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An Investigation of the Effects of Neurofeedback Training on Attention Deficit-Hyperactivity Disorder (ADHD) Symptoms, Depression, Anxiety, and Academic Self-Efficacy in College Students.

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AN INVESTIGATON OF THE EFFECTS OF NEUROFEEDBACK TRAINING ON ATTENTION DEFICIT-HYPERACTIVITY DISORDER (ADHD) SYMPTOMS, DEPRESSION, ANXIETY, AND ACADEMIC SELF-EFFICACY IN COLLEGE STUDENTS

by

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ABSTRACT

College students diagnosed with Attention Deficit-Hyperactivity Disorder (ADHD) are at an increased risk of depression, anxiety, and lower academic self-efficacy as compared to college students not diagnosed with ADHD. Additionally, college students with ADHD diagnoses struggle to obtain effective treatment options for their ADHD symptoms. Specifically, pharmacological interventions are effective in mitigating ADHD symptoms; however, adverse effects of stimulant medications (i.e., increased/decreased appetite, headache) impact medication adherence in college students with ADHD. Neurofeedback is a non-invasive, drug-free intervention that uses the theories of biofeedback and cybernetics to increase self-regulation of brain functions.

The purpose of this dissertation study was to examine differences in college student participants' scores on inattention, hyperactivity, impulsivity, self-concept, depression, anxiety, and self-efficacy measures over time when exposed to the neurofeedback intervention. The researcher employed a quasi-experimental, one group, time series design to explore differences in levels of symptomology in 11 participants over four assessment points. The results identified participants' scores in inattention ($p = .016$), hyperactivity ($p = .017$), self-concept ($p = .008$), depression ($p = .004$), and anxiety ($p = .018$) significantly decreased of the course of the intervention (16 neurofeedback sessions). Moreover, the participants' self-reported levels of academic self-efficacy increased significantly over time ($p < .001$). The findings for the current study provide practical, professional, and public policy implications, expanding the neurofeedback training and ADHD literature.

Dedicated to my father, my strength, my motivation.

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CHAPTER ONE: INTRODUCTION

Approximately 6-8% of adults in the United State have a diagnosis of Attention Deficit Hyperactivity Disorder (ADHD). Moreover, 11% of children in the United States have an ADHD diagnosis with 66% of those with ADHD diagnoses retaining their symptoms into adulthood (Children and Adults with Attention Deficit Hyperactivity Disorder [CHADD], 2016; Faraone Biederman, & Mick, 2016). Children with ADHD are more likely to struggle academically and are more likely to be placed in exceptional education classes than children not diagnosed with ADHD (Barry, Lyman, & Klinger, 2002; Loe & Feldman, 2007). Further, children with ADHD show deficits in executive functioning which has been defined as the ability to maintain the cognitive abilities necessary to engage in goal-directed behavior, leading to a lack of planning, organizing, or problem solving (Biederman et al, 2004). In addition to issues with academic achievement and cognitive functioning, children with ADHD tend to struggle with social and emotional issues as well.

Adults with ADHD face similar challenges and are at risk of higher levels of stress, work impairment, and marijuana dependence (e.g., Combs, Canu, Broman-Fulks, Rocheleau, & Nieman, 2015). Contrary to children, adults with ADHD are able to choose work environments conducive to their ADHD symptoms, thus coping with their symptomology by incorporating it into their daily lives. Many college students with ADHD are unable to cope with their ADHD symptoms in the same way as they are in an environment in which they are expected to manage excessive activity. Thus, college students need to find ways to mitigate their ADHD symptoms in order to adapt to the classroom environments in college. As a result, many college students with

ADHD have increased incidence of (a) social impairment, (b) sleep disorders, (c) depression, (d) suicidality, (e) anxiety, and (f) academic difficulties (Buchannan, 2011; Gaultney, 2014).

Statement of the Problem

Universities may have structures in place to assist college students diagnosed with ADHD such as classroom accommodations through student accessibility/disability services offices, counseling and mental health services through counseling and psychological services offices, and physical services and medication prescriptions through student health services offices. A specific issue with medication accessibility to college students involves a lack of willingness of psychiatric nurses and medical doctors at a university to prescribe medications to students with ADHD (Thomas, Rostain, Corso, Babcock, & Madhoo, 2016). Psychiatric nurses and medical doctors at a university reported that they felt comfortable that they could identify an individual with ADHD and could properly diagnose the disability; however, they were less comfortable with prescribing medication to the students and were more comfortable with referring the students to an outside practitioner for additional evaluation (Thomas, et. al, 2016). The challenge in receiving mediation can be an added barrier for college students to receive help for their ADHD symptoms as some college students may not have insurance that covers an outside practitioner, or may not be able to drive to an off campus site to get medication. Thus, college students with ADHD are in need of more accessible treatments for their ADHD. Another issue with pharmacological intervention for ADHD symptoms are side effects. Stimulant medications such as Ritalin or Adderall (most often used in the treatment of ADHD) carry with them side effects that range from drastic changes in appetite to headaches, leading to college students discontinuing their medication (Cunill, Castells, Tobias, & Capella, 2016) or self-

medicating to cope with their ADHD symptoms. Thus, an intervention is needed to treat the symptoms of ADHD in college students without adverse side effects.

Neurofeedback (NF) is different than pharmacological interventions in that the side effects of NF are limited to increased feelings of tiredness, and the benefits are long lasting. Meyers and Young (2012) noted that NF is a drug free, non-invasive intervention that should be given more attention in the counseling literature. In addition, NF has shown efficacy in mitigating ADHD symptoms in children with ADHD with Cohen's *d* effect sizes ranging from .80 (Leins, Goth, Hinterberger, Klinger, Rumpf, & Strehl, 2007) to 2.08 (Duric, Assmus, Gundersen, & Elgen, 2012). The current study sought to add to the counseling and NF literature by expanding the research to adults with ADHD (a far less studied population), addressing the needs of college students with ADHD.

Significance of the Study

According to Ray and colleagues (2011), only six percent of the articles published in counseling journals explored the efficacy of counseling interventions. Thus, this study adds to the counseling literature by contributing to the intervention based research in the field as well as by providing a novel intervention for counselors to incorporate into research and practice. Providing research supporting the efficacy of NF may shift the overall attitude toward NF, generating more practical and research interest in it as an intervention. As college students with ADHD are also at higher risk of misusing stimulant medications for the purposes of cognitive enhancement and weight loss (Weyandt et al, 2014), providing evidence for a non-invasive and drug free alternative to stimulant medication may lessen the prevalence of stimulant medication abuse in college students with ADHD.

This study adds to the extant literature on NF with ADHD, depression, anxiety, and self-efficacy by providing data on these constructs and how they change or remain the same over the course of 16 sessions of NF. Moreover, the current investigation also adds to the research on therapeutic interventions to assist college students with ADHD, addressing the gap in the literature of meeting the needs of this population by providing a non-invasive and drug free intervention for ADHD symptoms. The results of this study may spark future research on identifying a causal relationship between NF sessions and changes in ADHD symptomology.

Specifically, implications for this research study include utilizing NF in conjunction with counseling. As NF focuses on the physiological factors associated with maladaptive behaviors in individuals, incorporating NF in addition to counseling may assist counselors in the psychotherapeutic process. Clients, especially with histories of trauma and neglect, may have a difficult time establishing a trusting relationship with their therapists and may be less willing to open up in counseling (Cohen, Mannarino, & Deblinger, 2006). However, utilizing NF with clients may increase feelings of calmness and relaxation, thus allowing clients to feel more comfortable with their counselors in session, allowing therapy to move faster. For example, Trauma Focused Cognitive Behavioral Therapy (TF-CBT; Cohen, Mannarino, & Deblinger, 2006) is a modality of psychotherapy that is tailored to treat individuals who have experienced a significant trauma. TF-CBT is organized into stages in which counselors prepare clients to process their trauma by (a) providing psychoeducation about the physiological effects of trauma, (b) teaching relaxation techniques to self-regulate when emotions surrounding the trauma are high, and (c) developing coping skills to manage emotions surrounding the traumatic experience. Theoretically, NF may have the same effects on individuals suffering from trauma as the initial

stages of TF-CBT as the purpose of NF is to improve self-regulation within the brain. Counselors may utilize NF in addition to TF-CBT with children and adults who have experienced trauma to assist them in preparing to process their traumatic experience by "teaching" the brain to regulate itself with NF and by teaching coping skills through counseling. Once clients have established a foundation in which they are able to regulate their emotional arousal, they will be able to process their trauma in psychotherapy.

Operational Definition of Terms

In order to ensure the constructs observed in this study are consistent with those noted in the literature, the researcher has operationally defined the constructs of interest. The operational definitions of the key terms in this study are provided in the following sections, providing continuity throughout the document. Additionally, the following definitions will offer clarity of the terms.

College Student

For the purpose of the study, the term College Student was used to describe an individual who is over the age of 18 and is enrolled in at least one class at an institution of higher education. Individuals who met the definition of college student were eligible to participate in the study. Individuals who were not enrolled in classes, were in high school, or were under the age of 18 were not be eligible to participate in the study. Participants included individuals enrolled full time or part time in classes and were enrolled at a four-year institution or a community college or trade school. Recruitment occurred at colleges in the central Florida area and included two and four year institutions of higher education.

Neurofeedback Training

Neurofeedback refers to the process of providing feedback to the brain in order to manipulate brainwave activity. Neurofeedback involves measuring brainwaves through electrodes or electrode caps attached to the scalp, and providing audio or visual feedback to an individual based on their brainwave activity as it is measured by the electrodes. There are various neurofeedback types and systems; however, the system used in this study was the NeurOptimal 2.0 system manufactured by the Zengar Institute (2013). Although the NeuOptimal system is similar to Z-Score Neurofeedback, which provides feedback based on brainwaves exceeding two standard deviations of the individual's mean activity, the Zengar institute does not divulge the particulars of how the NeurOptimal system operates. The NeurOptimal system provided audio feedback in the form of slight interruptions in the music the participants listened to. Thus, for the purpose of this study, NF was defined as brainwave feedback per the NeurOptimal system operation protocol.

Attention Deficit-Hyperactivity Disorder

Attention Deficit/Hyperactivity Disorder is a disorder characterized by inattention, hyperactivity or a combination of the two in children, adolescents, and adults. According to the DSM-5 (American Psychiatric Association, 2013), to meet the diagnostic criteria for ADHD, one must meet six or more symptoms of inattention, or six or more symptoms of hyperactivity with the symptoms being present before the age of 12. Additionally, the symptoms must be present in more than one environment, and interfere with quality of life. For the purpose of this study, ADHD diagnoses were verified by a treatment letter from a mental health professional. Further, ADHD symptoms were measured by participant self-reported responses on the *Conner's Adult*

ADHD Rating Scale (CAARS). The CAARS measured ADHD symptom severity in four subscales: (a) inattention, (b) hyperactivity, (c) impulsivity, and (d) self-concept. The researcher used the subscale scores for each participant to measure their level of ADHD symptomology.

Depression

Depression is a mood disorder characterized by persistent sadness and lack of energy. College students with ADHD are more likely to suffer from depressive symptoms than college students without ADHD diagnoses. Thus, the study measured depressive symptoms by participants' scores on the *Beck Depression Inventory II* (BDI-II). The BDI was developed to match the DSM-IV diagnostic criteria for depression. The BDI consists of 21 items that each relate to the symptoms of depression. The higher participants score on the BDI, the higher their level of depressive symptoms (Beck, Steer, & Brown, 1988).

Anxiety

Anxiety is characterized by excessive worry. College students with ADHD are more likely to suffer from symptoms of anxiety. Thus, the researcher measured anxiety symptoms with the *Beck Anxiety Inventory* (BAI; Beck & Steer, 1996). The BAI assesses the physical and cognitive symptoms associated with anxiety. The higher participants score on the BAI, the more symptoms of anxiety they possess (Beck & Steer, 1996).

Academic Self-Efficacy

Generally, self-efficacy refers to one's confidence in completing a specific task. Academic self-efficacy refers to the beliefs individuals have in their ability to complete academic tasks. As college students with ADHD are more likely to struggle academically and have lower

self-efficacy as a result, the researcher measured participant academic self-efficacy with the *Self-Efficacy for Learning Form Abridged* (SELF-A). The SELF-A measures students' beliefs in their ability to complete a list of academic tasks. The higher the individuals rate their confidence in completing the task, the higher their level of academic self-efficacy (Zimmerman & Kitsantas, 2005).

Methodology

This study utilized a quasi-experimental time series design (Shadish, Cook, & Campbell, 2002). Time series designs are characterized by multiple measures being made on the same variables over time. In the case of this study, a total of four data collection points (pre, mid, post, and follow-up) were made on the outcome variables (ADHD symptoms, depression, anxiety, and academic self-efficacy). Because there was only one group in this study, there was no random assignment nor was there random selection as participants self-selected to participate in the study, which made the study quasi-experimental (Shadish et al, 2002).

The primary research question guiding this study was: Are there mean rank differences in college students' scores on the *Conner's Adult ADHD Rating Scale* (CAARS), the *Beck Depression Inventory* (BDI-II), the *Beck Anxiety Inventory* (BAI), and the *Self Efficacy for Learning Form-Abridged* (SELF-A) over time when receiving a NF intervention?

Population and Sampling

This study utilized random sampling with inclusion criteria (Gall, Gall, & Borg, 1996). Because all eligible participants in the study had equal chance of participating in the study, the sample was random. The target population, to which the researcher would hope to generalize

results of the study, was all college students in the state of Florida with ADHD. Moreover, because the participants are self-selecting to participate in the study, differences between the participants in the study and the target population also threatened external validity. For example, Pagan, Eaton, Turkheimer, and Oltmanns (2006) found that college students were more likely to participate in a research study if they were labeled by their peers as being needier or self-sacrificing, suggesting that research participants may have specific personality traits that make them more likely to participate in a study. Therefore, individuals that choose to participate in research may have different characteristics than individuals choosing not to participate in research. Internal validity was threatened by treatment attrition. College students have busy schedules and missed NF sessions; therefore, they had to reschedule NF study sessions throughout the course of the study. If participants did *not* complete the total of 16 NF sessions, the ability to attribute change in participants' assessment scores to NF as an intervention would have been weakened.

Participants were students at universities in a Southeastern US state that had seen the recruitment flyers and/or were referred to the study by the Student Accessibility Services or Counseling and Psychological Services offices and had randomly selected themselves to participate in the study. Through screening criteria, interested students were assessed for eligibility for participation. Inclusion criteria for participation in the study included the following: (a) over 18 years of age; (b) enrolled at a college; (c) able to provide documentation of an ADHD diagnosis from a mental health professional; (d) no history of psychosis or psychotic disorders—verified in the treatment letter from the mental health professional and self-report; (e) no recent emotional hospitalizations—within the past month, verified by self-report;

(f) not currently pregnant; (g) no implanted electrical medical device such as a pacemaker; (h) no severe skin allergies; and (i) is able to speak, read, and understand English as all of the assessments are in English.

Recruitment

To expand the potential participants in this study, the researcher recruited from multiple colleges in a Southeastern US metropolitan city. Recruitment methods included posting flyers in each college student disability services or equivalent office, emailing students via list serves, placing flyers in the resident halls, presenting at local mental health counselor meetings, placing flyers in the office of Wellness and Health Promotions, passing out flyers outside of Psychology classes, placing flyers in the student union break room, and obtaining referrals from the Counseling and Psychological Services office.

As it was impossible to know for sure how many individuals were exposed to the study recruitment flyers, the researcher was unaware of and cannot report a response rate. However, in the 2014-2015 school year, there were 60,810 students enrolled at the large University in the southeastern United States. Statistically, between two percent and eight percent of college students are diagnosed with ADHD (Weyandt & Dupaul, 2013; Weyandt, Linterman, & Rice, 1995); therefore, there were potentially between 1,216 and 4,865 students on campus diagnosed with ADHD. Over the course of the two semesters of recruitment, 18 students expressed interest in participating in the study. However, due to ineligibility, scheduling conflicts, and overall attrition, 11 students completed all 16 sessions and the 4 week follow up.

Data Collection Procedures

Each round of data collection for the study was conducted over a total of 12 weeks with 8 weeks of NF sessions and a 4 week post-NF follow-up. The timeline for the study was as follows: (a) there were two total semesters of data collection (Summer and Fall 2016); (b) recruitment was ongoing until the conclusion of NF sessions in the fall semester (12/4/16); (c) summer data collection began the week of 5/23/16 and fall data collection started the week of 9/12/16. Midpoint assessments for each round of data collection occurred four weeks later and post assessments four weeks after the midpoint assessments; and (d) four weeks after the final NF session, participants came in for a follow-up assessment session in which they completed their assessments again. Participants attended a total of 16 sessions of NF over the course of 8 or more weeks with 1-2 sessions per week. Assessments were administered at the first, eighth, sixteenth session as well as at the four week follow-up meeting. In addition, $10.00 gift cards were given to participants at these four data collection intervals as well.

Study Funding

The Association for Assessment and Research in Counseling (AARC) 2016 *Scholarship Grant* provided funding for the gift card incentives, assessments, and printing costs. This grant was awarded to the researcher in the amount of $1,778.25 after the researcher submitted an application outlining the research protocol of the study. The purpose of this scholarship grant is to encourage research in the counseling field on assessment and client outcomes. Additionally, the NeurOptimal system to be used in this study was loaned to the researcher by the Zengar Institute for the purposes of conducting research. The researcher's co-chair, a certified

neurofeedback professional, petitioned the Zengar Institute for a loaned machine for the purpose of the researcher's dissertation study.

Instrumentation

The data collection packet included four measures: (a) the *Conner's Adult ADHD Report Scale Brief* (Conners, Erhardt, & Sparrow, 1999), (b) the *Beck Depression Inventory-II* (Beck, Steer, & Brown, 1996), (c) *the Beck Anxiety Inventory* (Beck, & Steer, 1990), and (d) *Self-Efficacy for Learning Form-Abridged* (SELF-A; Zimmerman & Kitsantas, 2005). In addition, the first data collection packet (first session) also included a psychosocial inventory, tracking the participants' age, ethnicity, gender, and physical, emotional, and substance abuse histories.

Conner's Adult ADHD Report Scale Self-Report Short Form

The Conner's Adult ADHD Report Scale Self-Report Short Form (CAARS-S:S; Conners, Erhardt, & Sparrow, 1999) was developed in 1999, is a 26 item, Likert-type, self-report measure of ADHD symptoms. The CAARS was normed on a non-clinical sample of 1,026 adults ranging in age from 18 to 80 years old. The authors used ANOVAs to compare differences in CAARS scores based on age and gender. Because the authors found some significant differences in scores based on these factors, they are taken into consideration in the scoring of the measure.

The version of the CAARS used in this study was the self-report, short form (CAARS-S:S) as the researcher included four assessments and wanted to avoid testing fatigue by reducing the number of items participants completed. There are longer forms and observer forms available; however, for the purpose of this study, the most feasible version was the short, self-report version. The CAARS has four subscales: (a) inattention, (b) hyperactivity, (c) impulsivity, and (d) self-concept. The internal consistency reliability of the CAARS is strong with subscale

alphas ranging from .80-.92. Test retest reliability (one month between administrations) yielded a correlation of > .8. The CAARS was compared to the *Wender Utah Rating Scale*, another ADHD scale, and showed a moderate relationship (subscale correlations ranged from r = .3-.6). Moreover, Conner's and colleagues used the structured interview (based on the DSM-IV-TR) with the CAARS and the CAARS correctly identified ADHD diagnoses 87% of the time. The CAARS assessment has also been used in numerous studies on adults with ADHD, including studies evaluating the efficacy of NF on ADHD symptoms.

Beck Depression Inventory-II

The *Beck Depression Inventory-II* (BDI-II; Beck, Ward, Mendelson, Mock, & Erbaugh 1961; Beck, Steer, & Brown, 1996) is a 21-item, self-report measure of depressive symptoms. The original BDI (Beck et al, 1961) items were based on 21 symptom attitude categories which were derived from Beck's clinical observations of symptoms of depressed individuals. The BDI was normed on a clinical population of 400 outpatient and inpatient individuals at a University Hospital. These individuals were 60% female, and 64% White. Participants in this study were only categorized as either White or Black. The assessment was read aloud by the researchers, who recorded participants responses by circling the response the participant identified as most salient at the current moment for them. Participants were also interviewed by psychiatrists who had come to a consensus as to how to diagnose depression from the *Diagnostic and Statistical Manua*l (DSM). The researchers found a significant relationship between each of the items on the inventory and the overall score (p < .01), indicating strong internal consistency and reliability of the measure. The researchers also compared participants' self-report *Depression Inventory* and clinician administered *Depth of Depression* ratings and found a significant positive relationship

in symptom self-reported and clinician rated severity ($p < .001$), supporting sound validity with these data.

The BDI-II is a revised version of the BDI that includes clearer statements and was created to make self-reporting easier for subjects. The BDI-II includes questions on suicidality which the research assistants were trained to scan for. If an individual provided an answer other than "0-I do not have any suicidal thoughts or plans", the RA contacted the researcher and completed a SLAP assessment. If the participant needed to be placed under the Baker Act, Community Counseling and Research Center (CCRC) protocol would have been followed and UCF police would have been called to escort the individual to the nearest hospital. The reliability of the BDI is strong with an alpha >.8 and the authors compared the BDI to the *Hamilton Rating Scale for Depression* (HRSD) and the correlation was moderate ($r = .6$). The BDI has been widely used in the research on depression and in most studies utilizing NF to decrease depressive symptoms.

Beck Anxiety Inventory

The *Beck Anxiety Inventory* (BAI; Beck, & Steer, 1990) is a 21-item self-report measure of anxiety symptoms. The BAI was created from an 86 item pool that were drawn from extant anxiety scales including the *Anxiety Checklist*, the *Physician's Desk References Checklist*, and the *Situational Anxiety Checklist*. The authors selected the 21 items for the BAI by conducting numerous rounds of item analysis including reducing items based on their similarity to one another and their validity after conducting a factor analysis. The BAI is scored by summing the total numbers correlating to the responses the participants choose. The larger the sum, the more symptoms of anxiety present. The internal consistency and test-retest reliability of the BAI is

sound with an alpha of .92 and test-retest correlation of .75. The authors compared the BAI to other measures of anxiety and found that there were moderate relationships amongst the measures (r = .5). Additionally, the authors sought to compare the BDI and BAI to ensure there was no overlap in the measures. As depression and anxiety may manifest in the same ways, the BDI and BAI are good to use together because they are independent of one another and each measure what they are intended to measure without overlap. Although most of the studies on NF and anxiety utilize specific anxiety disorder scales (e.g. the *Yale-Brown Obsessive Compulsive Scale for Obsessive Compulsive Disorder*), the BAI is often used with the BDI because of their construct reliability.

