring of region-specific brain activity is needed.

PMID: 17370340 [PubMed - indexed for MEDLINE]

IEEE Trans Neural Syst Rehabil Eng. 2008 Feb;16(1):74-81.

337. Objective quantification of the tinnitus decompensation by synchronization measures of auditory evoked single sweeps.

Strauss DJ, Delb W, D'Amelio R, Low YF, Falkai P.

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Abstract

Large-scale neural correlates of the tinnitus decompensation might be used for an objective evaluation of therapies and **neurofeedback** based therapeutic approaches. In this study, we try to identify large-scale neural correlates of the tinnitus decompensation using wavelet phase stability criteria of single sweep sequences of late auditory evoked potentials as synchronization stability measure. The extracted measure provided an objective quantification of the tinnitus decompensation and allowed for a reliable discrimination between a group of compensated and decompensated tinnitus patients. We provide an interpretation for our results by a neural model of top-down projections based on the Jastreboff tinnitus model combined with the adaptive resonance theory which has not been applied to model tinnitus so far. Using this model, our stability measure of evoked potentials can be linked to the focus of attention on the tinnitus signal. It is concluded that the wavelet phase stability of late auditory evoked potential single sweeps might be used as objective tinnitus decompensation measure and can be interpreted in the framework of the Jastreboff tinnitus model and adaptive resonance theory.

PMID: 18303808 [PubMed - indexed for MEDLINE]

BMC Biol. 2008 Jan 16;6:4.

338. *Transient reduction of tinnitus intensity is marked by concomitant reductions of delta band power.

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Abstract

BACKGROUND: Tinnitus is an auditory phantom phenomenon characterized by the sensation of sounds without objectively identifiable sound sources. To date, its causes are not well understood. Previous research found altered patterns of spontaneous brain activity in chronic tinnitus sufferers compared to healthy controls, yet it is unknown whether these abnormal oscillatory patterns are causally related to the tinnitus sensation. Partial support for this notion comes from a **neurofeedback** approach developed by our group, in which significant reductions in tinnitus loudness could be achieved in patients who successfully normalized their patterns of spontaneous brain activity. The current work attempts to complement these studies by scrutinizing how modulations of tinnitus intensity alter ongoing oscillatory activity.

RESULTS: In the present study the relation between tinnitus sensation and spontaneous brain activity was investigated using residual inhibition (RI) to reduce tinnitus intensity and source-space projected magnetencephalographic (**MEG**) data to index brain activity. RI is the sustained reduction (criteria: 50% for at least 30 s) in tinnitus loudness after cessation of a tonal tinnitus masker. A pilot study (n = 38) identified 10 patients who showed RI. A significant reduction of power in the delta (1.3-4.0 Hz) frequency band was observed in temporal regions during RI (p </= 0.001).

CONCLUSION: The current results suggest that changes of tinnitus intensity induced by RI are mediated by alterations in the pathological patterns of spontaneous brain activity, specifically a reduction of delta activity. Delta activity is a characteristic oscillatory activity generated by deafferented/deprived neuronal networks. This implies that RI effects might reflect the transient reestablishment of balance between excitatory and inhibitory neuronal assemblies, via reafferentation, that have been perturbed (in most tinnitus individuals) by hearing damage. As enhancements have been reported in the delta frequency band for tinnitus at rest, this result conforms to our assumption that a normalization of oscillatory properties of cortical networks is a prerequisite for attenuating the tinnitus sensation. For RI to have therapeutic significance however, this normalization would have to be stabilized.

PMID: 18199318 [PubMed - indexed for MEDLINE]PMCID: PMC2254377 Free PMC Article
See complete free article at: http://www.biomedcentral.com/1741-7007/6/4.

Conf Proc IEEE Eng Med Biol Soc. 2008;2008:5136-9.

339. *Neurofeedback by neural correlates of auditory selective attention as possible application for tinnitus therapies.

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Abstract

More and more people are suffering from tinnitus. There are many treatments for tinnitus that have been claimed based on different causes. Unfortunately, until now none of the existing treatments has been found to be effective in general. Here, we would like to suggest a treatment to tinnitus based on **neurofeedback** using neural correlates of auditory selective evoked potentials (ASEPs). We have shown that the wavelet phase synchronization of auditory late responses (ALR) single sweeps allows for a direct online monitoring of phase locked auditory attention. The results show that after a simple training, subjects learned to control their attention to the auditory modality. To improve the ability in the attention control system is an objective of many tinnitus treatments, so that the perception of the patients towards the tinnitus noise can be reduced to a minimum. It is concluded that our proposed **neurofeedback** system by wavelet phase synchronization measure might be used in a clinical treatment of tinnitus patients and it is possible to extent to other therapeutic based control systems.

PMID: 19163873 [PubMed - indexed for MEDLINE]

Conf Proc IEEE Eng Med Biol Soc. 2008;2008:3860-3.

340. *Sleep onset estimator: evaluation of parameters.

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Abstract

The electroencephalographic (**EEG**) alterations during the human sleep onset (falling asleep period) has been evaluated by several studies in the past. However, the analysis part has been limited due to standard signal processing methods. This paper has attempted to evaluate a number of advanced parameters for improved sleep onset estimation, such as **EEG** non-parametric coherence, power frequency and spectral band power. These parameters can be utilised in an on-line algorithm design for **neurofeedback** applications.

PMID: 19163555 [PubMed - indexed for MEDLINE]

J Pers Soc Psychol. 2008 Jan;94(1):1-15.

341. *Left frontal cortical activation and spreading of alternatives: tests of the action-based model of dissonance.

Harmon-Jones E, Harmon-Jones C, Fearn M, Sigelman JD, Johnson P.

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Abstract
The action-based model of dissonance predicts that following decisional commitment, approach-oriented motivational processes occur to assist in translating the decision into effective and unconflicted behavior. Therefore, the modulation of these approach-oriented processes should affect the degree to which individuals change their attitudes to be more consistent with the decisional commitment (spreading of alternatives). Experiment 1 demonstrated that a **neurofeedback**-induced decrease in relative left frontal cortical activation, which has been implicated in approach motivational processes, caused a reduction in spreading of alternatives. Experiment 2 manipulated an action-oriented mindset following a decision and demonstrated that the action-oriented mindset caused increased activation in the left frontal cortical region as well as increased spreading of alternatives. Discussion focuses on how this integration of neuroscience and dissonance theory benefits both parent literatures.

PMID: 18179314 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2007 Dec;32(3-4):169-83. Epub 2007 Nov 3.

342. *Changes in EEG current sources induced by neurofeedback in learning disabled children. An exploratory study.

Fernández T, Harmony T, Fernández-Bouzas A, Díaz-Comas L, Prado-Alcalá RA, Valdés-Sosa P, Otero G, Bosch J, Galán L, Santiago-Rodríguez E, Aubert E, García-Martínez F.

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Abstract
The objective of this work was to explore **Neurofeedback** (**NFB**) effects on **EEG** current sources in Learning Disabled (LD) children, and to corroborate its beneficial consequences on behavioral and cognitive performance. **NFB** was given in twenty 30-min sessions to 11 LD children to reduce their abnormally high theta/alpha ratios (Experimental Group). Another five LD children with the same characteristics received a placebo treatment (Control Group). In the Control Group no changes in behavior or **EEG** current source were observed. In the Experimental Group, immediately after treatment children showed behavioral and cognitive improvements, but current source analysis showed few modifications; however, 2 months after treatment many changes occurred: a decrease in current of frequencies within the theta band, mainly in left frontal and cingulate regions, and enhancement in current of frequencies

within the alpha band, principally in the right temporal lobe and right frontal regions, and of frequencies within the beta band, mainly in left temporal, right frontal and cingulate cortex regions. In conclusion, **NFB** is a possibly efficacious treatment for LD children with an abnormally high theta/alpha ratio in any lead. The changes observed in **EEG** current sources may reflect the neurophysiological bases of the improvement that children experienced in their behavioral and cognitive activities.

PMID: 17978869 [PubMed - indexed for MEDLINE]

PLoS One. 2007 Oct 31;2(10):e1094.

343. A blueprint for real-time functional mapping via human intracranial recordings.

Lachaux JP, Jerbi K, Bertrand O, Minotti L, Hoffmann D, Schoendorff B, Kahane P.

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Abstract

BACKGROUND: The surgical treatment of patients with intractable epilepsy is preceded by a pre-surgical evaluation period during which intracranial **EEG** recordings are performed to identify the epileptogenic network and provide a functional map of eloquent cerebral areas that need to be spared to minimize the risk of post-operative deficits. A growing body of research based on such invasive recordings indicates that cortical oscillations at various frequencies, especially in the gamma range (40 to 150 Hz), can provide efficient markers of task-related neural network activity.

PRINCIPAL FINDINGS: Here we introduce a novel real-time investigation framework for mapping human brain functions based on online visualization of the spectral power of the ongoing intracranial activity. The results obtained with the first two implanted epilepsy patients who used the proposed online system illustrate its feasibility and utility both for clinical applications, as a complementary tool to electrical stimulation for presurgical mapping purposes, and for basic research, as an exploratory tool used to detect correlations between behavior and oscillatory power modulations. Furthermore, our findings suggest a putative role for high gamma oscillations in higher-order auditory processing involved in speech and music perception.

CONCLUSION/SIGNIFICANCE: The proposed real-time setup is a promising tool for presurgical mapping, the investigation of functional brain dynamics, and possibly for **neurofeedback** training and **brain computer interfaces**.

PMID: 17971857 [PubMed - indexed for MEDLINE]PMCID: PMC2040217 Free PMC Article
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/pmid/17971857/?tool=pubmed.

Behav Brain Funct. 2007 Jul 26;3:35.

344. *Controlled evaluation of a neurofeedback training of slow cortical potentials in children with Attention Deficit/Hyperactivity Disorder (ADHD).

Drechsler R, Straub M, Doehnert M, Heinrich H, Steinhausen HC, Brandeis D.

Department of Child and Adolescent Psychiatry, University of Zurich, Switzerland. renate.drechsler@kjpd.uzh.ch.

Abstract

BACKGROUND: Although several promising studies on **neurofeedback** training in Attention Deficit/Hyperactivity Disorder (ADHD) have been performed in recent years, the specificity of positive treatment effects continues to be challenged.

METHODS: To evaluate the specificity of a **neurofeedback** training of slow cortical potentials, a twofold strategy was pursued: First, the efficacy of **neurofeedback** training was compared to a group training program for children with ADHD. Secondly, the extent of improvements observed in the **neurofeedback** group in relation to successful regulation of cortical activation was examined. Parents and teachers rated children's behaviour and executive functions before and after treatment. In addition, children underwent neuropsychological testing before and after training.

RESULTS: According to parents' and teachers' ratings, children of the **neurofeedback** training group improved more than children who had participated in a group therapy program, particularly in attention and cognition related domains. On neuropsychological measures children of both groups showed similar improvements. However, only about half of the **neurofeedback** group learned to regulate cortical activation during a transfer condition without direct **feedback**. Behavioural improvements of this subgroup were moderately related to **neurofeedback** training performance, whereas effective parental support accounted better for some advantages of **neurofeedback** training compared to group therapy according to parents' and teachers' ratings.

CONCLUSION: There is a specific training effect of **neurofeedback** of slow cortical potentials due to enhanced cortical control. However, non-specific factors, such as parental support, may also contribute to the positive behavioural effects induced by the **neurofeedback** training.

PMID: 17655749 [PubMed - in process]PMCID: PMC1988816 Free PMC Article
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http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1988816/?tool=pubmed.

Agri. 2007 Jul;19(3):47-53.

345. *Neurofeedback in fibromyalgia syndrome.

Kayiran S, Dursun E, Ermutlu N, Dursun N, Karamürsel S.

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Abstract
EEG biofeedback (**Neurofeedback**-**NFB**) is a learning strategy that enables people to alter their brainwaves. In the present case study, we applied a **NFB** protocol on three patients with Fibromyalgia Syndrome (FMS). The existing symptoms and clinical conditions of the patients attributed to FMS, Visual Analog Scale for pain and fatigue, Hamilton Depression and Anxiety Inventory Scales, Beck Depression and Anxiety Inventory Scales, and SF-36 were recorded before and after **NFB** training. Most of the symptoms were decreased after ten sessions. There was also improvement in all of the scales after the treatment. The results of the present study may suggest **NFB** training as a novel treatment method in FMS.

PMID: 18095199 [PubMed - indexed for MEDLINE] Free Article
See complete free article at: http://www.journalagent.com/pubmed/linkout.asp?ISSN=1300-0012&PMID=18095199.

Altern Med Rev. 2007 Jun;12(2):146-51.

346. *EEG biofeedback in the treatment of attention deficit hyperactivity disorder.

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Abstract
Electroencephalogram **(EEG) biofeedback**, also known as **neurofeedback**, is a promising alternative treatment for patients with attention deficit/hyperactivity disorder (AD/HD). **EEG biofeedback** therapy rewards scalp **EEG** frequencies that are associated with relaxed attention, and suppresses frequencies associated with under- or over-arousal. In large-scale clinical trials, the efficacy of **EEG biofeedback** for AD/HD is comparable to that of stimulant medications. Many different **EEG biofeedback** protocols for AD/HD are available. Single-channel protocols developed by Lubar and interhemispheric protocols developed by the Othmers are widely practiced and supported by large-scale clinical studies.

PMID: 17604459 [PubMed - indexed for MEDLINE] Free Article
See complete free article at: http://www.altmedrev.com/publications/12/2/146.pdf.

Clin Neurophysiol. 2007 Jun;118(6):1377-86. Epub 2007 Mar 29.

347. Event-based sonification of EEG rhythms in real time.

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Abstract
OBJECTIVE: To introduce a sound synthesis tool for human **EEG** rhythms that is applicable in real time.

METHODS: We design an event-based sonification which suppresses irregular background and highlights normal and pathologic rhythmic activity.

RESULTS: We generated sound examples with rhythms from well-known epileptic disorders and find stereotyped rhythmic auditory objects in single channel and stereo display from generalized spike-wave runs. For interictal activity, we were able to separate focal rhythms from background activity and thus enable the listener to perceive its frequency, duration, and intensity while monitoring.

CONCLUSIONS: The proposed event-based sonification allows quick detection and identification of different types of rhythmic EEE events in real time and can thus be used to complement visual displays in monitoring and **EEG feedback** tasks.

SIGNIFICANCE: The significance of the work lies in the fact that it can be implemented for on-line monitoring of clinical **EEG** and for **EEG feedback** applications where continuous screen watching can be substituted or improved by the auditory information stream.

PMID: 17398153 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2007 Jun;32(2):73-88. Epub 2007 Mar 14.

348. *Neurofeedback for children with ADHD: a comparison of SCP and Theta/Beta protocols.

Leins U, Goth G, Hinterberger T, Klinger C, Rumpf N, Strehl U.

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Abstract

Behavioral and cognitive improvements in children with ADHD have been consistently reported after **neurofeedback**-treatment. However, **neurofeedback** has not been commonly accepted as a treatment for ADHD. This study addresses previous methodological shortcomings while comparing a **neurofeedback**-training of Theta-Beta frequencies and training of slow cortical potentials (**SCP**s). The study aimed at answering (a) whether patients were able to demonstrate learning of cortical self-regulation, (b) if treatment leads to an improvement in cognition and behavior and (c) if the two experimental groups differ in cognitive and behavioral outcome variables. **SCP** participants were trained to produce positive and negative **SCP**-shifts while the Theta/Beta participants were trained to suppress Theta (4-8 Hz) while increasing Beta (12-20 Hz). Participants were blind to group assignment. Assessment included potentially confounding variables. Each group was comprised of 19 children with ADHD (aged 8-13 years). The treatment procedure consisted of three phases of 10 sessions each. Both groups were able to intentionally regulate cortical activity and improved in attention and IQ. Parents and teachers reported significant behavioral and cognitive improvements. Clinical effects for both groups remained stable six months after treatment. Groups did not differ in behavioural or cognitive outcome.

PMID: 17356905 [PubMed - indexed for MEDLINE]

Neuroimage. 2007 Apr 15;35(3):1238-46. Epub 2007 Jan 31.

349. Regulation of anterior insular cortex activity using real-time fMRI.

Caria A, Veit R, Sitaram R, Lotze M, Weiskopf N, Grodd W, Birbaumer N.

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Abstract

Recent advances in functional magnetic resonance imaging (**fMRI**) data acquisition and processing techniques have made real-time **fMRI** (rt**fMRI**) of localized brain areas feasible, reliable and less susceptible to artefacts. Previous studies have shown that healthy subjects learn to control local brain activity with operant training by using rt**fMRI**-based **neurofeedback**. In the present study, we investigated whether healthy subjects could voluntarily gain control over right anterior insular activity. Subjects were provided with continuously updated information of the target ROI's level of activation by visual **feedback**. All participants were able to successfully regulate BOLD-magnitude in the right anterior insular cortex within three sessions of 4 min each. Training resulted in a significantly increased activation cluster in the anterior portion of the right insula across sessions. An increased activity was also found in the left anterior insula but the percent signal change was lower than in the target ROI. Two different control conditions intended to assess the effects of non-specific **feedback** and mental imagery demonstrated that the training effect was not due to unspecific activations or non **feedback**-related cognitive strategies. Both control groups showed no enhanced activation across the sessions, which confirmed our main hypothesis that rt**fMRI feedback** is area-specific. The increased activity in the right anterior insula during training demonstrates that the effects observed are anatomically specific and self-regulation of right anterior insula only is achievable. This is the first group study investigating the volitional control of emotionally relevant brain region by using rt**fMRI** training and confirms that self-regulation of local brain activity with rt**fMRI** is possible.

PMID: 17336094 [PubMed - indexed for MEDLINE]

Int J Neurosci. 2007 Mar;117(3):337-57.

350. The effects of neurofeedback training in the cognitive division of the anterior cingulate gyrus.

Cannon R, Lubar J, Congedo M, Thornton K, Towler K, Hutchens T.

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Abstract

This study examines the efficacy of **neurofeedback** training in the cognitive division of the anterior cingulate gyrus and describes its relationship with cortical regions known to be involved in executive functions. This study was conducted with eight non-clinical students, four male and four female, with a mean age of twenty-two. Learning occurred in the ACcd at significant levels over sessions and in the anterior regions that receive projections from the

AC. There appears to be a multidimensional executive circuit that increases in the same frequency in apparent synchrony with the AC and it may be possible to train this sub-cortical region using L**NFB**.

PMID: 17365119 [PubMed - indexed for MEDLINE]

Clin Neuropsychol. 2007 Jan;21(1):110-29.

351. *EEG neurofeedback: a brief overview and an example of peak alpha frequency training for cognitive enhancement in the elderly.

Angelakis E, Stathopoulou S, Frymiare JL, Green DL, Lubar JF, Kounios J.

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Abstract

Neurofeedback (**NF**) is an electroencephalographic **(EEG) biofeedback** technique for training individuals to alter their brain activity via operant conditioning. Research has shown that **NF** helps reduce symptoms of several neurological and psychiatric disorders, with ongoing research currently investigating applications to other disorders and to the enhancement of non-disordered cognition. The present article briefly reviews the fundamentals and current status of **NF** therapy and research and illustrates the basic approach with an interim report on a pilot study aimed at developing a new **NF** protocol for improving cognitive function in the elderly. **EEG** peak alpha frequency (PAF) has been shown to correlate positively with cognitive performance and to correlate negatively with age after childhood. The present pilot study used a double-blind controlled design to investigate whether training older individuals to increase PAF would result in improved cognitive performance. The results suggested that PAF **NF** improved cognitive processing speed and executive function, but that it had no clear effect on memory. In sum, the results suggest that the PAF **NF** protocol is a promising technique for improving selected cognitive functions.

PMID: 17366280 [PubMed - indexed for MEDLINE]

Comput Intell Neurosci. 2007:94561.

352. Fully online multicommand brain-computer interface with visual neurofeedback using SSVEP paradigm.

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Abstract

We propose a new multistage procedure for a real-time **brain-machine/computer interface** (**BCI**). The developed system allows a **BCI** user to navigate a small car (or any other object) on the computer screen in real time, in any of the four directions, and to stop it if necessary. Extensive experiments with five young healthy subjects confirmed the high performance of the proposed online **BCI** system. The modular structure, high speed, and the optimal

frequency band characteristics of the **BCI** platform are features which allow an extension to a substantially higher number of commands in the near future.

PMID: 18354725 [PubMed]PMCID: PMC2266836 Free PMC Article
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http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2266836/?tool=pubmed.

Conf Proc IEEE Eng Med Biol Soc. 2007;2007:2485-8.

353. The role of attention in the tinnitus decompensation: reinforcement of a large-scale neural decompensation measure.

Low YF, Trenado C, Delb W, Corona-Strauss FI, Strauss DJ.

Computational Diagnostics and Biocybernetics Unit, Saarland University, Homburg/Saarbruecken, Germany. yinfen@cdb-unit.de

Abstract
Large-scale neural correlates of the tinnitus decompensation have been identified by using wavelet phase stability criteria of single sweep sequences of auditory late responses (ALRs). The suggested measure provided an objective quantification of the tinnitus decompensation and allowed for a reliable discrimination between a group of compensated and decompensated tinnitus patients. By interpreting our results with an oscillatory tinnitus model, our synchronization stability measure of ALRs can be linked to the focus of attention on the tinnitus signal. In the following study, we examined in detail the correlates of this attentional mechanism in healthy subjects. The results support our previous findings of the phase synchronization stability measure that reflected neural correlates of the fixation of attention to the tinnitus signal. In this case, enabling the differentiation between the attended and unattended conditions. It is concluded that the wavelet phase synchronization stability of ALRs single sweeps can be used as objective tinnitus decompensation measure and can be interpreted in the framework of the Jastreboff tinnitus model and adaptive resonance theory. Our studies confirm that the synchronization stability in ALR sequences is linked to attention. This measure is not only able to serve as objective quantification of the tinnitus decompensation, but also can be applied in all online and real time **neurofeedback** therapeutic approach where a direct stimulus locked attention monitoring is compulsory as if it based on a single sweeps processing.

PMID: 18002498 [PubMed - indexed for MEDLINE]

Hippocampus. 2007;17(6):413-9.

354. Human neocortical and hippocampal near-DC shifts are interconnected.

Fell J, Fritz NE, Burr W, Ludowig E, Axmacher N, Elger CE, Helmstaedter C.

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Abstract
Hippocampal DC shifts have been observed under various physiological and pathological conditions. Here, we studied the interconnection of slow shifts (0.01 Hz high-pass) in surface **EEG** and hippocampal shifts as emerging in an event-related **EEG biofeedback** paradigm. Hippocampal **EEG** activity was monitored by depth electrodes implanted in four epilepsy patients for presurgical evaluation. Trials were sorted according to the near-DC shifts occurring at the surface position Cz, which was the **feedback** electrode, into positive, indistinct (i.e., small or biphasic) and negative shifts. We found significant hippocampal near-DC shifts being positively or negatively correlated to the shifts in surface **EEG** in all four patients. The amplitudes of the hippocampal near-DC shifts were several times larger than the surface shifts. The polarity of the shifts appears to depend on the location of the electrode contacts with respect to the hippocampal subfields. The finding that neocortical and hippocampal near-DC shifts are interconnected may open new perspectives for the prediction and control of mediotemporal lobe seizures.

PMID: 17372976 [PubMed - indexed for MEDLINE]

J Child Psychol Psychiatry. 2007 Jan;48(1):3-16.

355. *Annotation: neurofeedback - train your brain to train behaviour.

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Abstract
BACKGROUND: **Neurofeedback** (**NF**) is a form of behavioural training aimed at developing skills for self-regulation of brain activity. Within the past decade, several **NF** studies have been published that tend to overcome the methodological shortcomings of earlier studies. This annotation describes the methodical basis of **NF** and reviews the evidence base for its clinical efficacy and effectiveness in neuropsychiatric disorders.

METHODS: In **NF** training, self-regulation of specific aspects of electrical brain activity is acquired by means of immediate **feedback** and positive reinforcement. In frequency training, activity in different **EEG** frequency bands has to be decreased or increased. Training of slow cortical potentials (**SCP**s) addresses the regulation of cortical excitability.

RESULTS: **NF** studies revealed paradigm-specific effects on, e.g., attention and memory processes and performance improvements in real-life conditions, in healthy subjects as well as in patients. In several studies it was shown that children with attention-deficit hyperactivity disorder (ADHD) improved behavioural and cognitive variables after frequency (e.g., theta/beta) training or **SCP** training. Neurophysiological effects could also be measured. However, specific and unspecific training effects could not be disentangled in these studies. For drug-resistant patients with epilepsy, significant and long-lasting decreases of seizure frequency and intensity through **SCP** training were documented in a series of studies. For other child psychiatric disorders (e.g., tic disorders, anxiety, and autism) only preliminary investigations are available.

CONCLUSIONS: There is growing evidence for **NF** as a valuable treatment module in neuropsychiatric disorders. Further, controlled studies are necessary to establish clinical efficacy and effectiveness and to learn more about the mechanisms underlying successful training.

PMID: 17244266 [PubMed - indexed for MEDLINE]

Prog Brain Res. 2007;166:473-85.

356. *Neurofeedback for treating tinnitus.

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Abstract

Many individuals with tinnitus have abnormal oscillatory brain activity. Led by this finding, we have developed a way to normalize such pathological activity by **neurofeedback** techniques (Weisz et al. (2005). PLoS Med., 2: e153). This is achieved mainly through enhancement of tau activity, i.e., oscillatory activity produced in perisylvian regions within the alpha frequency range (8-12 Hz) and concomitant reduction in delta power range (0.5-4 Hz). This activity is recorded from electrodes placed on the frontal scalp. We have found that modification of the tau-to-delta ratio significantly reduces tinnitus intensity. Participants who successfully modified their oscillatory pattern profited from the treatment to the extent that the tinnitus sensation became completely abolished. Overall, this **neurofeedback** training was significantly superior in reducing tinnitus-related distress than frequency discrimination training.

PMID: 17956812 [PubMed - indexed for MEDLINE]

Restor Neurol Neurosci. 2007;25(3-4):371-8.

357. *Tuning the tinnitus percept by modification of synchronous brain activity.

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Abstract

PURPOSE: Tinnitus, the perception of sound without the presence of a physical stimulus, provides the opportunity to study neural codes of percepts without simultaneous processing of stimuli. Previously, we have found that tinnitus is associated with enhanced delta- and reduced tau-power in temporal brain regions. By operantly modifying corresponding aspects of spontaneous **EEG** activity, the aim of the present study was to corroborate the assumption that tinnitus should be reduced if patterns of ongoing synchronous brain activity are normalised.

METHODS: In response to different variants of **neurofeedback**, a total of twenty-one patients produced significant changes in **EEG** frequency bands.

RESULTS: Simultaneous alteration of both frequency bands was strongly related to changes in tinnitus intensity matched before and after the intervention (r=-0.74). In those two patients with the greatest modulatory success, the tinnitus sensation resided completely in response to the treatment. Comparing the **neurofeedback**-treated patients with a group of patients trained with a frequency discrimination task (n=27), the tinnitus relief in the **neurofeedback** group was significantly stronger.

CONCLUSIONS: This study supports the notion that altered patterns of intrinsic ongoing brain activity lead to phantom percepts and offer new routes to the treatment of tinnitus.

PMID: 17943012 [PubMed - indexed for MEDLINE]

Brain Res Bull. 2006 Dec 11;71(1-3):83-90. Epub 2006 Sep 1.

358. Relaxation strategies and enhancement of hypnotic susceptibility: EEG neurofeedback, progressive muscle relaxation and self-hypnosis.

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Abstract

Hypnosis has been shown to be efficacious in a range of clinical conditions, including the management of chronic pain. However, not all individuals are able to enter a hypnotic state, thereby limiting the clinical utility of this technique. We sought to determine whether hypnotic susceptibility could be increased using three methods thought to facilitate relaxation, with particular interest in an **EEG neurofeedback** protocol which elevated the theta to alpha ratio. This was compared with progressive muscle relaxation and self-hypnosis. Ten subjects with moderate levels of susceptibility (2-7/12) were randomly assigned to each condition and assessed for hypnotic susceptibility prior to and upon completion of 10 sessions of training. Hypnotic susceptibility increased post-training in all groups, providing further evidence that operant control over the theta/alpha ratio is possible, but contrary to our predictions, elevation of the theta/alpha ratio proved no more successful than the other interventions. Nonetheless, all three techniques successfully enhanced hypnotic susceptibility in over half of the participants (17/30), a similar incidence to that reported using other methods. As previously reported, the majority who were not susceptible to modification were at the lower levels of susceptibility, and the greater increases tended to occur in the more susceptible subjects. However, here enhancement was disclosed in some at low levels, and capability was found of reaching high levels, both features not typically reported. Further research is warranted.

PMID: 17113932 [PubMed - indexed for MEDLINE]

Pediatrics. 2006 Nov;118(5):e1530-40. Epub 2006 Oct 23.

359. *Self-regulation of slow cortical potentials: a new treatment for children with attention-deficit/hyperactivity disorder.

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Abstract

OBJECTIVE: We investigated the effects of self-regulation of slow cortical potentials for children with attention-deficit/hyperactivity disorder. Slow cortical potentials are slow event-related direct-current shifts of the electroencephalogram. Slow cortical potential shifts in the electrical negative direction reflect the depolarization of large cortical cell assemblies, reducing their excitation threshold. This training aims at regulation of cortical excitation thresholds considered to be impaired in children with attention-deficit/hyperactivity disorder. Electroencephalographic data from the training and the 6-month follow-up are reported, as are changes in behavior and cognition.

METHOD: Twenty-three children with attention-deficit/hyperactivity disorder aged between 8 and 13 years received 30 sessions of self-regulation training of slow cortical potentials in 3 phases of 10 sessions each. Increasing and decreasing slow cortical potentials at central brain regions was fed back visually and auditorily. Transfer trials without **feedback** were intermixed with **feedback** trials to allow generalization to everyday-life situations. In addition to the **neurofeedback** sessions, children exercised during the third training phase to apply the self-regulation strategy while doing their homework.

RESULTS: For the first time, electroencephalographic data during the course of slow cortical potential **neurofeedback** are reported. Measurement before and after the trials showed that children with attention-deficit/hyperactivity disorder learn to regulate negative slow cortical potentials. After training, significant improvement in behavior, attention, and IQ score was observed. The behavior ratings included Diagnostic and Statistical Manual of Mental Disorders criteria, number of problems, and social behavior at school and were conducted by parents and teachers. The cognitive variables were assessed with the Wechsler Intelligence Scale for Children and with a computerized test battery that measures several components of attention. All changes proved to be stable at 6 months' follow-up after the end of training. Clinical outcome was predicted by the ability to produce negative potential shifts in transfer sessions without **feedback**.

CONCLUSIONS: According to the guidelines of the efficacy of treatments, the evidence of the efficacy of slow cortical potential **feedback** found in this study reaches level 2: "possibly efficacious." In the absence of a control group, no causal relationship between observed improvements and the ability to regulate brain activity can be made. However, it could be shown for the first time that good performance in self-regulation predicts clinical outcome. "Good performance" was defined as the ability to produce negative potential shifts in trials without **feedback**, because it is known that the ability to self-regulate without **feedback** is impaired in children and adults with attention problems. Additional research should focus on the control of unspecific effects, medication, and subtypes to confirm the assumption that slow cortical potential **feedback** is a viable treatment option for attention-deficit/hyperactivity disorder. Regulation of slow cortical potentials may involve similar neurobiological pathways

as medical treatment. It is suggested that regulation of frontocentral negative slow cortical potentials affects the cholinergic-dopaminergic balance and allows children to adapt to task requirements more flexibly.

