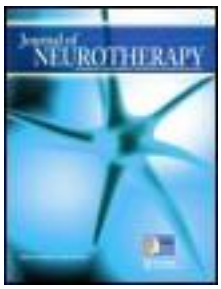

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Long-Term Follow-Up of a Clinical Replication of the Peniston Protocol for Chemical Dependency

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Long-Term Follow-Up of a Clinical Replication of the Peniston Protocol for Chemical Dependency

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ABSTRACT. *Introduction*. This study is a long-term follow-up of an early replication of the Peniston EEG biofeedback (EEG-BFB) Protocol for chemical dependency (Peniston & Kulkosky, 1989, 1990).

Method. This clinical trial included 16 chemically dependent adult participants treated with the Peniston Protocol in a university outpatient clinic between 1993 and 1995. Ten participants were probationers classified as high risk for rearrest. Treatment effects were assessed using pre/posttreatment measures (Beck Depression Inventory, Minnesota Multiphasic Personality Inventory-2) and long-term follow-up of abstinence and rearrest rates. Probationer rearrest rates were compared to an equivalent probation sample ($n = 24$) that did not receive EEG-BFB.

Results. Initial Beck Depression Inventory scores indicated mild/moderate depression but were significantly reduced posttreatment to within normal limits. Substantial differences were noted posttreatment on 7 Minnesota Multiphasic Personality Inventory-2 clinical scales suggesting less psychopathology following treatment. Long-term (74–98 months) follow-up indicated that 81.3% ($n = 13$) participants were abstinent. Rearrest rates and probation revocations for the probationer subgroup were lower than the comparison group (40% vs. 79.16%).

Conclusion. This study provides evidence of the durability of Peniston Protocol results over time but has the usual limitations of a clinical trial with a small sample, nonrandomized, and uncontrolled design. Implications for further research are discussed including the relevance of recent modifications to the Peniston Protocol and qEEG–based protocols in treating substance abuse.

KEYWORDS. Arrests, abstinence, chemical dependency, EEG biofeedback, long-term follow-up, Peniston protocol

Alpha-theta EEG biofeedback (EEG-BFB) for alcoholism first emerged as a viable alternative to traditional chemical dependency treatment approaches in 1989 with the publication of an innovative study by Peniston and Kulkosky. These authors expanded on the foundation of previous EEG-BFB work carried out at the Menninger

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Institute and Topeka Veteran's Administration Medical Center (VAMC; Goslinga, 1975; Twemlow & Bowen, 1976, 1977; Twemlow, Sizemore, & Bowen, 1977). Peniston and Kulkosky's research marked the first published controlled and randomized study of alpha-theta biofeedback treatment with chronic alcoholic inpatients. Their study, conducted at the VAMC in Fort Lyon, Colorado, compared three groups containing 10 male participants each. One alcoholic and one nonalcoholic group acted as control participants. A second group of 10 alcoholics composed the experimental group. The alcoholic participants had a 20-year history (or more) of alcoholism and had been previously hospitalized on four or more occasions for alcoholism treatment. The nonalcoholic control group received only treatment for their medical conditions and no substance abuse treatment. The alcoholic control group received the VAMC's traditional alcoholism treatment (abstinence, psychotherapy, group therapy, and psychoactive drugs). The experimental alcoholic group participated in 8 (30-min) sessions of temperature biofeedback followed by 30 (30-min) EEG alpha-theta biofeedback sessions (Peniston, 1994). The experimental protocol also involved instruction in other psychophysiological self-regulation techniques including autogenic training and rhythmic breathing, similar to methods used at the Menninger Institute. However, Peniston and Kulkosky's protocol also added an imagery/visualization component in conjunction with "scripting" of desired emotional/behavioral outcomes. The multimodal treatment thus developed and administered to their experimental group became known as the Peniston Protocol and has been outlined in more detail in Peniston and Kulkosky (1999). In their initial study, several pre- and posttreatment measures were administered to all participants: a brief depression screen (Beck Depression Inventory [BDI]; Beck & Steer, 1987; Beck, Ward, Medelson, Mock, & Erbaugh, 1961), an EEG baseline rating, and a blood sample to derive serum β-endorphin levels. Postassessment measures indicated that in comparison to the control groups (alcoholic, nonalcoholic), the EEG-BFB alcoholic sample demonstrated significant increases in alpha amplitudes as well as percentages of theta and alpha activity. Significantly elevated serum β-endorphin levels (a physiological index of stress) were noted only in the alcoholic control group upon posttreatment testing. Compared to the alcoholic group control, the EEG-BFB group demonstrated significant improvement in depressive symptomatology as assessed by the BDI.

A subsequent report by Peniston and Kulkosky (1990) presented additional pre- and posttreatment psychometric assessment data (Sixteen Personality Factor Questionnaire [16 PF]; Million Clinical Multiaxial Inventory [MCMI]) on the same groups of participants that they initially reported on in 1989. Pretreatment 16 PF results suggested that the personality characteristics of both alcoholic groups tended to be characterized by more negative features (e.g., more submissive, shy, apprehensive, tense, and more impacted by feelings). In the EEG-BFB group, posttreatment 16 PF results showed significant increases what could be viewed as more positive personality features (e.g., warmth, stability, conscientiousness, imaginativeness, self-control, boldness, and abstract thinking). The alcoholic controls demonstrated a significant increase in the 16 PF scale measuring concrete thinking. Pretreatment MCMI findings revealed that both alcoholic groups scored significantly higher compared to the nonalcoholic group on numerous scales. Upon posttreatment assessment, the EEG-BFB group demonstrated significant decreases on several MCMI scales (e.g., schizoid, avoidant, passive-aggressive, schizotypal, borderline, paranoid, anxiety, somatoform, dysthymia, alcohol abuse, psychotic thinking, psychotic depression, and psychotic delusion), whereas the alcoholic control group demonstrated sizable reductions in only two MCMI scales (Avoidant and Psychotic Thinking) and a substantial increase on one scale (Compulsive).

A later uncontrolled study by Saxby and Peniston (1995), involving 14 depressed alcoholic inpatients, resulted in similar findings. The study reported significantly reduced

posttreatment BDI scores and similar posttreatment MCMI-I results following EEG-BFB treatment with the Peniston Protocol. Significant post-MCMI-I changes were found in comparison to pretreatment data on MCMI-I scales labeled schizoid, avoidant, dependent, histrionic, passive-aggressive, schizotypal, borderline, anxiety, somatoform, hypomanic, dysthmic, alcohol abuse, drug abuse, psychotic thinking, and psychotic depression. In addition, Fahrion, Walters, Coyne, and Allen (1992) utilized the Minnesota Multiphasic Personality Inventory-2 (MMPI-2; Hathaway & McKinley, 1989b) to assess changes in personality dynamics following the Peniston Protocol in an alcoholic outpatient who had been abstinent for 18 months. On the MMPI-2, significant posttreatment change was observed including increased openness and ''normalization of response'' (p. 550).

In another uncontrolled clinical trial of the Peniston Protocol, Kelley (1997) treated 19 Dine' (Navajo) clients with an average of 40 ''culturally modified'' (p. 24) alpha-theta biofeedback sessions that were provided in addition to their 33-day inpatient substance abuse treatment program. A 3-year follow-up classified 12 (63%) of the 19 participants as in ''sustained partial remission'' according to criteria from the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; American Psychiatric Association, 1994) and 4 (21%) participants as ''sustained full remission.'' The remaining 3 (16%) were considered treatment failures. The study also reported significant reduction in posttreatment depression in the experimental group as measured by the BDI.

