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### **Neurofeedback Training for Substance Use Disorders: A Review of the Applicability in Treatment**

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#### **Abstract**

This paper reviews the applicability of implementing neurofeedback training in the treatment of substance use disorders. This is a relatively symptom free treatment modality that is based on operant conditioning in which clients receive audio or visual feedback to reinforce and/or inhibit certain brainwave frequencies. By helping clients change brainwave patterns and alter some aspects of neuronal functioning, neurofeedback training promotes neuroplasticity, which can be beneficial in the treatment of substance use disorders. The primary treatment modalities for neurofeedback when used with substance use disorders include the Peniston Protocol, the Scott-Kaiser Modification of the Peniston Protocol, and quantitative electroencephalography (QEEG) guided training. Studies implementing the Peniston Protocol with alcohol dependent individuals have shown higher abstinence rates and lower levels of depression compared to traditional treatment. Research on the Scott-Kaiser Modification of the Peniston Protocol suggests that this protocol is highly successful in terms of retention and abstinence for a variety of substance use disorders. While few studies have been conducted on QEEG-guided neurofeedback training, the results of this training have been comparable to the other two modalities in terms of abstinence rates. Overall, neurofeedback training appears to be an efficacious treatment modality that promotes high rates of abstinence for individuals with substance use disorders.

#### **Introduction**

Substance use disorders are marked by cognitive, behavioral, and physiological symptoms and a change in brain circuitry that may continue despite detoxification (American Psychiatric Association, 2013). Treatment of substance use disorders is often difficult and it is estimated that 65–70% of clients using traditional methods such as talk therapy and 12-step programs relapse within a year (McKay, Atterman, Rutherford,

Cacciola, & McLellan, 1999). Recently, a growing body of research has focused on using electroencephalographic (EEG) biofeedback, also known as neurofeedback, in the treatment of substance use disorders with positive results.

Research on the use of EEG biofeedback as a treatment modality began around 1970 for uncontrolled epilepsy and anxiety (Cantor & Evans, 2014; Chapin & Russell-Chapin, 2014; Demos, 2005). Since then, numerous studies have found neurofeedback training to be effective for the treatment of several disorders including attention deficit hyperactivity disorder (ADHD), anxiety, depression, substance abuse, post-traumatic stress disorder, chronic pain, epilepsy, headaches, insomnia, traumatic brain injury, autism spectrum disorders, cognitive inefficiency, and personality disorders (Cantor & Evans, 2014; Chapin & Russell-Chapin, 2014). Neurofeedback training can also be used for performance enhancement in athletics, academics, the arts, and business (Chapin & Russell-Chapin, 2014; Demos, 2005).

EEG biofeedback is a form of neurotherapy that typically involves a brain-computer interface to map certain areas of an individual's brain activity by placing one or more electrodes on specific locations on the scalp with reference and/or ground electrodes on the ears or scalp (Cantor & Evans, 2014; Chapin & Russell-Chapin, 2014; Demos, 2005). This allows for computerized systems to provide real-time feedback of the brain's activity. Neurofeedback training is a treatment modality that is relatively side effect free (minor headache and/or temporary disorientation are the most common side effects reported) and is based on operant conditioning, in which clients receive feedback to reinforce and/or inhibit certain brainwave frequencies. These frequencies include delta, theta, alpha, beta, and gamma. By helping clients change brainwave patterns and alter some aspects of neuronal functioning, neurofeedback training promotes neuroplasticity (Cantor & Evans, 2014; Chapin & Russell-Chapin, 2014; Demos, 2005). Typically, visual and/or audio feedback is provided to clients when they reach a pre-set threshold that is established by the clinician (Cantor & Evans, 2014; Demos, 2005). Research suggests that approximately 75–80% of people can retrain how the brain functions (Cantor & Evans, 2014). Because such a large percentage of people have the ability to retrain their brain functioning, evidence from research (Burkett, Cummins, Dickson, & Skolnick, 2005; Calloway & Bodenheimer-Davis, 2008; Cantor & Evans, 2014; Chapin & Russell-Chapin, 2014; DeBeus, Prinzel, Ryder-Cook, & Allen, 2002; Demos, 2005; Dughani-Arani, Rostami, & Nadali, 2013; Peniston & Kulkosky, 1989; Romano-Micha, 2003; Saxby & Peniston, 1995; Scott & Kaiser, 1998; Scott, Kaiser, Othmer, & Sideroff, 2005; Sokhadze, Cannon, & Trudeau, 2008; Sokhadze, Trudeau, & Cannon, 2014; Trudeau, 2005a; Trudeau, Sokhadze, & Cannon, 2009; Utterainer, Chen, & Gruzelier, 2013) continually shows that EEG biofeedback training is effective in the treatment of several areas of problematic functioning including substance use disorders.