PMID: 17060480 [PubMed - indexed for MEDLINE] Free Article
See complete free article at: http://pediatrics.aappublications.org/cgi/content/full/118/5/e1530.

Magn Reson Med Sci. 2006 Oct;5(3):157-65.

360. Real-time functional MRI: development and emerging applications.

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Abstract
Real-time functional magnetic resonance imaging (**fMRI**) is an emerging technique for assessing the dynamic and robust changes in brain activation during an ongoing experiment. Real-time **fMRI** allows measurement of several processes within the brain as they occur. The extracted information can be used to monitor the quality of acquired data sets, serve as the basis for **neurofeedback** training, and manipulate scans for interactive paradigm designs. Although more work is needed, recent results have demonstrated a variety of potential applications for real-time **fMRI** for research and clinical use. We discuss these developments and focus on methods enabling real-time analysis of **fMRI** data sets, novel research applications arising from these approaches, and potential use of real-time **fMRI** in clinical settings.

PMID: 17139142 [PubMed - indexed for MEDLINE] Free Article
See complete free article at: http://joi.jlc.jst.go.jp/JST.JSTAGE/mrms/5.157?from=PubMed.

Neuroreport. 2006 Aug 21;17(12):1273-8.

361. Increasing cortical activity in auditory areas through neurofeedback functional magnetic resonance imaging.

Yoo SS, O'Leary HM, Fairneny T, Chen NK, Panych LP, Park H, Jolesz FA.

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Abstract
We report a functional magnetic resonance imaging (**fMRI**) method to deliver task-specific brain activities as **biofeedback** signals to guide individuals to increase cortical activity in auditory areas during sound stimulation. A total of 11 study participants underwent multiple functional magnetic resonance imaging scan sessions, while the changes in the activated cortical volume within the primary and secondary auditory areas were fed back to them between scan sessions. On the basis of the **feedback** information, participants attempted to

increase the number of significant voxels during the subsequent trial sessions by adjusting their level of attention to the auditory stimuli. Results showed that the group of individuals who received the **feedback** were able to increase the activation volume and blood oxygenation level-dependent signal to a greater degree than the control group.

PMID: 16951568 [PubMed - indexed for MEDLINE]

Sleep Med Rev. 2006 Aug;10(4):255-66. Epub 2006 Jun 27.

362. *Neurophysiological aspects of primary insomnia: implications for its treatment.

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Abstract

Insomnia has usually been studied from a behavioral perspective. Somatic and/or cognitive conditioned arousal was shown to play a central role in sleep complaints becoming chronic, and was used as a starting point for the development of treatment modalities. The introduction of the neurocognitive perspective, with its focus on cortical or CNS arousal, has given rise to a renewed interest in the neurophysiological characteristics of insomnia. Recent research, using quantitative **EEG**, neuroimaging techniques and the study of the microstructure of sleep, suggests a state of hyperarousal with a biological basis. Furthermore, insomnia might not be restricted to sleep complaints alone because it appears to be a 24-h disorder, affecting several aspects of daytime functioning as well. These new findings have implications for the treatments used and indicate that a focus on cortical or CNS arousal should be pursued. As such, the use of **EEG neurofeedback**, a self-regulation method based on the paradigm of operant conditioning, might be a promising treatment modality. Preliminary results for insomnia and successful applications for other disorders suggest that this treatment can have the necessary stabilizing effects on the **EEG** activity, possibly resulting in a normalizing effect on daytime as well as nighttime functioning.

PMID: 16807007 [PubMed - indexed for MEDLINE]

Clin EEG Neurosci. 2006 Jul;37(3):198-203.

363. *Follow-up study of learning-disabled children treated with neurofeedback or placebo.

Becerra J, Fernández T, Harmony T, Caballero MI, García F, Fernández-Bouzas A, Santiago-Rodríguez E, Prado-Alcalá RA.

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Abstract

This report is a 2-year follow-up to a previous study describing positive behavioral changes and a spurt of **EEG** maturation with theta/alpha **neurofeedback** (**NFB**) training in a group of Learning Disabled (LD) children. In a control paired group, treated with placebo, behavioral

changes were not observed and the smaller maturational **EEG** changes observed were easily explained by increased age. Two years later, the **EEG** maturational lag in Control Group children increased, reaching abnormally high theta Relative Power values; the absence of positive behavioral changes continued and the neurological diagnosis remained LD. In contrast, after 2 years **EEG** maturation did continue in children who belonged to the Experimental Group with previous **neurofeedback** training; this was accompanied by positive behavioral changes, which were reflected in remission of LD symptoms.

PMID: 16929704 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2006 Jun;31(2):97-114. Epub 2006 Jul 15.

364. The significance of sigma neurofeedback training on sleep spindles and aspects of declarative memory.

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Abstract

The functional significance of sleep spindles for overnight memory consolidation and general learning aptitude as well as the effect of four 10-minute sessions of spindle frequency (11.6-16 Hz, sigma) **neurofeedback**-training on subsequent sleep spindle activity and overnight performance change was investigated. Before sleep, subjects were trained on a paired-associate word list task after having received either **neurofeedback** training (**NF**T) or pseudofeedback training (PFT). Although **NF**T had no significant impact on subsequent spindle activity and behavioral outcomes, there was a trend for enhanced sigma band-power during NREM (stage 2 to 4) sleep after **NF**T as compared to PFT. Furthermore, a significant positive correlation between spindle activity during slow wave sleep (in the first night half) and overall memory performance was revealed. The results support the view that the considerable inter-individual variance in sleep spindle activity can at least be partly explained by differences in the ability to acquire new declarative information. We conclude that the short **NF**T before sleep was not sufficient to efficiently enhance phasic spindle activity and/or to influence memory processing. **NF**T was, however, successful in increasing sigma power, presumably because sigma **NF**T effects become more easily evident in actually trained frequency bands than in associated phasic spindle activity.

PMID: 16845599 [PubMed - indexed for MEDLINE]

Mol Psychiatry. 2006 Jun;11(6):528-38.

365. How psychotherapy changes the brain--the contribution of functional neuroimaging.

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Abstract

A thorough investigation of the neural effects of psychotherapy is needed in order to provide a neurobiological foundation for widely used treatment protocols. This paper reviews **functional neuroimaging** studies on psychotherapy effects and their methodological background, including the development of symptom provocation techniques. Studies of cognitive behavioural therapy (CBT) effects in obsessive-compulsive disorder (OCD) were consistent in showing decreased metabolism in the right caudate nucleus. Cognitive behavioural therapy in phobia resulted in decreased activity in limbic and paralimbic areas. Interestingly, similar effects were observed after successful intervention with selective serotonin reuptake inhibitors (SSRI) in both diseases, indicating commonalities in the biological mechanisms of psycho- and pharmacotherapy. These findings are discussed in the context of current neurobiological models of anxiety disorders. Findings in depression, where both decreases and increases in prefrontal metabolism after treatment and considerable differences between pharmacological and psychological interventions were reported, seem still too heterogeneous to allow for an integrative account, but point to important differences between the mechanisms through which these interventions attain their clinical effects. Further studies with larger patient numbers, use of standardised imaging protocols across studies, and ideally integration with molecular imaging are needed to clarify the remaining contradictions. This effort is worthwhile because **functional imaging** can then be potentially used to monitor treatment effects and aid in the choice of the optimal therapy. Finally, recent advances in the **functional imaging** of hypnosis and the application of **neurofeedback** are evaluated for their potential use in the development of psychotherapy protocols that use the direct modulation of brain activity as a way of improving symptoms.

PMID: 16520823 [PubMed - indexed for MEDLINE]

Expert Rev Neurother. 2006 Apr;6(4):533-40.

366. *Electroencephalographic biofeedback for the treatment of attention-deficit hyperactivity disorder in childhood and adolescence.

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Abstract

Considerable scientific effort has been directed at developing effective treatments for attention-deficit hyperactivity disorder (ADHD). Among alternative treatment approaches, electroencephalographic **(EEG) biofeedback** has gained promising empirical support in recent years. Short-term effects were shown to be comparable to those of stimulant medication at the behavioral and neuropsychological level, leading to significant decreases of inattention, hyperactivity and impulsivity. In addition, **EEG biofeedback** results in concomitant improvement of neurophysiological patterns. **EEG biofeedback** may already be used within a multimodal setting, providing affected children and adolescents with a means of learning to counterbalance their ADHD symptoms without side effects. However, there is still a strong need for more empirically and methodologically sound evaluation studies.

PMID: 16623652 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2006 Mar;31(1):21-35.

367. *Foundation and practice of neurofeedback for the treatment of epilepsy.

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Abstract

This review provides an updated overview of the neurophysiological rationale, basic and clinical research literature, and current methods of practice pertaining to clinical **neurofeedback**. It is based on documented findings, rational theory, and the research and clinical experience of the authors. While considering general issues of physiology, learning principles, and methodology, it focuses on the treatment of epilepsy with sensorimotor rhythm (**SMR**) training, arguably the best established clinical application of **EEG** operant conditioning. The basic research literature provides ample data to support a very detailed model of the neural generation of **SMR**, as well as the most likely candidate mechanism underlying its efficacy in clinical treatment. Further, while more controlled clinical trials would be desirable, a respectable literature supports the clinical utility of this alternative treatment for epilepsy. However, the skilled practice of clinical **neurofeedback** requires a solid understanding of the neurophysiology underlying **EEG** oscillation, operant learning principles and mechanisms, as well as an in-depth appreciation of the ins and outs of the various hardware/software equipment options open to the practitioner. It is suggested that the best clinical practice includes the systematic mapping of quantitative multi-electrode **EEG** measures against a normative database before and after treatment to guide the choice of treatment strategy and document progress towards **EEG** normalization. We conclude that the research literature reviewed in this article justifies the assertion that **neurofeedback** treatment of epilepsy/seizure disorders constitutes a well-founded and viable alternative to anticonvulsant pharmacotherapy.

PMID: 16614940 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2006 Mar;31(1):3-20.

368. *Functional magnetic resonance imaging investigation of the effects of neurofeedback training on the neural bases of selective attention and response inhibition in children with attention-deficit/hyperactivity disorder.

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Abstract

Two functional magnetic resonance imaging (**fMRI**) experiments were undertaken to measure the effect of **neurofeedback** training (**NF**T), in AD/HD children, on the neural substrates of

selective attention and response inhibition. Twenty unmedicated AD/HD children participated to these experiments. Fifteen children were randomly assigned to the Experimental (EXP) group whereas the other five children were randomly assigned to the Control (CON) group. Only subjects in the EXP group underwent **NF**T. EXP subjects were trained to enhance the amplitude of the **SMR** (12-15 Hz) and beta 1 activity (15-18 Hz), and decrease the amplitude of theta activity (4-7 Hz). Subjects from both groups were scanned one week before the beginning of **NF**T (Time 1) and 1 week after the end of **NF**T (Time 2), while they performed a "Counting Stroop" task (Experiment 1) and a Go/No-Go task (Experiment 2). At Time 1, in both groups, the Counting Stroop task was associated with significant activation in the left superior parietal lobule. For the Go/No-Go task, no significant activity was detected in the EXP and CON groups. At Time 2, in both groups, the Counting Stroop task was associated with significant activation of the left superior parietal lobule. This time, however, there were significant loci of activation, in the EXP group, in the right ACC, left caudate nucleus, and left substantia nigra. No such activation loci were seen in CON subjects. For the Go/No-Go task, significant loci of activation were noted, in the EXP group, in the right ventrolateral prefrontal cortex, right ACcd, left thalamus, left caudate nucleus, and left substantia nigra. No significant activation of these brain regions was measured in CON subjects. These results suggest that **NF**T has the capacity to functionally normalize the brain systems mediating selective attention and response inhibition in AD/HD children.

PMID: 16552626 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2006 Mar;31(1):85-94.

369. *Deactivation of brain areas during self-regulation of slow cortical potentials in seizure patients.

Strehl U, Trevorrow T, Veit R, Hinterberger T, Kotchoubey B, Erb M, Birbaumer N.

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Abstract
This study investigates the neurophysiological basis of **EEG feedback** for patients with epilepsy. Brain areas are identified that become hemodynamically deactivated when epilepsy patients, trained in **EEG** self-regulation, generate positive slow cortical potentials (**SCP**s). Five patients were trained in producing positive **SCP**s, using a training protocol previously established to reduce seizure frequency in patients with drug refractory epilepsy. Patients attempted to produce positive **SCP** shifts in a functional magnetic resonance imaging (**fMRI**) scanner. Two patients were able to reliably produce positive **SCP** shifts. When these successful regulators were prompted to produce positive **SCP**s, blood oxygen level-dependent (BOLD) response indicated deactivation, in comparison to a control state, around the recording electrode, frontal lobe, and thalamus. Unsuccessful regulators' BOLD response indicated no deactivation in cortical areas proximal to the active electrode. No thalamic deactivation was found in poor regulators. Decreased seizure frequency from **SCP** training may be the result of positively reinforced inhibition in cortical areas proximal to active electrode placement, the frontal cortex, and the thalamus.

PMID: 16752105 [PubMed - indexed for MEDLINE]

Neurosci Lett. 2006 Feb 20;394(3):216-21. Epub 2005 Dec 15.

370. *Effect of neurofeedback training on the neural substrates of selective attention in children with attention-deficit/hyperactivity disorder: a functional magnetic resonance imaging study.

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Abstract
Attention Deficit Hyperactivity Disorder (AD/HD) is a neurodevelopmental disorder mainly characterized by impairments in cognitive functions. **Functional neuroimaging** studies carried out in individuals with AD/HD have shown abnormal functioning of the anterior cingulate cortex (ACC) during tasks involving selective attention. In other respects, there is mounting evidence that **neurofeedback** training (**NF**T) can significantly improve cognitive functioning in AD/HD children. In this context, the present functional magnetic resonance imaging (**fMRI**) study was conducted to measure the effect of **NF**T on the neural substrates of selective attention in children with AD/HD. Twenty AD/HD children--not taking any psychostimulant and without co-morbidity-participated to the study. Fifteen children were randomly assigned to the Experimental (EXP) group (**NF**T), whereas the other five children were assigned to the Control (CON) group (no **NF**T). Subjects from both groups were scanned 1 week before the beginning of the **NF**T (Time 1) and 1 week after the end of this training (Time 2), while they performed a Counting Stroop task. At Time 1, for both groups, the Counting Stroop task was associated with significant loci of activation in the left superior parietal lobule. No activation was noted in the ACC. At Time 2, for both groups, the Counting Stroop task was still associated with significant activation of the left superior parietal lobule. This time, however, for the EXP group only there was a significant activation of the right ACC. These results suggest that in AD/HD children, **NF**T has the capacity to normalize the functioning of the ACC, the key neural substrate of selective attention.

PMID: 16343769 [PubMed - indexed for MEDLINE]

Expert Rev Neurother. 2006 Feb;6(2):247-57.

371. *Neurofeedback treatment of epilepsy: from basic rationale to practical application.

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Abstract
The treatment of epilepsy through operant conditioning of the sensorimotor rhythm electroencephalogram has a 35-year history. Neurophysiological studies have shown that this phasic oscillation reflects an inhibitory state of the sensorimotor system. Operant learning of

sensory motor rhythm production results in an upregulation of excitation thresholds within the thalamocortical sensory and motor circuitry, which in turn is associated with reduced susceptibility to seizures. The clinical benefits derived from this **neurofeedback** training protocol, particularly in patients that are nonresponsive to pharmacotherapy, have been documented in many independent laboratories. Recent advances in computer technology have resulted in the availability of relatively inexpensive high-quality equipment for the application of **neurofeedback** therapy, thus presenting a viable and promising treatment alternative to the interested clinician.

PMID: 16466304 [PubMed - indexed for MEDLINE]

Prax Kinderpsychol Kinderpsychiatr. 2006;55(5):384-407.

372. *[Neurofeedback for children with ADHD: a comparison of SCP- and theta/beta-protocols]

[Article in German]

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Abstract

Research groups have consistently reported on behavioral and cognitive improvements of children with ADHD after **neurofeedback**. However, **neurofeedback** has not been commonly accepted as a treatment for ADHD. This is due, in part, to several methodological limitations. The **neurofeedback** literature is further complicated by having several different training protocols. Differences between the clinical efficacy of such protocols have not been examined. This study addresses previous methodological shortcomings while comparing the training of theta-beta-frequencies (theta-beta-group) with the training of slow cortical potentials (**SCP**-group). Each group comprised of 19 children with ADHD that were blind to group assignment. The training procedure consisted of 30 sessions and a six months follow-up training. Pre-/post measures at pretest, the end of the training and the follow-up included tests of attention, intelligence and behavioral variables. After having already reported intermediate data (Strehl et al. 2004), this paper gives account on final results: Both groups are able to voluntarily regulate cortical activity, with the extent of learned self-regulation depending on task and condition. Both groups improve in attention and IQ. Parents and teachers report significant behavioral and cognitive improvements. Clinical effects for both groups remain stable six months after training. Groups do not differ in behavioral or cognitive outcome variables.

PMID: 16869483 [PubMed - indexed for MEDLINE]

Prog Brain Res. 2006;159:421-31.

373. *Validating the efficacy of neurofeedback for optimising performance.

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Abstract

The field of **neurofeedback** training has largely proceeded without validation. Here we review our studies directed at validating **SMR**, beta and alpha-theta protocols for improving attention, memory, mood and music and dance performance in healthy participants. Important benefits were demonstrable with cognitive and neurophysiological measures which were predicted on the basis of regression models of learning. These are initial steps in providing a much needed scientific basis to **neurofeedback**, but much remains to be done.

PMID: 17071246 [PubMed - indexed for MEDLINE]

Prog Brain Res. 2006;159:151-65.

374. Upper alpha ERD and absolute power: their meaning for memory performance.

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Abstract

A variety of studies have shown that **EEG** alpha activity in the upper frequency range is associated with different types of cognitive processes, memory performance, perceptual performance and intelligence, but in strikingly different ways. For semantic memory performance we have found that resting or reference power is positively associated with performance, whereas during actual processing of the task, small power--reflected by a large extent of event-related desynchronization (ERD)--is related to good performance. We also have shown that the induction of large alpha reference power by **neurofeedback** training or repetitive transcranial magnetic stimulation (rTMS) at individual alpha frequency mimicked exactly the situation which is typical for good memory performance under normal situations: increased alpha reference power is associated with large ERD and good performance. Recent studies have demonstrated that this relationship holds true only for memory and not perceptual tasks that require the identification of simple visual stimuli under difficult conditions. In contrast to good memory performance, good perceptual performance is related to small pre-stimulus alpha power and a small ERD. We interpret this finding in terms of cortical inhibition vs. activation preceding task performance by assuming that large rhythmic alpha activity reflects inhibition. We assume that small reference alpha enhances perceptual performance because the cortex is activated and prepared to process the stimulus, whereas memory performance is enhanced if the cortex is deactivated before a task is performed because in typical memory tasks selective processing can start only after the to-be-remembered item or cue is presented. We also suggest that conflicting results about alpha ERD and the neural efficiency hypothesis (which assumes that highly intelligent exhibit a small ERD) can also be interpreted in terms of inhibition. Only if an intelligence test actually requires the activation of (semantic) memory, a large (because task specific) ERD can be observed. If other processing systems are required, the semantic memory system may even become suppressed, which is reflected by alpha event-related synchronization (ERS) or at least a largely decreased ERD.

PMID: 17071229 [PubMed - indexed for MEDLINE]

Zh Nevrol Psikhiatr Im S S Korsakova. 2006;106(2):31-6.

375. *[The use of individual EEG peculiarities for increase of neurofeedback efficiency]

[Article in Russian]
Bazanova OM, Aftanas LI.

Abstract

An aim of the study was to demonstrate efficiency of **neurofeedback** in using individual frequency ranges of electroencephalogram (**EEG**). The sessions of theta/beta decreasing and alpha simulating trainings were carried out in 2 outpatients: one of them with attention deficit disorder (a schoolboy) and another one with functional pain contraction (a professional musician). The **neurofeedback** with standard frequency did not result in any improvement of psychometric and **EEG** characteristics of both patients. The **neurofeedback** training with individual frequency of maximal peak and alpha band width improved these characteristics that suggest efficiency of the approach used.

PMID: 16548372 [PubMed - indexed for MEDLINE]

Prog Brain Res. 2005;150:513-25.

376. Brain-computer interfaces--the key for the conscious brain locked into a paralyzed body.

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Abstract

Brain-computer interfaces (**BCI**s) are systems that allow us to translate in real-time the electrical activity of the brain in commands to control devices. They do not rely on muscular activity and can therefore provide communication and control for those who are severely paralyzed (locked-in) due to injury or disease. It has been shown that locked-in patients are able to achieve **EEG**-controlled cursor or limb movement and patients have successfully communicated by means of a **BCI**. Current **BCI**s differ in how the neural activity of the brain is recorded, how subjects (humans and animals) are trained to produce a specific **EEG** response, how the signals are translated into device commands, and which application is provided to the user. The present review focuses on approaches to **BCI**s that process the **EEG** on-line and provide **EEG feedback** or **feedback** of results to the user. We regard online processing and **feedback** cornerstones for routine application of **BCI**s in the field. Because training patients in their home environment is effortful and personal and financial resources are limited, only few studies on **BCI** long-term use for communication with paralyzed patients are available. The need for multidisciplinary research, comprising computer science, engineering, neuroscience, and psychology is now being acknowledged by the **BCI** community. A standard **BCI** platform, referred to as **BCI**2000, has been developed, which

allows us to better combine and compare the different **BCI** approaches of different laboratories. As **BCI** laboratories now also join to unify their expertise and collaborations are funded, we consider it realistic that within few years we will be able to offer a **BCI**, which will be easy to operate for patients and caregivers.

PMID: 16186045 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2005 Dec;30(4):365-73.

377. *Neurofeedback: an alternative and efficacious treatment for Attention Deficit Hyperactivity Disorder.

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Abstract

Current research has shown that **neurofeedback**, or **EEG biofeedback** as it is sometimes called, is a viable alternative treatment for Attention Deficit Hyperactivity Disorder (ADHD). The aim of this article is to illustrate current treatment modalities(s), compare them to **neurofeedback**, and present the benefits of utilizing this method of treatment to control and potentially alleviate the symptoms of ADHD. In addition, this article examines the prevalence rates and possible etiology of ADHD, the factors associated with ADHD and brain dysfunction, the current pharmacological treatments of ADHD, Ritalin, and the potential risks and side effects. Behavior modification and cognitive behavioral treatment for ADHD is discussed as well. Lastly, a brief history of the study of **neurofeedback**, treatment successes and clinical benefits, comparisons to medication, and limitations are presented.

PMID: 16385424 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2005 Dec;30(4):347-64.

378. *Can neurofeedback training enhance performance? An evaluation of the evidence with implications for future research.

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Abstract

There have been many claims regarding the possibilities of performance enhancement training. The aim of such training is for an individual to complete a specific function or task with fewer errors and greater efficiency, resulting in a more positive outcome. The present review examined evidence from **neurofeedback** training studies to enhance performance in a particular area. Previous research has documented associations between specific cortical states and optimum levels of performance in a range of tasks. This information provides a plausible rationale for the use of **neurofeedback** to train individuals to enhance their performance. An

examination of the literature revealed that **neurofeedback** training has been utilised to enhance performance from three main areas; sport, cognitive and artistic performance. The review examined evidence from **neurofeedback** training studies within each of these three areas. Some suggestive findings have been reported with regard to the use of **neurofeedback** training to enhance performance. However, due to a range of methodological limitations and a general failure to elicit unambiguous changes in baseline **EEG** activity, a clear association between **neurofeedback** training and enhanced performance has yet to be established. Throughout, the review highlights a number of recommendations to aid and stimulate future research.

PMID: 16385423 [PubMed - indexed for MEDLINE]

Brain Cogn. 2005 Dec;59(3):314-21.

379. Effect of neurofeedback on hemispheric word recognition.

Barnea A, Rassis A, Zaidel E.

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Abstract
We applied **SMR**/theta **neurofeedback** (**NF**) training at central sites of 20 Israeli children aged 10-12 years, half boys and half girls. Half of the subjects received C3 training and the other half C4 training, consisting of 20 half-hour sessions. We assessed the effects of training on lateralized lexical decision in Hebrew. The lateralized lexical decision test reveals an independent contribution of each hemisphere to word recognition (Barnea, Mooshagian, & Zaidel, 2003). Training increased accuracy and sensitivity. It increased left hemisphere (LH) specialization under some conditions but it did not affect interhemispheric transfer. Training did affect psycholinguistic processing in the two hemispheres, differentially at C3 and C4. Training also increased hemispheric independence. There were surprising sex differences in the effects of training. In boys, C4 training improved LH accuracy, whereas in girls C3 training improved LH accuracy. The results suggest that the lateralized **NF** protocol activates asymmetric hemispheric control circuits which modify distant hemispheric networks and are organized differently in boys and girls.

PMID: 16337872 [PubMed - indexed for MEDLINE]

Neuropsychiatr Dis Treat. 2005 Dec;1(4):357-63.

380. *An open label study of the use of EEG biofeedback using beta training to reduce anxiety for patients with cardiac events.

Michael AJ, Krishnaswamy S, Mohamed J.

Abstract
OBJECTIVE: To establish the effectiveness of **EEG biofeedback** using beta training as a relaxation technique and ultimately reducing anxiety levels of patients with confirmed unstable angina or myocardial infarction.

METHODOLOGY: Patients with confirmed unstable angina or myocardial infarction referred by cardiologists were recruited 2-3 days after their cardiac event from the cardiology wards. Their initial anxiety scores were determined using the Hospital Anxiety and Depression Scale. Those that returned for therapy underwent instrument **feedback** training using **EEG** every two weeks for a total of five sessions. **EEG** frequencies were measured for all sessions. Dropouts who did not participate in the program agreed to return 3 months later for the second psychological assessment. The study design was uncontrolled.

RESULTS: Subjects had significantly lower anxiety scores at the second screening ($p < 0.001$), while the dropouts had significantly higher scores ($p < 0.001$). Beta training was effective in increasing sensory motor rhythm (**SMR**) waves but no significant effect was present for the alpha waves.

CONCLUSIONS: The uncontrolled nature of the study limits firm conclusions. However, the significantly lowered anxiety scores for subjects and enhancing of **SMR** waves indicate the effectiveness of beta training as a promising approach to **EEG biofeedback** for anxiety reduction.

PMID: 18568116 [PubMed - in process]PMCID: PMC2424123 Free PMC Article
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/pmid/18568116/?tool=pubmed (HS?).

Neurorehabil Neural Repair. 2005 Sep;19(3):206-18.

381. An auditory brain-computer interface based on the self-regulation of slow cortical potentials.

Pham M, Hinterberger T, Neumann N, Kübler A, Hofmayer N, Grether A, Wilhelm B, Vatine JJ, Birbaumer N.

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Abstract
OBJECTIVES: Communication support for severely paralyzed patients with visual impairment is needed. Therefore, the feasibility of a **brain-computer interface** (**BCI**) using auditory stimuli alone, based on the self-regulation of slow cortical potentials (**SCP**s), was investigated.

METHODS: Auditory stimuli were used for task and **feedback** presentation in an **SCP self-regulation** paradigm. Voluntarily produced **SCP** responses and measures of communication performance were compared between 3 groups (total of N = 59) of visual, auditory, and cross-modal visual-auditory modality. Electroencephalogram recordings and training from Cz-mastoids were carried out on 3 consecutive sessions. Data of 1500 trials per subject were collected.

RESULTS: Best performance was achieved for the visual, followed by the auditory condition. The performance deficit of the auditory condition was partly due to decreased self-produced positivity. Larger **SCP** response variability also accounted for lower performance of the

auditory condition. Cross-modally presented stimuli did not lead to significant learning and control of **SCP**.

CONCLUSIONS: **Brain-computer communication** using auditory stimuli only is possible. Smaller cortical positivity achieved in the auditory condition, as compared to the visual condition, may be a consequence of increased selective attention to simultaneously presented auditory stimuli. To optimize performance, auditory stimuli characteristics may have to be adapted. Other suggestions for enhancement of communication performance with auditory stimuli are discussed.

PMID: 16093411 [PubMed - indexed for MEDLINE]

Related citations

Prilozi. 2005 Aug;26(1):71-80.

382. *Neurofeedback treatment of children with attention deficit hyperactivity disorder.

Pop-Jordanova N, Markovska-Simoska S, Zorcec T.

Department of Pediatrics, Faculty of Medicine, University of Skopje, R. Macedonia.

Abstract

BACKGROUND: **Biofeedback** is a modern computer-related technique used for assessment and therapy of many psychophysiological disorders, especially stress-related ones. After a short overview of the basic concepts of **biofeedback**, in this study the application of **EEG biofeedback** (**neurofeedback**) in the assessment of and therapy for attention deficit hyperactivity disorders (ADHD) is presented and discussed.

METHODS: The study comprised 12 children diagnosed as ADHD, selected according to ICD-10, and assessed by WISC-R, Q-**EEG**, **neurofeedback** and Conner's questionnaire for parents and teachers. The mean age was 9.5 years (7 to 13), both sexes. Each of them participated in a five-month programme of **neurofeedback** training, performed two times weekly with Biograph/ProComp 2.0 protocols.

RESULTS: Post-treatment results showed an improved **EEG** pattern expressed in increased 16-20 Hz (beta) activity and decreased 4-8 Hz (theta) activity. In parallel, higher scores on WISC-R, better school notes and improved social adaptability and self-esteem were obtained.

CONCLUSIONS: **EEG biofeedback** operant conditioning is a good choice for treatment of ADHD children. The method is non-invasive and has high cost-benefit. Optimal results are obtained in children of higher age. Cooperation with family members and teachers is crucial.

PMID: 16118616 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2005 Jun;30(2):95-114.

383. *Electroencephalographic biofeedback in the treatment of attention-deficit/hyperactivity disorder.

Monastra VJ, Lynn S, Linden M, Lubar JF, Gruzelier J, LaVaque TJ.

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Abstract
Historically, pharmacological treatments for attention-deficit/hyperactivity disorder (ADHD) have been considered to be the only type of interventions effective for reducing the core symptoms of this condition. However, during the past three decades, a series of case and controlled group studies examining the effects of **EEG biofeedback** have reported improved attention and behavioral control, increased cortical activation on quantitative electroencephalographic examination, and gains on tests of intelligence and academic achievement in response to this type of treatment. This review paper critically examines the empirical evidence, applying the efficacy guidelines jointly established by the Association for Applied Psychophysiology and **Biofeedback** (AAPB) and the International Society for Neuronal Regulation (ISNR). On the basis of these scientific principles, **EEG biofeedback** was determined to be "probably efficacious" for the treatment of ADHD. Although significant clinical improvement was reported in approximately 75% of the patients in each of the published research studies, additional randomized, controlled group studies are needed in order to provide a better estimate of the percentage of patients with ADHD who will demonstrate such gains in clinical practice.

PMID: 16013783 [PubMed - indexed for MEDLINE]

Int J Neurosci. 2005 Jun;115(6):781-802.

384. Unconscious operant conditioning in the paradigm of brain-computer interface based on color perception.

Kaplan AY, Lim JJ, Jin KS, Park BW, Byeon JG, Tarasova SU.

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Abstract
This study investigate the mutual fine-tuning of ongoing **EEG** rhythmic features with RGB values controlling color shades of computer screen during **neurofeedback** training. Fifteen participants had not been informed about the existence of **neurofeedback** loop (**NF**), but were guided only to look at the computer screen. It was found that during such unconscious **NF** training, a variety of color shades on the screen gradually changed from rather various types to the main one within the framework of color palette specified for each individual. This phenomenon was not observed in control experiments with simulated **neurofeedback**. Individual color patterns induced on the screen during **NF** did not depend on the schema of connection between of **EEG** rhythms and RGB controller. It is suggested that the basic neurophysiological mechanism of described **NF** training consists of the directed selection of **EEG** patterns reinforced by comfortable color shades without conscious control.

