TREATMENT OUTCOMES RELATED TO EEG-BIOFEEDBACK FOR CHEMICAL DEPENDENCY: CHANGES IN MMPI-2™ PERSONALITY MEASURES AND LONG TERM ABSTINENCE RATES

Tonya Gayle Callaway, B. S., M. S.

Dissertation Prepared for the Degree of

DOCTOR OF PHILOSOPHY

UNIVERSITY OF NORTH TEXAS

May 2005

APPROVED:

Eugenia Bodenhamer-Davis, Major Professor
Ernest Harrell, Committee Member
Jerry McGill, Committee Member
James Quinn, Committee Member
Warren Watson, Committee Member
Linda Marshall, Chair of the Department of Psychology
Sandra L. Terrell, Dean of the Robert B. Toulouse School of Graduate Studies

Callaway, Tonya Gayle, Treatment Outcomes Related to EEG-Biofeedback for Chemical Dependency: Changes in MMPI-2™ (University of Minnesota) Personality Measures and Long Term Abstinence Rates. Doctor of Philosophy (Health Psychology and Behavioral Medicine), May 2005, 111 pp., 14 tables, 4 figures, references, 100 titles.

Peniston and Kulkosky (1989, 1990) demonstrated the effectiveness of alpha-theta EEG-Biofeedback (EEG-BFB) in treating inpatient alcoholics noting significant improvements in depression, psychopathology, serum β-endorphin levels, and abstinence rates. The present study is an extension of a previously unpublished replication of the Peniston EEG-BFB protocol with 20 chemically dependent outpatients (Bodenhamer-Davis, Callaway, & DeBeus, 2002). Fifteen subjects were "high risk for re-arrest" probationers. Data for the EEG-BFB group was collected from archival records. Subjects completed an average of 39 sessions (*SD* = 6.096), with 33 of those being EEG-BFB. Pre/post-treatment MMPI-2s™ (University of Minnesota) were collected and follow-up (4-11 years) data obtained (abstinence rates, re-arrests in some cases). Treatment effects were evaluated by comparing assessment data (pre/post) and documenting abstinence rates. Post-treatment MMPI-2 results were within normal limits, with several scales significantly reduced from baseline suggesting less psychopathology. Results were then compared to 20 subjects receiving standard addiction treatment (OT-CD group), but not EEG-BFB. OT-CD subjects completed a 2-week inpatient program followed by 18 outpatient sessions. Pre/post assessment and follow-up data was collected on the OT-CD group. The OT-CD group's post-assessment results showed three elevations (MMPI-2 scales 4/6/8), suggestive of characteriological problems. Post-MMPI-2 results of the two groups were compared via ANCOVAs. Findings indicated no significant differences between groups on targeted scales; however, there was a trend for the EEG-BFB group to have lower scores. Follow-up data was

obtained on 13 EEG-BFB subjects. Results indicated 92% (n = 12) were sober, with 8% (n = 1) claiming significantly reduced alcohol intake. Probationer re-arrest and revocation rates were collected on the subset of probationers (n = 14 out of 15). The majority of the probationers (79%, n = 11) had not been re-arrested nor had their probation been revoked. Short-term follow-up information (35-131 days post-assessment), available at the time of writing, for the OT-CD group (N = 13) showed 85% (n = 11) were sober, with 15% (n = 2) relapsed. Limitations and implications of the study are discussed.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Substance-related disorders are prevalent within the United States (Doweiko, 2002, chap. 1; Ordorica & Nace, 1998) and have been labeled our nation's "number one health problem" (The Robert Wood Johnson Foundation, 2001). Recent escalating health care costs and reforms, brought about by managed care plans, have placed substance abuse treatment programs and modalities under increased scrutiny. There is much debate regarding the efficacy of available treatments and programs (Doweiko, chap. 28). Opinions of the various treatment methods and their actual success rates vary according to the source or study accessed. In 1999, the National Institute on Alcohol Abuse and Alcoholism's report on alcoholism programs concluded that treatment results have typically been "modest" (Priorities section, para. 2). The Institute for Health Policy reported that more than 50% of the patients admitted to substance-related treatment programs had received treatment 12 months before their current admission and averaged 1.9 treatment admissions per year (National Institute on Drug Abuse & National Institute on Alcohol Abuse and Alcoholism, 1992, Adjustments for returns to treatment section, para. 1). Some recent sources have stated that 80% of substance abusers relapse shortly after treatment (Alterman et al., 1998; Morral, Iguchi, Belding, & Lamb, 1997).

One method of evaluating treatment effectiveness is to determine outcomes such as abstinence or relapse rates; however, there are practical difficulties involved in obtaining reliable short- and long-term outcome data that can be used to compare across the heterogeneous array of public and private chemical dependency treatment programs. Miller and colleagues (1995) completed one of the most extensive reviews of all published substance abuse treatment outcome studies. Their report concluded that, "…there are a number of promising treatment approaches

supported by efficacy research." However, "current practice reflects little of this knowledge, and instead relies largely on various strategies for which scientific evidence is lacking" (p. 13).

Background Information Related to EEG-Biofeedback for Chemical Dependency

One strategy that has been accumulating an increasing amount of quantifiable evidence supporting its efficacy in the treatment of chemical dependency is a form of EEG (electroencephalographic) biofeedback (EEG-BFB) termed "alpha-theta" brainwave training. Nevertheless, this biofeedback technique remains relatively unknown and underutilized by the alcohol and drug rehabilitation community. Although many health care professionals may lack awareness of the potential of EEG-BFB in treating substance abuse, the technique's neuroscience underpinnings and clinical application are not recent developments.

An early rationale for applying alpha-theta brainwave training to the treatment of chemical dependency evolved from EEG studies of chronic alcoholics. Initial research revealed that the alcoholics had lower levels of alpha brainwave activity versus non-alcoholics (Funderburk, 1949; Funkhauser, Nagler, & Walker, 1953). The deficit alpha pattern was also evidenced in alcoholics who had been abstinent for a long period of time. An argument could be made that the chronic alcohol usage affected the brain and cumulated in this alpha deficiency. However, further investigation with male children of alcoholics demonstrated the same signature EEG pattern (Gabrielli et al., 1982). Interestingly, alcohol consumption has been shown to increase alpha activity in those studied (Kaplan, Hesselbrock, O'Connor, & Depalma, 1988), including alcoholics and sons of alcoholics.

From the early days of brainwave biofeedback research, different brainwave frequencies have been equated with different states of consciousness. For instance, alpha frequencies (8-12 Hz) have been associated with a "relaxed state" (Kamiya, 1968). Therefore, clinical researchers,

hypothesized that chronic alcoholics (demonstrating this deficit alpha activity pattern) might be more vulnerable to the effects of alcohol, as alcohol ingestion appears to have a "normalizing" effect upon the production of alpha activity in alcoholic populations (Propping, Kruger, & Janah, 1980). The consumption of alcohol in these individuals would increase alpha activity and thereby enhance feelings of calmness and relaxation. In effect, by ingesting alcohol, the alcoholics would be neurochemically inducing a relaxed state as well as creating a more psychologically reinforcing condition. However, this effect would only induce a temporary change in their neurophysiological state (Collins, n.d., ¶ 4). An initial EEG-BFB investigation used an "enhance alpha" protocol in their alcohol treatment regimen; outcomes measures noted increased alpha levels and reductions in anxiety levels, but post-treatment differences regarding drinking behavior were not reported (Passini, Watson, Dehnel, Herder, & Watkins, 1977).

Early investigations of the EEG status of monks while in meditative states of consciousness revealed predominant slow wave frequencies of both alpha and theta brainwave activity (Benson & Klipper, 1975, chap. 4; Kasamatsu & Hirai, 1969, as cited by Peniston, 1998; Trudeau, 2000). As previously mentioned, alpha has been likened to a state of relaxation; theta frequencies (4-7 Hz) have been equated with a pre-sleep or reverie state in which spontaneous hypnogogic images may arise (Peniston, ¶ 4). Further, it has been speculated that there is a connection between theta activity and access to the unconscious, as indicated by Elmer Green's still timely narrative (reprinted in 1999), "If one wishes to reprogram the body, emotions, or mind, visualization while in the theta state tends to be converted into reality" (p. 228). Both alpha and theta have been associated with altered and meditative states of consciousness that are conducive to heightened levels of insight and/or suggestibility (Green, 1993). Therefore, it was

theorized that adding an "enhance theta" component to the alpha EEG-BFB protocol for alcoholic subjects might maximize benefits.

Green and associates at the Menninger Institute in Topeka, Kansas, began using a protocol combining autogenics, breathing exercises, and finger temperature training with alpha-theta biofeedback (Green, Green, & Walters, 1970). In the original alpha-theta biofeedback protocols, the participants were taught to increase the amplitude and prevalence of occipital alpha and theta by receiving auditory signals when the microvolt amplitudes of these slower frequencies exceeded a preset threshold. As early as 1973, a program was piloted at the Topeka Veteran's Administration Medical Center (VAMC) that combined alpha-theta EEG-BFB, several peripheral biofeedback modalities (temperature, EMG), and therapy (individual, group) to treat substance-use disorders (Goslinga, 1975). In 1976 and 1977, clinical researchers at the Topeka VAMC reported on the ability of alpha-theta EEG-BFB to enhance psychotherapeutic insight and modification of viewpoints with a group of chronic alcoholic male inpatients (Tremlow & Bowen; Tremlow, Sizemore, & Bowen). However, since control groups were not used for comparison and relapse rates were not reported, results were interesting, but not definitive regarding the efficacy of this treatment modality.

Alpha-theta EEG-BFB for alcoholism first emerged as a viable alternative to traditional chemical dependency treatment approaches in 1989 with the publication of a study by Peniston and Kulkosky. These authors expanded upon the foundation of previous EEG-BFB work carried out at the Menninger Institute and Topeka VAMC. 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 subjects each. Two groups (one alcoholic, one non-

alcoholic) served as controls. A second group of 10 alcoholics comprised the experimental group. The alcoholic subjects had a 20-year history or more of alcoholism and had been previously hospitalized on four or more occasions for alcoholism treatment. The non-alcoholic control group received only treatment for their medical conditions, but no substance abuse treatment. The alcoholic control group received the VAMCs traditional alcoholism treatment (abstinence, psychotherapy, group therapy, and medication management). The experimental alcoholic group participated in eight (30-minute) sessions of temperature biofeedback followed by 15 (30-minute) EEG alpha-theta biofeedback training sessions at site 01, per the International 10-20 electrode placement system. It should be noted that in a later report, Peniston (1994) recommended using 30 EEG-BFB sessions. The experimental protocol also involved instruction in other psychophysiological self-regulation techniques including autogenic training and rhythmic breathing methods similar to those used at the Menninger Institute. However, Peniston and Kulkosky's protocol added an imagery/visualization component involving "scripting" of desired emotional/behavioral outcomes and covert rehearsal of alcohol rejection responses. The multi-modal 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).

Peniston EEG-BFB Protocol Outcomes on Psychometric Instruments

In Peniston and Kulkosky's initial study (1989), several pre- and post-treatment measures were administered to all subjects: a brief depression screen (Beck Depression Inventory®, BDI®; The Psychological Corporation; Beck, Ward, Medelson, Mock, & Erbaugh, 1961; Beck & Steer, 1987), an EEG baseline rating, and a blood sample to derive serum ß-endorphin levels. Post-assessment measures indicated that in comparison to the control groups (alcoholic, non-

alcoholic), the EEG-BFB alcoholic sample demonstrated significant increases in alpha amplitudes as well as percentages of theta and alpha activity. Significantly elevated serum ß-endorphin levels (a physiological index of stress) were noted only in the alcoholic control group upon post-treatment testing. Compared to the alcoholic group control, the EEG-BFB group demonstrated significant improvement in depressive symptomatology as assessed by the BDI. Further, the EEG-BFB group's post-treatment BDI scores did not significantly differ from the non-alcoholic control group.

Similar BDI findings have been documented in uncontrolled clinical trials of the Peniston protocol. For instance, Saxby and Peniston (1995) noted significantly reduced post-treatment BDI scores in their sample of 14 depressed alcoholic inpatients who had undergone alpha-theta EEG-BFB training. Kelley (1997) treated 19 Navajo alcoholic inpatients with an average of 40 "culturally modified" (p.24) alpha-theta biofeedback sessions. These sessions were completed in addition to their 33-day substance abuse treatment program. Significant reductions in post-treatment depression were noted in this experimental group as well.

In addition to improvements noted in brief self-report depression screens, several clinical investigations (controlled and uncontrolled) utilizing the Peniston EEG-BFB protocol with alcoholic populations have documented significant changes in personality characteristics following treatment. Three different personality inventories have been used to evaluate outcome in these studies. In 1990, Peniston and Kulkosky presented additional pre- and post-treatment psychometric assessment data (Sixteen Personality Factor Questionnaire®, 16 PF®, Institute for Personality and Ability Testing, Inc.; Million Clinical Multiaxial Inventory™, MCMI™, Dicandrien, Inc.) on the same groups of subjects that they initially reported on in 1989. Pre-treatment 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, post-treatment 16 PF results showed significant increases that could be viewed as more positive personality features (e.g., warmth, stability, conscientiousness, imaginativeness, self-control, boldness, abstract thinking). Upon post-16 PF assessment, the alcoholic control group demonstrated a significant increase in only one scale (a measure of concrete thinking). The pre-treatment MCMI findings revealed that both alcoholic groups scored significantly higher on numerous scales compared to the non-alcoholic group. Upon post-treatment 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).

The later uncontrolled investigation by Saxby and Peniston (1995) resulted in comparable improvements on the MCMI-I. Post-treatment results of the 14 depressed alcoholic inpatients undergoing the Peniston EEG-BFB protocol revealed significant changes on several scales in comparison to pre-treatment data (e.g., schizoid, avoidant, dependent, histrionic, passive-aggressive, schizotypal, borderline, anxiety, somatoform, hypomanic, dysthmic, alcohol abuse, drug abuse, psychotic thinking, and psychotic depression).

The Minnesota Multiphasic Personality Inventory-2™ (MMPI-2™, University of Minnesota) has also been utilized to evaluate changes in personality dynamics following EEG-BFB treatment utilizing the Peniston protocol. An uncontrolled study by Fahrion, Walters, Coyne, and Allen (1992) documented significant post-treatment alterations on the MMPI-2 in an

alcoholic inpatient, such as increased openness and an overall "normalization of response" (p. 550). However, generalizations cannot be made based upon this single subject design.

Modified Peniston Protocol Effects in Alcohol/Drug Dependency Cases

The above-mentioned studies have utilized the Peniston EEG-BFB protocol in the primary treatment of alcoholism. Some preliminary evidence of the efficacy of using a "modified" Peniston protocol with subjects experiencing polysubstance abuse problems (e.g., methamphetamine, crack, heroin, or other controlled substances, as well as alcohol) has been reported. Scott and Kaiser (1998) randomly assigned polysubstace-abusing inpatients to one of two groups. Both groups received conventional addiction treatment based upon the Minnesota Model (Doweiko, 2002, chap. 28), which encompassed counseling (individual, group, and family) and a 12-step recovery process. In conjunction with this component, the experimental group participated in 40-50 sessions of EEG-BFB training (modified Peniston protocol). Specifically, the experimental subjects received 10-20 sessions of beta/SMR training (inhibit 4-7 Hz and 22-30 Hz, reward 12-18 Hz) at sites C3 and C4 followed by 30 sessions of alpha-theta EEG-BFB (site PZ) during a 45-day period. 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, 43 controls and 48 experimental subjects had completed treatment. The MMPI-2 was administered to both groups pre- and post-treatment to evaluate outcome. Upon post-treatment testing, the EEG-BFB group exhibited significant improvement on seven basic clinical scales (1/*Hs*, 2/*D*, 3/*Hy*, 4/*Pd*, 7/Pt, 8/*Sc*, and 0/*Si*) in comparison to controls. Both groups improved on the psychopathic deviate scale (4/*Pd*) and the control group improved on scale 6/*Pa*. This investigation continued and in 1999, Kaiser, Othmer, and Scott presented additional findings. Similar improvements were noted in the post-treatment MMPI-2

scores (Scales 1/*Hs,* 2/*D*, 3/*Hy*, 4/*Pd*, 8/*Sc*, and 0/*Si*) of the EEG-BFB group (n = 50). In 2002, this research group (Scott et al.) again provided an update on the above-mentioned investigation. The design of the study had remained essentially the same with a few exceptions. The EEG-BFB group underwent 40 EEG-BFB sessions (beta/SMR followed by alpha-theta), but the type of alpha-theta training received was determined by baseline alpha amplitudes. For instance, if the subject demonstrated a high initial level of alpha activity (i.e., above 12 microvolts), an alpha suppression protocol was utilized, whereas, if the subject's baseline alpha level was low (below 12 microvolts), alpha amplitudes were enhanced. One hundred twenty-one subjects (61 controls, 60 EEG-BFB experimental) were included in this project. As in the previous reports, the post-treatment MMPI-2 data indicated that the EEG-BFB group significantly improved on several scales in comparison to the control group (Scales 1/*Hs*, 2/*D*, 3/*Hy*, 8/*Sc*, and 0/*Si*); both groups significantly improved on Scale 4/*Pd*. Although the EEG-BFB group scored significantly lower on Scale 7/*Pt* post-treatment, their performance was not different from the control group's. In the 1999 report, Kaiser and associates had concurred that supplementing conventional treatment with EEG-BFB had a considerable impact upon psychological functioning (as assessed by the MMPI-2) in their chemically dependent sample.

Another important investigation of the Peniston protocol has been underway at the Open Door Mission in Houston, Texas (in association with the Southwest Health Technology Foundation; Crane, 2001, Skolnick, Cummins, & Dickson, 2001). This faith-based mission offers inpatient treatment to male crack cocaine addicts who are homeless and unemployed. Many have had multiple arrests (e.g., drug/alcohol-related; other offenses). The Mission's regular 9-month treatment program consists of drug testing, educational services, job training, non-denominational religious study, and spiritual guidance. In 2000, residents gained the option

to participate in EEG-BFB training using a modified Peniston protocol, which involved pre-training sessions (inhibit theta, enhance SMR) followed by 30 alpha-theta EEG-BFB sessions (site O1). Although this larger research project has been on-going since that time, a recently completed, but unpublished, dissertation project involved a subset of subjects receiving treatment at the facility (Burkett, 2004). Burkett's project involved 50 "crack" cocaine addicts randomly assigned to one of two substance abuse treatment groups. Both groups participated in the standard treatment protocol offered at the inpatient facility. The experimental group received seven EEG-BFB sessions (4-8 Hz inhibit, 13-15 Hz enhance at FP1/T4-bipolar) followed by 30 alpha-theta (Peniston protocol) EEG-BFB sessions. The treatment control group also underwent a "sham" EEG-BFB protocol condition for the same number of sessions as the experimental group. Both groups completed pre and post assessment measures, which included the MMPI-2. Analyses were conducted on scales 1/*Hs*, 2/*D*, 3/*Hy*, 8/*Sc*, and 0/*Si* and the ANCOVA results demonstrated no significant differences between the two groups. The experimental group did show more improvement on these scales versus the controls, but the differences between groups were not significant. These findings were in contrast to those of Scott and Kaiser (1998), Kaiser et al. (1999), and Scott et al. (2002).

MMPI/MMPI-2 Profiles in Substance Abuse Subjects

The MMPI-2 is widely utilized for clinical and research purposes (Archer, 1992). A few previous EEG-BFB studies have used the MMPI-2 to evaluate treatment effects in subjects with substance-related disorders (Fahrion et al., 1992; Kaiser et al., 1999; Scott & Kaiser, 1998). Furthermore, the MMPI/MMPI-2 has frequently been used in research to determine the overall personality profiles in substance abuse populations. Previous research, conducted primarily with the original MMPI, has suggested there is not a single definitive personality profile that emerges

with substance abusers (Graham, 1993, chap. 9; Tosi, Eshbaugh, & Murphy, 1993, chap. 8), but several studies have found various codetype patterns. Butcher and Williams (1992, chap. 8) reported that clinically significant elevations are frequently noted on these MMPI-2 scales: 1) 4/*Pd*; 2) 4/*Pd* and 2/*D*; and; 3) 2/*D*, 4/*Pd*, and 7/*Pt* with substance abusers. In 1988, Graham and Strenger reviewed the MMPI literature with alcoholic populations. Six different MMPI personality profiles emerged with the codetypes 4-2/2-4 occurring most often. However, Svikis, Gorenstein, Paluzzi, and Fingerhood (1998) concluded that 2-4/4-2 as well as 4-9/9-4 were the most frequently MMPI/MMPI-2 codetypes in alcoholic patients. In a study comparing the MMPI results of alcoholics to cocaine addicts, Johnson, Tobin, and Cellucci (1992) noted that both groups were similar and demonstrated a 4-2 codetype. MMPI studies investigating drug dependent and opiate or cocaine-addicted subjects have documented several codetypes including 4-9/9-4 (Craig, 1984; Craig & Olson, 1992; Dougherty & Lesswing, 1989; Tosi, Eshbaugh, Raines, & Murphy, 1986), 2/4-4/2, and 4-8/8-4 (Craig). Further, Craig and Olson found, in addition to the 4-9/9-4 codetypes, a floating profile with elevations on 8, 2, 7, 4, and 6 in a sample of cocaine abusers. In summarizing all of these MMPI/MMPI-2 results, it appears that an elevation on scale 4/*Pd* is one of the most common findings (Graham). In addition, Butcher and Williams indicated that moderate to high elevations (T-scores $\geq$ 60) on the three addiction scales (MAC-R, AAS, APS) are frequently noted in individuals with chemical dependency problems.

The MMPI-2 as an Outcome Assessment Measure

Given these documented changes in personality dynamics cited in earlier EEG-BFB research (Fahrion et al., 1992; Kaiser et al., 1999; Peniston & Kulkosky, 1990; Saxby & Peniston, 1995; Scott & Kaiser, 1998; Scott et al., 2002), it is of interest that the MMPI and the revised version, MMPI-2, are generally considered to measure enduring and stable dimensions of

personality (Gordon, 2001). According to Greene and Clopton (1999), several of these MMPI-2 scales (1/*Hs*, 4/*Pd*, 8/*Sc*, and 0/*Si*) assess personality characteristics that "will not change over time" (p. 1034); whereas, other scales such as 2/*D* and 7/*Pt* are reactive to situational changes. Svikis and associates (1998) stated that, "The MMPI-2 generally measures stable personality traits. Although absolute scale scores often vary as a function of life experiences, the general profile configurations tend to remain stable over time." (p. 95). Further, Spiro, Butcher, Levenson, Aldwin, and Bosse (2000) completed a five-year pre- and post-MMPI-2 study with 1,072 older male subjects and concluded that, "…MMPI-2 scores demonstrate an impressive amount of differential stability over time" (p.457). Thus, repeated testing with the instrument should not yield substantially different results. According to Gordon (p. 60), "the MMPI/MMPI-2 does not seem significantly affected by repeated administrations, nor do high scores seem to regress to the mean." For this reason, Gordon (p. 61) stated that the MMPI/MMPI-2 has typically "…not been very reactive as an outcome measure." A critique that has been raised regarding the use of the MMPI-2 in treatment outcome studies is that many of the questions are worded in the past tense and query past behavioral patterns (R. L. Greene, personal communication, January 21, 2005). Examples of some of these items are as follows: 1) I have never been in trouble with the law; 2) I have used alcohol excessively; and 3) I have made lots of bad mistakes in my life. Thus, lack of changes noted in post-treatment scores (as compared to pre-) may simply be a consequence of the language of the items (Greene & Clopton, 2004). However, Spiro and associates asserted that, "Given the high stability of test scores over time, when an individual deviates considerably from his or her previous test score, one should recognize that this change may be the result of important life or personality changes rather than test unreliability" (p.458).