In addition to its use in treatment, EEG can be used to assess clients for mental health disorders (Cantor & Evans, 2014; Chapin & Russell-Chapin, 2014). This usually involves conducting a quantitative EEG (QEEG) assessment in which clinicians place 19 to 21 electrodes on the scalp according to the International 10 20 system (Cantor & Evans, 2014). Information from this assessment is matched with a database that compares the data to norms for a client's age. It is then possible from QEEG to choose either a standard training protocol or individualized one to reinforce and/or inhibit certain EEG frequencies that are different from the norm (Romano-Micha, 2003).

The purpose of this paper is to review the applicability of using the Peniston Protocol, the Scott-Kaiser Modification of the Peniston Protocol, and QEEG-guided neurofeedback training in the treatment of substance use disorders. Additionally, a brief review is provided of the brainwave frequencies, EEG frequency abnormalities caused by different substances of abuse, and alpha-theta training. Lastly, suggestions are given about future considerations for research and therapy.

### **Major Brainwave Frequencies and Rhythms**

The major brainwave frequencies of the brain include delta, theta, alpha, beta, and gamma (Chapin & Russell-Chapin, 2014; Demos, 2005; Myers & Young, 2012; Russell-Chapin & Chapin, 2011; Soutar, 2014). Delta waves occur at 1–4 Hertz (Hz) and are associated with sleep (Chapin & Russell-Chapin, 2014; Demos, 2005; Myers & Young, 2012; Russell-Chapin & Chapin, 2011) and hypothalamic function (Chapin & Russell-Chapin, 2014). These waves are also linked to memory function and general neurotransmitter activity. Slower frequency delta waves may play a role in cortical integration with the body, while higher frequency delta function may be associated with cognitive processes such as working memory (Soutar, 2014).

Theta waves (4–7 Hz) appear to play a role in emotion, memory, and spatial processing and are present in encoding and retrieval (Soutar, 2014). High frequencies of theta waves are seen during creativity and spontaneity (Demos, 2005), drowsiness (Chapin & Russell-Chapin, 2014; Demos, 2005; Myers & Young, 2012; Russell-Chapin & Chapin, 2011), hypnosis (Chapin & Russell-Chapin, 2014), and inattention (Demos, 2005). For alpha waves (8–12 Hz), it is suggested that they are related to thalamic function (Chapin & Russell-Chapin, 2014; Soutar, 2014), relaxation (Chapin & Russell-Chapin, 2014; Demos, 2005; Myers & Young, 2012; Russell-Chapin & Chapin, 2011), brain idling (Myers & Young, 2012; Russell-Chapin & Chapin, 2011), and resource allocation in the cortex (Soutar, 2014).

Sensorimotor rhythm (SMR; 12–16 Hz) is not a frequency but rather a rhythm that is commonly trained and researched (Chapin & Russell-Chapin, 2014; Demos, 2005; Myers & Young, 2012; Russell-Chapin & Chapin, 2011; Soutar, 2014). SMR is associated with being internally oriented. These waves are found in the sensorimotor cortex and increase when the brain's motor circuitry is idle (Demos, 2005). Beta waves (13–21 Hz) are active during concentration and problem solving (Chapin & Russell-Chapin, 2014; Demos, 2005; Myers & Young, 2012; Russell-Chapin & Chapin, 2011; Soutar, 2014), while high beta (20–32 Hz) is associated with anxiety (Chapin & Russell-Chapin, 2014; Demos, 2005; Myers & Young, 2012; Soutar, 2014), arousal (Demos, 2005; Soutar, 2014), rumination, and peak performance (Demos, 2005). Lastly, gamma waves (35–45 Hz) appear to be associated with cortical processing related to cognitive efficiency (Chapin & Russell-Chapin, 2014; Demos, 2005; Soutar, 2014), and recent research has investigated the potentiality of enhancing intelligence through gamma training (Soutar, 2014).

## **EEG Changes in Substance Use**

It is well documented that different EEG abnormalities are produced by different substances of abuse (Alper, 1999; Alper, Prichep, Kowalik, Rosenthal, & John, 1998; Fingelkurts et al., 2006; Gilbert & Diggs, 2013; Prichep et al., 1996; Prichep et al., 1999; Rajeswaran, Bennet, Thomas, & Rajakumari, 2013; Ross, 2013; Sokhadze et al., 2008; Trudeau et al., 2009). In alcohol dependency, much of the research suggests that EEG abnormalities include lower frontal alpha and slow-beta coherence, increases in absolute and relative beta, and decreases in alpha and delta/theta power (Gilbert & Diggs, 2013; Rajeswaran et al., 2013; Ross, 2013; Sokhadze et al., 2008; Trudeau et al., 2009). QEEG for acute marijuana exposure tends to show an increase in relative power of alpha, a decrease in alpha frequency, and a decrease in relative power of beta at posterior electrode sites (Gilbert & Diggs, 2013; Ross, 2013; Sokhadze et al., 2008; Trudeau et al., 2009), while chronic use is associated with persistent elevations of alpha absolute power, relative power, and interhemispheric coherence as well as decreases in delta and beta relative power over the frontal cortex (Ross, 2013).