Self-efficacy for Learning Form-Abridged

The *Self-efficacy for Learning Form* (SELF-A; Zimmerman & Kitsantas, 2005) is a 19-item self-report, Likert-type, measure of self-efficacy for self-regulated learning. That is, the SELF-A measures students' perceived responsibility and ability to take control of their learning, including items that ask about students' ability to take notes in class, or if they do not understand something, their ability to get the information they need. The answers are on a 100 point scale from 0—I definitely cannot do this, to 100—I definitely can do this. The authors have yet to complete reliability and validity analyses on SELF-A scale; however, they report that the communalities of the items in the factor analysis were all above .9, identifying that the items relate well to one another. Further, the authors compared students' responses on the SELF to their teacher's perceptions of the students' self-efficacy and found a strong relationship between the students' responses and the teacher's perceptions, suggesting the measure is moderately

valid. The SELF-A encompasses the construct of self-efficacy for college students and has been normed on college students with ADHD.

Data Analysis

The researcher conducted a Friedman's Analysis of Variance (ANOVA) for each of the dependent variables of interest. A Friedman's ANOVA (Friedman, 1937; Friedman, 1940) was selected to analyze the data because the data collected did not meet the assumptions for a parametric analysis. The data did, however, meet the assumptions for a Friedman's ANOVA which include the following: (a) one group is measures three or more times; (b) the group is a random sample from the population in that all eligible participants had equal opportunity of participating in the study; (c) the dependent variable is measured at the ordinal or continuous level; and (d) the sample does not need to be normally distributed (Daniel, 1990). The researcher used the inattention, hyperactivity, impulsivity and self-concept subscales of the CAARS:S-S; in addition to the BDI, BAI, and SELF-A total scores in the analyses for a total number of 7 dependent variables on which the researcher ran Friedman's ANOVAs.

Ethical Considerations

The researcher obtained relevant approval from the University's Institutional Review Board (IRB) and took additional precautions to ensure the safety of the participants in the study. As part of the IRB approval process, the researcher provided an explanation of the research study protocol, instrumentation, and recruitment documents for the board to review. Participants were made aware of the risks and benefits of participating in the study and were provided an informed consent document that outlined their rights as participants in the research study. Further, to

protect the privacy and confidentiality of the participants, the researcher assigned each participant an identification number that the researcher used rather than the participant's name to identify the participant's data. The researcher also kept the data collected in the study in a locked cabinet in the researcher's locked office. Participants were able to withdraw from the study at any time.

Limitations

Shadish and colleagues (2002) note some potential threats to validity in this study, including maturation, alternative treatment, and the placebo effect. The threat of maturation calls into question whether the participants' scores on the assessments would have changed even if they hadn't been exposed to the intervention. Because Conners and colleagues (1999) conducted their test-retest reliability test with a month between the test and retest and found that the scores were stable across time, maturation may not be a threat to this study. However, a way to combat the threat of maturation in future studies would be by adding a control group for comparison. Alternative treatment (e.g., medication, counseling) was another threat to the validity of this study. One participant began taking medication in the middle of the study and that may have impacted the results of the participant's assessments. Finally, participants may have expected to get better or felt socially obligated to get better and as a result, responded more positively on the assessments.

Other limitations to this study include a lack of a control group. Shadish and colleagues (2002) state that causality is hard to determine with a one-group pretest-posttest design and suggest that a control group be added to increase the strength of the design. An additional limitation to the study is the sample size. Although a sample of 11 participants is sufficient to

conduct a Friedman test, such a small sample size may not accurately show differences in scores over time and limits the generalizability of the results. Future studies should incorporate larger samples to more effectively determine statistical significance.

Conclusion

Chapter one has provided an overview of the study. The background of the study was discussed in relation to the problem the study addresses and the significance of the study. Further, the constructs that the study explored were introduced and operationally defined as they were measured in the study. An overview of the methodology of the study was provided. The data collection procedures including sampling, recruitment, instrumentation, and study protocol were discussed. Additionally, data analysis procedures, potential limitations, and ethical considerations of the study were provided.

CHAPTER TWO: REVIEW OF THE LITERATURE

Chapter two presents an overview of the existing literature relevant to college students with ADHD. Specifically, the challenges college students with ADHD face, and the effects of these challenges on their academic achievement is presented. Chapter two also provides a rationale for studying college students with ADHD, extant research on interventions that assist college students with ADHD, a critique of extant methods of reducing ADHD symptoms, and literature supporting neurofeedback (NF) as an effective intervention for reducing ADHD symptoms in college students with ADHD.

The researcher met with a research librarian to thoroughly search the appropriate databases for the literature included in chapter two. The researcher searched PsychInfo, Academic Search Premier, ERIC, PubMed, Wiley Online Library, Taylor & Francis Journals, Sage Journals, Web of Science, Cochrane Library, and Science Direct. The researcher used the following keywords: Neurotherapy, Biofeedback, Attention Deficit Disorder with Hyperactivity, Depression (emotion), Anxiety, Academic Self-Concept, College Students, and Graduate Students.

Introduction

Approximately 6-8% of adults in the United State have a diagnosis of Attention Deficit Hyperactivity Disorder (ADHD; Kessler, 2006). Moreover, 11% of children in the United States have an ADHD diagnosis with approximately 66% of those with ADHD diagnoses retaining their symptoms into adulthood (Children and Adults with Attention Deficit Hyperactivity Disorder [CHADD], 2016; Faraone, Biederman, & Mick, 2016). Over time, the diagnosis of

ADHD has shifted from its introduction into the second edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-II) in 1968 as "Hyperkinetic Reaction of Childhood"; to its more contemporary "Attention Deficit-Hyperactivity Disorder" in the DSM-5. Moreover, before ADHD was a diagnosis, there were numerous documented examples of what is now classified as ADHD. One of the most popular examples of ADHD before it became a diagnosis was Heinrich Hoffmann's "*Fidgety Philip*". Hoffmann, a German physician, wrote the children's story of Fidgety Philip which outlines the troubles of a child at a dinner table, whose parents try to convince him to be still. The story ends with Philip falling to the floor, toppling over the food that was on the table with him. Philip exhibited many of the characteristic symptoms of ADHD including hyperactivity and impulsivity. Other instances of ADHD-like symptomology appeared in the work of Sir George Frederic Still (1902) who studied children with a Defect of Moral Control which he defined as children who lack the "control of action in conformity with the idea of the good of all" (Still, 1992, p. 1008). Children with a defect of moral control were characterized as having excessive shamelessness, destructiveness, and also had issues with a delay of gratification; the last of which is a part of contemporary ADHD research. ADHD behaviors were also described as disorders of the brain. Tredgold (1908) observed inattentive and hyperactive behaviors in children who had brain damage early in life that led to learning difficulties, which was named Postencephalitic Behavior Disorder. Further, brain damage was attributed to hyperactive behaviors in children and thus a continuum was developed that described brain damage ranging in severity from diseases such as Cerebral Palsy to minimal brain damage. In the 1960s however, critics began to disapprove of the idea that brain damage is the only contributor to childhood hyperactive behaviors and argued that children who did not

have past brain damage or brain illnesses were still experiencing severe hyperactivity, thus leading to the disorder's introduction into the DSM-II.

In addition to the changes in the name of ADHD, the criteria for diagnosing ADHD has shifted throughout the revisions of the DSM. In its debut, ADHD (or "Hyperkinetic Reaction of Childhood") was characterized by distractibility, restlessness, and over activity in young children. Additionally, the diagnostic criteria asserted that the disorder would usually diminish by adolescence. Further, as the DSM shifted into the third edition, the criteria for ADHD shifted as well. The focus of the disorder shifted from the hyperactive aspect of the disorder to the lack of attention. Thus, the American Psychiatric Association (1980) changed the name of the disorder to Attention Deficit Disorder for the DSM-III. Additionally, the DSM-III version of ADHD was the first to differentiate the presence of the disorder with or without hyperactivity. That is, hyperactivity no longer needed to be present in order to diagnose a child with ADD. The lack of hyperactivity as a major focus of diagnostic criteria in the DSM-III was different than the International Classification of Diseases (ICD-9), which continued to focus on hyperactivity as a major symptom of ADHD. The third edition of the DSM was also the first to introduce specific objective diagnostic criteria and cutoff scores for symptoms in addition to exclusion criteria, age of onset criteria, and criteria for duration of the condition. The fourth edition of the DSM (1994) drew from the research in the 1980s that identified different types of ADHD. It was in the DSM – IV that the three subtypes of ADHD (predominantly inattentive type, predominantly hyperactive-impulsive type, and combined type) were identified and distinguished from one another. As the DSM-IV was revised to the DSM-IV-TR in 2000, the symptoms for ADHD in the DSM and the ICD -10 were almost identical, however, the differences remain in the number

of symptoms necessary to provide a diagnosis of ADHD. Furthermore, the fifth version of the DSM (2013) was the first to address the persistence of ADHD into adulthood by providing wording of symptoms that could be expanded to adults' workplaces rather than only school settings in childhood. The DSM-5 built upon the DSM-IV-TR criteria for ADHD diagnoses by providing a separate cutoff for symptom presentation in adults and adolescents than children. That is, children are required to meet six or more criteria to receive a diagnosis whereas adults and adolescents 17 and older are only required to meet five or more criteria. There are stark differences in the criteria for ADHD from its introduction in the DSM-II to the present DSM-5, these differences can be attributed to the research being conducted on individuals with ADHD and the expansion of knowledge about ADHD that comes as a result of the research.

Faraone and colleagues (2016) conducted a meta-analysis on follow up studies examining the persistence of ADHD symptoms in children. Many of the studies included in this meta-analysis found that a significant number of participants retained their ADHD symptoms over time. However, these studies utilized diagnostic criteria that ranged from the DSM-II to the DSM-IV, including a wide range of potential DSM criteria for participants to maintain. Although in Faraone and colleagues' (2016) meta-analysis the authors found that children's ADHD symptoms slightly decrease over time, it should be noted that the studies included in the analysis evaluated symptom retention through the lens of the DSM diagnosis criteria. As many diagnostic criteria for ADHD in earlier versions of the DSM are developmentally inappropriate for adults, the criteria used to evaluate the participants in the included studies may not have used developmentally appropriate criteria for assessing for ADHD in adolescents and adults; thus, reducing the likelihood that an adolescent or adult will meet the criteria long term. In addition,

Karam and colleagues (2015) conducted a follow up study on adults with ADHD ($N = 344$) over the course of seven years examining the persistence of ADHD symptomology. Unlike Faraone and colleagues' findings, Karam and colleagues found that the majority (69%) of participants in the follow up study retained their ADHD symptoms and continued to meet DSM-IV criteria for ADHD in adulthood. These stark differences in findings may be attributed to differences in the diagnostic criteria used in each study. Nevertheless, the number of children and adults with ADHD is high considering the research on negative outcomes associated with ADHD.

Children with ADHD are more likely to have poor grades, poor reading and math standardized test scores, and be placed in exceptional education classes (Loe & Feldman, 2007). Specifically, Barry and colleagues (2002) support the idea that students with ADHD struggle with academic achievement with their study on 66 children with ADHD. The researchers compared 33 children who met the DSM-IV criteria for ADHD (male, $n = 21$; female, $n = 12$) to 33 children without ADHD diagnoses (male, $n = 15$; female, $n = 18$) and found that the ADHD children showed lower scores on all academic subjects tests (basic skills t [65] =4.82, $p < .001$; reading t [65] = 3.60, $p < .01$; writing t [65] = 3.82, $p < .001$; and math t [65] = 4.21, $p < .001$). In addition to academic barriers, children with ADHD also have lower executive functioning (Biederman et al., 2004). That is, children with ADHD lack some cognitive abilities necessary for goal-directed behavior. Some examples of executive functions include planning and organizing, inhibiting an inappropriate response, working memory, cognitive flexibility, and problem solving with a future goal in mind. Children and adolescents with ADHD ($n = 259$), when compared to those without ($n = 222$) had significantly higher instance of executive functioning deficits (EFD) with more than double the number of participants with ADHD

exhibiting EFDs (33%) than those without (12%; $\chi^2[1, 480] = 30.9$, $p < .01$). Further, children with ADHD experience problems in relationships with their peers which are further perpetuated by their behavioral reactions to the problems experienced with peers (Hoza, 2007). As such, children with ADHD are faced with not only academic, but social and emotional challenges as well. Moreover, Currie, Stabile, and Jones (2014) examined the effects of pharmacological intervention on academic or emotional outcomes in children with ADHD and found that although children in Canada showed a sharp increase in stimulant medication use, these children did not show improvement in academic or emotional functioning. Although 30 - 47% of children diagnosed with ADHD take medication (Froehlich, Lanphear, Epstein, Barbaresi, Katusic, & Kahn, 2007), it is concerning that medications may not address the social and academic challenges faced by children with ADHD.

Similarly, adults with ADHD face their own challenges and are at risk for higher levels of stress (Combs, Canu, Broman-Fulks, Rocheleau, & Nieman, 2015), functional impairment at school or work, conduct disorder, and marijuana dependence. Moreover, adults with late-onset ADHD—that were not diagnosed as a child—are likely to show lower prevalence of externalizing problems, and higher Intelligence Quotients (IQ) than those diagnosed in childhood (Agnew-Blais, Polanczyk, Danese, Wertz, Moffitt, & Arseneault, 2016). However, adults with ADHD often develop coping skills to deal with their hyperactive symptomology. As adults have more control of their surroundings, they are better able to choose environments in which their ADHD symptoms are not as problematic (Weiss & Weiss, 2004). Children with ADHD have issues in the classroom, where they are expected to hinder their activity, and pay attention to the teacher. Adults with ADHD are able to choose their work environments and may choose

environments that fit their needs. College students are in classrooms and are expected to pay attention and manage excessive activity. Specifically, college students with ADHD face unique challenges and have more difficulty with organization, setting goals, social impairment, and sleep than college students not diagnosed with ADHD (Buchannan, 2011; Gaultney, 2014). In a study examining overall wellbeing of college students with ADHD, Buchannan (2011) compared wellbeing scores of college students who had reported a prior diagnosis of ADHD (n = 34) and those who did not (n = 283). The researcher found that students reporting an ADHD diagnosis scored significantly lower on overall wellbeing (t [315] = 3.6, $p < .001$), perceptions of environmental mastery (t [315] = 2.3, $p < .05$), personal growth (t [315] = 3.4, $p < .001$), purpose in life (t [315] = 4.6, $p < .001$), and self-acceptance (t [315] = 2.1, $p < .05$) than those who did not report an ADHD diagnosis with the latter four variables being subscales of the total wellbeing scale. It should be noted that the results for purpose in life are consistent with the extant literature on college students with ADHD. Further, Gaultney (2014) administered a survey to freshman college students on their sleep patterns and their ADHD symptomology and found that college students with ADHD diagnoses reported less sleep during the weekday than college students without ADHD (t [1084] = -2.1, $p < .05$). In addition, Fedele and colleagues found that gender differences exist in college students with ADHD in that women in college with ADHD experience more inattentive symptoms and have more problems with home life, social life, education, money management, and daily life activities (Fedele, Lefler, Hartung, & Canu, 2012).

Depression in College Students with ADHD

Most salient in the literature on college students with ADHD is the prevalence of depression, anxiety, and problems with academic achievement. Specifically, Harrison and

colleagues (2013) found that college students experiencing stress, depression, and anxiety at high levels are more likely to exhibit ADHD symptomology; thus, making misdiagnosis on college campuses common due to the comorbidity and similarity in expression with ADHD, depression, anxiety, and stress. The authors stress the importance of assessing for depression, anxiety, and academic stressors in college students who exhibit ADHD symptoms. Further, Kearns and Ruebel (2011) examined emotional regulation in adults with ADHD. The researchers found that there are gender differences in ADHD presentation in adults with women scoring higher on negative emotion scales (as defined by the *Attention-Deficit Scales for Adults*; ADSA-Emotive Scale) than men. Additionally, irrespective of gender, the researchers found that college students with ADHD scored higher on negative emotion (F [2,170] = 7.29, $p < .01$; $\eta^2 = .07$). The results of these studies further support the evidence that college students with ADHD score different on measures of executive functioning, depression, and anxiety, than those without ADHD.

Specifically, the literature on depression in college students with ADHD further supports the notion that college students with ADHD are in need of support for their depressive symptoms. An example of such literary support includes Patros and colleagues' (2013) study on college students with depression and hyperactive and inattentive symptoms. The authors surveyed college students on their ratings of depression, suicidal ideation, self-harm attempts, and hyperactive/inattentive behaviors and found that students with more hyperactive and inattentive behaviors were more likely to have more severe depression scores and greater prevalence of suicidal thoughts (t [1054] = 3.89, $p < .001$, $R^2 = .25$) and suicide attempts (t [1054] = 3.74, $p < .001$, $R^2 = .12$). These results identified a strong correlation between suicidal behaviors and ADHD symptoms. Similarly, Van Eck, Ballard, Hart, Newcomer, Musci, and

Flory (2015) sought to add to these findings by addressing specific mechanisms that contribute to suicidal ideation in college students with ADHD. These authors found through path analysis that depression was a significant mediator of the association between ADHD and suicidal ideation with approximately 33% of the variance in the relationship between ADHD and suicidal ideation being accounted for by depression. Further building upon the depression in college students with ADHD literature, Meinzer and colleagues (2015) found that ADHD and depressive symptoms are positively related ($r = .44$, $p < .01$). Moreover, they found that parental involvement in terms of maternal and paternal warmth, autonomy, and involvement are significant mediators for depression in college students with ADHD.

Contrastingly, Nelson and Gregg (2012) examined college students with ADHD and college students with Dyslexia. Dyslexia is a learning disorder that makes it hard for an individual to read. Similar to ADHD, Dyslexia is not a result of delayed development or a lack of intelligence; however, academic achievement in children with ADHD and dyslexia may be more difficult. The researchers found no significant differences in depression and anxiety scores between clinical groups (college students with ADHD and dyslexia) and the nonclinical group (college students without a diagnosis of ADHD nor dyslexia). These results are in stark contrast to the results of other studies in this area. A potential limitation of this study that may have impacted the findings is a lack of a formal validation process for the diagnoses. The researchers used self-report assessments and self-reports of ADHD and Dyslexia diagnoses, they may not have found differences in the groups in depression and anxiety because the participants may not have met the full criteria for the disorders they reported having.

Anxiety in College Students with ADHD

In addition to increased prevalence of depression and suicidal ideation, college students with ADHD are at higher risk for anxiety (Anastopoulos et al, 2016). Schatz and Rostain (2006) conducted a review of the literature on comorbid anxiety and ADHD. The authors reported differences in presentation of ADHD symptomology when comorbid anxiety is present and when it is not. Compared to individuals without comorbid anxiety, those with comorbid ADHD and anxiety showed higher levels of aggressiveness in childhood (Brown, 2000), lower levels of self-esteem (Brown, 2000), decreased working memory (Tannock & Schachar, 1995), decreased incidence of Conduct Disorder (MTA Cooperative Group, 1999), and increased prevalence of sluggish cognitive tempo (Carlson & Mann, 2002; Hartman, Willcutt, Rhee, & Pennington, 2004). It should be noted, that the studies examined in Shatz and Rostain's literature review included children rather than adults; thus, challenges, adults with comorbid anxiety and ADHD may differ from challenges children face.

Specifically, college students with ADHD have greater incidence of test anxiety and anxiety surrounding academic achievement (Nelson, Lindstrom, & Foels, 2014; Prevatt, Dehili, Taylor, & Marshall, 2015). Jarrett (2016) examined anxiety and ADHD in college students as it relates to executive functioning and found that students with comorbid anxiety and ADHD showed less executive functioning—as defined by problem solving, time management, emotion regulation, restraint, and motivation—than students with ADHD and anxiety separately. Using structural equation modeling, the results identified deficits in executive functioning were most closely related to inattention and hyperactive/impulsive symptoms and anxiety.

Specifically, test anxiety saturates the college student with ADHD literature. Hembree (1988) conducted a meta-analysis on the construct of test anxiety and found that test anxiety has a relationship to self-esteem, fears of evaluation, and other forms of anxiety. Supporting the relationship between anxiety and self-esteem, Dan and Raz (2015) examined ADHD, test anxiety, and self-esteem in female college students with ADHD. The authors matched 25 college students with ADHD to 30 control participants and administered questionnaires based on the constructs of self-esteem and test anxiety. Participants with ADHD reported higher levels of test anxiety (t [53] = 5.98, $p < .001$; $d = .63$). Further, participants with ADHD reported lower levels of self-esteem than the control group (t [53] = -4.33, $p < .001$; $d = .5$). The results of this study provide support for the relationship between ADHD symptoms, anxiety, and low self-esteem in college students.

In addition, Lewandoski, Gathje, Lovett, and Gordon (2013) examined differences between college students with ADHD and those without in their reading skills, and anxiety during a high stakes test. The researchers found that although there were no significant differences between groups on reading skills, students with ADHD presented with higher test anxiety (t [218] = 5.93, $p < .001$; $d = 0.85$) and perceived themselves as having more difficulty in reading the questions (t [218] = 5.66, $p < .001$; $d = 1.05$) than their peers without ADHD diagnoses. The results identified that although college students with ADHD perceive themselves as having more difficulty reading during a test, their scores were similar to those who do not have ADHD; further supporting the idea that college students with ADHD have lower self-efficacy and self-esteem than those who do not. Moreover, these findings also identified that college students with ADHD have higher test anxiety than their peers without ADHD diagnoses.

Prevatt and colleagues (2015) expanded the literature on college students with ADHD by examining the impact of anxiety on college students with ADHD. The researchers found that college students with ADHD reported higher levels of anxiety than those without ADHD. Moreover, the college students with ADHD that reported higher anxiety expressed that their anxiety is more closely related to their academic factors like studying or test taking, (F [1, 300] = 30.00, $p < .01$; $d = 0.68$) than life in general. In addition to Prevatt and colleagues' findings, Nelson and colleagues (2014) found that college students with ADHD present with higher levels of overall anxiety as well as test anxiety. The findings reported above provide further support for the premise that college students with ADHD are not only in need of generalized anxiety support, but academic anxiety support as well.

Finally, in a large multi-site study comparing college students with ADHD to those without any comorbid disorders, Anastopoulos and colleagues (2016) collected data on ADHD symptomology, mood disorders (anxiety and depression), and externalizing behavior (Anastopoulos, et al, 2016). Symptomology was assessed using the *ADHD Rating Scale, Self-Report* and *Parent Report* scales, *Semi-Structured Interview for Adult* ADHD, *Beck Anxiety Inventory*, *Beck Depression Inventory*, and the *Externalizing Behavior Rating Scale*. Overall, 55% of the ADHD group exhibited comorbidity, significantly more than the non-ADHD group (11%; χ^2 [1] = 96.1, $p < .001$). Moreover, 31% of the ADHD group showed evidence of two or more comorbid disorders, being more prevalent than the non-ADHD group in which only 4% showed evidence of two or more non-ADHD disorders (χ^2 [1] = 58.3, $p < .001$). Further, anxiety disorders were more prominent in the ADHD group as well (χ^2 [1] = 51.6, $p < .001$) with 28.6% of participants with ADHD presenting with anxiety disorders as compared to 3.6% of the non-

ADHD group. Anxiety disorders included generalized anxiety disorder, panic disorder, social phobia, and anxiety disorder not otherwise specified. This study's findings adds to the literature by illuminating the breadth of anxiety disorders college students with ADHD may face and expanding the literature to include forms of anxiety in addition to test anxiety.