In discussing their initial 1990 pre- and posttreatment assessment results, Peniston and Kulkosky surmised that ''the application of alpha-theta brainwave treatment produces fundamental changes in alcoholic personality variables'' (p. 37). Nine years later (and after reports of similar results by other clinical researchers), these researchers still concluded that ''the technique has demonstrated decreases in self-assessed depression and other fundamental changes in personality variables as noted on objective psychometric measures'' (1999, p. 172), specifically, ''psychological tests indicate a normalization of the personality'' in which variables ''are closer to, or within, the range of normal controls'' (p. 172).

Many consider the functional/behavioral outcomes (e.g., abstinence, maintenance of employment, and positive personal and social adjustment) to be the most important indicators of successful substance abuse treatment. The studies evaluating the Peniston Protocol have noted that many of the experimental participants report no longer having urges for alcohol or drugs after completing treatment. In 1989, Peniston and Kulkosky reported that the relapse rates were significantly higher in the alcoholic control group receiving traditional treatment (80%) versus the Peniston Protocol group (20%) at 13 months' posttreatment. The EEG-BFB group also demonstrated an 80% abstinence rate and a 20% relapse rate at the 2-year follow-up (Peniston & Kulkosky, 1999). However, the two EEG-BFB participants who relapsed were reported to have significantly reduced their alcohol consumption and some negative physical symptoms after drinking. E. G. Peniston has subsequently reported (personal communication, 2000) that, with one exception (a participant who is now deceased), all individuals from the original treatment group are currently abstinent. High abstinence success rates also were observed in the study completed by Saxby and Peniston (1995). At the 21-month posttreatment mark, only 1 of 14 (7%) participants undergoing the Peniston Protocol had relapsed.

The aforementioned studies have utilized the Peniston Protocol in the primary treatment of alcoholism. Evidence of the efficacy of using a modified Peniston Protocol with polysubstance abuse populations has also been reported. Kaiser, Othmer, and Scott (1999) randomly assigned polysubstance abusing inpatients (e.g., methamphetamine, crack, heroin, or other controlled substances, as well as alcohol) to one of two groups (control, experimental). Both groups received conventional addiction treatment based on the Minnesota Model (Doweiko, 2002, chap. 28), which encompassed counseling

and a 12-step recovery process. The experimental group received this component in conjunction with 40 to 50 sessions of EEG-BFB, using a modified Peniston Protocol. The control group received additional counseling sessions, which were matched to the number of sessions the EEG-BFB group completed. At the time this study was initially reported, 35 controls and 50 experimental participants had completed treatment. Experimental participants received 10 to 20 sessions of beta/sensorimotor response (SMR; inhibit 4–7 Hz and 22–30 Hz, reward 12–18 Hz) training at sites C3 and C4 prior to beginning alpha-theta biofeedback at site Pz. A psychological inventory (e.g., MMPI-2) was administered to both groups. Upon posttreatment testing, the EEG-BFB group exhibited significant improvement on six of the MMPI-2 basic clinical scales (1/Hypochondriasis, 2/Depression, 3/Hysteria, 4/Psychopathic Deviate, 8/Schizophrenia, and 0/Social introversion). Both groups improved on scale 4/Psychopathic Deviate. Kaiser and associates concur that supplementing conventional treatment with EEG-BFB had a considerable impact on psychological functioning as assessed by the MMPI-2. At 1-year posttreatment, 67% of the control group and 35% of the treatment group had relapsed. The subsequent report of the completed research project provided further details and yielded similar results (Scott, Kaiser, Othmer, & Sideroff, 2005). A total of 121 participants (60 EEG-BFB, 61 controls) participated in this controlled and randomly assigned design. Both groups were administered pre- and posttreatment measures including the Test of Variables of Attention and MMPI-2. Prior to beginning alpha-theta biofeedback, the experimental group received an average of 13 EEG-BFB sessions consisting of inhibiting 2–7 Hz and 22–30 Hz as well as either enhancing beta (15–18 Hz at C3-Fpz) or SMR (12–15 Hz at C4-Pz). Once the EEG-BFB participants' Test of Variables of Attention results normalized, then the alpha-theta protocol (30 sessions) was initiated. Results revealed that in comparison to the control group, the experimental group had significantly: lower dropout rates (24% vs. 46%), longer lengths of stay in treatment (136 days vs. 98), higher abstinence rates at the 12-month follow-up interval (77% vs. 44%), and improved on five MMPI-2 clinical scales (e.g., 1/Hypochondriasis, 2/Depression, 3/Hysteria, teria, 8/Schizophrenia, and 0/Social introversion). As in the initial study report, both groups improved on MMPI-2 scale 4/Psychopathic Deviate. Treatment retention and relapse prevention in the experimental group may be related to these noted changes in personality dynamics.

The alterations in personality dynamics that have been observed following treatment using the Peniston Protocol (and the modified protocol; Fahrion et al., 1992; Kaiser et al., 1999; Peniston & Kulkosky, 1990; Saxby & Peniston, 1995; Scott et al., 2005) may contribute to the low relapse rates reported in all of these previously mentioned outcome studies. Norris (1999) described these changes in personality variables as "broad and far reaching" accompanied by "less psychopathology in depression, anxiety, poor self-regard, delusional thinking, and a reduction in avoidant and aggressive behaviors" (p. 334). According to Peniston and Kulkosky (1990), "the application of alpha-theta brainwave treatment produces fundamental changes in alcoholic personality variables" which may underlie the "sustained prevention of relapse" (p. 37). Green (1999) also contended that those who have undergone alpha-theta biofeedback treatment for addictions are able to maintain their sobriety because of the other transformations that occur during and/or following treatment. These changes have been noted to follow the psychophysiological principle in which each change in the physiological state is accompanied by an appropriate change in the mental-emotional state (consciously or unconsciously; Norris, 1999).

More rigorous tests of the reliability and efficacy of EEG-BFB treatments based on the Peniston Protocol have come from investigations of its use with traditionally underserved populations (e.g., incarcerated public offenders, homeless populations, and dually diagnosed patients) with chemical addictions in publicly supported state

institutions and mental hospitals. Fahrion (1999) summarized the results of a 4-year project performed with a large sample of male and female chemically dependent adult and juvenile public offenders in the Kansas Criminal Justice system. This report indicated that of 283 participants who completed the full 30 sessions of EEG-BFB, 224 (79%) were categorized as successful (no relapse, rearrest, or probation violation) and 59 (21%) were considered treatment failures according to these outcome criteria. There was an 85% success rate for the participants ($n = 104$) who received their treatment in jail. Of the 120 who were treated as outpatients, 75% remained abstinent and free of repeat offenses. A 30% dropout rate was reported for the first 3 years of the project. In 2002, Fahrion (as cited in Sokhadze, Cannon, & Trudeau, 2008) provided data on the completed project, which involved 520 participants and a 2-year follow-up. Results revealed that EEG-BFB treatment for addictions was effective for those with specific demographic characteristics (e.g., younger and non-White) and within certain drug abuse categories (i.e., nonstimulant drugs of choice).