The most frequent changes in heroin involve a deficit in alpha activity and an excess of fast beta (Fingelkurts et al., 2006; Gilbert & Diggs, 2013; Ross, 2013; Sokhadze et al., 2008; Trudeau et al., 2009). Increases in absolute theta, alpha, and beta power are associated with acute cocaine and crack cocaine use (Alper, 1999; Gilbert & Diggs, 2013; Ross, 2013; Sokhadze et al., 2008; Trudeau et al., 2009). Long-term use of cocaine and crack cocaine shows increased alpha and beta activity and reduced delta and theta activity (Alper, 1999; Alper et al., 1998; Prichep et al., 1996; Ross, 2013; Sokhadze et al., 2008; Trudeau et al., 2009). Prichep et al. (1999) suggested that different EEG profiles for individuals with cocaine use disorder may predict treatment outcomes. Results from their study showed that individuals with an excess of power in the alpha frequency band stayed in treatment longer than individuals with relative excess of anterior beta activity and excess alpha. When looking at QEEG profiles in methamphetamine use, consistent findings include increases in delta and theta frequencies (Gilbert & Diggs, 2013; Ross, 2013; Sokhadze et al., 2008; Trudeau et al., 2009).

## **Alpha-Theta Training**

Both the Peniston Protocol and the Scott-Kaiser Modification of the Peniston Protocol use alpha-theta training (Peniston & Kulkosky, 1989; Saxby & Peniston, 1995; Scott & Kaiser, 1998; Scott et al., 2005). The primary purpose of alpha-theta training is to increase the frequency of both alpha and theta waves (Demos, 2005). By increasing the frequency of these waves, it helps promote a twilight state in which the individual can feel relaxation and effects similar to mindfulness meditation. This twilight state can result in the client experiencing hypnagogic imagery, which is imagery that can be very powerful in the healing process by helping clients create subconscious images such as repressed feelings and memories. Peniston and Kulkosky (1989) believed that inducing a hypnagogic state would improve recovery because it can create a state of reverie and suggestibility to enhance personal insight during therapy.

Traditional treatment for substance use disorders may raise levels of beta endorphins, which can cause clients to have more cravings due to increased anxiety (Demos, 2005; Peniston & Kulkosky, 1989). Research on alpha-theta training for substance use disorders often indicates that cravings and anxiety are reduced (Calloway & Bodenheimer-Davis, 2008; Demos, 2005; Peniston & Kulkosky, 1989; Saxby & Peniston, 1995; Scott & Kaiser, 1998; Scott et al., 2005). One side effect of this training is the Peniston effect, which can cause some clients to have an allergic reaction (often becoming physically ill) to the substance they previously abused (Demos, 2005). While Demos (2005) stated that he has personally never seen a client have this effect, he discussed how some studies have reported this side effect occurring in individuals who use eyes-closed alpha/theta or alpha training five or more times a week. The Peniston effect attests to the strong, positive results that neurofeedback training can have on treating individuals for substance use disorders.

### **Neurofeedback Training Protocols**

As mentioned earlier, the neurofeedback training protocols this paper focuses on include the Peniston Protocol, the Scott-Kaiser Modification of the Peniston Protocol, and QEEG-guided neurofeedback training. This section provides an overview of the procedures for using these protocols with clients in therapy. Additionally, studies using these protocols are presented to provide evidence of their effectiveness in the treatment of substance use disorders.

#### **Peniston Protocol**

Success of the Peniston Protocol in the treatment of substance use disorders is well documented (Calloway & Bodenheimer-Davis, 2008; Chapin & Russell-Chapin, 2014; Peniston & Kulkosky, 1989; Peniston & Kulkosky, 1991; Rajeswaran et al., 2013; Ross, 2013; Saxby & Peniston, 1995; Sokhadze et al., 2008; Sokhadze et al., 2014; Trudeau, 2005a; Trudeau et al., 2009). This protocol aims to enhance occipital alpha and theta frequencies in order to induce a theta state to heighten awareness and suggestibility, which should improve recovery (Peniston & Kulkosky, 1989; Ross, 2013; Trudeau, 2005a; Trudeau et al., 2005b). This protocol was first used in research by Peniston and Kulkosky (1989).

Peniston and Kulkosky (1989) tested the effects of an alpha-theta EEG training protocol with a group of subjects from the Topeka Veterans Affairs (VA) hospital inpatient program for alcohol dependence. The results of the alpha-theta training group ( $n = 10$ ) were compared to an alcohol dependent control group ( $n = 10$ ) that received traditional treatment and a control group ( $n = 10$ ) of individuals who were not diagnosed with a substance use disorder. All participants took pre- and post-test EEG assessments, Beck Depression Inventory (BDI), and blood sample measures for beta endorphin levels.