Academic Achievement in College Students with ADHD

In addition to increased prevalence of depression and anxiety in college students with ADHD, academic achievement and self-efficacy is yet another area in which college students with ADHD struggle. Academic self-efficacy is defined as judgements of one's capabilities to achieve academic or educational tasks (Bandura, 1977). Tabassam and Grainger (2002) further supported the idea that self-efficacy may contribute to academic achievement. The researchers examined the differences in scores on academic self-concept, academic attributional styles, and academic self-efficacy beliefs in elementary school students with Learning Disabilities (LD), and comorbid ADHD and LD. They found that both the LD and LD/ADHD groups scored lower on the self-efficacy assessments than students not diagnosed with ADHD or LD (F [2, 166] = 18.43, $p < .001$). However, there were no differences between the LD/ADHD and LD only groups. These findings identified that even from a young age, students with ADHD struggle with self-efficacy as it pertains to academic achievement. Academic self-efficacy has a positive relationship to grades and achievement throughout one's development (Caprara, et al, 2008). Thus, children with lower academic self-efficacy are likely to retain their low academic self-efficacy into adulthood (Zimmerman, 1995). Additionally, in a study on the academic self-efficacy of adolescents with ADHD, Major, Martinussen, and Weiner (2012) found that students with ADHD had lower academic self-efficacy (as measured by the *SELF*; Zimmerman &

Kitsantas, 2007) than students without ADHD. Further, female students with ADHD showed the lowest academic self-efficacy of the groups (F [3, 51] = 6.46, $p < .01$; $\eta^2 = .26$). Male adolescents with ADHD had lower academic self-efficacy than females without ADHD but higher academic self-efficacy than females with ADHD.

As noted, college students with ADHD are at higher risk of failing classes, withdrawing from courses, and dropping out of degree programs than students without ADHD (Blase et al, 2009; Heiligenstein et al, 1999; Weyandt & DuPaul, 2013). Moreover, Dupaul and colleagues (2015) examined the differences in self-rated academic achievement in college students with and without ADHD. The researchers found that students with ADHD showed lower academic self-ratings than those without ADHD (F [3, 12335] = 66.61, $p < .001$; $\eta^2 = .016$). Of course, the symptoms associated with ADHD (i.e., inattention, hyperactivity, impulsivity) make academic achievement difficult for students. However, the literature on ADHD and academic achievement has shifted to include other factors such as study skills and self-efficacy for learning as potential covariates in the relationship between ADHD and academic success in students. Advokat and colleagues (2011) found that college students with ADHD, when compared to college students without ADHD, have similar study habits, yet, the students with ADHD had lower high school and college grade point averages (GPAs), withdrew from more classes, and had lower American College Test (ACT) scores. Turnock, Rosen, and Kaminski (1998) examined the differences in academic coping behaviors of students with ADHD and those without. They found that college students with higher ADHD symptomology used fewer academic coping behaviors than those without ADHD (F [7, 135] = 10.47, $p < .001$; $R^2 = .35$). Additionally, expanding Turnock and colleagues' findings, Norwalk and colleagues (2009) found that higher ADHD symptomology

related to lower career decision making self-efficacy (r = -.27, p < .001), academic adjustment (r = -.32, p < .001), and study skills (r = -.25, p < .001), suggesting that various factors, including academic self-efficacy, may influence academic achievement in college students with ADHD.

Additionally, it should be noted that there exists literature supporting differences between the subtypes of ADHD (inattentive and hyperactive/impulsive) and academic achievement with inattentive symptoms predicting academic impairment better than hyperactive symptoms in adults (Frazier, Youngstrom, Glutting, & Watkins, 2007; Rogers, Hwang, Toplak, Weiss, & Tannock, 2011). However, other studies examining the effects of inattentive and hyperactive symptoms on academic achievement show that both inattentive symptoms and hyperactivity in children influence academic achievement (Loe & Feldman, 2007; Merrell & Tymms, 2001). The difference between the former and the latter being that the former studies included adult samples while the latter included children in their samples; which is important to note as hyperactive/impulsive symptoms in adult ADHD are less reported (Millstein, Wilens, Biederman, & Spencer, 1997).

Interventions for the Treatment of ADHD

In light of the aforementioned challenges and negative outcomes associated with ADHD, helping professionals utilize various interventions to help mitigate the symptoms of ADHD. Researchers have long been testing the efficacy of interventions to assist children, adolescents and adults with ADHD. Extant literature on the treatments for ADHD vary from interventions like hypnosis to stimulant medication. The following section presents the literature on treatment options for individuals with ADHD.

Medication is the most common form of treatment for ADHD in children and adults. Cunill, Castells, Tobias, and Capella (2016) conducted a meta-regression on studies utilizing placebo controlled designs to assess the efficacy of medication on ADHD symptoms. The authors found that: (a) medications are effective in reducing ADHD symptoms, (b) participants in studies where concurrent psychotherapy was offered showed better improvements, (c) individuals who received medications were more likely to discontinue their medication than those in placebo groups, and (d) medications were associated with more side effects than placebo groups. These themes reported in Cunil and colleagues' study are supported by other researchers as well.

Prince and colleagues (2006) noted that stimulant medications are the most often used form of treatment for ADHD symptom management in adults. Extant research identifies that ADHD symptoms may be a result of imbalanced neurotransmitters (such as dopamine) in the brain (Preston, O'Neal, & Talaga, 2010). Stimulant medications address the imbalance of dopamine in the brain by inhibiting dopamine reuptake. That is, when neurons release dopamine into a synapse to be absorbed by other neurons, the stimulant medications bind to the neurons to prevent the dopamine from being absorbed back into its neuron of origin, thus creating more dopamine in the brain. There are four classes of stimulant medications that are used to treat ADHD: (a) Methylphenidate, (b) Dextroamphetamine, (c) Amphetamines, and (d) Lisdexamphetamine (Preston, et al., 2010). When prescribed to treat ADHD, each of these medications may be prescribed in an immediate-release or an extended-release form. The main effects of stimulant medications include increased attention and concentration. Additionally, Alpha-2 andregenic agonists such as clonidine and guanfacine may be used to treat irritability

and impulsivity in children with ADHD. Further, because depression is often comorbid with ADHD in children, antidepressants such as Wellbutrin and Strattera may be prescribed. Only antidepressants whose mechanisms of action increase dopamine or norepinephrine in the brain may be effective on ADHD symptoms. For example, antidepressants that are classified as selective serotonin reuptake inhibitors (SSRIs) do not have the same effects on ADHD symptoms as antidepressants that inhibit the reuptake of dopamine. One stimulant medication that shows potential in having a longer duration of effect than most stimulants is Lisdexamfetamine dimeslyate (LDX). DuPaul and colleagues (2011) conducted a double-blind, placebo controlled crossover study on the effects of LDX in college students with ADHD. Twenty-four college students with ADHD and 26 students without ADHD participated in the study. Treatment began with a one week baseline which included no medication, in the following four weeks, participants were administered a placebo, and LDX in 30, 50, and 70mg doses, each for one week. Control participants did not receive LDX at all and only participated in the baseline phase. The researchers found significant differences in ADHD symptom presentation (as measured by the CAARS) between baseline assessment and with each dosage of LDX. Inattention scores were significantly lower (F [4, 84) = 8.88, $p < .001$; $\eta^2 = .30$) as well as hyperactivity (F [4, 84) = 14.7, $p < .001$; $\eta^2 = .41$) and ADHD Index (F [4, 84) = 10.9, $p < .001$; $\eta^2 = .34$). Other researchers (e.g., Adler, et al, 2008; Brams, Giblin, Gasior, Gao, & Wigal, 2011; Faraone, Spencer, Kollins, Glatt, & Goodman, 2011; Findling, et al., 2011) support the efficacy of LDX in reducing ADHD symptoms as well.

Another prescribed and researched medication for ADHD symptoms is methylphenidate (MPH). Researchers have found that MPH is effective in reducing ADHD symptoms in adults

(Bouffard, Hechtman, Minde, & Iaboni-Kassab, 2003; Kooij, Burger, Boonstra, Van der Linden, Kalma, & Buitelaar, 2004; Rosler, Fischer, Ammer, Ose, & Retz, 2009; Spencer, et al, 2005). Although the efficacy of MPH has been researched at length, there are no studies that specifically explore the efficacy of MPH in college students.

Additionally, Weyandt and colleagues (2014) conducted a systematic review of the literature on the efficacy of stimulant medications on ADHD symptoms. They found that medications such as methylphenidate, amphetamines, and LDX are effective in reducing ADHD symptoms in adolescents and adults with ADHD. However, Weyandt and colleagues also explored the phenomenon of stimulant medication misuse in adolescents and adults with and without ADHD. Depending on the population studied, prevalence of stimulant misuse is between 1.7% and 55%. Individuals at higher grade levels tend to misuse stimulant medications at a higher rate which is alarming when considering college students with ADHD. Arria and colleagues reported that 26.7% of college students with ADHD overuse their medications and 15% use other individuals' medications in order to increase attention and help them stay up all night (Arria, Caldeira, O'Grady, Vincent, Johnson, & Wish, 2008). In addition to the increased likelihood of stimulant medication misuse, another issue with pharmacological intervention is long term effects. Craig and colleagues (2015) evaluated the long term effects of stimulant medication when used to treat ADHD. The researchers reviewed the key articles on long term outcomes associated with medication and ADHD. They found that although stimulant medication is effective when used as prescribed in the short term, long-term randomized trials have not been done, thus limiting the ability to determine how effective stimulant medications are in treating ADHD longitudinally.

Craig and colleagues (2015) brought to light another issue pertaining to using medication to reduce ADHD symptoms. The authors state that short term use of medication is beneficial when the medication is taken as prescribed. Medication adherence is a common challenge in adolescence as youth tend to gravitate toward independence and prefer not to take medication for ADHD (Meaux, Hester, Smith, & Shoptaw, 2006). Langberg and Becker (2012) reviewed the literature on stimulant medication in youth with ADHD and found that from nine studies, stimulant medication is effective in improving academic achievement in children with ADHD. However, they found that the studies included in the review had major limitations including the protocol for measuring medication adherence. They call for more stringent forms of measuring medication adherence in studies and more research on medication adherence in children with ADHD. More research is also needed in adults with ADHD and medication adherence as there is a dearth in the literature on this topic. Additionally, Gau and colleagues (2006) conducted a study on 307 children with ADHD examining their medication adherence patterns and their reasons for not adhering to medication. They found that 25.7% of the children involved in the study had poor medication adherence. The researchers then sought to determine the reasons for the children not adhering to their medication routines. They found that 72.7% of children reported forgetting to take their medications as their primary reason, with 20% reporting that a lack of effect of the medication led to them discontinuing, and, 12.7% of children refused to take their medication.

Moreover, Gould and Doucette (2016) examined reasons why college students with ADHD do not adhere to their medications. They found that college students with ADHD are more likely to take their medication on weekdays because of their beliefs that the medication

helps with schoolwork. Additionally, they found that students attributed forgetfulness and side effects to their lack of medication adherence on weekends. McCarthy (2014) reviewed the literature on overall stimulant medication adherence in individuals with ADHD. She found that the beliefs about medication had a large effect on adherence in adolescents and adults with ADHD. Similar to Gould and Doucette (2016), participants in the studies McCarthy reviewed expressed that the pros of taking medication include a reduction in ADHD symptomology, increased productivity at school/work, and improved social relationships. However, the cons reported by the participants in the reviewed studies included the physical side effects associated with stimulant medications, stigma associated with medication use, and the inconvenience of taking medications.

While medication is the most common form of treatment for ADHD symptoms in adults and children, the Multimodal Treatment Study of Children with ADHD (MTA group) suggest that medication, paired with psychotherapy, is the most beneficial in reducing ADHD symptoms (MTA Cooperative Group, 1999). However, between 1987 and 1997, children receiving medication and psychotherapy decreased the number of psychotherapy sessions and increased stimulant prescriptions (Olfson, Gameroff, Marcus, & Jensen, 2003). With that said, adults with ADHD are often referred for psychotherapy services due to comorbid anxiety and depression, or substance abuse (Faraone, et. al, 2000). They types of psychotherapy offered to adults with ADHD varies as presenting concerns may differ within this population. The most common form of psychotherapeutic treatment for adults with ADHD are cognitive and behavioral therapies. Safren and colleagues (2005) explored the efficacy of a Cognitive Behavioral Therapy (CBT) therapeutic intervention with 31 adults with ADHD who were also concurrently taking

medication during the CBT intervention (Safren, Otto, Sprich, Winett, Wilens, & Biederman, 2005). The researchers randomly assigned participants to either the CBT or non CBT groups. All participants continued taking their medication as prescribed regardless of assigned group. They found that participants in the CBT group showed greater improvements in self-report (F [1, 27] = 10.54, $p < .01$) and evaluator reported (F [1, 28] = 8.72, $p < .01$) ADHD symptomology. Thus, supporting the notion that combined medication and psychotherapy is more beneficial than medication alone. Further, Wilens and colleagues (1999) evaluated 26 charts of adults with ADHD receiving Cognitive Therapy (CT) and taking medication as prescribed for their ADHD symptoms. They found that 69% of the participants were "improved" or "much improved" after 24 sessions of CT.

Further, Costello and Stone (2012) call for the use of positive psychology with college students with ADHD. The authors assert that helping professionals in higher education should utilize positive psychology principles to improve self-efficacy by focusing on students' strengths. Although it is important to emphasize students' strengths to increase self-efficacy, positive psychology may not assist in the mediation of the specific ADHD symptoms of impulsivity and inattention in college students. To address specific ADHD symptoms in college students, researchers utilize more cognitive and behavioral interventions. For example, Eddy and colleagues (2015) evaluated the efficacy of a CBT protocol for ADHD in four college students (Eddy, Canu, Broman-Fulks, & Michael, 2015). The researchers utilized a CBT protocol that included eight sessions with four modules. The purpose of the CBT intervention was to provide psychoeducation about ADHD, introduce skills to manage attention span and distractibility issues, and adapt cognitive patterns contributing to the maladaptive symptoms of ADHD. The

participants overall showed marked improvement in their inattention and hyperactivity as evidenced by a mean score reduction on the *Conner's Adult ADHD Rating Scale* (CAARS) of 8.25. Additionally, the participants showed an increase on the self-concept scale of the CAARS, providing evidence that CBT can help in reducing ADHD symptoms and increasing self-concept in college students with ADHD. Although there were only four participants in Eddy and colleagues' study, the promising results provide evidence for a future randomized control trial (RCT) on the efficacy of CBT as an intervention for ADHD symptoms in college students.

Moreover, Fleming, McMahon, Moran, Peterson, and Dreessen (2015) conducted a small scale RCT on the efficacy of a Dialectical Behavioral Therapy (DBT) group intervention for college students with ADHD. Building upon Philipsen and colleagues' research on the efficacy of DBT with adults with ADHD, Fleming and colleagues sought to apply DBT to college students with ADHD. Dialectical Behavioral Therapy was designed to be used to treat Borderline Personality Disorder (BPD), Philipsen (2006) argues that because ADHD and BPD have some similar behavioral components (i.e., impulsivity, emotion regulation), DBT may also be effective in treating ADHD symptoms in adults. Specifically, a DBT skill group intervention may be useful with this population because of its integration of mindfulness and behavioral strategies that may increase attention and decrease impulsivity in college students with ADHD (Philipsen, 2006). Fleming and colleagues assessed ADHD symptoms in a treatment and control group pre and post the nine session DBT intervention. They found that at post assessment, the control group—which received self-guided skills training handouts—did not differ significantly than the treatment group (F [1, 31] = 2.29, p = .14; d = .55). However, participants in the DBT group

showed greater improvement at the three month follow up assessment than the control group with a large effect size (F [1, 31] = 5.82, $p < .05$; $d = .81$).

Yet another form of psychotherapeutic intervention posed by Anastopoulos and King (2015) is a group therapy intervention that incorporates Cognitive Behavioral Therapy as well as mentoring for college students with ADHD to mitigate their symptoms and improve daily functioning. Participants were provided eight weeks of 90 minute group CBT sessions after which, the participants met with mentors for 30 minutes each week. The CBT group sessions included psychoeducation about ADHD, skills training to help mitigate issues with inattention and impulsivity, and time management/ organization strategies. The mentoring sessions included a mentor providing campus resources to individuals and as well as monitoring the student's understanding of ADHD symptoms and progress in learning the skills from the group sessions. Additionally, the mentors assisted the students in applying the skills they learned in group to their daily lives. The researchers found significant improvements in inattentive symptoms (t [42] = 4.81, $p < .001$; d =.76), and total ADHD symptoms (t [42] =3.8, p <.001; $d = .60$).

The aforementioned studies provide evidence of the efficacy of cognitive and behavioral interventions with ADHD in college students. Although psychotherapy provides a holistic solution to the social and emotional challenges of ADHD in college students, CBT does not address the physiological aspect of ADHD. As such, college students may learn the skills necessary to regulate their impulsivity; however, counselors may not be aware of how the neurological aspects of ADHD play a role in therapy. Meyers and Young (2012) acknowledge neurofeedback (NF) as an intervention that addresses the physiological complexities of mental

disorders while also providing an avenue through which counselors may integrate neuroanatomy and neuroscience into clinical counseling practice.

Neurofeedback as a Treatment for Mental Disorders

Neurofeedback (NF), also called neurotherapy, is a clinical application of neuroscience in which the basic principles of biofeedback and cybernetics are combined. Biofeedback is the monitoring of an automatic bodily function in order to raise awareness of the function and assist an individual in gaining control of that function. In NF, the bodily function being observed is the brain's electrical activity. Cybernetics is the study of automatic control systems in machines and living things. In NF, the automatic control system being studied is the autonomic nervous system (ANS) in the brain, the ANS is responsible for controlling bodily functions such as breathing and the heartbeat. Thus, neurofeedback is a form of monitoring the automatic systems in the brain and providing feedback to the brain in order to increase self-regulation of brain functioning (Gunkelman & Johnstone, 2005).

The brain self-regulates blood flow to certain areas through the dilation and constriction of blood vessels. An increase in blood flow to a particular area of the brain has been shown to directly relate to the electrical activity in that area of the brain. Therefore, Electroencephalogram (EEG) activity is directly regulated by the brain itself. Consequently, maladaptive behaviors may manifest in an individual whose EEG patterns are dysregulated. Specifically, in individuals with ADHD, Chabot and Serfontein (1996) found that EEG activity characterized by insufficient alpha and/or theta wave activity in the frontal lobe was more prominent in children and adults with ADHD than in those without ADHD. The frontal lobe is located at the front of the brain and is one of the latest lobes to reach maturity. Additionally, the frontal lobe is mostly associated

with logic, reasoning, attention, focus, planning, motivation, and short term memory. Moreover, alpha and theta brainwaves are associated mostly with relaxation, memories, and emotions. An excess or deficiency of alpha or theta wave activity can lead to difficulties in attention, concentration, problem solving, and relaxation. Thus, an electrical dysregulation in the frontal lobe, specifically with alpha and theta wave imbalance, provides physiological support for the inattentive and hyperactive behaviors associated with ADHD.

As has been established by Sterman (2000) in his early 1960's research, it is possible to train the brain to regulate EEG activity. The brain's electrical activity is a form of behavior, and by providing feedback to the brain on its dysregulated behavior, clinicians may condition the brain to regulate its behavior, thus mitigating the symptoms associated with the dysregulated behavior. The purpose of NF is to determine what the deficits or excesses are in an individual's EEG activity, and provide feedback to the brain to remediate the discrepancies. Clinicians collect quantitative EEG (qEEG) data of the individual's brain activity to interpret and develop an individualized NF training protocol for the individual. Clinicians may compare the qEEG data from a client to a large external database (available from the Journal of Neurotherapy, 2003) to determine which brainwave frequencies should be targeted in NF training. However, there are some types of NF (i.e., sLORETA Z-Score training) that have combined the NF training with the database comparison of qEEG scores in a seamless process. In Z-Score NF training software, individuals' qEEG scores are continuously being compared to a database of qEEG scores from individuals who are similar in demographics. When an individual's brainwave activity is different than the database determined norm, the NF system provides feedback to the brain through visual or auditory avenues. The audio and visual feedback allows the brain to become

aware of how it is dysregulated so that it may function in a more regulated manner. Specifically, clinicians may target "problem areas" for individuals that are related to their symptomology. For example, individuals with ADHD may receive NF protocols that target frontal alpha/theta activity as research shows that individuals with ADHD have dysregulated activity in that area.

Arnold (1999) conducted a systematic literature review on the existing research on alternative treatments for ADHD. In this review, the author listed a total of 23 alternative treatments to medication for ADHD and the research supporting the treatments as well as the limitations of the treatments. Of the 23 alternative treatments, EEG biofeedback (also called neurofeedback) was included on the list and rated as "3: promising prospective data, lacking important control trials with trends suggesting further exploration" (p. 38) on a rating scale from one to six, with six representing treatments that "should be considered established treatment for the appropriate subgroup" (p. 38). It should be noted, however, that Arnold's review was completed in 1999. Since then, numerous controlled trials have been conducted and have shown the efficacy of NF on ADHD symptoms in numerous populations.

Neurofeedback as a Treatment for Depression

College students with ADHD are at risk of experiencing depression at a higher rate than college students without ADHD (Nelson & Gregg, 2012). Much of the research on NF efficacy has been conducted on small samples. Case studies and single case designs populate much of the neurofeedback literature (Decker, Roberts, & Green, 2014; Gracefire & Durgin, 2012; Hammond, 2003; Leddick, 2011); however, the results of studies on the efficacy of NF in the depression literature are promising. Hammond (2005) reviewed the NF and depression literature and concluded that NF has the potential to reduce depressive symptoms by training the functions

in the brain that contribute to depression. Researchers have theorized that depressive symptoms are a result asymmetry in frontal alpha wave activity (Davidson, 1998, Henriques & Davidson, 1991). As such, when utilizing NF with individuals with depression, researchers have incorporated NF protocols that target frontal alpha asymmetry (Hammond, 2000; Rosenfeld, 1997).