Another important investigation of the Peniston Protocol took place at the Open Door Mission in Houston, Texas (Burkett, Cummins, Dickson, & Skolnick, 2005; Skolnick, Cummins, & Dickson, 2001). This faith-based mission offers inpatient treatment to male crack cocaine addicts who also are homeless and unemployed. Many have had multiple arrests for drug/alcohol-related, as well as other, offenses. The mission's regular treatment program consists of drug testing, educational services, job training, nondenominational religious study, and spiritual guidance. In 1999, residents gained the option to participate in EEG-BFB training using a modified Peniston Protocol, along with the mission's regular treatment activities. The protocol utilized includes pretraining sessions (inhibit theta, enhance SMR; site FP1-T4) followed by 30 alpha-theta EEG-BFB sessions at site O1. The 2005 report by Burkett and colleagues regarding the posttreatment results of the 87 participants completing the EEG-BFB component of treatment noted significant improvement in posttreatment anxiety and depression measures. The 1-year follow-up of these treatment completers indicated that approximately 50% were not using drugs (confirmed by urinalysis), whereas roughly 10% had fully relapsed. Forty percent of participants had experienced a lapse (i.e., used one to nine times) but were sober at 12 months posttreatment. Further, the majority of these participants had not been rearrested (88%) and were no longer homeless (92%) or unemployed (91%).

The study to be reported in the remainder of this article was conducted between 1993 and 1995 and represents an early uncontrolled clinical replication of the Peniston Protocol with outpatients experiencing chemical dependency problems (e.g., alcoholism, illicit drug abuse, and/or nonmedical use of prescription medications). Overall, the purpose of this study was to determine if the findings reported by Peniston and Kulkosky (1989, 1990) could be replicated in a mixed-gender outpatient population with a variety of chemical dependency problems, as Peniston and Kulkosky's initial research was conducted only with male chronic alcoholic inpatients. This replication also represents one of the first attempts, following the publication of Peniston and Kulkosky's studies, to treat individuals who had been arrested for drug/alcohol related offenses, because this group was creating the explosion of the U.S. prison population.

METHODS

Participants

Participant data were collected using client archival records from a university-based clinic that specializes in EEG-BFB treatment. The sample consisted of 16 (13 male, 3 female) clients referred to the clinic, between 1993 and 1995, for EEG-BFB treatment of addictions. All participants had been previously diagnosed with a substance-related disorder. Their self-reported history of addiction averaged 20.92 years. Alcohol was the drug of choice

for 50% ($n = 8$) of the sample and 25% ($n = 4$) abused alcohol in combination with another drug (e.g., methamphetamine, cocaine, or prescription medications). Marijuana was the drug of choice for 12.5% of the sample ($n = 2$) and prescription medications for 12.5% ($n = 2$). The majority of the clients ($n = 10$, 62.5%) were referred to the clinic by the county adult probation department. These probation clients were rated by their probation officers to be at high risk for rearrest. Other referral sources included professionals ($n = 3$; 18.8%) and self ($n = 3$; 18.8%). In addition, 87.5% ($n = 14$) of the participants reported a history of prior arrest or conviction and 56% ($n = 9$) disclosed that their previous offenses were substance related. Eight participants (50%) reported that they were in recovery and sober prior to beginning treatment. Four of these participants were probationers and their reports may be of questionable accuracy because remaining abstinent was a condition of their probation. One participant (6.3%) reported still using on a daily basis. Most of the participants had received prior substance-abuse treatment and/or participated in programs such as Alcoholics Anonymous (AA). Participants ranged in age from 26 to 67 with a mean age of 40.06 ($SD = 10.47$). The ethnic heritage of the sample consisted of 14 Caucasians (87.5%), 1 African American (6.25%), and 1 Hispanic (6.25%). Of the 16 participants, 31.3% ($n = 5$) reported a previous closed head injury. Additional participant demographic data (e.g., other presenting problems, martial status, educational levels, employment status, etc.) are displayed in Table 1. Participants were required to read an informed consent document that delineated the purpose of the study and treatment requirements. Their signature on the form indicated their voluntary consent to participant in the study and that they understood all possible known side effects of alpha-theta training. Participant data were excluded from this report if the participant did not complete: (a) the informed consent process, (b) pre- and posttreatment assessment instruments, and (c) at least 30 EEG-BFB treatment sessions.

TABLE 1. Sociodemographic characteristics of EEG biofeedback participants.

Information	*n*	%
Marital status		
Divorced/Separated	6	37.5
Married	5	31.3
Single	5	31.3
Employment status		
Employed at intake	11	68.8
Unemployed at intake	3	18.8
Not recorded in file	2	12.5
Educational level		
Associate degree or college credits	7	43.8
Advanced degree	3	18.8
GED or high school diploma	3	18.8
Less than a high school diploma	3	18.8
Additional presenting problems		
Depression or bipolar disorder[a]	8	
Anxiety[a]	5	
Sleep disturbance[a]	4	
History of childhood abuse[a]	3	
Family history of addiction		
History reported at intake	5	31.3

Note. $n = 16$.
[a]Categories are not mutually exclusive under percentages.

Probation Participant Comparisons

The average age of the 10 probation participants in our study was 39.30 ($SD = 11.94$) and ranged from 26 to 67. Eighty percent ($n = 8$) of the probationers were male and 20% ($n = 2$) were female. Because the majority of these probationers had been referred to the clinic by the same probation officer, the 1992–93 caseload of this local probation officer was reviewed to select a group of individuals with whom to compare this study's participants on rearrest rates, probation revocations, and so on. Twenty-four probationers that did not undergo EEG-BFB (EEG-NOT) were chosen from the caseload files. The EEG-NOT group was matched, as closely as possible, by age and by gender with the probationers undergoing EEG-BFB. The EEG-NOT group's average age was 34.7 ($SD = 10.81$) and ranged from 21 to 65. Male participants comprised

79.2% ($n = 19$) of the EEG-NOT sample, and 28.8% ($n = 5$) were female.

Assessment Instruments

Participants completed a battery of psychometric measures; however, information is reported here on only two of those inventories: the BDI (Beck et al., 1961) and the MMPI-2 (Hathaway & McKinley, 1989b). Although the clinic now routinely performs pre- and posttreatment quantitative EEG (qEEG) on all clients, qEEG was not available to the clinic at the time most of these clients were treated.

BDI. Each participant completed the BDI prior to beginning sessions and after completing EEG-BFB treatment. Administration and scoring were conducted per BDI standardized guidelines. The BDI is a 21-item (with four options each) self-report questionnaire designed to detect depressive symptomatology and to assess depression severity. The BDI is appropriate for individuals between the ages of 13 to 80 who possess a fifth-grade reading level (Kramer & Conoley, 1992). Administration time ranges from 5 to 15 min. The BDI yields a total score (sum of all items) as well as a cognitive-affective score (first 13 items summed) and a somatic-performance score (last 8 items summed; Beck & Steer, 1987). Depressive severity classifications are as follows: Normal or asymptomatic (total = 0–9), Mild to Moderate Depression (total = 10–18), Moderate to Severe Depression (total = 19–29), and Extremely Severe Depression (total = 30 or above). At the time these clients were assessed, the BDI was one of the most widely clinically utilized self-report measures of depression. The BDI has been used in previous studies to assess depression prevalence and severity in substance abuse populations (Peniston & Kulkosky, 1989; Saxby & Peniston, 1995; Steer, McElroy, & Beck, 1983). The BDI has been shown to have adequate test–retest reliability coefficients (e.g., range = .48–.86) for patient populations (*Eleventh Mental Measurements Yearbook*; see Kramer & Conoley, 1992). Based on a meta-analysis of 25 years of studies utilizing the BDI, mean internal consistency coefficients were found to range from .81 (nonpsychiatric samples) to .86 (psychiatric samples; Beck, Steer, & Garbin, 1988). According to the *Eleventh Mental Measurements Yearbook* (Kramer & Conoley, 1992) "the BDI is a well-researched assessment tool with substantial support for its reliability and validity" (p. 78).