Subjects who participated in EEG training saw significant increases in alpha and theta activity and alpha rhythm amplitude (Peniston & Kulkosky, 1989). Compared to the pre-test, the post-test EEG of the experimental group revealed nearly a 12-fold increase in alpha waves and nearly a five-fold increase in theta waves. No differences were seen between pre- and post-test EEG for the alcohol dependent control group or the non-alcohol dependent control group. For the BDI, only the experimental group showed a

significant decrease in scores compared to the pre-test. Additionally, this group saw its scores reduce by half and to a level that was no different than the non-alcohol dependent control group. Only the alcohol dependent control group experienced changes in beta endorphin levels, and the increase in these levels was believed to be related to rising stress related to abstinence that may have been causing cravings. Data from a 13-month follow-up revealed significant differences in sustained abstinence between the EEG group and alcohol dependent control group. Only two of the participants in the EEG treatment group relapsed compared to eight members of the alcohol dependent control group.

The EEG training protocol, which has become known as the Peniston Protocol, consists of an average of eight 30-minute temperature biofeedback sessions prior to 15 30-minute alpha-theta biofeedback sessions (Peniston & Kulkosky, 1989). During the temperature biofeedback sessions, a thermometer is attached to the middle finger of the client's non-dominant hand, and temperature feedback is practiced until the hand can be warmed to over 95 degrees Fahrenheit for the duration of one session. The reasoning is that temperature training possibly increases theta activity to produce a more hypnotic state, which may better prepare individuals for the neurofeedback training, which tries to produce a theta state (Chapin & Russell-Chapin, 2014; Peniston & Kulkosky, 1989; Peniston & Kulkosky, 1991; Saxby & Peniston, 1995).

For the EEG protocol, an electrode is placed at the International 10 20 site 01, which is on the left hemisphere at the occipital lobe (Peniston & Kulkosky, 1989). Clients are instructed to close their eyes and relax during this protocol while a standard induction script is read to them to help them relax and sink down into a state of reverie (Peniston & Kulkosky, 1989; Peniston & Kulkosky, 1991; Saxby & Peniston, 1995). Feedback in the form of audio tones is presented when clients exceed a preset threshold for alpha and theta waves. A pleasant tone is heard when they meet the threshold for alpha waves, and by learning to voluntarily produce this tone, clients become more relaxed. When the threshold for theta is exceeded, a different pleasant tone is produced, and learning to voluntarily produce this tone can put clients into a hypnagogic state of high suggestibility and free reverie (Peniston & Kulkosky, 1989). A counseling session follows the neurofeedback training while the client is in this state to explore the imagery and any abreactions experienced during the session (Chapin & Russell-Chapin, 2014; Peniston & Kulkosky, 1989; Peniston & Kulkosky, 1991; Saxby & Peniston, 1995; Trudeau, 2005b).

Additional studies using the Peniston Protocol have produced similar results to the original study by Peniston and Kulkosky (1989). Saxby and Peniston (1995) used this protocol with a group ( $n = 14$ ) of alcohol dependent patients from an outpatient treatment program. Compared to pre-test results, the subjects had significantly lower BDI scores and significantly decreased personality variable scores on the Million Clinical Mutliaxial Inventory (MCMI) across schizoid, avoidant, dependent, histrionic, passive-aggressive, schizotypal, borderline, anxiety, somatoform, hypomanic, dysthymic, alcohol abuse, drug abuse, psychotic thinking, and psychotic depression scales. At a 21-month follow-up, it was reported that only one of the 14 subjects relapsed.

In an uncontrolled study, Kelley (1997) used the Peniston Protocol with a group of subjects ( $n = 19$ ) who were members of the Navajo Nation and alcohol dependent. Forty neurofeedback sessions were given in addition to the treatment received during a 33-day inpatient abuse program. The results at a 3-year follow-up indicated that 12 of the

subjects had sustained partial remission, four had sustained full remission, and three remained dependent on alcohol. A significant decrease in BDI scores at post-test was seen in this group. Of note, the author developed a culturally appropriate protocol that included Navajo terminology, imagery, music, and metaphors, and this protocol was formally approved by the Navajo Nation and the U.S. Indian Health Service, among other tribal agencies.

Calloway and Bodenheimer-Davis (2008) investigated the use of the Peniston Protocol with a variety of substance use disorders including alcohol, marijuana, prescription medication, and polysubstance use with alcohol and another drug. A group of 16 participants (13 male, 3 female) from a university-based clinic who underwent the Peniston Protocol was compared to a control group that consisted of 24 subjects (19 male, 5 female). In the experimental group, 10 (8 male, 2 female) were probationers, and the control group was intended to closely resemble them. The results showed that 13 (81.3%) members from the Peniston Protocol group were abstinent at follow-up between 74 and 98 months after treatment, which is a higher rate of long-term abstinence than conventional treatments for substance dependence that report 65–70% of clients relapse within a year (McKay et al., 1999). From the subjects in the EEG group who were probationers, 60% ( $n = 6$ ) had no probation revocations or rearrests, which was much better than the 19 (79.16%) who had probation revocations or rearrests in the non-EEG probationer group.