Gordon contends that personality change, as noted on the MMPI-2, can only be accomplished via "long-term" psychotherapy.

Peniston EEG-BFB Protocol Effects on Relapse Rates

Although these documented post-treatment changes in various personality variables are of interest, many authorities consider the functional or behavioral outcomes (e.g., abstinence, maintenance of employment, and positive personal/social adjustment) to be the most important indicators of successful substance abuse treatment. Follow-up studies evaluating the Peniston protocol have noted significantly lower relapse rates in subjects participating in the Peniston EEG-BFB protocol in comparison to control groups or other studies reporting abstinence rates in chemical dependency populations. In 1989, Peniston and Kulkosky noted 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 post-treatment. The EEG-BFB group also demonstrated an 80% abstinence rate and a 20% relapse rate at the two-year (Peniston & Kulkosky, 1999) and 36-month follow-ups (Peniston, 1998, ¶ 9). The two EEG-BFB subjects who relapsed were reported to have significantly reduced their alcohol consumption and to have some negative physical symptoms after drinking such as flu-like symptoms (which later came to be known as the "Peniston flu"). Peniston subsequently reported (Personal Communication, 2000) that, with one exception (a subject now deceased), all individuals from the original treatment group were currently abstinent. He further stated that, "such a success rate of a treatment modality has never before been achieved" (1998, ¶ 11).

High abstinence rates were also observed in the uncontrolled study completed by Saxby and Peniston (1995). At the 21-month post-treatment mark, only one of 14 (7%) subjects undergoing the Peniston protocol had relapsed. In addition, Kelley (1997) followed up on the 19

alcoholic Navajo subjects who had participated in the Peniston EEG-BFB treatment protocol. The 3-year follow-up classified 12 (63%) of the subjects as in "sustained partial remission" according to *DSM-IV* criteria and four (21%) subjects as in "sustained full remission." The remaining three subjects (16%) were considered treatment failures.

Controlled investigations that have utilized a "modified" Peniston EEG-BFB protocol with various chemically dependent populations have reported low relapse rates at follow-up as well. Kaiser and colleagues' 1999 study with polysubstance-abusers noted that 67% of the control group and only 35% of the EEG-BFB group had relapsed at one-year post-treatment. The 2002 updated report indicated that 77% of the treatment group was abstinent versus 44% of the control group. Another ongoing research project has documented high abstinence rates for experimental treatment groups. For instance, DeBeus, Prinzel, Ryder-Cook, and Allen (2001) have been investigating the efficacy of EEG-BFB with chemically dependent outpatients. Subjects are randomly assigned to one of three groups: 1) Waitlist control group; 2) EEG-BFB group (utilizing QEEG to guide protocol selection) and; 3) EEG-BFB group (using a modified Peniston protocol--10-15 initial beta/SMR sessions followed by 30 alpha/theta sessions). The authors documented that 100% of the 14 experimental subjects (seven = QEEG-based group, seven = modified Peniston protocol group) were abstinent 6-months after treatment in comparison to only 71% of the control group participants. Although results are preliminary, DeBeus and colleagues noted that QEEG-based protocols might be just as effective as the Peniston protocol in chemical dependency treatment.

More rigorous tests of the reliability and efficacy of EEG-BFB treatments based on the Peniston protocol may come from investigations of its use with traditionally underserved chemically dependent populations (e.g., incarcerated public offenders, homeless populations, and

dually-diagnosed patients) in private or publicly-supported state institutions. In fact, two investigations with these populations are currently underway or recently completed. These studies include relatively large numbers of subjects. The final outcome reports have yet to be published; however, interim reports from these investigations have been issued. One summarized the third year results of a 4-year project performed with male and female chemically dependent adult and juvenile public offenders in the Kansas Criminal Justice system (Fahrion, 1999). The progress summary indicated that of 283 subjects who completed the full 30 sessions of EEG-BFB using the Peniston protocol, 224 (79%) were categorized as successful (no relapse, re-arrest, or probation violations), but 59 (21%) were considered treatment failures according to these outcome criteria. There was an 85% success rate for the subjects (n = 104) who received their treatment in jail. Of the 120 who were treated as outpatients, 75% remained abstinent and free of repeat offenses. In addition, a 30% dropout rate was reported for the first 3 years of the project. Likewise, the Open Door Mission has reported high success rates with their inpatient population of male crack cocaine addicts following EEG-BFB treatment for addictions (Crane, 2001; Skolnick et al., 2001). A preliminary project report on the 1-year follow-up of 17 treatment completers indicated that 11 (65%) had not been re-arrested and were no longer homeless, unemployed, or using drugs/alcohol (confirmed by urinalysis). A later report noted that 249 subjects had completed the EEG-BFB component of their addiction treatment program. A 1-year follow-up of 79 of those treatment completers found that 62% had not been re-arrested and had shelter, employment, and an alcohol/drug free life (Burkett, Cummins, Dickson, & Skolnick, 2005, in press).

In these previously outlined outcome studies, the relapse prevention noted in the experimental Peniston EEG-BFB protocol groups (or a modified version thereof) may be related

to the documented alterations in personality dynamics as assessed via psychometric tools. Norris (1999, p. 334) 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." When Peniston and Kulkosky (1990) initially discussed the changes documented between pre- and post-treatment psychometric assessments in their study, they 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 investigators 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). They further asserted that this "normalization of the personality" might underline the documented "sustained prevention of relapse" (1990, p.37). Green (1999) supported these conclusions, as he asserted that those who have undergone alpha-theta biofeedback treatment for addictions are able to maintain their sobriety due to 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).

Present Investigation Extends Previous Pilot Study

The present investigation extended a previous uncontrolled pilot study by Bodenhamer-Davis, Callaway, and DeBeus (2002), which represented one of the earliest attempts to clinically replicate the Peniston protocol with outpatients experiencing a range of chemical dependency

problems. The overall purpose of this pilot project was to determine if some of the findings reported by Peniston and Kulkosky (1989, 1990) could be replicated in a mixed-gender chemically dependent outpatient population, since Peniston and Kulkosky's pioneering studies were conducted with chronic alcoholic male inpatients. Participant data was collected using 1993-1995 client archival records from a University-based clinic specializing in EEG-BFB treatment. The sample consisted of 16 (13 males, 3 females) clients referred to the clinic for EEG-BFB treatment of addictions. Table 1 displays the demographic characteristics of the sample. The majority of the clients (62.5%) were public offenders classified as "high risk for re-arrest." Thus, this study also represented one of the first attempts, following the publication of Peniston and Kulkosky's research, to treat individuals who had been arrested for drug/alcohol-related offenses. Subjects completed several pre-treatment assessments including the BDI and MMPI-2. After participating in at least 30 EEG-BFB sessions using the Peniston protocol, subjects again completed the assessment measures. Pre-treatment BDI results ($N = 16$) revealed that most of the subjects evidenced mild/moderate depression (37.5%) and moderate/severe depression levels (31.2%). Upon post-treatment BDI administration, 60% of the subjects scored within the normal or asymptomatic range; results significantly differed from the pre-treatment ratings (see Tables 2 and 3; see Figure 1). In addition, the effect of EEG-BFB on the BDI scores was large (BDI Total; BDI-Cognitive) to medium (BDI-Somatic). The BDI has been used in other treatment evaluation studies and has been reported to be sensitive to changes occurring as the result of treatment in subjects initially presenting with depressive symptomatology (Gordon, 2001).

In addition to the BDI, the MMPI-2 was used to evaluate treatment effects with 14 of the EEG-BFB subjects who completed both pre/post assessments. On average, the pre-treatment

MMPI-2 T-scores revealed an "inverted V" validity scale configuration and a "floating" clinical scale profile with elevations (T score $\geq$ 65) on several scales (e.g., F, 1/*Hs*, 2/*D*, 4/*Pd*, 7/*Pt*, and 8/*Sc*). The highest two clinical scales were 4/*Pd* and 8/*Sc* (a five-point T-score difference did not exist between these scales). A clinically significant low mean score (T score $\leq$ 44) was noted on validity scale K. According to Graham (1993, chap. 10), the level of psychopathology or serious functional impairment can be assessed in several ways, via the MMPI-2, including: a significantly elevated F validity scale (e.g., T-score $\geq$ 65) and a "floating" clinical profile (e.g., several of the basic scales with T-scores $\geq$ 65). Further, the higher the mean scores and the more T-scores above 65, the greater the level of psychopathology. Therefore, these overall pre-treatment results were indicative of the presence of psychopathology in this sample. In general, studies have shown a negative association between psychopathology and treatment outcomes (Greene & Clopton, 2004; Shepherd, 1997). As previously noted, the mean MMPI-2 clinical scales in this pilot study showed significant elevations on five scales (1/*Hs*, 2/*D*, 4/*Pd*, 7/*Pt*, 8/*Sc*). However, mean post-treatment MMPI-2 results revealed a clinical elevation on scale 4/*Pd* only and a validity scale configuration that was within normal limits (see Table 2). Significant differences between the two MMPI-2 testing periods (pre- versus post-) were noted on scales 1/*Hs*, 2/*D*, 4/*Pd*, 7/*Pt*, 8/*Sc*, 9/*Ma*, and 0/*Si* (see Table 3 and Figure 2). However, once adjustments were made due to multiple comparisons, only clinical scales 2/*D*, 7/*Pt*, and 8/*Sc*, remained significant. Large treatment effects sizes ($d > .80$) were observed on scales 2/*D*, 7/*Pt*, and 8/*Sc*, while medium effect sizes ($d > .50$) were noted on several scales (1/*Hs*, 3/*Hy*, 4/*Pd*, 9/*Ma*, and 0/*Si*).

Long-term follow-up information (ranging from 74 to 98 months post-treatment) regarding abstinence was also collected in this pilot study. Abstinence data was gathered on

these subjects via direct communication and/or collateral contact (e.g., family, friends, former therapist, or probation officer). Of the 16 original treatment subjects, 15 were still living. One male subject died from alcohol-related complications over two years ago. Eighty-one percent (n = 13) of the remaining subjects were abstinent and 12.5% (n = 2) were not; they were using on a daily basis. In addition, follow-up information (e.g., re-arrests, probation revocations) was obtained on all probation subjects by accessing computerized judicial records. Of the 10 probation clients that completed EEG-BFB treatment, 60% did not have any probation revocations or re-arrests. However, 40% of these subjects had additional problems with the law including probation revocations (n = 2) and/or re-arrests (n = 3). Only two subjects were re-arrested for alcohol and/or drug-related offenses. These results were then compared to another probation group (n = 24) selected from a local probation officer's 1992-93 "high risk for re-arrest" caseload. The other group of probationers had not received EEG-BFB treatment for addictions (EEG-NOT group). This EEG-NOT group was matched by age and gender with the probationers who had undergone EEG-BFB for chemical dependency. Records indicated that of the 24 EEG-NOT probationer subjects, 79.16% (n = 19) were re-arrested (11 for DWI violations) and/or had their probation revoked; 12.5% percent (n = 3) were not arrested again. Overall, the results of this pilot study were similar to the psychometric and functional outcomes previously reported by other EEG-BFB investigators (DeBeus et al., 2001; Fahrion et al., 1992; Kaiser et al., 1999; Kelley, 1997; Peniston & Kulkosky, 1989, 1990; Saxby & Peniston, 1995; Scott & Kaiser, 1998; Scott et al. 2002; Skolnick et al., 2001).

This pilot study also documented long-term abstinence rates higher than those reported for persons receiving conventional forms of substance abuse treatment. The latter typically report approximately 65-70% of patients' relapse within one year of treatment, with the majority of

these relapsing within less than three months (McKay, Atterman, Rutherford, Cacciola, & McLellan, 1999). However, these results can only be considered suggestive of positive outcomes after completing the "Peniston protocol" for chemical dependency because this study was uncontrolled, non-randomized, and contained a small sample size. In spite of these limitations, the results provided additional consistency to the growing number of clinical replications using EEG-BFB techniques (Peniston protocol) for substance abuse. Of particular interest, are the transformations typically noted on personality measures, such as the MMPI-2, following relatively short-term EEG-BFB treatment in chemically dependent subjects. In discussing the MMPI-2 as an outcome measure for psychotherapy treatment, Gordon (2001) asserted that the instrument does not react to short-term treatment. Furthermore, he stated, "…it would be a matter of years before personality traits would reliably change." (p.63). In fact, "since the MMPI/MMPI-2 has not been very supportive of treatment effectiveness, it has fallen out of favor as an outcome instrument" (p. 63). Therefore, additional attention to this matter of personality change, as assessed by the MMPI-2, following a relatively short-term intervention is warranted, especially given today's managed health care environment. As part of the efforts to curtail mental health care expenses, third-party insurers are progressively requiring health care providers to demonstrate the efficacy of their treatment modalities (Lambert & Finch, 1999) within a relatively short period of time. Moreover, the fact that this treatment modality remains relatively unknown and underutilized in a time of prison overcrowding and court systems clogged with persons arrested for drug/alcohol related offenses presents a challenge to EEG-BFB researchers and clinicians alike. It is clear that better designed and controlled studies demonstrating treatment efficacy continues to be required.

CHAPTER 2

AIMS OF THE PRESENT INVESTIGATION

The overall aim of the current investigation was to extend research done in the previous pilot study (Bodenhamer-Davis et al., 2002) by meeting several objectives:

1) To increase the sample size of the EEG-BFB group by including additional client archival data (1995 to the present) from the NT Lab. Only subjects that completed EEG-BFB treatment for chemical dependency were included.
2) To collect long-term follow-up information on the additional EEG-BFB subjects regarding abstinence rates as well as re-arrest/probation revocation rates in the subgroup of probationers.
3) To add a comparison group of subjects presenting for chemical dependency treatment at another facility, but not receiving EEG-BFB treatment (other treatment-chemical dependency group, OT-CD). Then, collect pre- and post-treatment MMPI-2™ (University of Minnesota) data on this group.
4) To ascertain the overall demographic characteristics of the two treatment groups (EEG-BFB, OT-CD) as well as their pre- and post-treatment mean MMPI-2 scores (e.g., validity, basic clinical, and two addiction scales).
5) To ascertain if there were significant differences between the pre- versus post-treatment MMPI-2 average scores (e.g., validity, basic clinical, and two addiction scales) in the EEG-BFB group.
6) To ascertain if there were significant differences between the pre- versus post-treatment MMPI-2 average scores (e.g., validity, basic clinical, and two addiction scales) in the OT-CD group.

7) To ascertain if the two treatment groups (EEG-BFB, OT-CD) significantly differed from one another in terms of MMPI-2 treatment outcome. These treatment effects were assessed by comparing the post-treatment MMPI-2 mean scores of each group, with adjustments made for any potential pre-treatment differences (e.g., pre-treatment scores treated as covariates).

8) To ascertain if the two treatment groups (EEG-BFB, OT-CD) were not statistically equivalent to one another in terms of MMPI-2 treatment outcome. These treatment effects were assessed by comparing the adjusted post-treatment MMPI-2 mean scores of each group (adjustments were made for any potential pre-treatment differences).

9) To determine if the EEG-BFB group's pre-treatment as well as post-treatment MMPI-2 raw mean scores (by gender) were substantially different from the MMPI-2s "normal" standardization group's raw mean scores (by gender).

Research Questions and Hypotheses in the Present Investigation

I. Research Question: Does alpha-theta EEG-BFB training result in significant positive changes in personality variables, as measured by the MMPI-2, in subjects with chemical dependency problems?

Hypothesis I: The post-treatment MMPI-2 mean T-scores on one validity and four basic scales will be significantly lower than the pre-treatment MMPI-2 mean T-scores in the EEG-BFB group.

Sub-Hypothesis I-1: On validity scale F, the EEG-BFB group's post-treatment MMPI-2 mean T-score will be significantly lower than the pre-treatment MMPI-2 mean T-score.

Sub-Hypothesis I-2: On basic scale 1/*Hs,* the EEG-BFB group's post-treatment MMPI-2 mean T-score will be significantly lower than the pre-treatment MMPI-2 mean T-score.

Sub-Hypothesis I-3: On basic scale 4/*Pd,* the EEG-BFB group's post-treatment MMPI-2 mean T-score will be significantly lower than the pre-treatment MMPI-2 mean T-score.

Sub-Hypothesis I-4: On basic scale 8/*Sc,* the EEG-BFB group's post-treatment MMPI-2 mean T-score will be significantly lower than the pre-treatment MMPI-2 mean T-score.

Sub-Hypothesis I-5: On basic scale 0/*Si,* the EEG-BFB group's post-treatment MMPI-2 mean T-score will be significantly lower than the pre-treatment MMPI-2 mean T-score.

II. Research Question: Does alpha-theta EEG-BFB training result in significant positive changes in substance abuse variables, as measured by two of the MMPI-2 supplemental addiction scales, in subjects with chemical dependency problems?

Hypothesis II: The post-treatment MMPI-2 mean T-scores on two supplementary addiction scales will be significantly lower than the pre-treatment MMPI-2 mean T-scores in the EEG-BFB group.

Sub-Hypothesis II-1: On supplementary scale AAS, the post-treatment MMPI-2 mean T-score will be a significantly lower than the pre-treatment MMPI-2 mean T-score in the EEG-BFB group.

Sub-Hypothesis II-2: On supplementary scale APS, the post-treatment MMPI-2 mean T-score will be a significantly lower than the pre-treatment MMPI-2 mean T-score in the EEG-BFB group.

III. Research Question: Does standard chemical dependency treatment (OT-CD) result in significant positive changes in personality variables, as measured by the MMPI-2, in subjects with chemical dependency problems?

Hypothesis III: The post-treatment MMPI-2 mean T-scores on one validity scale and four basic scales will not be significantly different from the pre-treatment MMPI-2 mean T-scores in the OT-CD group.

Sub-Hypothesis III-1: On validity scale F, the OT-CD group's post-treatment MMPI-2 mean T-score will not significantly differ from the pre-treatment MMPI-2 mean T-score.

Sub-Hypothesis III-2: On basic scale 1/*Hs,* the OT-CD group's post-treatment MMPI-2 mean T-score will not significantly differ from their pre-treatment MMPI-2 mean T-score.

Sub-Hypothesis III-3: On basic scale 4/*Pd,* the OT-CD group's post-treatment MMPI-2 mean T-score will not significantly differ from their pre-treatment MMPI-2 mean T-score.

Sub-Hypothesis III-4: On basic scale 8/*Sc,* the OT-CD group's post-treatment

MMPI-2 mean T-score will not significantly differ from their pre-treatment MMPI-2 mean T-score.

Sub-Hypothesis III-5: On basic scale 0/*Si,* the OT-CD group's post-treatment MMPI-2 mean T-score will not significantly differ from their pre-treatment MMPI-2 mean T-score.

IV. Research Question: Does standard chemical dependency treatment result in significant positive changes in substance abuse variables, as measured by two of the supplemental addiction scales on the MMPI-2, in subjects with chemical dependency problems?

Hypothesis IV: The post-treatment MMPI-2 mean T-scores on two supplementary addiction scales will not be significantly different from the pre-treatment MMPI-2 mean T-scores in the OT-CD group.

Sub-Hypothesis IV-1: On supplementary scale AAS, the post-treatment MMPI-2 mean T-score will not be significantly different from the pre-treatment MMPI-2 mean T-score in the OT-CD group.

Sub-Hypothesis IV-2: On supplementary scale APS, the post-treatment MMPI-2 mean T-score will not be significantly different from the pre-treatment MMPI-2 mean T-score in the OT-CD group.

V. Research Question: Does alpha-theta EEG-BFB for chemical dependency result in greater positive changes in personality characteristics, as measured by the MMPI-2, than another form of chemical dependency treatment?

Hypothesis V: The EEG-BFB group's post-treatment MMPI-2 mean T-scores on six basic scales will be significantly lower than the OT-CD group's post-treatment MMPI-2 mean T-scores after the effect of the covariate (e.g., pre-treatment MMPI-2 mean T-scores) has been partialed out of the analysis.

Sub-Hypothesis V-1: On MMPI-2 basic scale 1/*Hs*, the EEG-BFB group's post-treatment MMPI-2 mean T-score will be significantly lower than the OT-CD group's post-treatment mean T-score, after the effect of the covariate (e.g., pre-treatment MMPI-2 mean T-scores on scale 1/*Hs*) has been partialed out of the analysis.

Sub-Hypothesis V-2: On MMPI-2 basic scale 2/*D,* the EEG-BFB group's post-treatment mean T-score will be significantly lower than the OT-CD group's post-treatments mean T-score, after the effect of the covariate (e.g., pre-treatment mean T-scores on scale 2/*D*) has been partialed out of the analysis.

Sub-Hypothesis V-3: On MMPI-2 basic scale 3/*Hy,* the EEG-BFB group's post-treatment mean T-score will be significantly lower than the OT-CD group's post-treatment mean T-score, after the effect of the covariate (e.g., pre-treatment mean T-scores on scale 3/*Hy*) has been partialed out of the analysis.

Sub-Hypothesis V-4: On MMPI-2 basic scale 4/*Pd,* the EEG-BFB group's post-treatment mean T-score will be significantly lower than the OT-CD group's post-treatment mean T-score, after the effect of the covariate (e.g., pre-treatment mean T-scores on scale 4/*Pd*) has been partialed out of the analysis.

Sub-Hypothesis V-5: On MMPI-2 basic scale 8/*Sc,* the EEG-BFB group's post-treatment mean T-score will be significantly lower than the OT-CD group's post-treatment mean T-score, after the effect of the covariate (e.g., pre-treatment mean T-scores on scale 8/*Sc*) has been partialed out of the analysis.

Sub-Hypothesis V-6: On MMPI-2 basic scale 0/*Si,* the EEG-BFB group's post-treatment mean T-score will be significantly lower than the OT-CD group's post-treatment mean T-score, after the effect of the covariate (e.g., pre-treatment mean T-scores on scale 0/*Si*) has been partialed out of the analysis.

VI. Research Question: Does alpha-theta EEG-BFB for chemical dependency result in greater positive changes in substance abuse variables, as measured by the MMPI-2, than another form of chemical dependency treatment?