PMID: 16019574 [PubMed - indexed for MEDLINE]

Int J Rehabil Res. 2005 Jun;28(2):159-63.

385. *Effects of electroencephalogram biofeedback with Asperger's syndrome.

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Abstract
This article reports the pilot study of electroencephalogram **(EEG) biofeedback** to improve focusing and decrease anxiety in 10 adolescent boys diagnosed with Asperger's syndrome attending a therapeutic day school. Five of the boys dropped out of the study before 12 sessions were completed. The analysis of pre- and post-intervention quantitative **EEG**s for the five students who completed the study showed a trend to "normalization", but did not reach statistical significance. All five boys who completed 24 sessions showed improved behavior as rated by parents and teachers, but other factors, such as maturation could not be ruled out as causes of the improvement. The challenges facing this research and proposals for further exploration are outlined.

PMID: 15900187 [PubMed - indexed for MEDLINE]

PLoS Med. 2005 Jun;2(6):e153. Epub 2005 Jun 28.

386. Tinnitus perception and distress is related to abnormal spontaneous brain activity as measured by magnetoencephalography.

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Abstract
BACKGROUND: The neurophysiological mechanisms underlying tinnitus perception are not well understood. Surprisingly, there have been no group studies comparing abnormalities in ongoing, spontaneous neuronal activity in individuals with and without tinnitus perception.

METHODS AND FINDINGS: Here, we show that the spontaneous neuronal activity of a group of individuals with tinnitus (n = 17) is characterised by a marked reduction in alpha (8-12 Hz) power together with an enhancement in delta (1.5-4 Hz) as compared to a normal hearing control group (n = 16). This pattern was especially pronounced for temporal regions. Moreover, correlations with tinnitus-related distress revealed strong associations with this abnormal spontaneous activity pattern, particularly in right temporal and left frontal areas. Overall, effects were stronger for the alpha than for the delta frequency band. A data stream of 5 min, recorded with a whole-head neuromagnetometer under a resting condition, was sufficient to extract the marked differences.

CONCLUSIONS: Despite some limitations, there are arguments that the regional pattern of abnormal spontaneous activity we found could reflect a tinnitus-related cortical network. This finding, which suggests that a **neurofeedback** approach could reduce the adverse effects of this disturbing condition, could have important implications for the treatment of tinnitus.

PMID: 15971936 [PubMed - indexed for MEDLINE]PMCID: PMC1160568 Free PMC Article
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http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1160568/?tool=pubmed.

Semin Pediatr Neurol. 2005 Jun;12(2):106-13.

387. Nonpharmacological treatment options for epilepsy.

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Abstract
Approximately one third of children with epilepsy have persistent seizures despite trials of multiple antiepileptic medications. For some of these patients, epilepsy surgery may provide freedom from seizures. However, in many cases, epilepsy surgery is not a viable treatment option. Nonpharmacological approaches are a useful adjunct to help manage seizures in these children. This review examines the role of vagus nerve stimulation, the ketogenic diet, and various forms of **EEG biofeedback** therapy in children with intractable epilepsy. Although the mechanism of action is not known precisely for any of these adjunctive therapies, they add an important and evolving dimension to the management of difficult to control epilepsy in children. In addition, pyridoxine-dependent seizures are discussed as an example of an etiology of refractory seizures that responds well to replacement therapy.

PMID: 16114176 [PubMed - indexed for MEDLINE]

Brain Res Cogn Brain Res. 2005 May;23(2-3):287-92.

388. *The effects of alpha/theta neurofeedback on personality and mood.

Raymond J, Varney C, Parkinson LA, Gruzelier JH.

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Abstract
Alpha/theta **neurofeedback** has been shown to be successful both in treating addictions and in enhancing artistry in music students. How its effects are mediated are not yet clear. The present study aimed to test the hypothesis that alpha/theta **neurofeedback** works inter alia by normalising extreme personality and raising feelings of well being. 12 participants with high scores for Withdrawal (as measured by the PSQ) were given either alpha/theta **neurofeedback** or mock **feedback** and their personality and mood were assessed. Withdrawal

scores on the PSQ-80 were not found to change in either group but significant effects were found for the Profile Of Mood States (POMS), with real **feedback** producing higher overall scores than mock **feedback** (P = 0.056). Real **feedback** caused participants to feel significantly more energetic (P < 0.01) than did mock **feedback**. Sessions of real **feedback** made participants feel more composed (P < 0.01), agreeable (P < 0.01), elevated (P < 0.01) and confident (P < 0.05), whilst sessions of mock **feedback** made participants feel more tired (P < 0.05), yet composed (P < 0.01). These findings suggest that, whilst 9 sessions of alpha/theta **neurofeedback** was insufficient to change personality, improvements in mood may provide a partial explanation for the efficacy of alpha/theta **neurofeedback**.

PMID: 15820636 [PubMed - indexed for MEDLINE]

J Clin Psychol. 2005 May;61(5):621-5.

389. *Neurofeedback in adolescents and adults with attention deficit hyperactivity disorder.

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Abstract
Neurofeedback is being utilized more commonly today in treating individuals who have attention deficit hyperactivity disorder (ADHD). **Neurofeedback**, which is based on theories that recognize the organic basis of ADHD, utilizes **biofeedback** to guide individuals to regulate their brain activity. **Neurofeedback** relies on research that has demonstrated that most individuals who have ADHD, as compared to matched peers, have excess slow wave activity and reduced fast wave activity. It provides immediate **feedback** to the individual about his or her brain wave activity in the form of a video game, whose action is influenced by the individual's meeting predetermined thresholds of brain activity. Over several sessions of using the video and auditory **feedback**, individuals reduce their slow wave activity and/or increase their fast wave activity. Individuals who complete a course of training sessions often show reduced primary ADHD symptoms. Research has shown that **neurofeedback** outcomes compare favorably to those of stimulant medication.

PMID: 15723361 [PubMed - indexed for MEDLINE]

Int J Psychophysiol. 2005 May;56(2):143-55. Epub 2005 Jan 8.

390. Alpha-contingent EEG feedback reduces SPECT rCBF variability.

McLaughlin T, Steinberg B, Mulholland T, Friberg L.

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Abstract
EEG feedback methods, which link the occurrence of alpha to the presentation of repeated visual stimuli, reduce the relative variability of subsequent, alpha-blocking event durations.

The temporal association between electro-cortical field activation and regional cerebral blood flow (rCBF) led us to investigate whether the reduced variability of alpha-blocking durations with **feedback** is associated with a reduction in rCBF variability. Reduced variability in the rCBF response domain under **EEG feedback** control might have methodological implications for future brain-imaging studies. Visual stimuli were randomly presented to seven subjects, contingent upon the occurrence of alpha (alpha-contingent stimulation (ACS)) or alpha-blocking (not-alpha-blocking-contingent stimulation (NACS)) events. We employed a within-subjects design. rCBF was measured from multiple, cortical and sub-cortical regions. The primary dependent variables were the Mean, Standard Deviation and the ratio of Mean/Standard Deviation of: 1) the alpha-blocking response durations and 2) the temporally summated rCBF responses within the Visual Associative regions of interest (ROIs). Additional within-subjects rCBF measures were derived to quantify the variance-reducing effects of ACS across multiple, distributed areas of the brain. Both **EEG** and rCBF measures demonstrated decreased variability under ACS. This improved control was seen for localized as well as anatomically distributed rCBF measures.

PMID: 15804449 [PubMed - indexed for MEDLINE]

Clin EEG Neurosci. 2005 Apr;36(2):99-107.

391. Clinical database development: characterization of EEG phenotypes.

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Abstract

We propose development of evidence-based methods to guide clinical intervention in neurobehavioral syndromes based on categorization of individuals using both behavioral measures and quantification of the **EEG** (q**EEG**). Review of a large number of clinical **EEG** and q**EEG** studies suggests that it is plausible to identify a limited set of individual profiles that characterize the majority of the population. Statistical analysis has already been used to document "clusters" of q**EEG** features seen in populations of psychiatric patients. These clusters are considered here as intermediate phenotypes, based on genetics, and are reliable indices of brain function, not isomorphic with DSM categories, and carry implications for therapeutic intervention. We call for statistical analysis methods to be applied to a broad clinical database of individuals diagnosed with neurobehavioral disorders in order to empirically define clusters of individuals who may be responsive to specific neurophysiologically based treatment interventions, namely administration of psychoactive medication and/or **EEG neurofeedback**. A tentative set of q**EEG** profiles is proposed based on clinical observation and experience. Implication for intervention with medication and **neurofeedback** for individuals with these neurophysiological profiles and specific q**EEG** patterns is presented.

PMID: 15999905 [PubMed - indexed for MEDLINE]

Fertil Steril. 2005 Apr;83(4):857-64.

392. Stress reactivity and family relationships in the development and treatment of endometriosis.

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Abstract

OBJECTIVE: To examine stress physiology and facts of family functioning associated with development and course of endometriosis symptoms.

DESIGN: Clinical case data and literature review.

SETTING: Private practice in hospital-affiliated medical office.

PATIENT(S): One woman with endometriosis, her parents, and a nonsymptomatic volunteer.

INTERVENTION(S): Measures of physiologic and neural reactivity with **biofeedback** and **neurofeedback** equipment during family history interview and while sitting quietly.

MAIN OUTCOME MEASURE(S): Electroencephalography (**EEG**), digital skin temperature (DST), electrodermal response (EDR), and electromyography (EMG); facts of family history; contact with family.

RESULT(S): Endometriosis symptoms were associated with DST, EDR, EMG, and **EEG** measures indicating prolonged stress reactions for the symptomatic woman and her parents. Facts of family history and relationships for three generations set the stage for stress reactions. Striking differences are evident in the physiology, family history, and contact with family of the nonsymptomatic woman.

CONCLUSION(S): Differences warrant further study, a larger sample, and additional measures using hormone assay to establish connections between stress reactions in the family, endometriosis symptoms, and response to treatment. Further research will document changes in physiology and in symptoms that accompany interruption of stress reactions with self-regulation training and family systems psychotherapy.

PMID: 15820791 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2005 Mar;30(1):64-73.

393. *Biofeedback and dance performance: a preliminary investigation.

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Abstract

Alpha-theta **neurofeedback** has been shown to produce professionally significant performance improvements in music students. The present study aimed to extend this work to a different performing art and compare alpha-theta **neurofeedback** with another form of **biofeedback**: heart rate variability (HRV) **biofeedback**. Twenty-four ballroom and Latin dancers were randomly allocated to three groups, one receiving **neurofeedback**, one HRV **biofeedback** and one no intervention. Dance was assessed before and after training. Performance improvements were found in the **biofeedback** groups but not in the control group. **Neurofeedback** and HRV **biofeedback** benefited performance in different ways. A replication with larger sample sizes is required.

PMID: 15889586 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2005 Mar;30(1):1-10.

394. *Increasing individual upper alpha power by neurofeedback improves cognitive performance in human subjects.

Hanslmayr S, Sauseng P, Doppelmayr M, Schabus M, Klimesch W.

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Abstract

The hypothesis was tested of whether **neurofeedback** training (**NF**T)--applied in order to increase upper alpha but decrease theta power--is capable of increasing cognitive performance. A mental rotation task was performed before and after upper alpha and theta **NF**T. Only those subjects who were able to increase their upper alpha power (responders) performed better on mental rotations after **NF**T. Training success (extent of **NF**T-induced increase in upper alpha power) was positively correlated with the improvement in cognitive performance. Furthermore, the **EEG** of **NF**T responders showed a significant increase in reference upper alpha power (i.e. in a time interval preceding mental rotation). This is in line with studies showing that increased upper alpha power in a prestimulus (reference) interval is related to good cognitive performance.

PMID: 15889581 [PubMed - indexed for MEDLINE]

Am J Drug Alcohol Abuse. 2005;31(3):455-69.

395. *Effects of an EEG biofeedback protocol on a mixed substance abusing population.

Scott WC, Kaiser D, Othmer S, Sideroff SI.

Neuropsychiatric Institute, University of California, Los Angeles, California, USA.

Abstract

This study examined whether an **EEG biofeedback** protocol could improve outcome measures for a mixed substance abusing inpatient population.

METHOD: One hundred twenty-one volunteers undergoing an inpatient substance abuse program were randomly assigned to the **EEG biofeedback** or control group. **EEG biofeedback** included training in Beta and **SMR** to address attentional variables, followed by an alpha-theta protocol. Subjects received a total of 40 to 50 **biofeedback** sessions. The control group received additional time in treatment equivalent to experimental procedure time. The Test of Variables of Attention (TOVA), and MMPI, were administered with both tester and subject blind as to group placement to obtain unbiased baseline data. Treatment retention and abstinence rates as well as psychometric and cognitive measures were compared.

RESULTS: Experimental subjects remained in treatment significantly longer than the control group ($p < 0.005$). Of the experimental subjects completing the protocol, 77% were abstinent at 12 months, compared to 44% for the controls. Experimental subjects demonstrated significant improvement on the TOVA ($p < .005$) after an average of 13 beta-**SMR** sessions. Following alpha-theta training, significant differences were noted on 5 of the 10 MMPI-2 scales at the $p < .005$ level.

CONCLUSIONS: This protocol enhanced treatment retention, variables of attention, and abstinence rates one year following treatment.

PMID: 16161729 [PubMed - indexed for MEDLINE]

Appl Neuropsychol. 2005;12(2):64-76.

396. *Clinical utility of EEG in attention deficit hyperactivity disorder.

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Abstract

Electrophysiological measures were among the first to be used to study brain processes in children with attention deficit hyperactivity disorder (ADHD; Diagnostic and Statistical Manual of Mental Disorders [4th ed.], American Psychiatric Association, 1994) and have been used as such for over 30 years (see Hastings & Barkley, 1978, for an early review). More recently, electroencephalography (**EEG**) has been used both in research to describe and quantify the underlying neurophysiology of ADHD, but also clinically in the assessment, diagnosis, and treatment of ADHD. This review will first provide a brief overview of **EEG** and then present some of the research findings of **EEG** correlates in ADHD. Then, the utility of **EEG** in making an ADHD diagnosis and predicting stimulant response will be examined. Finally, and more controversially, we will review the results of the most recent studies on **EEG biofeedback** (**neurofeedback**) as a treatment for ADHD and the issues that remain to be addressed in the research examining the efficacy this therapeutic approach.

PMID: 16083395 [PubMed - indexed for MEDLINE]

Child Adolesc Psychiatr Clin N Am. 2005 Jan;14(1):163-76, viii.

397. *Neurofeedback treatment of epilepsy.

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Abstract

With electroencephalographic **(EEG) biofeedback** (or **neurofeedback**), it is possible to train the brain to de-emphasize rhythms that lead to generation and propagation of seizure and emphasize rhythms that make seizures less likely to occur. With recent improvements in quantitative **EEG** measurement and improved **neurofeedback** protocols, it has become possible in clinical practice to eliminate seizures or reduce the amount of medication required to control them. In this article, the history of **neurofeedback** for epilepsy is presented followed by discussions of the relevant neurophysiology of epilepsy. A model of how **neurofeedback** might raise the seizure threshold is then presented. Clinical experience using a quantitative **EEG**-guided approach is described, including a representative case study.

PMID: 15564057 [PubMed - indexed for MEDLINE]

Child Adolesc Psychiatr Clin N Am. 2005 Jan;14(1):137-62, vii.

398. *Electroencephalogram biofeedback for reading disability and traumatic brain injury.

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Abstract

The application of electroencephalogram **(EEG) biofeedback** with reading disability and traumatic brain injury (TBI) is relatively recent. There are many studies regarding the effectiveness (improving attention and IQ scores) of **EEG biofeedback** in patients with attention deficit hyperactivity disorder, who are known to have a high rate of comorbidity for learning disabilities. This suggests the possibility that **EEG biofeedback** specifically aimed at remediating reading disability and TBI would be effective. This article provides strong initial support for this idea and provides reason to believe that assessment and training under task conditions are likely to be fruitful. Given the significance of these problems and the absence of very effective alternatives for remediation of these conditions, efforts to complete the needed research seem warranted. Clinical use of this intervention seems to be warranted with informed consent.

PMID: 15564056 [PubMed - indexed for MEDLINE]

Child Adolesc Psychiatr Clin N Am. 2005 Jan;14(1):125-36, vii.

399. *Applicability of brain wave biofeedback to substance use disorder in adolescents.

Trudeau DL.

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Abstract

Neurofeedback treatment for addictions in adults is probably efficacious, and several reported approaches are described with their indications. **Neurofeedback** is promising as a treatment modality for adolescents, especially those with stimulant abuse and attention and conduct problems. It is attractive as a medication-free, neurophysiologic, and self-actualizing treatment for a substance-based, brain-impaired and self-defeating disorder. More research, beginning with case reporting, is needed to assess use and efficacy in adolescents.

PMID: 15564055 [PubMed - indexed for MEDLINE]

Child Adolesc Psychiatr Clin N Am. 2005 Jan;14(1):105-23, vii.

400. *Neurofeedback with anxiety and affective disorders.

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Abstract

A robust body of neurophysiologic research is reviewed on functional brain abnormalities associated with depression, anxiety, and obsessive-compulsive disorder. A review of more recent research finds that pharmacologic treatment may not be as effective as previously believed. A more recent neuroscience technology, electroencephalographic **(EEG) biofeedback** (**neurofeedback**), seems to hold promise as a methodology for retraining abnormal brain wave patterns. It has been associated with minimal side effects and is less invasive than other methods for addressing biologic brain disorders. Literature is reviewed on the use of **neurofeedback** with anxiety disorders, including posttraumatic stress disorder and obsessive-compulsive disorder, and with depression. Case examples are provided.

PMID: 15564054 [PubMed - indexed for MEDLINE]

Child Adolesc Psychiatr Clin N Am. 2005 Jan;14(1):83-104, vi.

401. *Critical validation studies of neurofeedback.

Gruzelier J, Egner T.

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Abstract

The field of **neurofeedback** training has proceeded largely without validation. In this article the authors review studies directed at validating sensory motor rhythm, beta and alpha-theta protocols for improving attention, memory, and music performance in healthy participants. Importantly, benefits were demonstrable with cognitive and neurophysiologic measures that were predicted on the basis of regression models of learning to enhance sensory motor rhythm and beta activity. The first evidence of operant control over the alpha-theta ratio is provided, together with remarkable improvements in artistic aspects of music performance equivalent to two class grades in conservatory students. These are initial steps in providing a much needed scientific basis to **neurofeedback**.

PMID: 15564053 [PubMed - indexed for MEDLINE]

Child Adolesc Psychiatr Clin N Am. 2005 Jan;14(1):55-82, vi.

402. *Electroencephalographic biofeedback (neurotherapy) as a treatment for attention deficit hyperactivity disorder: rationale and empirical foundation.

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Abstract

During the past three decades, electroencephalographic **(EEG) biofeedback** has emerged as a nonpharmacologic treatment for attention-deficit/hyperactivity disorder (ADHD). This intervention was derived from operant conditioning studies that demonstrated capacity for neurophysiologic training in humans and other mammals and targets atypical patterns of cortical activation that have been identified consistently in neuroimaging and quantitative **EEG** studies of patients diagnosed with ADHD. This article presents the rationale for **EEG biofeedback** and examines the empirical support for this treatment using efficacy guidelines established by the Association for Applied Psychophysiology and **Biofeedback** and the International Society for Neuronal Regulation. Based on these guidelines, **EEG biofeedback** is considered to be "probably efficacious" for the treatment of ADHD and merits consideration as a treatment for patients who are stimulant "nonresponders." Although research findings published to date indicate positive clinical response in approximately 75% of patients treated in controlled group studies, additional randomized, controlled trials are needed to provide a better estimate of the robustness of this treatment.

PMID: 15564052 [PubMed - indexed for MEDLINE]

Child Adolesc Psychiatr Clin N Am. 2005 Jan;14(1):1-19, v.

403. *Emerging brain-based interventions for children and adolescents: overview and clinical perspective.

Hirshberg LM, Chiu S, Frazier JA.

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Abstract
Electroencephalogram biofeedback (**EBF**), repetitive transcranial magnetic stimulation (rTMS), and vagal nerve stimulation (VNS) are emerging interventions that attempt to directly impact brain function through neurostimulation and **neurofeedback** mechanisms. This article provides a brief overview of each of these techniques, summarizes the relevant research findings, and examines the implications of this research for practice standards based on the guidelines for recommending evidence based treatments as developed by the American Academy of Child and Adolescent Psychiatry for attention deficit hyperactivity disorder (ADHD). **EBF** meets the "Clinical Guidelines" standard for ADHD, seizure disorders, anxiety, depression, and traumatic brain injury. VNS meets this same standard for treatment of refractory epilepsy and meets the lower "Options" standard for several other disorders. rTMS meets the standard for "Clinical Guidelines" for bipolar disorder, unipolar disorder, and schizophrenia. Several conditions are discussed regarding the use of evidence based thinking related to these emerging interventions and future directions.

PMID: 15564050 [PubMed - indexed for MEDLINE]

Conf Proc IEEE Eng Med Biol Soc. 2005;5:5362-4.

404. Development of EEG biofeedback system based on virtual reality environment.

Mingyu L, Jue W, Nan Y, Qin Y.

Key Lab. of Biomed. Inf. Eng. of Ministry of Educ., Xi'an Jiaotong Univ.

Abstract
A noninvasive **EEG biofeedback** system based on virtual reality (VR) environment is developed. The system translates **EEG** signals into movement and interaction. VR environment provides an ideal medium to represent the spatial and temporal nature of electrical activity emanating from the brain. The VR environment is developed based on MS DirectX technique. **SMR**-component based **biofeedback** training in three normal male subjects and two female subjects are reported. The difficulties in **biofeedback** research and our future research interests are discussed.

PMID: 17281463 [PubMed - in process]

Conf Proc IEEE Eng Med Biol Soc. 2005;5:4568-71.

405. *Nonlinear analysis in treatment of intractable epilepsy with EEG biofeedback.

Zhao L, Liang Z, Hu G, Wu W.

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Abstract
About 25% epilepsy patients are suffering from medically intractable epileptic seizure. Many studies have shown that electroencephalogram **(EEG) biofeedback** therapy has the exciting

potential for seizure control. In this paper, five patients with intractable epilepsy were trained to increase the production of sensorimotor (12~15Hz) activity and decrease the production of slow theta (4~7Hz) activity. Nonlinear analysis are proposed to evaluate the effect of **biofeedback** training. In all the five patients, the complexity and approximate entropy of **EEG** increased significantly (P<0.05) after (about 1-month) of the **biofeedback** treatment.

PMID: 17281256 [PubMed - in process]

HNO. 2005 Jan;53(1):29-37.

406. *[Neurofeedback-based EEG alpha and EEG beta training. Effectiveness in patients with chronically decompensated tinnitus]

[Article in German]
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Abstract

BACKGROUND: Persisting tinnitus is an often devastating disease condition with restricted and rarely successful therapeutic options.

PATIENTS AND METHODS: The present study investigates the therapeutic effect of short term **neurofeedback**-based **EEG**-Alpha- and **EEG**-Beta-training in 40 patients suffering from "chronic decompensated tinnitus". Patients were assigned to the Alpha or Beta group according to results of an initial **EEG** monitored stress-test. Four patients were excluded because they showed abnormal reactions in both **EEG** patterns.

RESULTS: During 12 sessions, 23 patients succeeded to increase **EEG** Alpha activity by 16% (p< or =0.042) while 13 patients achieved no decrease of **EEG** Beta activity. However, both groups showed a significant reduction of subjective tinnitus annoyance by the end of the therapy (p< or =0.001)

CONCLUSIONS: The results indicate that **neurofeedback** may represent a new promising technique in the therapy of chronic decompensated tinnitus. However, it remains to be established whether the reduction of tinnitus annoyance results from the altered brain activity patterns supported by the **neurofeedback** learning process.

PMID: 15565424 [PubMed - indexed for MEDLINE]

Int J Psychophysiol. 2005 Jan;55(1):23-34.

407. ERPs correlates of EEG relative beta training in ADHD children.

Kropotov JD, Grin-Yatsenko VA, Ponomarev VA, Chutko LS, Yakovenko EA, Nikishena IS.

Laboratory for Neurobiology of Action Programming, Institute of the Human Brain of Russian Academy of Sciences, ul. Academica Pavlova 12a, 197376 St. Petersburg, Russia.

Abstract
Eighty-six children (ages 9-14) with attention deficit hyperactivity disorder (ADHD) participated in this study. Event-related potentials (ERPs) were recorded in auditory GO/NOGO task before and after 15-22 sessions of **EEG biofeedback**. Each session consisted of 20 min of enhancing the ratio of the **EEG** power in 15-18 Hz band to the **EEG** power in the rest of spectrum, and 7-10 min of enhancing of the ratio of the **EEG** power in 12-15 Hz to the **EEG** power in the rest of spectrum with C3-Fz electrodes' placements for the first protocol and C4-Pz for the second protocol. On the basis of quality of performance during training sessions, the patients were divided into two groups: good performers and bad performers. ERPs of good performers to GO and NOGO cues gained positive components evoked within 180-420 ms latency. At the same time, no statistically significant differences between pre- and post-training ERPs were observed for bad performers. The ERP differences between post- and pretreatment conditions for good performers were distributed over frontal-central areas and appear to reflect an activation of frontal cortical areas associated with beta training.

PMID: 15598513 [PubMed - indexed for MEDLINE]

J Huazhong Univ Sci Technolog Med Sci. 2005;25(3):368-70.

408. *A controlled study of the effectiveness of EEG biofeedback training on-children with attention deficit hyperactivity disorder.

Xiong Z, Shi S, Xu H.

Department of Child Health, Hubei Maternal and Child Hospital, Wuhan 430070, China.

Abstract
In order to study the treatment of the children with attention deficit hyperactivity disorder (ADHD), the integrated visual and auditory continuous performance test (IVA-CPT) was clinically applied to evaluate the effectiveness of electroencephalogram **(EEG) biofeedback** training. Of all the 60 children with ADHD aged more than 6 years, the effective rate of **EEG biofeedback** training was 91.6% after 40 sessions of **EEG biofeedback** training. Before and after treatment by **EEG biofeedback** training, the overall indexes of IVA were significantly improved among predominately inattentive, hyperactive, and combined subtype of children with ADHD (P<0.001). It was suggested that **EEG biofeedback** training was an effective and vital treatment on children with ADHD.

PMID: 16201300 [PubMed - indexed for MEDLINE]

Ment Retard Dev Disabil Res Rev. 2005;11(2):116-30.

409. Old and new controversies in the alternative treatment of attention-deficit hyperactivity disorder.

Rojas NL, Chan E.

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Abstract

Use of complementary and alternative medicine (CAM) for treatment of attention-deficit hyperactivity disorder (ADHD) has become widespread in both referral and primary care populations. We review the purported mechanism of action and available evidence for selected CAM therapies for ADHD. Enduring controversies, such as elimination of artificial food additives, colors, and/or preservatives; the effect of sugar on behavior in children; and the use of **EEG biofeedback**, have been well studied but lack support as effective sole treatments for ADHD. The initial evidence for some emerging CAM therapies, such as essential fatty acid supplementation, yoga, massage, homeopathy, and green outdoor spaces, suggests potential benefits as part of an overall ADHD treatment plan. More rigorously designed studies are needed to evaluate their effectiveness as single therapy for ADHD.

PMID: 15977318 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2004 Dec;29(4):233-43.

410. *The effectiveness of neurofeedback and stimulant drugs in treating AD/HD: part II. Replication.

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Abstract

This study replicated T. R. Rossiter and T. J. La Vaque (1995) with a larger sample, expanded age range, and improved statistical analysis. Thirty-one ADIHD patients who chose stimulant drug (MED) treatment were matched with 31 patients who chose a **neurofeedback** (**EEG**) treatment program. **EEG** patients received either office (n = 14) or home (n = 17) **neurofeedback**. Stimulants for MED patients were titrated using the Test of Variables of Attention (TOVA). **EEG** (effect size [ES] = 1.01-1.71) and MED (ES = 0.80-1.80) groups showed statistically and clinically significant improvement on TOVA measures of attention, impulse control, processing speed, and variability in attention. The **EEG** group demonstrated statistically and clinically significant improvement on behavioral measures (Behavior Assessment System for Children, ES = 1.16-1.78, and Brown Attention Deficit Disorder Scales, ES = 1.59). TOVA gain scores for the **EEG** and MED groups were not significantly different. More importantly, confidence interval and nonequivalence null hypothesis testing confirmed that the **neurofeedback** program produced patient outcomes equivalent to those obtained with stimulant drugs. An effectiveness research design places some limitations on the conclusions that can be drawn.

PMID: 15707253 [PubMed - indexed for MEDLINE]

IEEE Trans Neural Syst Rehabil Eng. 2004 Dec;12(4):387-97.

411. Low-resolution electromagnetic tomography neurofeedback.

Congedo M, Lubar JF, Joffe D.

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Abstract

Through continuous **feedback** of the electroencephalogram (**EEG**) humans can learn how to shape their brain electrical activity in a desired direction. The technique is known as **EEG biofeedback**, or **neurofeedback**, and has been used since the late 1960s in research and clinical applications. A major limitation of **neurofeedback** relates to the limited information provided by a single or small number of electrodes placed on the scalp. We establish a method for extracting and feeding back intracranial current density and we carry out an experimental study to ascertain the ability of the participants to drive their own **EEG** power in a desired direction. To derive current density within the brain volume, we used the low-resolution electromagnetic tomography (**LORETA**). Six undergraduate students (three males, three females) underwent tomographic **neurofeedback** (based on 19 electrodes placed according to the 10-20 system) to enhance the current density power ratio between the frequency bands beta (16-20 Hz) and alpha (8-10 Hz). According to **LORETA** modeling, the region of interest corresponded to the Anterior Cingulate (cognitive division). The protocol was designed to improve the performance of the subjects on the dimension of sustained attention. Two hypotheses were tested: 1) that the beta/alpha current density power ratio increased over sessions and 2) that by the end of the training subjects acquired the ability of increasing that ratio at will. Both hypotheses received substantial experimental support in this study. This is the first application of an **EEG** inverse solution to **neurofeedback**. Possible applications of the technique include the treatment of epileptic foci, the rehabilitation of specific brain regions damaged as a consequence of traumatic brain injury and, in general, the training of any spatial specific cortical electrical activity. These findings may also have relevant consequences for the development of **brain-computer interfaces**.

PMID: 15614994 [PubMed - indexed for MEDLINE]

Clin Neurophysiol. 2004 Nov;115(11):2452-60.

412. The effects of neurofeedback training on the spectral topography of the electroencephalogram.

Egner T, Zech TF, Gruzelier JH.

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Abstract

OBJECTIVE: To investigate the impact of **EEG** frequency band **biofeedback** (**neurofeedback**) training on spectral **EEG** topography, which is presumed to mediate cognitive-behavioural training effects. In order to assess the effect of commonly applied **neurofeedback** protocols on spectral **EEG** composition, two studies involving healthy participants were carried out.

METHODS: In Experiment 1, subjects were trained on low beta (12-15 Hz), beta1 (15-18 Hz), and alpha/theta (8-11 Hz/5-8 Hz) protocols, with spectral resting **EEG** assessed before and after training. The specific associations between learning indices of each individual training protocol and changes in absolute and relative spectral **EEG** topography was assessed by means of partial correlation analyses. Results of Experiment 1 served to generate hypotheses for Experiment 2, where subjects were randomly allocated to independent groups of low beta, beta1, and alpha/theta training. Spectral resting **EEG** measures were contrasted prior and subsequent to training within each group.