While studies have shown that the Peniston Protocol has been effective in the treatment of alcohol and other substances including marijuana and prescription medication, Fahrion (1995) found that it was not as effective for cocaine dependence. His study used the Peniston Protocol with a group of male felons who abused cocaine and marijuana and were in a prison-based treatment program. While the neurofeedback group featured a higher percentage of clean urine drug screens and less parole violations compared to a control group after 6 and 12 months following release from prison, Fahrion noted that the Peniston Protocol was more effective for the marijuana abusers than the cocaine abusers.

### **Scott-Kaiser Modification of the Peniston Protocol**

Scott and Kaiser (1998) modified the Peniston Protocol in an effort to use neurofeedback training with people who abused stimulants. Based on the prevalence of pre-existing ADHD in many adults who abuse stimulants, Scott and Kaiser combined a beta-SMR training protocol with the alpha-theta training of the Peniston Protocol. Beta-SMR training is commonly used in the treatment of ADHD, and it is believed untreated ADHD in adolescence can be a risk factor for substance use disorders, particularly stimulant abuse (Bauer, 2001; Sokhadze et al., 2014; Trudeau, 2005a). In this study by Scott and Kaiser (1998), participants who mainly abused stimulants underwent 10 to 20 sessions of beta-SMR training followed by 30 alpha-theta training sessions. This group showed significant improvements in attention, as measured by the Test of Variables of Attention (TOVA) scores; general distress, as measured by Minnesota Multiphasic Personality Inventory (MMPI) scores; and abstinence rates compared to a control. Additionally, this group stayed in a substance abuse program longer than the control group that received traditional treatment.

This protocol became known as the Scott-Kaiser Modification of the Peniston Protocol. Two phases make up this protocol (Scott & Kaiser, 1998; Scott et al., 2005). In Phase I, clients engage in 10–20 sessions of an eyes-open protocol for beta-SMR augmentation and theta suppression. Electrode placement is based on the International 10/20 system, and electrodes are placed at C3 (just left of the midpoint on the brain) for beta and C4 (just right of the midpoint on the brain) for SMR with both electrodes referenced to Fpz, which is the middle of the forehead. The Test of Variable of Attention (TOVA) is administered after 10 sessions, and if clients score within normal limits of attention, they can move on to Phase II. If not, five to 10 additional sessions are given. After completion of beta-SMR training, clients receive 30 sessions of alpha-theta training, which is similar to the Peniston Protocol. One difference between the two protocols is the Scott-Kaiser Modification of the Peniston Protocol does not use temperature biofeedback training prior to neurofeedback.

A follow-up study (Scott et al., 2005) for the Scott-Kaiser Modification of the Peniston Protocol featured 121 subjects from a residential treatment facility in the Los Angeles area who had a variety of substance use disorders including alcohol, heroin, cocaine, and methamphetamine. The treatment group ( $n = 61$ ) participated in the Scott-Kaiser Modification of the Peniston Protocol and conventional treatment, while the control group ( $n = 60$ ) participated only in conventional treatment, which was based on the Minnesota Model 12-step group. The results showed that on average the experimental group stayed in treatment for 136 days compared to 98 days for the control group. Additionally, 46% of the control group dropped out of treatment following the first 12 weeks of the program, while only 24% of the experimental group dropped out. Of those individuals who completed the program, 36 of 47 (77%) participants in the experimental group were abstinent in the year follow-up compared to 12 of 27 (44%) from the control group.

In another study, Burkett et al. (2005) conducted a 5-year research project on the effectiveness of neurofeedback training for crack cocaine abuse. Participants from the Open Door Mission in Houston, TX, a faith-based homeless and drug treatment facility, were recruited to take part in training based on the Scott-Kaiser Modification of the Peniston Protocol. Results from this study showed that the individuals who received neurofeedback training stayed in treatment on average 103 days longer than those who did not. It was also seen that 92% of the participants at follow-up were maintaining a regular residence, 90.8% were employed or in training, and 88% had no arrests. Additionally, significant decreases were seen in depression and anxiety based on BDI and Clinical Anxiety Scale (CAS) scores at follow-up. The follow-up also revealed that 49.4% of participants remained abstinent, 40% used crack cocaine between one and nine times, and only 10.4% used more than 20 times.

Additional studies by Utterainer et al. (2013) and Denghani-Arani et al. (2013) used protocols similar to the Scott-Kaiser Modification of the Peniston Protocol to train subjects with substance use disorders with beta-SMR training followed by alpha-theta training. In a single case study, Utterainer et al. combined neurofeedback and short-term psychodynamic psychotherapy (STPP) to treat a college student who abused ketamine and psilocybin mushrooms and presented with depression. Ten weekly sessions were conducted that included neurofeedback and STPP. During each session, this student underwent a STPP session followed by two neurofeedback training sessions with the first

being beta-SMR training and the second being alpha-theta training. Results at follow-up from the Brief Symptom Inventory, BDI, the Schizotypal Personality Questionnaire, the Big Five Inventory, and the Multidimensional Inventory for Religious/Spiritual Well-Being indicated that the intervention reduced psychopathology. However, beta-SMR training was suboptimal due to no clear reduction in theta during this training, so it is difficult to measure how much of an effect neurofeedback training had in the treatment of this student.