Hypothesis VI: On two of the supplementary addiction scales, the EEG-BFB group's post-treatment MMPI-2 mean T-scores will be significantly lower than the OT-CD group's post-treatment mean T-scores, after the effect of the covariate (e.g., pre-treatment MMPI-2 mean T-scores on the two supplementary addiction scales) has been partialed out of the analysis.

Sub-Hypothesis VI-1: On MMPI-2 supplementary scale AAS, the EEG-BFB group's post-treatment mean T-score will be significantly lower than the OT-CD group's post-treatment mean T-score, after the effect of the covariate (e.g., pre-treatment mean T-scores on the AAS scale) has been partialed out of the analysis.

Sub-Hypothesis VI-2: On MMPI-2 supplementary scale APS, the EEG-BFB group's post-treatment mean T-score will be significantly lower than the OT-CD group's post-treatment mean T-score, after the effect of the covariate (e.g., pre-treatment mean T-scores on the APS scale) has been partialed out of the analysis.

VII. Research Question: Will the two treatment groups (EEG-BFB, OT-CD) be equivalent on MMPI-2 measures of personality characteristics following treatment?

Hypothesis VII: The adjusted (to account for the effect of the covariate) post-treatment MMPI-2 mean T-scores (on six basic scales) of the two treatment groups will not be equivalent to one another.

Sub-Hypothesis VII-1: On MMPI-2 basic scale 1/*Hs*, the EEG-BFB group's adjusted post-treatment MMPI-2 mean T-score will not be equivalent to the OT-CD group's adjusted post-treatment mean T-score.

Sub-Hypothesis VII-2: On MMPI-2 basic scale 2/*D*, the EEG-BFB group's adjusted post-treatment mean T-score will not be equivalent to the OT-CD group's adjusted post-treatment mean T-score.

Sub-Hypothesis VII-3: On MMPI-2 basic scale 3/*Hy*, the EEG-BFB group's adjusted post-treatment mean T-score will not be equivalent to the OT-CD group's adjusted post-treatment mean T-score.

Sub-Hypothesis VII-4: On MMPI-2 basic scale 4/*Pd*, the EEG-BFB group's adjusted post-treatment mean T-score will not be equivalent to the OT-CD group's adjusted post-treatment mean T-score.

Sub-Hypothesis VII-5: On MMPI-2 basic scale 8/*Sc*, the EEG-BFB group's adjusted post-treatment mean T-score will not be equivalent to the OT-CD group's adjusted post-treatment mean T-score.

Sub-Hypothesis VII-6: On MMPI-2 basic scale 0/*Si*, the EEG-BFB group's adjusted post-treatment mean T-score will not be equivalent to the OT-CD group's adjusted post-treatment mean T-score.

VIII. Research Question: Will the two treatment groups (EEG-BFB, OT-CD) be equivalent on MMPI-2 measures of substance abuse following treatment?

Hypothesis VIII: The adjusted post-treatment MMPI-2 mean T-scores (on two supplemental addiction scales) of the two treatment groups will not be equivalent to one another.

Sub-Hypothesis VIII-1: On MMPI-2 supplemental scale AAS, the EEG-BFB group's adjusted post-treatment MMPI-2 mean T-score will not be equivalent to the OT-CD group's adjusted post-treatment mean T-score.

Sub-Hypothesis VIII-2: On MMPI-2 supplemental scale APS, the EEG-BFB group's adjusted post-treatment MMPI-2 mean T-score will not be equivalent to the OT-CD group's adjusted post-treatment mean T-score.

IX. Research Question: Does this group of chemically dependent subjects (e.g., EEG-BFB) demonstrate significant elevations on the basic MMPI-2 scales that previous research has typically shown to be elevated in those with substance abuse problems?

Hypothesis IX: The EEG-BFB sample's initial MMPI-2 raw mean scores (by gender) will be significantly higher than the MMPI-2 "normal" standardization population's raw mean scores (by gender) on one validity scale and five basic scales.

Sub-Hypothesis IX-1: On MMPI-2 validity scale F, the EEG-BFB sample's pre-treatment raw mean score (by gender) will be significantly higher than the MMPI-2 "normal" standardization population's raw mean score (by gender).

Sub-Hypothesis IX-2: On MMPI-2 basic scale 2/*D*, the EEG-BFB sample's pre-treatment raw mean score (by gender) will be significantly higher than the MMPI-2 "normal" standardization population's raw mean score (by gender).

Sub-Hypothesis IX-3: On MMPI-2 basic scale 4/*Pd*, the EEG-BFB sample's pre-treatment raw mean score (by gender) will be significantly higher than the MMPI-2 "normal" standardization population's raw mean score (by gender).

Sub-Hypothesis IX-4: On MMPI-2 basic scale 7/*Pt*, the EEG-BFB sample's pre-treatment raw mean score (by gender) will be significantly higher than the MMPI-2 "normal" standardization population's raw mean score (by gender).

Sub-Hypothesis IX-5: On MMPI-2 basic scale 8/Sc, the EEG-BFB sample's pre-treatment raw mean score (by gender) will be significantly higher than the MMPI-2 "normal" standardization population's raw mean score (by gender).

Sub-Hypothesis IX-6: On MMPI-2 basic scale 9/*Ma*, the EEG-BFB sample's pre-treatment raw mean score (by gender) will be significantly higher than the MMPI-2 "normal" standardization population's raw mean score (by gender).

Sub-Hypothesis IX-7: On MMPI-2 addiction scale AAS, the EEG-BFB sample's pre-treatment raw mean score (by gender) will be significantly higher than the MMPI-2 "normal" standardization population's raw mean score (by gender).

Sub-Hypothesis IX-8: On MMPI-2 addiction scale APS, the EEG-BFB sample's pre-treatment raw mean score (by gender) will be significantly higher than the MMPI-2 "normal" standardization population's raw mean score (by gender).

X. Research Question: Does alpha-theta EEG-BFB for chemical dependency result in "normalization" of personality variables, as measured by the MMPI-2?

Hypothesis X: The EEG-BFB sample's post-treatment MMPI-2 raw mean scores (by gender), on six of the basic scales, will not be significantly different from the MMPI-2 "normal" standardization population's raw mean scores (by gender).

Sub-Hypothesis X-1: On MMPI-2 validity scale F, the EEG-BFB sample's post-treatment raw mean score (by gender) will not be significantly different from the MMPI-2 "normal" standardization population's raw mean score (by gender).

Sub-Hypothesis X-2: On MMPI-2 basic scale 2/*D*, the EEG-BFB sample's post-treatment raw mean score (by gender) will not be significantly different from the MMPI-2 "normal" standardization population's raw mean score (by gender).

Sub-Hypothesis X-3: On MMPI-2 basic scale 4/*Pd*, the EEG-BFB sample's post-treatment raw mean score (by gender) will not be significantly different from the MMPI-2 "normal" standardization population's raw mean score (by gender).

Sub-Hypothesis X-4: On MMPI-2 basic scale 7/*Pt*, the EEG-BFB sample's post-treatment raw mean score (by gender) will not be significantly different from the MMPI-2 "normal" standardization population's raw mean score (by gender).

Sub-Hypothesis X-5: On MMPI-2 basic scale 8/*Sc*, the EEG-BFB sample's post-treatment raw mean score (by gender) will not significantly differ from the MMPI-2 "normal" standardization population's raw mean score (by gender).

Sub-Hypothesis X-6: On MMPI-2 basic scale 9/*Ma*, the EEG-BFB sample's post-treatment raw mean score (by gender) will not significantly differ from the MMPI-2 "normal" standardization population's raw mean score (by gender).

Sub-Hypothesis X-7: On MMPI-2 addiction scale AAS, the EEG-BFB sample's post-treatment raw mean score (by gender) will not significantly differ from the MMPI-2 "normal" standardization population's raw mean score (by gender).

Sub-Hypothesis X-8: On MMPI-2 addiction scale APS, the EEG-BFB sample's post-treatment raw mean score (by gender) will not significantly differ from the MMPI-2 "normal" standardization population's raw mean score (by gender).

CHAPTER 3

METHODS

Participants

EEG-BFB Group Subjects

Participants included the 14 members of the original pilot study who completed the Peniston EEG-BFB treatment program. Data for these subjects was collected using 1993-1995 client archival records from the University of North Texas, Department of Rehabilitation, Social Work, and Addictions' Neurotherapy Lab (NT Lab). Six additional subjects were included in this study by accessing NT Lab client archival files from 1995 to the present. All 20 subjects participated in EEG-BFB treatment for chemical dependency. As part of their treatment package, subjects were required to read an informed consent document that delineated their treatment requirements and possible side effects or risks. The consent form further advised that any information gained through this process might be used for educational or research purposes; however, clients were assured that they would not be personally identified in such publications. Their signature on the form indicated their voluntary consent to participate in the study and that they understood the possible side-effects of alpha-theta EEG-BFB training (e.g., "Peniston flu" and/or abreactions). Subjects also authorized representatives of the NT Lab to contact them for follow-ups as well as their designated friends, family members, and/or probation officer(s). Participant data was excluded if the subject did not complete: 1) the informed consent process; 2) at least 30 sessions of EEG-BFB treatment for addictions and; 3) both pre- and post-treatment assessment periods (MMPI-2™, University of Minnesota). Subjects must have been at least 18 years of age, as the MMPI-2 is valid for those 18 years of age or older. Subjects were not excluded based on gender or ethnicity.

The sociodemographic characteristics of the 20 subjects in the EEG-BFB group are as follows. The sample was comprised of 85% males (n = 17) and 15% females (n = 3). Subjects ranged in age from 26 to 54, with a mean age of 39.35 (SD = 8.331). Their ethnic heritage included 85% Caucasian (n = 17), 5% African American (n = 1), and 5% Hispanic (n = 1); one (5%) archival file failed to contain ethnicity information. The majority of subjects had been referred for treatment by the local Adult Probation Department (n = 12, 60%), but 75% (n = 15) were on probation at the time of treatment. Ninety percent of the clients (n = 18) self-reported a previous arrest history, while 10% (n = 2) did not. The majority of the subjects indicated they had received previous treatment (n = 18, 90%) while 10% did not (n = 2). Seventy percent (n = 14) of the subjects were previously involved with AA and/or NA groups. Their average history of addiction was 22.25 years (SD = 9.391, range = 8 to 39). Forty percent (n = 8) of the sample reported being clean and sober at intake, while 35% (n = 7) disclosed they were not; five (25%) client files did not contain sobriety information. Sixty percent (n = 16) of the sample presented with additional mental health problems. Specifically, 30% (n = 6) presented with depression or bipolar disorder and 15% (n = 3) with mixed anxiety and depressive symptoms. Thirty-five percent (n = 7) of subjects denied having depression or anxiety problems. Four (20%) files failed to contain any information related to co-existing mental health issues. A history of sleep disturbance was recorded in 25% (n = 5) of the sample and 10% (n = 2) acknowledged having attention deficit (ADD/ADHD) problems. Six (30%) subjects disclosed they were survivors of childhood abuse while four (20%) denied such a history. Child abuse history was not recorded in 50% (n = 10) of the records. Additional sociodemographic information related to the EEG-BFB group is displayed in Tables 4 and 5. The sample's alcohol and drug-related information can be

found in Table 6. Nineteen (95%) of the subjects lived in a transitional housing location following completion of their residential phase of treatment.

Other Treatment for Chemical Dependency Group Subjects (OT-CD)

Participants for this group were solicited from Homeward Bound, Inc., located in the Trinity Recovery Center, Dallas, Texas. Homeward Bound provides residential and outpatient chemical dependency treatment service. The facility also offers transitional housing opportunities, at two locations, for males that have completed their residential treatment in good standing and are continuing to participate in the outpatient services program. Approval for conducting the research project was granted by the Directors of the facility after reviewing the requirements and all related documentation. The primary investigator of this project was allowed access to the separate male and female residential departments in order to solicit volunteers from among those newly admitted clients. Presentations regarding this project were provided by the investigator in a group format and included the purpose of the study, time requirements, benefits to participants or others, description of possible risks in completing materials, and assurance of confidentiality of the information obtained. It was also emphasized that participation was voluntary. Subject inclusion criteria were outlined: 1) must be at least 18 years of age; 2) must have been referred for alcohol and/or substance abuse treatment; 3) must be enrolled in the two week residential treatment program; 4) must be planning to enroll in the outpatient treatment program after being discharged from the residential program; 4) must not have previously undergone EEG-BFB treatment for chemical dependency; 5) must be willing to complete all required research materials (e.g., consent form, background history questionnaire, and pre/post-treatment psychological inventory). Subjects that so desired would be provided feedback regarding their psychological test results. Participants were not excluded based on ethnic origin.

Subjects indicated their voluntary consent to participate in the investigation by signing the informed consent; a copy of this document was then provided to them. Participants were solicited over a 5-month period. During that time, 105 subjects (92 males, 88%; 13 females, 12%) volunteered for the study, but 16 (15%; 75% male versus 25% females) of these failed to complete all pre-treatment materials. Of the initial 105 participants, only twenty percent (n = 21; all males) completed the second phase of testing. However, a total of 20 subjects comprised this group; one subject was excluded from analysis, as he participated in a different treatment regimen at the facility (e.g., 60-day residential program rather than the two week residential program plus outpatient treatment). Only three subjects (all male) that completed their residential and outpatient treatment at the facility failed to finish the post-treatment MMPI-2.

Regarding the demographic characteristics of the OT-CD group, all 20 subjects were male, with an average age of 37.40 (SD = 9.236, range = 21 to 53 years). At the time subjects signed up for this study, all were residential patients and, therefore, 100% were abstinent. The majority of subjects had undergone prior treatment (60%, n = 12) and averaged 2.25 (SD = 3.701) previous treatments. Their years of addiction problems ranged from 2.5 to 35 years, with a mean of 18.6 years (SD = 9.814). Sixty-five percent (n = 13) of the sample acknowledged having other mental health problems, but 35% (n = 7) denied co-morbidity. Self-reported depression and/or anxiety history of the sample are as follows: 30% (n = 6) anxiety and depression; 25% (n = 5) depression or bipolar disorder; and 5% (n = 1) anxiety alone. Thirty percent (n = 6) had a history of sleep disturbance and 25% (n = 5) reported attention deficit (ADD/ADHD) problems. A large portion of the sample had a previous arrest history (75%, n = 15), with an average of 4.125 (SD = 4.353) prior arrests, but only a mean of 1.45 (SD = 1.761) convictions. Most of the arrests were drug/alcohol-related (M = 3.30, SD = 3.701). Subjects had

previously spent an average of 16.35 (*SD* = 26.376, range = 0 to 99) months incarcerated. However, only a few were currently on parole (*n* = 2, 10%) or probation (*n* = 1, 5%) according to self-reports. Eighty-five percent (*n* = 17) of subjects had a family history of chemical dependency problems. Further, 55% (*n* = 11) of the sample reported being a survivor of childhood abuse, while 45% (*n* = 9) denied such history. Refer to Tables 4 and 5 for additional demographic information pertaining this group. Table 6 lists the drugs of choice for this group.

MMPI-2 Standardization Population

The MMPI-2 "normal" standardization group consisted of 2600 adult volunteers (1138 males, 1462 females) who were randomly solicited from seven different US locations (Graham, 2000, chap. 1). Subjects ranged in age from 18 to 85 (*M* = 41.04; *SD* = 15.29). Approximately 72% of the males and 61% of the females were married (Butcher, Dahlstrom, Graham, Tellegen & Kaemmer, 1989). The ethnic heritage of this population included 81% Caucasians, 12% African-Americans, 3% Hispanics, 3% Native-Americans, and 1% Asian-Americans (Graham). Roughly 32% of the males and 21% of the females were employed in professional or managerial positions, while 12% of the males and 5% of the females were laborers. Some of the subjects (6% females, 3% males) were participating in mental health treatment at the time of the assessment.

Assessment Instrument (MMPI-2; Hathaway & McKinley, 1989)

Participants concluding chemical dependency treatment at the NT Lab completed the MMPI-2 on at least two occasions (pre- and post-treatment). The OT-CD group also completed the MMPI-2 during similar time periods. MMPI-2 administration and scoring was performed according to standardized guidelines. The MMPI-2 is a 567-item self-administered inventory used to assess personality characteristics and psychopathology for clinical and non-clinical

populations. The inventory is designed for individual's age 18 and older. It takes approximately 90 minutes to complete and requires an eighth grade reading level (Holden, 2000). The MMPI-2 consists of three validity scales (*L, F, K*) and 10 basic clinical scales (1/*Hs,* 2/*D,* 3/*Hy,* 4/*Pd,* 5/*Mf,* 6/*Pa,* 7/*Pt,* 8/*Sc,* 9/*Ma,* and 0/*Si*). For the purposes of this study, the 5/*Mf* scale was not used due to the mixed-gender sample in the EEG-BFB group (Greene, 1991, chap. 2; R. L. Greene, personal communication, February 09, 2005). Raw scores for each of the scales were converted to standardized T-scores with a mean of 50 (*SD* = 10). T-scores above 65 (1.5 *SDs* above the *M*) are considered to be clinically significant. In addition, three supplementary scales measuring pathology and various aspects related to addictions (*MAC-R, AAS*, and *APS*) can be administered, but only two were used in the present investigation (*AAS, APS*). Of these, the *AAS* scale has been reported to be the better indicator of substance abuse (Rouse, Butcher, & Miller, 1999). Further, the pre- and post-treatment raw mean scores (by gender) of the EEG-BFB sample were used to compare to the raw mean scores of the MMPI-2s normative population (by gender). This procedure was necessary since a review of the literature revealed that the norms were only reported in terms of scale raw mean scores (and *SD*s) per gender (Friedman, Lewak, Nichols, Webb, appendix A, 2001). Personnel at the University of Minnesota were contacted in order to locate the T-score *M*s and *SD*s of the normative group, but to no avail.

The MMPI-2 administration manual reported adequate test-retest reliability coefficients for the basic scales ranging from .67 to .92 for males and .58 to .91 for females (Butcher et al., 1989). Internal consistency was reported to be sufficient for the basic scales (ranging from .58 to .85 for males, .57 to .87 for females), with the exception of scale 6/*Pa* (.34 for males, .39 for females). Graham (1993, chap. 8) examined the MMPI-2 validity literature and found evidence

supporting convergent and discriminant validity for the clinical scales. Graham concluded that the, "…existing data suggest that the MMPI-2 has validity" (p. 192).

The demographic characteristics of the MMPI-2 standardization group approximated that of the 1980 US census data (Graham, 2000, chap. 1). The restandardization of the MMPI-2 has received criticism (Holden, 2000). For instance, intercorrelations between some of the scales are as high as .80, indicating a high amount of overlapping items. In addition, subjects of upper socioeconomic status were over-represented, as were those who had post-high school education. However, several studies revealed that the relationship between the MMPI-2s scales (e.g., validity; basic) and the educational level of MMPI-2s standardization group was not significant (Butcher, 1990, as cited in Graham, 2000; Dahlstrom & Tellegen, 1993, as cited in Graham; Long, Graham, & Timbrook, 1994).

Procedure Information Related to the EEG-BFB Group

The following information pertains to the EEG-BFB group and includes biofeedback equipment specifics, clinician training, overall session formats, and biofeedback training procedures.

Biofeedback Apparatus

The F1000 Biofeedback System (Focused Technology, Ridgecrest, CA) was utilized with the majority of subjects (Focus only, $n = 17$, 85%; Focus in combination with other EEG-BFB equipment, $n = 2$, 10%) included in this investigation who completed EEG-BFB treatment for chemical dependency. Hence, the following technical information will be specific to that equipment. The Focused Technology F1000 Instrumentation System processes 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

is converted via a 12-bit high-speed analog to digital converter. The computer typically reads the filter output at 1/64-second intervals. One pre-amp channel supplies EEG signals to both filters to provide dual feedback bands (e.g., alpha-theta). The response time of the filters is determined by the frequency band being measured; the filters are tunable over a range of 2 Hz to1000 Hz. Smoothing is applied to achieve effective feedback. The manufacturer states that the gain factors of the amplifiers are set to allow a 300-millivolt peak-to-peak signal to be processed without clipping. The raw EEG signal is recorded at 128 samples per second and is available for additional filtering using digital methods such as FFT. The EEG ground is safety isolated from the computer ground. The EEG amplifier has a CMRR of at least 120 dB. Electrode cables are electrically shielded (differentially). Thermal data uses a separate 13-bit high precision ratiometric analog to digital conversion. This conversion provides stable, high-resolution information necessary, in particular, for effective temperature feedback. The software provides .02 to .002 º F resolution. Thermal data is recorded at 7.2 samples per second; whereas, processed EEG data is recorded at 10 samples per second (F. Deits, personal communication, December 18, 2001, January 10, 2002).

Clinicians

Most of the biofeedback clinicians who provided services to the EEG-BFB subjects in this group were staff members or practicum students at the Neurotherapy Lab. Two were doctoral-level counselors employed by the university. The clinicians had varied levels of previous counseling experience, with the majority being relatively inexperienced practicum students. All service providers had received some professional training 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.

Overall Session Procedures

A procedures manual was developed and was used to guide the treatment (e.g., intake, assessment, sessions, and termination) of these clients. Session formats were modeled after the "Peniston protocol" as well as other previous research in biofeedback and relaxation techniques. Biofeedback procedures were specific to the type of equipment utilized and are outlined below. As recommended by Peniston, an individualized visualization "script" was developed for each subject (Peniston & Walters, 1992). The script incorporated the following components: 1) Autogenic Training phrases and guided relaxation statements; 2) connection to the subconscious mind; 3) rejection of undesired behaviors or feelings (e.g., consuming alcohol or illicit drugs; feeling unworthy); 4) 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; 5) command to the subconscious mind to accomplish the goals. The script was developed over the course of the first few sessions and was modified as therapy progressed. Clinicians were instructed to follow these standardized procedures for all client sessions; however, due to the different therapists and clients involved in this process, some variability in session proceedings occurred. All client sessions were conducted in individual treatment rooms.

Pre-Training Sessions (Temperature-BFB) Training

Prior to beginning the first phase of treatment, participants received a brief demonstration informing them as to how the temperature-BFB (Temp-BFB) equipment worked and how to interpret the audio feedback signals. The subjects 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 non-dominant hand. A portion of the thermistor cable was secured with micropore tape to the wrist (non-dominant). After the thermistor was attached and the computer activated, a resting baseline of finger temperature data was collected in º F. Subjects were then advised to recline and relax with eyes closed while the clinician read the personalized script. 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 subject's current hand temperature. For example, the pitch of the bell-tone became higher as the subject's finger temperature increased. On the F1000, each tone that sounded represented a temperature change of approximately .02 º F. Visual data regarding current temperature readings also could be viewed on the computer monitor. The overall training objective was for the subject to develop the ability to increase his/her finger temperature to at least 94-95 º F within 10 minutes and maintain it for at least 15 minutes. Temp-BFB training proceeded until the criterion was reached. One-hour sessions were conducted three to five times per week with the BFB portion of the session being approximately 30 minutes in length. The majority of EEG-BFB subjects (n = 15; 75%) participated in the temperature-BFB pre-training sessions, but four subjects (20%) did not; there was missing data

in one file (5%). For those that participated in temperature-BFB, they completed an average of 5.47 sessions (*SD* = 4.671; range = 2-19). In some instances, subjects (*n* = 6, 30%) participated in either an enhance SMR protocol (site CZ), an inhibit theta/enhance SMR protocol (either site CZ or C4), or an inhibit theta/enhance Beta protocol (site C4) prior to beginning the alpha-theta EEG-BFB training.