MMPI–2. Fourteen of the 16 participants completed pre- and posttreatment MMPI-2s. Administration and scoring were performed according to standardized MMPI-2 guidelines (Hathaway & McKinley, 1989a).The MMPI-2 is a 567-item self-administered inventory used to assess personality characteristics and psychopathology for clinical and nonclinical populations. It is widely utilized for clinical and research purposes (Archer, 1992). The inventory is designed for individuals age 18 and older. It takes approximately 90 min to complete and requires an eighth-grade reading level. Raw scores for each of the scales are converted to standardized T scores ($M = 50$, $SD = 10$). T scores above 65 are considered to be clinically significant. The MMPI-2 administration manual reported adequate test–retest reliability coefficients for the basic scales. Internal consistency was also reported to be sufficient for the basic scales, with the exception of scale 6 (*Pa*). Several EEG-BFB studies have utilized the MMPI-2 to evaluate posttreatment effects in participants with substance-related disorders (Burkett, 2004; Fahrion et al., 1992; Kaiser et al., 1999; Scott et al., 2005).

Biofeedback Apparatus

The F1000 Biofeedback System (Focused Technology, Ridgecrest, CA) was utilized with the majority of these participants ($n = 15$). The Discovery Engineering International 2000 (Topeka, KS) was utilized initially with 1 participant, and another participant was trained on both the Discovery Engineering International 2000 and the CapScan Prism 5 (8 sessions; American Biotec Corporation, Ossining, NY). Because

the F1000 was used for EEG-BFB training for the preponderance of participants included in this study, the following technical information is specific to that equipment.

The Focused Technology F1000 Instrumentation System (no longer manufactured) processed the EEG signal through two digitally tunable analog filters (consisting of six-pole low-pass filters followed by six-pole high-pass filters) and true RMS level detectors before analog to digital conversion. Data were converted via a 12-bit high-speed analog to digital converter. The computer typically read the filter output at 1/64-sec intervals. One pre-amp channel supplied EEG signals to both filters to provide dual feedback bands (e.g., alpha-theta). The response time of the filters was determined by the frequency band being measured; the filters were tunable over a range of 2 to 1000 Hz. Smoothing was applied to achieve effective feedback. The gain factor of the amplifiers was set to allow a 300-millivolt peak-to-peak signal to be processed without clipping. The raw EEG signal was recorded at 128 samples per second and was available for additional filtering using digital methods such as Fast Fourier transform. Thermal data used a separate 13-bit high precision ratiometric analog to digital conversion recorded at 7.2 samples per second. EEG data were recorded at 10 samples per second (F. Deits, personal communication, December 18, 2001, January 10, 2002; see http://www.focused-technology.com/).

Clinicians

Most of the biofeedback clinicians who provided services to the participants in this study were staff members or practicum students at the university's EEG-BFB clinic. Two were doctoral-level counselors employed by the university who had received their initial EEG-BFB training directly from Eugene Peniston. The clinicians had varied levels of previous counseling experience, with the majority being relatively inexperienced graduate or undergraduate practicum students. All service providers had completed university courses in counseling, relaxation skills, and biofeedback techniques prior to conducting sessions with their clients. In a few cases, more than one clinician worked with an individual client during the treatment process (e.g., practicum student finished with their rotation before client had completed treatment). The clinic's director, a licensed psychologist trained in EEG-BFB, individually supervised all treatment sessions. In addition, the supervisor and all clinicians met on a weekly basis to discuss client progress and relevant treatment issues.

Session Procedures

A procedures manual was developed and was used to guide this multimodal treatment (e.g., intake, assessment, sessions, and termination). Session formats were modeled after the original Peniston Protocol (Peniston & Kulkosky, 1999) as well as other previous research in biofeedback and relaxation techniques. Biofeedback procedures were specific to the type of equipment utilized and are outlined next. As recommended by E. G. Peniston (personal communication, 1992), an individualized visualization "script" was developed for each participant (Peniston & Walters, 1992). The script incorporated the following components: (a) Autogenic Training phrases and relaxation inductions, (b) suggestions of intentional connection to the subconscious mind, (c) visualization of the rejection of undesired behaviors or feelings (e.g., consuming alcohol or illicit drugs; feeling unworthy), (d) visualization of desired outcomes (e.g., increasing finger temperature; increasing alpha and theta amplitudes; emotionally healthy; balanced lifestyle; free from desires/cravings for alcohol or drugs; clean and sober; achievement of life goals, etc.), and (e) command to the subconscious mind to accomplish the goals. Components three and four of the script were developed over the course of the first few sessions and were modified as therapy progressed. Clinicians were instructed to follow these standardized procedures for all client sessions; however, because of the different therapists and clients involved in this process, some variability in session proceedings occurred.

All client sessions were conducted in individual treatment rooms, with therapists remaining in the rooms throughout sessions.

Temperature-Biofeedback (Temp-BFB) training. Prior to beginning the first phase of treatment, participants received a brief demonstration informing them as to how the Temp-BFB equipment worked and how to interpret the audio feedback signals. The participants were also instructed in several relaxation techniques such as diaphragmatic breathing, Autogenic Training, imagery, and brief progressive muscle relaxation skills. They were encouraged to practice these relaxation skills daily. In each session, participants sat in a recliner in front of the computer monitor. The clinician attached the thermistor with micropore tape to the dorsal area of the index finger on the client's nondominant hand. A portion of the thermistor cable was secured with micropore tape to the wrist (nondominant). After the thermistor was attached and the computer activated, a resting baseline of finger temperature data was collected in degrees Fahrenheit. Participants were then advised to recline and relax with eyes closed while the clinician read the personalized script (approximately 5–8 minutes in duration). Upon completion of the script, the clinician turned on the computer's audio feedback system. Audio stimuli—in the form of a tone's pitch—conveyed information regarding the participant's current hand temperature. For example, the pitch of the bell tone became higher as the participant's finger temperature increased. On the F1000, each tone that sounded represented a temperature change of approximately .02°F. Visual data regarding current temperature readings also could be viewed on the computer monitor. The overall training objective was for the participant to develop the ability to increase his or her finger temperature to at least 94 to 95°F within 10 min and maintain it for at least 15 min. Temp-BFB training proceeded until the criterion was reached. One-hr sessions were conducted three to five times per week with the BFB portion of the session being approximately 30 min in length. Participants completed an average of eight (range = 3–19) Temp-BFB sessions.