RESULTS: Only few associations between particular protocols and spectral **EEG** changes were found to be consistent across the two studies, and these did not correspond to expectations based on the operant contingencies trained. Low-beta training was found to be somewhat associated with reduced post-training low-beta activity, while more reliably, alpha/theta training was associated with reduced relative frontal beta band activity.

CONCLUSIONS: The results document that **neurofeedback** training of frequency components does affect spectral **EEG** topography in healthy subjects, but that these effects do not necessarily correspond to either the frequencies or the scalp locations addressed by the training contingencies. The association between alpha/theta training and replicable reductions in frontal beta activity constitutes novel empirical neurophysiological evidence supporting inter alia the training's purported role in reducing agitation and anxiety.

SIGNIFICANCE: These results underline the complexity of the neural dynamics involved **EEG** self-regulation and emphasize the need for empirical validation of predictable neurophysiological outcomes of training **EEG biofeedback** protocols.

PMID: 15465432 [PubMed - indexed for MEDLINE]

Clin EEG Neurosci. 2004 Oct;35(4):198-209.

413. *The usefulness of quantitative EEG (QEEG) and neurotherapy in the assessment and treatment of post-concussion syndrome.

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Abstract

Mild traumatic brain injury (TBI) is associated with damage to frontal, temporal and parietal lobes. Post-concussion syndrome has been used to describe a range of residual symptoms that persist 12 months or more after the injury, often despite a lack of evidence of brain abnormalities on **MRI** and CT scans. The core deficits of post-concussion syndrome are similar to those of ADHD and mood disorders, and sufferers often report memory, socialization problems and frequent headaches. While cognitive rehabilitation and psychological support are widely used, neither has been shown to be effective in redressing the core deficits of post-concussion syndrome. On the other hand, quantitative **EEG** has been shown to be highly sensitive (96%) in identifying post-concussion syndrome, and

neurotherapy has been shown in a number of studies to be effective in significantly improving or redressing the symptoms of post-concussion syndrome, as well as improving similar symptoms in non-TBI patients.

PMID: 15493535 [PubMed - indexed for MEDLINE]

Cyberpsychol Behav. 2004 Oct;7(5):519-26.

414. *Neurofeedback training with virtual reality for inattention and impulsiveness.

Cho BH, Kim S, Shin DI, Lee JH, Lee SM, Kim IY, Kim SI.

Department of Biomedical Engineering, Hanyang University, Seoul, Korea.

Abstract

In this research, the effectiveness of **neurofeedback**, along with virtual reality (VR), in reducing the level of inattention and impulsiveness was investigated. Twenty-eight male participants, aged 14-18, with social problems, took part in this study. They were separated into three groups: a control group, a VR group, and a non-VR group. The VR and non-VR groups underwent eight sessions of **neurofeedback** training over 2 weeks, while the control group just waited during the same period. The VR group used a head-mounted display (HMD) and a head tracker, which let them look around the virtual world. Conversely, the non-VR group used only a computer monitor with a fixed viewpoint. All participants performed a continuous performance task (CPT) before and after the complete training session. The results showed that both the VR and non-VR groups achieved better scores in the CPT after the training session, while the control group showed no significant difference. Compared with the other groups, the VR group presented a tendency to get better results, suggesting that immersive VR is applicable to **neurofeedback** for the rehabilitation of inattention and impulsiveness.

PMID: 15667046 [PubMed - indexed for MEDLINE]

Chest. 2004 Aug;126(2):352-61.

415. Biofeedback treatment for asthma.

Lehrer PM, Vaschillo E, Vaschillo B, Lu SE, Scardella A, Siddique M, Habib RH.

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Abstract

STUDY OBJECTIVES: We evaluated the effectiveness of heart rate variability (HRV) **biofeedback** as a complementary treatment for asthma.

PATIENTS: Ninety-four adult outpatient paid volunteers with asthma.

SETTING: The psychophysiology laboratory at The University of Medicine and Dentistry of New Jersey-Robert Wood Johnson Medical School, and the private outpatient offices of participating asthma physicians.

INTERVENTIONS: The interventions were as follows: (1) a full protocol (ie, HRV **biofeedback** and abdominal breathing through pursed lips and prolonged exhalation); (2) HRV **biofeedback** alone; (3) placebo **EEG biofeedback**; and (4) a waiting list control.

DESIGN: Subjects were first prestabilized using controller medication and then were randomly assigned to experimental groups. Medication was titrated biweekly by blinded asthma specialists according to a protocol based on National Heart, Lung, and Blood Institute guidelines, according to symptoms, spirometry, and home peak flows.

MEASUREMENTS: Subjects recorded daily asthma symptoms and twice-daily peak expiratory flows. Spirometry was performed before and after each weekly treatment session under the HRV and placebo **biofeedback** conditions, and at triweekly assessment sessions under the waiting list condition. Oscillation resistance was measured approximately triweekly.

RESULTS: Compared with the two control groups, subjects in both of the two HRV **biofeedback** groups were prescribed less medication, with minimal differences between the two active treatments. Improvements averaged one full level of asthma severity. Measures from forced oscillation pneumography similarly showed improvement in pulmonary function. A placebo effect influenced an improvement in asthma symptoms, but not in pulmonary function. Groups did not differ in the occurrence of severe asthma flares.

CONCLUSIONS: The results suggest that HRV **biofeedback** may prove to be a useful adjunct to asthma treatment and may help to reduce dependence on steroid medications. Further evaluation of this method is warranted.

PMID: 15302717 [PubMed - indexed for MEDLINE] Free Article
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http://www.chestjournal.org/cgi/pmidlookup?view=long&pmid=15302717.

Z Kinder Jugendpsychiatr Psychother. 2004 Jul;32(3):187-200.

416. *[Neurofeedback for the treatment of attention-deficit/hyperactivity disorder (ADHD) in childhood and adolescence]

[Article in German]
Holtmann M, Stadler C, Leins U, Strehl U, Birbaumer N, Poustka F.

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Abstract

INTRODUCTION: A variety of non-pharmacological treatments for ADHD have failed to prove their effectiveness. The basis of evidence for **neurofeedback** (or **EEG-biofeedback**) has improved recently. **Neurofeedback** is aiming at an improvement of ADHD core-

symptoms via the voluntary modification of abnormal neurophysiologic parameters, e.g. **EEG**-frequency spectrum and event-related potentials.

METHODS: Our review presents an overview of the current research on **neurofeedback** for the treatment of ADHD.

RESULTS: In three controlled studies short-term effects of **feedback** matched those of stimulant treatment. **Neurofeedback** lead to significant improvement of attention, impulsivity and hyperactivity, without adversive side effects. Additionally, there was a persistent amelioration of **EEG** parameters, while stimulants did not lead to a comparable normalization. Results on the stability of **feedback** effects are encouraging but are based on small numbers of patients.

CONCLUSION: **Neurofeedback** is a promising approach for the treatment of children with ADHD. However, there is a demand for further controlled studies using standardized diagnostic criteria, sufficient sample sizes and appropriate measures and follow-up.

PMID: 15357015 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2004 Jun;29(2):95-112.

417. *The effectiveness of neurofeedback and stimulant drugs in treating AD/HD: Part I. Review of methodological issues.

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Abstract

The paper examines major criticisms of AD/HD (Attention Deficit/Hyperactivity Disorder) **neurofeedback** research using T. R. Rossiter and T. J. La Vaque (1995) as an exemplar and discusses relevant aspects of research methodology. J. Lohr, S. Meunier, L. Parker, and J. P. Kline (2001), D. A. Waschbusch and G. P. Hill (2001), and J. P. Kline, C. N. Brann, and B. R. Loney (2002) criticized Rossiter and La Vaque for (1) using an active treatment control; (2) nonrandom assignment of patients; (3) provision of collateral treatments; (4) using nonstandardized and invalid assessment instruments; (5) providing artifact contaminated **EEG feedback**; and (6) conducting multiple non-alpha protected t tests. The criticisms, except those related to statistical analysis, are invalid or are not supported as presented by the authors. They are based on the critics' unsubstantiated opinions; require redefining Rossiter and La Vaque as an efficacy rather than an effectiveness study; or reflect a lack of familiarity with the research literature. However, there are broader issues to be considered. Specifically, what research methodology is appropriate for studies evaluating the effectiveness of **neurofeedback** and who should make that determination? The uncritical acceptance and implementation of models developed for psychotherapy, pharmacology, or medical research is premature and ill-advised. **Neurofeedback** researchers should develop models that are appropriate to the technology, treatment paradigms, and goals of **neurofeedback** outcome studies. They need to explain the rationale for their research methodology and defend their choices.

PMID: 15208973 [PubMed - indexed for MEDLINE]

IEEE Trans Biomed Eng. 2004 Jun;51(6):1057-61.

418. BCI Competition 2003--Data sets Ib and IIb: feature extraction from event-related brain potentials with the continuous wavelet transform and the t-value scalogram.

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Abstract
The t-CWT, a novel method for feature extraction from biological signals, is introduced. It is based on the continuous wavelet transform (CWT) and Student's t-statistic. Applied to event-related brain potential (ERP) data in **brain-computer interface** (**BCI**) paradigms, the method provides fully automated detection and quantification of the ERP components that best discriminate between two samples of **EEG** signals and are, therefore, particularly suitable for classification of single-trial ERPs. A simple and fast CWT computation algorithm is proposed for the transformation of large data sets and single trials. The method was validated in the **BCI** Competition 2003, where it was a winner (provided best classification) on two data sets acquired in two different **BCI** paradigms, P300 speller and slow cortical potential **(SCP) self-regulation**. These results are presented here.

PMID: 15188878 [PubMed - indexed for MEDLINE]

IEEE Trans Biomed Eng. 2004 Jun;51(6):971-4.

419. An EEG-driven brain-computer interface combined with functional magnetic resonance imaging (fMRI).

Hinterberger T, Weiskopf N, Veit R, Wilhelm B, Betta E, Birbaumer N.

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Abstract
Self-regulation of slow cortical potentials (**SCP**s) has been successfully used to prevent epileptic seizures as well as to communicate with completely paralyzed patients. The thought translation device (TTD) is a **brain-computer interface** (**BCI**) that was developed for training and application of **SCP self-regulation**. To investigate the neurophysiological mechanisms of **SCP** regulation the TTD was combined with functional magnetic resonance imaging (**fMRI**). The technical aspects and pitfalls of combined **fMRI** data acquisition and **EEG neurofeedback** are discussed. First data of **SCP feedback** during **fMRI** are presented.

PMID: 15188866 [PubMed - indexed for MEDLINE]

IEEE Trans Biomed Eng. 2004 Jun;51(6):966-70.

420. Principles of a brain-computer interface (BCI) based on real-time functional magnetic resonance imaging (fMRI).

Weiskopf N, Mathiak K, Bock SW, Scharnowski F, Veit R, Grodd W, Goebel R, Birbaumer N.

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Abstract

A **brain-computer interface** (**BCI**) based on functional magnetic resonance imaging (**fMRI**) records noninvasively activity of the entire brain with a high spatial resolution. We present a **fMRI**-based **BCI** which performs data processing and **feedback** of the hemodynamic brain activity within 1.3 s. Using this technique, differential **feedback** and self-regulation is feasible as exemplified by the supplementary motor area (SMA) and parahippocampal place area (PPA). Technical and experimental aspects are discussed with respect to **neurofeedback**. The methodology now allows for studying behavioral effects and strategies of local self-regulation in healthy and diseased subjects.

PMID: 15188865 [PubMed - indexed for MEDLINE]

Curr Opin Pediatr. 2004 Apr;16(2):217-26.

421. Update on attention-deficit/hyperactivity disorder.

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Abstract

PURPOSE OF REVIEW: Attention-deficit/hyperactivity disorder (ADHD) is present in 3% to 10% of children in the United States. Children with ADHD can have academic impairments, social dysfunction, and poor self-esteem. There is also a higher risk of both cigarette smoking and substance abuse. Given this, the importance of treatment for ADHD needs to be underscored. This article will briefly review the diagnosis, etiology, and treatment of ADHD, with particular focus on nonstimulant medication and alternative treatment modalities.

RECENT FINDINGS: Recent evidence suggests that the overall rate of medication treatment for ADHD has been increasing, with over 2 million children being treated with stimulants in 1997. With this increase, controversy has arisen over the possible association of stimulants with growth suppression. In addition, estimates indicate that as many as 30% of children with ADHD either do not respond to stimulant treatment or cannot tolerate the treatment secondary to side effects. This has lead to the consideration of treatment with both nonstimulant medications as well as alternative therapies, including diet, iron supplementation, herbal medications, and **neurofeedback**. Considering the various treatment options now available

for ADHD, along with the complexity of the condition, clinical practice guidelines are emerging for the treatment of ADHD and will be discussed.

SUMMARY: ADHD continues to be a serious health problem. Adequate treatment is needed to avoid academic impairments, social dysfunction, and poor self-esteem. This treatment includes consideration of stimulant medication, nonstimulant medication, as well as alternative therapies. The child with ADHD is likely better served with a mutimodal treatment plan, including medication, parent/school counseling, and behavioral therapy. Implementing an evidenced based algorithm for the treatment of ADHD may prove to be most effective.

PMID: 15021207 [PubMed - indexed for MEDLINE]

Clin Neurophysiol. 2004 Mar;115(3):628-35.

422. Automatic processing of self-regulation of slow cortical potentials: evidence from brain-computer communication in paralysed patients.

Neumann N, Hinterberger T, Kaiser J, Leins U, Birbaumer N, Kübler A.

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Abstract

OBJECTIVE: Direct **brain-computer communication** utilizes self-regulation of brain potentials to select letters, words or symbols from a computer menu. Selection of letters or words with brain potentials requires simultaneous processing of several tasks such as production of certain brain potentials at predefined time points simultaneously with processing of presented letter strings. This study addresses the question of whether the self-regulation of slow cortical potentials (**SCP**) automatizes with practice and can thus be considered as a skill comparable to motor or cognitive skills.

METHODS: Two nearly completely paralysed patients learned over several months to produce electrocortically negative and positive **SCP** by means of visual **feedback**. Improved performance and a reduction in performance variability were regarded as behavioural indicators for automaticity, while the topographic focalization of cortical activation was considered as a neurophysiological indicator for automaticity. Different indicators of automaticity were expected to covary along with practice.

RESULTS: In patient 1, performance measured as the percentage of correct **SCP** shifts increased simultaneously with the topographic focalization of cortical activation. His performance became more stable with practice. For this patient the criteria for automaticity were all met. In patient 2, performance also improved, but his cortical activity became topographically less focal. His performance was less stable than that of patient 1.

CONCLUSIONS: The present findings, albeit on only two subjects, provide preliminary evidence that **SCP self-regulation** may automatize with long-term practice and can therefore be considered a skill.

PMID: 15036059 [PubMed - indexed for MEDLINE]

Clin Neurophysiol. 2004 Jan;115(1):131-9.

423. *EEG biofeedback of low beta band components: frequency-specific effects on variables of attention and event-related brain potentials.

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Abstract

OBJECTIVE: To test a common assumption underlying the clinical use of electroencephalographic **(EEG) biofeedback** training (**neurofeedback**), that the modulation of discreet frequency bands is associated with frequency-specific effects. Specifically, the proposal was assessed that enhancement of the low beta components sensorimotor rhythm (**SMR**: 12-15 Hz) and beta1 (15-18 Hz) affect different aspects of attentional processing.

METHODS: Subjects (n=25) were randomly allocated to training with either an **SMR** or beta1 protocol, or to a non-**neurofeedback** control group. Subjects were assessed prior and subsequent to the training process on two tests of sustained attention. The **neurofeedback** participants were also assessed on target P300 event-related potential (ERP) amplitudes in a traditional auditory oddball paradigm.

RESULTS: Protocol-specific effects were obtained in that **SMR** training was associated with increased perceptual sensitivity 'd prime' (d'), and reduced omission errors and reaction time variability. Beta1 training was associated with faster reaction times and increased target P300 amplitudes, whereas no changes were evident in the control group.

CONCLUSIONS: **Neurofeedback** training of **SMR** and beta1 band components led to significant and protocol-specific effects in healthy subjects. The data can be interpreted as indicating a general attention-enhancing effect of **SMR** training, and an arousal-enhancing effect of beta1 training.

PMID: 14706480 [PubMed - indexed for MEDLINE]

Brain Res Bull. 2003 Dec 30;62(3):241-53.

424. The impact of self-hypnosis and Johrei on lymphocyte subpopulations at exam time: a controlled study.

Naito A, Laidlaw TM, Henderson DC, Farahani L, Dwivedi P, Gruzelier JH.

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Abstract

In a prospective randomised controlled trial, 48 students were randomly assigned to stress reduction training before exams with self-hypnosis, Johrei or a mock **neurofeedback**

relaxation control. Peripheral blood lymphocyte subpopulations and self-reported stress (Perceived Stress Scale) were measured before training and 1-2 months later as exams approached. Absolute number and percentages of CD3(+)CD4(+) and CD3(+)CD8(+) T lymphocytes, CD3(-)CD56(+) Natural Killer cells (NK cells) and NK cell cytotoxic activity was measured from venous blood. Stressed participants showed small but significant declines in both CD3(-)CD56(+) NK cell percentages and NK cell cytotoxic activity levels while CD3(+)CD4(+) T cell percentages increased, changes supported by correlations with perceived stress. The effects of stress were moderated in those who learned Johrei at exam time; 11/12 showed increases in CD3(-)CD56(+) NK cell percentages with decreased percentages of CD3(+)CD4(+) T cells, effects not seen in the relaxation control group. Stress was also buffered in those who learned and practised self-hypnosis in whom CD3(-)CD56(+) NK cell and CD3(+)CD4(+) T cell levels were maintained, and whose CD3(+)CD8(+) T cell percentages, shown previously to decline with exams, increased. The results compliment beneficial effects on mood of self-hypnosis and Johrei. The results are in keeping with beneficial influences of self-hypnosis and provide the first evidence of the suggestive value of the Japanese Johrei procedure for stress reduction, which clearly warrants further investigation.

PMID: 14698357 [PubMed - indexed for MEDLINE]

Neuroimage. 2003 Dec;20(4):2209-24.

425. Real-time independent component analysis of fMRI time-series.

Esposito F, Seifritz E, Formisano E, Morrone R, Scarabino T, Tedeschi G, Cirillo S, Goebel R, Di Salle F.

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Abstract

Real-time functional magnetic resonance imaging (**fMRI**) enables one to monitor a subject's brain activity during an ongoing session. The availability of online information about brain activity is essential for developing and refining interactive **fMRI** paradigms in research and clinical trials and for **neurofeedback** applications. Data analysis for real-time **fMRI** has traditionally been based on hypothesis-driven processing methods. Off-line data analysis, conversely, may be usefully complemented by data-driven approaches, such as independent component analysis (ICA), which can identify brain activity without a priori temporal assumptions on brain activity. However, ICA is commonly considered a time-consuming procedure and thus unsuitable to process the high flux of **fMRI** data while they are acquired. Here, by specific choices regarding the implementation, we exported the ICA framework and implemented it into real-time **fMRI** data analysis. We show that, reducing the ICA input to a few points within a time-series in a sliding-window approach, computational times become compatible with real-time settings. Our technique produced accurate dynamic readouts of brain activity as well as a precise spatiotemporal history of quasistationary patterns in the form of cumulative activation maps and time courses. Results from real and simulated motor activation data show comparable performances for the proposed ICA implementation and standard linear regression analysis applied either in a sliding-window or in a cumulative mode. Furthermore, we demonstrate the possibility of monitoring transient or unexpected

neural activities and suggest that real-time ICA may provide the **fMRI** researcher with a better understanding and control of subjects' behaviors and performances.

PMID: 14683723 [PubMed - indexed for MEDLINE]

Rehabilitation (Stuttg). 2003 Dec;42(6):371-7.

426. [EEG-based communication--a new concept for rehabilitative support in patients with severe motor impairment]

[Article in German]
Neuper C, Müller GR, Staiger-Sälzer P, Skliris D, Kübler A, Birbaumer N, Pfurtscheller G.

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Abstract
This paper describes a paralyzed patient diagnosed with severe infantile cerebral palsy, trained over a period of several months to use an **EEG**-based **brain-computer interface** (**BCI**) for verbal communication. The patient learned to "produce" two distinct **EEG** patterns by mental imagery and to use this skill for **BCI**-controlled spelling. The **EEG feedback** training was conducted at a clinic for Assisted Communications, supervised from a distant laboratory with the help of a telemonitoring system. As a function of training sessions significant learning progress was found, resulting in an average accuracy level of 70% correct responses for letter selection. At present, "copy spelling" can be performed with a rate of approximately one letter per minute. The proposed communication device, the "Virtual Keyboard", may improve actual levels of communication ability in completely paralyzed patients. "Telemonitoring-assisted" training facilitates clinical application in a larger number of patients.

PMID: 14677109 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2003 Sep;28(3):241-53.

427. *Neurofeedback training for a patient with thalamic and cortical infarctions.

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Abstract
One year after a left posterior and thalamic stroke, a 52-year-old male participant was treated with 14 weeks of theta reduction **neurofeedback** training. Imaging studies revealed left temporal, parietal, occipital, and bilateral thalamic infarctions along the distribution of the posterior cerebral artery. Neuropsychological testing demonstrated severe verbal memory, naming, visual tracking, and fine motor deficits. Additionally, alexia without agraphia was present. A pretraining quantitative electroencephalograph (Q**EEG**) found alpha attenuation, lack of alpha reactivity to eye opening, and excessive theta activity from the left posterior

head region. **Neurofeedback** training to inhibit 4-8 Hz theta activity was conducted for 42 sessions from left hemisphere sites. Over the course of the training, significant reductions in theta amplitude occurred from the training sites as assessed from the post-session baseline periods. Posttraining, a relative normalization of the Q**EEG** was observed from the left posterior head region.

PMID: 12964455 [PubMed - indexed for MEDLINE]

J Atten Disord. 2003 Sep;7(1):43-55.

428. *EEG biofeedback vs. placebo treatment for attention-deficit/hyperactivity disorder: a pilot study.

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Abstract

METHOD: Seven children diagnosed with attention-deficit hyperactivity disorder (ADHD) were trained using a standard **EEG biofeedback** treatment protocol designed to alter **SMR**/theta ratios and reduce behavioral symptomatology diagnostic of ADHD. During alternate periods they were also trained using a placebo protocol that was identical to the treatment protocol, save that the association between **EEG** patterns and **feedback** to the participants was random. Single-case design elements were used to control for the effects of internal validity threats such as maturation, history, and treatment order. Two participants failed to complete all training sessions, and the effects of training on behavior were analyzed both including and excluding these non-completers.

RESULTS: When all participants were included in analyses that controlled for overall trend, **EEG biofeedback** was found to be no more effective than the placebo control condition involving non-contingent **feedback**, and neither procedure resulted in improvements relative to baseline levels. When overall behavioral trends unrelated to training were not controlled for and non-completers were excluded from the analysis, it could be mistakenly concluded that **EEG biofeedback** is significantly more effective than placebo and that the effect sizes involved are moderate to large. These results indicate that many previous reports of the efficacy of **EEG biofeedback** for ADHD, particularly those presenting series of single cases, might well have been based on spurious findings.

PMID: 14738180 [PubMed - indexed for MEDLINE]

Neurol Neurosurg Psychiatry. 2003 Aug;74(8):1117-21.

429. Predictors of successful self control during brain-computer communication.

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Abstract
OBJECTIVES: Direct **brain-computer communication** uses self regulation of brain potentials to select letters, words, or symbols from a computer menu to re-establish communication in severely paralysed patients. However, not all healthy subjects, or all paralysed patients acquire the skill to self regulate their brain potentials, and predictors of successful learning have not been found yet. Predictors are particularly important, because only successful self regulation will in the end lead to efficient **brain-computer communication**. This study investigates the question whether initial performance in the self regulation of slow cortical potentials of the brain (**SCP**s) may be positively correlated to later performance and could thus be used as a predictor.

METHODS: Five severely paralysed patients diagnosed with amyotrophic lateral sclerosis were trained to produce **SCP** amplitudes of negative and positive polarity by means of visual **feedback** and operant conditioning strategies. Performance was measured as percentage of correct **SCP** amplitude shifts. To determine the relation between initial and later performance in **SCP self regulation**, Spearman's rank correlations were calculated between maximum and mean performance at the beginning of training (runs 1-30) and mean performance at two later time points (runs 64-93 and 162-191).

RESULTS: Spearman's rank correlations revealed a significant relation between maximum and mean performance in runs 1-30 and mean performance in runs 64-93 (r= 0.9 and 1.0) and maximum and mean performance in runs 1-30 and mean performance in runs 162-191 (r=1.0 and 1.0).

CONCLUSIONS: Initial performance in the self regulation of **SCP** is positively correlated with later performance in severely paralysed patients, and thus represents a useful predictor for efficient **brain-computer communication**.

PMID: 12876247 [PubMed - indexed for MEDLINE]PMCID: PMC1738580 Free PMC Article
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http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1738580/?tool=pubmed.

Clin Electroencephalogr. 2003 Jul;34(3):145-52.

430. *EEG and behavioral changes following neurofeedback treatment in learning disabled children.

Fernández T, Herrera W, Harmony T, Díaz-Comas L, Santiago E, Sánchez L, Bosch J, Fernández-Bouzas A, Otero G, Ricardo-Garcell J, Barraza C, Aubert E, Galán L, Valdés R.

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Abstract
Neurofeedback (**NFB**) is an operant conditioning procedure, by which the subject learns to control his/her **EEG** activity. On one hand, Learning Disabled (LD) children have higher values of theta **EEG** absolute and relative power than normal children, and on the other hand, it has been shown that minimum alpha absolute power is necessary for adequate performance.

Ten LD children were selected with higher than normal ratios of theta to alpha absolute power (theta/alpha). The Test Of Variables of Attention (TOVA) was applied. Children were divided into two groups in order to maintain similar IQ values, TOVA values, socioeconomical status, and gender for each group. In the experimental group, **NFB** was applied in the region with highest ratio, triggering a sound each time the ratio fell below a threshold value. Noncontingent reinforcement was given to the other group. Twenty half-hour sessions were applied, at a rate of 2 per week. At the end of the 20 sessions, TOVA, WISC and **EEG** were obtained. There was significant improvement in WISC performance in the experimental group that was not observed in the control group. **EEG** absolute power decreased in delta, theta, alpha and beta bands in the experimental group. Control children only showed a decrease in relative power in the delta band. All changes observed in the experimental group and not observed in the control group indicate better cognitive performance and the presence of greater **EEG** maturation in the experimental group, which suggests that changes were due not only to development but also to **NFB** treatment.

PMID: 14521276 [PubMed - indexed for MEDLINE]

Neuroreport. 2003 Jul 1;14(9):1221-4.

431. *Ecological validity of neurofeedback: modulation of slow wave EEG enhances musical performance.

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Abstract

Biofeedback-assisted modulation of electrocortical activity has been established to have intrinsic clinical benefits and has been shown to improve cognitive performance in healthy humans. In order to further investigate the pedagogic relevance of electroencephalograph **(EEG) biofeedback** (**neurofeedback**) for enhancing normal function, a series of investigations assessed the training's impact on an ecologically valid real-life behavioural performance measure: music performance under stressful conditions in conservatoire students. In a pilot study, single-blind expert ratings documented improvements in musical performance in a student group that received training on attention and relaxation related **neurofeedback** protocols, and improvements were highly correlated with learning to progressively raise theta (5-8 Hz) over alpha (8-11 Hz) band amplitudes. These findings were replicated in a second experiment where an alpha/theta training group displayed significant performance enhancement not found with other **neurofeedback** training protocols or in alternative interventions, including the widely applied Alexander technique.

PMID: 12824763 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2003 Mar;28(1):1-12.

432. *Neurofeedback treatment for attention-deficit/hyperactivity disorder in children: a comparison with methylphenidate.

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Abstract
Clinical trials have suggested that **neurofeedback** may be efficient in treating attention-deficit/hyperactivity disorder (ADHD). We compared the effects of a 3-month electroencephalographic **feedback** program providing reinforcement contingent on the production of cortical sensorimotor rhythm (12-15 Hz) and betal activity (15-18 Hz) with stimulant medication. Participants were N = 34 children aged 8-12 years, 22 of which were assigned to the **neurofeedback** group and 12 to the methylphenidate group according to their parents' preference. Both **neurofeedback** and methylphenidate were associated with improvements on all subscales of the Test of Variables of Attention, and on the speed and accuracy measures of the d2 Attention Endurance Test. Furthermore, behaviors related to the disorder were rated as significantly reduced in both groups by both teachers and parents on the IOWA-Conners Behavior Rating Scale. These findings suggest that **neurofeedback** was efficient in improving some of the behavioral concomitants of ADHD in children whose parents favored a nonpharmacological treatment.

PMID: 12737092 [PubMed - indexed for MEDLINE]

Clin Neurophysiol. 2003 Mar;114(3):399-409.

433. Clinical application of an EEG-based brain-computer interface: a case study in a patient with severe motor impairment.

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Abstract
OBJECTIVE: This case study describes how a completely paralyzed patient, diagnosed with severe cerebral palsy, was trained over a period of several months to use an electroencephalography (**EEG**)-based **brain-computer interface** (**BCI**) for verbal communication.

METHODS: **EEG feedback** training was performed in the patient's home (clinic), supervised from a distant laboratory with the help of a 'telemonitoring system'. Online **feedback** computation was based on single-trial analysis and classification of specific band power features of the spontaneous **EEG**. Task-related changes in brain oscillations over the course of training steps was investigated by quantifying time-frequency maps of event-related (de-)synchronization (ERD/ERS).

RESULTS: The patient learned to 'produce' two distinct **EEG** patterns, beta band ERD during movement imagery vs. no ERD during relaxing, and to use this for **BCI**-controlled spelling. Significant learning progress was found as a function of training session, resulting in an average accuracy level of 70% (correct responses) for letter selection. 'Copy spelling' was performed with a rate of approximately one letter per min.

CONCLUSIONS: The proposed **BCI** training procedure, based on electroencephalogram **(EEG) biofeedback** and concomitant adaptation of feature extraction and classification, may improve actual levels of communication ability in locked-in patients. 'Telemonitoring-assisted' **BCI** training facilitates clinical application in a larger number of patients.

PMID: 12705420 [PubMed - indexed for MEDLINE]

Int J Psychophysiol. 2003 Jan;47(1):75-85.

434. *The effect of training distinct neurofeedback protocols on aspects of cognitive performance.

Vernon D, Egner T, Cooper N, Compton T, Neilands C, Sheri A, Gruzelier J.

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Abstract

The use of **neurofeedback** as an operant conditioning paradigm has disclosed that participants are able to gain some control over particular aspects of their electroencephalogram (**EEG**). Based on the association between theta activity (4-7 Hz) and working memory performance, and sensorimotor rhythm (**SMR**) activity (12-15 Hz) and attentional processing, we investigated the possibility that training healthy individuals to enhance either of these frequencies would specifically influence a particular aspect of cognitive performance, relative to a non-**neurofeedback** control-group. The results revealed that after eight sessions of **neurofeedback** the **SMR**-group were able to selectively enhance their **SMR** activity, as indexed by increased **SMR**/theta and **SMR**/beta ratios. In contrast, those trained to selectively enhance theta activity failed to exhibit any changes in their **EEG**. Furthermore, the **SMR**-group exhibited a significant and clear improvement in cued recall performance, using a semantic working memory task, and to a lesser extent showed improved accuracy of focused attentional processing using a 2-sequence continuous performance task. This suggests that normal healthy individuals can learn to increase a specific component of their **EEG** activity, and that such enhanced activity may facilitate semantic processing in a working memory task and to a lesser extent focused attention. We discuss possible mechanisms that could mediate such effects and indicate a number of directions for future research.

