

# Neurofeedback Treatment for Traumatic Brain Injury

By:

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Following acute TBI rehabilitation there have been a limited number of strategies that have been used in the treatment of cognitive disorders. These methods have included restorative cognitive rehabilitation procedures that utilize stimulation and practice (e.g., of vigilance with a computer intervention); strategy cognitive rehabilitation (e.g., utilizing visualization, creating associations), compensatory cognitive rehabilitation strategies; and medications (e.g., cognitive enhancing medications directed at arousal, attention and/or memory). All of these methodologies provide at best modest improvements, but it is still common for patients with TBI to be told that after a year and a half they have obtained about all of the improvement that they can expect, and that, therefore, they must simply adjust to the current state of affairs.

There is, however, another rehabilitation strategy that is commonly underutilized, but which holds definite potential to provide further assistance in cognitive rehabilitation. This method is neurofeedback (EEG biofeedback).

## **What is Neurofeedback?**

Neurofeedback training is brainwave biofeedback. The process consists of placing an electrode or two on the scalp and reference and ground electrodes on the earlobes. Ordinarily we cannot reliably influence brainwave activity because we lack awareness of that activity. However, when EEG biofeedback equipment allows us to see a representation of our brainwave activity a few thousandths of a second after it occurs, it allows us to influence this activity. A computer display may be as simple as two bar graphs, with one representing slow, inefficient activity, and another efficient beta brainwave activity. When the patient concentrates on the display and through this concentration decreases slow (e.g., theta or alpha) activity and slightly increases efficient activity, they receive both visual and auditory feedback (for instance, a bell may ring after they have held these improvements for one-half a second). Change occurs through a process of operant conditioning, gradually reconditioning and retraining how the brain is functioning.

## **Problems that Neurofeedback Can Address**

There are several problem areas that are not uncommonly seen in TBI patients that neurofeedback has been used to improve. These difficulties include problems with attention, impulse and emotional control, seizures, memory, anxiety, insomnia, depression, and physical balance.

Research on neurofeedback began about 40 years ago. The initial research focused on reduction of anxiety and on the treatment of drug-resistant, uncontrolled epilepsy. Sterman (2000) reviewed this literature, which included blinded, placebo-controlled cross-over studies, on the use of neurofeedback with uncontrolled epilepsy. Out of a total of 174 medically intractable patients in these studies it was found that in 82% of cases there were significant improvements in the seizure rate, and there were no reports of an increase in seizures. Some of these studies evaluated pre- and post-treatment sleep EEG's, finding that following treatment even when the patient was asleep, their EEG showed less epileptiform activity, thus demonstrating that conditioned changes in brain function.

Studies with ADD/ADHD have likewise documented improvements equivalent to (e.g., Fuchs et al., 2003) or superior (Monastra et al., 2002) to those produced by methylphenidate on 1 year follow-up, and follow-ups have continued for as long as 10 years demonstrating the maintenance of improvements. This is significant since the average stimulant medication follow-up study is only 3 weeks long, Symptomatic changes have occurred in

concentration/attention, academic performance, mood stability, impulsiveness, hyperactivity, and sleep. Along with behavioral changes, various studies have also shown post-treatment improvements in brain function on EEG measures, and a recent study (Levesque, Beauregard, & Mensour, 2006) established with fMRI that not only did neurofeedback improve behavior in ADHD children compared with a no-treatment control group, but that positive changes in both subcortical and cortical functioning also occurred. Overall, close to 80% of ADD/ADHD patients show significant improvement. Placebo-controlled research with learning disabilities (Fernandez et al., 2003) has also demonstrated the effectiveness of neurofeedback.

Some recent studies with normal individuals also have implications for TBI treatment. Vernon et al. (2003) documented in a control group study that only 8 sessions of neurofeedback could improve memory recall, and a recent placebo controlled study (Hoedlmoser et al., 2008) of neurofeedback validated that only 10 sessions improved sleep onset latency and subsequent declarative learning in normal subjects. Other reviews have been published on the use of neurofeedback in the treatment of depression and anxiety (Hammond, 2005a), for improving physical balance (Hammond, 2005b), and in the treatment of obsessive-compulsive disorder (Hammond, 2003).