EEG-BFB training. Participants attended EEG-BFB treatment sessions a minimum of three times per week for approximately 60 to 90 min each. Participants received at least 30 min of biofeedback during each session. Most participants completed four sessions per week. From the available archived session records, it appears these clients averaged 31 alpha-theta EEG-BFB sessions. Prior to beginning these sessions, all participants received a brief EEG-BFB demonstration and basic instruction in how the equipment operated (e.g., how to interpret the audio stimuli). The same general guidelines for applying the electrodes (e.g., ground, actives) were followed each session. These procedures included attaching the wrist ground electrode first. A small amount of Spectra 360 gel was placed on the bottom surface of the electrode on the ground wrist strap. The electrode was placed over the bony wrist prominence and then secured via a Velcro strap. The thermistor cable was secured under the wrist strap. The thermistor was attached as just noted. Prior to connecting the other electrodes, the necessary areas (e.g., earlobe, scalp site) were cleaned with prepackaged alcohol antiseptic swabs. EEG electrode paste was utilized to fill the electrode cavities prior to attaching them. The electrode placement was monopolar/referential. The reference earclip electrode was attached to the left earlobe. The International 10–20 system was employed to determine scalp electrode placement. An active electrode was placed on the left-hemisphere occipital site (O1). One participant received training at site Pz. The active surface electrode (9 mm disk) was secured in place with an elastic headband. The EEG cables were supported via loosely clipping them to the participant's clothing. Recording of the session did not begin until the quality of the "hook-up" was ensured (e.g., check for artifact including 60 Hz artifact). If problems in the signal were detected, appropriate measures were taken to remove all possible signal artifact. The client was then asked to recline in the chair and relax with eyes closed. Theta (e.g., 4–8 Hz) and alpha (e.g., 8–12 Hz) resting baseline amplitude data were collected in microvolts for 3 to

5 min. Then the clinician read the client's personalized script. After this phase, the clinician set the theta and alpha thresholds based on the baseline amplitude information or the participant's previous session's threshold settings. The EEG audio feedback system was then activated. Although finger temperature data were also collected on the F1000, the participants received no audio feedback related to this measure. The training protocol consisted of enhancing theta (4–8 Hz) and alpha (8–12 Hz) amplitudes. Participants received auditory feedback tones contingent upon the theta band and/or alpha activity surpassing the preset threshold for theta and/or alpha amplitude(s). After the amplitude exceeded the defined threshold, the tone(s) increased in volume as the theta or alpha amplitude increased. The pitch of the theta tone was lower than that of the alpha tone, allowing for discrimination between the two auditory stimuli. The participants were advised to attempt to increase the amount of time the tone was heard by relaxing. A feedback proportion of 70–80% alpha to 20–30% theta was targeted, as specified by E. G. Peniston (personal communication, 1992). Specifically, thresholds were set so that 20 to 30% of the session, the client would receive theta feedback, whereas 70 to 80% of the session they would receive alpha feedback. This standard was used to prevent the conditioning of a dominant theta to alpha ratio. Following each biofeedback session, most participants received some supportive counseling, as was included in Peniston's original treatment model (E. G. Peniston, personal communication, 1992). This counseling was used primarily to build a supportive therapeutic relationship between therapist and client, to add additional cognitive focus on therapeutic goals, and to help the client integrate any emotional and behavioral changes resulting from the overall therapy program.

EEG-BFB training protocol alterations. During the course of treatment, it became necessary to alter the training protocols of four clients. For example, one client (treated 1993–1994) who primarily abused methamphetamines was switched to a beta/SMR protocol (sites C3/C4). Another 1993 client participated in a theta/SMR (inhibit/enhance) protocol (site CZ) after completing alpha-theta training; this participant abused prescription medications. Two participants (one treated in 1993 and the other in 1995) completed this CZ theta/SMR protocol (inhibit/enhance; 11–13 sessions) prior to beginning alpha-theta sessions. The drugs of choice for these participants involved alcohol and cocaine or crack cocaine. According to the available records, protocol alterations did not occur for the participants that abused alcohol only.

Follow-Up Process

Abstinence information was gathered on these participants via direct communication and/or by contacting their family, friends, former therapist, or probation officer. The follow-up periods ranged from 74 to 98 months' posttreatment, as some of these participants completed treatment in 1993 and others in 1995.

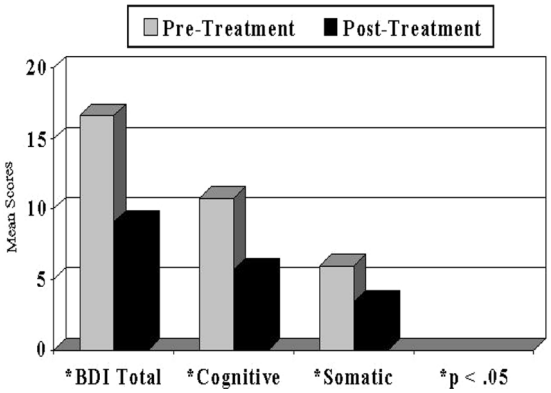
Probationer follow-up information. Follow-up information (e.g., rearrests, probation revocations) was obtained on all probation participants by accessing the computerized judicial records maintained by the county and/or the county probation office.

Statistical Analyses

The SPSS 10.0 for Windows PC statistical package was utilized for the creation of the database and for statistical analyses where applicable. Because mixed gender sample was used, non-K corrected MMPI-2 raw scores were used to convert the data to standardized *T* scores per guidelines by Greene (1991; R. L. Greene, personal communication, February 9, 2005). Scale 5 (Masculinity-Femininity) of the MMPI-2 was not included in this analysis because of the mixed gender sample (Greene, 1991). Paired samples *t* tests were used to determine if there was a significant difference between pre- and posttreatment assessment results (e.g., BDI, MMPI-2). Q-Q plots were inspected and Shapiro-Wilk tests were computed to ascertain if the pre/posttreatment

scores were normally distributed (Stevens, 1996). An alpha level of .01 was selected for the Shapiro-Wilk test results (Tabachnick & Fidell, 1996). A Wilcoxan signed pairs test was used to compare pre- and posttreatment results for the MMPI-2 scale that did not meet the normality assumption (Cates, 1985). Treatment effect sizes were determined by using Cohen's r formula (Rosenthal & Rosnow, 1991). Effect sizes of .50, .30, and .10 were considered large, medium, and small, respectively (Rosenthal & Rosnow, 1991). Probability levels (two-tailed) of .05 or lower were considered statistically significant for all computations.

FIGURE 1. Pre- and posttreatment mean Beck Depression Inventory (BDI) scores ($n = 16$). *Note.* Paired t-test results were significant at $p < .05$. Treatment effect sizes were large (Cohen r values $> .50$).



RESULTS

BDI

The number of participants falling into the four different BDI depression classifications for both assessments periods are listed in Table 2. Pretreatment testing revealed that most of the participants evidenced mild/moderate depression (37.5%) and moderate/severe depression levels (31.2%). Upon posttesting, 60% of the participants scored within the normal or asymptomatic range. Descriptive statistics were computed for the BDI and its subscales (Cognitive-Affective, Somatic-Performance) for both assessment periods. Figure 1 displays the graph of the pre/posttreatment BDI average scores including the subscales.

Table 3 presents the pre/posttreatment mean BDI scores and standard deviations of the sample. Overall, the pretreatment BDI mean score for the sample was 16.69 ($SD = 8.07$), indicative of mild to moderate levels of depression. The posttreatment BDI average score was 9.06 ($SD = 7.76$), suggesting that scores were within the normal or asymptomatic range. The pretreatment cognitive-affective mean score was 10.75 ($SD = 5.64$), and the somatic-performance mean score was 5.94 ($SD = 3.11$), suggesting that the sample experienced somewhat more cognitive than somatic symptoms of depression.

Upon posttesting, the cognitive-affective mean score was 5.69 ($SD = 5.16$) and somatic-performance was 3.38 ($SD = 3.20$). Q-Q plots for all BDI data were within normal limits. Paired samples t tests for the overall BDI, and each subscale revealed that post results were significantly different from the pretreatment ratings. The effect of the EEG-BFB treatment program on the BDI scores was large. These results are described in Table 4.

TABLE 2. BDI pre- and posttreatment depression classifications.

