

Developments in Neurofeedback: Should Health Educators Be Paying Attention?

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Abstract

Since the early 1970s, neuroscientists recognized that it was possible for patients to re-regulate brain wave activity. Much of this early work focused on helping persons with epilepsy control their seizures and was later extended toward helping children with attention-deficit hyperactivity disorder (ADHD) with concentration. This brainwave training is called quantitative electroencephalography (QEEG) biofeedback or neurofeedback. Today, there is increasing scientific evidence that neurofeedback training can help address a variety of cognitive and behavioral issues in children and adults; particularly in the area of ADHD. In addition, neurofeedback is being employed in the treatment of those persons with alcohol and drug dependency, anxiety disorders, traumatic brain injury, chronic pain, depression, and autism spectrum disorders. Further, there appears to be a growing public awareness and support of this technology. This article explores the history of QEEG, reviews the biological basis for neurofeedback training, identifies how this technology appears to help clients with a variety of psychological and physiological disorders, and offers a critique concerning the state-of-research regarding neurofeedback efficacy. Strategies on the part of health educators to responsibly engage emergent developments in the field of neurofeedback are offered.

Introduction

Berger's (1929) seminal research on electrical brain activity is generally credited with allowing clinicians and scientists to observe brain waves for the first time in a meaningful way. During a 10 year period, Berger would publish over a dozen reports on human electroencephalography (EEG) and its relation to an individual's mental state. For example, bursts of sinusoidal waves tended to occur in a predictable fashion and were consistently observed in persons exhibiting inattention or inactivity while other types of brain wave activity tended to be associated with neurological disturbances (Kaiser, 2005).

In the 1960s and 1970s, neuroscientists recognized that it was possible to re-regulate brain wave activity. Much of this early work focused on helping persons with epilepsy control their seizures (Lubar & Bahler, 1976) and later was extended toward helping children with attention-deficit hyperactivity disorder (ADHD) with concentration (Sternman, 2000). Today,

this brainwave training is called QEEG or neurofeedback. QEEG neurofeedback treatment developed from years of EEG research that shows that symptoms common to many disorders are associated with specific patterns of abnormal brain wave activity. QEEG-guided neurofeedback helps target specific brain waves believed to play a role in undesirable symptoms. Until relatively recently, the electrical signals generated by the brain (and measured by electrodes on the scalp) were considered too small or haphazard to be employed to diagnose aberrant brain activity. The 1965 discovery of the Fast Fourier Transformation algorithm coupled with rapid advances in computer technology, however, now enable clinicians to employ multimedia computer screens and speakers that display meaningful patterns of brainwave activity in "real-time" (Othmer, 2009). These developments allow clinicians to train a client's brain activity toward an age-matched population norm because any deficit or excess of specific brain waves is conceived as evidence of an abnormal neurophysiological and mental state (Peniston & Kulkosky, 1989). Two other unique forms of neurofeedback are the Low Energy Neurofeedback System (Hammond, 2007) which introduces a tiny electrical signal to the brain to effect changes in brain wave modulation and hemoencephalography, which trains the client to modify blood flow to specific areas in the brain (Toomim & Carmin, 2009).

Neurofeedback Training

To evaluate brainwave function, a QEEG assessment is normally performed with the client wearing a secure fitting cap which contains electrodes to measure the strength of conventional frequency bands such as beta, alpha, theta, delta, and gamma in cycles per second or hertz (Hz). During the assessment, the client may sit quietly or sometimes be asked to read a book or engage in an intellectual challenge such as solving a math problem. The data are compared to a large normative database containing representative samples of healthy and otherwise normal functioning individuals with no history of neurological, psychiatric, or behavioral problems (Thatcher & Lubar, 2009). To further assist in a diagnosis, clinicians can compare the client's results with QEEG profiles typically identified in persons with epilepsy, traumatic brain injury (TBI), anxiety disorders, depression, autistic disorders, substance abuse, and ADHD. For example, many children with ADHD generate excessive theta activity while reading which results in day-dreaming and lack of focus (Thompson & Thompson, 2009).

During a neurofeedback training session, the client learns to modify brain wave activity to enable a video, a song, or a game to be played. Knowledge about brain waves or EEGs is not necessary for the client to possess—the brain will simply find a way to stay in those frequencies that allow the video or

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game to continue playing. Through consistent practice and feedback (sometimes up to 40-60 hourly training sessions over several weeks), most persons can re-train their brain waves to healthier frequencies - a change that is long lasting and even permanent in some (Serman, 2000). At present, QEEG-guided neurofeedback is considered efficacious for the clinical treatment of epilepsy (Thompson & Thompson, 2009).

Traumatic Brain Injury and Chronic Pain

Since the 1980s, QEEG neurofeedback has been employed to treat mild to moderate head-injured persons (Ayers, 1987). Specific benefits include improvements in self-reported symptoms, better performance on cognitive assessments and significant normalization of the patients' brain waves (Duff, 2004). More recently, Thornton and Carmody (2005) showed success employing QEEG neurofeedback with children with ADHD who have experienced traumatic brain injury.