Baehr, Rosenfeld, and Baher (2001) examined the efficacy of NF on depressive symptoms in adults, including exploring the impact of alpha–theta neurofeedback on alpha asymmetry. This study incorporated participants that had been provided at least 27 neurofeedback sessions prior to the data collection. The authors collected *Beck Depression Inventory* (BDI; Beck, Steer, & Garbin, 1988) scores from each participant before and after the NF intervention as well as either one, three, or five years after the participant completed NF sessions. The participants in this study included three adult individuals, one male (one year follow-up), and two females (three and five years follow-up). BDI scores were compared from pre NF to post NF and from pre to follow up. The differences in the scores were calculated and the authors found that participants retained their BDI scores from their posttest to the follow-up, providing evidence that the effects of NF can last as long as five years.

Building upon this research by including a pretest, Cheon and colleagues (2015) conducted a one group pretest posttest quasi-experiment examining the effects of NF on adult psychiatric patients' symptomology. This study included adult 77 psychiatric patients with a DSM – IV diagnosis of a mental disorder, patients with a diagnosis of any personality disorder were excluded from the study. The researchers used an audio-visual NF model in which the feedback for participants was provided in the form of an increase in scores and graphs on a

computer game. They trained beta and SMR audio-visually while training alpha-theta activity with audio feedback only. The purpose of the training was to reduce alpha and increase theta and beta activity. Approximately half of the participants in the study received more than 10 sessions of NF (n = 39), with 25 participants receiving more than 20 sessions of NF. Of the 77 participants in the study, 19 participants presented with depressive disorders; however, all participant data were analyzed together regardless of symptomology. The authors utilized the *Clinical Global Impression-Severity* scale which provided a broad overall objective rating of treatment effectiveness on a 7-point scale. Thus, no specific psychiatric disorder was examined, rather, the overall functioning of participants was assessed. The team of researchers each rated the participants on the scale and the interrater reliability was good ($\kappa > .9$). Additionally, for a subjective measure of outcomes, the researchers utilized the *Hill-Castro Checklist* for a rating of symptom improvement. The *Hill-Castro Checklist* provides a broader view of patient functioning by providing a percentage rather than a cutoff score. The researchers used a paired t test to examine the effect of NF on the participants by comparing pre and post CGI and *Hill-Castro* scores on PASW (statistical analysis software). They found a significant decrease in CGI scores after treatment ($p < .001$, no effect size reported). It should be noted that although only 22 participants completed the pre and post *Hill-Castro* assessments, they reported improvements in depression, anxiety, self-esteem, hostility, attention, and hyperactivity scales of the *Hill-Castro* (all $p < .001$) but not for other scales.

Further into the depression and NF literature, Cheon, Koo and Choi (2016) investigated the effects of NF on depressive symptoms and electrophysiological disturbances in 20 adults (female n = 16, male n = 4) with DSM-IV-TR diagnoses of Major Depressive Disorder (MDD).

This study builds upon Baer and colleagues' (2001) study by including a pre- and post-test while also examining the effects of NF on depression specifically in an adult population. The participants in this study were diagnosed by trained psychiatrists using the *DSM-IV Structured Clinical Interview for Depression*. Individuals were not excluded from participation if they were taking medications but were not allowed to begin a new medication regimen over the course of the study. The authors used one total hour of beta and alpha training to increase beta activity (30 minutes) and reduce alpha activity (30 minutes). Participants attended training sessions 2-3 times per week for eight weeks. Assessments (*Hamilton Depression Rating Scale*, HAM-D; *Hamilton Anxiety Rating Scale*, HAM-A; *Beck Depression Inventory*, BDI; and *Clinical Global Impression-Severity*, CGI:S) were administered at the baseline (pre), four week (mid), and eight week (post) time points. The researchers conducted a Repeated Measures ANOVA on the PASW statistical software and found significant improvements in HAM-D, HAM-A, BDI, and CGI-S scores ($p < .005$, no effect size reported). BAI scores did not significantly change but were approaching significance ($p = .01$; Bonferroni adjusted $\alpha = .005$). The results indicate that individuals who are provided a NF intervention over the course of eight weeks are likely to improve in their depression scores. However, a limitation of this study is its lack of a control group, preventing the authors from stating causality or generalizing their results.

Choobforoushzadeh and colleagues (2014) sought to expand the NF efficacy research to individuals who have been diagnosed with Multiple Sclerosis (MS) who have also experienced significant depression and fatigue. The researchers utilized a comparison group (treatment as usual, TAU) experimental design with 24 participants in an Iranian Hospital. Participants in the treatment group received two sessions of NF each week for a total of eight weeks. The

researchers used a similar NF protocol as Choi and colleagues (2011). Procomp 2 Infiniti NF system was used to train the increase of theta activity and the decrease of alpha activity with reinforcement of 15-18hz beta activity. Feedback was administered in the form of a videogame with audio and visual feedback. When beta activity was higher than the predetermined threshold and alpha or theta was lower than the threshold, participants were rewarded by the game being active, if the game was not active, that was indication that the beta, alpha, or theta waves were out of the training range. Assessments included the *Expanded Disability Status Scale* (EDDS; only administered at the first session to confirm MS symptom severity), *Fatigue Severity Scale*, and the Depression Subscale of *Hospital Anxiety and Depression Scale* (HADS). Each of these assessments were administered pre, post, and two months after the end of NF sessions (follow up). The researchers conducted a Repeated Measures ANOVA to determine if there were differences in the assessment scores over time between groups. They found that there is a difference between pre to post to follow up in depression scores for the treatment group (F [2, 21] = 6.5, $p < .005$), and there is a difference between treatment and control group scores on the assessments for pre, post, and follow up for interaction of group and time (F [2, 21] = 13.7, $p < .005$). The mean differences indicated that the treatment group improved whereas the control group scores remained stable across time. The largest improvement was from pre to post assessments in the treatment group, but both groups were stable between post and follow up. The authors reported a small effect size ($d = .29$), indicating that the means of the treatment group were not largely (but statistically significantly) different than the means of the comparison group. Thus providing evidence that the intervention made a significant impact on depression and fatigue in adults with MS and that NF has the potential to improve depression in adults.

To build further upon the depression literature, Choi and colleagues (2011) addressed the limitation of Cheon and colleagues' study by implementing a comparison group in their study design examining the effects of alpha-wave NF on depressive symptoms. The researchers conducted five weeks of mid-frontal alpha targeted NF using the Procomp Infinity asymmetry protocol. The goal of this protocol is to increase right mid-frontal alpha activity and decrease left mid-frontal alpha activity to reduce asymmetry in alpha frequencies across the brain. After the treatment group finished their NF sessions, they were provided additional practice sessions to help them practice retaining their mental states without the assistance of the NF protocol. The comparison group in this study received psychoeducation sessions in which they were administered assessments and provided an interpretation of their results. The participants in the comparison group were also provided psychoeducation on their depressive symptoms. The authors utilized the HAM-D (clinician-rated and verified by two other psychologists) as an objective form of assessment. Subjectively, the authors administered the *Daily Stress Scale*, *Automatic Thought Questionnaire-Positive,* ATQ-P, *Automatic Thought Questionnaire-Negative*, ATQ-N, and the BDI-II to assess participant levels of depression. To analyze the data gathered, the researchers conducted a Repeated Measures ANOVA on the pre and post scores of the assessments. There were no significant pre-training differences between the treatment and control groups; however, they found a significant difference in BDI-II, ATQ-N, and HAM-D scores over time (BDI-II, F [1, 20] = 6.87, $p < .05$; ATQ-N, F [1, 20] = 6.02, $p < .05$; HAM-D, F [1, 20] = 5.96, $p < .05$). The BDI-II and ATQ-P data did not meet did not meet parametric assumptions for a post hoc test, so they used Mann Whitney U tests for each group individually. Post hoc tests determined that the scores in the treatment and control group were significantly

different (ATQ-N, t [21] = -2.27, $p < .05$; HAM-D, t [21] = -2.70, $p < .05$; BDI-II $U = 31$, $p < .05$; ATQ-P $U = 32.5$, $p < .05$; no effect sizes reported). The results identified that NF may be effective in decreasing depression in adults with depression when compared to psychoeducation. It should be noted that there are no NF and depression studies in the counseling literature and that the psychoeducation provided in this study was provided by psychologists rather than counselors. Meyers and Young (2012) further state the need for more research on NF in the counseling literature.

Overall, the literature on depression and depressive symptom reduction with NF is scarce. Further, there is no literature specifically on the efficacy of NF in college students with depression, let alone college students with comorbid depression and ADHD. However, the research that exists shows that NF, regardless of specific protocol, has the potential to reduce depressive symptoms in adults. The current study seeks to build on the depression and NF literature by examining changes in depressive symptoms in college students with ADHD, a population that has not yet been examined in the literature.

Neurofeedback as a Treatment for Anxiety

Moore (2000) conducted a review of the literature on Electroencephalogram (EEG) NF and its use with anxiety symptoms. The literature review included studies that focused on the four most studied types of anxiety, including Generalized Anxiety Disorder, Phobic Anxiety, Obsessive Compulsive Disorder, and Post-Traumatic Stress Disorder. Moore concluded after reviewing the literature on NF and anxiety that the research on NF and anxiety shows promise. Of the eight studies included in this review, the largest sample was 18 in Garrett and colleagues' (1976) study with Phobic Anxiety. Glueck and Stroebel's (1975) study on Obsessive Compulsive

Disorder (OCD) had the least number of participants with a sample of four. Most of the protocols in the review used NF protocols to increase alpha and theta activity and most reported statistically significant increase in targeted brainwave activity. Clinical outcomes included decreases in test anxiety (Garrett & Silver, 1976; $p < .001$), decrease in rumination in OCD (Mills & Solyom, 1974; 22% increase in alpha levels for one of four participants), and decrease in the need for pharmacological intervention (Peniston, 1991; $\chi^2 = 23.26$, $p < .05$, participants in the treatment group significantly reduced their medicine use over the course of NF treatment). The results of these studies show that NF has the potential to be effective in decreasing symptoms of anxiety and the need for medication in individuals with anxiety.

Hammond (2003) conducted case studies on two individuals with Obsessive Compulsive Disorder (OCD) diagnoses. Both 25 years old, the male and female participants were given the *Yale-Brown Obsessive Compulsive Scale* (Y-BOCS) and *Padua Inventories* before and after their respective NF sessions. The female participant received 21 sessions of NF using Hammond's depression protocol. The male participant, who also had an ADHD diagnosis, received 93 total NF sessions, 44 of which specifically targeted beta activity. The results are significant in that they are comparable to effects found in pharmacological intervention studies in which the most commonly used medication for OCD (clomipramine) was shown to produce a 1.33 *SD* improvement in participants on the Y-BOCS (Ackerman & Greenland, 2002). With that being said, the female participant experienced a 3.7 *SD* improvement and the male participant experienced a 3.0 *SD* improvement on pre and post Y-BOCS scores, suggesting that NF was more effective than clomipramine in reducing anxiety symptoms in these two individuals.

However, the design of this study does not allow the researchers to state causation nor are the researchers able to generalize these findings to other adults with anxiety.

In addition, Gracefire and Durgin (2012) completed a study including three individuals who presented with anxiety. Each participant received NF in the form of 19 point Z score Low-Resolution Electromagnetic Tomography (LORETA) training. That is, the clinicians measured brain activity using an electrode cap with 19 points for measuring electrical activity in the brain. LORETA training is specifically different and more sophisticated than from other forms of NF in that it includes a three-dimensional representation of brainwave activity. The researchers measured participant brain activity at their most problematic areas. That is, qEEG data were recorded and reviewed after the completion of NF sessions. Participant 1 (a 30 year old female taking clonazepam for Generalized Anxiety Disorder symptoms) was experiencing excessive activity at 21hz before NF. By the end of one NF session, the participants 21hz activity decreased from 3.32 SD to 2.31 SD. Moreover, Participant 2 (29 year old female with severe social anxiety) showed a decrease in hibeta activity after two 20 minute sessions from 2.96 *SD* to 1.67. Finally, Participant 3 (a 36 year old male presenting with concerns with rumination) completed one 20 minute session of NF, in which his hibeta activity decreased from 3.12 *SD* to 2.27 *SD*. These results identified the efficacy of NF in regulating brain wave patterns; however, they are more anecdotal in nature and lack the statistical, internal, and external validity necessary to draw valid conclusions from the data.

Moreover, the results of Gracefire and Durgin's (2012) study contradict the findings of Kluetsch and colleagues (2014) who found that a single session of NF does not decrease anxiety in participants. In this study, the researchers sought to identify if one session of NF was related

to significant changes in anxiety in individuals with PTSD. In this study, the researchers recruited 21 adults with diagnoses of PTSD as a result of childhood sexual or physical abuse. The STAI was administered to gauge the levels of anxiety pre and post an MRI guided NF session. In this session, participants were scanned via MRI to assess their EEG oscillations, provided one session of EEG NF, and scanned again after the EEG NF. Additionally, the participants received the STAI after the session. The researchers found through a paired *t* test that there were no significant pre to post session STAI score differences ($p > .05$); however, there was an increase in calmness at the end of the session ($t = 2.72$, $p < .05$). These results could be expected due to the fact that participants may not report differences on the STAI after only one session of NF. The differences between these two studies is that in the first study, anxiety was measured by self-report and quantitative EEG data whereas the latter study did not incorporate EEG data and defined anxiety through the results of the STAI measure. The difference in these studies results indicate that although there may be physiological changes that occur after one or two sessions of NF, participants may not be aware of the changes after one session.

Kerson and colleagues (2009) utilized NF protocol that reduced frontal asymmetry in eight adult participants. Excessive alpha wave activity in the frontal lobes of the brain are related to rumination, depression, excessive worry, and repetitive thinking. Frontal asymmetry describes the phenomenon of an imbalance in alpha wave activity in the frontal lobes of the brain, which can lead to an increase in symptoms of anxiety and depression. The participants (five women and three men) all presented with multiple generalized anxiety behaviors or a diagnosis of Generalized Anxiety Disorder. Additionally, the participants were screened for the presence of high alpha activity and asymmetry in frontal sites. The *State-Trait Anxiety Inventory* (STAI) was

administered before the beginning of NF sessions, one week after the NF sessions ended, and at a 6 month follow up. The researchers utilized suppression training and asymmetry training with a 19 point EEG protocol. Participants were instructed to reduce alpha wave activity by 10%. Audio feedback was given to the participants in the form of nine tones indicating the magnitude of their activity. That is, higher pitch of the sound the participants heard was related to higher the alpha activity. Additionally, visual feedback was provided by a line on a screen representing EEG channels. The researchers used a one way ANOVA to compare the scores of the STAI from pre to post, and from pre to follow up. The researchers found that state anxiety was significantly different when compared pre and post to follow up (F [3, 21] = 13.9, $p < .001$). Trait anxiety was also significantly different when comparing pre and post to follow-up (F [3, 21] = 15.51, $p < .001$). Overall, the researchers did not find significant differences from pre to post assessment, but the findings indicate that the participants experienced a significant change in state and trait anxiety between pre assessment and follow up. The researchers did not report the mean scores for each STAI assessment point. The results provide evidence that NF has an effect on state and trait anxiety in adults.

The aforementioned studies investigating the effects of NF on anxiety in adults are limited, with most of the current literature utilizing case study or designs with a very small sample. Although the extant literature provides support that NF may be effective in reducing anxiety symptoms, further research needs to be conducted with larger sample sizes that include demographically diverse individuals. It should be noted, however, that the studies reviewed show that NF has shown efficacy in reducing anxiety symptoms in adults and may, have the same efficacy in reducing anxiety in college students with ADHD.

Neurofeedback as a Treatment for ADHD

ADHD is a common disorder in childhood that research has shown is characterized by maladaptive EEG patterns in the brain. The fact that maladaptive EEG patterns play a role in ADHD symptomology supports the rationale for NF to be used as a treatment for ADHD as NF directly addresses and alters EEG brainwave patterns. Lubar and Shouse in a seminal study (1976) sought to examine the effects of EEG neurofeedback in boys with Hyperkinetic Disorder (the DSM-II diagnosis for ADHD). Based on the theory that Sensorimotor Rhythm (SMR) is both trainable and directly related to relaxation and reduction in muscle tension (Chase and Harper, 1971); Lubar and Shouse sought to reduce over activity in boys with hyperkinetic disorder by training SMR with NF. The researchers found that using NF to train SMR activity in the brain reduced over activity and distractibility in boys with hyperkinetic disorder.

Vernon and colleagues (2004) noted that research should address identifying the best mode of feedback (auditory, visual, combined) to produce results in this population, identifying which training protocol is best, and identify if training procedures have different effects on the different types of ADHD (inattentive, hyperactive, combined). However, the extant research on NF and ADHD in children is somewhat contradictory and there is a need for more methodologically sound studies on the efficacy of NF and ADHD, specifically in college student populations. The following is a review of the recent and relevant literature on the efficacy of NF in children and adults with ADHD.

Neurofeedback as a Treatment for ADHD in Children

Unlike studies conducted on NF and anxiety and depression, much of the NF and ADHD literature, especially with children, includes experimental or quasi-experimental designs with control or comparison groups. Bakhshayesh and colleagues (2011) sought to answer the research question of if NF was more effective than EEG biofeedback in reducing ADHD symptoms in children through a randomized controlled trial. Their sample consisted of 38 children with the International Classification of Diseases (ICD) diagnosis for ADHD (either Hyperkinetic Disorder, ICD-9; or Attention Deficit Disorder without Hyperactivity, ICD-10). The ICD is the diagnostic manual used in Germany, where this study was conducted, and there are few differences between the ICD and DSM – IV criteria for ADHD. Participant ages ranged from six to fourteen years old (M = 9.32, SD = 1.92). Much like other studies on individuals with ADHD, participants were allowed to continue their medication as prescribed, with the caveat that parents were asked to keep medications stable throughout the course of treatment. Children were randomly assigned to the NF and EEG biofeedback groups and were not informed about the specific differences between groups. The Structured Clinical Interview was used to determine a diagnosis and ensure there were no comorbid disorders. Neurofeedback trainings were held two to three times per week (30 mins per session) for a total of 30 sessions (for both groups). Additionally, all parents met with a psychotherapist twice a month for four total sessions receiving psychoeducation. Outcome assessments in this study included the *Structured Clinical Interview* for the DSM-IV, parent and teacher rating scales of the *German ADHD Rating Scale*, a paper and pencil attention test, nonverbal intelligence tests, continuous performance tests, and standardized behavioral observations in the classrooms. The authors found that there were no

significant differences between the groups at the outset of the study. They also found that three children did not complete the study due to loss of motivation or protocol violation. Two ANOVAs were completed, one comparing the groups to one another (between) and one comparing pre vs post treatment (within). The researchers found that parent report scores on the *German ADHD Rating Scale* in both groups significantly decreased over time (total score F [1] = 12.59, $p < .001$). However, there was a difference between the NF group and the EEG biofeedback group in which the NF group total ADHD scores improved with a moderate to large effect size ($d = -.77$) with a p value approaching significance ($p = .06$). For the paper and pencil attention test, again, there was no significant difference in scores amongst treatment groups but all participants scores increased as a result of time (total concentration scores F [1] = 31.75, $p <$ .001). These results identified that NF protocol may not make a difference and that NF and EEG biofeedback are effective in reducing ADHD symptoms and increasing concentration regardless of training protocol.

Bink, Nieuwenhuizen, Popma, Bongers, and van Boxtel, (2015) also utilized a comparison group in their study design; however, rather than comparing NF protocols, the researchers compared NF and medication ($n = 45$) to medical or behavioral treatment as usual (TAU; $n = 26$) group in adolescents with ADHD. The subjects in this study were 71 male adolescents. Inclusion criteria was as follows: (a) spoke Dutch as their native language, (b) were between ages 12 and 24, (c) had a DSM-IV-TR diagnosis of ADHD, (d) had an Intelligence Quotient above 80. Comorbid disorders including Autism Spectrum Disorder (ASD) did not exclude participants from the study. Exclusion criteria included psychotic disorders, and neurological disorders. Because there are sex differences in the EEG spectra of male and female

adolescents with ADHD which would have created an uncontrollable variable, this study did not include female participants. Treatment as usual included participants taking their medications as prescribed or continuing behavioral interventions including CBT or other supportive counseling for the individual or family. Adherence to this treatment was verified by self-report after questioning. Neurofeedback was provided over 25 weeks for a total of 40 total sessions at 30 minutes each. Although not all participants completed the same amount of sessions, 37 participants completed at least 19 sessions. A Biofeedback Certification International Alliance (BCIA) certified psychologist trained the psychologists that conducted the sessions. The aim of the NF protocol used in the study was to increase sensorimotor rhythm (SMR) activity, which is strongly associated with motor activity. SMR typically increases in states of immobility and relaxation, and according to the authors, individuals with ADHD may benefit from increasing their SMR activity. Further, the NF protocol in this study aimed to decrease theta, alpha, and electromyographic (EMG) activity. Electromyographic activity is measured by the electric activity in muscles, thus a reduction in EMG would theoretically relate to an increase in relaxation. Medication type ($\chi^2 = 2.48$, $p = .63$) and dose (F [1, 32] = .57, $p = .46$) were not different between groups at the outset of the study. In addition, there were no differences between the pre-medicated and the non-medicated participants in either group based on *Global Assessment Functioning* (GAF) scores or behavioral measures. The researchers found that in both groups, the ADHD rating scale (inattention $F = 31.57$, $p < .001$; $\eta^2 = .31$; hyperactive/impulsive $F = 13.01$, $p < .001$; $\eta^2 = .16$), *Youth Self Report* ($F = 12.35$, $p < .001$; $\eta^2 = .15$), and *Childhood Behavioral Checklist* ($F = 12.08$, $p < .001$; $\eta^2 = .18$) scores decreased over time with no difference between groups. There was also no difference between medicated and

non-medicated participants as it pertains to the changes in assessment scores. These findings identify that NF paired with medication is just as effective as medication and psychotherapy in reducing ADHD symptoms over time. This study did not, however, examine the sole effects of NF on ADHD symptoms in participants as the treatment group was receiving medication as well as NF training.

Escolano and colleagues (2014) conducted a pilot study specifically utilizing NF with children with ADHD. Participants included 20 children diagnosed with ADHD using the DSM – IV criteria based on semi-structured interview with the parents using the Structured Developmental History portion of the *Behavior Assessment System for Children* (BASC). Participants were not on medication and were not in psychotherapy for at least one month before starting the study. The final sample included 17 participants after three participants did not complete the study (combined type ADHD $n = 10$, inattentive type ADHD $n = 7$). The training procedures for this study included 18 sessions of NF over the course of two months with two or three sessions per week with each training session lasting a total of 20 minutes. The focus of the protocol was to increase upper alpha activity in the frontal sites, each session was recorded and used to inform the protocol for the next session. The *Behavioral Assessment System for Children Parent Rating Scales* (BASC-PRS) and the *Conners Parent Rating Scales Revised* were used as outcome measures in the study. After conducting a *t* test of pre and post scores on the assessments, the researchers found a significant difference in pre and post scores (externalizing problems, $t\ [16] = 3.52$, $p < .005$; $d = .85$; internalizing problems, $t\ [16] = 4.12$, $p < .001$; $d = 1.00$) for the BASC-PRS. No change was found in adaptive skills of the BASC. These results identified that NF has the potential to positively impact parent reports of internalizing and

externalizing behaviors in children with ADHD. Because this study had a small sample size and only one group, the external validity (ability of the authors to generalize their findings) is threatened; however, the large effect sizes indicate that the treatment had a notable influence on the pre to post change in scores.