BDI Depression Classifications	Pretreatment[a]	Posttreatment[a]	Posttreatment Classification Difference
1. Normal/Asymptomatic	4 (25.00%)	10 (62.50%)	+6
2. Mild/Moderate	6 (37.50%)	3 (18.75%)	−2
3. Moderate/Severe	5 (31.20%)	3 (18.75%)	−2
4. Extremely Severe	1 (6.25%)	0 (0.00%)	−1

Note. [a]$n = 16$.

TABLE 3. Pre- and posttreatment mean and standard deviation results for the Beck Depression Inventory (BDI) and Minnesota Multiphasic Personality Inventory-2 (MMPI-2).

	Pretreatment		Posttreatment	
Scales	*M*	*SD*	*M*	*SD*
BDI				
BDI total	16.69	8.07	9.06	7.76
Cognitive	10.75	5.64	5.69	5.16
Somatic	5.94	3.11	3.38	3.20
MMPI-2 Scale[a]				
L	46.36	8.62	48.57	9.09
F	67.14	16.09	60.07	18.56
K	40.93	7.92	44.29	8.59
1/Hs	68.21	10.18	60.57	14.92
2/D	69.07	11.15	60.50	15.14
3/Hy	61.57	14.01	55.93	14.89
4/Pd	75.00	12.08	66.64	17.30
6/Pa	63.50	15.21	59.71	16.78
7/Pt	69.14	11.14	58.36	15.88
8/Sc	71.64	15.34	60.36	19.64
9/Ma	62.14	12.54	57.00	9.74
0/Si	58.29	11.87	52.50	13.53

Note. MMPI-2 *T* scores above 65 considered clinically significant.
[a]*M* column reflects mean for *T* scores.

TABLE 4. Paired *t*-test results for the Beck Depression Inventory (BDI) and Minnesota Multiphasic Personality Inventory-2 (MMPI-2).

Scales	*M* Difference	*SD*	SEM	Paired *t* test	α	Cohen *r* (ES)
BDI[a]						
BDI total	7.63	6.64	1.66	4.592	.000	.76
Cognitive	5.06	4.12	1.03	4.912	.000	.79
Somatic	2.56	4.11	1.03	2.491	.025	.54
MMPI-2[b]						
L	−2.21	8.42	2.25	−.984	.343	.26
F	7.07	7.40	1.98	3.578	.003	–
K	−3.36	10.05	2.69	−1.250	.233	.33
1/Hs	7.64	11.37	3.04	2.515	.026	.57
2/D	8.57	9.41	2.52	3.408	.005	.69
3/Hy	5.64	11.31	3.02	1.867	.085	.50
4/Pd	8.36	13.96	3.73	2.239	.043	.53
6/Pa	3.79	13.57	3.63	1.044	.315	.28
7/Pt	10.79	12.27	3.28	3.288	.006	.67
8/Sc	11.29	9.75	2.61	4.329	.001	.77
9/Ma	5.14	8.56	2.29	2.249	.042	.53
0/Si	5.79	10.24	2.74	2.113	.054	.51

Note. Results significant at the $p < .05$ level or lower.
[a]$n = 16$.
[b]$n = 14$.

MMPI-2

Descriptive statistics were computed for the pre/posttreatment MMPI-2 validity scales (L, F, K) and nine of the clinical scales (1, 2, 3, 4, 6, 7, 8, 9, 0). The MMPI-2 scale means for both assessment periods are graphed in Figure 2.

FIGURE 2. Pre- and posttreatment mean Minnesota Multiphasic Personality Inventory-2 *T* scores ($n = 14$). *Note.* *Indicates the paired *t*-test results were significant at $p < .05$. Treatment effect sizes for the significant results were large (Cohen *r* values > .50).

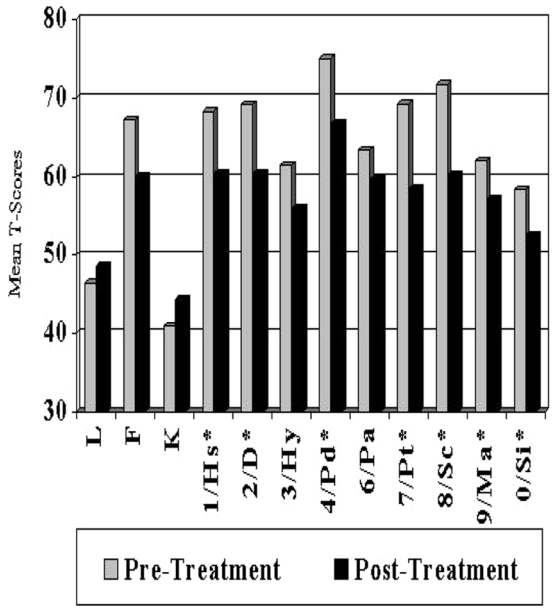


Table 3 displays the actual scale means and standard deviations. Inspection of the pretreatment mean scores revealed an "inverted V" validity scale configuration and a floating clinical profile with a 4–8 codetype. Specifically, pretreatment MMPI-2 mean scores for the sample demonstrated clinical elevations (T score ≥ 65) on scales F/Infrequency, 1/Hypochondriasis, 2/Depression, 4/Psychopathic Deviate, 7/Psychasthenia, and 8/Schizophrenia. A clinically significant low mean score (T score ≥ 44) was found on validity scale K (Correction). Posttreatment results showed a clinical elevation on MMPI-2 scale 4/Psychopathic Deviate. The posttreatment validity scale configuration demonstrated an inverted V pattern that was within normal limits. Inspection of Q-Q plots for all MMPI-2 data revealed all scales were within normal limits, with the exception of the posttreatment *F* scale. A Shapiro-Wilk test confirmed the post *F* scores were not normally distributed (Shapiro-Wilk = .802, $p = .01$). On the post *F* scale, there was a high T score outlier. The Wilcoxan signed pairs test on the *F* scale data determined there was a significant difference between the pre- and post *F* scale averages ($Z = -2.551$, $p = .011$). Table 4 presents the paired samples *t*-test results, mean differences, standard deviation, structural equation modeling, and alpha levels for the MMPI-2 data. The *t* tests revealed significant differences between the two testing periods on clinical scales 1/Hypochondrias, $t(13) = 2.515$, $p = .026$; 2/Depression, $t(13) = 3.408$, $p = .005$; 4/Psychopathic Deviate, $t(13) = 2.239$, $p = .043$; 7/Psychasthenia, $t(13) = 3.288$, $p = .006$; 8/Schizophrenia, $t(13) = 4.329$, $p = .001$; 9/Hypomania, $t(13) = 2.249$, $p = .042$; and 0/Social Introversion, $t(13) = 2.113$, $p = .054$. Large treatment effect sizes ($\geq .50$) were noted on several scales (see Table 4). The MMPI-2 findings on scale 2/Depression substantiated the significant pre- and post-treatment average score differences noted on the BDI.

Follow-Up Information

In 2001 and 2002, a follow-up was conducted of the original 16 participants treated in the 1993–1995 Peniston Protocol replication study. Of these 16 participants, 15 were still living. One male participant had died from alcohol-related complications. Follow-up information was obtained on the remaining 15 participants toward the end of 2001 and beginning of 2002. Two of the participants (12.5%) reported relapse; both were using on a daily basis. None of the participants whose protocols were altered with some beta/SMR training reported relapse. The other 13 participants (81.3%) were abstinent.