Although better and more well controlled research is needed preliminary neurofeedback treatment outcome studies of closed and open brain injuries too numerous to cite have been published. For example, Schoenberger et al (2001) compared treatment (25 sessions) with the Low Energy Neurofeedback System (LENS) of 9 mild and 3 moderate TBI patients with a wait-list control group. They found significant improvement in measures of attention and recall. Thornton and Carmody (2005) found 186% improvement in memory scores in TBI patients treated with neurofeedback compared to a control group with no TBI history. When Thornton and Carmody (2008) compared neurocognitive rehabilitation strategies, medication treatment, and neurofeedback treatment in an effect size analysis, neurofeedback appeared more efficacious than other treatment strategies. Ayers (1999) has even brought many patients out of coma using neurofeedback.

### **Successful Neurofeedback Treatment of Post-Traumatic Anosmia**

In an acceleration-deceleration, coup-contrecoup injury damage can be done to cranial nerve I as the brain moves within the anterior cranial fossa. This can result in either focal or diffuse injury in the orbitofrontal, and less frequently temporal areas, producing posttraumatic anosmia. This symptom is most likely to occur in patients with posttraumatic amnesia lasting for 5 or more minutes. Subsequent improvements in smell have only been found in 36% of patients (Doty, Yousem, Pham, Kreshak, Geckle, & Lee, 1997), usually in the first 6-12 months (while 18% of cases worsen in this time period), and usually such injuries are regarded as permanent with no more than 10% of patients improving more than 2 years post-injury (Costanzo & Becker, 1986). Posttraumatic anosmia has proven resistant to treatment with medication (Hirsch, Dougherty, Aranda, Vanderbilt, & Weclaw, 1996). Reviews have found that anosmia has a very severe negative effect on quality of life, safety and interpersonal relations, as well as eating habits and nutritional intake. However, I (Hammond, 2007) reported a case study of a 29 year old male in which neurofeedback was used to treat a patient nine and one-half years following a moderate level TBI which had resulted in loss of consciousness for 10-15 minutes and resulted in a week long hospitalization. The accident resulted in a change in personality, increased irritability, difficulties concentrating, explosiveness, problems with short-term memory, insomnia, anxiety, and mood swings. The only medication he was taking was testosterone. After his 13th treatment session utilizing the Low Energy Neurofeedback System (LENS) the patient spontaneously reported being able to smell sagebrush. The author had been unaware of his anosmia until that time. After 22 sessions the patient's mean rating (on a 0-10 scale) on the symptoms identified above had decreased from 9 to 3.75 and he indicated that his sense of smell and taste seemed completely normal.

### **Conclusions & Recommendations**

Neurofeedback research has documented its value in the treatment of a variety of symptoms relevant to a brain injury population, including seizures, memory, concentration and attention, unstable mood, impulsiveness, anxiety, depression, sleep issues, and even anosmia and physical balance. Preliminary research on neurofeedback treatment of TBI is very encouraging, but certainly more rigorous research is needed. The accumulating work on neurofeedback led Frank H. Duffy, M.D., a Professor and Pediatric Neurologist at Harvard Medical School, to state in an editorial in the January 2000 issue of the journal Clinical Electroencephalography that scholarly literature now suggests that neurofeedback “should play a major therapeutic role in many difficult areas. In my opinion, if any medication had demonstrated such a wide spectrum of efficacy it would be universally accepted and widely used: (p. v). “It is a field to be taken seriously by all” (p. vii).

I find it unfortunate when physicians including those involved with TBI neurorehabilitation tell patients that after 18 months they have obtained all the return they can expect and will have to learn to adapt to their remaining deficits. I have often seen neurofeedback produce significant improvements years after the original injury.

There is one cautionary note, however. It has been documented (Hammond & Kirk, 2008) that neurofeedback in unskilled hands can occasionally result in side effects and less frequently in adverse effects. We are seeing an increasing number of lay persons (as well as untrained “professionals”) inappropriately obtaining neurofeedback equipment in violation of FDA regulations. Some of these individuals are then presuming that they are qualified to put electrodes on someone’s head and to seek to alter the brain functioning of persons with serious medical and psychological conditions. As part of consumer protection it is incumbent upon professionals to report such unlicensed lay practitioners to state regulatory bodies as practicing psychology and medicine without a license when they are found to be offering services for medical, psychiatric and psychological conditions.

Health care professionals who are licensed for independent practice may learn more about neurofeedback training and certification, or identified certified individuals, through consulting the Biofeedback Certification Institute of America ([www.bcia.org](http://www.bcia.org)), the International Society for Neurofeedback and Research ([www.isnr.org](http://www.isnr.org)) or the Association for Applied Psychophysiology and Biofeedback ([www.bcia.org](http://www.bcia.org)). The ISNR website also includes a comprehensive bibliography of outcome literature on neurofeedback which is periodically updated.

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