EEG-Biofeedback (EEG-BFB) Training

Subjects attended EEG-BFB sessions a minimum of three times per week for approximately 60 to 90 minutes each. From the available data, the subjects completed an average of 33 alpha-theta sessions (*SD* = 7.377). Each subject received at least 30 minutes of biofeedback during each session. Prior to beginning these sessions, all subjects 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 noted above. Prior to connecting the other electrodes, the necessary areas (e.g., earlobe, scalp site) were cleaned with pre-packaged alcohol antiseptic swabs. If applicable, the subject removed any earrings prior to cleaning. EEG electrode paste was utilized to fill the electrode cavities prior to attaching them. The electrode placement was monopolar. The reference earclip electrode was attached to the left earlobe. If the subject had more than one ear piercing, the area directly behind the ear was properly cleaned and an electrode applied there. The International 10-20 electrode system was employed to determine scalp electrode placement.

An active electrode was placed on the left-hemisphere occipital site O1 in the majority of subjects (n = 13, 65%); this site is located approximately one cm above and one cm left of the subject's inion. Four subjects (20%) received alpha-theta EEG-BFB training at another posterior site such as PZ (n = 1; 5%), P3 (n = 1; 5%), or P4 (n = 2; 10%); three (15%) archival files failed to list the placement site. The active surface electrode (9 mm disk) was typically secured in place with an elastic headband. The EEG cables were supported via loosely clipping them to the subject'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 was collected in microvolts for three to five minutes. Then, the clinician read the client's personalized script. After this phase, the clinician set the theta and alpha thresholds based upon the baseline amplitude information or the subject's previous session's threshold settings. The EEG audio feedback system was then activated. Although finger temperature data was also collected on the F1000, the subjects received no audio feedback related to this measure once the pre-training sessions (e.g., temperature-BFB) were completed. The EEG training protocol primarily consisted of enhancing theta (4-8 Hz) and enhancing alpha (8-12 Hz) amplitudes. Participants received auditory feedback tones contingent upon the theta band and/or alpha activity surpassing the pre-set 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 subjects were advised to attempt to increase the amount of time the tone was heard by relaxing. A feedback proportion of

79-80% alpha to 20 to 30% theta was targeted. Specifically, thresholds were set so that 20-30% of the session the client would receive theta feedback, while 70-80% of the session they would receive alpha feedback. This standard was used to prevent the conditioning of a dominant theta to alpha ratio. At the end of each session, the participant's subjective experience(s) were processed either verbally with the clinician or via non-verbal methods (e.g., journaling, drawing). In addition to biofeedback training, most subjects received some supportive counseling. Many received instruction in cognitive-behavioral techniques. 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.

Follow-Up Process

Attempts were made to contact all subjects in the EEG-BFB group via direct communication and/or by contacting their family, friends, former therapist(s), or probation officer. Subjects had previously provided their voluntary consent for this contact (during the intake and informed consent process) as well as the names, phone numbers, and addresses of collateral contacts. In several instances, the telephone contacts originally provided were no longer valid and Internet searches were completed to locate those contacts.

Probationer Follow-up Information

Follow-up information (e.g., re-arrests, probation revocations) was obtained on the subgroup of probation subjects in the EEG-BFB sample by accessing the computerized judicial records maintained by the county and/or the county probation office (County of Denton, TX). In addition, one of the referring probation officers was contacted as well as the local probation

department for follow-up information. Probation department personnel accessed their records and provided available data.

Procedure Information Related to the OT-CD Group

The following information pertains to the OT-CD group and includes an overview of the chemical dependency treatment regimen offered at Homeward Bound, Inc. of Dallas, Texas. Since none of the OT-CD treatment group completers were female, the treatment program delineated will be specific to services offered to male clients. Following an intake interview process and voluntary admission to the program, treatment typically proceeds in three phases: 1) detoxification of alcohol or illicit substances over a two to four day period (depending upon condition); 2) residential placement for 14 days and; 3) enrollment in the intensive outpatient services program (IOP), which consists of 18 sessions. The first process, known as "de-tox," typically consists of withdrawal from alcohol and/or illicit substances concomitant with medical and medication management (i.e., anti-anxiety and/or sleep medication). The later two treatment stages involve the following aspects:

Homeward Bound's Phoenix Residential Program

Upon admission to the 36-bed residential program, clients are provided with an orientation manual that outlines the center's mission, available professionals and services, center rules, client responsibilities, dress codes, chain of communication channels, responsibilities of peer-support members, constructive methods for addressing nonproductive modes of thinking or behaviors, protocols for accessing services, and instruction in completing required paperwork. The program places a heavy emphasis on the 12-step recovery process of Alcoholics/Narcotics Anonymous (AA/NA) and the manual contains these steps (see Appendix A). The Narcotics Anonymous textbook is the main one utilized for educational and homework assignments;

however, the Alcoholics Anonymous text, known as the "Big Book" serves as an adjunct. Both texts explain the history of the organizations as well as the 12-step recovery process. Residents follow a schedule of activities beginning at 6:30 a.m. until 10:30 p.m. Activities are generally completed in a group format. Five days per week, residents participate in a once per day process group (i.e., discuss feelings, thoughts, daily assignments, etc.) and a twice per day educational group. The educational groups present information related to the disease concept of addiction, relapse triggers, relapse prevention, productive coping skills, and how to access the AA/NA support network. After clients have been in residence for at least three days, they are required to daily attend evening AA or NA group sessions that are offered in the community. Residents also have the option of participating in acupuncture detoxification, which is available five times per week; staff advises residents that such techniques have proven to reduce stress and drug/alcohol cravings. Once per week, personnel from the Greater Dallas Council on Alcohol and Drug Abuse provide educational information related to sexually transmitted diseases, HIV, AIDS, and hepatitis; they also offer free testing for HIV. In addition to the group services, residents have two individual one-hour sessions with their assigned counselor (i.e., mid-treatment, discharge) to discuss treatment goals, progress, and discharge plans. The overall goal of the treatment modalities is to facilitate change in beliefs/attitudes, behavior, emotions, and character. Prior to discharge, the residents are required to have secured an AA or NA sponsor; the sponsor must be of the same gender and must have been clean and sober for at least two years.

Homeward Bound's Outpatient Treatment Program

Once a client is discharged from the residential program, they have the option to enroll in the intensive outpatient program (IOP). Upon voluntary admission, clients are provided with a program manual that describes the overall services, group guidelines, client rights, and

confidentiality limits. The treatment schedule consists of an additional 18 sessions (16 group sessions, four days per week for four days; two individual sessions, once every other week). The groups typically meet for a period of three hours and clients have the option of attending morning or evening sessions. The group meetings consist of counseling, education, and peer support. As in the residential program, the 12-step recovery process is emphasized along with education regarding the disease of addiction, developing new coping skills, and support of recovery. An educational group session is available for the family members of clients on Wednesday evenings. Failure to attend group sessions for a period of one week (without notifying staff as to the reason) results in discharge from the program.

Homeward Bound Transitional Housing

Homeward Bound offers transitional housing opportunities in two locations for those discharged from the residential program in good standing; however, space is limited and there is often a waiting list. This housing option is available only to those who enroll in the outpatient services program at Homeward Bound. Residents of the house are required to attend IOP sessions as well as AA/NA meetings. Transitional housing allows the individual additional time to secure housing and employment as well as maintain peer support during their recovery process. Drug testing occurs on a random basis. Clients are allowed to remain in such housing for 40 days, but failure to maintain sobriety or to adhere to the rules of the house results in dismissal.

Homeward Bound Personnel

Staff members include medical personnel (i.e., medical doctor, nurse, and a psychiatrist), service technicians, and a variety of licensed counselors (master's level, bachelor's level, and/or LCDC certified). The medical and clinical staff members are experienced professionals in the

field of chemical dependency. Many of the staff members such as technicians, maintenance, housekeeping, and clerks are in various stages of their own recovery process. The psychiatric and medical services are accessible upon written request.

Homeward Bound Data Collection Process

The collection of data from the OT-CD sample occurred in two phases. The primary investigator of this study approached potential subjects after they had completed the detoxification phase and were newly admitted into the residential treatment program. For those that volunteered for the project, a signed consent form was obtained as well as a completed background history questionnaire. Subjects received a copy of the consent document and their questionnaires were reviewed to ensure all items were complete. Next, the subjects were given verbal instructions in how to complete the MMPI-2 per standardized guidelines. Some of the subjects were unable to finish the personality inventory in one sitting and were allowed time each day to work on the inventory until completed. The subjects were advised that their progress in the program would be tracked and when they completed their 18th outpatient session, they would again be contacted to complete the second stage of testing. Personnel of Homeward Bound provided data regarding the status of subjects in their program (i.e., discharged due to relapse, successful discharge, unknown, etc.). In addition, many of the subjects that enrolled in the outpatient program would advise the primary investigator as to their projected date of completion. The primary investigator frequently kept in contact with many of the subjects that enrolled in the outpatient program by telephone, visits to the transitional housing location, and meetings before or after their outpatient sessions. Once the subject had completed the intensive outpatient program, they were scheduled to complete the post-treatment MMPI-2. The majority of subjects completed the post- MMPI-2 at a transitional housing location operated by

Homeward Bound. Again, subjects were allotted extra time to complete the measure if necessary. Subjects were provided with feedback as to their psychological test results if they so desired; feedback sessions ranged in length from 45 minutes to an hour and a half. Recommendations for future directions such as issues to address via counseling and/or techniques that may be beneficial to them were also offered.

Follow-Up Process

The primary investigator of this study had initially been advised that follow-up information on the OT-CD subjects would be provided by the treatment facility, but this data was not available with the exception of two cases. The facility had also initially promised to provide their 60-day follow-up averages (i.e., abstinence rates) for all clients. However, it was later discovered that the facility does not maintain a database that tracks the follow-up information of their former clients. In order to gather follow up information on the OT-CD subjects, the primary investigator attempted to contact those that had provided phone numbers or collateral contacts to the investigator. In several instances, the telephone contacts originally provided were no longer valid. Attempts were also made to collect information from personnel at the treatment facility.

Statistical Analyses

The SPSS for Windows PC statistical package (11.0, 12.0, and 13.0; SPSS-PC, SPSS Inc., Chicago, IL) was utilized for the creation of the database and for the majority of the statistical analyses. Additional analyses were conducted using S-PLUS for Windows (6.1 Professional Edition, 2002, Insightful Corp., Seattle, WA) and well as R (Version 1.4.1, 2002, Free Software Foundation, Inc., Boston, MA), which is a GNU S language. According to Herrington (2002, ¶ 1), "R is a statistical programming environment that is a clone of the S and S-Plus language developed at Lucent Technologies." Analysis of the MMPI-2 data for both

treatment groups (EEG-BFB, OT-CD) was restricted to those participants who completed both assessment periods (pre/post). As previously mentioned, Scale 5 (Masculinity-Femininity) of the MMPI-2 was not included in the analyses due to the mixed gender sample in the EEG-BFB group (Greene, 1991, chap. 2). Per guidelines by Greene (personal communication, February 09, 2005), non-K corrected MMPI-2 scores for five of the basic scales (1/*Hs*, 4/*Pd*, 7/*Pt*, 8/*Sc*, and 9/*Ma*) were used since the data involved one mixed gender sample. Descriptive statistics were calculated on the demographic information of both treatment groups (EEG-BFB, OT-CD) to ascertain their overall characteristics. Likewise, descriptive statistics and frequencies were utilized to determine the follow-up data (e.g., abstinence and/or re-arrest/probation revocation rates) on both groups. Descriptive statistics were also computed to determine the pre/post-treatment mean scores (T-scores and raw scores) and standard deviations on several MMPI-2 scales for both of the treatment groups. Independent *t*-tests were utilized to determine if there were significant initial mean differences between the two groups according to gender, age, and assessment of substance abuse problems, as measured by the pre-treatment mean T-scores on the MMPI-2 supplementary scale AAS (Addiction Admission Scale). Unless otherwise specified, results were considered statistically significant if the probability levels were .05 or less. The False Detection Rate (FDR) method was utilized to adjust probability levels due to multiple contrasts (Benjamini & Hochberg, 1995; Benjamini & Yekutieli, 2001; Herrington). The FDR technique has been found to be more powerful than traditional procedures for controlling for family wise error rate such as the Bonferroni method. The alpha criterion levels generated by the FDR method were then used to access significance levels. Additional statistical analysis information is as follows:

Analyses of Hypotheses I, II, III, and IV

To compare each group's pre-treatment MMPI-2 mean T-scores to their corresponding post-treatment mean T-scores on several scales, paired *t*-tests were conducted. Q-Q plots were inspected and measures of kurtosis computed to ascertain if the pre/post-treatment scores were normally distributed (Stevens, 1996, chap. 6). A Shapiro-Wilk test was performed on the MMPI-2 scales that appeared to violate the assumption. An alpha level of .01 was selected for the Shapiro-Wilk test results (Tabachnick & Fidell, 1996; chap. 4). A Wilcoxan signed pairs test was used to compare pre/post-treatment results for theMMPI-2 scales that did not meet the normality assumption (Cates, 1985, chap. 17). For the paired *t*-test results, treatment effect sizes were calculated utilizing Cohen's *d* formula ($d = t \div \sqrt{df}$; Rosnow & Rosenthal, 2003). Effect sizes of .80, .50, and .20 were considered large, medium, and small, respectively (Rosenthal & Rosnow, 1991).

Analyses of Hypotheses V and VI

One-way, between groups ANCOVAs were calculated to compare the MMPI-2 post-treatment results of the two treatment groups (Bonate, 2000, chap. 5). Each group's pre-treatment MMPI-2 mean T-score on a particular scale served as the covariate in this analysis in order to adjust for any baseline differences. According to Bonate, ANCOVA is the method of choice in analyzing pre- and post-test research designs. It is also commonly used to analyze quasi-experimental designs that have nonparametric samples (Cates, 1985, chap. 17). Tests will be conducted to determine if any of the underlying assumptions (e.g., normality, homogeneity of variance, error-free measurement of pre-test scores, and homogeneity of within-group regression coefficients) of the ANCOVA have been violated (Bonate). Nonparametric rank-transformed ANCOVAs were also conducted, which is a robust analysis that takes into account any non-

normality of the data or measurement error in the pre-test scores (Bonate). Treatment effect sizes were determined using Cohen's f^2 formula (Cohen, 1992). Treatment effect sizes for this formula include .02 (small), .15 (medium), and .35 (large).

Analyses of Hypotheses VII and VIII

Equivalency testing (as delineated by Hatch, 1996) was used to determine if the MMPI-2 post-treatment T-score means (on several scales) of the two groups were statistically equivalent to one another. The standard error and adjusted means from the ANCOVA results were used in this analysis to take into account any differences, which might have been due to the pre-treatment scores (R. Herrington, personal communication, February 23, 2005). Equivalence testing is a method frequently utilized in biomedical research (Clark, 2005, ¶ 5; Hatch; Windeler & Trampisch, 1996). Rogers, Howard, and Vessey (1993, p. 553) stated that, "Though largely unfamiliar to social scientists, formal statistical tests of equivalence have been evolving over the past 20 years." Hatch recommended the use of this technique in biofeedback research. The traditional methods of null hypothesis testing provide, for example, information as to whether the means of two groups are not significantly different from one another. According to Hatch (p. 107), "failure to reject the null hypothesis, however, does not justify the conclusion that the treatments are exactly equivalent, nor does it necessarily justify the conclusion that the difference between treatments is inconsequential. In equivalence testing the situation is reversed so that the null hypothesis asserts inequivalence and the alternative hypothesis asserts equivalence." Rogers et al. indicated that, with equivalence testing, the objective is to "determine whether mean values are "equivalent" rather than "different" (p. 553). The equivalence interval was set at $\pm$ 20 % for all computations (R. Herrington, personal communication, August 16, 2002). A statistical

program was written in S-Plus to calculate the equivalence tests by a statistical consultant for the University (R. Herrington, personal communication, February 23, 2005).

Analyses of Hypotheses IX and X

For several of the MMPI-2 scales, one-sample *z*-tests (known population *M* and *SD*) were used to determine if the pre-treatment MMPI-2 raw mean scores of the EEG-BFB sample (by gender) significantly differed from the MMPI-2 normative population's raw mean scores (by gender). The same procedure was followed to compare the post-treatment raw mean scores of the EEG-BFB sample (by gender) to the MMPI-2 norms (by gender). *Z*-tests were completed via hand calculation (Howell, 1997, chap. 7). Exact probability levels were determined by utilizing an on-line probability calculator for *z*-scores (Pezzullo, 2005).

CHAPTER 4

RESULTS

Frequency and descriptive statistics were calculated on the demographic data of the two treatment groups (EEG-BFB, OT-CD, see Tables 4, 5, and 6). Due to the archival nature of the EEG-BFB group's information, some of the demographic data was not available. Independent *t*-tests were utilized to determine if there were significant baseline mean differences between the two groups according to gender, age, or assessment of substance abuse problems (as measured by the pre-treatment AAS mean T-scores. Results demonstrated there were no significant differences between groups according to age (t (38) = .701, p = .487; adjusted p = .893), gender (t (38) = 1.831, p = .075 confirmed by U = 170.00, p = .075, adjusted p = .404), or T-scores means on the AAS scale (t (38) = -1.481, p = .147, adjusted p = .404). The FDR method was utilized to derive the adjusted probability levels (Benjamini & Hochberg, 1995; Benjamini & Yekutieli, 2001; Herrington, 2002).

The remainder of the findings will be presented as initially delineated in the hypotheses section and are as follows. Analyses of the EEG-BFB group's data will be outlined first followed by the OT-CD group's. Next, the comparison of the data between the two groups will be reviewed. Finally, the comparison of the MMPI-2s™ (University of Minnesota) normal standardization group's raw scores means (by gender) to both the pre- and post-treatment raw score means (by gender) of the EEG-BFB group will be summarized.

EEG-BFB Group

Pre- and Post-Treatment MMPI-2 Results

For the EEG-BFB group, descriptive statistics were computed for the pre/post treatment MMPI-2 validity scales (L, F, K), nine of the basic clinical scales (1/*Hs*, 2/*D*, 3/*Hy*, 4/*Pd*, 6/*Pa*,

7/*Pt*, 8/*Sc*, 9/*Ma*, 0/*Si*), and two of the supplementary addiction scales (AAS, APS). The MMPI-2 mean T-scores for both assessment periods are graphed in Figure 3. Table 7 displays the actual scale means and standard deviations for this sample. Inspection of the overall pre-treatment mean T-scores in the EEG-BFB group revealed an "inverted V" validity scale configuration (i.e., scales L and K < T-score of 50 and F scale > T-score of 60; Greene, 1991, chap. 3) with validity scales (L, F, K) within normal limits. In regard to the clinical scales, pre-treatment results indicated a floating profile with a 4-8 codetype. Specifically, clinically significant elevations (T-score $M \geq 65$) were noted on five basic scales: 1 (Hypochondriasis, $M = 65.25$); 2 (Depression, $M = 66.95$); 4 (Psychopathic Deviate, $M = 72.70$); 7 (Psychasthenia, $M = 66.55$); and 8 (Schizophrenia, $M = 67.95$). The group also demonstrated significant elevations on addiction scales, AAS (Addiction Admission, $M = 69.70$) and APS (Addiction Potential, $M = 66.30$).

As depicted in Figure 3 and Table 7, the EEG-BFB group's post-treatment mean scores were all within normal limits (T-score $M < 65$; i.e., validity, basic, and 2 addiction scales). For the seven scales that were significantly elevated at pre-treatment assessment, the average T-score decreases upon post-testing ranged from 5.25 to 9.70 (with a M decrease of 8.05), as shown in Table 8.

Comparison between Pre/Post Assessment Periods (Hypothesis I and II)

Paired *t*-tests were used to determine if there were significant differences between the pre/post assessment periods in the EEG-BFB group on certain MMPI-2 scales, as delineated in Hypothesis I (sub-hypotheses I-1 through I-5). Preliminary checks on the data were completed to ascertain if the assumptions underlying the use of this statistical technique were met. Inspection of Q-Q plots as well as kurtosis analyses on the MMPI-2 data revealed that all scales met the assumption of normality, with the exception of the post-treatment MMPI-2 F scale. A Shapiro-

Wilk test confirmed the post F scores were not normally distributed (Shapiro-Wilk = .819, p = .002) and further inspection revealed there was a high T-score outlier of 106 on that scale. Thus, a nonparametric test (i.e., Wilcoxan signed pairs) was utilized on the pre/post F scale data. Results revealed a significant difference between the pre/post-F scale averages (Z = -3.219, p = .001). Table 8 presents the paired samples t-test results including the mean differences, *SDs*, *SEMs*, alpha levels, and adjusted alpha levels for the remaining MMPI-2 clinical scales under investigation (1/*Hs*, 4/*Pd*, 8/*Sc*, and 0/*Si*). Significant pre/post differences were found on these clinical scales: 1 (Hypochondrias, $t(19) = 2.122$, p = .047); 4 (Psychopathic Deviate, $t(19)$ = 2.863, p = .010), 8 (Schizophrenia, $t(19) = 4.695$, p = .000), and 0 (Social Introversion, $t(19)$ = 2.421, p = .026). As shown in Table 8, medium treatment effect sizes (d = .50) were noted on clinical scales 4/*Pd* and 0/*Si*; whereas, a large treatment effect size (d = .80) was observed for scale 8/*Sc*. Due to multiple comparisons, a false detection rate (FDR) adjustment was applied to control the family wise error rate (Benjamini & Hochberg, 1995; Benjamini & Yekutieli, 2001; Herrington, 2002), which provided adjusted probability levels (see Table 8). Following adjustment procedures, three of the original five findings were still significant: F (adjusted p = .006), 4/*Pd* (adjusted p = .038), and 8/*Sc* (adjusted p = .000). As a result of these findings, Hypothesis I, "The post-treatment MMPI-2 mean T-scores on the several scales (F, 1/*Hs*, 4/*Pd*, 8/*Sc* and 0/*Si*) will be significantly lower than the pre-treatment MMPI-2 mean T-scores in the EEG-BFB group," was accepted for scales F, 4/*Pd*, and 8/*Sc*, but rejected for scales 1/*Hs* and 0/*Si*.