PMID: 12543448 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2002 Dec;27(4):283-97.

435. The circle of the soul: the role of spirituality in health care.

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Abstract
This paper examines the critical attitude of behavioral professionals toward spiritual phenomena, and the current growing openness toward a scientific study of spirituality and its effects on health. Health care professionals work amidst sickness and suffering, and become immersed in the struggles of suffering persons for meaning and spiritual direction. **Biofeedback** and **neurofeedback** training can facilitate relaxation, mental stillness, and the emergence of spiritual experiences. A growing body of empirical studies documents largely positive effects of religious involvement on health. The effects of religion and spirituality on health are diverse, ranging from such tangible and easily understood phenomena as a reduction of health-risk behaviors in church-goers, to more elusive phenomena such as the distant effects of prayer on health and physiology. Psychophysiological methods may prove useful in identifying specific physiological mechanisms mediating such effects. Spirituality is also a dimension in much of complementary and alternative medicine (CAM), and the CAM arena may offer a window of opportunity for **biofeedback** practice.

PMID: 12557456 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2002 Dec;27(4):271-2.

436. Task Force Report on methodology and empirically supported treatments: introduction.

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Abstract
Recent criticism of **biofeedback** has increased the importance of rating the efficacy of each **biofeedback** and **neurofeedback** therapy. A joint task force of the Association for Applied Psychophysiology and **Biofeedback** (AAPB) and the Society for Neuronal Regulation (SNR) has developed standards for efficacy research methodology and template for rating the level of efficacy of each application. The Task Force Report has been approved as a policy guideline by both the AAPB and SNR Boards.

PMID: 12557454 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2002 Dec;27(4):261-70.

437. EEG signature and phenomenology of alpha/theta neurofeedback training versus mock feedback.

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Abstract

Alpha/theta (a/t) **neurofeedback** training has in the past successfully been used as a complementary therapeutic relaxation technique in the treatment of alcoholism. In spite of positive clinical outcomes, doubts have been cast on the protocol's specificity when compared to alternative relaxation regimes. This study investigated the basic tenet underlying the a/t training rationale, that accurate a/t **feedback** representation facilitates the generation of these frequency components. Two groups of healthy volunteers were randomly assigned to either (a) real contingent a/t **feedback** training or (b) a noncontingent mock **feedback** control condition. The groups were compared on measures of theta/alpha (t/a) ratios within and across training sessions, as well as activational self-report scales after each session. The contingent a/t **feedback** group displayed significant within-session t/a ratio increments not evident in the mock control group, as well as higher overall t/a ratios in some but not all of the training sessions. No differences were found between the groups in terms of subjective activational phenomenology, in that both groups reported significantly lower levels of activation after training sessions. The data demonstrate that irrespective of considerations of clinical relevance, accurate a/t **neurofeedback** effectively facilitates production of higher within-session t/a ratios than do noncontingent **feedback** relaxation.

PMID: 12557453 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2002 Dec;27(4):231-49.

438. *The effects of stimulant therapy, EEG biofeedback, and parenting style on the primary symptoms of attention-deficit/hyperactivity disorder.

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Abstract

One hundred children, ages 6-19, who were diagnosed with attention-deficit/hyperactivity disorder (ADHD), either inattentive or combined types, participated in a study examining the effects of Ritalin, **EEG biofeedback**, and parenting style on the primary symptoms of ADHD. All of the patients participated in a 1-year, multimodal, outpatient program that included Ritalin, parent counseling, and academic support at school (either a 504 Plan or an IEP). Fifty-one of the participants also received **EEG biofeedback** therapy. Posttreatment assessments were conducted both with and without stimulant therapy. Significant improvement was noted on the Test of Variables of Attention (TOVA; L. M. Greenberg, 1996) and the Attention Deficit Disorders Evaluation Scale (ADDES; S. B. McCarney, 1995)

when participants were tested while using Ritalin. However, only those who had received **EEG biofeedback** sustained these gains when tested without Ritalin. The results of a Quantitative Electroencephalographic Scanning Process (Q**EEG**-Scan; V. J. Monastra et al., 1999) revealed significant reduction in cortical slowing only in patients who had received **EEG biofeedback**. Behavioral measures indicated that parenting style exerted a significant moderating effect on the expression of behavioral symptoms at home but not at school.

PMID: 12557451 [PubMed - indexed for MEDLINE]

Cyberpsychol Behav. 2002 Dec;5(6):565-80.

439. An evaluation model for psychoeducational interventions using interactive multimedia.

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Abstract
A review of published evaluations of psychoeducational interventions using interactive digital multimedia shows that evaluations typically address only some of the areas that collectively would constitute a comprehensive evaluation. There appears to be a need for an accepted standard for these evaluations, based on a general evaluation model that encompasses all relevant aspects of development, efficacy and use of multimedia interventions. A comprehensive model is proposed which includes special features of multimedia interventions that lead to unique evaluation requirements. The model integrates relevant aspects of program evaluation and clinical trials models in order to provide a unique model that includes all the evaluation domains relevant to digital multimedia interventions. These include evaluation of intervention theory, intervention design strategies, the formative process, intervention efficacy (process and outcome) and contextual issues such as evaluability assessment, reporting and stakeholder issues. The application of individual components of the model is illustrated with reference to problems in the evaluation literature on a particular type of digital multimedia intervention, **electroencephalographic biofeedback** for Attention-Deficit/Hyperactivity Disorder. The model should be useful for researchers planning evaluations of digital multimedia interventions, especially in the psychoeducational domain. This paper provides a theoretical and evidential background for the evaluation model, and includes a checklist and flowchart for the planning and conduct of the evaluation.

PMID: 12556120 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2002 Sep;27(3):203-13.

440. *On the pathophysiology of migraine--links for "empirically based treatment" with neurofeedback.

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Abstract
Psychophysiological data support the concept that migraine is the result of cortical hypersensitivity, hyperactivity, and a lack of habituation. There is evidence that this is a brain-stem related information processing dysfunction. This cortical activity reflects a periodicity between 2 migraine attacks and it may be due to endogenous or exogenous factors. In the few days preceding the next attack slow cortical potentials are highest and habituation delay experimentally recorded during contingent negative variation is at a maximum. These striking features of slow cortical potentials are predictors of the next attack. The pronounced negativity can be fed back to the patient. The data support the hypothesis that a change in amplitudes of slow cortical potentials is caused by altered habituation during the recording session. This kind of **neurofeedback** can be characterized as "empirically based" because it improves habituation and it proves to be clinically efficient.

PMID: 12206051 [PubMed - indexed for MEDLINE]

Neuroreport. 2002 Aug 7;13(11):1377-81.

441. Functional MRI for neurofeedback: feasibility study on a hand motor task.

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Abstract
We present an **fMRI**-based method that enables subjects to monitor and actively modulate their own brain activity as a form of **biofeedback**. On a 1.5 T clinical MR scanner, functional areas during a simple hand motor task were delineated by detecting signal variations associated with the brain activity. Then, the subject adopted a different strategy to expand the activation in motor and somatosensory areas that were not activated previously. Statistical maps of brain activity were visually presented back to the subject, being updated at the end of each segmented rest-task block in near real-time manner. Our results suggest that the visual **feedback** of the functional brain activation maps guided subjects to adjust their task performance to achieve the desired modulation of cortical activity. This method may offer a potential utility for **fMRI**-based **neurofeedback**.

PMID: 12167756 [PubMed - indexed for MEDLINE]

Epilepsy Behav. 2002 Jun;3(3):214-218.

442. *Neurofeedback and epilepsy.

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Abstract
Over the past three decades, researchers have examined various behavioral approaches to the treatment of epilepsy. One prominent line of inquiry concerns the effectiveness of

neurofeedback, which entails the entrainment of specific electroencephalographic frequencies for the purpose of decreasing seizure frequencies in patients with epilepsy. This article reviews the current literature on the efficacy of **neurofeedback** in reducing seizure frequency. While it is clear that **neurofeedback** had a positive effect in most of the studies reviewed, these findings are limited due to multiple confounding factors. In the absence of any rigorously controlled studies, the relationship between **neurofeedback** and seizure frequency cannot be firmly established. Despite these limitations, the promising role of **neurofeedback** as a treatment for epilepsy is illustrated.

PMID: 12662600 [PubMed - as supplied by publisher]

Schizophr Res. 2002 Mar 1;54(1-2):95-103.

443. *A Janusian perspective on the nature, development and structure of schizophrenia and schizotypy.

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Abstract

A personal review is presented of the functional basis of activation, withdrawal and unreality, individual differences in schizophrenia that Venables et al. pioneered. Activated and withdrawn syndromes were delineated from the totality of symptoms by classifying unmedicated patients on the basis of lateral asymmetries in electrodermal responses. A neuropsychological syndrome translation led to a syndrome hemispheric imbalance model supported by a literature review disclosing widespread cortical and infracortical involvement extending to motoneurone excitability, with validation from tests of learning, memory and evoked responses including the P300. It is contended that the centrality of arousal, the extensive substrate and the evidence of asymmetry modification with recovery and treatment all implicate specific and nonspecific thalamo-cortical systems whose uncoupling may lead to dysfunction of input, cognition and to unreality symptoms (found inconsistently related to asymmetry). The three syndromes have developmental associations including immune competence, ventricular changes and lateral asymmetry, putative regressive neuronal changes in connectivity and electrocortical measures of connectivity, as well as sensory gating and anomalies of P50 suppression and habituation. Replication of the syndromal structure in psychometric schizotypy indicates that syndrome expression is based on the premorbid personality, compatible with evidence of early determinants of the approach/withdrawal balance in social encounters. Functional considerations for the nature of schizophrenia support neurophysiological approaches to treatment such as **neurofeedback**.

PMID: 11853983 [PubMed - indexed for MEDLINE]

Altern Ther Health Med. 2002 Jan-Feb;8(1):68-70, 72-4.

444. Alternative treatments for attention-deficit/hyperactivity disorder: does evidence support their use?

Brue AW, Oakland TD.

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Comment in Altern Ther Health Med. 2002 May-Jun;8(3):18; author reply 18.

Abstract

Attention-deficit/hyperactivity disorder (ADHD) affects approximately 2 to 3 million children in the United States. Stimulant medication is one of the most common treatments for ADHD; however, adverse reactions from its use cause many parents to seek complementary or alternative treatments. Many individuals use complementary and alternative medicine (CAM) because they are attracted to CAM philosophies and health beliefs, dissatisfied with the process or results of their conventional care, or concerned about adverse effects of stimulants. The success of CAM in treating children with ADHD varies, and parents typically use a trial-and-error method when evaluating CAM. Alternative treatments often include **neurofeedback**, homeopathy, herbal medicines, iron supplements, and dietary modifications or supplements. Although anecdotal and empirical evidence is surfacing to support the efficacy of these alternatives, further research is needed before they can be regarded as effective, reliable treatments for ADHD. Therefore, the use of more conventional treatments should be considered if alternative interventions prove unsuccessful.

PMID: 11795624 [PubMed - indexed for MEDLINE]

Int Tinnitus J. 2002;8(2):87-93.

445. *Neurofeedback and quantitative electroencephalography.

Weiler EW, Brill K, Tachiki KH, Schneider D.

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Abstract

This study was conducted in an attempt to determine the efficacy of **neurofeedback** (**NFB**) in the treatment of patients suffering from vertigo or tinnitus. Results indicated that after **NFB**, power for delta and theta bands was reduced; however, an increase of power was noted for the alpha bands. Furthermore, normalization was observed for the vestibular evoked potentials (VestEP). After **NFB**, a normalization of the VestEP was also demonstrated in a patient suffering from a bilateral tinnitus. A follow-up study (12 months after **NFB**) demonstrated that the VestEP were normal.

PMID: 14763216 [PubMed - indexed for MEDLINE]

NeuroRehabilitation. 2002;17(1):69-80.

446. *The improvement/rehabilitation of auditory memory functioning with EEG biofeedback.

Thornton KE.

Center for Health Psychology, Ste. 2a, 2509 Park Ave. S. Plainfield, NJ 07080, USA. chp.ket@worldnet.att.net

Abstract

Five clinical case studies (1 normal, 3 brain injured and 1 subject who had a left frontal hematoma) are presented which addressed the effectiveness of **EEG biofeedback** for auditory memory impairment. A normative Q**EEG** activation database of 59 right-handed subjects was developed, which delineated the Q**EEG** variables which were positively related to auditory memory performance (paragraphs). Persons who had experienced a brain injury underwent the same procedure employed in the development of the database. The person's values on the effective parameters of memory functioning were determined. **EEG biofeedback** interventions were determined by the individual's deviation from the normative reference group in terms of the relevant Q**EEG** parameters of effective auditory memory (paragraph recall). Improvements ranged from 39% subjects who had a follow up assessment that occurred from one month to one year following termination of treatment.

PMID: 12016349 [PubMed - indexed for MEDLINE]

Stud Health Technol Inform. 2002;85:89-95.

447. *Clinical test for Attention Enhancement System.

Cho BH, Ku J, Jang D, Lee J, Oh M, Kim H, Lee J, Kim J, Kim I, Kim S.

Department of Biomedical Engineering, College of Medicine, Hanyang University, Seoul, Korea.

Abstract

Attention Deficit Hyperactivity Disorder (ADHD) is a childhood syndrome characterized by short attention span, impulsiveness, and hyperactivity, which often leads to learning disabilities and various behavioral problems. The prevalence rates for ADHD varied from a low of 2.0% to a high of 6.3% in 1992 statistics, and it may be higher now. Using Virtual Environments and **Neurofeedback**, we have developed an Attention Enhancement System for treating ADHD. And we made a clinical test. Classroom-based virtual environments are constructed for intimacy and intensive attention enhancement. In this basic virtual environment, subjects performed some training sessions. There are two kinds of training sessions. One is Virtual Reality Cognitive Training (VRCT) and the other is Virtual Reality **Neurofeedback** Training (VRNT). In VRNT, we made a change in the virtual environment by **Neurofeedback**. Namely, if the Beta ratio is greater than the specified threshold level, the change as positive reinforce is created in the virtual environment. 50 subjects, aged 14 to 18, who had committed crimes and had been isolated in a reformatory took part in this study. They were randomly assigned to one of five 10-subject groups: a control Group, two placebo groups, and two experimental groups. The experimental groups and the placebo groups underwent 10 sessions over two weeks. The control group underwent no training session during the same period of time. While the experimental groups used HMD and Head Tracker

in each session, the placebo groups used only a computer monitor. Consequently, only the experimental Groups could look around the virtual classroom. Besides that, Placebo Group 1 and Experimental Group 1 performed the same task (**Neurofeedback** Training), and Placebo Group 2 and Experimental Group 2 also performed the same task(Cognitive Training). All subjects Continuous Performance Task(CPT) before and after all training sessions. In the number of correct answers, omission errors and signal detection index (d'), the subjects' scores from CPT showed significant improvement ($p<0.01$) after all of the training sessions, while control group indicated no significant change. And experimental groups showed significant difference ($p<0.01$) with placebo groups. Lastly, the Virtual Reality **Neurofeedback** training group and the Virtual Reality Cognitive training group indicated not significant difference. Our System is supposed to enhance subjects' attention and lead their behavioral improvement. And also, we can conclude that virtual reality training (both **Neurofeedback** training and Cognitive training) has an advantage for attention enhancement compared with desk-top training.

PMID: 15458066 [PubMed - indexed for MEDLINE]

Neuroreport. 2001 Dec 21;12(18):4155-9.

448. *Learned self-regulation of EEG frequency components affects attention and event-related brain potentials in humans.

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Abstract

Learned enhancement of **EEG** frequency components in the lower beta range by means of **biofeedback** has been reported to alleviate attention deficit hyperactivity disorder (ADHD) symptoms. In order to elucidate frequency-specific behavioural effects and neurophysiological mediators, this study applied **neurofeedback** protocols to healthy volunteers, and assessed impact on behavioural and electrocortical attention measures. Operant enhancement of a 12-15 Hz component was associated with reduction in commission errors and improved perceptual sensitivity on a continuous performance task (CPT), while the opposite relation was found for 15-18 Hz enhancement. Both 12-15 Hz and 15-18 Hz enhancement were associated with significant increases in P300 event-related brain potential amplitudes in an auditory oddball task. These relations are interpreted as stemming from band-specific effects on perceptual and motor aspects of attention measures.

PMID: 11742256 [PubMed - indexed for MEDLINE]

Top Stroke Rehabil. 2001 Autumn;8(3):45-53.

449. *Effect of neurofeedback on motor recovery of a patient with brain injury: a case study and its implications for stroke rehabilitation.

Wing K.

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Abstract
This case study showed the effect of **neurofeedback** (**NFB**) training in a patient with a brain tumor and co-existing traumatic brain injury. The patient received 40 sessions of **NFB** intervention. Tests and videotaped recordings evaluated pre- and post-**NFB** intervention. This study demonstrated minimal to significant improvements in several functional tasks. The conclusion is that the use of **NFB** for a person with a head injury and brain tumor can be generalized to be used with stroke survivors.

PMID: 14523737 [PubMed] Free Article
See complete free article at: http://thomasland.metapress.com/content/4g2f5plvrnm9bggn/.

Paediatr Child Health. 2001 Sep;6(7):451-5.

450. *The efficacy of neurofeedback in the management of children with attention deficit/hyperactivity disorder.

Baydala L, Wikman E.

Department of Pediatrics, University of Alberta.

Abstract
Attention deficit/hyperactivity disorder (ADHD) is a behavioural disorder characterized by an inappropriate level of inattention with or without impulsivity or overactivity. The estimated prevalence of ADHD is 7% to 10% in boys and 3% in girls aged four to 11 years. The higher prevalence in boys is believed to be the result of a referral bias because boys with ADHD are more disruptive and aggressive, and, therefore, more likely to be referred to specialty clinics. ADHD is caused by a combination of biological - often genetically determined neurochemical disturbances - and environmental disadvantages that are associated with learning difficulties, behavioural problems and social rejection. The identification and treatment of children with ADHD are essential in preventing or at least minimizing the serious complications associated with this disorder. Stimulant medications are the most effective means of symptomatic control of ADHD symptoms, and the safety and efficacy of these medications is well established in the literature. Despite the known efficacy of stimulant medications, alternatives are often sought by parents of children with ADHD. A number of alternative and controversial treatments for ADHD are available, including dietary management, nutritional supplementation, vision therapy, hypnotherapy, guided imagery, relaxation training and electroencephalogram (**EEG**) **neurofeedback**. Published well controlled scientific studies either to support or refute the effectiveness of **EEG neurofeedback** for children with ADHD are not available. At the present time, **EEG neurofeedback** needs to be considered as an experimental treatment, the validity of which has not yet been determined.

PMID: 20107553 [PubMed - in process]PMCID: PMC2807759 Free PMC Article
See complete free article at:
http://www.ncbi.nlm.nih.gov/pmc/articles/pmid/20107553/?tool=pubmed.

Ann N Y Acad Sci. 2001 Jun;931:342-58.

451. *EEG biofeedback treatment of ADD. A viable alternative to traditional medical intervention?

Ramirez PM, Desantis D, Opler LA.

Doctoral Program in Clinical Psychology at Long Island University (Brooklyn Campus), Brooklyn, New York 11201, USA.

Abstract
Literature searches dating back to 1968 were conducted through Psychlit and Medline services to review the scientific literature on **EEG biofeedback** treatment of ADD. While anecdotal and case reports cite promising evidence, methodological problems coupled with a paucity of research precludes any definitive conclusions as to the efficacy of enhanced alpha and hemisphere-specific **EEG biofeedback** training. One of the more promising **EEG biofeedback** treatment paradigms involves theta/beta training. Studies have reported that academic, intellectual, and behavioral gains have been attained with this approach. Significant behavioral and cognitive changes have also been reported following **SMR** training. However, research into these treatment approaches has also been marred by methodological inadequacies and lack of sufficient follow-up studies. A number of recommendations for future research into this treatment approach are made.

PMID: 11462752 [PubMed - indexed for MEDLINE]

Ann N Y Acad Sci. 2001 Jun;931:310-41.

452. Alternative treatments for adults with attention-deficit hyperactivity disorder (ADHD).

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Abstract
A previous review of alternative treatments (Tx) of ADHD--those other than psychoactive medication and behavioral/psychosocial Tx--was supplemented with an additional literature search focused on adults with ADHD. Twenty-four alternative Tx were identified, ranging in scientific documentation from discrediting controlled studies through mere hypotheses to positive controlled double-blind clinical trials. Many of them are applicable only to a specific subgroup. Although oligoantigenic (few-foods) diets have convincing double-blind evidence of efficacy for a properly selected subgroup of children, they do not appear promising for adults. Enzyme-potentiated desensitization, relaxation/EMG **biofeedback**, and deleading also have controlled evidence of efficacy. Iron supplementation, magnesium supplementation, Chinese herbals, **EEG biofeedback**, massage, meditation, mirror feedback, channel-specific

perceptual training, and vestibular stimulation all have promising prospective pilot data, many of these tests reasonably controlled. Single-vitamin megadosage has some intriguing pilot trial data. Zinc supplementation is hypothetically supported by systematic case-control data, but no systematic clinical trial. Laser acupuncture has promising unpublished pilot data and may be more applicable to adults than children. Essential fatty acid supplementation has promising systematic case-control data, but clinical trials are equivocal. RDA vitamin supplementation, non-Chinese herbals, homeopathic remedies, and antifungal therapy have no systematic data in ADHD. Megadose multivitamin combinations are probably ineffective for most patients and are possibly dangerous. Simple sugar restriction seems ineffective. Amino acid supplementation is mildly effective in the short term, but not beyond 2-3 months. Thyroid treatment is effective in the presence of documented thyroid abnormality. Some alternative Tx of ADHD are effective or probably effective, but mainly for certain patients. In some cases, they are the Tx of choice, and initial evaluation should consider the relevant etiologies. A few have failed to prove effective in controlled trials. Most need research to determine whether they are effective and/or to define the applicable subgroup. Some of them, although not safer than standard Tx, may be preferable for an etiologic subgroup.

PMID: 11462750 [PubMed - indexed for MEDLINE]

Sheng Wu Yi Xue Gong Cheng Xue Za Zhi. 2001 Jun;18(2):256-9.

453. [Study of EEG processing system and EEG wavelet transform]

[Article in Chinese]
Zhou W, Yin L, Wang Z.

Department of Electronics, Shangdong University, Jinan 250100.

Abstract
In this paper are reported our studies on the time and frequency characteristics of wavelet transform, the **EEG** signals processing through wavelet transform, the **EEG** analysis and reconstruction results. The related **EEG** processing system design and implementation are given in detail. This system may be applied to **EEG feedback** research and **EEG** monitoring.

PMID: 11450548 [PubMed - indexed for MEDLINE]

J Head Trauma Rehabil. 2001 Jun;16(3):260-74.

454. *Flexyx Neurotherapy System in the treatment of traumatic brain injury: an initial evaluation.

Schoenberger NE, Shif SC, Esty ML, Ochs L, Matheis RJ.

Kessler Medical Rehabilitation Research and Education Corporation, West Orange, New Jersey, USA. nschoen1@midsouth.rr.com

Abstract

OBJECTIVE: To conduct a preliminary experimental evaluation of the potential efficacy of Flexyx **Neurotherapy** System (FNS), an innovative electroencephalography (**EEG**)-based therapy used clinically in the treatment of traumatic brain injury (TBI).

PARTICIPANTS: Twelve people aged 21 to 53 who had experienced mild to moderately severe closed head injury at least 12 months previously and who reported substantial cognitive difficulties after injury, which interfered with their functioning.

DESIGN: Participants were randomly assigned to an immediate treatment group or a wait-list control group and received 25 sessions of FNS treatment. They were assessed at pretreatment, posttreatment, and follow-up with standardized neuropsychological and mood measures.

RESULTS: Comparison of the two groups on outcome measures indicated improvement after treatment for participants' reports of depression, fatigue, and other problematic symptoms, as well as for some measures of cognitive functioning. Most participants experienced meaningful improvement in occupational and social functioning.

CONCLUSION: On the basis of these results, FNS appears to be a promising new therapy for TBI and merits more extensive evaluation.

PMID: 11346448 [PubMed - indexed for MEDLINE]

Epilepsia. 2001 Mar;42(3):406-16.

455. *Modification of slow cortical potentials in patients with refractory epilepsy: a controlled outcome study.

Kotchoubey B, Strehl U, Uhlmann C, Holzapfel S, König M, Fröscher W, Blankenhorn V, Birbaumer N.

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Abstract
PURPOSE: To compare self-regulation of low-frequency **EEG** components (slow cortical potentials, **SCP**s) with other methods of seizure control for patients with drug-refractory partial epilepsy and to separate the real anticonvulsive effect from placebo effects.

METHODS: Results of a treatment program of **SCP self-regulation** (experimental group) are compared with two groups of patients, one of which learned self-control of respiratory parameters (end-tidal CO2 and respiration rate: RES group); the other received medication with new anticonvulsive drugs (AEDs) in combination with psychosocial counseling (MED group). Clinical, cognitive, behavioral, and personality measures were assessed before and after treatment. In addition, to control for placebo responses, patients repeatedly estimated their beliefs in the efficiency of the respective treatment, their satisfaction and expectations, and the quality of the relationship with their therapists.

RESULTS: **SCP** and MED groups showed a significant decrease of seizure frequency, but the RES group did not. Clear positive changes in the sociopsychological adjustment were obtained in all three groups, with the maximal improvement being attained in the RES group.

CONCLUSIONS: All kinds of therapy result in considerable improvement of patients' emotional state, which may in part be due to potential placebo effects: however, this improvement is not related to the quality of the therapeutic effect proper (i.e., seizure reduction). Traditional double-blind control group designs are inappropriate for behavioral interventions or treatments with psychoactive pharmacologic drugs. Rather, specific tests can be developed to control the placebo effect and to separate it from the genuine therapeutic effects.

PMID: 11442161 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2001 Mar;26(1):23-37; discussion 61-5.

456. The ethical use of placebo controls in clinical research: the Declaration of Helsinki.

La Vaque TJ, Rossiter T.

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Comment in Appl Psychophysiol Biofeedback. 2001 Mar;26(1):17-21.

Abstract

Medical ethicists have questioned the use of no-treatment (placebo and sham procedure) controlled studies of new therapies when safe and effective standard therapies are available for use as an active or "equivalence" control. Current ethical principles of conduct for biomedical research specifically prohibit designs that withhold or deny "the best proven diagnostic and therapeutic" treatment to any participant in a clinical study, including those individuals who consent to randomization into a control group. Studies of psychophysiological therapies are often criticized on the grounds they lack a placebo or sham treatment control group. This paper briefly reviews the history of the problem and discusses the ethical standards that govern human research as derived from the Nuremberg Code and the Declaration of Helsinki. An examination of the problem with regard to research involving **EEG biofeedback** therapy for Attention-Deficit/Hyperactivity Disorder, Traumatic Brain Injury, and depression serves to highlight the issues. It is concluded that the active treatment control (treatment equivalence) design is most appropriate for those clinical studies examining disorders for which there is a known, effective treatment. Sham- or placebo-controlled studies are ethically acceptable for those disorders for which no effective treatment is available.

PMID: 11387859 [PubMed - indexed for MEDLINE]

Am J Psychother. 2001;55(2):234-50.

457. Agitation therapy for antisocial and psychopathic personalities: an outline.

Martens WH.

Institute of Theoretical Psychiatry and Neuroscience, Elst, Utrecht, The Netherlands.

Abstract
In this paper, a hypothetical model of agitation therapy for some categories of antisocial and psychopathic patients/offenders is presented. Agitation therapy is mainly meant for very problematic and aggressive individuals who do not (or hardly) respond (in some periods) to any other type of psychotherapy, **neurofeedback**, and/or psychopharmacotherapy. The author makes an attempt to develop an adequate model of agitation therapy that makes optimal use of learning moments in controlled conflict situations. During agitation therapy the aggressive antisocial or psychopathic individual will be exposed to external agitation of other patients in a controlled manner in order to increase his/her self-knowledge; awareness of his or her intolerable behavior and limitations; sublimation of aggression/anger; the willingness (and insight in the necessity) to change; feelings of responsibility and emotional, social and moral development. Agitation therapy is not intended to be an isolated form of psychotherapy, but it may be rather often successful in combination with other types of psychotherapy, **neurofeedback**, and/or psychopharmacotherapy.

PMID: 11467259 [PubMed - indexed for MEDLINE]

HNO. 2001 Jan;49(1):29-35.

458. ***[Neurofeedback in therapy of tinnitus]**

[Article in German]
Gosepath K, Nafe B, Ziegler E, Mann WJ.

Römerwallklinik, Klinik für Neurootologische Erkrankungen, Mainz.

Abstract
BACKGROUND AND OBJECTIVE: **Biofeedback** is known as a possibility to control physiologic processes like body temperature or heart frequency. **Neurofeedback** is a form of **biofeedback** linked to aspects of the electrical activity of the brain such as frequency, location or amplitude of specific **EEG** activity. It has been successfully used in patients with closed head injury, hyperactivity disorder or epilepsy.

PATIENTS/METHODS: In this study 40 patients with tinnitus were treated with **neurofeedback**.They trained to upregulate the amplitude of their alpha-activity and downregulate the amplitude of beta-activity during muscle relaxation and acoustic orientation on sounds or music in order to suppress their tinnitus.

RESULTS: After 15 sessions of training 24 patients with a duration of their tinnitus for an average of 1 year showed significant increase of alpha-amplitudes while 16 patients with duration of their tinnitus on an average of 7 years showed a decrease of beta-amplitudes without any change in alpha-activity. After the training all patients had a significant reduction of the score in the tin nitusquestionaire of Gobel and Hiller. In a control-group of 15 persons without tinnitus we didn't see any changes of alpha- or beta-amplitudes during the same training.

CONCLUSIONS: In conclusion **neurofeedback** is a new therapy for patients with tinnitus. Patients get the possibility of selfcontrol and therefore of influence on their disease.

PMID: 11219406 [PubMed - indexed for MEDLINE]

NeuroRehabilitation. 2001;16(4):295-300.

459. *Treatment of chronic fatigue with neurofeedback and self-hypnosis.

Hammond DC.

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Abstract
A 21 year old patient reported a relatively rapid onset of serious chronic fatigue syndrome (CFS), with her worst symptoms being cognitive impairments. Congruent with research on rapid onset CFS, she had no psychiatric history and specialized testing did not suggest that somatization was likely. Neuroimaging and **EEG** research has documented brain dysfunction in cases of CFS. Therefore, a quantitative **EEG** was done, comparing her to a normative data base. This revealed excessive left frontal theta brainwave activity in an area previously implicated in SPECT research. Therefore, a novel treatment approach was utilized consisting of a combination of **EEG neurofeedback** and self-hypnosis training, both of which seemed very beneficial. She experienced considerable improvement in fatigue, vigor, and confusion as measured pre-post with the Profile of Mood States and through collaborative interviews with both parents. Most of the changes were maintained at 5, 7, and 9 month follow-up testing.

PMID: 11790917 [PubMed - indexed for MEDLINE]

J Head Trauma Rehabil. 2000 Dec;15(6):1285-96.

460. *Improvement/rehabilitation of memory functioning with neurotherapy/QEEG biofeedback.

Thornton K.