Denghani-Arani et al. (2013) investigated whether treatment using neurofeedback could lead to changes in mental health and substance craving in individuals with opiate dependency. Participants ( $n = 20$ ) were recruited from an outpatient clinic for treatment of substance dependence disorders. The experimental group received neurofeedback treatment plus Methadone maintenance treatment (MMT) or Buprenorphine maintenance treatment (BMT) while the control group received only MMT or BMT. Each neurofeedback session included 20 minutes of beta-SMR training at the central brain cortex (Cz) followed by 20 minutes of alpha-theta training at parietal brain cortex (Pz). Both of these electrode placements are different than the Scott-Kaiser Modification of the Peniston Protocol. Based on results from this study, the experimental group decreased opiate craving and improved mental health more than the control. This group showed significant improvements in physical symptoms, depression, and overall mental health on the General Health Questionnaire (GHQ-28) and for anticipation of positive outcome, desire to use, and relief from withdrawal on the Heroin Craving Questionnaire (HCQ-45) compared to the control. Additionally, this study showed that neurofeedback training can be used in conjunction with medication for the treatment of substance use disorders.

### **QEEG-Guided Neurofeedback Training**

As reviewed earlier, QEEG abnormalities vary among different drugs, which is why some researchers recommend that clinicians consider an individualized treatment approach based on QEEG findings for substance use disorders (DeBeus et al., 2002; Romano-Micha, 2003; Sokhadze et al., 2008; Sokhadze et al., 2014; Trudeau, 2005a). Romano-Micha (2003) believed that some of the training protocols for substance use disorders oversimplify neurotherapy by providing a one-size-fits-all approach to different substances. While research is limited, preliminary results are promising for the QEEG-guided approach (DeBeus et al., 2002; Sokhadze et al., 2008; Sokhadze et al., 2014; Trudeau, 2005a).

The premise of the QEEG-guided approach is to conduct a QEEG assessment and identify brainwave frequencies that deviate from a normative database. The clinician then uses this information to develop an individualized protocol to train those frequencies at the specific locations on the scalp where they deviate from normal (DeBeus et al., 2002; Romano-Micha, 2003; Sokhadze et al., 2008; Sokhadze et al., 2014; Trudeau, 2005a). Romano-Micha (2003) stressed that QEEG analysis is complicated and requires additional training to differentiate different pathologies.

Compared to the Scott-Kaiser Modification of the Peniston Protocol, preliminary data from one study shows that the QEEG-guided approach is just as effective for treating substance use disorders after a two year follow-up (DeBeus et al., 2002). However, this study's small sample size makes it difficult to determine the efficacy of this training

protocol. Trudeau (2005a) believed that QEEG-guided neurofeedback training is a viable alternative to the Peniston Protocol and Scott-Kaiser Modification of the Peniston Protocol. More controlled research needs to be conducted on QEEG-guided neurofeedback to determine its efficacy (Romano-Micha, 2003; Sokhadze et al., 2008; Sokhadze et al., 2014; Trudeau, 2005a).

### **Conclusion and Future Directions**

EEG biofeedback training appears to be effective in the treatment of substance use disorders. Although several research studies have been conducted on the neurofeedback training protocols, Trudeau (2005a) and Yucha and Montgomery (2008) rate neurofeedback training for substance use disorders as probably efficacious due to a lack of well-controlled studies. Even with this rating, EEG biofeedback training is a viable option to consider when treating clients for substance use disorders because of the results from several studies showing long term abstinence, lower levels of depression and anxiety, longer time spent in treatment, and positive personality changes. Neurofeedback promotes self-regulation, and it appears that clients are motivated to engage in this type of therapy because they are responsible for the changes in their brainwaves, not the therapist (Demos, 2005).

White (2008) argued that the effectiveness of using neurofeedback training for substance use disorders has not been easily measured by empirical scientific methods because “it is heuristic (nonmeasurable), nonlinear, and difficult to control” (p. 294). While it may appear that using neurofeedback training is more dependent on the equipment than the therapist, White (2008) discussed that the neurofeedback equipment and training protocol are not in and of themselves the healing element and that the effectiveness of neurofeedback training depends on a combination of the procedure and the therapeutic skills of the therapist, particularly empathy. She suggested that using a protocol such as the Peniston protocol helps induce higher states of consciousness and insight, which allows individuals to reach a state where they are capable of making positive changes.