Although not under current investigation, Table 8 also lists the paired t-test results for the remaining validity (L, K) and clinical scales (2/*D*, 3/*Hy*, 6/*Pa*, 7/*Pt*, and 9/*Ma*) in the EEG-BFB group. There were significant differences noted between testing periods on scales 2 (Depression,

$t(19) = 3.723$, $p = .001$), 3 (Hysteria, $t(19) = 2.696$, $p = .014$), 7 (Psychasthenia, $t(19) = 3.707$, $p = .001$), and 9 (Hypomania, $t(19) = 2.557$, $p = .019$). However, once FDR adjustments were made (Benjamini & Hochberg, 1995; Benjamini & Yekutieli, 2001; Herrington, 2002), only two of these four results remained significant (2/Depression, adjusted $p = .009$; 7/Psychasthenia, adjusted $p = .009$).

Paired *t*-tests were also computed to ascertain if there were pre/post differences in the EEG-BFB sample on the two supplementary addiction scales (AAS and APS), as proposed in Hypothesis II (sub-hypotheses II-1 through II-2). Preliminary checks insured that the underlying assumptions of the *t*-test had been met. Results indicated significant pre/post differences on both scales, as presented in Figure 3 and Table 8 (AAS, $t(19) = 3.395$, $p = .003$, and APS $t(19) = 2.582$, $p = .018$). After the application of the FDR method (Benjamini & Hochberg, 1995; Benjamini & Yekutieli, 2001; Herrington, 2002), findings were still significant (AAS, adjusted $p = .009$; APS, adjusted $p = .027$). Further, the effect of the EEG-BFB training was medium ($d > .50$) to large ($d \sim .80$) on the APS and AAS scales, respectively (see Table 8). Therefore, Hypothesis II, "The post-treatment MMPI-2 mean T-scores on two supplementary addiction scales will be significantly lower than the pre-treatment MMPI-2 mean T-scores in the EEG-BFB group," was accepted.

OT-CD Group

Pre- and Post-Treatment MMPI-2 Results

Descriptive statistics were computed for the OT-CD group's pre/post mean T-scores on the MMPI-2 validity scales, nine clinical scales, and two supplementary addiction scales (see Table 7 and Figure 4). The pre-treatment results indicated an "inverted V" validity scale configuration (e.g., scales L and K < T-score of 50 and F scale > T-score of 60; Greene, 1991,

chap. 3). Specifically, validity scale F was significantly elevated (T-score > 65) while validity scales L and K were within normal limits. Further, a floating clinical profile was noted with a 4/6 codetype, which included significant pre-treatment elevations (T-score > 65) on scales 1 (Hypochondriasis, $M = 68.85$); 2 (Depression, $M = 69.15$); 4 (Psychopathic Deviate, $M = 78.6$); 6 (Paranoia, $M = 75.5$), 7 (Psychasthenia, $M = 71.65$); and 8 (Schizophrenia, $M = 72.55$). The pre-treatment AAS (Addiction Admission, $M = 74.80$) scale was elevated as well.

Table 7 also provides the post-treatment mean T-scores of the OT-CD group. Validity scales L and K were still within normal limits with an elevation on scale F (see Figure 4). In addition, three of the basic clinical scales were still elevated (4/*Pd*, 6/*Pa*, and 8/*Sc*) with a codetype of 4/6/8, but the two supplementary addiction scales were not elevated. The average T-score differences between assessment periods ranged from -6.35 to 11.55 (see Table 9).

Comparison between Pre/Post Assessment Periods (Hypothesis III and IV)

Paired *t*-tests were computed on the OT-CD groups' pre- versus post-treatment MMPI-2 mean T-scores for validity scale F and four clinical scales (1/*Hs*, 4/*Pd*, 8/*Sc* and 0/*Si*), as designated in Hypothesis III (sub-hypotheses III-1 through III-5). Examination of the QQ plots and kurtosis measures for the MMPI-2 scale data in this group indicated the normality assumptions were satisfied. As displayed in Table 9, results revealed significant pre/post-treatment differences on four of these scales: F ($t(19) = 2.785$, $p = .012$, adjusted $p = .034$), 1/*Hs* ($t(19) = 3.372$, $p = .003$, adjusted $p = .017$), 4/*Pd* ($t(19) = 3.733$, $p = .001$, adjusted $p = .011$), and 8/*Sc* ($t(19) = 2.808$, $p = .011$, adjusted $p = .034$), which were still significant once multiple contrast adjustments were made (Benjamini & Hochberg, 1995; Benjamini & Yekutieli, 2001; Herrington, 2002). Medium to large treatment effect sizes were observed on scales F ($d = .639$), 1/*Hs* ($d = .773$), 4/*Pd* ($d = .856$), and 8/*Sc* ($d = .644$), but a small effect size was noted on scale

0/*Si* (*d* = .216). Thus, Hypothesis III, "The post-treatment MMPI-2 mean T-scores on several scales (F, 1/*Hs*, 4/*Pd*, 8/*Sc*, and 0/*Si*) will not be significantly different from the pre-treatment MMPI-2 mean T-scores in the OT-CD group," was rejected.

Paired *t*-tests were computed to determine if there were significant pre/post changes on two of the supplementary addiction scales, as set forth in Hypothesis IV (sub-hypotheses IV-1 through IV-2). Again, preliminary checks were conducted to ensure the assumptions underlying the use of this inferential technique were met and it was determined that there were no violations. As shown in Table 9, findings indicated a significant pre/post change on the AAS scale ($t(19) = 5.32$, p and adjusted $p = .000$), but not on the APS scale ($t(19) = .641$, $p = .529$, adjusted $p = .794$). The FDR method was again used to adjust for multiple contrast comparisons (Benjamini & Hochberg, 1995; Benjamini & Yekutieli, 2001; Herrington, 2002). The effect of the standard chemical dependency treatment on the AAS scale was large, but small on the APS scale (see Table 9). Therefore, Hypothesis IV, "the post-treatment MMPI-2 mean T-scores on two supplementary addiction scales (AAS, APS) will not be significantly different from the pre-treatment MMPI-2 mean T-scores in the OT-CD group," was accepted for scale APS, but rejected for scale AAS.

Table 9 presents additional paired *t*-test findings for the remaining validity and clinical scales. Significant pre/post differences were noted on scales: L ($t(19) = -3.695$, $p = .002$), 2/*D* ($t(19) = 3.040$, p .007), and 7/*Pt* ($t(19) = 2.795$, $p = .012$; however, only scale L was significant once the FDR adjustment was applied (L, adjusted $p = .036$; 2/*D*, adjusted $p = .064$; 7/*Pt*, adjusted $p = .073$); Benjamini & Hochberg, 1995; Benjamini & Yekutieli, 2001; Herrington, 2002). In addition, inspection of QQ plots and kurtosis measures indicated that the MMPI-2 scale 9/*Ma* (post-treatment) did not meet the assumption of normality, which a Shipiro-Wilk test

confirmed (p = .002). A nonparametric test (i.e., Wilcoxon signed pairs) was utilized to analyze the pre/post scale 9/*Ma* data and revealed no significant differences in scores between assessment phases (Z = -1.157, p = .247, adjusted p = .64).

EEG-BFB Group in Comparison to OT-CD Group

MMPI-2 Clinical Scale Results (Hypothesis V)

A one-way, between-groups (EEG-BFB, OT-CD) ANCOVA was conducted to determine the effectiveness of the EEG-BFB training ("Peniston protocol") compared to the standard chemical dependency treatment on several MMPI-2 scales (1/*Hs*, 2/*D*, 3/*Hy*, 4/*Pd*, 8/*Sc*, 0/*Si*), as proposed in Hypothesis V (sub-hypotheses V-1 through V-6). Each corresponding pre-treatment mean T-score on each of these scales were employed as the covariates in the analyses. Results of the evaluation of the assumptions of normality of sampling distributions, linearity, homogeneity of variance, and homogeneity of regression were satisfactory. After adjustments for the pre-treatment scores, there were no significant differences noted between treatment groups (EEG-BFB, OT-CD) on the aforementioned MMPI-2 scales (p ranging from .245 to .960; adjusted p = 1.0; see Table 10). Table 11 lists the adjusted means for these MMPI-2 scales by group. Overall, there was a trend for the OT-CD group to have higher T-score adjusted means on these scales (1/*Hs*, 2/*D*, 3/*Hy*, 4/*Pd*, 8/*Sc*, 0/*Si*), with their adjusted means ranging from .152 to 3.788 higher than the EEG-BFB group's, but these differences were not statistically significant. In addition, treatment effect sizes were low (Cohen's $f^2 < .15$). Therefore, Hypothesis V, "The EEG-BFB group's post-treatment MMPI-2 mean T-scores on six basic scales (1/*Hs*, 2/*D*, 3/*Hy*, 4/*Pd*, 8/*Sc*, 0/*Si*) will be significantly lower than the OT-CD group's post-treatment MMPI-2 mean T-scores after the effect of the covariate (e.g., pre-treatment MMPI-2 mean T-scores) has been partialed out of the analysis," was rejected.

MMPI-2 Addiction Scale Results (Hypothesis VI)

A one-way, between-groups ANCOVA was also performed to ascertain the effectiveness of the EEG-BFB treatment compared to the OT-CD treatment on two addiction scales of the MMPI-2, as delineated in Hypothesis VI (sub-hypotheses VI-1 through VI-2). Pre-treatment mean T-scores of each scale served as the covariates in the analysis. Preliminary checks were again conducted to ensure the underlying assumptions of the ANCOVA had been met and results were satisfactory. After adjustments for the pre-treatment scores, results indicated there were no significant differences between the treatment groups on the AAS or APS (see Table 10). Examination of the adjusted means on the AAS scale for both groups revealed that the EEG-BFB group's mean (M = 62.410, SE = 1.782) was slightly higher than the OT-CD group's (M = 62.29, SE = 1.782) for a difference of .12. However, on the APS scale, the adjusted mean was higher in the OT-CD group (M = 58.565, SE = 2.456) versus the EEG-BFB sample (M = 57.885, SE = 2.456), with a mean difference of .68; again results were not significantly different between groups. Treatment effect sizes were also low. Therefore, Hypothesis VI, "On two of the supplementary addiction scales (AAS, APS), the EEG-BFB group's post-treatment MMPI-2 mean T-scores will be significantly lower than the OT-CD group's post-treatment mean T-scores, after the effect of the covariate (e.g., pre-treatment MMPI-2 mean T-scores on AAS and APS) has been partialed out of the analysis," was rejected.

Equivalence Test Results on MMPI-2 Clinical Scales (Hypothesis VII)

Equivalence testing was conducted to ascertain if the two treatment groups were statistically equivalent to one another on several MMPI-2 clinical scales (1/*Hs*, 2/*D*, 3/*Hy*, 4/*Pd*, 8/*Sc*, and 0/*Si*) upon post-treatment assessment, as outlined in Hypothesis VII (sub-hypotheses VII-1 through VII-6). Essentially, equivalence analyses are conducted to determine the

equivalence of two different treatments. In order to adjust for any post-treatment differences that were due to the pre-treatment scores, adjusted T-score means and the adjusted standard error were utilized in the two one-sample *t*-test analyses for each scale. On each measure assessed, results indicated that the scores between groups were statistically equivalent, as presented in Table 12. Thus, Hypothesis VII, "The adjusted post-treatment MMPI-2 mean T-scores (on scales 1/*Hs*, 2/*D*, 3/*Hy*, 4/*Pd*, 8/*Sc*, and 0/*Si*) of the two treatment groups will not be equivalent to one another," was rejected.

Equivalence Test Results on Supplementary Addiction Scales (Hypothesis VIII)

Procedures outlined directly above were also followed to determine if the two treatment groups were equivalent to one another on measures of substance abuse following treatment, as proposed in Hypothesis VIII (sub-hypotheses VIII-1 and 2). As shown in Table 12, results indicated that the two groups performed statistically equivalent to one another on MMPI-2 scales AAS and APS. Therefore, Hypothesis VIII, "The adjusted post-treatment MMPI-2 mean T-scores (on two supplemental addiction scales) of the two treatment groups will not be equivalent to one another," was rejected.

EEG-BFB Group in Comparison to MMPI-2 Normative Population

Pre-Treatment MMPI-2 Results (Hypothesis IX)

Descriptive statistics were computed on the MMPI-2 raw scale scores (by gender) in the EEG-BFB group. As previously mentioned, the MMPI-2s normative group's average performance (and *SD*s) on this instrument was only published by gender and in raw mean (and *SD*) form. Due to the copyrighted nature of the information, these raw score means (and *SDs)* will not be reported herein, but interested readers should consult Appendix A in Friedman and colleagues (2001). The subscale raw score means and standard deviations of the EEG-BFB group

(by gender) are displayed in Tables 13 (male) and 14 (female). As proposed in Hypothesis IX (sub-hypotheses IX-1 through IX-8), the pre-treatment raw scores of the EEG-BFB (male, female) samples were compared to the MMPI-2 standardization scores of "normal adults" on several MMPI-2 scales (F, 2/*D*, 4/*Pd*, 6/*Pa*, 7/*Pt*, 8/*Sc*, 9/*Ma*, AAS, and APS) via one-sample *z*-tests (Howell, 1997, chap. 7). Previous research has typically shown these scales to be elevated in substance abuse populations (Butcher & Williams, 1992, chap. 8; Craig, 1984; Craig & Olson, 1992; Dougherty & Lesswing, 1989; Graham & Strenger, 1988; Johnson et al., 1992; Tosi et al., 1986). The resulting *z*-scores and mean difference values are presented in Tables 13 (males) and 14 (females). The males in the EEG-BFB sample differed significantly from the MMPI-2 male normative group on every scale assessed, with *z*-scores ($M = 0$, $SD = 1$) ranging from 5.13 to 8.92 (with $p = .000$; Pezzullo, 2005; adjusted $p = .000$; Benjamini & Hochberg, 1995; Benjamini & Yekutieli, 2001; Herrington, 2002). Significant results ($p \leq .0031$) were also found between the female EEG-BFB sample and the MMPI-2 female normative group on five MMPI-2 scales (pre-treatment) including F, 2/*D*, 4/*Pd*, 8/*Sc*, and AAS, with *z*-scores ranging from 2.96 to 4.63 and $ps \leq .0031$ (see Table 14). Once the FDR adjustment was applied, these results were still significant ($ps \leq .013$; Benjamini & Hochberg; Benjamini & Yekutieli; Herrington). The female EEG-BFB sample's pre-treatment MMPI-2 raw mean scores were not significantly different from the MMPI-2 female normative group's scores on the following scales: 7/Pt ($z = -.32$, $p = .7490$; adjusted $p = 1.00$), 9/Ma ($z = .87$, $p = .384$; adjusted $p = 1.00$), and APS ($z = 1.50$, $p = .134$; adjusted $p = .486$). Due to these findings, Hypothesis IX, "The EEG-BFB sample's initial MMPI-2 raw mean scores (by gender) will be significantly higher than the MMPI-2 "normal" standardization population's raw mean scores (by gender) on several scales (F, 2/*D*, 4/*Pd*, 6/*Pa*, 7/*Pt*, 8/*Sc*, 9/*Ma*, AAS, and APS)," was accepted for the male EEG-BFB sample. Likewise, for

the female EEG-BFB sample, the hypothesis was accepted for several scales (F, 2/*D*, 4/*Pd*, 8/*Sc*, and AAS), but rejected for three scales (7, 9, and APS).

Post-Treatment MMPI-2 Results (Hypothesis X)

The same procedures as outlined above were completed utilizing the EEG-BFB sample's post-treatment MMPI-2 raw scores means (by gender) in comparison to the MMPI-2 norms (by gender), as proposed in Hypothesis X (sub-hypotheses X-1 through X-8). The subsequent *z*-scores results, alpha and adjusted alpha levels, and mean differences are also displayed in Tables 13 (males) and 14 (females). The male EEG-BFB sample again significantly differed from the male MMPI-2 norms on eight out of eight scales assessed, with *z*-scores from 2.30 to 5.90 ($ps \leq .0214$). Once the FDR correction was made, only scale F was no longer significant (adjusted $p = .058$; Benjamini & Hochberg, 1995; Benjamini & Yekutieli, 2001; Herrington, 2002). The female EEG-BFB sample's post-treatment raw scores were significantly different from the MMPI-2 female norms on the same scales as they were pre-treatment (F, 2/*D*, 4/*Pd*, 8/*Sc*, and AAS), with *z*-scores from 2.39 to 4.01 ($p < .017$; see Table 14); however, once the multiple comparison correction was applied, two of those scales were no longer significant (2/*D*, adjusted $p = .074$; 8/*Sc*, adjusted $p = .074$). Likewise, no significant differences were observed between the female EEG-BFB sample and the female normative group on three other scales (7/*Pt*, 9/*Ma*, and APS). According to these findings, Hypothesis X, "The EEG-BFB sample's post-treatment MMPI-2 raw mean scores (by gender), on several scales (F, 2/*D*, 4/*Pd*, 6/*Pa*, 7/*Pt*, 8/*Sc*, 9/*Ma*, AAS, and APS), will not be significantly different from the MMPI-2 norms raw mean scores (by gender)," was primarily rejected for the male EEG-BFB sample, with the exception of scale F. For the female EEG-BFB sample, the hypothesis was primarily accepted (i.e., for scales 2/*D*, 7/*Pt*, 8/*Sc*, 9/*Ma*, and APS), but rejected for three scales (F, 4/*Sc*, and AAS).

Follow-Up Information

Of the 20 subjects in the EEG-BFB sample, 10% (n = 2) were deceased. Of the remaining 18 subjects, follow-up information was obtained on 13 (72%) and 92% (n = 12) of those were clean and sober. Eight percent (n = 1) of those 13 former clients acknowledged using alcohol, but at a significantly modified or reduced level. The follow-up period ranged from 4 to 11 years post-treatment, with an average of 8.92 years (SD = 2.811). Whether subjects had received additional treatment following EEG-BFB training was gathered on eight subjects and of those, 63% (n = 5) had not participated in any additional treatment program, but 38 % (n = 3) had. Regarding the subset of 15 probationers in this sample, follow-up information was obtained on 14 (93%) of them, primarily from the local Probation department. Seventy-nine percent (n = 11) did not have any subsequent arrests following completion of EEG-BFB for addictions, but 21% (n = 3) were re-arrested. Of those three subjects that were re-arrested, only 33% (n = 1) were alcohol or drug-related charges. Currently, only two (14%) of the original subset of probationers were on probation; one of those was placed back on probation due to a new offense.

Follow-up information was collected on 13 (65%) out of 20 subjects in the OT-CD group. The follow-up time period ranged from 35 to 131 days (M = 82.08, SD = 29.86) post-completion of their intensive outpatient program. Of those contacted, 85% (n = 11) were sober, while 15% (n = 2) had relapsed. Four (31%) of the individuals that were sober were still living in transitional housing where sobriety must be maintained in order to remain there. None of those contacted had been re-arrested. Employment information was available on 11 subjects and of those, seven (64%) were currently employed.

CHAPTER 5

DISCUSSION

The present line of research sought to extend the findings of an earlier pilot study by Bodenhamer-Davis et al. (2002). The initial investigation was an attempt to replicate some of the treatment outcome effects noted in controlled studies by Peniston and Kulkosky (1989, 1990) in which these authors utilized alpha-theta EEG-BFB training in an inpatient treatment program for alcoholism. They reported several significant positive changes in the experimental group upon post-treatment assessment and follow-up in comparison to the treatment control group. Subsequently, various clinical researchers have replicated their findings to various degrees in controlled studies (e.g., improvement in personality measures, changes in brainwave amplitudes, low relapse rates). Likewise, the uncontrolled pilot study by Bodenhamer-Davis and associates demonstrated significant positive pre to post changes in the BDI® (The Psychological Corporation) and MMPI-2™ (University of Minnesota; on several scales) as well as low relapse rates in an outpatient sample. Limitations in that study involved a low sample size and lack of a control group. The present investigation attempted to extend this pilot study by increasing the sample size and adding another substance abuse treatment group for comparison purposes.

The main goal of this present study was to determine the effects on the MMPI-2 of EEG-BFB training for addictions. A secondary objective was to collect follow-up information (e.g., abstinence and re-arrest rates) on subjects in both treatment groups. Not all subjects were located for follow-up. Of the information that was obtained on 13 of the EEG-BFB subjects, current abstinent rates were high, as 92% (n = 12) were sober and eight percent (n = 1) had significantly reduced alcohol intake. The follow-up time period ranged from 4 to 11 years (M = 8.92) post-treatment. Sixty-three percent (n = 5 out of 8) indicated they had not participated in a treatment

program following the EEG-BFB regimen. Overall, these long-term abstinence rates are high, but similar to Peniston's 2000 report (personal communication) that, at the 10-year follow-up, all subjects from his original study (Peniston & Kulkosky, 1989) were abstinent, with the exception of one that was deceased. The abstinence rates obtained for the 13 out of 20 subjects in the OT-CD group also was high, with 85% abstinent and 15% relapsed. However, the timeframe for this follow-up was much shorter than that of the EEG-BFB group, as it ranged from 35 to 131 days following completion of their intensive outpatient program. Additionally, four (31%) of those individuals were still residing in transitional housing, which could be viewed as a continuation of treatment. As in the EEG-BFB group, the abstinence rates for the OT-CD were high as well. The follow-up results for the OT-CD group were unexpected given the previous relapse reports of treatment controls in the EEG-BFB related literature and given the high relapse rates reported for most chemical dependency treatment regimens (Correctional Service of Canada, 2003, Relapse techniques section, para. 1; Parks & Marlatt, 2000, ¶ 3). Although finding national or state statistics regarding treatment success rates is virtually impossible because many governmental agencies do not report such statistics on their websites (S. Koch, personal communication, March, 8, 2005), some sources have listed relapse rates as high as 80% (Alterman et al., 1998; Morral et al., 1997), with the majority of relapses occurring within 3 months post-treatment (Lash, 1998). Explanations for the high abstinence rates noted in the OT-CD group may include the following. First, the follow-up period for the majority of subjects was less than 3 months (n = 9, 2-month follow-up or less), with only two individuals currently reaching the 4 months post-assessment period. It remains to be seen if these rates will hold up at the 6-months and 1-year follow-ups. Secondly, the majority of subjects resided in a transitional housing unit following completion of the residential phase of treatment as well as their intensive outpatient program.

One of the requirements for living in transitional housing is to maintain sobriety and to continue to participate in AA/NA support groups, religious groups (if desired), and/or the outpatient support groups available at the treatment facility. Therefore, these subjects may have had extended support (environmental, peer, organizational, professional) that would not have been the case if they had returned to their original home environments. Lastly, the individuals that completed their treatment program and the second phase of MMPI-2 assessment appeared to be functioning better than many of those that did not complete the program; they also tended to be the ones that seemed better at establishing a relationship with the primary investigator in this study. Although this supposition (of better psychological functioning in the completers) has yet to be formerly tested by analyzing the MMPI-2 profiles of those that did not complete their program or post-assessment, this post-hoc analysis is planned. As previously mentioned, only 21 out of 105 OT-CD subjects that initially agreed to participate in this study completed the post-assessment phase; the majority of the ones that failed to finish phase two testing did so because they had already relapsed or failed to complete treatment. This completion rate, of about 20%, mirrors the typical treatment success rates often given in the chemical dependency literature. It is unfortunate that the treatment facility does not tabulate or collectively track their relapse rate statistics, which prevented any comparison of the OT-CD group's abstinence rates to the facility's average rates.