Probationer follow-up information. Follow-up information (e.g., rearrests, probation revocations) was obtained on all of the probation participants who were in this study's total sample by accessing the computerized judicial records maintained by the county and/or the county probation office. Records indicated that of the 24 probation clients not receiving EEG-BFB (EEG-NOT), 79.16% ($n = 19$) were rearrested (11 for DWI violations) and/or had their probation revoked. Three participants (12.5%) were not arrested

again. After being arrested, 9 (37.5%) of these comparison participants received some form of treatment (e.g., AA meetings, individual or group counseling, and/or after-care programs). After receiving treatment, 78% ($n = 7$) of these 9 were rearrested, and 8.33% ($n = 2$) were not. Of the 10 probation clients that completed EEG-BFB treatment, 60% ($n = 6$) had no probation revocations or rearrests. However, 40% ($n = 4$) of these participants had additional problems with the law including probation revocations ($n = 2$) and/or rearrests ($n = 3$); 1 participant fit into both of these categories. Only 2 of these participants were rearrested for alcohol and/or drug-related offenses.

Additional Findings: qEEG

Although qEEG was not available to the researchers during the period in which most of the participants in this study were treated, one of the last study participants to enter treatment was administered a pre- and posttreatment qEEG. The result of this single qEEG assessment is reported here because it so clearly supports Bauer's (2001) finding that high-frequency, high-amplitude beta in the EEG is a reliable predictor of relapse for individuals undergoing treatment for chemical dependency. The pretreatment qEEG of a 52-year-old male alcoholic treated as part of this investigation revealed a highly significant elevation in beta activity concentrated over most of the right frontotemporal, right and left central, posterior parietal, and occipital areas. Beta amplitude Z score values at these sites constituted 2 to 3 standard deviation elevations above the mean relative to the Nx Link normative database (John, as cited in Thatcher, 1999). At the completion of 30 sessions of EEG-BFB using the Peniston Protocol, the participant's posttreatment qEEG revealed that most of the pretreatment beta activity had normalized, with the exception of a 3 standard deviation elevation that remained concentrated across the central motor strip (sites C3-Cz-C4). The clinical treatment team predicted relapse at that time (January 1995), which in fact happened within a few months.

DISCUSSION

This study represented a long-term follow-up of one of the earliest attempts to replicate the Peniston Protocol for treating substance-related disorders in an outpatient setting and with a population comprised mostly of public offenders considered at high risk for rearrest. The findings with regard to psychometric data and relapse rates were similar to those reported by other investigators, but this study is weakened by its small sample size as well as its uncontrolled and nonrandomized design. The study does, however, add to the number of successful replications in the literature on EEG-BFB treatment based on the Peniston Protocol for substance abuse. As has been previously discussed by several authors (Egner, Strawson, & Gruzelier, 2002; Graap & Freides, 1998; Sokhadze et al., 2008; Taub & Rosenfeld, 1994; Trudeau, 2000), it is also difficult to determine the impact on treatment outcomes of the individual modalities involved in the Peniston Protocol. The protocol involves the use of relaxation strategies, supportive counseling, and visualization of desired behavioral outcomes, along with the biofeedback techniques. Also, it must be mentioned that most of the participants treated in this study were concurrently, or had at some time previously, participated in AA. However, Miller and colleagues (1995) concluded from their review of substance abuse treatment outcome studies that AA programs could not document beneficial effects as a treatment modality. Furthermore, some of the participants may have received subsequent substance abuse treatment that was not disclosed to the investigators.

In spite of these limitations, the results derived from this small clinical trial provide additional consistency of findings in the Peniston Protocol literature and evidence of the long-term maintenance of effects in the majority of individuals participating in this substance abuse treatment option. Results of this replication study were consistent with the psychometric and functional outcomes previously reported by others (Burkett et al., 2005; Fahrion, 1999; Fahrion et al., 1992; Kaiser et al., 1999; Kelley, 1997; Peniston

& Kulkosky, 1989, 1990; Saxby & Peniston, 1995; Scott et al., 2005; Skolnick et al., 2001). This study also documents long-term abstinence rates higher than those that have been reported for persons receiving conventional forms of substance abuse treatment. The latter typically report that approximately 65 to 70% of patients relapse within 1 year of treatment, with the majority of these relapsing within less than 3 months (McKay, Atterman, Rutherford, Cacciola, & McLellan, 1999). Eighty-one percent of the participants in this initial study were found to be abstinent 74 to 98 months' post-treatment, including 9 of 10 probationers. However, it was disappointing to learn that 4 probationers in the EEG-BFB group had additional encounters with the law after completion of treatment, even though for nonviolent offenses.

It should be reiterated that one fourth of the participants in this group were poly-substance abusers who used alcohol in addition to some form of prescription or nonprescription stimulant. Four participants (three were polysubstance abusers; one abused prescription medications) ultimately received protocol variations from the original one utilized by Peniston and Kulkosky (1989, 1990) in their studies with combat veterans that were primarily chronic alcoholics. The results with these four participants who required protocol alterations support the subsequent trend in the field toward use of a "modified" Peniston Protocol with substance abuse populations, as chemical dependency problems today are overwhelmingly related to polysubstance abuse. All of the participants who received the modified Peniston Protocol were abstinent at the last follow-up. Because more research is now available on the qEEG features of various substances of abuse (Sokhadze et al., 2008), pretreatment assessment utilizing qEEG also seems warranted for selecting individually tailored protocols in EEG-BFB. Many BFB practitioners now use qEEG-based protocols for treating substance abuse, and apparently many of these protocols do not include Peniston Protocol components such as posterior alpha-theta training or visualization scripts. Preliminary, unpublished, clinical reports are suggesting that qEEG-based protocols may produce outcomes comparable to those reported in studies of Peniston and modified Peniston protocols (R. L. Cannon, personal communication, 2007; C. T. Cripe, personal communication, 2007; R. E. Davis, personal communication, 2007; A. T. Fisher, personal communication, 2007). Although there is little research available on the efficacy of qEEG-based protocols for substance abuse, a preliminary report by deBeus, Prinzel, Ryder-Cook, and Allen (2001, 2002) suggests that further study of their efficacy compared to Peniston or modified Peniston protocols is warranted. In 1999 White discussed the therapeutic mechanisms of the Peniston Protocol, identifying the visualization and other script elements as well as the alpha-theta biofeedback induction as key components in the protocol's successful outcomes. It would appear that more understanding and development of EEG-BFB treatments for chemical dependency requires a well-designed study comparing short-term as well as long-term clinical outcomes of qEEG-based EEG-BFB protocols to the results already published for Peniston and modified Peniston protocols.

REFERENCES

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

Archer, R. P. (1992). Review of the Minnesota Multiphasic Personality Inventory-2. In J. Kramer & J. Conoley (Eds.), *The eleventh mental measurements yearbook* (pp. 558–562). Lincoln: The University of Nebraska Press.

Bauer, L. O. (2001). Predicting relapse to alcohol and drug abuse via quantitative electroencephalography. *Neuropsychopharmacology*, *3*, 332–340.

Beck, A. T. & Steer, R. A. (1987). *BDI: Beck depression inventory manual*. San Antonio, TX: The Psychological Corporation/Harcourt Brace Jovanovich.

Beck, A. T., Steer, R. A., & Garbin, M. C. (1988). Psychometric properties of the Beck Depression Inventory: Twenty-five years of evaluation. *Clinical Psychology Review*, *8*, 77–100.

Beck, A. T., Ward, C. H., Medelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring

depression. *Archives of General Psychiatry*, *4*, 561–571.

Burkett, V. S. (2004) *Treatment effects related to eeg-biofeedback for crack cocaine dependency: Changes in personality and attentional variables*. Unpublished doctoral dissertation, University of North Texas, Denton.