Similar to Escolano and collegues' pilot study which used parent report measures to assess differences in participants' ADHD symptomology, Duric, Assmus, Gundersen, and Elgen, (2012) utilized parent report measures to assess differences in ADHD symptoms as a result of NF training in children and adolescents. However, the researchers conducted a three group Randomized Control Trial (RCT) with one group taking medication (n = 31), one group provided NF (n = 30), and one combined NF and medication group (n = 30). The sample in this study included a total of 91 children aged six to eighteen in a Child and Adolescent Mental Health clinic in Norway. Participants met the ICD 10 criteria for an ADHD diagnosis and received 30 sessions of NF which included receiving visual feedback in the form of a videogame or movie. The purpose of the NF was to increase beta activity and decrease theta activity. These sessions lasted for 40 minutes, three times per week. Medication was administered as a twice daily dose of one milligram of methylphenidate. Assessments occurred at the baseline and one week after the end of NF sessions. The assessment used in this study included the *Clinician's Manual for Assessment of Disruptive Behavior Disorders – Rating Scale for Parents* (Barkley, 1997). In addition, a medical exam was conducted at the outset of the study to exclude physiological explanation of ADHD symptoms. With no differences between the groups at the baseline, parents reported effects of treatments over time in attention and hyperactivity ($p < .001$). However, there was no difference in scores over time between groups. Thus, these findings

provide evidence that NF is just as effective in treating ADHD symptoms in children as methylphenidate based on parent reports. It should also be noted that the NF group did show almost double pre to post change in attention compared to the other groups (NF t_1-t_2 = 3.1, medication only group t_1-t_2 = 1.5, NF and medication t_1-t_2 = 1.1), this difference in pre to post change was not statistically significant.

Gonzalez-Castro, Cucli, Rodriguez, Garcia, and Alvarez (2015) sought to compare NF and medication in children with ADHD. One hundred thirty-one total participants between ages eight and eleven were split into four groups (control/no medication nor NF, n = 33, NF only, n = 33, medication only, n = 34, combined NF and medication, n = 31). Inclusion criteria included an IQ above 80 and an ADHD diagnosis from participants' own neuropediatrician. The authors did not specify whether the participants were randomly assigned or if they self-selected into their groups. Pretreatment assessment included the *Tests of Variables of Attention* (TOVA), *Attention Deficit Hyperactivity Disorder Adult Assessment Scale* (EDAH), and a Quantified EEG spectrum. The authors did not explain the specific NF protocol used in the study; however, the authors explained that the NF specialist modified the goals and thresholds for each participant, and the participants experience feedback through a videogame. Sessions spanned three months with three sessions per week, each session lasting 15 minutes. Participants in the groups in which medication was administered were given methylphenidate which was administered in doses based on the clinical judgement of the neuropediatricians for each individual participant based on age and weight. After the three months of treatment based on group assignment, assessments were re-administered to participants. It should be noted that the pretreatment TOVA scores were significantly different amongst groups (Wilks' $\lambda = 0.691$, F [18, 339] = 6.906, $p < 0.001$). So, the

researchers controlled for TOVA scores by including the pre TOVA score as a covariate in the posttreatment analyses. The authors found differences between the control group and neurofeedback groups ($p < .001$) and between the control group and combined groups ($p < .005$). However, there was no difference the control group and medication only group ($p = 0.128$). The NF and medication group obtained more benefits, while the NF group improved more in executive control than the medication only group. These results identified that NF and medication may together provide benefits for children with ADHD, and NF may be more effective than medication in improving executive functioning in this population.

The research on the efficacy of NF and ADHD symptoms in children is limited; however, it is more robust than the literature on NF and adults with ADHD. Moreover, of the few studies conducted with adults, even fewer include college students with ADHD in the population.

Neurofeedback as a Treatment of ADHD in Adults

White, Hutchens, and Lubar (2005) suggested that NF is effective in reducing ADHD symptoms in adults from what they found by using brain imaging to compare brains of Adults with ($n = 10$) and without ADHD ($n = 10$) during a task. Participants aged 21-47 (ADHD group), and 22-44 (control group) met the following inclusion criteria: (a) a score higher than 85 on a vocabulary test; (b) no history of neurological or psychotic disorder; and (c) no head injury, substance abuse, or learning disability. Participants with ADHD who were taking medication were evaluated 12 hours after taking their medication. Participants in the control group were not able to take any medications with the exception of birth control pills. Participants wore electrode caps with 19 channels to measure brainwave activity while they completed the *Paced Auditory Serial Addition Task* (PASAT), *Wisconsin Card Sorting Test* (WCST), and the *Integrated Visual*

and Auditory Continuous Performance Test (IVA) after being attached to the EEG. Independent *t* tests were used with a Bonferroni adjusted alpha ($\alpha = .005$) to examine the difference between groups on the tasks. The groups did not differ based on demographic variables with the exception of participants with ADHD having higher inattentive and hyperactive/impulsive symptoms. However, there was a significant difference in performance on the PASAT (t [18] = 5.46, $p < .001$) between the control group (M = 157.7, SD = 21.26) and the ADHD group (M = 94.9, SD = 29.51). These results identified that adults with ADHD have more difficulty with attention, information processing, and memory than do adults without ADHD. Moreover, the authors found that adults with ADHD had increased upper alpha activity during the IVA performance test and that increased theta/beta performance during the IVA test was related to poor attention. Thus, the results supported the extant NF protocols that target theta/beta and alpha bands (Hammond, 2000).

Of the extant research on utilizing NF with Adults with ADHD, Mayer and colleagues are at the forefront. Mayer, Wyckoff, Schulz, and Strehl (2012) investigated the effects of Slow Cortical Potential (SCP) NF on ADHD in adults. Slow Cortical Potentials in the brains of adults with ADHD has been shown to have a relationship with cognitive and behavioral performance (Birbaumer, Elbert, Canavan, & Rockstroh, 1990). Thus, NF targeting SCP in adults with ADHD may improve short-term memory and attention. Mayer and colleagues sought to provide evidence of SCP NF in a total of 20 adults (with ADHD n = 10; without ADHD n = 10). Participants in the control group were matched in age, gender, and IQ. In order to be included in the study, participants with ADHD met the cutoff score of 18 on an ADHD self-rating scale (ADHD-SB), which is a subscale of the *German Assessment Battery for ADHD;* participants in

the control group scored less than 18. Participants in the ADHD group were administered the ADHD-SB—which included inattention, hyperactive, and overall ADHD symptomology subscales—and the *Beck Depression Inventory* (BDI) before receiving 15 NF sessions (1-3 times per week). Participants were also administered the same assessments (ADHD-SB, and BDI) at the conclusion of their NF sessions. The researchers found a reduction in ADHD symptom total scores (t [9] = 2.653, $p < .05$; Cohen's d = -.73), attention (t [9] = 3.597, $p < .05$; d = -.56), impulsivity (t [9] = 2.395, $p < .05$; d = -.6). It should be noted that not only were there reductions in symptoms in the ADHD group, but that the effect sizes are also moderate to large, suggesting that NF has a moderate to large effect on ADHD symptoms in adults with ADHD in comparison to a control group of adults without ADHD.

Mayer and colleagues (2015) sought to answer the research question of whether SCP NF is effective in treating ADHD symptoms in adults' long term. Adults between 18 and 60, meeting DSM-IV criteria for ADHD inattentive hyperactive or combined type participated in the study. Stimulant medication was allowed during participation in the study; however, participants were required to not take their medication within 24 hours of beginning their NF session. Additionally, participants were required to maintain their medication regimen throughout the course of treatment. Participants were initially screened over the phone, then mailed a packet of assessments and the informed consent. After the consent and assessments had been mailed, participants completed a diagnostic interview with the researchers and began NF sessions. The participants attended 30 sessions of NF and were assessed on ADHD symptoms in every 5th session with the *German Assessment Battery for ADHD***.** After 15 sessions, participants took a three week break from sessions, after which, they returned for another 15 sessions and a follow

up assessment 6 months later. Although none of the participants dropped out of the study during the treatment phase, there was attrition between posttest and follow up. The researchers do not report how many participants began the study; however, they report that they only received follow up data from 18 participants. The researchers found reductions in self-rated scores on the self-report German ADHD test battery scores from pre to post (t [23] = 5.85, p <.000; d = 1.40) and observer reports of ADHD symptoms (t [17] = 3.87, p < .001; d = 0.57). Further, self-report symptoms of ADHD reduced over 25% in 14 participants with 6 participants no longer meeting diagnostic criteria for ADHD. Symptoms for depression (t [23] = 4.81, p < .001; d = 0.93), state anxiety (t [23] = 2.192, p < .05; d = 0.51) and trait anxiety (t [23] = 4.25, p < .001; d = 0.87) decreased as well.

Neurofeedback as a Treatment for ADHD in College Students

Surprisingly, there is limited research examining the efficacy of NF with college students with ADHD. However, the following studies were conducted with college students, although the participants do not have ADHD, the researchers found that NF was effective in improving attention in a college sample.

Rasey, Lubar, McIntyre, Zoffuto, and Abbott, (1995) conducted a study on the effects of NF on attention in college students. Participants in this study included seven undergraduate students between 18 and 45 years of age who classified themselves as a freshman or sophomore. Participant grade point averages (GPAs) were between 2.0 and 2.5 and participants did not have a learning disorder nor a history of EEG biofeedback training. Over the course of the study three participants dropped out, leaving the researchers with four participants. Screening sessions for participants included the *Integrated Variables of Attention* (IVA), Quantitative EEG assessment,

and the *Wechsler Adult Intelligence Scale- Revised* (WAIS-R). Participants received a mean number of 20 sessions using a protocol designed to increase beta activity (16 - 22hz) and inhibit high theta and low alpha activity (6 - 10hz). Participants were provided both visual and auditory feedback. For IVA scores, the researchers found that participants one and two increased by 2.2 and 3.73 *SD* and participants three and four increased by -.93 and .13 *SD* respectively on the *Full Attention Quotient*. The researchers' classified participants one and two as "Learners" and participants three and four as "Non-Learners" based on improvements on the IVA and improvements in reaction time on the IVA. The results identified that some college students can learn to increase EEG activity and attention based on the measures used in the study, whereas some students may not. The researchers attribute the "Non-Learners" inability to make progress to the limited number of sessions, they explain that if the participants had more sessions, they may have experienced more positive effects of NF.

Further, Fritson and colleagues (2007) examined the effects of NF in a sample of college students. Participants included 16 nonclinical college students and 16 control group participants with ages ranging from 19 to 38. Criteria for participation in this study included no current diagnosis of a mental disorder, no history of a psychotic disorder, no prior EEG biofeedback, no current medications for a mental disorder, and no history of epilepsy. The treatment group participants were all female, whereas the control group contained four males. Although all participants were told they were receiving NF, only the treatment group received NF and audio feedback. Control group participants were told that they were receiving NF; however, the NF system was in the "off" position and the participants did not receive any audio feedback. All participants received a baseline session lasting 12 minutes and subsequent twice weekly sessions.

Total, including the baseline session, the participants received 20 sessions of NF over the course of 12 weeks with each session lasting 20-25 minutes. Originally, there were 39 participants, however seven participants dropped out due to scheduling conflicts. Data gathered from the participants that did not complete the NF sessions were not used in the analysis. The protocol used for the treatment group was designed to increase task performance by training low beta activity to 12-15hz. Assessments used in this study include a demographics form, the *Integrated Variables of Attention + Plus* (IVA + Plus), the *Kaufman Brief Intelligence Test 2* (KBIT 2), the *Wide Range Intelligence Test* (WRIT), *Self-Efficacy Questionnaire*, *Brief Mood Introspection Scale*, and the *Beck Depression Inventory-II* (BDI-II). The researchers found a main effect of training/time-pre to post (Wilks's $\lambda = .74$) but there was no difference between groups (Wilks's $\lambda = .95$) nor was the interaction significant (Wilks's $\lambda = .99$). The treatment group did show an improvement in response control as measured by the IVA scores (F [1, 30] = 6.66, $p < .015$). The treatment group also showed greater improvements than the control group in the IVA subscales of *Response Control Auditory Quotient*, (F [1, 30] = 4.97, $p < .05$), and *Response Control Visual Quotient*, (F [1, 30] = 6.83, $p < .05$). Moreover, the researchers did not find a difference in pre to post scores on the BDI, Mood scale, total IQ or Emotional IQ scales. The fact that they didn't find a difference in BDI scores could be attributed to the characteristics of the population. Therefore, because the participants in the study were non-clinical college students, they may not have had significant issues with their mood to begin with. Despite the obvious need for an alternative intervention for college students with ADHD, there have been no studies conducted examining the effect of NF in reducing ADHD symptoms in college students, providing further rationale for the current study.

Conclusion

Chapter two reviewed the relevant literature as it pertains to negative outcomes associated with ADHD in adults and college students. With college students facing increased precedence of depression, anxiety, and lower academic self-efficacy, they are in need of treatment options that address their unique needs. Additionally, this review of the literature identified treatment options of college students with ADHD; providing a critique of the efficacy and feasibility of current treatment options such as CBT and pharmacological intervention. Although medication and therapy are effective in reducing ADHD symptoms, there are some limitations to each. Medication includes inherent difficulties in adherence and adverse side effects, while psychotherapy does not address the physiological aspect of ADHD. In answering Meyers and Young's (2012) call for incorporating NF in counseling as a means by which counselors can understand and treat the physiological aspect of mental disorders, an argument was made for the use of NF as an effective form of treatment in decreasing depression, anxiety, and ADHD symptomology while increasing academic self-efficacy in college students with ADHD.

CHAPTER THREE: METHODS

The purpose of this study was to investigate the effects of neurofeedback training on college students with ADHD diagnoses symptoms of ADHD (as measured by the *Conner's Adult ADHD Rating Scale* [CAARS-S:S; Conners, Erhardt, & Sparrow, 1999]), symptoms of depression (as measured by the *Beck Depression Inventory-II* [BDI-II; Beck Ward, Mendelson, Mock, & Erbaugh, 1961; Beck, Steer, & Brown, 1996]), anxiety symptoms (as measured by the *Beck Anxiety Inventory*, [BAI; Beck, Epstein, Brown, & Steer, 1988]), and academic self-efficacy (as measured by the *Self-Efficacy for Learning Form-Abridged* [SELF-A; Zimmerman & Kitsantas, 2005]). Specifically, this investigation attempted to determine if participants scores on the BDI, BAI, and CAARS-S:S would decrease, and the scores on the SELF-A would increase over time after 16 sessions of neurofeedback.

The research methods chapter provides a description of the research design and protocols for the study. Threats to validity (i.e., statistical conclusion, internal, construct, and external) are discussed in addition to mechanisms that were implemented to mitigate these threats to validity. Additionally, data collection procedures including population, sample, recruitment, incentives, and screening criteria are described. Moreover, data collection assessments and the rationale for selecting instruments and their respective psychometric properties is presented. The neurofeedback (NF) training protocol and study timeline is also reviewed. Data analysis procedures are presented along with ethical considerations and potential limitations of the study.

Research Design

This study used a quasi-experimental, time-series design (Gall, Gall, & Borg, 2007; Shadish, Cook, & Campbell, 2002). A time-series research design is a quasi-experimental

research design involving one group that is repeatedly tested while exposed to the experimental treatment (Fraenkel, Wallen, & Hyun, 2012; Gall et al., 2007). Participants received 16 total sessions of the NF training intervention over the course of eight to ten weeks. There were four data collection points within the study, including (a) baseline data collection conducted prior to the intervention, (b) midpoint data collection after eight sessions (four weeks) of the intervention, (c) post data collection occurred after the intervention (the end of session 16), and (d) follow-up data collection four weeks after the final intervention session.

Threats to Validity

Validity in research refers to the veracity of the claim the study is asserting. That is, the ability of a researcher to assert causal claim in an experimental or quasi-experimental study design (Murname & Willett, 2010). Threats to validity may be addressed in the development of a study, with researchers accounting for threats to validity by incorporating methodological mechanisms to account for specific threats to validity. Shadish and colleagues (2002) noted that researchers may design studies that are methodologically sound and address potential limitations of the study before the data are collected. Additionally, researchers may increase validity by accounting for covariates after the data have been collected during the statistical analysis. In order to design a sound study, researchers first identify threats to validity, determine if the threats are plausible, and put mechanisms in place to address these threats. Not all threats to validity may be mitigated by incorporating methodological factors, thus statistical adjustments may need to be made in order to strengthen the validity of a study. Moreover, when attempting to mitigate one threat to validity, researchers may run into problems with other threats to validity. For example, addressing the threat of homogeneity of treatment implementation may lessen the

external validity in that it may not be feasible to implement the treatment the exact same way across settings and populations, thus it is not generalizable (Murname & Willett, 2010). The following section presents four aspects of validity (i.e., statistical conclusion, construct, internal, and external) as well as strategies in which the researcher tried to mitigate these threats in the study.

Statistical Conclusion Validity

Statistical conclusion validity addresses whether a relationship between the independent variable (IV) and dependent variable (DV) exists based on the statistics used in the analysis. In experimental and quasi-experimental research, the most common form of testing the relationship between an IV and DV is null hypothesis significance testing (NHST). In NHST, researchers place most of the emphasis on whether or not one can reject or accept a null hypothesis (i.e., the difference in mean scores before and after an intervention is zero). The issue with only considering the *p* value is that the size of the effect of the treatment on the scores is often neglected. Lipsey and Wilson (1993) note that researchers should report effect sizes as well as confidence intervals in order to accurately describe the effects of treatment in an experiment or quasi-experiment. An effect size is the magnitude of the effect of the treatment whereas the *p* value provides researchers with the ability to correctly state that the findings are not due to error or chance. That is, the higher the *p* value, the more likely a researcher will incorrectly identify a covariation between the treatment and the effects the outcome. Some specific threats to statistical validity include (a) low statistical power, (b) violated assumptions of statistical tests, (c) unreliability of treatment implementation, and (d) restriction of range (Shadish et al, 2002).

Low Statistical Power

Statistical power refers to the ability of a statistical test to detect relationships in a sample as well as correctly identify this relationship. If a study has low power, the risk of identifying a relationship between variables that does not exist (type I error) or failing to identify a relationship when one actually exists (type II error) increases. Further, effect size estimates may be less accurate, that is, confidence intervals will be wider indicating that the true value of the effect size may fall between a larger range of values. Low power often occurs in experimental designs, thus causing experimental researchers to falsely reject null hypotheses (Shadish et al., 2002). Because of the increased likelihood of type I and II error in experimental designs, it is important that researchers report effect sizes and power when reporting the results of a statistical analysis (Shadish et al., 2002).

This study was quasi-experimental in nature, and thus, it is probable that low statistical power may have been a threat to the validity of this study. Additionally, due to the small sample size ($N = 11$), statistical power was low. However, the researcher reported effect sizes in the form of positive and negative ranks as a measure of the power of the results.

Violated Assumptions of Statistical Tests

Each type of statistical procedure has its own set of assumptions that need to be met in order for the results of the procedure to be accurate. Assumptions for the Friedman ANOVA statistical procedure include the following; (a) that one group is measured at three or more different occasions, (b) the group is a random sample of the population, (c) the dependent variable is measured at the ordinal or continuous level, and (d) the data do not need to be normally distributed. The first three assumptions were met as the study was designed. The study

design included one group of subjects with assessments at four time points throughout the study. Additionally, the participants were randomly sampled from the population and randomly self-selected to participate in the study. Due to the small sample in the current study, the data were not normally distributed. The data do not need to be normally distributed for the Friedman's ANOVA; thus, the assumption of normality did not need to be met in this study.

Unreliability of Treatment Implementation

Unreliability of treatment implementation refers to the inconsistency of the treatment when it is administered to participants in the study. Inconsistent treatment implementation may decrease the effect size of an intervention, begging the need for additional design mechanisms to increase power (i.e., larger sample size). However, in some studies, the intervention may need to be tailored to each individual subject. In this study, treatment fidelity was not a plausible threat to validity as the NF software automatically provides the exact same amount of NF training to each participant. Treatment fidelity may have become an issue if participants missed NF sessions. Each participant was scheduled for 16 total sessions of NF training; however, if participants did *not* attend all 16 sessions, treatment implementation may have been a plausible threat to validity (Shadish et al, 2002). In October, 2016, during the fall semester round of data collection, Hurricane Matthew made landfall in Florida making attending sessions on October 6th dangerous. The researcher canceled the study sessions on that date, pushing data collection further than eight total weeks; however, each participant received a total of 16 sessions while participating in the study. An exception to this occurred when a mistake by an RA caused one participant to receive 17 sessions of NF training instead of 16; Nevertheless, all participants received at least 16 sessions of NF.

Restriction of Range

Restriction of range refers to a lack of variation in the IV or DVs. Restriction of IVs may occur when the researcher is only evaluating two possible outcomes of the treatment or comparing two similar treatment interventions. Restriction of DVs may occur when the ceiling effect or floor effect occurs. The ceiling effect occurs when participants' scores on the instruments at baseline assessment cluster on the high end of the scale. The floor effect occurs when participants' scores on the instruments at baseline cluster around the lower end of the scale. If the researcher seeks to evaluate an increase or decrease in scores on an assessment but the scores at baseline are already on the highest or lowest end of the assessment scale, a significant change will not be observable due to a lack of variation in the scores at the outset (Shadish, et. al., 2002).

Participant scores on the *Beck Depression Inventory-II* and the *Beck Anxiety Inventory* were relatively low at the outset of the study. For example, of the 11 total participants, 6 participants scored in the "mild" category (total score < 9) on the BAI. Further, seven of the eleven participants scored in the "minimal" range on the BDI-II (total score < 13). Restriction of range is a probable threat to validity, especially in the depression and anxiety constructs for this study, as participants may not present with impairments on the depression, anxiety, or academic self-efficacy variables. Theoretically, college students with ADHD are more likely to suffer from higher prevalence of depression and anxiety with lower levels of academic self-efficacy. However, some college students with ADHD may not be impaired by depression, anxiety and/or low academic self-efficacy (Murnane & Willett, 2010).