As previously mentioned, a primary aim in the present study was to ascertain the effects of EEG-BFB treatment for addictions on the MMPI-2 and compare results to those of another group receiving standard chemical dependency treatment. It was predicted that the EEG-BFB group would demonstrate significant improvements following treatment on several scales of the MMPI-2. Results revealed the overall pre-treatment MMPI-2 clinical profile of the EEG-BFB

sample included a 4/8 codetype, with additional elevations on scales 1/*Hs*, 2/*D*, and 7/*Pt*. Clinical interpretations of this profile indicated chronic maladjustment problems or psychopathology characterized by a history of interpersonal difficulties (Butcher, 1990, chap. 3; Graham, 1993, chap. 5; Greene, 1991, chap. 6). Problems with establishing deep, intimate relationships would be likely due, in part, to an inability to develop trust in others. Further, they would be apt to have difficulties with social judgment or thinking of behavioral consequences; their behavior would tend to be impulsive, unpredictable, and rebellious. This rebellious nature would likely lead to conflict with authority figures and involvement in the criminal justice system. Instead of taking responsibility for their actions, clients with this codetype tend to blame others for their difficulties. Additionally, chemical dependency problems are often present in those with a 4/8 profile. The presence of substance abuse problems in the current sample was further substantiated by elevations on two MMPI-2 supplemental substance abuse measures (scales AAS and APS). Profile results also indicated the sample was experiencing significant levels of anxiety as well as moderate levels of depressive symptoms. In discussing treatment issues, Butcher contends that the therapist will likely encounter considerable obstacles if utilizing traditional psychotherapy techniques with 4/8 individuals. According to Butcher (p. 65), "verbal psychotherapy, because of 48/84's aloofness, unconventionality, and relationship-formation deficits, is likely to be unproductive at worst and difficult at best. Acting-out behavior is likely to complicate treatment planning as well as other aspects of life. The client's lack of trust may lead to early termination of therapy." Greene (p. 276) concurred and stated, "These clients are chronically maladjusted, which indicates that any form of psychological intervention will be of limited benefit." However, due to previous research concerning the normalization of personality characteristics in substance abuse samples following the Peniston EEG-BFB protocol, it was

predicted that the EEG-BFB group would demonstrate significant changes upon post MMPI-2 assessment on the supplementary addiction scales (AAS, APS), a validity scale (F), and four clinical scales (1/*Hs*, 4/*Pd*, 8/*Sc*, and 0/*Si*) selected because these scales were prominent in earlier related research. As previously mentioned, these four particular clinical scales have been identified as representing enduring personality characteristics or traits, rather than more situational aspects or states of functioning.

Post-assessment results from this study revealed significant positive changes for the EEG-BFB subjects from pre-treatment scores on the targeted scales, and the entire post-treatment profile was "within normal limits." Statistical analyses of the pre- versus post-treatment MMPI-2 results supported the study's hypotheses; however, once adjustments were made due to the multiple contrast comparison's, five of those seven initial post-treatment results remained significant, including scales F, 4/*Pd*, 8/*Sc*, AAS, and APS. On clinical scales 4/*Pd* and 8/*Sc*, the post-treatment mean T-score decreases were 8.60 and 9.70, respectively. Of the scales that were initially elevated in the overall profile of this sample, scales 4/*Pd* and 8/*Sc* demonstrated the highest elevations, and these scales are considered to represent significant long-standing characteriological problems (Butcher, 1990, chap. 3; Graham, 1993, chap. 5; Greene, 1991, chap. 6). These post-assessment findings of significant change in the EEG-BFB group, particularly on scales 4/*Pd* and 8/*Sc*, were important from a clinical perspective, especially given that the changes occurred within a relatively short time frame. These findings also lent support to previous uncontrolled study reports of objectively measured personality changes in subjects who completed EEG-BFB for chemical dependency (Bodenhamer-Davis et al., 2002; Fahrion et al., 1992; Saxby & Peniston, 1995).

Another level of analysis in the present project involved comparing both the pre-treatment as well as post-treatment raw mean scores of the EEG-BFB sample (by gender) to the raw mean scores of the MMPI-2s standardization population (by gender) on several MMPI-2 scales (F, 2/*D*, 4/*Pd*, 7/*Pt*, 8/*Sc*, 9/*Ma*, AAS, and APS). Previous research had identified these particular scales as typically being elevated in substance abuse subjects. It had been hypothesized that while the EEG-BFB sample (by gender) would demonstrate significant mean score differences from the MMPI-2 normative group (by gender) upon baseline sampling, this would not be the case upon post assessment. It was predicted that upon post-treatment assessment the two groups (EEG-BFB, MMPI-2 normative group) would not significantly differ from each other since previous research indicated a "normalization" of personality characteristics in substance abuse subjects who completed EEG-BFB training (Peniston protocol or modified Peniston protocol). The pre-treatment results of the males in the EEG-BFB group were significantly different from the MMPI-2 male normative group's on every scale assessed, as initially predicted. This was also the case for the male EEG-BFB sample's post-treatment scores, which were significantly different from the MMPI-2 normative group on the same scales as for pre-treatment. However, once the FDR technique was applied, scale F was no longer significantly different (adjusted $p = .058$). Overall, the null hypothesis regarding these post-assessment results was rejected. Inspection of the raw mean score differences between groups from the pre/post results revealed decreased differences on post assessment (4.14-13.09 on pre; 1.82-7.09 on post), but the EEG-BFB male sample was still significantly different from the normative male group on post assessment. Regarding the females in the EEG-BFB group, it was predicted that their pre-treatment raw mean scores on all MMPI-2 scales assessed would be significantly different from the raw mean scores of the MMPI-2 female normative group's.

Results supported that hypothesis for scales F, 2/*D*, 4/*Pd*, 8/*Sc*, and AAS, but failed to support it for scales 7/*Pt*, 9/*Ma*, and APS. On post-treatment assessment, it was proposed that the EEG-BFB females would not significantly differ from the MMPI-2 female normative group on the previously mentioned MMPI-2 scales. After making adjustments for multiple contrast comparisons, that hypothesis was supported for MMPI-2 scales 2/*D*, 7/*Pt*, 8/*Sc*, 9/*Ma*, and APS, but was rejected for scales F, 4/*Pd*, and AAS; the female EEG-BFB sample still significantly differed from the MMPI-2 female norms on those three scales (F, 4/*Pd*, and AAS). Overall, these post-treatment results were somewhat unexpected (predominantly in the male sample) given the previous research reports of normalization of personality variables following the Peniston EEG-BFB protocol. There is the possibility that in previous EEG-BFB research using the MMPI-2 as an outcome measure, some actual differences that may have existed in the EEG-BFB sample were obscured by the transformation of raw scores to standardized T-scores ($M = 50$, $SD = 10$) and using the criterion of profiles with scores below 65 as "normal."

The MMPI-2 results for the OT-CD comparison group were also under examination in this study. Upon initial assessment, the OT-CD group's overall validity scale configuration ("an inverted V") suggested they experienced a significant degree of emotional distress in conjunction with insecurity regarding their abilities to cope with their problems (Greene, 1991, chap. 3). The F scale elevation also suggested a significant degree of psychopathogy, which the "floating" clinical profile further confirmed (Graham, 1993, chap. 10). Significant elevations were found on clinical scales 1/*Hs*, 2/*D*, 4/*Pd*, 6/*Pa*, 7/*Pt*, and 8/*Sc*. The highest three clinical scales in this profile were, in the order of highest to lowest, 4/*Pd*, 6/*Pa*, and 8/*Sc*. Individuals with a 4/6/8 codetype have been described as quite defensive, hostile, and uncooperative (Butcher, 1990, chap. 3; Greene, chap. 6). They tend to have a deep-seated mistrust or suspiciousness of others

and, hence, significant difficulty in forming deep, close, emotional ties with others. Difficulty with interpersonal relationships and social interactions negatively impacts upon their work relationships as well. Further, these clients tend to have difficulties with logic and thinking. Under periods of distress, they may have difficulty controlling feelings of anger and hostility toward others and act out. In describing the client with a 4/6 elevation, Greene (p.275) asserted that they are "poor candidates for any type of psychological intervention." Greene mentioned that if the 4/6 profile also included an elevation on scale 8/*Sc*, "the process is even more malignant" (p. 275). Additionally, significant depressive features including feelings of hopelessness were suggested as well as significant problems with anxiety, tension, and worry including preoccupation or concern with vague physical symptoms. In this sample, concern about their physiological status is understandable given the negative toll alcoholism and drug addiction has on the brain and body. Since the major components of treatment for this comparison group involved verbal psychotherapy and verbal psychoeducational information (not Neurotherapy) over a relatively short period, it was predicted that this group would not demonstrate significant pre/post changes on MMPI-2 scales F, 1/*Hs*, 4/*Pd*, 8/*Sc*, 0/*Si*, or on the two supplemental addiction scales. Upon post-treatment assessment, significant elevations were still evidenced on validity scale F as well as clinical scales 4/*Pd*, 6/*Pa*, and 8/*Si*, and the post-treatment codetype was the same as before (4/6/8). Neither of the two supplemental addiction scales were elevated at post assessment; however, the overall post-treatment MMPI-2 profile of this group had not "normalized" as it had in the EEG-BFB sample. Statistical analyses of the OT-CD group's targeted MMPI-2 scales indicated significant pre/post changes on scales F, 1/*Hs*, 4/*Pd*, 8/*Sc*, and AAS. These results were still significant after the application of the FDR technique to correct for multiple contrasts. Predominantly, these post-treatment findings did not

support the null hypotheses, as significant differences were noted between testing phases on scales F, 1/*Hs*, 4/*Pd*, 8/*Sc*, and AAS for the OT-CD comparison group. In fact, both treatment groups had improved significantly according to the majority of the post-treatment MMPI-2 results of the scales under examination.

The next level of analysis in the present investigation involved comparing the post-treatment MMPI-2 results of both treatment groups (with adjustments made for pre-treatment MMPI-2 performance). It was hypothesized that the EEG-BFB group's post-treatment mean scores on several scales (1/*Hs*, 2/*D*, 3/*Hy*, 4/*Pd*, 8/*Sc*, 0/*Si*, AAS, and APS) would be significantly lower than the OT-CD group's mean scores. Of the scales under analysis, the EEG-BFB sample's post-treatment MMPI-2 scores were "within normal limits;" whereas, the OT-CD group still showed elevations on 4/*Pd* and 8/*Sc*. There was an overall trend for the EEG-BFB sample's mean scores to be lower than the OT-CD group's on post-assessment (even after adjusting for any differences that may have been due to pre-treatment performance). However, since both treatment groups showed improvements on these scales, the differences between groups were not statistically significant. Further analysis was performed on the data (e.g., linear hierarchical regression), which indicated that, taken collectively, the overall group (combined EEG-BFB and OT-CD) showed significant pre/post changes on the MMPI-2 scales under investigation (clinical scales, $p = .000$; addiction scales, $p \leq .004$), but once group membership (i.e., EEG-BFB, OT-CD) was added into the analysis, the results were no longer significant. In addition, equivalence testing was conducted to determine if the post-treatment performance (after adjusting for differences that may have been due to pre-treatment scores) of the two treatment groups were statistically equivalent to one another. It had been hypothesized that the performance of the two groups would not be equivalent to each other on post-assessment.

However, findings indicated that the performance of the two groups (with adjustments made for pre-treatment performance) were statistically equivalent to one another. Thus, the two treatment groups were not significantly different from each other on the scales assessed; they were equivalent to each other on post assessment.

These above-mentioned results were unexpected and contradicted previous randomized and controlled research studies, which have utilized different psychological inventories (MCMI, 16PF; Peniston & Kulkosky, 1990) as well as the same psychometric tool (MMPI-2; Scott & Kaiser, 1998; Kaiser et al., 1999; Scott et al., 2002). In these earlier investigations, the experimental subjects (i.e., receiving EEG-BFB) showed significant improvements on objective personality measures over the treatment controls (i.e., not receiving EEG-BFB) following treatment. In reviewing the body of work that utilized the MMPI-2 as a treatment outcome measure (Scott & Kaiser; Kaiser et al.; Scott et al.), several questions regarding the statistical analysis may be raised, especially since the information about their research comes from conference presentations rather than published journal articles. For instance, the 1998 report by Scott and Kaiser was presented at a conference and only highlights of their investigation were released. They reported finding significant post-treatment differences between the experimental group (EEG-BFB) versus treatment control group on seven MMPI-2 scales at the .01 level of significance. There are several problems with interpreting these particular results, as their statistical techniques were not stated in their overview. Their report did not state whether they controlled for any initial differences between groups or utilized techniques to control family wise error rates due to the multiple comparisons of several MMPI-2 scales. The 1999 conference presentation by Kaiser and colleagues provided more information than the previous one regarding their on-going substance abuse research project. In the later report, the authors

indicated significant differences ($p < .005$) between the experimental group compared to conventional treatment controls on several MMPI-2 scales (1/*Hs*, 2/*D*, 3/*Hy*, 4/*Pd*, 8/*Sc*, and 0/*Si*). The statistical technique utilized to analyze the post-treatment data was stated (i.e., ANOVA); however, not mentioned was whether an ANOVA was conducted on the pre-treatment data as well to determine whether the two groups significantly differed initially on any scales. Further, there was no indication that adjustments were made for multiple comparisons, which, had they been performed, may have rendered some of the results insignificant. Since the exact probability levels for each of the scales were not provided, an FDR analysis could not be performed to determine if there would have been changes in those reported probability levels. Likewise, in the latest report by Scott et al. (2002), the post-treatment MMPI-2 data between the experimental versus treatment control groups was analyzed using an ANOVA. Results indicated significant improvements ($p < .05$) in the experimental sample over the treatment controls on 5 of 10 MMPI-2 clinical scales (1/*Hs*, 2/*D*, 3/*Hy*, 8/*Sc*, and 0/*Si*). Again, there was no statement as to whether there were adjustments made to the probability levels to control for the multiple contrast comparisons. Likewise, there was no indication of whether there were any initial differences between groups on the pre-treatment scores and the actual T-scores *M*s and *SD*s on the MMPI-2 were not provided. It appears from their graphic presentation of the MMPI-2 data of both treatment groups that there may have been some pre-treatment differences on certain scales such as 8/*Sc* and 0/*Si*, but whether they were statistically different remains unknown. Conducting ANOVAs only on the post-treatment data could have biased the results, as this statistical technique does not take into account any differences that may have existed at baseline between groups.

In order to test the notion that earlier research reports of significant MMPI-2 changes following EEG-BFB (Peniston protocol) treatment for substance abuse may have been influenced by limitations in the statistical analysis used, an additional analysis was conducted in the present study using only the post-treatment data (scales 1/*Hs*, 2/*D*, 3/*Hy*, 4/*Pd*, 8/*Sc*, and 0/*Si*). Post-treatment MMPI-2 differences between groups were assessed utilizing ANOVAs (rather than ANCOVAs). Although the results still indicated no significant differences between groups on the scales investigated, the probability levels on some of the scale results had changed. For instance, on scales 3/*Hy* and 8/*Sc*, the probability levels (unadjusted) in the ANOVA analyses were .159 and .187, respectively; whereas they were .245 and .245 in the ANCOVA results. There is the possibility that with a large enough sample size, such as the one obtained in the Kaiser et al. (1999) and Scott et al. (2002) studies, significant results would have been demonstrated in the ANOVA example. For one of the scales not currently under scrutiny (scale 6/*Pa*), the ANOVA results were significant ($p = 0.16$), but reporting this as a significant post-treatment finding would have been misleading, as the two groups were significantly different from one another on this scale at baseline testing (EEG-BFB $M = 56.25$; OT-CD $M = 68.75$). Nevertheless, it remains somewhat unclear as to why the current study failed to replicate earlier reports in which subjects completing EEG-BFB for addictions showed significant improvements in personality characteristics in comparison to treatment controls not receiving EEG-BFB treatment (Peniston & Kulkosky, 1990; Scott & Kaiser; Kaiser et al.; Scott et al., 2002). Both the present investigation and the study completed by Burkett (2004) derived similar MMPI-2 results, and in both, the MMPI-2 data was analyzed using ANCOVAs rather than ANOVAs to control for pre-treatment scores. The present investigation extends the previous research in this area by

utilizing more appropriate statistical control techniques, such as the ANCOVA and the FDR for multiple comparisons as well as the newly emerging equivalence testing approach.

There were several limitations in the design of the present study that may have had an impact upon the results. For instance, the sample size in both groups was small and there was no randomized assignment of subjects to a treatment condition. Data was not collected concurrently for both groups, as the EEG-BFB sample's information was taken from archival client records. Subjects that presented for treatment and were, therefore, accessible were utilized in the design. Since this introduced a selection bias, the generalizability of findings to other substance abuse individuals may be limited. For instance, the EEG-BFB sample consisted of a high percentage of probation clients that had been referred to treatment by the local Probation department. Most of the remainder of the EEG-BFB subjects were referred to the NT Lab for treatment by their therapist or physician. Many of the subjects in the OT-CD group self-referred for treatment, and the subjects that clinical observation suggested were coping better tended to be the ones that completed the treatment and finished the second phase of testing. However, although this study was not a randomized one, both groups were surprisingly similar to one another according to their pre-treatment MMPI-2 results (scales 1/*Hs*, 2/*D*, 3/*Hy*, 4/*Pd*, 8/*Sc*, 0/*Si*, and AAS). Subsequent analyses (e.g., independent *t*-tests) of pre-treatment data found no significant differences between groups on these particular scales. At baseline, the groups differed significantly only on scale APS (EEG-BFB $M = 66.30$; OT-CD $M = 58.60$; $t(19) = 2.228$, $p = .032$), but when the FDR adjustments were applied due to the multiple comparisons, this finding was no longer significant ($p = .696$). There were also no significant differences between groups according to age, gender, or history of chemical dependency problems. Another commonality between groups was their involvement in the AA or NA network. Many of the EEG-BFB

subjects previously participated in AA/NA (or were concurrently at the time of treatment). In the treatment received by the OT-CD group, there was a heavy emphasis on following the principles of AA such as working the 12-steps, involvement in AA/NA support groups, and securing a sponsor before discharge. Therefore, there was evidence to warrant the group comparisons made in this study.

Another limitation in this study involved the use of archival data for the EEG-BFB group. Because the older files contained variability in the background information collected, some of the demographic or background data desired for this investigation was not available, and inability to contact several of the previous clients hampered collection. There may have been certain background variables that differentiated the two groups that went undetected or unidentified. However, in the OT-CD group, only one investigator was involved in collecting information from subjects via a background history questionnaire. If there was any missing data or questionable information, the investigator clarified or gathered this from the subject.

Current results may also be a reflection of the "time differential," which existed between the two treatment groups. The subjects in the EEG-BFB condition received outpatient treatment, while the OT-CD group participated in a 2-week intensive inpatient program followed by outpatient treatment. Although the actual number of sessions completed by each group was comparable, the OT-CD group's sessions tended to be longer and this condition was more intense from a time involvement standpoint. For instance, the agenda in the inpatient program involved activities scheduled from 6:30 a.m. until 10:30 p.m. Although there were three sessions scheduled per day (one "process" and two educational groups, 5 days per week), the inpatients were involved in other related activities in between those group sessions, such as completing homework assignments. Then, the outpatient program involved 3-hour sessions scheduled four

times per week for 4 weeks, plus two 1-hour individual counseling sessions. This time differential (i.e., lengthier sessions) in the OT-CD group may have contributed to current findings.

An additional confound in interpreting these findings is that subjects in the OT-CD group had the option of participating in acupuncture treatment at the facility if they so desired. According to the Homeward Bound, Inc., website (n.d., Program section, para.1 and 2), the NADA acupuncture protocol "helps people recover from drugs and alcohol dependencies. Acupuncture can decrease cravings for drugs and alcohol (sic) reduces withdrawal symptoms, relieve (sic) tension, and help (sic) people relax. Acupuncture treatments, taken DAILY FOR THE FIRST 45 DAYS, clear the mind, build energy, and give a sense of well being. Western science has confirmed that acupuncture treatments change levels of chemicals in the body and act on the nervous system." In a recent analysis of alcohol treatment programs, Miller, Wilbourne, and Hettema (2003) concluded, after examining controlled research designs of 47 different treatment regimes, that acupuncture ranked 17th in efficacy; whereas, the 12-step facilitation and Alcoholics Anonymous ranked 37th and 38th, respectively. Therefore, if the OT-CD subjects participated in the acupuncture program, this may have had an impact on their treatment outcome. Although efforts were made to determine how many of the OT-CD subjects had participated in this adjunct treatment, this information was not available to the primary investigator.

Finally, it may be that the assessment tool utilized in this study to detect pre to post treatment changes is not a sensitive enough instrument or an appropriate one to assess changes occurring as part of EEG-BFB treatment. Greene, considered one of the leading authorities on the MMPI-2, indicated that he could not recommend using the instrument as a treatment outcome

tool (personal communication, January 21, 2005). He related several reasons for not using the MMPI-2 as an outcome measure including: 1) it was originally designed for baseline assessment, aiding in diagnosis, and guiding intervention planning; 2) due to the length of the inventory (567 items), subjects may not be as receptive to a second testing phase; 3) due to the phrasing of many items (i.e., past tense or querying past behavioral patterns), the results may not accurately reflect changes that have taken place over the course of treatment. Greene and Clopton (2004, p. 462) stated, "…the sensitivity of the MMPI to changes in the patient's status may be limited…" In summarizing the results of her study, Burkett (2004) questioned the utility of the MMPI-2 with her population of crack cocaine addicts, as she felt the vernacular of many MMPI-2 items was not appropriate for her formerly homeless subjects. Greene and Clopton further point out a fundamental problem when MMPI-2 researchers amalgamate subjects together and consider them as a single group, as there is a high probability that an interaction exists between the client "type" (dependant on background and demographic characteristics) and the treatment outcome. Thus, there may be subsets of patients that respond differently to the treatment and grouping subjects together could overlook such information. In discussing limitations of this assessment tool, the authors stated (p. 466), "the primary problem in using the MMPI-2 in assessing the outcomes of treatment is the fact that background and demographic variables tend to be better predictors." Taking this feedback into consideration, perhaps future exploratory analysis with the current data set could be conducted to determine if there are subsets of subjects within each group that tended to benefit more (or less) from the treatment approaches.