Chronic pain due to head trauma also responds to neurofeedback training. In addition, patients with pain related to neck and back injuries, cancer, bruxism, rheumatoid arthritis, and various lower limb neuropathies often experience significant relief when following tailored neurofeedback treatment protocols (Ibric & Dragomirescu, 2009).

Mood Disorders and Addictions

QEEG neurofeedback has been reported to be effective in treating several types of mood disorders including depression (Walker, Lawson, & Kozlowski, 2007) and anxiety (Price & Budzynski, 2009). Post-traumatic stress disorders also appear to be positively impacted by neurofeedback (Trudeau et al., 1998). QEEG neurofeedback and other neurofeedback protocols such as alpha/ theta feedback training have been reported to be helpful among adults in the treatment of substance abuse disorders including alcoholism (Passini, Watson, Dehnel, Herder, & Watkins, 1997) and stimulant abuse (Scott, Kaiser, Othmer, & Sideroff, 2005). Neurofeedback also shows potential as a treatment modality for adolescents, particularly those presenting with stimulant abuse, attentional disorders, and behavioral problems (Trudeau, 2005).

ADHD, Learning Disorders, and Developmental Disabilities

In the pediatric field, the most widespread application of neurofeedback is for the treatment of ADHD (Gruzelier & Egner, 2005). Rossiter and Lavaque (1995) and Fuchs, Birbaumer, Lutzenberger, Gruzelier, and Kaiser (2003) have shown this type of intervention to be as effective as stimulant medication. In addition, the effects of neurofeedback do not disappear after training stops whereas the effects of stimulant medications such as Ritalin and Adderall last only as long as the child is taking them (Thompson & Thompson,

2009). Duffy (2000) believes the research literature supports neurofeedback as a major therapeutic modality in the treatment of this difficult condition. More specifically he states "In my opinion, if any medication had demonstrated such a wide spectrum of efficacy it would be universally accepted and widely used" (Duffy, 2000, p. v).

Neurofeedback training appears to enhance scholastic achievement among children with learning disorders on measures of reading, mathematics, and written expression (Hirshberg, Chiu, & Frazier, 2005; Beccara et al., 2006). Another recent area of QEEG neurofeedback application has been with persons diagnosed with Asperger's syndrome and other autism spectrum disorders (Scolnick, 2005).

Combining Neurofeedback with Traditional Treatments

Multiple modality approaches have consistently been recommended by leaders in the field of neurofeedback (Lubar & Lubar, 1999). Hammond and Baehr (2009), for example, combine neurofeedback training for depression with psychotherapy, exercise, nutritional counseling, and antidepressants. Trudeau, Sokhadze, and Cannon (2009) stress that neurofeedback is not to be used as a standalone treatment for addictive disorders but should be integrated with other therapies including 12-step programs, cognitive behavioral therapy, and medication. Likewise, Thompson and Thompson (2009) believe the establishment of regular routines, consistent bedtimes, parental training, family therapy, and standard front-line stimulant medications like Ritalin are all useful in promoting self-regulation skills to address ADHD.

Concerns Regarding Efficacy

Despite its growing popularity, neurofeedback is not without its critics. One of the most outspoken is Dr. Russell Barkley, who has long held the view that ADHD neurofeedback research relies overly much on case studies that typically lack control groups, involve small sample sizes, do not include randomized assignment to treatments, and lack placebo control procedures (as cited in Loos & Barkley, 2005). In addition, the confounding effect of collateral treatments including concurrent behavior modification and use of stimulant medication among some neurofeedback recipients makes it difficult to determine the effect of neurofeedback per se (Lohr, Meunier, Parker, & Kline, 2001)

Many neurofeedback practitioners and researchers agree with these criticisms and the last decade has witnessed more tightly controlled studies specifically designed to address earlier methodological weaknesses; particularly in the area of ADHD (Lavaque et al., 2002). These studies confirm findings of previous neurofeedback investigations, even under stricter control conditions. For example, in comparing the effectiveness of neurofeedback with that of Ritalin while controlling for variables such as parenting programs and school-based academic support, Monastra and his

colleagues found that neurofeedback produced better results than medication (Monastra, Monastra, & George, 2002). In replicating an earlier study using a larger sample size and improved statistical analysis, Rossiter (2004) was again able to demonstrate neurofeedback outcomes equivalent to those obtained from stimulant drugs. Employing the 4-level scale of the American Academy of Child and Adolescent Psychiatry (AACAP), Hirshberg et al. (2005) stated that neurofeedback met the AACAP criteria for “Clinical Guidelines,” which is based upon strong empirical evidence and/or strong clinical consensus. (See Table 1 for the four levels.)