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.

Cates, W. M. (1985). Statistical procedures for analyzing data. In *A practical guide to educational research* (pp. 146–190). Englewood Cliffs, NJ: Prentice-Hall.

DeBeus, R., Prinzel, H., Ryder-Cook, A., & Allen, L. (2001, October). *QEEG-based versus research-based eeg biofeedback treatment with chemically dependent outpatients: Preliminary results*. Paper presented at the 9th annual conference for the Society of Neuronal Regulation, Monterey, CA.

DeBeus, R., Prinzel, H., Ryder-Cook, A., & Allen, L. (2002). QEEG-based versus research-based EEG biofeedback treatment with chemically dependent outpatients: Preliminary results. *Journal of Neurotherapy*, *6*(1), 64–66.

Doweiko, H. E. (2002). The treatment of chemical dependency. In *Concepts of chemical dependency* (5th ed., pp. 342–351). Pacific Grove, CA: Brooks/Cole.

Egner, T. Strawson, E., & Gruzelier, J. H. (2002). EEG signature and phenomenology of alpha/theta neurofeedback training versus mock feedback. *Applied Psychophysiology and Biofeedback*, *27*(4), 261–270.

Fahrion, S. L. (1999, June). *Kansas criminal justice anti-drug grant program (*13-BJA*)*. Topeka, KS: Life Sciences Institute of Mind-Body Health.

Fahrion, S. L., Walters, E. D., Coyne, L., & Allen, T. (1992). Alterations in EEG amplitude, personality factors, and brain electrical mapping after alpha-theta brainwave training: A controlled case study of an alcoholic in recovery. *Alcoholism, Clinical and Experimental Research*, *16*(3), 547–552.

Goslinga, J. J. (1975). Biofeedback for chemical problem patients: A developmental process. *Journal of Biofeedback*, *2*, 17–27.

Graap, K. & Freides, D. (1998). Regarding the database for the Peniston protocol alpha-theta eeg biofeedback protocol. *Applied Psychophysiology and Biofeedback*, *23*(4), 265–272.

Green, E. (1999). Alpha-theta brainwave training: Instrumental vipassana. *Subtle Energies and Energy Medicine. An Interdisciplinary Journal of Energetic and Informational Interactions*, *10*, 221–230.

Greene, R. L. (1991). *MMPI-2/MMPI: An interpretive manual*. Boston: Allyn & Bacon.

Hathaway, S. R. & McKinley, J. C. (1989a). *Manual for administration and scoring: Minnesota Mutiphasic Personality Inventory-2*. Minneapolis: University of Minnesota Press.

Hathaway, S. R. & McKinley, J. C. (1989b). *Minnesota Mutiphasic Personality Inventory-2*. Minneapolis: University of Minnesota Press.

Kaiser, D., Othmer, S., & Scott, B. (1999, January). *Effects of neurofeedback on chemical dependency treatment*. Paper presented at the meeting of the AAAS and Science Innovation Exposition, Anaheim, CA.

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.

Kramer, J. J. & Conoley, J. C. (Eds.) (1992). *The eleventh mental measurements yearbook*. Lincoln: The University of Nebraska Press.

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.

Miller, W. R., Brown, J. M., Simpson, T. L., Handmaker, N. S., Bien, T. H., Luckie, L. F., et al. (1995). What works: A methodological analysis of the alcohol treatment outcome literature. In R. Hester & W. Miller (Eds.), *Handbook of alcoholism treatment approaches: Effective alternatives* (2nd ed., pp. 12–44). Boston: Allyn & Bacon.

Norris, P. A. (1999). Psychophysiology, psychosynthesis and the search for self. *Subtle Energies and Energy Medicine. An Interdisciplinary Journal of Energetic and Informational Interactions*, *10*, 321–339.

Peniston, E. G. (1994, March). EEG alpha-theta neuro-feedback: Promising clinical approach for future psychotherapy and medicine. *Paper presented at the meeting of the Association for Applied Psychophysiology and Biofeedback*, Atlanta, GA.

Peniston, E. G. & Kulkosky, P. J. (1989). Alpha-theta brainwave training and β-endorphin levels in alcoholics. *Alcoholism, Clinical and Experimental Research*, *13*(2), 271–279.

Peniston, E. G. & Kulkosky, P. J. (1990). Alcoholic personality and alpha-theta brainwave training. *Medical Psychotherapy*, *3*, 37–55.

Peniston, E. G. & Kulkosky, P. J. (1999). Neurofeedback in the treatment of addictive disorders. In J. R. Evans & A. Abarbanel (Eds.), *Introduction to quantitative EEG and neurofeedback* (pp. 157–179). San Diego, CA: Academic Press.

Peniston, E. G. & Walters, D. (1992). *Clinical alpha-theta brainwave training for alcohol and drug addiction/post traumatic stress disorder*. Training conducted at the Menninger Clinic in Topeka, KS.

Rosenthal, R. & Rosnow, R. L. (1991). Assessing and increasing power. In *Essentials of behavioral research: Methods and data analysis* (pp. 439–456). New York: McGraw-Hill.

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., 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.

Skolnick, M., Cummins, J., & Dickson, R. (2001, October). *Effects of neurotherapy on homeless male crack cocaine users*. Paper presented at the meeting of the Biofeedback Society of Texas, TX.

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. *Applied Psychophysiology and Biofeedback*, *33*(1), 1–28.

Steer, R. A., McElroy, M. G., & Beck, A. T. (1983). Correlates of self-reported and clinically assessed depression in outpatient alcoholics. *Journal of Clinical Psychology*, *39*(1), 144–149.

Stevens, J. (1996). Assumptions in MANOVA. In J. Stevens (Ed.), *Applied multivariate statistics for the social sciences* (3rd ed., pp. 237–260). Mahwah, NJ: Erlbaum.

Tabachnick, B. G. & Fidell, L. S. (1996). Cleaning up your act: Screening data prior to analysis. In *Using multivariate statistics* (pp. 57–125). New York, NY: HarperCollins College.

Taub, E. & Rosenfeld, J. P. (1994). Is alpha-theta training the effective component of the alpha/theta therapy package for the treatment of alcoholism. *Biofeedback*, *22*(3), 12–14.

Thatcher, R. W. (1999). EEG database-guided neurotherapy. In J. R. Evans & A. Abarbanel (Eds.), *Introduction to quantitative EEG and neurofeedback* (pp. 29–64). San Diego, CA: Academic Press.

Trudeau, D. L. (2000). The treatment of addictive disorders by brain wave biofeedback: a review and suggestions for future research. *Clinical EEG (Electroencephalography)*, *31*(1), 13–22.

Twemlow, S. W. & Bowen, W. T. (1976). EEG biofeedback induced self actualization in alcoholics. *Journal of Biofeedback*, *3*, 20–25.

Twemlow, S. W. & Bowen, W. T. (1977). Sociocultural predictors of self actualization in EEG biofeedback treated alcoholics. *Psychological Reports*, *40*, 591–598.

Twemlow, S. W., Sizemore, D. G., & Bowen, W. T. (1977). Biofeedback induced energy redistribution in the alcoholic EEG. *Journal of Biofeedback*, *3*, 14–19.

White, N. E. (1999). Theories of the effectiveness of alpha-theta training for multiple disorders. In J. R. Evans & A. Abarbanel (Eds.), *Introduction to quantitative EEG and neurofeedback* (pp. 341–367). San Diego, CA: Academic Press.