Perhaps different assessment tools should be utilized in future treatment outcome studies with EEG-BFB. Since EEG-BFB or Neurotherapy is designed to help modify or improve dysfunctional brainwave patterns, perhaps it would be more appropriate to utilize different

pre/post measures in accessing treatment outcomes such as: 1) QEEG assessment, which provides a measure of how the brain is functioning and where abnormalities in functioning exist such as location, brainwave amplitudes, coherence problems, etc.; 2) mean changes in certain brainwave amplitudes (such as theta or alpha); 3) changes in variability (*SD*s) in the brainwave amplitudes. The present study was unable to determine if there had been significant pre/post improvements in mean brainwave amplitudes (alpha, theta) or variability in the EEG-BFB subjects for several reasons, such as incomplete or missing data, lack of ability to access the older biofeedback equipment database, and confounds in the available data (e.g., mean brainwave amplitudes and *SD*s collected during EEG-BFB combined with data from their relaxation script procedures during which time no feedback was provided).

An important implication can be made from the current findings of this study in terms of treatment costs and benefits. Today's health care environment is fraught with escalating costs of services in combination with decreasing levels of reimbursements for those services, whether from insurance companies, managed care providers, and/or government-funded programs. In an effort to trim costs related to substance abuse treatment, many funding sources are covering less, including fewer sessions in shorter time frames. The subjects in the OT-CD group received treatment that was paid for by a government-sponsored program. However, the program only reimbursed the facility $92.00 per day for each inpatient during the two-week residential phase, followed by $45.00 per day for each client during the outpatient program (18 sessions). There was no extra reimbursement (other than the $45.00/day) for clients who resided in the transitional housing units (J. Malatich, personal communication, March, 2005). The low level of reimbursement for services ultimately results in a cash flow deficit, as the operational costs of running the facility and programs surpass the funding sources (W. Hornyak, personal

communication, March 6, 2005). Given that the EEG-BFB group and the OT-CD group demonstrated comparable improvements on the MMPI-2 following treatment and that the EEG-BFB treatment condition involved less time, financial expense, and with less experienced personal in some cases (e.g., student therapists), EEG-BFB may provide a beneficial and cost effective option for chemical dependency treatment.

Table 1

Sociodemographic Characteristics of Pilot Study EEG-BFB Subjects' ($N = 16$)

Information	*n*	*P*
Marital Status		
Divorced/Separated	06	37.5%
Married	05	31.3%
Single	05	31.3%
Employment Status		
Employed at Intake	11	68.8%
Unemployed at Intake	03	18.8%
Not Recorded in File	02	12.5%
Educational Level		
Associate Degree or College Credits	07	43.8%
Advanced Degree	03	18.8%
GED or High School Diploma	03	18.8%
Less than a High School Diploma	03	18.8%
Additional Presenting Problems		
Depression or Bipolar Disorder	08	Categories Not Mutually Exclusive
Anxiety	05	
Sleep Disturbance	04	
History of Childhood Abuse	03	
Family History of Addiction		
History Reported at Intake	05	31.3%

Table 2

Pilot Study EEG-BFB Sample:

Pre/Post-Treatment *M* and *SD* Results for the BDI and MMPI-2

BDI	Pre-Treatment *M*	Pre-Treatment *SD*	Post-Treatment *M*	Post-Treatment *SD*
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	Pre-Treatment T-Score *M*	Pre-Treatment *SD*	Post-Treatment T-Score *M*	Post-Treatment *SD*
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.

Table 3

Pilot Study EEG-BFB Sample:

Paired *t*-test Results for the BDI ($N = 16$) and MMPI-2 ($n = 14$)

BDI	*M* Difference	*SD*	*SEM*	Paired *t*-test	*p*	Adjusted *p*	Effect Size, *d*
BDI Total	7.63	6.64	1.66	4.592	.000*	.000*	1.186
Cognitive	5.06	4.12	1.03	4.912	.000*	.000*	1.268
Somatic	2.56	4.11	1.03	2.491	.025*	.038*	.643
MMPI-2 Scale	*M* Difference	*SD*	*SEM*	*t*-test	*p*	Adjusted *p*	Effect Size, *d*
L	-2.21	8.42	2.25	-.984	.343	--	-.273
F	7.07	7.40	1.98	3.578	.003	--	--
K	-3.36	10.05	2.69	-1.250	.233	--	-.347
1/Hs	7.64	11.37	3.04	2.515	.026*	.113	.70
2/D	8.57	9.41	2.52	3.408	.005*	.033*	.945
3/Hy	5.64	11.31	3.02	1.867	.085	--	.518
4/Pd	8.36	13.96	3.73	2.239	.043*	.134	.621
6/Pa	3.79	13.57	3.63	1.044	.315	--	.29
7/Pt	10.79	12.27	3.28	3.288	.006*	.033*	.912
8/Sc	11.29	9.75	2.61	4.329	.001*	.022*	1.20
9/Ma	5.14	8.56	2.29	2.249	.042*	.134	.624
0/Si	5.79	10.24	2.74	2.113	.054*	.147	.586

Note. *Results significant at the $p < .05$ level or lower.

Table 4

Sociodemographic Characteristics of the EEG-BFB and OT-CD Groups (n = 20 each)

	EEG-BFB		OT-CD	
Information	*n*	*P*	*n*	*P*
Marital Status				
Divorced/Separated	08	40%	7	35%
Married/Living with Significant Other	07	35%	2	10%
Single	05	25%	10	50%
Widowed	0	0%	1	5%
Employment Status				
Employed at Intake	16	80%	4	20%
Unemployed at Intake	3	15%	16	80%
Not Recorded in File	1	5%	--	--
Educational Level				
Advanced/Graduate Degree	2	10%	1	5%
Associate Degree or College Credits	11	55%	8	40%
GED or High School Diploma	4	20%	9	45%
Less than a High School Diploma	3	15%	2	10%
Occupation				
Professional	4	20%	3	15%
Skilled Laborer	12	60%	9	45%
Unskilled Laborer	3	15%	8	40%
Not Recorded in File	1	5%	--	--

Table 5

Sociodemographic Characteristics of the EEG-BFB and OT-CD Groups (n = 20 each)

	EEG-BFB		OT-CD	
Information	*n*	*P*	*n*	*P*
Referral Source				
Probation Department	12	60%	--	--
Professional-including TCADA	5	25%	6	30%
Self	2	10%	13	65%
Family and/or Friends	--	--	1	5%
AA/NA Involvement				
Previous Involvement	14	70%	12	60%
No Previous Involvement	3	15%	8	40%
Current Involvement	5	25%	20	100%
No Current Involvement	3	15%	--	--
Not Recorded in File				
Regarding Previous Involve.	3	15%	--	--
Regarding Current Involve.	12	60%	--	--
Family Addiction History				
Family History	8	40%	17	85%
Denied Family History	--	--	3	15%
Not Recorded in File	12	60%	--	--
History of Previous Head Injury				
History of Head Injury	9	45%	12	60%
Denied Head Injury History	2	10%	8	40%
Not Recorded in File	9	45%	--	--

Table 6

Alcohol and Drug-Related Information of the EEG-BFB and OT-CD Groups

	EEG-BFB		OT-CD	
Addiction Substance(s) Information	*n*	*P*	*n*	*P*
Alcohol Addiction	16	80%	12	60%
Alcohol Addiction Alone	8	40%	2	10%
Denied History of Alcoholism	4	20%	8	40%
Alcohol and Cocaine Derivatives	4	20%	3	15%
Alcohol and Amphetamines	1	5%	--	--
Alcohol and Prescription Meds.	1	5%	--	--
Alcohol and Other Drugs (2 or more)	2	10%	7	35%
Cocaine Addiction Alone	--	--	4	20%
Cocaine and Prescription Meds.	1	5%	--	--
Heroin Addiction Alone	--	--	1	5%
Prescriptions Medications Only	1	5%	--	--
Prescription Medications and Marijuana	--	--	1	5%
Prescription Meds., Methamphetamine, and Several Street Drugs	--	--	1	5%
Marijuana Addiction Alone	2	10%	--	--
Polysubstance Abusers (More than 3)	2	10%	10	10%

Table 7

MMPI-2 Pre- and Post-Treatment *M* and *SD* Results for Both Treatment Groups

Group	EEG-BFB				OT-CD			
Phase	Pre-		Post-		Pre-		Post-	
Scale	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
L	46.30	8.72	46.75	8.22	46.80	8.74	53.15	12.16
F	64.15	14.53	57.0	16.69	75.60*	25.21	66.15*	22.16
K	41.95	7.27	44.95	8.42	43.20	8.19	45.50	10.92
1/Hs	65.25*	11.60	60.0	14.44	68.85*	15.53	63.40	16.39
2/D	66.95*	11.64	58.70	13.72	69.15*	17.67	60.65	16.58
3/Hy	59.75	12.01	53.35	13.57	63.45	16.62	59.45	13.31
4/Pd	72.70*	13.75	64.10	15.56	78.6*	10.59	69.80*	14.34
6/Pa	61.30	15.32	56.25	15.63	75.5*	18.06	68.75*	15.86
7/Pt	66.55*	12.15	56.90	13.92	71.65*	17.25	63.45	18.44
8/Sc	67.95*	14.87	58.25	17.48	72.55*	8.98	66.35*	20.53
9/Ma	62.15	11.90	56.20	9.04	64.10	14.90	61.80	12.76
0/Si	55.60	11.49	50.65	12.82	56.85	13.85	54.60	13.1
AAS	69.70*	9.82	61.45	8.33	74.80*	11.87	63.25	9.19
APS	66.30*	9.15	59.65	11.14	56.60	12.45	56.80	12.10

Note. *MMPI-2 T-scores above 65 considered clinically significant.

Table 8

EEG-BFB Group's Paired Sample *t*-test Results for Pre- and Post-Treatment MMPI-2 ($n = 20$)

Scales	*M* Difference	*SD*	*SEM*	*t*-test (19 *df*)	*p*	Adjusted *p*	Effect Size, *d*
L	-.45	8.38	1.87	-.240	.813	1.00	-.055
F	7.15	6.56	1.47	see text	.001*	.006*	---
K	-3.00	9.43	2.11	-1.423	.171	.517	-.326
1/*Hs*	5.25	11.06	2.48	2.122	.047*	.107	.486
2/*D*	8.25	9.91	2.22	3.723	.001*	.009*	.854
3/*Hy*	6.40	10.62	2.37	2.696	.014*	.847	.618
4/*Pd*	8.60	13.43	3.00	2.863	.010*	.038*	.656
6/*Pa*	5.05	13.17	2.94	1.715	.103	.374	.393
7/*Pt*	9.65	11.64	2.60	3.707	.001*	.009*	.850
8/*Sc*	9.70	9.24	2.01	4.695	.000*	.000*	1.078
9/*Ma*	5.95	10.41	2.33	2.557	.019*	.086	.587
0/*Si*	4.95	9.15	2.05	2.421	.026*	.074	.555
AAS	8.25	10.87	2.43	3.395	.003*	.009*	.779
APS	6.65	11.52	2.58	2.582	.018*	.027*	.592

Note. *Results significant at the $p < .05$ level or lower.

Table 9

OT-CD Group's Paired Sample *t*-test Results for Pre- and Post-Treatment MMPI-2 ($n = 20$)

Scale	*M* Difference	*SD*	*SEM*	*t*-test (19 df)	*p*	Adjusted *p*	Effect Size, *d*
L	-6.35	7.69	1.72	-3.695	.002*	.036*	-.848
F	9.45	15.17	3.39	2.785	.012*	.034*	.639
K	-2.30	7.47	1.67	-1.377	.185	.559	-.316
1/Hs	5.45	7.23	1.62	3.372	.003*	.017*	.773
2/D	8.5	12.51	2.796	3.040	.007*	.064	.697
3/Hy	4.00	11.99	2.68	1.492	.152	.552	.342
4/Pd	8.80	10.54	2.36	3.733	.001*	.011*	.856
6/Pa	6.75	16.89	3.78	1.788	.09	.408	.410
7/Pt	8.20	13.261	2.965	2.795	.012*	.073	.641
8/Sc	6.20	9.876	2.208	2.808	.011*	.034*	.644
9/Ma	2.30	8.980	2.008	see text	.247	.640	---
0/Si	2.25	10.71	2.40	.939	.359	.819	.216
AAS	11.55	9.72	2.17	5.32	.000*	.000*	1.22
APS	1.80	12.56	2.81	.641	.529	.794	.147

Note. *Results significant at the $p < .05$ level or lower.

Table 10

ANCOVA Results on Post-Treatment MMPI-2 Scores between Treatment Groups ($N = 40$)

Scale	$F(1,37)$	p	Adjusted p	eta^2	Power	Effect size
1/*Hs*	.003	.960	1.0	.000	.050	0
2/*D*	.010	.921	1.0	.000	.051	0
3/*Hy*	1.393	.245	1.0	.036	.210	.037
4/*Pd*	.100	.754	1.0	.003	.061	.003
8/*Sc*	1.394	.245	1.0	.036	.210	.037
0/*Si*	1.060	.310	1.0	.028	.171	.029
AAS	.002	.963	1.0	.000	.050	0
APS	.036	.850	1.0	.001	.054	.001

Note. *Results significant at the $p < .05$ level of lower.

Table 11

Both Groups Adjusted MMPI-2 *M*s and *SE*s (from ANCOVAs) used in Equivalence Testing

Scale	*SE*	EEG-BFB Adjusted *M*	OT-CD Adjusted *M*	*M* Difference
1/*Hs*	2.105	61.624	61.776	.152
2/*D*	2.394	59.506	59.844	.338
3/*Hy*	2.260	54.506	58.294	3.788
4/*Pd*	2.693	66.340	67.560	1.22
8/*Sc*	2.174	60.476	64.124	3.648
0/*Si*	2.100	51.095	54.155	3.06

Table 12

Treatment Group Equivalence Testing Results on Several MMPI-2 Scales ($N = 40$)

Scale	*t*1	*t*1 critical value	*t*2	*t*2 critical value	Result
1/*Hs*	2.854	1.686	-3.053	-1.686	Equivalent
2/*D*	2.854	1.686	-3.053	-1.686	Equivalent
3/*Hy*	1.943	1.686	-4.314	-1.686	Equivalent
4/*Pd*	2.305	1.686	-2.946	-1.686	Equivalent
8/*Sc*	2.066	1.686	-4.439	-1.686	Equivalent
0/*Si*	2.337	1.686	-4.398	-1.686	Equivalent
AAS	4.016	1.686	-3.920	-1.686	Equivalent
APS	2.683	1.686	-3.075	-1.686	Equivalent

Table 13

Comparison of EEG-BFB Male Sample (n = 17) to MMPI-2 Male Normative Group

	EEG-BFB Males					
Scale	Pre-treatment Raw *M*	*SD*	Mean Diff	*z*-score	*p*	Adj. *p*
F	8.71	4.24	4.18	5.32	.000*	.000*
2/*D*	25.94	6.09	7.62	6.86	.000*	.000*
4/*Pd*	26.47	6.34	9.99	8.92	.000*	.000*
7/*Pt*	22.24	8.28	11.00	6.88	.000*	.000*
8/*Sc*	24.29	11.08	13.09	7.57	.000*	.000*
9/*Ma*	22.47	4.42	5.59	5.13	.000*	.000*
AAS	7.00	2.03	4.14	8.33	.000*	.000*
APS	29.76	2.88	6.39	7.18	.000*	.000*
	Post-treatment Raw *M*					
F	6.35	4.12	1.82	2.30	.0214*	.058
2/*D*	23.00	7.12	4.68	4.22	.000*	.000*
4/*Pd*	23.18	6.20	6.61	5.90	.000*	.000*
7/*Pt*	16.76	9.67	5.52	3.45	.0006*	.002*
8/*Sc*	18.29	12.30	7.09	4.10	.000*	.000*
9/*Ma*	20.41	3.28	3.53	3.24	.0012*	.004*
AAS	5.00	1.66	2.14	4.28	.000*	.000*
APS	27.29	3.80	3.92	4.36	.000*	.000*

Note. Results significant at the $p < .05$ level or lower.

Table 14

Comparison of EEG-BFB Female Sample (n = 3) to MMPI-2 Female Normative Group

	EEG-BFB Females					
Scale	Pre-treatment Raw *M*	*SD*	Mean Diff	*z*-score	*p*	Adj. *p*
F	9.67	6.66	6.01	3.58	.0003*	.002*
2/*D*	31.33	3.21	11.19	3.90	.0001*	.0007*
4/*Pd*	28.67	5.86	12.46	4.63	.000*	.000*
7/*Pt*	26.00	11.36	-1.33	-.32	.749	1.00
8/*Sc*	31.00	20.42	19.76	4.51	.000*	.000*
9/*Ma*	18.33	5.86	2.26	.87	.384	1.00
AAS	5.00	2.00	3.02	2.96	.003*	.013*
APS	26.33	5.03	3.20	1.50	.134	.486
	Post-treatment Raw *M*					
F	9.00	9.54	5.34	3.18	.0015*	.016*
2/*D*	27.00	6.00	6.86	2.39	.017*	.074
4/*Pd*	27.00	10.58	10.79	4.01	.0001*	.002*
7/*Pt*	17.33	12.74	4.64	1.12	.263	.953
8/*Sc*	22.00	24.33	10.76	2.46	.014*	.074
9/*Ma*	16.67	4.16	.60	.23	.818	1.00
AAS	5.00	1.73	3.02	2.96	.003*	.022*
APS	24.67	5.86	1.54	.72	.472	1.00

Note. Results significant at the $p < .05$ level or lower.

Figure 1. Pre/Post-treatment *M* BDI scores for pilot study EEG-BFB sample (*N* = 16). Paired *t*-test results were significant ($p < .05$). Treatment effect sizes were large (Cohen *d* values > .80) to medium (Cohen *d* values > .50).

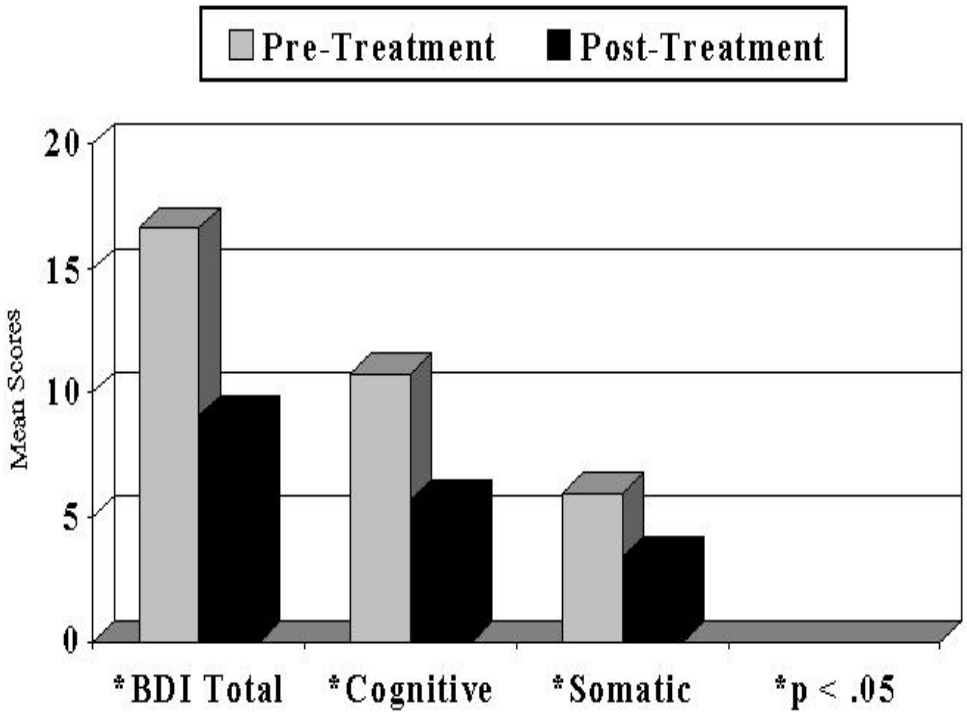


Figure 2. Pre/Post-treatment MMPI-2 *M* T-scores for pilot study EEG-BFB sample ($n = 14$).

* Indicates the paired *t*-test results were significant ($p < .05$).

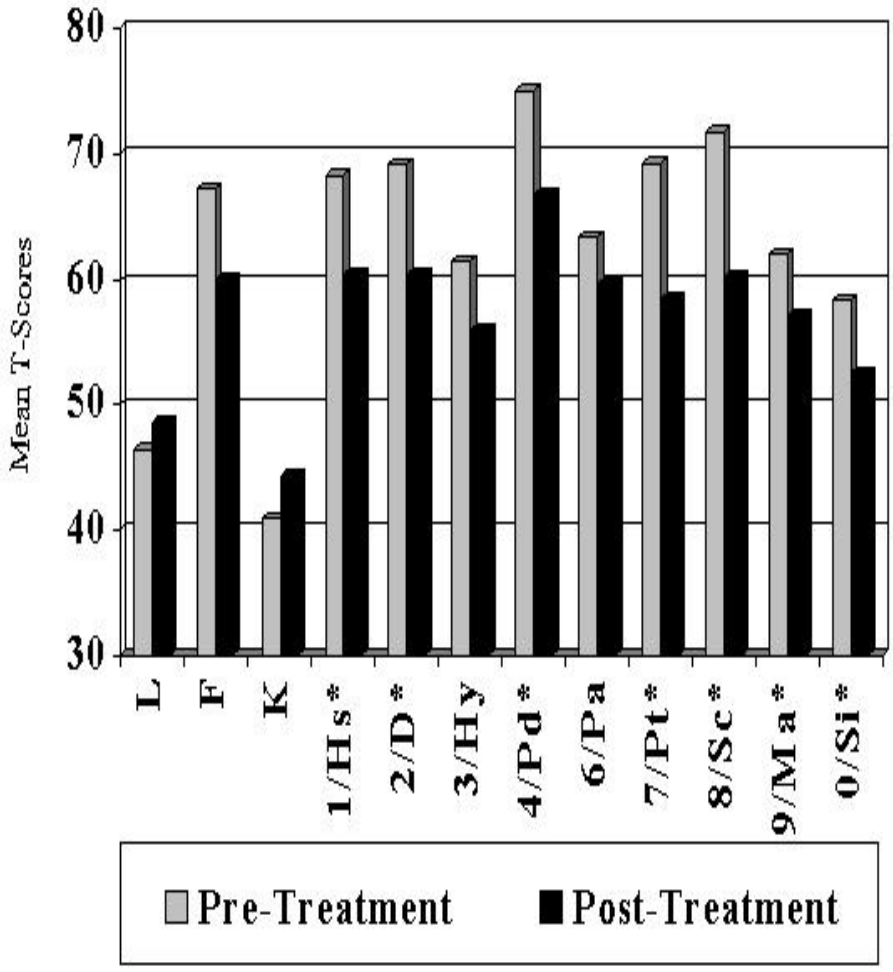


Figure 3. Pre/Post-treatment MMPI-2 *M* T-Score results for EEG-BFB group ($n = 20$).

* Indicates the paired *t*-test results were significant ($p < .05$).