Internal Validity

Internal validity refers to the ability of a causal inference to be made between the IV (i.e., time, or the intervention) and the DV (i.e., assessment scores). That is, does the IV cause changes in the DV? The term causality is most important when considering internal validity. Though similar to statistical conclusion validity, internal validity differs from statistical conclusion validity in that the former refers to a lack of alternative explanations for changes in the DVs whereas the latter refers to the confidence a researcher has in the veracity of the statistical findings. A major threat to internal validity is ambiguous temporal precedence. Researchers may not confidently state causality if cause does not precede effect. A strategy to mitigate the threat of ambiguous temporal precedence is implementing a pretest, or a measure of the outcome variables, before implementing the treatment in order to more confidently attribute change in the outcome variables to the treatment. Other examples of threats to internal validity that are relevant to this study include (a) history, (b) regression to the mean, (c) attrition, and (d) testing (Gall et al., 2006).

History

History refers to events that occur within the course of the intervention that may possibly effect the outcome variables (Shadish et al, 2002). If participants began taking medications or attending psychotherapy sessions while receiving NF training sessions, any changes in the outcome variables may have been attributed to the medications or the psychotherapy rather than the NF training intervention. The researcher asked participants at the outset of the study what they were implementing to treat their ADHD symptoms on the *Psychosocial Inventory*. Additionally, the researcher asked that participants disclose if they began a new treatment for

their ADHD symptoms while participating in the study. During the course of the study, one participant disclosed that they began taking medication soon after beginning the study and was unsure whether to attribute positive changes they had noticed to the NF or to their medication. This participant beginning medication around the same time as NF training sessions threatened the internal validity of the findings for this one participant because the researcher cannot state with complete certainty that the changes in scores on the assessments were due solely to the NF training intervention.

Additionally, the researcher conducted multiple rounds of data collection at different time periods (i.e., Summer 2016 and Fall 2016), events may have occurred that influenced the participants' moods, motivation, and scores on the instruments. For example, in June of 2016, a tragic mass shooting occurred in Orlando, Florida that could have affected the moods of the participants in the summer round of data collection. Participants who completed their assessments the week following the shooting may have responded more severely on the depression and anxiety scales due to heightened feelings of sadness and anxiety following the shooting. Specifically, one participant reported feeling sadder and crying more, but attributing the sadness and crying to the shooting rather than overall feelings of depression. Moreover, Hurricane Matthew made landfall in October of 2016 during the fall semester round of data collection. No participants reported being directly harmed or affected by the Hurricane, but if the hurricane had affected participants (i.e; destroyed their property) they may have responded differently to their assessments.

Further, differences in the time the participant received the intervention (i.e., Fall or Summer semester) may have impacted the participants' reaction to the intervention. That is,

there may have been some factors that affected the impact of the intervention based upon the time of year. For example, students that take summer courses and participated in the summer round of data collection may have been more motivated than students who take courses within the academic school year. However, Marshall and colleagues (2012) found that students who completed a course in their major were equally as successful in their subsequent coursework as those who completed their major coursework in the fall or spring semester. Thus, Marshall and colleagues' finding identified that students who take summer courses are not different than those students who do not take summer courses.

Regression to the Mean

Regression to the mean, or regression artifacts, refers to the tendency for extreme scores on a measure to naturally gravitate toward the mean score (Shadish et al, 2002). When administering an assessment numerous times to the same participants, regression to the mean is more likely to occur. Further, when participants present with extreme scores at the outset, regression to the mean is also more probable. As the study utilized four data collection points with the same participants, whose scores may be extreme due to the selection process—that is participants are expected to have high ADHD symptomology scores, a natural decrease in scores was possible.

Attrition

Attrition is defined by research participants discontinuing their participation in the study or failing to complete the outcome measures. In a pretest-posttest design, the purpose of the outcome measures is to provide data from which the researcher can make inferences about the impact of the treatment intervention (Murnane & Willett, 2010). If there are no outcome

measures, the researcher's ability to determine a change in scores from pretest to posttest is diminished. The researcher was contacted by 23 total students (over the course of the summer and fall semesters) to participate in the study. Two participants were ineligible because they were not currently enrolled in classes at a college. Three individuals did not show up for their first sessions and did not respond to the researcher's attempts to contact them to reschedule. Four potential participants did not have time in their schedules to participate in summer or fall. One potential participant called the researcher but did not answer when the researcher attempted to contact them again. Two participants expressed interest, and began sessions but did not complete all of their sessions due to one participant starting a new class and not being able to come in for sessions and the other participant reported feeling more tired than usual after having started the NF sessions. Thus, due to their fatigue, they did not want to continue with the study.

Further, it is also important for researchers to assess the reasons and characteristics of participants who do not complete the outcome measures. That is, if all of the participants that did not complete the outcome measures share a common characteristic, that characteristic may provide more information about the sample of participants and the relationship of that characteristic to the intervention or outcome measures. Thus, the characteristic may interfere with the researcher's ability to state cause by limiting the outcome data.

Testing and Instrumentation

Testing refers to any changes in an individual such as practice effects, familiarity, or fatigue that cause changes in assessment responses that may be falsely attributed to treatment effects (Gall et al, 2006). Similarly, instrumentation refers to changes in the instruments that affect the outcome. Although testing and instrumentation may seem similar in that they are both

related to the outcome measure, they are different in that the former focuses on changes in the individual that affect outcomes whereas the latter focuses on changes in the assessment that affect outcomes. Nevertheless, instrumentation was not a plausible threat in this study as all of the instruments were the same for all participants. Testing, however may have been a probable threat to validity due to the fact that participants in the study were administered the assessments four times over the course of the study.

Construct Validity

Constructs in research are important in that they set the parameters of what concepts will be studied and how these concepts will be measured. Without a solid definition of the constructs of interest, researchers may be unable to develop clear methods of assessing the constructs and as a result, the ability of the researcher to assert a relationship between constructs is weakened. Further, well defined constructs allow researchers to interpret their findings as they relate to other relevant constructs. Due to the implications constructs have on the interpretation of research, it is important to thoroughly define constructs of interest as well as the measures used to gather data on the constructs. If constructs are not well defined or mislabeled, the findings of a study may not be relatable to other similar concepts in the literature. That is, the research findings may be misinterpreted and implications may be incorrect. To address this threat to construct validity, the researcher incorporated measures that assess each of the constructs of interest in a comprehensive manner (Shadish et al, 2002). The researcher understands that the instruments utilized in the study may not fully assess all symptoms of ADHD, depression, anxiety, and academic self-efficacy; however, the specific construct validity of each instrument is presented in the instrumentation section below.

Construct validity refers to the validity of the means by which the researcher is measuring the constructs of interest. That is, construct validity relates to how well the DVs actually represent the constructs of interest. Construct validity is the veracity of the explication of the constructs involved in the study (Shadish et al, 2002). For example, in this study, college students with ADHD were the population being studied and as such, ADHD and college students are constructs that must be defined for the purposes of this study. As delineated in the sampling section of this chapter, participants were diagnosed with ADHD by a mental health professional and were enrolled in at least one course at an institute of higher education in the central Florida area. Further, construct validity can be threatened in various ways. Shadish and colleagues (2002) outline 14 specific threats to construct validity. As some of these threats were not plausible in this study (i.e., reactive self-report changes, compensatory equalization, compensatory rivalry, resentful demoralization, and treatment diffusion), because they are specific to experimental designs with more than one group, they will not be described at length in this section. Additionally, treatment sensitive factorial structure and reactivity to the experimental situation are not plausible in the current study and are not discussed in this section. The threats to construct validity that are possible include construct confounding, mono-method bias, mono-operation bias, experimenter expectancies, and novelty and disruption effects (Shadish et al, 2002).

Construct Confounding

The threat of construct confounding refers to the possibility of constructs being inherently grouped within the constructs of interest in the study (Shadish et al, 2002). That is, researchers may observe or label a specific construct as a construct of interest in the study without

accounting for other constructs that may play a role in their construct of interest. The other constructs that play a role in the constructs of interest would be the confounding constructs and may affect the validity of the observed construct of interest. For example, in this study, it is possible that the participants that presented with high levels of depression may have attributed their depressive symptoms to different factors (e.g., bereavement, trauma, finances, etc.). Thus, it would have been incorrect for the researcher to assume that the construct of depression in this study is the same for all participants.

Mono-operation/Monomethod Bias

Mono-operation bias refers to the lack of multiple forms of defining a construct. That is, mono-operation bias may occur when a researcher uses only one operational definition of a construct, thus failing to address other potential facets of the construct (Shadish et al, 2002). This study operationally defined the constructs of interest by utilizing one measure per construct. A limitation to using only one measure per construct is that the researcher may fail to assess all aspects of the constructs in one assessment. Similarly, monomethod bias occurs when all outcome measures are the same in their method of recording responses. In the current study, all of the outcome measures were self-report, which limited the quality of the responses provided. As ADHD is a majorly behavioral disorder (American Psychiatric Association, 2013), observer report measures may have been beneficial in providing more information about the subjects' symptomology.

Experimenter Expectancies

Experimenter expectancies refers to the expectations researchers have that the treatment interventions they are providing is effective. Researchers may influence research participants by

telling them that the intervention will be effective, thus increasing participants' expectations that the intervention will be effective. As a result, the novelty or disruption effect occurs. Novelty or disruption effect refers to the excitement or expectations that are associated with a novel intervention. Contrarily, the disruption effect occurs when participants react negatively to the intervention introduced. Experimenter expectancies and the novelty effect may have played a role in this study as participants were expected and encouraged to research the intervention being provided. As most individuals are unfamiliar with NF and are curious about how it works, in order to gain trust and buy-in from the participants, the researcher encouraged participants to research NF as an intervention for ADHD. Most research on NF is promising, and the manufacturers of the NF system used in this study list a number of benefits of NF on their website. Therefore, participants may have been made aware of the potential benefits of NF and developed an expectation that NF would be effective in reducing their ADHD symptoms; thus, creating a placebo effect and threatening the validity of the study (Shadish et al, 2002).

External Validity

External validity refers to the ability of the researcher to generalize the results of a study across individuals, treatment settings, across treatment types, and across outcomes. Generalizability is important in experimental research because it strengthens the claims of causality or relationships among variables presented by allowing researchers to apply their findings to other individuals, settings, treatments, or outcomes (Shadish et al, 2002). Considering external validity in a study is important before collecting data as some issues of generalizability may be addressed methodologically. For example, a researcher may increase external validity by intentionally recruiting participants that represent a diverse background in a specific domain.

That is, if socioeconomic status (SES) may play a key role in how an intervention may affect the outcome in an experiment, the researcher may seek to recruit participants from varying SES levels to show that the intervention effects are similar regardless of SES. The threats to external validity that are plausible in the proposed study include the interaction of the causal relationship with units, treatment variations, outcomes, and settings (Shadish et al, 2002).

Interaction of the Causal Relationship with Units

As explained in the previous section, there may exist some specific factors that may interfere with the effects of the intervention on the research subjects in the sample. The threat of the interaction of the causal relationship with units refers to the possibility that the causal relationship may only occur with the populations in the study sample. That is, the results of a study are not generalizable to individuals who were not subjects in the study. To mitigate the threat of a lack of generalizability across individuals, the researcher sought to include subjects from diverse backgrounds in terms of age, ethnicity, gender, and ADHD subtype (Murnane & Willett, 2010).

Interaction of Causal Relationship over Treatment Variations

The threat of generalizability based on treatment variations refers to the ability of a researcher to manipulate the treatment while maintaining the same causal relationship (Murnane & Willett, 2010). In the study, NF as a treatment was administered as a total of 16 sessions over the course of at least eight weeks, with no more than two sessions in one week. Because the treatment is standardized across participants, the researcher is not able to generalize the results to include variations of the treatment. However, although the threat to external validity is increased

by standardizing the treatment, the researcher chose to sacrifice external validity to improve the statistical conclusion validity of the study by increasing treatment fidelity.

Interaction of Causal Relationship with Outcomes

Treatments or interventions in experimental research may show a cause-and-effect relationship with the researcher's constructs of interest (Murnane & Willett, 2010). However, the ability of a researcher to generalize the cause and effect relationship across outcome measures increases external validity. The current study sought to assess the interaction of the potential relationship between NF and ADHD symptoms as well as other constructs (i.e., depression, anxiety, and academic self-efficacy). Thus, the findings of the study may provide external validity in its ability to generalize a potential relationship across numerous outcomes.

Interaction of Causal Relationship Across Settings

As the current study was conducted on the campus of a large metropolitan university in the Southeastern United States with participants from the surrounding area, the researcher was not able to generalize the results of the study across settings and locations. If the researcher were to include multiple settings across the United States, the ability to generalize the results would increase. However, participants in the study were students of multiple universities in one state. Thus, the researcher can generalize the results of the study to include students from the universities represented in the sample (Murnane & Willett, 2010).

Procedures

In order to begin recruitment of participants and collecting data for the study, the researcher sought approval from the university's Institutional Review Board (IRB). The IRB application included essential information for the study including a rationale for conducting the

study, data collection procedures, data analysis plan, and potential risks and benefits for participants. Additionally, the study materials including recruitment materials and data collection instruments were included as well. All data were collected at the university's Community Counseling and Research Center (CCRC). Permission was granted from the CCRC director to utilize one room in the CCRC for the research study.

Population and Sample

This study utilized convenience sampling with an inclusion criteria (Gall et al., 1996). As this study sought to include participants from a specific population (college students with ADHD), it was not logical for the researcher to randomly sample all adults or all college students. Thus, inclusion criteria delineating ADHD diagnoses was also important in the sampling process. Sampling is important in quantitative research as the individuals who participate in the study should ideally represent the population. The target population, the population to which the researcher would ideally hope to generalize results of the study, was all college students in the United States with ADHD. The researcher will only be able to generalize results to the accessible population which included college students who participated in the study from the participating universities. Participants were students at universities in one Southeastern state that saw the recruitment flyers and/or were referred to the study by the Student Accessibility Services or Counseling and Psychological Services offices and had randomly selected to participate in the study. Through screening criteria, interested students were assessed for eligibility for participation. Inclusion criteria for participation in the study included the following: (a) over 18 years of age; (b) currently enrolled at a college; (c) able to provide documentation of an ADHD diagnosis from a mental health professional; (d) no history of

psychosis or psychotic disorders—to be verified in the treatment letter from the mental health professional and self-report; (e) no recent emotional hospitalizations—within the past month, to be verified by self-report; (f) not currently pregnant; (g) did not have an implanted electrical medical device such as a pacemaker; (h) did not have severe skin allergies; and (i) was able to speak, read, and understand English as all of the assessments were in English.

Intervention

The study was conducted over at least 12 weeks with 8-10 weeks of NF sessions (depending on the semester—fall semester participants' sessions lasted longer due to canceled sessions) and a 4 week post-NF follow-up. The tentative timeline for the study was as follows: (a) there were two total semesters of data collection (Summer and Fall 2016); (b) recruitment was ongoing throughout the fall semester; (c) summer data collection began the first week of the Summer 2016 semester with midpoint assessments four weeks later and post assessments four weeks after the midpoint assessments; and (d) four weeks after the final NF session, participants came in for a follow-up assessment session in which they completed the assessments again. Participants attended a total of 16 sessions of NF over the course of 8-10 weeks with 1-2 sessions per week. Assessments were administered at the first, eighth, sixteenth, and fourth week follow up sessions. In addition, $10.00 gift cards were provided at these four data collection intervals.

Research assistants (RAs) were trained to conduct the NF sessions in the study. The research assistants were recruited from the university's counselor education program and were Master's level counseling students. Research assistants expressed written interest via email to the researcher explaining their interest in joining the research team and their availability to devote time to the study. The researcher then met with the prospective research assistants to provide an

overview of the researcher's expectations of the RAs, as well as answer any questions the RAs had about joining the research team. If potential RAs were available to dedicate six to eight hours each week to the study, and were able to complete CITI training, they were asked to join the research team. Once the invitation was accepted, the RAs needed to provide proof of professional liability insurance, CITI training, and obtain an IRB account. RAs were then trained by the researcher's co-chair, a certified NF professional, on how to conduct NF sessions. The RA training lasted two total days in which the RAs learned about the NF system, watched a demonstration of how the NF system works, and practiced conducting a NF session. The researcher then created an RA schedule outlining the days and times the RAs were expected to conduct NF sessions for participants.

The first session consisted of the research assistant, or primary researcher, explaining to the participants the informed consent for the study. The informed consent outlined that the participants' participation in the study was voluntary and they could withdraw from the study at any time they desired. Further, the informed consent provided an outline of the benefits and risks associated with participation in the study. According to CCRC policy, when exempt research is conducted in the clinic (and the participants do not have to sign the informed consent, as is the case with this study), participants must sign an additional form stating that they have received a copy of the study's informed consent. The purpose this additional form is to ensure that each participant of research conducted in the CCRC has received a copy of an informed consent. Moreover, the Zengar institute, the manufacturers of the NeurOptimal NF system that was loaned to the researcher's co-chair for the purpose of this study, also required study participants to sign an informed consent. The purpose of this informed consent was to ensure that the

participant understood that the NeurOptimal system is not a medical device and that results may vary from participant to participant. In addition to the three informed consent forms, the participants also completed a psychosocial inventory. The psychosocial inventory was three pages total and included questions about participants' emotional history (i.e., history of mental illness or hospitalization due to mental illness), physical health history, and other basic demographics (gender, race, age, etc.). The purpose of the psychosocial inventory was to gather demographic information from the participant as well as confirm and screen again for psychotic symptoms such as hallucinations. Finally, the participants completed the four assessments (CAARS-S:S, BDI, BAI, and SELF-A) and once they completed those assessments they received 15 minutes of NF training and a $10 gift card at the end of the session. The first session of NF was always 15 minutes, every other session after the first session lasted 33.5 minutes.

In subsequent sessions, participants were greeted in the CCRC waiting room by the researcher or the research assistant conducting the session and guided to the designated research room where they were "hooked up" to the NF system and received 33.5 minutes of NF training. "Hooking up" the participant to the NF machine involved attaching a total of five sensors to the participants' ears and temples. These sensors "listened" to the participants' brainwaves and transmitted that information to a laptop equipped with the Neuroptimal software. Because the Zengar Institute does not delineate the particulars of how the software works, neither the researcher nor the RAs was qualified to explain exactly what was happening in session that was making the difference. According to the Zengar Institute, the NeurOptimal system does the following:

> NeurOptimal monitors the electrical activity of your brain, reminding your brain about what it's actually doing so your brain can function more optimally. When brain activity shows signs of turbulence, the music within the NeurOptimal NF software is momentarily interrupted. This subtle cue alerts your brain that it is operating inefficiently. With repeated training sessions, the brain learns to "reset" itself and function more smoothly. All of this learning is non-invasive and happens outside your conscious awareness. Over time, NeurOpitmal adjusts itself automatically in response to your brain's activity, individualizing the training microsecond by microsecond to your own brain's functioning. (Zengar, 2016, retrived from: http://www.zengar.com/the-brain-neuroptimal)

Neurofeedback training sessions lasted for 33.5 minutes as this is the standard length of time for sessions in the NeurOptimal software; the system automatically stopped itself when the session was over. According to NeurOptimal guidelines, participants may read, sleep, text, study, etc. as long as they did not talk or chew as the facial movements involved in that may have interfered with the readings of the sensors. At the end of the session, the RA removed and cleaned the sensors, shut down the NF machine, and asked the participant if they had noticed any changes since their last session. The RA then escorted the participant out of the research room and to the bathroom (to clean the electrode paste from their temples) or back through the CCRC waiting room. As a common effect of NF is a feeling of being tired, the RAs suggested that if participants were feeling particularly tired, they sit in the waiting room of the CCRC for 10-15 minutes before leaving. After each session, the RAs completed a research note which contained a section for what the participant reported as well as a section for what the RA observed in session.

The RA wrote whatever the participant reported as noticeable changes from their last session (e.g. “I’m feeling more alert”, or “I can study better”). In addition, the RA wrote on the note any things they notice that was different about the participant (ex: participant showed up late, was more/less fidgety than usual, etc.). The purpose of the research notes was to allow the researcher to keep track of the participant reported changes as well as ensure the sessions are being conducted in a structured way by all of the RAs.

In assessment sessions (sessions one, eight, and sixteen), the participants were greeted as usual and guided back to the research room where they received 33.5 minutes of NF. After the NF session, the RA administered the four assessments to the participant (CAARS-S:S, BDI, BAI, and SELF-A). It should be noted that participants completing their assessments after receiving NF may have impacted their responses on the assessments. That is, participants may have felt less anxious, for example, directly following their NF session; thus, impacting their responses on the BAI. As the participants completed these same assessments in their initial session, the researcher did not anticipate the participants having many questions about the assessments. However, if the participants had questions while completing the assessments, the RA’s were able to answer the questions as they were informed in their training on how the participants are supposed to complete the assessments. If the RA was unable to answer the participant’s question regarding the assessment, the RA contacted the researcher or the researcher’s co-chair to answer the question. The participants completed the assessments after the NF training in each assessment session (with the exception of the very first session and the follow-up) to ensure that each participant had received the exact same amount of NF when they completed their assessments. Participants also received a $10.00 gift card at the end of their first,

eighth, sixteenth, and follow up sessions. Follow-up sessions lasted approximately 30 minutes, the researcher administered the assessments and allowed the participants to ask any follow up questions they had about the study. Although participants that participated in the pilot study were allowed to participate in the first round of data collection, participants were not able to continue sessions once they finished their NF sessions in the summer semester.

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Instrumentation

The data collection packets included four measures: (a) the *Conner's Adult ADHD Rating Scale* (CAARS-S:S; Conners et al, 1999), (b) the *Beck Depression Inventory-II* (BDI-II; Beck et al, 1996), (c) the *Beck Anxiety Inventory* (BAI; Beck et al, 1988), and (d) the *Self-Efficacy for Learning Form-Abridged* (SELF-A; Zimmerman & Kitsantas, 2005). These packets were administered at the four data collection points of the study. In the first data collection point, participants also completed a *Psychosocial Inventory*, which included demographic information as well as physical health, emotional health, and substance abuse history. For an abridged version of the instrumentation information, see Table 1.

Psychosocial Inventory

The *Psychosocial Inventory* was adapted from the *Psychosocial Inventory* used in the university's CCRC for client intake sessions. The CCRC version of the Psychosocial Inventory was revised to address issues related to the study population. That is, some items on the questionnaire were reworded or changed to gather information from the participants that was relevant to the study. The *Psychosocial Inventory* included questions about the participants' demographic information (i.e., age, gender, ethnicity, contact information) in addition to brief questions about the participant's main concerns as it relates to their ADHD symptoms and what they are currently doing to manage their ADHD symptoms. Additionally, the psychosocial inventory included questions about participants' physical health history (i.e., present and past illnesses, presence of an electronic medical implanted device, or skin allergies). Moreover, to screen for current suicidal behaviors or substance abuse, the psychosocial inventory included questions about emotional history and substance abuse.