Psychologist, Center for Health Psychology, South Plainfield, New Jersey, USA.

Abstract
This article presents a new approach to the remediation of memory deficits by studying the electrophysiological functioning involved in memory and applying **biofeedback** techniques. A Quantitative **EEG** (Q**EEG**) activation database was obtained with 59 right-handed subjects during two auditory memory tasks (prose passages and word lists). Memory performance was correlated with the Q**EEG** variables. Clinical cases were administered the same Q**EEG** activation study to determine their deviations from the values that predicted success for the reference group. **EEG biofeedback** interventions were designed to increase the value (to normal levels) of the specific electrophysiological variable that was related to successful memory function and deviant in the subject. Case examples are presented that indicate the successful use of this intervention style in normal subjects and in subjects with brain injury; improvement cannot be fully explained by spontaneous recovery, given the time postinjury. Five cases (two normal, two subjects with brain injury, and one subject who had stereotactic

surgery of the hippocampus for seizure control) are presented. Improvements ranged from 68% to 181% in the group of patients with brain injury, as a result of the interventions.

PMID: 11056409 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 2000 Sep;25(3):167-75.

461. Neurofeedback--the significance of reinforcement and the search for an appropriate strategy for the success of self-regulation.

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Abstract

Nine healthy children took part in five sessions of **feedback** and instrumental conditioning of slow cortical potentials (**SCP**s). The **feedback** conditions (the relation between the **feedback** signal and amplitude of **SCP**) were inverted after two sessions. Neither the children nor the therapists were aware of this change. The adjustment of the children to the new **feedback** setting and the self-regulation strategies employed were investigated. The results were as follows: (a) Healthy children achieved control over cortical negativity within two sessions. (b) The change of **feedback** conditions worsened the regulation abilities, which then improved again within the following three sessions. (c) After the first two sessions, the participants were able to describe strategies that were successful during different phases of self-regulation. (d) Following the change in the **feedback** conditions, the children reevaluated the way they influenced their **SCP**s. However, they did not alter the cognitive or behavioral strategies. The study demonstrated that positive and negative reinforcement and the knowledge of results are more important for successful self-regulation than the search for effective strategies. The relevance of these findings is discussed.

PMID: 10999235 [PubMed - indexed for MEDLINE]

Newsweek. 2000 Jun 19;135(25):76.

462. *On the track with neurofeedback. A new treatment may help with problems from ADD to depression, sleep disorders and epilepsy.

Robbins J.

PMID: 10977155 [PubMed - indexed for MEDLINE]

Clin Electroencephalogr. 2000 Jan;31(1):38-44.

463. *EEG operant conditioning (biofeedback) and traumatic brain injury.

Thatcher RW.

Bay Pines VA Medical Center, University of South Florida College of Medicine and Defense and Veterans Head Injury Program, Washington D.C., USA.

Abstract

A review is presented of the currently sparse literature about **EEG** operant conditioning or **biofeedback** as a treatment to reduce symptomology and patient complaints following a traumatic brain injury. The paper also evaluates the general use of quantitative **EEG** (Q**EEG**) to assess traumatic brain injury and to facilitate **EEG biofeedback** treatment. The use of an age matched reference normative Q**EEG** database and Q**EEG** discriminant function are presented as a method to evaluate the nature or neurological basis of a patient's complaints as well as to individualize an efficient and optimal **feedback** protocol and to help evaluate the efficacy of the **biofeedback** therapy. Univariate and multivariate statistical issues are discussed, different classes of experimental designs are described and then a "double blind" research study is proposed in an effort to encourage future research in the area of **EEG biofeedback** for the treatment and rehabilitation of traumatic brain injury.

PMID: 10638351 [PubMed - indexed for MEDLINE]

Clin Electroencephalogr. 2000 Jan;31(1):30-7.

464. *Treatment of attention deficit hyperactivity disorder with neurotherapy.

Nash JK.

Behavioral Medicine Associates, Inc., MN 55434, USA.

Abstract

Significant public health concerns exist regarding our current level of success in treating ADHD. Medication management is very helpful in 60-70% of patients. Side effects, lack of compliance and the fact that stimulant medications cannot be given late in the day limit the benefits largely to school hours. While stimulants improve behavior and attention, less of an effect has been noted on academic and social performance. Continuing concerns exist about long-term safety, and studies on long-term cardiovascular and neurophysiological effects have not been carried out. **Neurotherapy** for ADHD offers an effective alternate for patients whose treatment is limited by side effects, poor medication response and in cases in which the patients and/or their parents refuse to consider medications. Studies indicate clinical improvement is largely related to measurable improvements in the **EEG** signature, evidenced by declining theta/beta ratios over frontal/central cortex and/or reduced theta/alpha band amplitudes.

PMID: 10638350 [PubMed - indexed for MEDLINE]

Clin Electroencephalogr. 2000 Jan;31(1):7-12.

465. *An EEG biofeedback protocol for affective disorders.

Rosenfeld JP.

Department of Psychology, Northwestern University, Evanston, Illinois 60208-2710, USA.

PMID: 10638347 [PubMed - indexed for MEDLINE]

Clin Electroencephalogr. 2000 Jan;31(1):1-6.

466. *A review of EEG biofeedback treatment of anxiety disorders.

Moore NC.

Brain Research Center, Mercer University School of Medicine, Macon, GA 31207, USA.

Abstract
Alpha, theta and alpha-theta enhancements are effective treatments of the anxiety disorders (Table 1). Alpha suppression is also effective, but less so (Table 2). Perceived success in carrying out the task plays an important role in clinical improvement. Research is needed to find out how much more effective they are than placebo, and which variables are important for efficacy. Variables needing study are: duration of treatment, type and severity of anxiety, number and type of **EEG** waveforms used, pretreatment with other kinds of **feedback**, position and number of electrodes, and presence of concomitant medication.

PMID: 10638346 [PubMed - indexed for MEDLINE]

Clin Electroencephalogr. 2000 Jan;31(1):V-VII.

467. *The state of EEG biofeedback therapy (EEG operant conditioning) in 2000: an editor's opinion.

Duffy FH.

PMID: 10638345 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 1999 Dec;24(4):213-33.

468. Changes in EEG power spectra during biofeedback of slow cortical potentials in epilepsy.

Kotchoubey B, Busch S, Strehl U, Birbaumer N.

Institute of Medical Psychology and Behavioral Neurobiology, University of Tübingen, Germany.

Abstract
The goal of the study was to explore parallel changes in **EEG** spectral frequencies during **biofeedback** of slow cortical potentials (**SCP**s) in epilepsy patients. Thirty-four patients with intractable focal epilepsy participated in 35 sessions of **SCP self-regulation** training. The

spectral analysis was carried out for the **EEG** recorded at the same electrode site (Cz) that was used for **SCP feedback**. The most prominent effect was the increase in the theta 2 power (6.0-7.9 Hz) and the relative power decrement in all other frequency bands (particularly delta 1, alpha 2 and beta 2) in transfer trials (i.e., where patients controlled their **SCP**s without continuous **feedback**) compared with **feedback** trials. In the second half of the training course (i.e., sessions 21-35) larger power values in the delta, theta, and alpha bands were found when patients were required to produce positive versus negative **SCP** shifts. Both across-subject and across-session (within-subject) correlations between spectral **EEG** parameters, on the one hand, and **SCP** data, on the other hand, were low and inconsistent, contrary to high and stable correlations between different spectral variables. This fact, as well as the lack of considerable task-dependent effects during the first part of training, indicates that learned **SCP** shifts did not directly lead to the specific dynamics of the **EEG** power spectra. Rather, these dynamics were related to nonspecific changes in patients' brain state.

PMID: 10788999 [PubMed - indexed for MEDLINE]

J Clin Neurophysiol. 1999 Jul;16(4):373-82.

469. Enhancement of left-right sensorimotor EEG differences during feedback-regulated motor imagery.

Neuper C, Schlögl A, Pfurtscheller G.

Ludwig-Boltzmann Institute for Medical Informatics and Neuroinformatics and Department of Medical Informatics, University of Technology, Graz, Austria.

Abstract
EEG feedback studies demonstrate that human subjects can learn to regulate electrocortical activity over the sensorimotor cortex. Such self-induced **EEG** changes could serve as control signals for a **Brain Computer Interface**. The experimental task of the current study was to imagine either right-hand or left-hand movement depending on a visual cue stimulus on a computer monitor. The performance of this imagination task was controlled on-line by means of a **feedback** bar that represented the current **EEG** pattern. **EEG** signals recorded from left and right central recording sites were used for on-line classification. For the estimation of **EEG** parameters, an adaptive autoregressive model was applied, and a linear discriminant classifier was used to discriminate between **EEG** patterns associated with left and right motor imagery. Four trained subjects reached 85% to 95% classification accuracy in the course of the experimental sessions. To investigate the impact of continuous **feedback** presentation, time courses of band power changes were computed for subject-specific frequency bands. The **EEG** data revealed a significant event-related desynchronization over the contralateral central area in all subjects. Two subjects simultaneously displayed synchronization of **EEG** activity (event-related synchronization) over the ipsilateral side. During **feedback** presentation the event-related desynchronization/event-related synchronization patterns showed increased hemispheric asymmetry compared to initial control sessions without **feedback**.

PMID: 10478710 [PubMed - indexed for MEDLINE]

Clin Neurophysiol. 1999 Apr;110(4):683-6.

470. *Negative potential shifts and the prediction of the outcome of neurofeedback therapy in epilepsy.

Kotchoubey B, Strehl U, Holzapfel S, Blankenhorn V, Fröscher W, Birbaumer N.

Institute for Medical Psychology and Behavioral Neurobiology, University of Tübingen, Germany. boris.kotchobey@uni-tuebingen.de

Abstract
About two-thirds of epilepsy patients who learn to control their slow cortical potential shifts (**SCP**) reduce their seizure rate, but the remaining third does not demonstrate clinical improvement. In the present study, this finding was replicated in a group of 27 patients with focal epilepsy. We found that patients who consistently produced larger negative **SCP** in all conditions during the first phase of treatment, showed no decrease in seizure frequency during the six-month follow-up, as compared with the three-month baseline phase. The large negative **SCP** explained about one-third of the variance of the clinical outcome. Age, medication, seizure history, or the localization of focus were found to be unrelated to clinical improvement.

PMID: 10378738 [PubMed - indexed for MEDLINE]

Exp Brain Res. 1999 Jan;124(2):223-32.

471. The thought translation device: a neurophysiological approach to communication in total motor paralysis.

Kübler A, Kotchoubey B, Hinterberger T, Ghanayim N, Perelmouter J, Schauer M, Fritsch C, Taub E, Birbaumer N.

Institute of Medical Psychology and Behavioral Neurobiology, University of Tübingen, Germany.

Abstract
A thought translation device (TTD) for **brain-computer communication** is described. Three patients diagnosed with amyotrophic lateral sclerosis (ALS), with total motor paralysis, were trained for several months. In order to enable such patients to communicate without any motor activity, a technique was developed where subjects learn to control their slow cortical potentials (**SCP**) in a 2-s rhythm, producing either cortical negativity or positivity according to the task requirement. **SCP** differences between a baseline interval and an active control interval are transformed into vertical or horizontal cursor movements on a computer screen. Learning **SCP self regulation** followed an operant-conditioning paradigm with individualized shaping procedures. After prolonged training over more than 100 sessions, all patients achieved self-control, leading to a 70-80% accuracy for two patients. The learned cortical skill enabled the patients to select letters or words in a language-supporting program (LSP) developed for inter-personal communication. The results demonstrate that the fast and stable **SCP** self-control can be achieved with operant training and without mediation of any muscle activity. The acquired skill allows communication even in total locked-in states.

PMID: 9928845 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 1998 Dec;23(4):265-72; 273-5.

472. *Regarding the database for the Peniston alpha-theta EEG biofeedback protocol.

Graap K, Freides D.

Emory University, Department of Psychology, Atlanta, GA 30322, USA.

Abstract
Five papers by Peniston and colleagues, which constitute the basic literature for alpha-theta **EEG biofeedback** treatment for alcoholism and posttraumatic stress disorder, are reviewed. As a result, we raise three questions: (a) Are the samples studied independent? (b) What was the clinical status of the participants prior to treatment? (c) What treatment did the participants actually receive? In seeking answers to these questions we aim to strengthen the database for **neurofeedback** with specific procedural information so that claims of efficacy can be tested and accepted or rejected on an objective basis.

PMID: 10457816 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 1998 Dec;23(4):243-63.

473. *Neurofeedback combined with training in metacognitive strategies: effectiveness in students with ADD.

Thompson L, Thompson M.

ADD Centre, Mississauga, Ontario, Canada.

Abstract
A review of records was carried out to examine the results obtained when people with Attention Deficit Disorder (ADD) received 40 sessions of training that combined **neurofeedback** with the teaching of metacognitive strategies. While not a controlled scientific study, the results, including pre- and post-measures, are consistent with previously published research concerning the use of **neurofeedback** with children. A significant addition is that a description of procedures is included. The 111 subjects, 98 children (age 5 to 17) and 13 adults (ages 18 to 63), attended forty 50-min sessions, usually twice a week. **Feedback** was contingent on decreasing slow wave activity (usually 4-7 Hz, occasionally 9-11 Hz) and increasing fast wave activity (15-18 Hz for most subjects but initially 13-15 Hz for subjects with impulsivity and hyperactivity). Metacognitive strategies related to academic tasks were taught when the **feedback** indicated the client was focused. Some clients also received temperature and/or EDR **biofeedback** during some sessions. Initially, 30 percent of the children were taking stimulant medications (Ritalin), whereas 6 percent were on stimulant medications after 40 sessions. All charts were included where pre- and post-testing results were available for one or more of the following: the Test of Variables of Attention (TOVA, n = 76), Wechsler Intelligence Scales (WISC-R, WISC-III, or WAIS-R, n = 68), Wide Range Achievement Test (WRAT 3, n = 99), and the electroencephalogram assessment (Q**EEG**) providing a ratio of theta (4-8 Hz) to beta (16-20 Hz) activity (n = 66). Significant improvements ($p < .001$) were found in ADD symptoms (inattention, impulsivity, and

variability of response times on the TOVA), in both the ACID pattern and the full-scale scores of the Wechsler Intelligence Scales, and in academic performance on the WRAT 3. The average gain for the full scale IQ equivalent scores was 12 points. A decrease in the **EEG** ratio of theta/beta was also observed. These data are important because they provide an extension of results from earlier studies (Lubar, Swartwood, Swartwood, & O'Donnell, 1995; Linden, Habib, & Radojevic, 1996). They also demonstrate that systematic data collection in a private educational setting produces helpful information that can be used to monitor students' progress and improve programs. Because this clinical work is not a controlled scientific study, the efficacious treatment components cannot be determined. Nevertheless, the positive outcomes of decreased ADD symptoms plus improved academic and intellectual functioning suggest that the use of **neurofeedback** plus training in metacognitive strategies is a useful combined intervention for students with ADD. Further controlled research is warranted.

PMID: 10457815 [PubMed - indexed for MEDLINE]

Biol Psychiatry. 1998 Dec 1;44(11):1196-9.

474. *Neurofeedback treatment of pseudoseizure disorder.

Swingle PG.

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Abstract

BACKGROUND: Previous research has shown that the suppression of theta wave activity and the enhancement of sensorimotor rhythm (**SMR**) through electroencephalographic **(EEG) biofeedback** is an effective treatment for epilepsy. The current research reports the results of **EEG biofeedback** treatment for patients presenting with seizure behaviors in the absence of eliptiform **EEG** activity.

METHODS: In addition to psychotherapy, 3 patients, 2 women and 1 man, were trained, using **EEG feedback** once per week, to reduce the ratio of theta band to **SMR** band **EEG** amplitudes.

RESULTS: The results showed that reductions in seizure activity were related to reductions in the theta-**SMR** ratio.

CONCLUSIONS: These findings support the view that theta-**SMR feedback** training, in conjunction with psychotherapy, is an effective adjunctive treatment for pseudoseizure disorder.

PMID: 9836025 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 1998 Sep;23(3):189-202.

475. *Behavioral psychophysiological intervention in a mentally retarded epileptic patient with brain lesion.

Holzapfel S, Strehl U, Kotchoubey B, Birbaumer N.

Epilepsy Center Kork, Kehl-Kork, Germany.

Abstract
Behavioral psychophysiological treatment entailing Slow Cortical Potential (**SCP**) **biofeedback** training and behavioral self-control training was conducted with a 27-year-old male epileptic patient (seizures for 23 years) with Wechsler IQ 64 who underwent callosotomy. The patient had 12/week secondary generalized tonic-clonic seizures. The treatment, consisting of 43 **SCP** training sessions and 22 behavioral control sessions, yielded a highly significant reduction of seizure frequency to about 7.5/week; such a decrease had never been observed after administration of new anticonvulsant drugs, nor after the callosotomy. During **SCP feedback** training, the patient was able to produce highly-significant cortical differentiation of **SCP**s of about 4 microV. In addition, he developed several new behaviors indicating growing ability of self-perception and self-regulation. These findings suggest that a combination of **SCP biofeedback** with behavioral treatment of epilepsy can be used even in mentally retarded patients with organic brain disorders.

PMID: 10384250 [PubMed - indexed for MEDLINE]

Integr Physiol Behav Sci. 1998 Apr-Jun;33(2):176-207.

476. *Electroencephalographic biofeedback methodology and the management of epilepsy.

Lubar JF.

University of Tennessee-Memphis, USA.

Abstract
Currently considerable research is being directed toward developing methodologies for controlling internal processes. An applied branch of the basic field of psychophysiology, known as **biofeedback**, has developed to fulfill clinical needs related to such control. Current scientific and popular literature abounds with numerous examples of how **biofeedback** is being used. For example, germinal studies by Kamiya (1962), and later work by Lynch and Paskewitz (1971), Beatty (1973), as well as many others have shown that the **EEG** alpha rhythm (8 to 13 Hz) recorded from occipital regions of the human brain can be behaviorally manipulated when **feedback** or reward is provided for changing the density of this activity. Other researchers have provided evidence that theta activity (4 to 7 Hz) and the beta activity (greater than 14 Hz) can also be controlled by humans and analogs of this activity have been conditioned in animals as well (Green, Green and Walters, 1971). In addition to the work that has been carried out with the **EEG**, researchers such as Engle and Bleecker (1973) have indicated that it might be possible to control cardiac arrhythmias through **biofeedback**. Studies by Elder et al. (1973) have provided some hope that blood pressure in humans might also be conditioned. Also, considerable effort has been directed to the control of responses from single muscles with particular applied emphasis in neuromuscular rehabilitation, control of muscle tension for tension headaches and the management of migraine headaches through vasomotor conditioning (Brudny et al., 1974; Basmajian, 1963, 1971; Sargent et al., 1973).

PMID: 9737738 [PubMed - indexed for MEDLINE]

Biomed Tech (Berl). 1998;43 Suppl 3:67-71.

477. *[GOFI--a neurofeedback system for child and adolescent psychiatry]

[Article in German]
Heinrich H, Nelson K, Moll GH, Rothenberger A.

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PMID: 11776226 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 1997 Jun;22(2):111-26.

478. *Neocortical dynamics: implications for understanding the role of neurofeedback and related techniques for the enhancement of attention.

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Abstract

For nearly 25 years, **EEG biofeedback** (**neurofeedback**) has been utilized in research and clinical settings for the treatment and investigation of a number of disorders ranging from attention deficit hyperactivity disorder to seizure disorders as well as many other established and investigational applications. Until recently, mechanisms underlying the generation and origins of **EEG** have been poorly understood but now are beginning to become much more clarified. Now it is important to combine the information gathered on the genesis of **EEG** and neocortical dynamics with the findings from **neurofeedback** investigations. This will help us to develop models of how **neurofeedback** might operate in producing the changes in **EEG** and in clinical symptomatology. We know that the cortex operates in terms of resonant loops between neocortical columns of cells known as local, regional, and global resonances. These resonances determine the specific **EEG** frequencies and are often activated by groups of cells in the thalamus known as pacemakers. There are complex excitatory and inhibitory interactions within the cortex and between the cortex and the thalamus that allow these loops to operate and provide the basis for learning. **Neurofeedback** is a technique for modifying these resonant loops, and hence, modifying the neurophysiological and neurological basis for learning and for the management of a number of neurologically based disorders. This paper provides an introduction to understanding **EEG** and neocortical dynamics and how these concepts can be used to explain the results of **neurofeedback** training and other interventions particularly in the context of understanding attentive mechanisms and for the management of attention deficit/hyperactivity disorders.

PMID: 9341967 [PubMed - indexed for MEDLINE]

Appl Psychophysiol Biofeedback. 1997 Jun;22(2):77-93.

479. A new method for self-regulation of slow cortical potentials in a timed paradigm.

Kotchoubey B, Schleichert H, Lutzenberger W, Birbaumer N.

Institute of Medical Psychology, University of Tübingen, Germany.

Abstract
A new method of slow cortical potential (**SCP**) **biofeedback** is described, in which subjects were presented with a sequence of two alternating tones. Subjects learned to adjust their **SCP**s with the 4-s rhythm of presented tones by producing directed **SCP** changes only in certain inter-tone intervals. Specifically, they learned to simultaneously produce two **EEG** signals: 1) positive or negative **SCP** shift at vertex, and 2) **SCP** asymmetry between the right and the left central area. After one training session, 13 healthy participants were able to differentiate significantly between the negativity and the positivity conditions; this differentiation was achieved within less than 300 ms after the discriminative signal, i.e. much faster than in previous studies employing traditional **SCP biofeedback** technique. However, these participants did not produce a significant hemispheric asymmetry in the first session. In the second experiment, five subjects participated in prolonged training (6 to 17 sessions). Highly significant control of **SCP** asymmetry over the precentral cortex was attained in four out of five participants. Advantages and disadvantages of the new method as compared with the "classical" **SCP biofeedback** technique are discussed.

PMID: 9341965 [PubMed - indexed for MEDLINE]

Postgrad Med. 1997 May;101(5):201-4, 213-4, 216 passim.

480. Attention-deficit hyperactivity disorder. Pharmacotherapy and beyond.

Tan G, Schneider SC.

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Abstract
Management of ADHD is a challenge that requires time, commitment, and great sensitivity on the part of the physician. Use of stimulant medications is often successful at improving symptoms, but it has become the knee-jerk treatment response for many. Given the wide-ranging effects of ADHD on aspects of patients' lives and the availability of various treatment alternatives, a multimodal approach is considered optimal. As more studies evaluate nonpharmacologic approaches such as behavior therapy, parent education, and **neurofeedback** and more physicians implement multimodal treatment, outcomes for patients with ADHD are expected to be even more positive.

PMID: 9158615 [PubMed - indexed for MEDLINE]

Neurosci Lett. 1997 Jan 17;221(2-3):117-20.

481. Frontal interhemispheric asymmetry: self regulation and individual differences in humans.

Hardman E, Gruzelier J, Cheesman K, Jones C, Liddiard D, Schleichert H, Birbaumer N.

Laboratory of Neuro-Psychophysiology, Department of Psychiatry, Charing Cross and Westminster Medical School, London, UK.

Abstract

Sixteen subjects naive to **biofeedback** learned lateralised interhemispheric control of slow cortical potentials (**SCP**s) across electrode sites F3-F4 during three sessions of visual electroencephalograph **(EEG) biofeedback**. Subjects were required to generate slow negativity shifts either towards the left or the right hemisphere in sixty pseudorandomly ordered trials per session. Group 1 (n = 8) were told to use emotional strategies in the task (positive emotions for left hemisphere activation, negative emotion for right hemisphere activation), group 2 received no guidance. Both groups received **feedback** in the form of an on-screen rocket-ship, initially centrally placed, which rose to indicate an increase in left hemisphere negativity (relative to the right hemisphere) and fell to indicate an increase in right hemisphere negativity (relative to the left hemisphere). A 2 x 3 x 3 x 2 ANOVA (group x session x block x trial) showed no performance differences between the strategy and no strategy groups. Both groups learned to produce correct direction shifts in the final third of each session during both trial types ($P < 0.001$). The no strategy group showed a particularly strong within session learning effect ($P < 0.0037$) with poor performance in the early part of the sessions, and strong shifts at the end. Subjects high on withdrawal showed stronger rightward shifts in keeping with right hemisphere involvement in behavioural withdrawal. This is the first demonstration of self regulation of interhemispheric frontal asymmetry.

PMID: 9121678 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1996 Sep;21(3):273-90.

482. *Biodesensitization: biofeedback-controlled systematic desensitization of the stress response to infant crying.

Tyson PD.

Department of Psychology, Brock University, St. Catharines, Ontario, Canada.

Abstract

Infant crying can be a source of parental stress both psychologically and physiologically and also may be an antecedent to physical child abuse or neglect. Biodesensitization is a new therapeutic technique that allows people to control the source of stress and develop self-control over their physiological responses to the stress-eliciting stimuli. Randomly assigned between three groups, 15 female participants were either given **EEG biofeedback** pretraining without stress, pretraining while listening to infant crying, or no stress management pretraining while listening to crying. After the pretraining manipulation all participants had biodesensitization training while listening to infant crying. Compared to control participants who were habituated to crying, stress management training significantly reduced the **EEG** cortical arousal as well as perceived arousal, and anxiety associated with listening to infant crying. The shift in participants' **EEG** power spectrum produced by infant crying was

significantly correlated with perceived arousal and this relationship was strengthened after **biofeedback** training. In conjunction with other research, the experimental results suggest that stress management training may help ameliorate an aversive response to infant crying and possibly prevent child abuse as a response to physiological hyperreactivity.

PMID: 8894059 [PubMed - indexed for MEDLINE]

Int J Psychophysiol. 1996 Aug-Sep;23(1-2):137-41.

483. Preliminary evidence that daily changes in frontal alpha asymmetry correlate with changes in affect in therapy sessions.

Rosenfeld JP, Baehr E, Baehr R, Gotlib IH, Ranganath C.

Department of Psychology, Northwestern University, Evanston, IL 60208-2710, USA. jp-rosenfeld@nwu.edu

Abstract

Frontal **EEG** alpha asymmetry was recorded from five depressed outpatients during early **EEG biofeedback** sessions. Mood was assessed prior to and after each session, and affect change scores were also derived by subtracting pre-session from post-session scores. Alpha magnitude was obtained via Fast Fourier Transforms. All scores (**EEG** alpha asymmetry and affect) were converted to deviation scores by subtracting each patient's daily score from that patient's mean across all available sessions for that patient. Pearson correlations were then computed between asymmetry and affect scores using the deviation scores combined over patients. There was little evidence of correlation between day-to-day asymmetry score and any single affect score. Strong correlations were obtained, however, between asymmetry score and affect change score and, in particular, between asymmetry score and change in positive affect.

PMID: 8880374 [PubMed - indexed for MEDLINE]

Behav Med. 1996 Summer;22(2):77-81.

484. *EEG biofeedback as a treatment for chronic fatigue syndrome: a controlled case report.

James LC, Folen RA.

Department of Psychology, Tripler Army Medical Center, Honolulu, USA.

Abstract

EEG neurofeedback has been identified as a potential diagnostic and treatment protocol with chronic fatigue syndrome (CFS) symptoms. In the present case study, the authors applied an **EEG neurofeedback biofeedback** paradigm as a treatment modality with a CFS patient. Baseline data were acquired using the Wechsler Adult Intelligence Scale-Revised and qualitative and subjective ratings of cognitive improvement. Test results and clinical findings revealed improvements in the patient's cognitive abilities, functional skill level, and quality of

life. The patient showed significant differences in pre- and post test levels on the Wechsler scale.

PMID: 8879459 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1996 Mar;21(1):35-49.

485. *A controlled study of the effects of EEG biofeedback on cognition and behavior of children with attention deficit disorder and learning disabilities.

Linden M, Habib T, Radojevic V.

Mission Psychological Consultants, San Juan Capistrano, California 92675, USA.

Erratum in:

1996 Sep;21(3):297.

Abstract

Eighteen children with ADD/ADHD, some of whom were also LD, ranging in ages from 5 through 15 were randomly assigned to one of two conditions. The experimental condition consisted of 40 45-minute sessions of training in enhancing beta activity and suppressing theta activity, spaced over 6 months. The control condition, waiting list group, received no **EEG biofeedback**. No other psychological treatment or medication was administered to any subjects. All subjects were measured at pretreatment and at posttreatment on an IQ test and parent behavior rating scales for inattention, hyperactivity, and aggressive/defiant (oppositional) behaviors. At posttreatment the experimental group demonstrated a significant increase (mean of 9 points) on the K-Bit IQ Composite as compared to the control group ($p < .05$). The experimental group also significantly reduced inattentive behaviors as rated by parents ($p < .05$). The significant improvements in intellectual functioning and attentive behaviors might be explained as a result of the attentional enhancement affected by **EEG biofeedback** training. Further research utilizing improved data collection and analysis, more stringent control groups, and larger sample sizes are needed to support and replicate these findings.

PMID: 8833315 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1996 Mar;21(1):3-33.

486. *Physiological origins and functional correlates of EEG rhythmic activities: implications for self-regulation.

Sterman MB.

Veterans Administration Medical Center, Sepulveda, CA 91343, USA.

Abstract

Recent neurophysiological findings in relation to thalamocortical mechanisms for sensory processing, together with established anatomical and expanding functional evidence, have

provided a rational theoretical framework for the interpretation of normal and abnormal **EEG** rhythmic activities. This perspective is integrated here with earlier animal studies which were the foundation for many current applications of **EEG** self-regulation as a clinical tool. Basic evidence concerning the origins, frequency modulation, and functional significance of normal **EEG** rhythmic activities is reviewed here in an effort to provide guiding principles for the interpretation of clinical abnormalities and their remediation with **EEG feedback** training.

PMID: 8833314 [PubMed - indexed for MEDLINE]

Fiziol Cheloveka. 1995 Nov-Dec;21(6):14-28.

487. *[Correction of neuro-psychic maladjustment disorders using functional EEG biofeedback]

[Article in Russian]
Soroko SI, Musuraliev TZh, Komarover IN.

PMID: 8566512 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1995 Sep;20(3):241-58.

488. *Operant (biofeedback) control of left-right frontal alpha power differences: potential neurotherapy for affective disorders.

Rosenfeld JP, Cha G, Blair T, Gotlib IH.

Department of Psychology, Northwestern University, Evanston, Illinois 60208, USA.

Abstract
Two experiments were done with subjects from a paid pool of undergraduates. In each study, there were five 1-hour sessions on each of 5 days: (1) Baseline: Rewards given for randomly selected 20% of the 700-ms sequential epochs; mean and SD of baseline power differences determined. 2) Exploration: Subjects were rewarded when right minus left alpha differences in an epoch were greater than the baseline mean plus about .85 SD ($p = .20$); subjects told to discover how to generate rewards. (3)-(5). Training: Subjects were paid (over and above the $8/h flat rate) in proportion to their hit rates. In the first study (in which active filters passed 8-12 Hz activity, and the rectified, integrated amplitude was utilized), 6 of 8 subjects met learning criteria (a significant difference between baseline and training scores). In the second study (in which on-line FFTs were used to extract alpha power), 3 of 5 subjects met learning criteria.

PMID: 7495918 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1995 Sep;20(3):211-28.

489. *Neurotherapy for stroke rehabilitation: a single case study.

Rozelle GR, Budzynski TH.

Center for Behavioral Medicine, University of West Florida, Pensacola, USA.