Perhaps the most rigorous examination of the effectiveness of neurofeedback on ADHD to date is the study carried out by German researchers that employed a large sample size, randomized assignment to an experimental or control group, and validated outcome measures. Findings indicated improvements in the neurofeedback group that were superior to those in the control group in the areas of inattention, oppositional behavior, and physical aggression (Gevensleben et al., 2009).

Cautions and Caveats

Unfortunately, as the prevalence of neurofeedback treatment increases, so do the ranks of questionable practitioners. At this time, certified neurofeedback practitioners can be found by examining the Biofeedback Certification International Alliance website (2011) or by consulting the membership directory for the International Society for Neurofeedback and Research (2011). In addition, Thompson and Thompson (2003) believe that any parent considering neurofeedback treatment for ADHD and other learning problems for their child should initially see a physician to rule out various medical conditions.

Another concern is expense. Depending upon the qualifications of the provider and the clinical setting, initial consultations can cost several hundred dollars with each treatment session costing as much as \$50 to \$120 (Thompson & Thompson, 2003). Despite its growing research base and utilization by thousands of health care practitioners

in 27 countries, most insurance companies still perceive neurofeedback as experimental and do not reimburse for these services (Hammond, 2011).

Discussion

As a non-invasive, drug-free treatment for a variety of mental and physical disorders and learning problems, neurofeedback is gathering support every year among researchers and practitioners. Recent articles in *U.S. News & World Report* (Johnson, 2009) and the *New York Times* (Ellison, 2010) point to a growing public awareness of this technology. Neurofeedback is being employed by Olympians, high school and college athletes, and corporate executives to enhance performance (Institute of Neuropsychology and Cognitive Performance, 2011). As stated earlier, over the last decade several schools in the United States have begun to employ neurofeedback for the special education of children with ADHD and learning problems (Hirschberg et al., 2005; Beccara et al., 2006).

A number of professional organizations are recognizing the legitimacy of neurofeedback. The American Psychological Association’s Division 42 Practice Directorate, for example, has declared neurofeedback to be a special competence within the field of psychology (Neblett, Shaffer, & Crawford, 2008). Neurofeedback training courses such as those offered by the Biofeedback Certification International Alliance (2011) have been approved by the American Psychological Association and by the National Association of Social Workers for continuing education credits. Since 2003, the American Psychiatric Association has sponsored a 6-hour continuing medical education course called EEG Neurofeedback in Psychiatry at its annual meeting (About Neurofeedback, 2011).

Translation to Health Education Practice

At this time, the major application of health education to neurofeedback is for the health educator to function as a resource person. For example, health educators and

Table 1

American Academy of Child and Adolescent Psychiatry (AACAP)

Level 1	Not Endorsed (NE)	Applies to practices known to be ineffective or contraindicated.
Level 2	Option (OP)	Applies to recommendations that are acceptable based on emerging empirical evidence (e.g., uncontrolled trials or case series/reports) or clinical opinion, but lack strong empirical evidence and/or clinical consensus.
Level 3	Clinical Guidelines (CG)	Applies to recommendations based on strong empirical evidence and/or strong clinical consensus. Clinical guidelines apply approximately 75% of the time (i.e., in most cases).
Level 4	Minimal Standard (MS)	Applies to recommendations backed up by rigorous empirical evidence, and/or an overwhelming clinical consensus. Minimal standards apply more than 95% of the time (i.e., in almost all cases).

coaches might be consulted by parents about the value of investing in neurofeedback treatments to achieve better sports performance. These parents might be directed to examine the web site of the Association for Applied Psychophysiology and Biofeedback (2011) to keep themselves up-to-date on the latest media coverage and research. Parents who are exploring the use of neurofeedback to help a child recover from a sports-related concussion should first be referred to their child's pediatrician, a neurologist, or a clinical neuropsychologist. Likewise, questions concerning the use of neurofeedback to enhance academic performance should be directed to the school psychologist who will typically have a great deal of training in learning disorders (Miller, 2009). School psychologists are also in position to know if any other students in the district are undergoing neurofeedback training. For their part, health educators might suggest parents and other caregivers visit the EEG Info Newsletter (n.d.) website that links to several video clips which allow parents to share personal experiences with neurofeedback. Table 2 lists several resources for those interested in learning more about neurofeedback and similar applications.

As neurofeedback gains greater acceptance among traditional health care providers, health educators could incorporate information about neurofeedback into consumer health courses in college/ university settings. Health educators who desire employment in clinical settings that utilize neurofeedback and related therapies may consider pursuing additional coursework in neuroscience and brain disorders.

Conclusions

The roles and opportunities for health education and behavior change professionals in the 21st century will continue to increase as new scientific tools for self-regulation

are developed, tested, and successfully employed to enhance health and prevent disease. Innovations in brain-based interventions such as neurofeedback will hopefully challenge many in our profession to consider how to responsibly integrate this emergent technology into the field of health education and health promotion.

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Table 2

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