The *Conner's Adult ADHD Rating Scale*

The *Conner's Adult ADHD Report Scale Self-Report Short* Form (CAARS-S:S; Conners, Erhardt, & Sparrow, 1999) was developed in 1999, is a 26 item, Likert-type, self-report measure of ADHD symptoms. The version of the CAARS being used in this study is the self-report, short form (CAARS-S:S). There are longer forms and observer forms available; however, for the purpose of this study, the most feasible version was the short, self-report version. The CAARS has four subscales: inattention, hyperactivity, impulsivity, and self-concept. The CAARS was normed on a non-clinical sample of 1,026 adults ranging in age from 18 to 80 years old. Gender and age were assessed for their relationship to overall CAARS scores in the nonclinical sample.

As such, the authors found significant differences based on gender and age on the inattention subscale with men scoring higher than women, (CAARS-S:L, F [1, 1018] = 13.24, $p < .001$; CAARS-S:S, F [1,1018] = 4.66, $p < .05$). Individuals aged 18 - 29 scored higher than the other age groups on the CAARS-S:L (F [3, 1018] = 4.10, $p < .01$), and the CAARS-S:S, (F [3, 1018] = 4.34, $p < .01$). On the hyperactivity subscale, men scored higher than women on the CAARS-S:L (F [1, 1018] = 8.27, $p < .005$) and the CAARS-S:S (F [1,1018] = 8.82, $p < .005$), lower scores were found in older age groups on the CAARS-S:L (F [3, 1018] = 14.79, $p < .001$) and the CAARS-S:S (F [3, 1018] = 19.08, $p < .001$). On the impulsivity subscale 18 to 29 year olds scored higher than the other age groups on the CAARS-S:L (F [3, 1018] = 5.59, $p < .001$), and the CAARS-S:L (F [3, 1018] = 5.86, $p < .001$). Finally, on the self-concept subscale women scored higher than men on the CAARS-S:L (F [1, 1018] = 19.32, $p < .001$) and the CAARS-S:S (F [1,1018] = 18.23, $p < .001$). Because of these gender and age differences in the normative sample, the scoring and interpretation of the CAARS forms take into consideration the respondents age and gender.

Internal consistency reliability of the CAARS is strong with the majority of the alpha coefficients above $\alpha = .80$. For the self-report measures of the CAARS the alpha coefficients ranged from $\alpha = .66$ (males, hyperactive/impulsive symptoms) to $\alpha = .90$ (males, hyperactivity/restlessness-CAARS-S:L). These strong coefficients suggest that there are strong relationships between the items on each of the subscales in the CAARS forms for both males and females of all ages. Further, Conners and colleagues reported the test-retest reliability of the CAARS forms. Participants were administered the CAARS forms initially and then re-administered the assessments either two weeks or four weeks later. For the two week

reassessment (n = 50), responses on each of the subscales were significantly correlated ($p < .05$) with correlations ranging from $r = .85$ to $r = .95$, suggesting that results of the assessments are stable over time. Further, the four week reassessment (n = 61) showed strong correlations between $r = .80$ and $r = .91$ ($p < .05$).

Conners and colleagues (1995) assessed the discriminant and construct validity of the CAARS scales. Discriminant validity addresses the assessments ability to distinguish the construct it is meant to measure from other similar constructs. To establish discriminant validity, the researchers compared scores on the CAARS between individuals that met DSM-IV-TR criteria for ADHD (n = 39) to a control group that did not meet ADHD criteria (n = 40). They found that the group of adults with ADHD diagnoses scored higher on inattention (t [38] = 8.62, $p < .001$), hyperactivity (t [38] = 4.55, $p < .001$), impulsivity (t [38] = 2.84, $p < .01$), and problems with self-concept (t [38] = 5.32, $p < .001$) than those who did not meet ADHD criteria (Erhardt, Epstein, Conners, Parker, & Sitarenios, 1999). Moreover, discriminant function scores correctly classified individuals as having ADHD or not 85% of the time. These findings identified strong validity in that the CAARS assessments measure what they intend to measure. To test the relationship between childhood symptoms of ADHD and current adulthood symptoms, the researchers compared participants' scores on the *Wender Utah Rating Scale* (WURS; Ward, Wender, & Reimherr, 1993) to CAARS scores. The WURS assesses retrospective ADHD symptomology in adults. Correlations the subscales ranged from $r = .37$ to $r = .67$, showing a moderate correlation between childhood ADHD symptoms and adulthood ADHD symptoms. Moreover, Conner's and colleagues used the structured interview (based on the DSM-IV-TR) with the CAARS and the CAARS correctly identified ADHD diagnoses 87%

of the time. The CAARS assessment has also been used in numerous studies on adults with ADHD, including studies evaluating the efficacy of NF on ADHD symptoms.

The *Beck Depression Inventory-II*

The *Beck Depression Inventory-II* (BDI-II; Beck, Ward, Mendelson, Mock, & Erbaugh 1961; Beck, Steer, & Brown, 1996) is a 21-item, self-report measure of depressive symptoms. The original BDI (Beck et al, 1961) items were based on 21 symptom attitude categories which were derived from Beck's clinical observations of symptoms of depressed individuals. The BDI was normed on a clinical population of 400 outpatient and inpatient individuals at a University Hospital. These individuals were 60% female, and 64% White. Participants in this study were only categorized as either White or Black. The assessment was read aloud by the researchers, who recorded participant's responses by circling the response the participant identified as most salient at the current moment for them. The researchers found a significant relationship between each of the items on the inventory and the overall score ($p < .01$), indicating strong internal consistency and reliability of the measure. The researchers also compared participants' self-report *Depression Inventory* and clinician administered *Depth of Depression* ratings and found a positive relationship in symptom self-reported and clinician rated severity ($p < .001$), supporting strong validity with these data.

The BDI-II is a revised version of the BDI that includes clearer statements and was created to make self-reporting easier for subjects. Moreover, the BDI-II was edited to match the DSM-IV diagnostic criteria for depression. Beck and colleagues provided psychometric data on the BDI-II from a sample of 500 outpatients representing both suburban and urban locations. The outpatient sample included individuals who had all been diagnosed according to the DSM-III or

DSM-IV criteria. Additionally, a sample of 120 college students served as a normative group to which the researchers compared the scores from the clinical (outpatient) group. Internal consistency reliability of the BDI is strong with an alpha of .92 for the clinical sample and .93 for the nonclinical college student sample. Test-retest reliability of the BDI-II showed a strong correlation (r = .93) when administered a week apart.

Construct validity for the BDI-II is moderate with moderate relationships between the BDI-II and the *Beck Hopelessness Scale* (BHS; r = .68), the *Revised Hamilton Psychiatric Rating Scale for Depression* (HRSD-R; r =.71). Additionally, the BDI-II is more strongly related to the HRSD-R than the *Revised Hamilton Anxiety Rating Scale* (HARS-R; r = .47), showing evidence of discriminant validity as the BDI-II is more similar to another depression inventory than an anxiety inventory (Beck et al, 1988). Factor analysis of the BDI-II showed that the items on the BDI-II loaded onto two factors. Beck and colleagues (1996) found that Loss of Pleasure, Crying, Agitation, Loss of Interest, Indecisiveness, Loss of Energy, Changes in Sleeping Pattern, Irritability, Changes in Appetite, Concentration Difficulty, Tiredness and Fatigue, and Loss of Interest in Sex all loaded on the first factor, which they concluded represented the Somatic-Affective aspect of depression. Sadness, Pessimism, Past Failure, Guilty Feelings, Punishment Feelings, Self-Dislike, Self-Criticalness, Suicidal Thoughts or Wishes, and Worthlessness were all items that loaded on the second factor which the researchers labeled as the Cognitive aspect of depression. Storch and colleagues (2004) conducted a confirmatory factor analysis in a sample of 414 nonclinical college students analyzing the factor structure Beck and colleagues (1996) identified and found that the scores loaded on the factors in the same way.

The researchers found that in both the clinical (t [498] = 2.69, $p < .01$) and nonclinical (t [118] = 2.53, $p < .05$) populations, women scored higher on the BDI than men. Race/ethnicity was not correlated with BDI-II scores; however, it should be noted that the researchers coded individuals as White or Non-White. As such, there may exist some differences between specific race/ethnicity groups had they been explored. As the clinical sample were diagnosed with various disorders, the researchers found that individuals diagnosed with a mood disorder scored significantly higher on the BDI-II than those with anxiety, adjustment, or "other" disorders (F [4, 259] = 4.93, $p < .001$).

Item nine in the BDI-II assesses suicidality, which the research assistants were trained to scan for. If an individual provided an answer other than "0-I do not have any suicidal thoughts or plans", the RA was instructed to contact the researcher and complete a SLAP assessment (Florida Therapy Services, n.d.). If the participant needed to be placed under the Baker Act (the emotional hospitalization for safety concerns in the state of Florida; Christy, Stiles, & Shanmugam, 2007), CCRC protocol would have been followed and university police would have been called to escort the individual to the nearest hospital. No participants in the study expressed suicidal ideation on the BDI-II, and the protocols set in place did not have to be implemented. The BDI-II has been used in the research on depression and in most studies utilizing NF to decrease depressive symptoms.

The *Beck Anxiety Inventory*

The *Beck Anxiety Inventory* (BAI; Beck, & Steer, 1990) is a 21-item self-report measure of anxiety symptoms. The BAI was created from an 86 item pool that were drawn from extant anxiety scales including the *Anxiety Checklist*, the *Physician's Desk References Checklist*, and

the *Situational Anxiety Checklist*. The authors selected the 21 items for the BAI by conducting numerous rounds of item analysis including reducing items based on their similarity to one another and their validity after conducting a factor analysis. The BAI is scored by summing the total numbers correlating to the responses the participants choose. The larger the sum, the more symptoms of anxiety present.

The BAI psychometric properties were examined on a clinical outpatient population (N = 1,086) that was diagnosed with mood disorders by meeting the DSM-III or DSM-III-R criteria. Beck and colleagues (1988) used a subsample of 160 for the reliability and validity analyses. A total of 243 college students were also used as a nonclinical comparison group. Thus, the following psychometric properties must be interpreted with that in mind. The internal consistency was high with an alpha of .92. Test-retest reliability was evaluated with a week between administrations, correlations were moderate with a correlation coefficient of .75. Concurrent validity was assessed by comparing the BAI to other measures of anxiety including the *Hamilton Anxiety Rating Scale-Revised* (HARS-R; Hamilton, 1956), the anxiety subscale of the *Cognition Checklist* (CCL-A; Beck, Brown, Steer, Eidelson, & Riskind, 1987), the trait and state subscales of the *State-Trait Anxiety Inventory* (STAI; Speilberger, 1983), and a seven day mean anxiety rating of the *Weekly Record of Anxiety and Depression* (WRAD; Barlow & Cerny, 1988). The researchers found that there were moderate relationships between the BAI and the HARS-R (r = .51), CCL-A (r = .51), trait anxiety (r = .58), state anxiety (r = .47), and WRAD (r = .54). These findings support the idea that anxiety and depression may be closely related; however, the fact that the relationship between the BDI-II and the anxiety scales is not strong

suggests that the BDI-II is able to discriminate between depressive symptoms and anxiety symptoms.

Beck and colleagues (1996) evaluated the discriminant validity of the BAI by assessing differences in BAI scores between groups of individuals diagnosed with the DSM-III-R criteria for Panic Disorder (with and without agoraphobia), Social Phobia, Obsessive-Compulsive Disorder, and Generalized Anxiety Disorder. The researchers found that BAI scores were different based on diagnosis with individuals diagnosed with Panic Disorders having higher BAI scores (F [4, 341] = 11.57, $p < .001$).

Construct validity of the BAI has been evaluated in the literature and researchers have found that the BAI shows strong relationships with depression scales including the BDI ($r = .48$), *Hamilton Psychiatric Rating Scale for Depression-Revised* ($r = .25$), and the depression subscale of the CCL ($r = .22$; Beck & Steer, 1996). As depression and anxiety may manifest in the same ways, anxiety scales are often related to depression scales (Gotlib & Cane, 1989), it is expected that there exist some relationships between the BAI and depression scales.

Factor analysis was conducted to determine correlations between the items on the BAI and how they relate to one another (Beck, Epstein, Brown, & Steer, 1988). The researchers found that the 21 BAI items can be clustered into four subscales: Neurophysiological, Subjective, Panic, and Autonomic. The Neurophysiological subscale includes the numbness or tingling, wobbliness in legs, dizzy or lightheaded, unsteady, hands trembling, shaky, and faint items. Subjective includes the unable to relax, fear of the worst happening, terrified, nervous, fear of losing control, and scared items. Panic includes the heart pounding or racing, feelings of choking, difficulty breathing, and fear of dying items. Feeling hot, indigestion or discomfort in

abdomen, face flushed, and sweating (not due to heat) are all included in the autonomic subscale. Similar to the BDI, women reported higher scores on the BAI than men (t [391] = 2.72, p <.01). Furthermore, younger individuals reported higher anxiety scores than older individuals (F [21, 370] = 1.72, p < .05).

The *Self-Efficacy for Learning Form-Abridged*

The *Self-efficacy for Learning Form* (SELF-A; Zimmerman & Kitsantas, 2005, 2007) is a 19-item self-report, measure of self-efficacy for self-regulated learning. That is, the SELF-A measures students' perceived responsibility and ability to take control of their learning, including items that ask about students' ability to take notes in class, or if they do not understand something, their ability to get the information they need. The answers are on a 100 point scale from 0—I definitely cannot do this, to 100—I definitely can do this. Respondents write the number that corresponds to their beliefs in their ability to complete the task.

Zimmerman and Kitsantas (2005, 2007) have yet to complete reliability and validity analyses on SELF-A scale; however, they report that the communalities of the items in the factor analysis were all above .9, identifying that the items relate well to one another. Further, the authors compared students' responses on the SELF to their teachers' perceptions of the students' self-efficacy via the *Perceived Responsibility for Learning Scale* (Zimmerman, & Kitsantas, 2007) and found a strong relationship between the students' responses and teachers' perceptions (r = .71), suggesting the measure is moderately valid. The SELF-A encompasses the construct of self-efficacy for college students and was normed on college students with ADHD (N = 223).

Table 1. Data Collection Instrument Reliability and Validity

	No. of Items	Norm Population	Type	Internal Consistency Reliability	Test-Retest Reliability	Validity
CAARS-S:S	26	Non-Clinical 1,026 adults	Self-Report	α = .66 - .80	*r* = .85 - .95 (two week) *r* = .80 - .91 (four week)	Moderately related to the WURS *r* = .37 - .67
BDI-II	21	Clinical population 400 adults	Self-Report	α = .92	*r* = .93	Moderately related to BHS (*r* = .68) HRSD-R (*r* = .47)
BAI	21	Clinical population 1,086 adults	Self-Report	α = .92	*r* = .75	Moderately related to HARS-R (*r* = .51) CCL-A (*r* = .51) STAI (*r* = .47 - .58) WRAD (*r* = .54)
SELF-A	19	223 College Students	Self-Report	α = .97	Not Reported	Strongly related to PRLS (*r* = .71)

Research Questions

The purpose of this study was to investigate the effect of 16 sessions of NF training on college students with ADHD diagnoses: (a) scores of ADHD symptoms (as measured by the CAARS-S:S; Conners et al, 1999), (b) depression (as measured by the BDI-II; Beck et al, 1996), (c) anxiety (as measured by the BAI; Beck & Steer, 1990), and (d) academic self-efficacy (as measured by the SELF-A; Zimmerman & Kitsantas, 2005) over time. The independent variable in this study was time whereas the dependent variables included (a) hyperactivity, (b) impulsivity, (c) inattention, (d) self-concept, (e) depression, (f) anxiety, and (g) academic self-

efficacy. The research question was: Are there mean rank differences in college students' scores on the *Conner's Adult ADHD Rating Scale* (CAARS), the *Beck Depression Inventory* (BDI), the *Beck Anxiety Inventory* (BAI), and the *Self Efficacy for Learning Form-Abridged* (SELF-A) over time when receiving a NF intervention?

Data Analysis

The Statistical Package for Social Science (SPSS) software package for Windows version 21.0 (IBM Corp., 2012) was used to analyze the data. This study employed a quasi-experimental, times-series design with one independent variable (time) and seven dependent variables. As such, the dataset will include the following continuous dependent variables (a) inattention (as measured by the CAARS-S:S inattention subscale), (b) hyperactivity (as measured by the CAARS-S:S hyperactivity subscale), (c) impulsivity (as measured by the CAARS-S:S impulsivity subscale), (d) self-concept (as measured by the CAARS-S:S self-concept subscale), (e) depression (as measured by the BDI-II), (f) anxiety (as measured by the BAI), and (g) academic self-efficacy (as measured by the SELF-A).

To answer the research question, the researcher used SPSS to conduct a Friedman's ANOVA (Friedman, 1937; Friedman, 1940; Daniel, 1990). Because the sample size was too small for a parametric analysis (i.e., the data were not normally distributed), the researcher conducted a Friedman's ANOVA for each of the DVs. The Friedman's ANOVA is the nonparametric equivalent to the repeated measures ANOVA. The Friedman's ANOVA converts continuous or ordinal scores into ranked scores for each individual over time and computes a test statistic (X^2) based on those ranked scores. If the test statistic falls above the threshold for statistical significance, the researcher is able to reject the null hypothesis (Daniel, 1990). Further,

because there were four groups (i.e., assessment time points), the researcher conducted post hoc tests to determine which groups had statistically significant differences (e.g. pretest-posttest, pretest-follow up…etc.).

The researcher addressed the following assumptions for Friedman's ANOVA before running the analyses. The data were collected from one group of subjects at four time points, the group of subjects randomly selected from the population to participate, the DVs are measured at the continuous level, and, because the Friedman's ANOVA is a nonparametric analysis, the data did not need to be normally distributed (Lowry, n.d.).

Ethical Considerations

The researcher took the following steps to ensure participants were treated in an ethical manner while participating in this study. The researcher obtained approval from the IRB before commencing any study related recruitment or activity. Once participants decided to participate in the study, they were informed of their rights while participating in the study through the informed consent process. Because the IRB labeled the study as exempt, participants were not required to sign the informed consent; however, they were made aware of the study protocol and potential risks and benefits. Further, participants' identifiable information was included on the treatment letter verifying an ADHD diagnosis. Thus, to protect participant confidentiality, the researcher separated the treatment letters from the participants' instrument packets and assigned participant numbers to the packets. Moreover, the researcher stored all participant data in a locked file cabinet in the researcher's locked office.

Limitations of the Study

A number of the limitations to this study were discussed in the threats to validity section. The lack of a control group is a limitation to the study design, adding a control group would allow the researcher to compare the scores on the assessments between the treatment and control group, increasing internal validity. Attrition is another limitation to the study in that internal validity was threatened due to a lack of completion from the participants. Further, the small and convenient sample is a limitation to the study as the power of the statistical results was low due to a small sample size. Shadish and colleagues (2002) suggest increasing the sample size in a study in order to increase statistical power. Moreover, data collection procedures (i.e., self-report measures) pose a limitation to the study as participants may respond to the questionnaires in a socially desirable manner. Including an observer-report measure would strengthen the validity of the results. Instrumentation error is also a potential limitation of the study. As some participants in the fall semester of data collection took longer than eight weeks to receive their 16 sessions of NF, treatment fidelity is threatened and serves as a limitation to the study.

The researcher described methods incorporated to mitigate the threats to validity explored in the validity section. Some elements that the researcher implemented to reduce the threats to validity include (a) collecting data over two semesters to increase sample size, (b) ensuring treatment fidelity in the RA training and session notes, and (c) ensuring the statistical procedure used to analyze the data is appropriate for the data gathered.

Conclusion

Chapter three has provided an overview of the research design and protocols for the proposed study. The research methods chapter described potential threats to validity (i.e., statistical conclusion, internal, construct, and external) in addition to mechanisms that may mitigate these threats. Additionally, data collection procedures including population, sample, recruitment, incentives, and screening criteria were described. Moreover, the reliability and validity of the data collection instruments used in the study were presented in addition to the data analysis procedures, ethical considerations, and limitations of the study.

CHAPTER FOUR: RESULTS

Chapter four presents the results of the current study investigating the effects of neurofeedback training on ADHD symptoms, depression, anxiety, and academic self-efficacy in college students diagnosed with ADHD. The purpose of the study was to test the hypothesis that after 16 sessions of neurofeedback training, participants' scores on the *Conners Adult ADHD Rating Scale* (CAARS; Conners et al, 1999), *Beck Depression Inventory-II* (BDI-II; Beck et al, 1961), and the *Beck Anxiety Inventory* (BAI; Beck et al, 1996) would decrease over time. Further, the researcher hypothesized that participant scores on the *Self-Efficacy for Learning Form-Abridged* (SELF-A, Zimmerman & Kitsantas, 2005) would increase. The current study incorporated a one-group time-series design to explore the effects of 16 sessions of neurofeedback on college students diagnosed with ADHD.

This chapter reviews the study's (a) research design, (b) sampling and data collection methods, (c) participants' descriptive data, (d) preliminary data analysis procedures and explanation of statistical assumptions, (e) results of statistical analyses, and (f) a conclusion of the findings of the study.

Research Design

The current study implemented a one group, quasi-experimental time series research design in which 11 study participants received 16 sessions of a neurofeedback training intervention over eight to ten weeks. Participants' symptoms of ADHD (CAARS:S-S; Conners, et al, 1999), depression (BDI-II; Beck et al, 1961), anxiety (Beck et al, 1996), and academic self-

efficacy (SELF-A, Zimmerman & Kitsantas, 2005) were measured at four time points throughout the study. Time series research designs allow researchers to repeatedly test participants over the course of an intervention. Repeatedly assessing participants increases the internal validity of the study as multiple assessment points strengthens the researcher's ability to state a causal relationship between the independent variable (IV) and the dependent variable (DV) (Shadish, Cook, & Campbell, 2002). Therefore, changes observed in scores over time can be better attributed to the intervention implemented rather than an external factor.

Data Collection

Data in the current study were collected over two rounds of data collection which spanned the course of nine total months (May 2016-January 2017). Participant recruitment began in April 2016 with the researcher recruiting participants from the pilot study and placing flyers around a large Southeastern University campus. Further, the researcher contacted the student accessibility/disability services offices at nearby colleges in the Southeastern United States with the hopes that the offices would share the study flyer with the students at their institutions. Neurofeedback sessions began in May 2016 for the first round of data collection and ended in July 2016. The second round of neurofeedback sessions began in September 2016 and ended in early December 2016. Follow up sessions were conducted in August 2016 and December 2016/January 2017 for the first and second rounds of data collection respectively.

Participants received 16 total sessions of neurofeedback (with the exception of one participant who, due to a clerical error, received 17 sessions) with 1-2 sessions of neurofeedback per week. Participants were scheduled for two sessions each week, however, due to unforeseen circumstances (i.e., Hurricane Matthew, scheduling conflicts) there were some weeks in which

participants received only one session. The researcher collected self-report data from the participants on their symptoms of ADHD, depression, anxiety, and academic-self-efficacy. Participants completed self-report assessments at the first session (pretest), after eight sessions of neurofeedback (mid), after their sixteen (or 17) total neurofeedback sessions (post), and at a four week follow up (follow-up). Multiple assessment points allowed the researcher to assess changes in scores over time. That is, the researcher was able to evaluate changes in scores based on whether the participants received eight (pre-mid) or sixteen sessions (pre-post). Further, the researcher was able to determine whether the changes in scores were lasting with the follow up scores.