To improve the efficacy of neurofeedback training, more well-controlled studies need to be conducted for the three training protocols, particularly QEEG-guided neurofeedback training. Additionally, more research needs to be conducted on using neurofeedback training with substance use disorders that are comorbid with other disorders and looking at comorbid ADHD, conduct disorder (CD), and oppositional defiant disorder (ODD) in adolescents. It is believed that comorbid ADHD, CD, and ODD in adolescents is a risk factor for substance use disorders, and treating these can prevent substance use disorders in adulthood (Bauer, 2001; Sokhadze et al., 2014; Trudeau, 2005a). Finally, it is suggested that neurofeedback training be used as an adjunct therapy and not as a standalone treatment (Cantor & Evans, 2014; Chapin & Russell-Chapin, 2014; Demos, 2005). Research needs to be conducted on using EEG biofeedback training with specific therapies such as cognitive behavioral, solution focused, and psychodynamic in the treatment of substance use disorders. This can add to the efficaciousness of neurofeedback training and also help practitioners gain knowledge about which therapies may be better suited to use with neurofeedback training.

## References

- Alper, K. R. (1999). The EEG and cocaine sensitization: A hypothesis. *The Journal of Neuropsychiatry and Clinical Neurosciences*, *11*, 209–221.
- Alper, K. R., Pritchep, L. S., Kowalik, S., Rosenthal, M., & John, E. R. (1998). Persistent qEEG abnormality in crack cocaine users at 6 months of drug abstinence. *Neuropsychopharmacology*, *19*(1), 1–9.
- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5<sup>th</sup> ed.) Arlington, VA: American Psychiatric Publishing.
- Bauer, L. O. (2001). Predicting relapse to alcohol and drug abuse via quantitative electroencephalography. *Neuropsychopharmacology*, *25*, 332–340.
- Burkett, V. S., Cummins, J. M., Dickson, R. M., & Skolnick, M. (2005). An open clinical trial utilizing real-time EEG operant conditioning as an adjunctive therapy in the treatment of crack cocaine dependence. *Journal of Neurotherapy*, *9*(2), 27–47.
- Calloway, T. G., & Bodenheimer-Davis, E. (2008). Long-term follow-up of a clinical replication of the Peniston Protocol for chemical dependency. *Journal of Neurotherapy: Investigations in Neuromodulation, Neurofeedback and Applied Neuroscience*, *12*(4), 243–259.
- Cantor, D. S., & Evans, J. R. (Eds.). (2014). *Clinical neurotherapy: Application of techniques for treatment*. Boston, MA: Academic Press.
- Chapin, T. J., & Russell-Chapin, L. A. (2014). *Neurotherapy and neurofeedback*. New York, NY: Routledge.
- DeBeus, R., Prinzel, H., Ryder-Cook, A., & Allen, T. (2002). QEEG-based versus research-based EEG biofeedback treatment with chemically dependent outpatients: preliminary results. *Journal of Neurotherapy*, *6*, 64–66.
- Demos, J. N. (2005). *Getting started with neurofeedback*. New York, NY: Norton.
- Denghani-Arani, F., Rostami, R., & Nadali, H. (2013). Neurofeedback training for opiate addiction: Improvement in mental health and craving. *Applied Psychophysiological Biofeedback*, *38*, 133–141.
- Fahrion, S. (1995). Human potential and personal transformations. *Subtle Energies*, *16*, 430–438.
- Fingelkurts, A. A., Fingelkurts, A. A., Kivisaari, R., Autti, T., Borisov, S., Puurskari, V., Jokela, O., & Kahkonen, S. (2006). Increased local and decreased remote functional connectivity at EEG alpha and beta frequency band in opioid-dependency patients. *Psychopharmacology*, *188*, 42–52.
- Gilbert, D. G., & Diggs, H. A. (2013). Using quantitative EEG and EEG tomography to understand drug abuse: A quantum leap in new methods and benefits. In J. MacKillop, & H. de Wit (Eds.), *The Wiley-Blackwell handbook of addiction psychopharmacology* (pp. 599–642).. Malden, MA: Wiley & Sons.
- Kelley, M. J. (1997). Native Americans, neurofeedback, and substance abuse theory: Three year outcome of alpha/theta neurofeedback training in the treatment of problem drinking among Dine' (Navajo) People. *Journal of Neurotherapy*, *2*(3), 24–60.
- McKay, J., Atterman, A., Rutherford, M., Cacciola, J., & McLellan, A. (1999). The relationship of alcohol use to cocaine relapse in cocaine dependent patients in an aftercare study. *Journal of Studies on Alcohol*, *60*, 176–180.