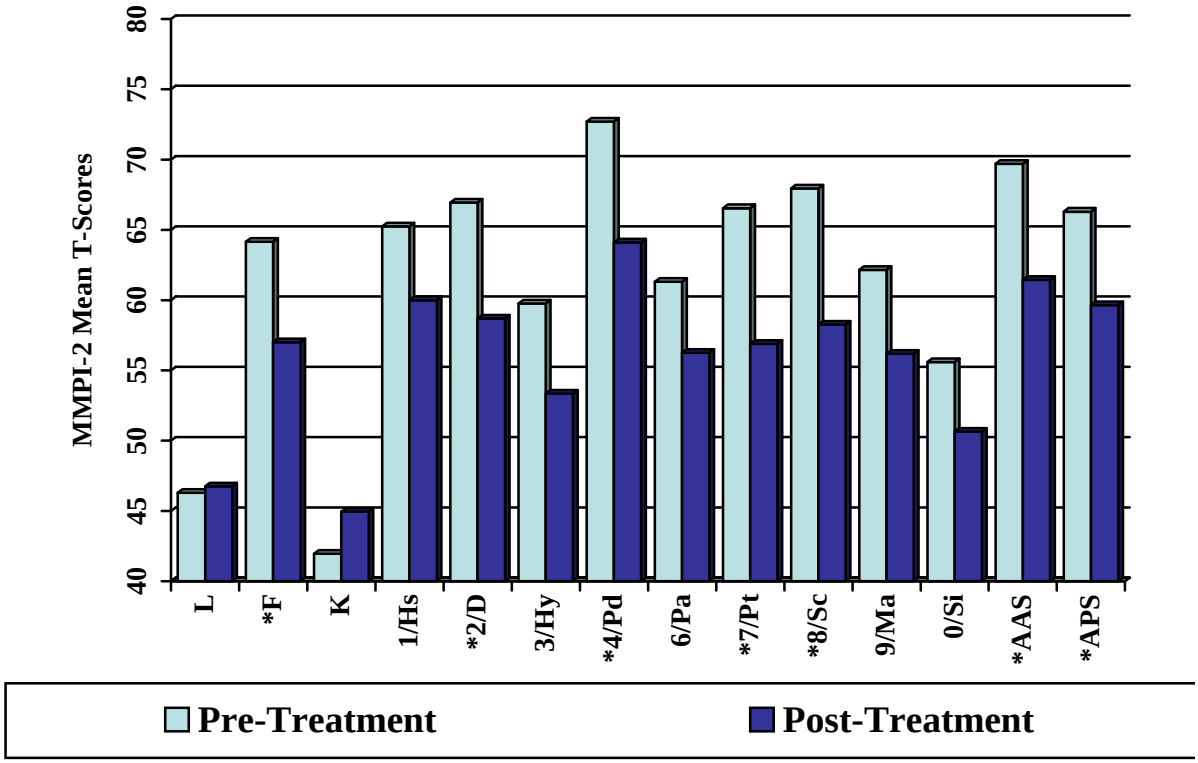
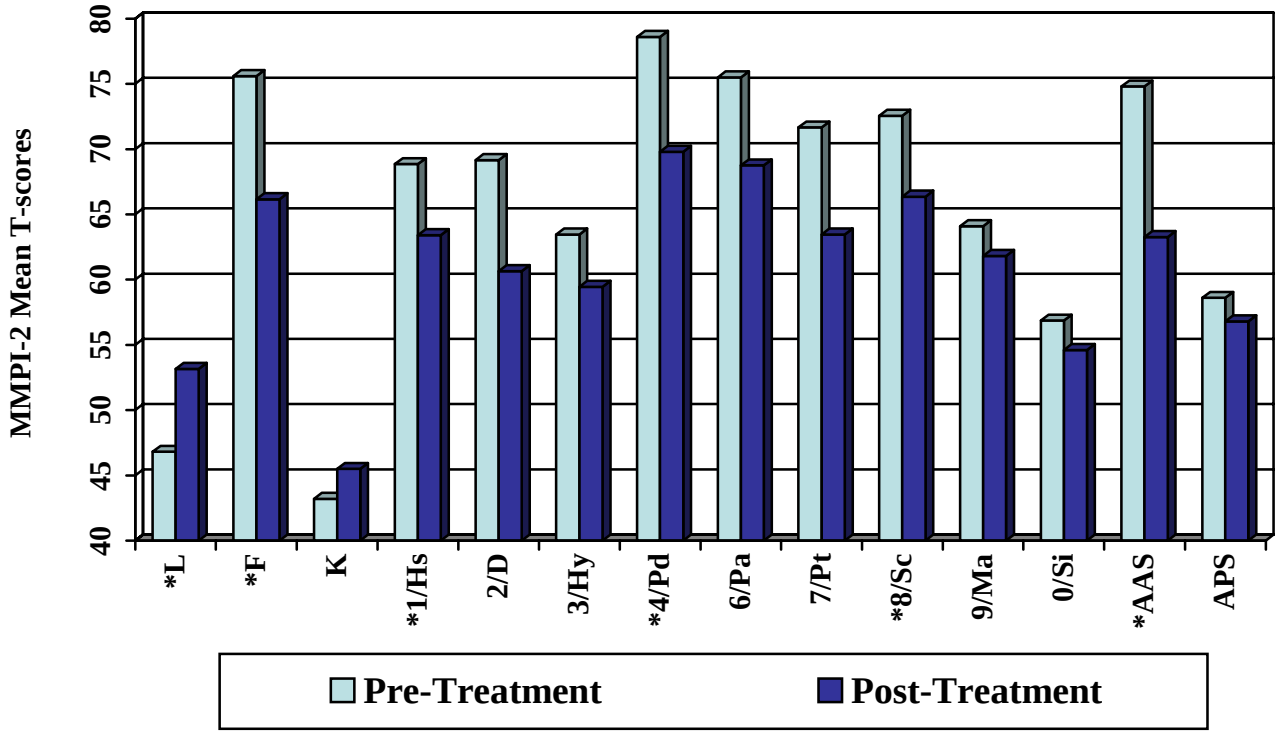


Figure 4. Pre/Post-treatment MMPI-2 *M* T-score results for the OT-CD Group ($n = 20$).

* Indicates the paired *t*-test results were significant ($p < .05$).



APPENDIX

TWELVE STEPS OF ALCOHOLICS/NARCOTICS ANONYMOUS

1. We admitted we were powerless over alcohol/drugs/our addiction –that our lives had become unmanageable.
2. We came to believe that a power greater than ourselves could restore us to sanity.
3. We made a decision to turn our will and our lives over to the care of God, as we understood him.
4. We made a searching and fearless moral inventory of ourselves.
5. We admitted to God, to ourselves, and to another human being the exact nature of our wrongs.
6. We were entirely ready to have God remove all these defects of character.
7. We humbly asked Him to restore our shortcoming.
8. We made a list of all persons we had harmed, and became willing to make amends to them all.
9. We made direct amends to such people whenever possible, except when to do so would injure them or others.
10. We continued to take personal inventory and when we were wrong promptly admitted it.
11. We sought through prayer and meditation to improve our conscious contact with God, as we understood him, praying only for knowledge of His will for us and the power to carry that out.
12. Having had a spiritual awakening as a result of these steps. We carried this message to alcoholics/addicts and to practice these principles in all our affairs.

REFERENCES

Alterman, A. I., McLellan, A. T., O'Brien, C. P., August, D. S., Snider, E. C., Drobe, M., Cornish, J. W., Hall, C. P., Raphaelson, A. H., & Schrade, F. (1994). Effectiveness and costs of inpatient vs. day hospital treatment for cocaine dependence. *Journal of Nervous and Mental Disease, 182,* 157-163.

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.

Beck, A. T., & Steer, R. A. (1987). *BDI: Beck Depression Inventory manual.* San Antonio: The Psychological Corporation Harcourt Brace Jovanovich.

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.

Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society B., 57,* 289-300.

Benjamini, Y., & Yekutieli, D. (2001). The control of the false discovery rate in multiple testing under dependency. *Annals of Statistics, 29,* 1165-1188.

Benson, H., & Klipper, M. (1975). Chapter 4. In, *The Relaxation Response* (pp. 76-103). New York: Wings Books.

Bodenhamer-Davis, E., Callaway, T., & DeBeus, M. (2002, September). Extended follow-up of Peniston protocol results with chemical dependency. Poster session presented at the annual meeting of the Society for Neuronal Regulation, Scottsdale, AZ.

Bonate, P. L. (2000). Chapter 5: Analysis of covariance. In, *Analysis of pretest-posttest designs*

(pp. 91-109). New York: Chapman and Hall.

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. S. (in press). An open clinical trial utilizing real-time EEG operant conditioning as an adjunctive therapy in treatment of crack-cocaine dependence. *Journal of Neurotherapy*.

Butcher, J. N. (1990). Chapter 3: Hypotheses about treatment from MMPI-2 scales and indexes. In, *MMPI-2 in psychological treatment* (pp. 45-68). New York: Oxford University Press.

Butcher, J. N., Dahlstrom, W. G., Graham, J. R., Tellegen, A., & Kaemmer, B. (1989). *Manual for administration and scoring: Minnesota Mutiphasic Personality Inventory-2.* Minneapolis: University of Minnesota Press.

Butcher, J. N., & Williams, C. L. (1992). Chapter 8: Integrating MMPI-2 inferences into an interpretive report. In, *Essentials of MMPI-2 and MMPI-A interpretation* (pp. 184-204). Minneapolis: University of Minnesota Press.

Cates, W. M. (1985). Chapter 17: Statistical procedures for analyzing data. In, *A practical guide to educational research* (pp. 146-190). Englewood Cliffs, NJ: Prentice-Hall.

Clark, M. (2005, February). Equivalence tests. *Research and Statistical Support (RSS) Matters.* Retrieved February 16, 2005, from http://www.unt.edu/benchmarks/archives/2005/february05/rss.htm

Cohen, J. (1992). Quantitative methods in psychology: A power primer. *Psychological Bullentin, 112(1),* 155-159.

Collins, A. (n.d.). *Neurofeedback for addictions: The state of the science.* Retrieved February 10,

2005, from the International Society for Neuronal Regulation Web site: http://www.isnr.org/pubarea/addiction.htm

Correctional Service of Canada. (2003). *Relapse Techniques.* Retrieved March 11, 2005, from http://www.csc-scc.gc.ca/text/pblct/litrev/treatmod/lit21e_e.shtml

Craig, R. J. (1984). A comparison of MMPI profiles of heroin addicts based on multiple methods of classification. *Journal of Personality Assessment, 48,* 115-120.

Craig, R. J., & Olson, R. (1992). MMPI subtypes for cocaine abusers. *American Journal of Drug and Alcohol Abuse, 18,* 197-205.

Crane, R. A. (2001, December). Crack cocaine, neurofeedback and Bob Dickson. *American Biotec and Health Training Seminar Newsletter*, *14*. Retrieved December 18, 2001, from newletter@mindfitness.com

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.

Dougherty, R. J., & Lesswing, N. J. (1989). Inpatient cocaine abusers: An analysis of psychological and demographic variables. *Journal of Substance Abuse Treatment, 6,* 45-47.

Doweiko, H. E. (2002). Chapter 1: Why worry about recreational chemical use in the United States? In, *Concepts of chemical dependency* (5th ed., pp. 1-10). Australia: Brooks/Cole.

Doweiko, H. E. (2002). Chapter 28: The treatment of chemical dependency. In, *Concepts of chemical dependency* (5th ed., pp. 342-351). Australia: Brooks/Cole.

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.

Friedman, A. F., Lewak, R., Nichols, D. S., & Webb, J. T. (2001). Psychological assessment with the MMPI-2. Appendix A: Scoring keys and norms for MMPI-2 scales and critical items. In, *Psychological Assessment with the MMPI-2.* (pp. 532-576). Mahway, N.J.: Lawrence Erlbaum Ass.

Funderburk, W. H. (1949). Electroencephalographic studies in chronic alcoholics. *EEG in Clinical Neurophysiology, 1,* 369-370.

Funkhauser, J. B., Nagler, B., & Walker, D. N. (1953). The electroencephalogram of chronic alcoholism. *Southern Medical Journal, 46,* 423-428.

Gabrielli, W. F., Mednick, S. A., Volavka, J., Pollack, V. E., Schulsinger, F., & Itil, T. M. (1982). Electroencephalograms in children of alcoholic fathers. *Psychophysiology, 19,* 404-407.

Gordon, R. M. (2001). MMPI/MMPI-2 changes in long-term psychoanalytic psychotherapy. *Issues in Psychoanalytic Psychology, 23(1, 2),* 59-79.

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

Graham, J. R. (1993). Chapter 5: Profile configurations. In, *MMPI-2: Assessing personality and psychopathology* (2nd ed., pp. 80-101). New York: Oxford University Press.

Graham, J. R. (1993). Chapter 8: Psychometric considerations. In, *MMPI-2: Assessing*

personality and psychopathology (2nd ed., pp. 168-192). New York: Oxford University Press.

Graham, J. R. (1993). Chapter 9: Use with special groups. In, *MMPI-2: Assessing personality and psychopathology* (2nd ed., pp. 193-217). New York: Oxford University Press.

Graham, J. R. (1993). Chapter 10: An interpretive strategy. In, *MMPI-2: Assessing personality and psychopathology* (2nd ed., pp. 218-266). New York: Oxford University Press.

Graham, J. R. (2000). Chapter 1: Development of the MMPI and MMPI-2. In, *MMPI-2: Assessing personality and psychopathology* (3rd ed., pp. 1-12). New York: Oxford University Press.

Graham, J. R., & Strenger, V. E. (1988). MMPI characteristics of alcoholics: A review. *Journal of Consulting and Clinical Psychology, 56(2),* 197-205.

Greene, R. L. (1991). Chapter 2: Administration and scoring. In, *MMPI-2/MMPI: An interpretive manual* (pp. 31-48). Boston: Allyn and Bacon.

Greene, R. L. (1991). Chapter 3: Validity indexes and validity configurations. In, *MMPI-2/MMPI: An interpretive manual* (pp. 49-133). Boston: Allyn and Bacon.

Greene, R. L. (1991). Chapter 6: Codetypes. In, *MMPI-2/MMPI: An interpretive manual* (pp. 231-285). Boston: Allyn and Bacon.

Greene, R. L. & Clopton, J. R. (1999). Chapter 33: Minnesota Multiphasic Personality Inventory-2 (MMPI-2). In M. E. Maruish (Ed.), *The use of psychological testing for treatment planning and outcomes assessment* (pp. 1023-1049). Mahwah, NJ: Lawrence Erlbaum Ass.

Greene, R.L. & Clopton, J. R. (2004). Chapter 15: Minnesota Multiphasic Personality Inventory-

2 (MMPI-2). In M. E. Maruish (Ed.), *The use of psychological testing for treatment planning and outcomes assessment* (pp. 449-477). Mahwah, NJ: Lawrence Erlbaum Ass.

Green, E. (1993, June). *Alpha-theta brainwave training: Instrumental vipassana.* Paper presented at a symposium, Montreal, Canada.

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.

Green, E. E., Green, A. M., & Walters, E. D. (1970). Voluntary control of internal states: Psychological and physiological. *Journal of Transpersonal Psychology, 2,* 1-26.

Hatch, J. P. (1996). Using statistical equivalence testing in clinical biofeedback research. *Biofeedback and Self-Regulation, 21(2),* 105-119.

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

Herrington, R. (2002, April). Controlling the false discovery rate in multiple hypothesis testing. *Research and Statistical Support (RSS) Matters.* Retrieved February 15, 2005, from http://www.unt.edu/benchmarks/archives/2002/april02/rss.htm

Holden, R. R. (2000). Are there promising MMPI substitutes for assessing psychopathology and personality? In R. H. Dana (Ed.), *Handbook of cross-cultural and multicultural personality assessment: Personality and clinical psychology series* (pp. 267-302). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Homeward Bound, Inc. (n. d.). *Programs.* Retrieved March 08, 2005, from http://www.homewardboundinc.org/

Howell, D. C. (1997). Chapter 7: Hypothesis tests applied to means. In *Statistical methods for*

psychology (4th ed., pp. 170-212). Belmont, CA: Duxbury Press.

Johnson, R. S., Tobin, J. W., & Cellucci, T. (1992). Personality characteristics of cocaine and alcohol abusers: More alike than different. *Addictive Behaviors, 17,* 159-166.

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

Kamiya, J. (1968). Conscious control of brainwaves. *Psychology Today, 1,* 56-60.

Kaplan, R. F., Hesselbrock, V. M., O' Connor, S., & Depalma, N. (1988). Behavioral and EEG responses to alcohol in nonalcoholic men with a family history of alcoholism. *Progress in Neuropsychopharmacology and Biological Psychiatry, 12(6),* 873-885.

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.

Lambert, M. J., & Finch, A. E. (1999). Chapter 27: The outcome questionnaire. In M. E. Maruish (Ed.), *The use of psychological testing for treatment planning and outcomes assessment* (pp. 831-869). Mahwah, NJ: Lawrence Erlbaum Ass.

Lash, S. J. (1998). Increasing participation in substance abuse aftercare treatment. *American Journal of Drug and Alcohol Abuse, 24(1),* 31-36.

Long, K. A., Graham, J. R., & Timbrook, R. E. (1994). Socioeconomic status and MMPI-2 interpretation. *Measurement and Evaluation in Counseling and Development, 27,* 158-177.

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 in Alcoholism, 60,* 176-180.

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

Miller, W. R., Wilbourne, P. L., & Hettema, J. E. (2003). Chapter 2: What works? A summary of alcohol treatment outcome research. In R. K. Hester & W. R. Miller, (Eds.), *Handbook of alcoholism treatment approaches* (3rd ed., pp. 13-63). Boston: Allyn and Bacon.

Morral, A. R., Iguchi, M. Y., Belding, M. A., & Lamb, R. J. (1997). Natural classes of treatment response. *Journal of Consulting and Clinical Psychology, 65,* 673-685.

National Institute on Alcohol Abuse and Alcoholism (1999). *Report of a subcommittee of the National Advisory Council on alcohol abuse and alcoholism on the review of the extramural research portfolio for treatment* (1999). Retrieved December 30, 2001, from http://www.niaaa.nih.gov/extramural/treatmentrpt.htm#summary

National Institute on Drug Abuse & National Institute on Alcohol Abuse and Alcoholism (1992). *The economic costs of alcohol and drug abuse in the United States – 1992.* Retrieved December 29, 2001, from http://www.health.org/govstudy/bkd265/Chapter4.aspx

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.

Ordorica, P. I., & Nace, P. E. (1998). Alcohol. In R. J. Frances & S. I. Miller (Eds.), *Clinical*

textbook of addictive disorders (pp. 91-119). New York: Guilford.

Parks, G. A., & Marlatt, G. A. (2000). Relapse prevention therapy: A cognitive-behavioral approach. *The National Psychologist, 9(5)*. Retrieved March 11, 2005, from http://nationalpsychologist.com/articles/art_v9n5_3.htm

Passini, F. T., Watson, C. G., Dehnel, L., Herder, J., & Watkins, B. (1977). Alpha wave biofeedback training therapy in alcoholics. *Journal of Clinical Psychology, 33(1),* 292-299.

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. O. (1998). The Peniston-Kulkosky brainwave neurofeedback therapeutic protocol: The future psychotherapy for alcoholism/PTSD/behavioral medicine. Retrieved February 03, 2005, from The American Academy of Experts in Traumatic Stress Web site: http://www.isnr.org/pubarea/addiction.htm

Peniston, E. G., & Kulkosky, P. J. (1989). Alpha-theta brainwave training and ß-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: 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.

Propping, P., Kruger, J., & Janah, A. (1980). Effects of alcohol on genetically determined variants of the normal EEG. *Psychiatry Research, 2,* 85-98.

Rogers, J. L., Howard, K. I., & Vessey, J. T. (1993). Using significance tests to evaluate equivalence between two experimental groups. *Psychological Bulletin, 113(3),* 553-565.

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.

Rosnow, R. L., & Rosenthal, R. (2003). Effect sizes for experimenting psychologists. *Canadian Journal of Experimental Psychology, 57(3),* 221-237.

Rouse, S. V., Butcher, J. N., & Miller, K. B. (1999). Assessment of substance abuse in psychotherapy clients: The effectiveness of the MMPI-2 substance abuse scales. *Psychological Assessment, 11(1),* 101-107.

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., Brod, T., Siderof, S., Kaiser, D., Sagan, M., & Cri-Help, Inc. (2002, May). Type-specific EEG biofeedback improves residential substance abuse treatment. Paper presented at the meeting of the American Psychiatric Association. Retrieved January 31, 2005, from http://www.cri-help.org/Research.asp

Scott, W., & Kaiser, D. (1998). Augmenting chemical dependency treatment with neurofeedback training. *Journal of Neurotherapy, 3(1),* 66.

Shepherd, K. L. (1997). Prediction of treatment outcome using the MMPI-2. (Doctoral dissertation, Kent State University, 1997). *UMI ProQuest Digital Dissertations,* AAT 9815926.

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, Houston, TX.

Spiro, A., III, Butcher, J. N., Levenson, M. R., Aldwin, C. M., & Bosse, R. (2000). Change and stability in personality: A five-year study of the MMPI-2 in older men. In J. N. Butcher (Ed.), *Basic sources on the MMPI-2* (pp. 443-462). Minneapolis: University of Minnesota Press.

Stevens, J. (1996). Chapter 6: Assumptions in MANOVA. In, *Applied multivariate statistics for the social sciences* (3rd ed., pp. 237-260). Mahwah, NJ: Lawrence Erlbaum.

Svikis, D. S., Gorenstein, S., Paluzzi, P, & Fingerhood, M. (1998). Personality characteristics of treatment-seeking HIV+ pregnant drug dependent women. *Journal of Addictive Diseases, 17(3),* 91-111.

Tabachnick, B. G., & Fidell, L. S. (1996). Chapter 4: Cleaning up your act: Screening data prior to analysis. In, *Using multivariate statistics* (pp. 57-125). HarperCollins College.

The Robert Wood Johnson Foundation. (2001). *Substance abuse: The nation's number one health problem: Key indicators for policy update.* Waltham, MA: Brandeis University.

Tosi, D. J., Eshbaugh, D. M., & Murphy, M. A. (1993). Chapter 8: Conclusions and implications for future research and treatment. In, *A clinician's guide to the personality profiles of alcohol and drug abusers: Typological descriptions using the MMPI* (pp. 85-94). Springfield, IL: Charles C. Thomas.

Tosi, D. J., Eshbaugh, D. M., Raines, M. G., & Murphy, M. A. (1986). Typological analysis of MMPI personality patterns of drug dependent men. *Journal of General Psychology, 113(4),* 329-339.

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

Tremlow, S. W., & Bowen, W. T. (1977). Sociocultural predictors of self actualization in EEG biofeedback treated alcoholics. *Psychology Report, 40,* 591-598.

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

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

Windeler, J., & Trampisch, H. (1996). Recommendations concerning studies on therapeutic equivalence. *Drug Information Journal, 30,* 195-199.