Abstract
A 55-year-old male subject was treated with a two-tiered **neurotherapy** approach for a period of six months beginning approximately one year after a left-side CVA. Medical evaluation revealed left posterior temporal/parietal infarctions secondary to occlusion of the left internal carotid artery. The patient complained of hesitant speech with word finding difficulty and paraphasia, difficulty focusing his right eye, lack of balance and coordination, poor short-term memory, poor concentration, anxiety, depression, and tinnitus. A quantitative electroencephalograph (Q**EEG**) analysis revealed increased left-side 4-7-Hz activity and alpha persistence on eye opening. Two **neurotherapy** approaches were used beginning with electroencephalographic entrainment **feedback** (EEF). This was followed by **neurofeedback** to inhibit 4-7 Hz and increase 15-21 Hz over sensorimotor and speech areas. At the conclusion of treatment there were significant reductions in slow-wave activity. Improvement was evident in speech fluency, word finding, balance and coordination, attention, and concentration. Depression, anxiety, and tinnitus were greatly reduced.

PMID: 7495916 [PubMed - indexed for MEDLINE]

J Clin Psychol. 1995 Sep;51(5):685-93.

490. *Alpha-theta brainwave neurofeedback training: an effective treatment for male and female alcoholics with depressive symptoms.

Saxby E, Peniston EG.

Biofeedback Center, Pacific Grove, CA 93950, USA.

Abstract
This was an experimental study of 14 alcoholic outpatients using the Peniston and Kulkosky (1989, 1991) brainwave treatment protocol for alcohol abuse. After temperature **biofeedback** pretraining, experimental subjects completed 20 40-minute sessions of alpha-theta brainwave **neurofeedback** training (BWNT). Experimentally treated alcoholics with depressive syndrome showed sharp reductions in self-assessed depression (Beck's Depression Inventory). On the Millon Clinical Multiaxial Inventory-I, the experimental subjects showed significant decreases on the BR scores: schizoid, avoidant, dependent, histrionic, passive-aggression, schizotypal, borderline, anxiety, somatoform, hypomanic, dysthmic, alcohol abuse, drug abuse, psychotic thinking, and psychotic depression. Twenty-one-month follow-up data indicated sustained prevention of relapse in alcoholics who completed BWNT.

PMID: 8801245 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1995 Mar;20(1):83-99.

491. *Evaluation of the effectiveness of EEG neurofeedback training for ADHD in a clinical setting as measured by

changes in T.O.V.A. scores, behavioral ratings, and WISC-R performance.

Lubar JF, Swartwood MO, Swartwood JN, O'Donnell PH.

University of Tennessee, Knoxville 37996-0900, USA.

Abstract
A study with three component parts was performed to assess the effectiveness of **neurofeedback** treatment for Attention Deficit/Hyperactivity Disorder (ADHD). The subject pool consisted of 23 children and adolescents ranging in age from 8 to 19 years with a mean of 11.4 years who participated in a 2- to 3-month summer program of intensive **neurofeedback** training. **Feedback** was contingent on the production of 16-20 hertz (beta) activity in the absence of 4-8 hertz (theta) activity. Posttraining changes in **EEG** activity, T.O.V.A. performance, (ADDES) behavior ratings, and WISC-R performance were assessed. Part I indicated that subjects who successfully decreased theta activity showed significant improvement in T.O.V.A. performance; Part II revealed significant improvement in parent ratings following **neurofeedback** training; and Part III indicated significant increases in WISC-R scores following **neurofeedback** training. This study is significant in that it examines the effects of **neurofeedback** training on both objective and subjective measures under relatively controlled conditions. Our findings corroborate and extend previous research, indicating that **neurofeedback** training can be an appropriate and efficacious treatment for children with ADHD.

PMID: 7786929 [PubMed - indexed for MEDLINE]

J Abnorm Child Psychol. 1995 Feb;23(1):125-40.

492. Some nontraditional (unconventional and/or innovative) psychosocial treatments for children and adolescents: critique and proposed screening principles.

Arnold LE.

Child and Adolescent Disorders Research Branch, NIMH, Rockville, Maryland 20587, USA.

Abstract
Five examples of nontraditional psychosocial treatments used for children/adolescents are reviewed: eye movement desensitization and reprocessing, electroencephalographic **(EEG) biofeedback**, deep pressure/touch therapies, stress-challenge treatments, and confrontational scare treatments. The generic recommendations from the September 1992 National Institutes of Health Conference on Unconventional Medical Treatments are summarized. Additional screening principles specific for psychosocial treatments are proposed and applied to the five treatments. The screens do not validate treatment efficacy or evaluate the quality of any previous research, but only facilitate decisions as to whether treatments deserve controlled investigation. Scientific evaluation of the nontraditional treatments reviewed could in general benefit from blinds (at least for assessment); control conditions matched for intensity, frequency, and duration (double blind where feasible); dose-response studies; testing of generalization and endurance supplements or boosters for quick, cheap treatments with time- or domain-limited effects; and comparing cost-effectiveness with established treatments. Two

unscientific pitfalls must be avoided: embracing new treatments uncritically and rejecting them without fair examination. These pitfalls must be skirted without dissipating scarce research resources.

PMID: 7759671 [PubMed - indexed for MEDLINE]

Child Abuse Negl. 1994 Nov;18(11):933-43.

493. *Perceptual responses to infant crying after EEG biofeedback assisted stress management training: implications for physical child abuse.

Tyson PD, Sobschak KB.

Department of Psychology, Brock University, St. Catharines, Ontario, Canada.

Abstract
The adult's perception of infant crying determines whether it is a source of stress and may be an antecedent to physical child abuse. The study had clients listen to infant crying and used stress management training to change their perceived arousal, anxiety, and evaluation of the crying. Fifteen nonparental female clients were randomly assigned to three groups who either had pretraining without stress, pretraining while listening to infant crying, or listened to yoked infant crying without pretraining. During the second stage all clients had stress management training while listening to infant crying. The clients' perceived anxiety and arousal elicited by crying were significantly diminished after stress management training and anxiety measures were strongly correlated with both perceived arousal and the clients' evaluation of infant crying. Although this is the first experiment applying **biofeedback** assisted stress management training to the perceptual responses and physiological arousal associated with infant crying, these results with inexperienced clients have implications for the prevention and treatment of parental stress and should encourage further research treating physical child abuse as a stress-related disorder.

PMID: 7850602 [PubMed - indexed for MEDLINE]

N J Med. 1994 Sep;91(9):616-20.

494. *Asthmatic extrathoracic upper airway obstruction: laryngeal dyskinesis.

Nahmias J, Tansey M, Karetzky MS.

Newark Beth Israel Medical Center, NJ 07112.

Abstract
Laryngeal dyskinesis is a functional asthma-like disorder refractory to bronchodilator regimens. Patients treated with electroencephalographic **neurofeedback** training demonstrate clinical improvement with reversal of their variable extrathoracic upper airway obstruction.

PMID: 7970287 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1994 Mar;19(1):1-11.

495. *Slow cortical potential biofeedback and the startle reflex.

Brody S, Rau H, Köhler F, Schupp H, Lutzenberger W, Birbaumer N.

University of Tübingen, Germany.

Abstract
The negativity of slow cortical potentials (**SCP**) of the surface **EEG** is a measure of brain excitability, correlating with motor and cognitive preparation. Self-control of **SCP** positivity has been shown to reduce seizure activity. Following **SCP biofeedback** from a central **EEG** electrode position, subjects gained bidirectional control over their **SCP**. The current study used a modified **feedback** methodology, and found a positive relationship between negativity and magnitude of EMG startle response (a measure of cortical and subcortical arousal, particularly aversive response disposition). Greater success in **SCP** differentiation was associated with self-report of less relaxation during negativity training.

PMID: 8167160 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1993 Mar;18(1):33-44.

496. *Ten-year stability of EEG biofeedback results for a hyperactive boy who failed fourth grade perceptually impaired class.

Tansey MA.

Abstract
Ten years ago, the first successful application of a clinical, private-practice based, **EEG** 14-Hz **biofeedback** training regimen for the treatment of learning disorders was performed by the author. After the 10-year-old boy, with presenting symptomatology including a developmental reading disorder, hyperactivity, and an educational classification of perceptually impaired, continued symptom free for a period of two years, his case was submitted for publication. Ten years after his termination from successful treatment, his ongoingly normal social and academic functioning is noted and his **EEG** brainwave signature examined and compared with a population of 24 "used-to-be" learning disabled, one-half of which had a pretreatment state including the educational classification of perceptually impaired. This 10-year follow-up confirms the long-term stability of the results of this **EEG** 14-Hz **biofeedback** regimen. Current findings on recent medical research identifying a major cerebral locus of dysfunction for hyperkinesis and how it supports the electrode placements of this clinical office setting regimen is also discussed.

PMID: 8448238 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1993 Mar;18(1):23-32.

497. *Self-regulation of slow cortical potentials in psychiatric patients: alcohol dependency.

Schneider F, Elbert T, Heimann H, Welker A, Stetter F, Mattes R, Birbaumer N, Mann K.

Department of Psychiatry, University of Pennsylvania, Philadelphia 19104.

Abstract
Ten unmediated alcohol-dependent male inpatients participated in a Slow Cortical Potential **(SCP) self-regulation** task utilizing **biofeedback** and instrumental conditioning. These patients were hospitalized for treatment of alcohol dependency after chronic abuse of alcoholic beverages. Somatic withdrawal symptomatology had occurred recently and the patients were free of any withdrawal symptoms of the autonomic nervous system. Immediately after hospitalization patients were unable to control their **SCP**s without the reinforcement of immediate **feedback** across 4 sessions. Seven patients participated in a fifth session an average of 4 months later. Six out of these 7 patients had not had a relapse at the follow-up. In the fifth session these patients were immediately able to differentiate between the required negativity and negativity suppression, whereas the seventh patient, who had relapsed, was unable to control his brain potentials successfully. Results are further evidence that some of the frontocortical dysfunctions in alcohol-dependent patients are reversible. This could covary with a morphological restitution of the cortex.

PMID: 8448237 [PubMed - indexed for MEDLINE]

Epilepsy Res. 1993 Jan;14(1):63-72.

498. *Cortical self-regulation in patients with epilepsies.

Rockstroh B, Elbert T, Birbaumer N, Wolf P, Düchting-Röth A, Reker M, Daum I, Lutzenberger W, Dichgans J.

Department of Psychology, University of Konstanz, Germany.

Abstract
The present study aimed at investigating to what extent the regulation of excitability in cortical networks, as indicated by surface-negative slow cortical potentials (**SCP**s), is impaired in epileptic patients and to what extent training of **SCP self-regulation** by means of **biofeedback** and instrumental learning procedures might affect seizure frequency. Twenty-five patients suffering from drug-refractory epilepsies (complex focal, grand mal, and absence type of seizures) participated in 28 1-h sessions of **feedback** and instrumental conditioning of their **SCP**s. Subjects' **EEG**s were obtained from the vertex. Depending on discriminative stimuli DC shifts towards increased or suppressed negativity relative to the pre-trial baseline were demonstrated by on-line visual **feedback** during intervals of 8 s each; each session comprised 110 trials. While performance on the **SCP self-regulation** task was initially below normal (as compared to healthy subjects), significant increases in **SCP** control were achieved by the patients across the 28 training sessions. In 18 patients at least 1-year follow-up data are available. Changes in seizure frequency were related to transfer of **SCP** control with six of the patients becoming seizure-free. Age affected the ability to acquire **SCP** control and its impact on seizure frequency.

PMID: 8449180 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1992 Sep;17(3):203-14.

499. *Self-regulation of slow cortical potentials in psychiatric patients: depression.

Schneider F, Heimann H, Mattes R, Lutzenberger W, Birbaumer N.

University of Tübingen, Germany.

Abstract
Findings on depressive patients indicate that depressives have electrophysiological characteristics similar to those of schizophrenics, in that they exhibit reduced Contingent Negative Variation (CNV) amplitudes and more distinct Postimperative Negative Variations (PINVs) than normal controls. In a **biofeedback** experiment, 8 medicated male inpatients with the DSM III-R diagnosis of "Bipolar Disorder, Depressive," and "Major Depression" demonstrated no impairment in the self-regulation of Slow Cortical Potentials (**SCP**) in comparison to schizophrenics in terms of increasing and suppressing negativity. Continuous visual **SCP feedback** is presented to the patient as a horizontally moving rocket in a video game format. The direction changes of the rocket represented **SCP** changes at each point in time, recorded by the central **EEG** (based on the pretrial baseline). Depressives demonstrated **SCP self-regulation** across 20 sessions, although with many between-and-within variations. The 8 male controls were unable to regulate their **SCP**s across 5 sessions. This result contradicts other findings of our laboratory on normal controls. Motivational factors and insufficient operant reinforcement (financial reward) may have facilitated this effect.

PMID: 1515477 [PubMed - indexed for MEDLINE]

Am J Obstet Gynecol. 1992 Aug;167(2):436-9.

500. Behavioral treatment of menopausal hot flushes: evaluation by ambulatory monitoring.

Freedman RR, Woodward S.

Lafayette Clinic, Detroit, MI 48207.

Abstract
OBJECTIVES: We attempted to develop an effective behavioral treatment for menopausal hot flushes and to determine the active behavioral components of this procedure.

STUDY DESIGN: Thirty-three women with frequent menopausal hot flushes were randomly assigned to receive eight sessions of training in paced respiration, muscle relaxation, or alpha-wave **electroencephalographic biofeedback** (placebo control). Hot flushes were objectively measured by means of 24-hour ambulatory monitoring of the sternal skin conductance level.

RESULTS: Subjects undergoing paced respiration had significant reductions in hot flush frequency and respiration rate, as well as increases in tidal volume.

CONCLUSION: Paced respiration training may be a useful treatment alternative for the reduction of hot flushes in women who cannot tolerate hormone replacement therapy.

PMID: 1497048 [PubMed - indexed for MEDLINE]

Seizure. 1992 Jun;1(2):111-6.

501. *Predictive factors for controlling seizures using a behavioural approach.

Andrews DJ, Schonfeld WH.

Andrews/Reiter Epilepsy Research Program, Santa Rosa, CA 95405.

Abstract
A behavioural approach using **EEG biofeedback** for controlling complex-partial seizures has been successful at the Andrews/Reiter Epilepsy Research Program. Records for a random sample of 83 patients with uncontrolled seizures, one third of those receiving care between 1980 and 1985, document that 69 (83%) achieved control by completion of the programme. Additional data about initial age of seizure onset, number of years seizures had been uncontrolled and seizure frequency when treatment started were collected to determine whether these factors predicted seizure control. Only frequency was significantly related to whether seizures were controlled when treatment ended. Further study using discriminant analysis showed that earlier onset age and higher seizure frequency were associated with a significantly greater number of treatment sessions required. Thus, these two factors predicted difficulty in controlling seizures, as measured by number of sessions, although onset age did not predict whether control was eventually achieved. Since even the subgroup achieving the lowest rate of control (i.e., patients having daily seizures when treatment started) had 67% success, these results suggest that a behavioural approach can be useful for many people with currently uncontrolled complex-partial seizures regardless of their characteristics on factors examined in this study.

PMID: 1344325 [PubMed - indexed for MEDLINE]

Z Exp Angew Psychol. 1992;39(2):216-28.

502. *[Biofeedback of slow brain potentials]

[Article in German]
Kisil A, Birbaumer N.

Technische Universität Wroclaw, Polen.

Abstract
Slow cortical potentials constitute neurophysiological indicators of cortical excitability. Behaviorally they correlate with attention and motor preparation. A system for **biofeedback** and self-regulation of slow cortical potentials (**SCP**) has been developed. The portable system allows on-line visual **feedback** of filtered and corrected slow brain potentials in a predetermined sequence of trials. Three different algorithms for transforming the original **SCP**-signal into a **feedback**-signal have been developed and were compared in a controlled outcome study. With the optimal **feedback** method subjects were able to produce cortical

positivity and negativity on command after three sessions. Increases and decreases of negativity of up to 20 microV were also achieved. Therefore a simple and portable PC-based device for the clinical application of **SCP-biofeedback** is now available.

PMID: 1413918 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1991 Sep;16(3):201-25.

503. *Discourse on the development of EEG diagnostics and biofeedback for attention-deficit/hyperactivity disorders.

Lubar JF.

University of Tennessee, Knoxville 37996-0900.

Abstract

This article presents a review of work that my colleagues and I have been doing during the past 15 years developing a rationale for the diagnosis of attention-deficit/hyperactivity disorder (ADHD) and treatment of ADHD employing **EEG biofeedback** techniques. The article first briefly reviews the history of research and theory for understanding ADHD and then deals with the development of **EEG** and event-related potential (ERP) assessment paradigms and treatment protocols for this disorder, including our work and that of others who have replicated our results. Illustrative material from our current research and child case studies is included. Suggestions for future experimental and clinical work in this area are presented and theoretical issues involving the understanding of the neurophysiological and neurological basis of ADHD are discussed.

PMID: 1932259 [PubMed - indexed for MEDLINE]

Med Sci Sports Exerc. 1991 Jan;23(1):123-9.

504. *The influence of electrocortical biofeedback on performance in pre-elite archers.

Landers DM, Petruzzello SJ, Salazar W, Crews DJ, Kubitz KA, Gannon TL, Han M.

Exercise and Sport Research Institute, Arizona State University, Tempe 85287-0404.

Abstract

The purpose of the present research was to determine whether **EEG biofeedback** training could improve archery performance as well as self-reported measures of concentration and self-confidence. Experienced pre-elite male (N = 16) and female (N = 8) archers were randomly assigned to one of three treatment conditions: (a) correct **feedback** (i.e., greater left hemisphere low frequency activity), (b) incorrect **feedback** (i.e., greater right hemisphere low frequency activity), and (c) no **feedback** control. The pretest and posttest consisted of 27 shots, with **EEG** data collected for the left and right temporal hemispheres (T3, T4). **Feedback** subjects were then given **EEG biofeedback**, while control subjects rested for 30 min. Analyses indicated that only the performance measure was significant. The correct **feedback** group significantly improved performance, while the incorrect **feedback** group showed a significant performance decrement from pre- to posttest (Ps less than 0.05). The

control group showed no significant pre-post differences in performance. **EEG** analyses showed differences that were consistent with the training given to the incorrect, but not the correct, **feedback** group. Overall, the results provide some support for the use of known relationships between **EEG** and performance as an effective means of providing **biofeedback** to affect the performance of pre-elite archers.

PMID: 1997806 [PubMed - indexed for MEDLINE]

Fiziol Cheloveka. 1990 Nov-Dec;16(6):71-6.

505. *[Efficacy of electroencephalographic biofeedback in autonomovascular dystonia and cerebral arachnoiditis]

[Article in Russian]
Chernigovskaia NV, Sviatogor IA.

PMID: 2091971 [PubMed - indexed for MEDLINE]

Zh Vyssh Nerv Deiat Im I P Pavlova. 1989 Jan-Feb;39(1):28-36.

506. [Relation of the individual specificity of emotional autoregulation controlled by EEG feedback to the influence of a genetic factor as revealed by a twin study]

[Article in Russian]
Suvorov **NF**, Mikheev VF.

Abstract
On the model of **biofeedback** connection by the given parameters of the **EEG** alpha-rhythm the dynamics of bioelectrical and vegetative characteristics and correlative connections between them were compared in the pairs of mono- and dizygotic twins. More likeness in the dynamics of the studied parameters was found in the pairs of genetically identical monozygotic twins. There was a maximum increase of the objective similarity characteristics in the moment of activity realization, judging by the change of alpha-rhythm parameters. The obtained results testify to genetic determination of individual specific styles in organization of complex integrative processes of the higher nervous activity.

PMID: 2735128 [PubMed - indexed for MEDLINE]

Int J Psychosom. 1989;36(1-4):23-33.

507. *The effects of electrode placement upon EEG biofeedback training: the monopolar-bipolar controversy.

Fehmi LG, Sundor A.

Abstract

Roles of tradition, convenience, and noise or artifact rejection are discussed with regard to the monopolar versus bipolar electrode placement controversy in electroencephalography (**EEG**). Particular emphasis is placed on the relevance to **biofeedback**. The crucial interactions between the differential amplifier, brain waves, and monopolar/bipolar placements are discussed. Through logical analysis and empirical observation, it is demonstrated how the very nature of the **EEG**'s differential amplifiers must destroy those elements of brain activity which are common to the recording electrodes. Controlled experiments further illustrate the critical importance of electrode placements. Various methods, including preferred electrode placements, are presented to help resolve recording problems that frequently arise. It is concluded that there are serious implications for researchers, **EEG** clinicians, **biofeedback** providers, and their clients in preferring one type of electrode placement technique over the other. **EEG** recording accuracy is affected by this choice.

PMID: 2599783 [PubMed - indexed for MEDLINE]

Int J Psychophysiol. 1988 Aug;6(3):185-94.

508. *EEG biofeedback and relaxation training in the control of epileptic seizures.

Tozzo CA, Elfner LF, May JG Jr.

Department of Psychology, Florida State University, Tallahassee 32306.

Abstract

Research utilizing sensorimotor rhythm **(SMR) biofeedback** with epileptics suggests that it is useful in decreasing seizures. Subjects were 6 young adults with a diagnosis of epilepsy of at least two years who had been unable to control their seizures with different regimens of anticonvulsant medications. Subjects ranged from severely mentally handicapped to above average functioning. Seizure type, frequency, and duration were recorded by subjects and caretakers. Measures of operant learning were percent time in **SMR**. The experiment utilized a single subject multiple baseline design which consisted of 6 phases: baseline one, relaxation training; baseline two, **biofeedback** training one; baseline three, **biofeedback** treatment two and follow-up. The results of this study are in agreement with other studies using **SMR biofeedback**. All subjects were able to significantly increase percent time in **SMR**. Five out of the 6 subjects demonstrated decreases in seizure frequency during the treatment phase. Two of the 6 subjects benefited from relaxation training. Four subjects demonstrated significant negative correlations between percent **SMR** and seizure rats. Consistent with other studies utilizing multiple baseline designs, a majority of the subjects did not follow the design of the study.

PMID: 3136105 [PubMed - indexed for MEDLINE]

Epilepsia. 1988 Mar-Apr;29(2):163-71.

509. *Neuropsychological assessment of subjects with uncontrolled epilepsy: effects of EEG feedback training.

Lantz DL, Sterman MB.

Neuropsychology Research, Veterans Administration Medical Center, Sepulveda, California 91343.

Abstract
A battery of neuropsychological tests was administered at baseline, postcontrol period, and posttraining period to 24 drug-refractory subjects with epilepsy participating in a study of sensorimotor electroencephalographic (**EEG**) normalization **feedback** training. Results revealed the following. First, subjects exhibited significant baseline deficits in psychosocial, cognitive and motor functioning. Second, certain tests discriminated subjects before training who were subsequently above and below the median in seizure reduction following **EEG** training. Subjects who showed the greatest seizure reduction performed better on a test of general problem-solving ability but not on other cognitive tests and worse on tests involving strong motor components and were more intact psychosocially. These subjects also took significantly fewer medications in combination than did less successful subjects. Third, improvement on several measures occurred following participation in the study. Cognitive and motor functioning improved only in subjects with the greatest seizure reduction and only after actual training as opposed to control conditions. Psychological functioning, as measured by the Minnesota Multiphasic Personality Inventory (MMPI) improved in both outcome groups. MMPI improvement, unlike cognitive improvement, was as likely to occur after control conditions, when seizure reduction had not yet occurred, as after **EEG** training. Thus, MMPI changes apparently reflected the nonspecific benefits of participation in this study.

PMID: 3349967 [PubMed - indexed for MEDLINE]

Int J Psychophysiol. 1986 Jul;4(2):91-7.

510. *A simple and a complex tic (Gilles de la Tourette's syndrome): their response to EEG sensorimotor rhythm biofeedback training.

Tansey MA.

Abstract
This study presents a clinical treatment regime for the treatment of tic manifestation, both simple and complex. The response of a case of simple tic and a case of complex tic (Gilles de la Tourette's syndrome) to **EEG** sensorimotor rhythm **biofeedback** training are presented. Specifically, the simple and the complex tic, both of long duration, were eliminated via this **EEG biofeedback** training procedure. It is hypothesized that this exercising of the sensorimotor cortex resulted in increased activation of this cerebrocortical subsystem and was reflected in increased voluntary muscle control and a heightened threshold for random motor discharge, resulting in the elimination of both tics as in the response of cases of epilepsy with motor involvement to **EEG** sensorimotor rhythm **biofeedback** training. The additional psychophysiologic sequelae of the complex tic--attention deficit disorder--remediated in the manner of the response of learning-disabled to **EEG** sensorimotor rhythm **biofeedback** training.

PMID: 3460976 [PubMed - indexed for MEDLINE]

Eur Neurol. 1986;25 Suppl 2:128-33.

511. Vigilance, sleep and epilepsy.

Vieth J.

Abstract

The correlations between vigilance and epilepsy are manifold. Nearly all epileptic seizures cause a diminution of vigilance extending to unconsciousness. Many of the influences triggering or inhibiting epileptic seizures produce alterations of vigilance or are produced by them. Nearly all chemical influences more or less cause diminution of vigilance. The enhancement of vigilance may inhibit seizures. Decreasing vigilance may act vice versa. As a means to enhance vigilance afferent stimuli are able to trigger seizures. This may be accomplished when singular or rhythmic stimulation of afferents gets the already excited neuronal system oscillating. This principle is also responsible for the strong correlation between triggering of seizures and the sleep/waking cycle with its different grades of neuronal synchronization. On the other hand, inhibition of seizures is possible by a continuously applied stimulation load, which may disturb the increasing excitatory oscillation. Also, conditioning may trigger or inhibit seizures. But the **EEG biofeedback** only is used to decrease abnormal neuronal activity.

PMID: 3758115 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1984 Mar;9(1):1-23.

512. *Electroencephalographic biofeedback of SMR and beta for treatment of attention deficit disorders in a clinical setting.

Lubar JO, Lubar JF.

Abstract

Six children were provided with long-term **biofeedback** and academic treatment for attention deficit disorders. Their symptoms were primarily specific learning disabilities, and, in some cases, there were varying degrees of hyperkinesis. The training consisted of two sessions per week for 10 to 27 months, with a gradual phase-out. **Feedback** was provided for either increasing 12- to 15-Hz **SMR** or 16- to 20-Hz beta activity. Inhibit circuits were employed for blocking the **SMR** or beta when either gross movement, excessive EMG, or theta (4-8 Hz) activity was present. Treatment also consisted of combining the **biofeedback** with academic training, including reading, arithmetic, and spatial tasks to improve their attention. All children increased **SMR** or beta and decreased slow **EEG** and EMG activity. Changes could be seen in their power spectra after training in terms of increased beta and decreased slow activity. All six children demonstrated considerable improvement in their schoolwork in terms of grades or achievement test scores. None of the children are currently on any medications for hyperkinetic behavior. The results indicate that **EEG biofeedback** training, if applied comprehensively, can be highly effective in helping to remediate children who are experiencing attention deficit disorders.

PMID: 6487671 [PubMed - indexed for MEDLINE]

Int J Psychophysiol. 1984 Feb;1(2):163-77.

513. *EEG sensorimotor rhythm biofeedback training: some effects on the neurologic precursors of learning disabilities.

Tansey MA.

Abstract

This study presents a clinical treatment regime for pathological interhemispheric dysfunction with respect to a population of learning disabled boys. The results obtained replicate and extend earlier findings with respect to operantly conditioned increases in amplitude of sensorimotor transactions and its positive effect on learning disability. Specifically, the **biofeedback**, and subsequent conditioning, of increased 14 Hz neural discharge patterns (sensorimotor rhythm-**SMR**) over the central Rolandic cortex, appeared to increase bilateral sensorimotor transactions resulting in substantive reduction/remediation in the learning disabilities of the recipients of such **EEG biofeedback** training.

PMID: 6542077 [PubMed - indexed for MEDLINE]

Psychophysiology. 1983 Nov;20(6):690-5.

514. Biological rhythms in arousal indices: a potential confounding effect in EEG biofeedback.

Gertz J, Lavie P.

PMID: 6657858 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1983 Mar;8(1):25-37.

515. *EMG and EEG biofeedback training in the treatment of a 10-year-old hyperactive boy with a developmental reading disorder.

Tansey MA, Bruner RL.

Abstract

The serial application of electromyographic (EMG) and sensorimotor **(SMR) biofeedback** training was attempted with a 10-year-old boy presenting a triad of symptoms: an attention deficit disorder with hyperactivity, developmental reading disorder, and ocular instability. Symptom elimination was achieved, for all three aspects of the triad, following the procedure of first conditioning a decrease in EMG-monitored muscle tension and then conditioning increases in the amplitude of sensorimotor rhythm over the Rolandic cortex. The learned reduction of monitored EMG levels was accompanied by a reduction in the child's motoric activity level to below that which had been achieved by past administration of Ritalin. In addition, the attention deficit disorder with hyperactivity was no longer diagnosable following the EMG **biofeedback** training. The learned increase in the amplitude of monitored **SMR** was accompanied by remediation of the developmental reading disorder and the ocular instability. These results remained unchanged, as ascertained by follow-ups conducted over a 24-month period subsequent to the termination of **biofeedback** training.

PMID: 6882815 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1982 Dec;7(4):479-90.

516. Neuroleptic-like electroencephalographic changes in schizophrenics through biofeedback.

Schneider SJ, Pope AT.

Abstract
Nine schizophrenic patients participated in a study which explored whether **EEG feedback** techniques could effect changes in the **EEG** similar to those associated with neuroleptic-induced improvement. During five sessions, each patient was presented **feedback** signals which continuously reflected the discrepancy between characteristics of the patient's **EEG** power spectral profile and spectral profile characteristics associated by past research with neuroleptic induced clinical improvement. Significant within-session changes were observed for two of three **EEG** power spectrum bands of interest. No significant session-to-session **EEG** changes were observed. The results suggest that the **EEG** of schizophrenics can be temporarily altered, using **feedback** techniques, in a way that mimics the **EEG** changes that have been shown to occur with neuroleptic induced clinical improvement.

PMID: 6131700 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1982 Jun;7(2):223-35.

517. *The treatment of psychophysiologic insomnia with biofeedback: a replication study.

Hauri PJ, Percy L, Hellekson C, Hartmann E, Russ D.

Abstract
To replicate a previous study, 16 psychophysiological insomniacs were randomly assigned to either Theta **feedback** or sensorimotor rhythm **(SMR) feedback**. Evaluations by home sleep logs and by 3 nights in the laboratory were done before **biofeedback**, immediately after **biofeedback**, and 9 months later. Results from this study replicate previous findings. Both Theta and **SMR feedback** seemed effective treatments of insomnia according to home sleep logs. According to evaluations at the sleep laboratory, tense and anxious insomniacs benefited only from Theta **feedback** but not from **SMR feedback**, while those who were relaxed at intake but still could not sleep benefited only from **SMR** but not from Theta **feedback**.

PMID: 7138954 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1982 Jun;7(2):211-21.

518. *Facilitation of performance on an arithmetic task as a result of the application of a biofeedback procedure to suppress alpha wave activity.

Jackson GM, Eberly DA.

Abstract

An electroencephalographic **(EEG) biofeedback** procedure was used in a pilot study to decrease the percent of time in alpha wave activity with five mentally retarded adults while engaged in an arithmetic test. Analysis of intrasubject and intersubject data revealed an overall significant decrease in the number of alpha events and percent of time in alpha wave activity as compared to baseline conditions. Such a decrease indicated facilitated attention by **EEG** definition. A collateral increase in percent of problems completed correctly and decrease in the number of distractible head-turning responses were noted. An automated method of determining head position was used and shown to be reliable in comparison to a human observer.

PMID: 7138953 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1982 Jun;7(2):193-209.

519. *A double-blind investigation of the relationship between seizure activity and the sleep EEG following EEG biofeedback training.