- Myers, J. E., & Young, J. S. (2012). Brain wave biofeedback: Benefits of integrating neurofeedback in counseling. *Journal of Counseling & Development, 90*(1), 20–28.
- Peniston, E. G., & Kulkosky, P. J. (1989). Alpha-theta training and beta endorphin levels in alcoholics. *Alcoholism: Clinical and Experimental Research, 13*(2), 271–279.
- Peniston, E. G., & Kulkosky, P. J. (1991). Alpha-theta brainwave neurofeedback for Vietnam veterans with combat-related post-traumatic stress disorder. *Medical Psychotherapy, 6*, 37–50.
- Prichep, L. S., Alper, K. R., Kowalik, S., Merkin, H., Tom, M., John, E. R., & Rosenthal, M. S. (1996). Quantitative electroencephalographic characteristics of crack cocaine dependence. *Biological Psychiatry, 40*, 986–993.
- Prichep, L. S., Alper, K. R., Kowalik, S. C., Vaysblat, L. S., Merkin, H., Tom, M., John, E. R., & Rosenthal M. S. (1999). Prediction of treatment outcome in cocaine dependent males using quantitative EEG. *Drug and Alcohol Dependence, 54*, 35–43.
- Rajeswaran, J., Bennet, C. N., Thomas, S., & Rajakumari, K. (2013). EEG neurofeedback training in clinical conditions. In J. Rajeswaran (Ed.), *Neuropsychological rehabilitation principles and applications* (pp. 57–78). Philadelphia, PA: Elsevier.
- Romano-Micha, J. (2003). Databases or specific training protocols for neurotherapy? A proposal for a “clinical approach to neurotherapy.” *Journal of Neurotherapy: Investigations in Neuromodulation, Neurofeedback and Applied Neuroscience, 7*(3–4), 69–85.
- Ross, S. M. (2013). Neurofeedback: An integrative treatment of substance use disorders. *Holistic Nursing Practice, 27*(4), 246–250.
- Russell-Chapin, L. A., & Chapin, T. J. (2011). Neurofeedback: A third option when counseling and medication are not sufficient. In *Ideas and research you can use: VISTAS 2011*. Retrieved from [http://www.counseling.org/docs/vistas/vistas\\_2011\\_article\\_48.pdf?sfvrsn=3](http://www.counseling.org/docs/vistas/vistas_2011_article_48.pdf?sfvrsn=3)
- Saxby, E., & Peniston, E.G. (1995). Alpha-theta brainwave neurofeedback training: An effective treatment for male and female alcoholics with depressive symptoms. *Journal of Clinical Psychology, 51*(5), 685–693.
- Scott, W. C., & Kaiser, D. (1998). Augmenting chemical dependency treatment with neurofeedback training. *Journal of Neurotherapy, 3*(1), 66.
- Scott, W. C., Kaiser, D., Othmer, S., & Sideroff, S. I. (2005). Effects of an EEG biofeedback protocol on a mixed substance abusing population. *The American Journal of Drug and Alcohol Abuse, 31*, 455–469.
- Sokhadze, T. M., Cannon, R. L., & Trudeau, D. L., (2008). EEG biofeedback as a treatment for substance use disorders: Review, rating of efficacy, and recommendations for further research. *Applied Psychophysiological Biofeedback, 33*, 1–28.
- Sokhadze, T. M., Trudeau, D. L., & Cannon, R. L. (2014). Treating addiction disorders. In D. S. Cantor, & J. R. Evans (Eds.), *Clinical neurotherapy: Application of techniques for treatment* (pp. 265–299). Philadelphia, PA: Elsevier.
- Soutar, R. An introductory perspective on the emerging application of qEEG in neurofeedback. In D. S. Cantor, & J. R. Evans (Eds.), *Clinical neurotherapy: Application of techniques for treatment* (pp. 19–54). Philadelphia, PA: Elsevier.

- Trudeau, D. L. (2005a). EEG biofeedback for addictive disorders: The state of the art for 2004. *Journal of Adult Development, 12*(2–3), 139–146.
- Trudeau, D. L. (2005b). Applicability of brain wave biofeedback to substance use disorders in adolescents. *Child and Adolescent Psychiatric Clinics of North America, 14*, 125–136.
- Trudeau, D., Sokhadze, E. M., & Cannon, R. L. (2009). Neurofeedback in alcohol and drug dependency. In T. H. Budzynski, H. K. Budzynski, J. R. Evans, & A. Abarbanel (Eds.), *Introduction to quantitative EEG and neurofeedback: Advanced theory and applications* (2<sup>nd</sup> ed., pp. 241–267). Waltham, MA: Academic Press
- Utterainer, H. F., Chen, M. L., & Gruzelier, J. H. (2013). EEG-neurofeedback and psychodynamic psychotherapy in a case of adolescent anhedonia with substance misuse: Mood/theta relations. *International Journal of Psychophysiology, 1–12*. doi:10.1016/j.ijpsycho.2013.03.011
- White, N. E. (2008). The transformational power of the Peniston protocol: A therapist's experiences. *Journal of Neurotherapy, 12*(4), 261–265.
- Yucha, C., & Montgomery, D. (2008). *Evidenced-based practice in biofeedback and neurofeedback*. Wheat Ridge, CO: Association of Applied Psychophysiology and Biofeedback.

*Note: This paper is part of the annual VISTAS project sponsored by the American Counseling Association. Find more information on the project at: <http://www.counseling.org/knowledge-center/vistas>*