Whitsett SF, Lubar JF, Holder GS, Pamplin WE, Shabsin HS.

Abstract

The sleep **EEG**s of eight medically refractory epileptic patients were examined as part of a double-blind, ABA crossover study designed to determine the effectiveness of **EEG biofeedback** for the control of seizures. The patients were initially reinforced for one of three **EEG** criteria recorded from electrodes placed over sensorimotor cortex: (a) suppression of 3- to 7-Hz activity, (b) enhancement of 12- to 15-Hz activity, or (c) simultaneous suppression of 3- to 7-Hz and enhancement of 11- to 19-Hz activity. Reinforcement contingencies were reversed during the second or B phase, and then reinstated in their original form during the final A' phase. All-night polysomnographic recordings were obtained at the end of each conditioning phase and were subjected to both visual and computer-based power spectral analyses. Four of the patients showed changes in their nocturnal paroxysmal activity that were either partially or totally consistent with the ABA' contingencies of the study. The spectral data proved difficult to interpret, though two trends emerged from the analyses. Decreases in nocturnal 4- to 7-Hz activity were correlated with decreases in seizure activity, and increases in 8- to 11-Hz activity were correlated with decreases in seizure activity. These findings were shown to strengthen the hypothesis that **EEG biofeedback** may produce changes in the sleep **EEG** that are related to seizure incidence.

PMID: 7138952 [PubMed - indexed for MEDLINE]

Arch Neurol. 1981 Nov;38(11):700-4.

520. *EEG operant conditioning in intractable epileptics.

Lubar JF, Shabsin HS, Natelson SE, Holder GS, Whitsett SF, Pamplin WE, Krulikowski DI.

Abstract

Eight epileptic patients with mixed seizures refractory to medical control participated in a double-blind crossover study to determine the effectiveness of operant conditioning of the **EEG** as an anticonvulsant procedure. Baseline levels of seizures were recorded for four months prior to the beginning of treatment. Participants then received false (noncontingent) **feedback** for two months followed by an ABA-patterned training program lasting a total of ten months. Subjects were assigned to three treatment groups based on different schedules of **EEG feedback**. They were first trained (A1 phase) either to suppress slow activity (3 to 8 Hz), to enhance 12- to 15-Hz activity, or to simultaneously suppress 3- to 8-Hz and enhance 11- to 19-Hz activity. This was followed by a B phase, in which patients were trained to enhance slow activity (3 to 8 Hz). In the final phase (A2), the initial training contingencies were reinstated. Neuropsychological tests were performed before and after training, and changes in **EEG** activity as determined by Fast Fourier spectral analyses were analyzed. Five of eight patients experienced a decrease in their mean monthly seizure rate at the completion of **feedback** training as compared with their initial baseline level.

PMID: 7305698 [PubMed - indexed for MEDLINE]

Neurosci Biobehav Rev. 1981 Fall;5(3):405-12.

521. *EEG biofeedback: physiological behavior modification.

Sterman MB.

Abstract

The author reviews the use of operant conditioning to alter electroencephalogram (**EEG**) patterns. A discrete rhythmic **EEG** pattern directly related to modulation of motor patterns (sensorimotor rhythm, **SMR**) was brought under voluntary control in the cat. This technique was modified for use in epileptic human volunteers in order to reduce motor seizures. The use of a newer experimental design and its successful application in one subject is described.

PMID: 7301228 [PubMed - indexed for MEDLINE]

Fiziol Zh SSSR Im I M Sechenova. 1981 Jul;67(7):970-7.

522. [Cyclic interaction of brain structures in different states and different types of activity]

[Article in Russian]
Suvorov NB, Vasilevskiĭ NN.

Abstract

Special method of multichannel **EEG** analysis with the aid of the matrix of consistent zero-crossing points distribution within the multichannel **EEG** registration calculated for the different functional states and behaviour revealed the cyclic forms of bilateral interrelationship between the brain structures. The variety of consistent connections increases in **EEG-biofeedback** food behaviour and visual stimulation, but the cycles prolongation decreases. The combination of zero-crossing points consistently distributed for different brain structures is typical for each functional state.

PMID: 7286329 [PubMed - indexed for MEDLINE]

Arch Gen Psychiatry. 1981 Jul;38(7):752-8.

523. *Treating psychophysiologic insomnia with biofeedback.

Hauri P.

Abstract
After evaluating 165 insomniacs, 48 psychophysiologic insomniacs were randomly assigned to one of the following four groups: electromyographic (EMG) **feedback**, combined EMG and theta **feedback**, sensorimotor rhythm **(SMR) feedback**, and no treatment (control). Sleep evaluations by home logs and in the laboratory were done before and after **biofeedback** and nine months later. No **feedback** group showed improved sleep significantly more than did the controls. The amount of **feedback** learning correlated significantly with sleep improvement for the **SMR** group but not for the other groups. Initial tension of the insomniacs correlated positively with sleep improvement for the EMG group, but negatively with sleep improvement for the **SMR** group. Those treated with the **biofeedback** that seemed appropriate for their specific deficiencies showed significant sleep improvements, while those who received inappropriate **feedback** did not. Appropriate **biofeedback** methods may be effective for specific types of insomnia, but these procedures offer no panacea for all poor sleep.

PMID: 7247638 [PubMed - indexed for MEDLINE]

J Learn Disabil. 1981 Apr;14(4):204-8.

524. *The effects of bilateral EEG biofeedback on verbal, visual-spatial, and creative skills in learning disabled male adolescents.

Cunningham MD, Murphy PJ.

PMID: 7229554 [PubMed - indexed for MEDLINE]

Electroencephalogr Clin Neurophysiol. 1980 Sep;49(5-6):558-76.

525. *Quantitative analysis of training, sleep EEG and clinical response to EEG operant conditioning in epileptics.

Sterman MB, Shouse MN.

Abstract
This report is a follow-up to a previous paper which described seizure rate changes with central cortical **EEG feedback** training in 8 poorly controlled epileptic subjects. Data examined here include associated training compliance and performance, sleep **EEG** spectra, clinical **EEG** and anticonvulsant blood levels. The study employed a double-cross-over, single blind ABA design applied to two subgroups of epileptic patients. Both groups had in common two training periods (A1, A2) in which either 12--15 c/sec (subgroup I, n = 4) or 18--23 c/sec (subgroup II, n = 4) was reinforced in the absence of 6--9 c/sec, movement or epileptiform discharge, and one training period (B) in which 6--9 c/sec was reinforced in the

absence of 12--15 or 18--23 c/sec as well as movement and epileptiform discharge. Training periods occurred primarily in the home and lasted 3 months. Compliance with training instructions and response acquisition were demonstrated. Overall anticonvulsant blood levels were low and unrelated to **EEG** or seizure changes. Clinical **EEG** findings corresponded to sleep **EEG** and seizure rate outcomes. Power spectral analysis of sampled non-REM sleep from all-night **EEG** recordings obtained after each training phase indicated contingency specific changes which were limited to sensorimotor recordings in subgroup I and corresponded to the pattern of seizure rate changes in this group. **EEG** changes were also limited to sensorimotor cortex in subgroup II, but were linear and paralleled a progressive decrease in seizure rate. Both groups, however, showed the same pattern of **EEG** changes with seizure reductions; low and high frequencies were reduced and intermediate, rhythmic frequencies increased. Correlational analysis confirmed this relationship. The pattern, duration and topographic specificity of these changes suggested a normalization of sensorimotor **EEG** substrates related to the **EEG feedback** traning.

PMID: 6158436 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1980 Jun;5(2):193-205.

526. Maintenance and generalization of 40-Hz EEG biofeedback effects.

Ford M, Bird BL, Newton FA, Sheer D.

Abstract

Maintenance of conditioning of 40-Hz **EEG** activity was investigated in six adults 1 to 3 years after they had experienced **biofeedback** training to increase 40-Hz **EEG**. Subjects were first retrained to alternately increase and suppress 40-Hz **EEG**. All six subjects achieved a preset performance criterion in 16-20 minutes. Five of these subjects also subsequently demonstrated significant control of 40-Hz **EEG** without **feedback**. The sixth subject did not demonstrate control after 76 minutes and four sessions of attempted retraining with **feedback**. Transfer of 40-Hz **EEG** control to a problem-solving task was tested in all subjects in a final session. Cognitive test items were presented and subjects were instructed to alternately increase and suppress 40-Hz **EEG** while solving the problems. Rates of 40-Hz **EEG** in suppression periods during problem solving were significantly greater than during suppression periods without problems. No significant differences in problem-solving performance were found comparing 40-Hz increase and suppression periods. This study supports previous research suggesting an association between 40-Hz **EEG** and mental activity, and suggests methods for further study of transfer of **EEG biofeedback** effects.

PMID: 7397274 [PubMed - indexed for MEDLINE]

Epilepsia. 1979 Jun;20(3):279-86.

527. *EEG operant conditioning for control of epilepsy.

Wyler AR, Robbins CA, Dodrill CB.

Abstract

We report the results of 23 severely epileptic patients who were given **EEG feedback** training. The paradigm reinforced the patients' 18 Hz activity over the scalp approximation of their focus while suppressing temporalis EMG and low frequency **EEG** activity. In contrast to other studies using **EEG feedback**, only 43% of patients showed significant changes in seizure occurrence and a lesser number were felt to have benefited clinically. None of our neuropsychological test parameters were helpful in identifying (prospectively or retrospectively) patients most likely to respond to this treatment. Although a few patients were significantly helped by this training, the mechanism for this effect is unclear.

PMID: 446436 [PubMed - indexed for MEDLINE]

J Clin Psychol. 1979 Apr;35(2):364-9.

528. *Correlates of alpha, beta and theta wave production.

Watson CG, Jacobs L, Herder J.

Abstract

Studied the correlations of alpha, beta and theta time densities with psychological and psychophysiological variables in a psychiatric population (N = 76). The correlations of the **EEG** variables with measures of adjustment were small and barely exceeded chance expectations. Alpha and beta were correlated positively with pain threshold, while beta was related inversely to blood pressure. Theta was correlated positively with blood pressure and negatively with pulse rate. The implications of these findings for **EEG biofeedback** treatment were discussed.

PMID: 457900 [PubMed - indexed for MEDLINE]

Exp Neurol. 1978 Dec;62(3):735-47.

529. Effects of sensorimotor EEG feedback training on seizure susceptibility in the rhesus monkey.

Sterman MB, Goodman SJ, Kovalesky RA.

PMID: 108125 [PubMed - indexed for MEDLINE]

Electroencephalogr Clin Neurophysiol. 1978 Dec;45(6):699-710.

530. *EEG feedback training of epileptic patients: clinical and electroencephalographic analysis.

Kuhlman WN.

Abstract

To evaluate the clinical efficacy and mechanisms underlying **EEG feedback** training of epileptic patients, 5 adult patients with poorly controlled seizures were studied for 4--10 months during which quantitative analysis of seizures, the **EEG**, and serum anticonvulsant levels was conducted. Sustained seizure reduction did not occur during the first 4--5 weeks in which **feedback** signals were presented randomly in relation to the **EEG**. When **feedback**

was then made contingent upon central 9--14 c/sec activity, seizures declined by 60% in 3 patients. Power spectral analysis showed upward shifts in **EEG** frequency, decreases in abnormal slow activity, and enhancement of alpha rhythm activity as a function of contingent training, but no specific **EEG** change was associated with seizure reduction in all patients. No evidence was obtained for the hypothesized involvement of a 'sensorimotor rhythm' or motor inhibition in the training effects. The lack of effect in two patients could not be attributed to insufficient training, lack of motivation, or to differences in seizure classification. A second phase of research showed that continued laboratory training was both sufficient and necessary for maintaining clinical and **EEG** effects. Results indicate that: (1) significant seizure reductions can occur with **EEG feedback** training which are not related to placebo effects, non-specific factors or to changes in medication; (2) **EEG** changes associated with such training can best be described as 'normalization'; (3) continued clinical investigation of **EEG feedback** training as a non-pharmacological adjunct to conventional therapy appears justified.

PMID: 84738 [PubMed - indexed for MEDLINE]

Electroencephalogr Clin Neurophysiol. 1978 Aug;45(2):290-4.

531. EEG feedback training: enhancement of somatosensory cortical activity.

Kuhlman WN.

Abstract
The mu rhythm is a spontaneous electroencephalographic pattern which can be recorded over human somatosensory cortex in the absence of movement. Power spectral analysis across 50 sessions of **EEG feedback** training showed that mu activity could be systematically enhanced, whereas the 12--14 c/sec component of low voltage fast activity could not be modified. Results indicate that long-term modification of at least one normal cortical rhythm, initially present in the human **EEG**, is possible with **feedback** training but that training cannot produce such a rhythm.

PMID: 78840 [PubMed - indexed for MEDLINE]

Epilepsia. 1978 Jun;19(3):207-22.

532. *Effects of central cortical EEG feedback training on incidence of poorly controlled seizures.

Sterman MB, Macdonald LR.

Abstract
This study examined the clinical effects of central cortical **EEG feedback** training in 8 patients with poorly controlled seizures. After base-line recordings, patients were trained in the laboratory and then initiated on a double or triple crossover design using portable equipment at home, with bimonthly laboratory test sessions. Performance at home was monitored by a strip chart recorder with the portable unit. Training was based on the simultaneous detection of two central cortical (C3--T3) **EEG** frequency bands (6--9 Hz and either 12--15 or 18--23 Hz), with reward provided for the occurrence of one in the absence of the other. The design consisted of successive 3 month periods of training, with reward

contingencies reversed after each period without the subject's knowledge. Seizure incidence records were compared statistically before, during, and after the design. Six of the 8 patients reported significant and sustained seizure reductions, which averaged 74%, following reward for either 12--15 or 18--23 Hz in the absence of 6--9 Hz. Response to positive reward for 12--15 Hz was specific, with seizure rates returning to base line when reinforcement contingencies were reversed. Reduced seizure rates following positive reward for 18--23 Hz were not altered with contingency reversals. A nonspecific interpretation of these effects is rejected in favor of an **EEG** normalizing hypothesis.

PMID: 354919 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1978 Mar;3(1):13-28.

533. Behavioral and electroencephalographic correlates of 40-Hz EEG biofeedback training in humans.

Bird BL, Newton FA, Sheer DE, Ford M.

Abstract
Two groups of eight adults successfully trained with **biofeedback** for increases in 40-Hz **EEG** responses in left or right hemispheres also demonstrated significant 40-Hz **EEG** increases during baseline periods, and increases in the contralateral hemisphere during training periods. No changes in heart rate, 40-Hz EMG, or 21- or 31-Hz beta, alpha, or theta **EEG** occurred over training days. Three subjects returning for additional training demonstrated suppression of 40-Hz **EEG**. A group of four subjects experiencing daily bidirectional training produced substantial within-session control of 40-Hz **EEG** but no changes over days. Data from posttraining tests without **feedback** for successful subjects in both groups indicated significant control of 40-Hz **EEG** responses in the initial parts of these sessions, and some correlated changes in other **EEG** responses. Measures of successful subjects' experiences during training and control tests indicated awareness of changes in subjective concomitants of **EEG** responses. This study suggests further strategies for research on behavioral correlates of **EEG** activity.

PMID: 667188 [PubMed - indexed for MEDLINE]

Int J Clin Exp Hypn. 1977 Oct;25(4):361-71.

534. *Developing a biofeedback model: alpha EEG feedback as a means for pain control.

Pelletier KR, Peer E.

PMID: 330421 [PubMed - indexed for MEDLINE]

Pavlov J Biol Sci. 1977 Jul-Sep;12(3):147-85.

535. *Electroencephalographic biofeedback methodology and the management of epilepsy.

Lubar JF.

PMID: 917599 [PubMed - indexed for MEDLINE]

Pavlov J Biol Sci. 1977 Jul-Sep;12(3):130-46.

536. *Operant conditioning of epileptic neurons in monkeys and its theoretical application to EEG operant conditioning in humans.

Wyler AR.

Abstract

This paper reviews a series of previous reports which summarize the physiology of chronic experimental epileptic foci in monkeys. It is shown that such monkeys can be trained to bidirectionally control the firing rates of normal and epileptic neurons which comprise the epileptic focus. As a result of this acquired operant performance, the monkeys show both a decrease in clinical seizures as well as a decrease in single unit epileptic activity. The **EEG** correlate of this change in single unit epileptic activity is generalized **EEG** desynchronization. The conclusion from these data would indicate epileptic neurons can be operantly controlled from and this control is not correlated with any specific **EEG** pattern. This brings to question the specificity of the **SMR** in **EEG biofeedback** paradigms which treat human epilepsy. This author feels that the result from such **biofeedback** studies are the result of the patient learning to manipulate electrical events within the CNS pathways through which the seizures propagates and is not contingent upon specific **EEG** frequencies.

PMID: 411099 [PubMed - indexed for MEDLINE]

Pavlov J Biol Sci. 1977 Apr-Jun;12(2):112-22.

537. *EEG feedback training in the treatment of epilepsy: some questions and some answers.

Kuhlman WN, Allison T.

Abstract

A basic question in **EEG feedback** training of epileptic patients is whether the decrease in seizures is specifically due to the training or to other factors. Questions may also be raised as to what **EEG** changes are involved. Preliminary results in five patients suggest that seizure reductions can occur with training which are not due to placebo or nonspecific effects or to changes in medication compliance. These changes occurred rapidly during **EEG**-contingent **feedback** training but not when **feedback** was random in relation to the **EEG**. Reliable changes in the **EEG** were also observed, but the question of which mechanism accounts for these results has yet to be answered.

PMID: 904959 [PubMed - indexed for MEDLINE]

Pavlov J Biol Sci. 1977 Apr-Jun;12(2):93-111.

538. *Operant conditioning of the EEG in two patients with epilepsy: methodologic and clinical considerations.

Finley WW.

Abstract
Methodologic and clinical considerations are discussed in sensorimotor rhythm **(SMR) biofeedback** research on two dissimilar but severe epileptic males. The first case, an akinetic epileptic who prior to **feedback** training experienced 80-100 clinical seizures every 10 hours, showed considerable seizure reduction after 6 months of **SMR** and epileptiform training. A number of methodologic and instrumentation advances were pioneered with the akinetic patient: (1) development of and ultra-sharp band-pass filter; (2) use of epileptiform inhibit and **feedback** circuitry; (3) use of monetary rewards as additional incentive; (4) use of correlational analysis for evaluation of acquisition in the major dependent variables and; (5) use of noncontingent **feedback** and reinforcement as control techniques. The second case, a psychomotor epileptic, also showed therapeutic benefit from **SMR** training. Clinical information regarding the effect of anticonvulsant medications on the course and therapeutic outcome of **SMR** training are described. In conjunction with operant conditioning of 12 Hz activity, corresponding changes for other **EEG** parameters are examined.

PMID: 904960 [PubMed - indexed for MEDLINE]

Psychol Rep. 1977 Apr;40(2):591-8.

539. *Sociocultural predictors of self-actualization in EEG-biofeedback-treated alcoholics.

Twemlow SW, Bowen WT.

PMID: 859981 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1976 Sep;1(3):293-306.

540. *EEG and behavioral changes in a hyperkinetic child concurrent with training of the sensorimotor rhythm (SMR): a preliminary report.

Lubar JF, Shouse MN.

Abstract
Reduced seizure incidence coupled with voluntary motor inhibition accompanied conditioned increases in the sensorimotor rhythm (**SMR**), a 12- 14 Hz rhythm appearing over rolandic cortex. Although **SMR biofeedback** training has been successfully applied to various forms of epilepsy in humans, its potential use in decreasing hyperactivity has been limited to a few cases in which a seizure history was also a significant feature. The present study represents a first attempt to explore the technique's applicability to the problem of hyperkinesis independent of the epilepsy issue. The results of several months of **EEG biofeedback** training in a hyperkinetic child tend to corroborate and extend previous findings. **Feedback** presentations for **SMR** were contingent on the production of 12- 14-Hz activity in the absence of 4- 7-Hz slow-wave activity. A substantial increase in **SMR** motor inhibition, as gauged by

laboratory measures of muscular tone (chin EMG) and by a global behavioral assessment in the classroom. Opposite trends in motor inhibition occurred when the training procedure was reversed and **feedback** presentations were contingent on the production of 4- 7 Hz in the absence of 12- 14-Hz activity. Although the preliminary nature of these results is stressed, the subject population has recently been increased to establish the validity and generality of the findings and will include the use of **SMR biofeedback** training after medication has been withdrawn.

PMID: 990355 [PubMed - indexed for MEDLINE]

Arch Psychiatr Nervenkr. 1976 Jun 22;221(4):331-43.

541. *[Controlled EEG alpha feedback training in normals and headache patients (author's transl)]

[Article in German]
Lehmann D, Lang W, Debruyne P.

Abstract
Headache patients and healthy controls underwent alpha-**EEG feedback** training in 12 sessions. The present study does not support the literature which reports alpha increase by **feedback** training. The study included a patient group receiving **feedback**, a patient control group receiving pseudofeedback, and a volunteer group receiving **feedback**. Increase of alpha **EEG** was observed under **feedback** and pseudofeedback. However, there was always more alpha during baseline times than during training times. Alpha increase over time is suggested to be a habituation effect. Headache pain decreased with training (within the boundaries of a placebo effect), and there was no difference in headache decrease between **feedback** and pseudofeedback patients.

PMID: 952600 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1976 Jun;1(2):227-35.

542. *Effects of sham feedback following successful SMR training in an epileptic: follow-up study.

Finley WW.

Abstract
After 1 year of **SMR biofeedback** training of a severe epileptic teenage male, incidence of atonic seizures decreased from 8/hr to less than 1/3 hr. **SMR** increased from 10% to 70%. Epileptiform discharges decreased from 45% to 15%. Unknown to the patient, his family, or certain members of our research staff, noncontingent **feedback** was introduced on 7/22/74, ending 9/11/74. A significant decrease occurred for **SMR** (down 8%), and a significant increase for epileptiform discharges (up 4%). Rate of seizures increased, but was not statistically significant over preceding months of contingent **feedback**. Incidence of seizures associated with urine loss increased from approximately 6/month to 23/month during noncontingent **feedback**, a significant increase. Urine-loss results suggest that although seizures did not become more frequent, those the patient did experience were "harder," i.e.,

more severe. Contingent **feedback** was reinstituted following the 7-wk sham, and recovery of all variables to their former levels (prior to sham) occurred.

PMID: 990351 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1976 Mar;1(1):63-75.

543. Conflicting results in EEG alpha feedback studies: why amplitude integration should replace percent time.

Hardt JV, Kamiya J.

Abstract
Success or failure of **EEG feedback** training for alpha enhancement can depend on how alpha activity is quantified and fed back. Alpha-enhancement failures usually employ a percent time (%) technique; successes typically use amplitude integration (variation of). To dramatize the differences between percent and integration techniques, we derived both measures simultaneously from left occipital (O1) and left central (C3) sites for 16 male subjects who were given 5.6 hours of integrated alpha **feedback** from the midline occipital (Ozeta) site. At both the O1 and C3 sites the integrated and percent measures were not equivalent and not linearly related. Statistically significant differences in the (integrated, percent) correlation coefficients (z-transpormed) were observed under the different recording conditions: alpha enhancement, alpha suppression, and baselines. Theoretical discussion of integration and percent techniques is given and the adoption of amplitude integration measures and **feedback** stimuli is strongly advocated.

PMID: 990344 [PubMed - indexed for MEDLINE]

Biofeedback Self Regul. 1976 Mar;1(1):77-104.

544. *Behavioral management of epileptic seizures following EEG biofeedback training of the sensorimotor rhythm.

Lubar JF, Bahler WW.

Abstract
Eight severely epileptic patients, four males and four females, ranging in age from 10 to 29 years, were trained to increase 12-14 Hzeta **EEG** activity from the regions overlying the Rolandic area. This activity, the sensorimotor rhythm (**SMR**), has been hypothesized to be related to motor inhibitory processes (Sterman, 1974). The patients represented a cross-section of several different types of epilepsy, including grand mal, myoclonic, akinetic, focal, and psychomotor types. Three of them had varying degrees of mental retardation. **SMR** was detected by a combination of an analog filtering system and digital processing. **Feedback**, both auditory and/or visual, was provided whenever one-half second of 12-14-Hz activity was detected in the **EEG**. Patients were provided with additional **feedback** keyed by the output of a 4-7-Hz filter which indicated the presence of epileptiform spike activity, slow waves, or movement. **Feedback** for **SMR** was inhibited whenever slow-wave activity spikes or movement was also present. During the treatment period most of the patients showed varying degrees of improvement. Two of the patients who had been severely epileptic, having multiple seizures per week, have been seizure free for periods of up to 1 month. Other patients

have developed the ability to block many of their seizures. Seizure intensity and duration have also decreased. Furthermore, the successful patients demonstrated an increase in the amount of **SMR** and an increase in amplitude of **SMR** during the training period. Spectral analyses for the **EEG**s were performed periodically. The effectiveness of **SMR** conditioning for the control of epileptic seizures is evaluated in terms of patient characteristics and type of seizures.

PMID: 825150 [PubMed - indexed for MEDLINE]

Biol Psychol. 1975 Nov;3(3):157-84.

545. *Reduction of epileptic seizures through EEG biofeedback training.

Seifert AR, Lubar JF.

Abstract
Biofeedback training of the sensorimotor rhythm (**SMR**) was carried out in three male and three female adolescent epileptics and in two normal controls. The patients represented a cross-section of epilepsies including grand mal, myoclonic, afocal and psychomotor types. Three of the cases were mentally retarded. 12-14 Hz (**SMR**) activity was detected by a combination of sharp analog filtering and digital processing. The patients were provided with **feedback** whenever they produced 0.5 sec of 12-14 Hz activity of a specified amplitude. Additional **feedback** was provided for epileptiform activity slow waves or movement. Furthermore, **feedback** for **SMR** production was inhibited by digital logic circuitry when movement, slow waves or spikes were present. Seizure reduction was obtained in five of the six epileptics. Several patients showed increased percentage of **SMR** when **feedback** was provided and varying degrees of normalization in their **EEG** as demonstrated by fast Fourier, crossed power spectral density and coherence analyses.

PMID: 812560 [PubMed - indexed for MEDLINE]

Electroencephalogr Clin Neurophysiol. 1975 Nov;39(5):557.

546. Proceedings: Low arousal induced by EMG and EEG feedback in various patient groups: description of the methodology in a pilot study.

Hoffmann E, Willanger R.

PMID: 52550 [PubMed - indexed for MEDLINE]

Minerva Med. 1975 Oct 31;66(73):3835-43.

547. [Neurophysiology of hypnosis. The suggestive process and contributions of the learned control of brain waves]

[Article in Italian]
Pinelli P.

Abstract
The contribution that neurophysiological examination, subordinate to psychodynamic analysis, can bring to the investigation of facts and results in the therapeutic application of hypnosis is discussed. Phenomena with a suggestive background are analysed, particularly those of ideomotor transformation with reference to prereflective though (Polanyi & Dyer). A special case is represented by phobic-obsessive disturbances. Here analysis of the process of ideative reinforcement must take account of the untranslatability of certain linguistico-syntactic connotations at this level. The part played by sensorimotor **EEG biofeedback** training in practical therapeutics is also examined.

PMID: 1187032 [PubMed - indexed for MEDLINE]

Epilepsia. 1975 Sep;16(3):477-85.

548. *Biofeedback in epileptics: equivocal relationship of reinforced EEG frequency to seizure reduction.

Kaplan BJ.

Abstract
It has been reported that **biofeedback** training of 12- to 14-Hz activity recorded over Rolandic cortex was accompanied by a reduction in seizure incidence in four human epileptics (Sterman et al., 1974). **Biofeedback** training of 12- to 14-Hz activity was provided for two epileptics and had no effect on clinical **EEG**s, seizure incidence, or proportion of **EEG** spectral power in the frequency range being trained. Subsequently, **biofeedback** training of 6- to 12-Hz Rolandic activity was provided for three epileptics. Two patients experienced reductions in seizure not accompanied by medication changes. Since no learning of 6- to 12-Hz activity was detected, the changes in seizure incidence are not attributed to **EEG biofeedback**. It is suggested that the experience in the **feedback** setting provided these two patients with new techniques of relaxation. In view of the lack of statistical evidence of **EEG** changes following **EEG biofeedback** and the small number of patients trained to date, it appears wise to maintain a cautious attitude until the issue of causality is clear.

PMID: 1183423 [PubMed - indexed for MEDLINE]

Biol Psychol. 1975 Sep;3(2):91-100.

549. Creativity and cortical activation during creative, intellectual and EEG feedback tasks.

Martindale C, Hines D.

Abstract
Thirty-two male subjects were divided into four groups based on their performance on the remote associates test and alternate uses test, two measures of creativity. Right **EEG** alpha presence was monitored under basal conditions, while subjects took tests of creativity and intelligence, and while they attempted to enhance and suppress the amount of alpha in a **feedback** situation. High scorers on the alternate uses test operated at a high percentage of basal alpha during all tests while high scorers on the remote associates test showed differential amounts of alpha presence across tests, with the highest percentage of basal alpha

during tests of creativity and the lowest percentage during an intellectual test. Both high creative groups tended to show increases in amount of alpha across trials when trying to suppress alpha as well as when trying to enhance it, but did not differ in overall control from the low creative groups.

PMID: 1225370 [PubMed - indexed for MEDLINE]

Biol Psychol. 1975;2(3):189-203.

550. *Reduction of seizures and normalization of the EEG in a severe epileptic following sensorimotor biofeedback training: preliminary study.

Finley WW, Smith HA, Etherton MD.

Abstract
Sensorimotor rhythm **(SMR) biofeedback** training was attempted in a 13-year-old male with frequent epileptic seizures. Prior to training the subject was averaging almost eight clinical seizures an hour. The **SMR** filter was tuned sharply to 12 plus or minus 1 Hz. **Feedback** was conducted over approximately six months and continues to the present. In that time the subject's percentage of **SMR** increased from about 10%, prior to training, to 65% after the 34th training session. Correspondingly, his rate of clinical seizures decreased by a factor of 10 and a significant reduction in percentage of epileptiform discharges was noted. Beginning with trial 35, the subject was provided **feedback** of epileptiform activity in combination with 12 Hz activity. The combined effect of these two treatment variables was to reduce the trial-to-trial variance in the dependent variables of interest.

PMID: 806309 [PubMed - indexed for MEDLINE]

Headache. 1974 Jan;13(4):164-72.

551. *The treatment of headache by means of electroencephalographic biofeedback.

McKenzie RF, Ehrisman WJ, Montgomery PS, Barnes RH.

PMID: 4810471 [PubMed - indexed for MEDLINE]

J Med Soc N J. 1974 Dec;71(12):927-31.

552. *Autogenic training and EEG biofeedback training in coronary heart disease.

Weber ES.

PMID: 4530874 [PubMed - indexed for MEDLINE]

Semin Psychiatry. 1973 Nov;5(4):507-25.

553. ***Neurophysiologic and clinical studies of sensorimotor EEG biofeedback training: some effects on epilepsy.**

Sterman MB.

PMID: 4770578 [PubMed - indexed for MEDLINE]

Electroencephalogr Clin Neurophysiol. 1972 Jul;33(1):89-95.

554. ***Suppression of seizures in an epileptic following sensorimotor EEG feedback training.**

Sterman MB, Friar L.

PMID: 4113278 [PubMed - indexed for MEDLINE]

Acta Biol Exp (Warsz). 1969;29(2):135-52.

555. **EEG feedback control of midbrain electrical stimulation inducing sleep or arousal in rabbits.**

Traczyk WZ, Whitmoyer DI, Sawyer CH.

PMID: 5367777 [PubMed - indexed for MEDLINE]