Sampling Procedures

The researcher recruited participants through the dissemination of flyers at the large Southeastern University and surrounding colleges. Participants from the student populations at these institutions were randomly exposed to the recruitment flyers and self-selected to participate based on the information outlined on the flyer. The researcher purposefully placed flyers in the offices on the campuses that would most likely serve the population of students that were eligible for the study. These offices included Student Accessibility/Disability Services (office serving students with accessibility/disability needs including learning disabilities and ADHD), Counseling and Psychological Services (office providing free counseling and psychological services to college students), and the Office of Wellness and Health Promotion (office providing biofeedback—a similar intervention to that used in the current study—to college students).

Potential participants who expressed interest in participating in the study called the researcher's office telephone and completed a short over-the-phone screening. Inclusion criteria

for the study included the following: (a) over 18 years of age; (b) currently enrolled at a college; (c) able to provide documentation of an ADHD diagnosis from a mental health professional; (d) no history of psychosis or psychotic disorders—to be verified in the treatment letter from the mental health professional and self-report; (e) no recent emotional hospitalizations—within the past month, to be verified by self-report; (f) not currently pregnant; (g) did not have an implanted electrical medical device such as a pacemaker; (h) did not have severe skin allergies; and (i) was able to speak, read, and understand English as all of the assessments were in English.

Response Rates

The researcher recruited participants through the dissemination of flyers on Southeastern United States higher education institutions' campuses. There is no method of determining how many individuals were exposed to recruitment flyers; thus, the researcher can no accurately calculate a response rate. However, 23 total individuals expressed interest in participating in the current study. Of the 23 interested participants, 2 individuals were not eligible to participate, 4 individuals never showed up for their first sessions, 4 individuals could not fit the sessions into their schedules, 13 individuals completed at least 1 neurofeedback session, and 11 of the 13 participants completed all 16 sessions of neurofeedback and all of the assessments. Therefore, the completion rate for the participants that expressed interest was 47.8%.

Descriptive Statistics

Participants in the current study included 11 college students who had been diagnosed with ADHD at some point in their lifetime. Participants in this study self-selected to participate in the study and provided proof of an ADHD diagnosis in the form of a treatment summary. Participants (n = 4) presented with Attention Deficit Hyperactivity Disorder, Combined type

(314.01, F90.2) as their diagnosis, one participant presented with Attention Deficit Hyperactivity Disorder with hyperactivity as their diagnosis, and the other six participants' treatment summaries did not specify the type of ADHD. At the outset of the study, eight participants reported using medication as a means by which they managed their ADHD symptoms (one participant reported beginning a medication regimen after the first week of NF sessions). Additional methods of managing ADHD symptoms for the participants included mental health counseling (n = 3), meditation (n = 9), and apps to help with studying and time management (n = 1). The sample included three participants (27%) who identified as males, and eight participants (73%) who identified as female. Participant ages ranged from 18 to 27 years of age. Students were enrolled in both the undergraduate (n = 8) and graduate (n = 3) level programs. The vast majority (n = 9) of the participants identified racially as White (non-Hispanic), with one participant identifying as Hispanic, and one participant identifying as Biracial.

Main concerns for the participants included issues surrounding focus/concentration, inattention, test anxiety, stress, memory, and time management. Participants reported expectations and hopes that participating in the study would help alleviate some of their symptoms of ADHD. Two participants mentioned a specific hope that participating in the study would help them to be able to reduce their need for medication for their ADHD and sleep. Participants also rated themselves as being in "good" (n = 8) or "average" (n = 3) physical health and all participants reported that they exercise and try to eat healthy as a positive thing they do to impact their health. Only one participant reported having migraines, sleep concerns were an issue for six participants, with participants reporting an average of between four and six hours of sleep per night. Participants also reported experiencing "blue moods" (n = 6), anxiety (n = 4),

difficulty concentrating (n = 11), lack of energy (n = 6), racing thoughts (n = 8), angry outbursts (n = 1), feelings of inferiority (n = 7), and memory problems (n = 10).

Participants reported conservative use of alcohol and drugs. Six participants reported drinking alcohol as often as several times per month and as seldom as several times per year. One participant reported using marijuana several times per year. No participants were in recovery for an addiction; however, three participants reported a family history of substance abuse. One participant reported having suicidal thoughts in the past; however, the participant reported she was not currently having suicidal thoughts and did not have a plan. Participants reported having "some (1-5)" (n = 7), or "many (5+)" (n = 4) supportive individuals in their lives. Further, participants reported activities such as reading, exercising, playing videogames, watching television, journaling, crafting, playing with pets, music, and engaging in prosocial activities around campus as positive things they do to foster their emotional health. See Table 2 for participant demographic information.

Table 2. Participant Demographics

Demographics	*Male*	*Female*
Gender	3	8
Race		
Hispanic	-	1
White	3	6
Biracial	-	1
Current Efforts to Manage ADHD Symptoms		
Medication	2	7
Counseling	-	2
Physical Health Rating		
Good	2	6
Average	1	2
Number of Supports		
1-5 Some	2	5
5+ Many	1	3
Alcohol or Drug Use		
Alcohol	1	5
Drugs	-	1
None	2	2
Frequency of Alcohol Use		
1/2x per month	1	4
Several times/month	-	1
Several times/year	-	1

Instrumentation

Conner's Adult ADHD Rating Scale

The *Conner's Adult ADHD Rating Scale* Short, Self-Report form (CAARS; Conners, Erhardt, & Sparrow, 1999) is a 26 item, Likert-scale measure of ADHD symptoms in adults. It is composed of four subscales (inattention, hyperactivity, impulsivity, and self-concept) as well as an ADHD index. The CAARS is scored by adding the responses from each item in each subscale to determine a total subscale score. Further interpretation of the CAARS may include plotting individuals' total subscale scores on a profile. When participants' scores are plotted in their profile, *T* scores are provided for each subscale total score based on the individual's age and gender. According to Conners and colleagues (1999), profile patterns including at least one clinically significant *T* score (> 65), are representative of marginally significant problems with ADHD symptoms. The more scales with clinically significant *T* scores, the higher the level of impairment. The researcher did not incorporate *T* scores into the analysis of the data for this study as raw total scores for each subscale were used instead. Using the raw scores allowed the researcher to analyze the data using the Friedman ANOVA. Using previously transformed data would have affected the interpretation and calculation of the X^2 statistics in the Friedman ANOVAs. Thus, *T* scores are useful in the practical interpretation of the CAARS scores as they provide information on how individuals' scores compare to a normed population; however, raw scores are best when running analyses on the data to compare subjects' scores across time (Pallant, 2010). The following is a report of reliability data for each of the subscales included in the current study.

Total reliability coefficients for the CAARS were strong for pre (α = .922), mid (α = .899), post (α = .848), and FW (α = .892). Specifically, the inattention subscale of the CAARS is composed of five items. Instrument statistics for the CAARS inattention subscale can be found in Table 3. Internal consistency coefficients below .7 are considered questionable, with coefficients around .7 considered moderate and those above .8 considered strong (Pallant, 2010). However, alpha coefficients may vary depending on the number of items on the assessment and the sample size. That is, smaller sample sizes and less assessment items may yield lower alpha coefficients (Leech, Onwuegbuzie, &O'Connor, 2011; Streiner, 2003). Coefficients for the inattention subscale of the CAARS were moderate to strong (pre α = .916; mid α = .785; FW α = .678) with the post coefficient being the most questionable (α = .585). The pre reliability coefficient from the current study sample is higher than that found in the norm population (α = .83; α = .80) for men and women respectively. The mid, post, and FW reliability coefficients are all below that of the norm population.

The hyperactivity subscale of the CAARS is also composed of five items measuring hyperactivity and restlessness. Reliability coefficients for the hyperactivity subscale of the CAARS were moderate to strong for the pre (α = .694), mid (α = .728), post (α = .840), and FW (α = .916). The mid and post coefficients from the current study's sample are consistent with the hyperactivity coefficients for males (α = .77) and females (α = .80). Pre and FW coefficients are lower and higher than hyperactivity reliability coefficients respectively.

The impulsivity subscale of the CAARS is also composed of five items measuring impulsivity and emotional lability. Reliability coefficients for the impulsivity subscale of the CAARS were moderate for the pre (α = .721), mid (α = .708), post (α = .681), and FW (α = .708)

administrations of the CAARS. The reliability coefficients from the current study's sample are lower than the hyperactivity coefficients for males (α = .80) and females (α = .77).

Finally, the self-concept subscale of the CAARS consists of five items measuring problems with self-concept. Reliability coefficients for the self-concept subscale of the CAARS were strong for the pre (α = .838), mid (α = .817), and post (α = .881) administrations of the CAARS. Coefficients for the FW administration were moderate (α = .741). The coefficients for the sample population in the current study were slightly lower than those from the normed non-clinical sample (α = .86) for men and women. It must be noted that the sample size in the current study (*N* = 11) was significantly smaller than the sample size from Conners and colleagues' study (*N* = 799; Erhardt et. al., 1999). Therefore, the lower alpha coefficients (i.e., post inattention) may reflect differences in consistency based on the smaller sample (i.e. a wider range of scores from a smaller number of subjects; Conners, et. al., 1999).

Beck Depression Inventory

The *Beck Depression Inventory-II* (BDI-II; Beck, Steer, & Brown, 1996) is a 21 item self-report Likert scale measure of depressive symptoms. Depression as a construct in the current study is defined as participants' scores on the BDI-II. Descriptive statistics for the BDI-II including means and standard deviations can be found in Table 3. Internal consistency coefficients were strong for the pretest (α = .934), midpoint (α = .937), posttest (α = .920), and FW (α = .912) administrations of the BDI-II. The reliability coefficients in the current sample are consistent with the coefficients found in a clinical sample (α = .92) and nonclinical sample (α = .93).

Beck Anxiety Inventory

The *Beck Anxiety Inventory* (BAI; Beck, & Steer, 1990) is a 21 item self-report Likert scale measure of symptoms of anxiety. The researcher has operationally defined anxiety as participants' self-report scores on the BAI. Descriptive statistics for the BAI including means and standard deviations can be found in Table 3. Internal consistency coefficients were strong for pretest (α = .946), midpoint (α = .944), posttest (α = .895), and FW (α = .962), suggesting that the items on the BAI sufficiently measure anxiety. The reliability coefficients in the current sample are consistent with the coefficients found in a nonclinical sample of college students (α = .92).

Self-Efficacy for Learning Form-Abridged

The *Self-Efficacy for Learning Form-Abridged* (SELF-A; Zimmerman & Kitsantas, 2005) is a 19 item self-report measure of academic self-efficacy in college students. The SELF-A assesses college students' perceived ability to complete academic related tasks and includes items related to study habits, note taking, and soliciting help if need be from a classmate or the instructor. Academic self-efficacy was operationally defined as the total score on the SELF-A. As participants' responses were measured on a scale of 0 – "I definitely cannot do this", to 100 – "I definitely can do this", higher total scores indicated higher academic self-efficacy. Descriptive data for the SELF-A can be found in Table 3. Internal consistency coefficients for the SELF-A were strong for midpoint (α = .954), posttest (α = .951), and FW (α = .944). The pretest reliability coefficient was questionable (α = .483), indicating a weak relationship between participants' responses on each of the items, suggesting that participants may have varied in the

types of academic self-efficacy with which they presented. That is, participants may have reported high efficacy on some of the items of the SELF-A and not others, providing a level of inconsistency for the instrument overall. The reliability coefficients found with the current study sample are consistent with the communalities reported by Zimmerman and Kitsantas (i.e., > .9) with the exception of the pretest reliability coefficient.

Table 3. Statistics for the CAARS, BDI-II, BAI, and SELF-A

Descriptive Statistics	*M*	*SD*	*Median*	*Mean Rank*	Range	Min.	Max.
CAARS—Inattention							
Pretest	10.55	4.204	11	3.14	12	3	15
Midpoint	8.73	2.867	9	2.86	9	5	14
Posttest	8.09	2.508	8	2.41	7	5	12
Follow Up	7.00	2.408	7	1.59	7	4	11
CAARS—Hyperactivity							
Pretest	10.18	2.750	10	3.36	8	6	14
Midpoint	8.09	2.844	8	2.50	10	4	14
Posttest	7.09	2.844	7	1.86	11	3	14
Follow Up	7.36	3.854	8	2.27	14	1	15
CAARS—Impulsivity							
Pretest	3.36	2.693	3	3.00	9	1	10
Midpoint	2.36	1.963	2	2.32	6	0	6
Posttest	2.45	1.916	2	2.36	6	0	6
Follow Up	2.27	1.954	2	2.32	6	0	6
CAARS—Self-Concept							
Pretest	7.09	4.036	6	3.41	13	0	13
Midpoint	4.91	2.700	4	2.68	9	0	9
Posttest	3.45	2.544	4	1.77	8	0	8
Follow Up	3.91	2.343	4	2.14	7	0	7
BDI-II							

Pretest	10.55	9.658	9	3.45	27	0	27
Midpoint	7.09	8.584	5	2.64	28	0	28
Posttest	5.82	7.692	4	1.86	26	0	26
Follow Up	5.64	6.860	2	2.05	20	0	20
BAI							
Pretest	13.18	13.273	8	3.45	42	1	43
Midpoint	8.91	10.737	4	2.55	31	2	33
Posttest	6.91	7.176	4	1.91	21	1	22
Follow Up	8.18	12.552	3	2.09	43	1	44
SELF-A							
Pretest	111.500	26.036	109	1.27	85.0	74.0	159.0
Midpoint	123.545	31.793	120	2.45	90.5	76.0	166.5
Posttest	127.455	29.874	132	2.68	85.0	84.0	169.0
Follow Up	132.909	29.156	134	3.59	92.0	82.0	174.0

Data Analysis

Preliminary Analyses

Friedman's Test (Friedman, 1937; 1940) was conducted using the Statistical Package for the Social Sciences Version 23.0. The researcher used the Friedman's ANOVA to answer the research question of: Are there mean rank differences in college students' scores on the *Conner's Adult ADHD Rating Scale* (CAARS), the *Beck Depression Inventory* (BDI-II), the *Beck Anxiety Inventory* (BAI), and the *Self Efficacy for Learning Form-Abridged* (SELF-A) over time when

receiving a NF intervention? Specifically, the researcher sought to explore differences in participants' scores on the inattention, hyperactivity, self-concept, impulsivity subscales of the CAARS; and the total depression, anxiety, and academic self-efficacy scores over time.

The purpose of the Friedman ANOVA is to examine mean rank differences in a dependent variable between three or more groups. Contrary to similar parametric analyses (i.e., Repeated Measures ANOVA), the Friedman ANOVA transforms the raw scores into ranked scores in each group and compares the ranks to one another (Daniel, 1990; Friedman, 1937). Comparing ranks instead of raw continuous scores allows the researcher to analyze data when the parametric assumption of normality is violated (Daniel, 1990). The ranks are calculated by assigning a number based on the rank of the individual's score in each group. For example, if an individual's highest score of the four data collection time points was the first score, the first score would be assigned the highest rank. And the other three scores would be assigned based on how they rank with one another. Individual subjects' scores are ranked and each groups rank is then totaled. That is, the total rank for each assessment point is included in the analysis. If the difference in total ranks of each group is significant at the $p < .05$ level based on the critical value calculation, the researcher can assert that there is a difference between the groups (Lowry, n.d.). Further, Wilcoxon post hoc tests were conducted to determine where differences lie between groups in the cases where significance was found in the Friedman analyses. When the researcher conducted the post hoc tests, a Bonferroni adjustment was implemented because six post hoc tests were run on the same datasets. Bonferroni adjustments are suggested as alpha levels are inflated when multiple tests are run on the same data (Gall, Gall, & Borg, 2006). Thus, the researcher calculated a reduced alpha level of significance based on the number of tests being

run on the data. In the case of the current study, six post hoc tests were run for each significant Friedman test; therefore, the researcher divided the alpha level by six. The new alpha level used in the post hoc tests to determine significance was ($\alpha = .0083$). Significance was also reported at the $p < .05$ level for the post hoc tests because although, statistically, the alpha level may be inflated, providing a larger probability for type I error; effect sizes provided support of a significant change in scores over time (Shadish, et. al., 2002). That is, the researcher sought to report the strength of the effect based on the positive and negative ranks regardless of the statistical significance (as determined by the Bonferonni adjusted alpha) as effects may occur in a sample even if statistical significance is not found (Shadish, et. al., 2002).

The Friedman ANOVA is the nonparametric equivalent to the parametric Repeated Measures ANOVA analysis. The data in the current study met the assumptions necessary for the Friedman ANOVA in that the data were: (a) collected from one group at three or more different occasions; (b) collected from a random sample of a population; (c) collected with the dependent variables at a continuous level; and (d) do not need to be normally distributed (Lowry, n.d.). As the assumptions for the Friedman ANOVA are more methodological in nature rather than statistical, specific statistical analyses were not necessary to show that the data met the assumptions. The data were gathered from one group of subjects who randomly self-selected to participate at four different occasions with measurements yielding continuous data. Further, the data are not normally distributed.

Primary Research Question

The research question guiding this study was: Are there mean rank differences in college students' scores on: (a) the *Conner's Adult ADHD Rating Scale* (CAARS), (b) the *Beck*

Depression Inventory (BDI-II), (c) the *Beck Anxiety Inventory* (BAI), and (d) the *Self Efficacy for Learning Form-Abridged* (SELF-A) over time when receiving a NF intervention? To answer the research question, seven Friedman ANOVAs were run to investigate differences in scores on each of the dependent variables (inattention, hyperactivity, impulsivity, self-concept, depression, anxiety, and academic self-efficacy). In cases in which differences were found (i.e., $p < .05$), post hoc analyses were run to determine which groups were significantly different.

Inattention

The *Conner's Adult ADHD Self-Report Scale* (CAARS; Conners, et. al., 1999) includes an inattention subscale which includes five items addressing problems with inattention and memory (e.g., I'm disorganized, I have trouble getting started on a task). A Friedman ANOVA was conducted on the pre, mid, post, and follow up scores on the inattention subscale for the CAARS. There was a significant difference in scores in the inattention subscale of the CAARS ($X^2_{(3)} = 10.268$, $p = .016$). Mean ranks for the groups were as follows (Pre $MR = 3.14$, Mid $MR = 2.86$, Post $MR = 2.41$, and FW $MR = 1.59$; See Table 3). That is, the pre assessment ranks for inattention were highest and the ranks decreased over time.

Post hoc Wilcoxon tests were conducted on the inattention data to examine which groups showed significant differences from one another. Wilcoxon analyses indicated significant differences at the $p < .05$ level in pre inattention and post inattention ($M = 8.09$, $SD = 2.508$) scores ($Z = -2.146$; $p = .032$) with post inattention scores lower than pre inattention scores in seven cases, post inattention scores higher than pre inattention scores in three cases, and one tie. There was also a significant difference in pre inattention and follow up (FW; $N = 11$, $M = 7.00$, $SD = 2.408$) inattention scores ($Z = -2.456$, $p = .014$) with FW inattention scores ranking less

than pre inattention scores in eight cases, FW inattention scores ranking higher than pre inattention scores in two cases, and one tie. There was also a significant difference in post inattention and FW inattention scores (Z = -2.047, p = .041) with FW scores ranking lower than post scores in six cases, FW scores ranking lower than post scores in one case, and four ties. Further, a difference was found at the Bonferroni corrected alpha level of $p < .0083$ between mid inattention and FW inattention scores (Z = -2.699, p = .007) with FW inattention ranking lower than mid inattention in nine cases, no instances of FW inattention ranking higher than mid inattention, and two ties.

Post hoc analyses indicated no significant difference between the pre and mid inattention scores (Z = -1.692, p = .091). However, when subtracting mid inattention scores (N = 11, M = 8.73, SD = 2.867) from pre inattention scores (N = 11, M = 10.55, SD = 4.204), mid inattention scores were lower than the pre inattention scores in seven cases, the mid inattention scores were higher than the pre inattention scores in three cases, and there was one tie. Further, there was no significant difference in mid inattention and post inattention scores (Z = -1.310, p = .190), yet post scores ranked lower than mid scores in six cases, post scores ranked higher than mid scores in three cases, and there were two ties. See Table 4 for statistical data.

Table 4. Inattention Statistical Data

Descriptive Statistics	X^2	p	Z	p	Neg. Ranks	Pos. Ranks	Ties
CAARS—Inattention	10.268	.016*					
Pre – Mid			-1.692	.091	7	3	1
Pre – Post			-2.146	.032*	7	3	1
Pre – FW			-2.456	.014*	8	2	1

Mid – Post	-1.310	.190	6	3	2
Mid – FW	-2.699	.007**	9	0	2
Post – FW	-2.047	.041*	6	1	4

* $p < .05$; ** $p < .0083$

Effect sizes were interpreted by the magnitude of positive and negative ranks. The negative ranks indicate how many times the latter assessment scores ranked lower than the former assessments scores. On the CAARS inattention scale, the lower the score, the lower the presence of symptomology. The largest effect size can be seen between the mid and FW assessment points with FW scores ranking lower than mid scores in nine cases and no cases of mid scores ranking higher than FW scores. The largest effect size suggests that the largest decrease in inattention scores occurred between the mid and FW assessment points.

Hyperactivity

The *Conner's Adult ADHD Self-Report Scale* (CAARS; Conners et al, 1999) includes a hyperactivity subscale which includes five items addressing problems with hyperactivity and restlessness (e.g., I tend to squirm or fidget, I'm bored easily). A Friedman ANOVA was conducted on the pre, mid, post, and follow up scores on the hyperactivity subscale for the CAARS. Results indicated there was a significant difference in hyperactivity scores in the CAARS over time ($X^2_{(3)} = 10.151$, $p = .017$). Pre hyperactivity mean rank scores were highest ($MR = 3.36$), with mid hyperactivity scores second highest ($MR = 2.5$), FW scores third highest ($MR = 2.27$), and post scores lowest ($MR = 1.86$; See Table 3).

Post hoc Wilcoxon tests indicate a significant difference between pre hyperactivity ($M = 10.18$, $SD = 2.750$) and mid hyperactivity scores ($M = 8.09$, $SD = 2.844$; $Z = -2.512$, $p = .012$)

with mid hyperactivity scores ranking lower than pre hyperactivity scores in eight cases, mid hyperactivity scores ranking higher than pre hyperactivity scores in one case, and two ties. Further a significant difference exists between pre hyperactivity and post hyperactivity scores (M = 7.09, SD = 2.844; Z = -2.375, p = .018) with post scores ranking lower than pre scores in seven cases, post scores ranking higher than pre scores zero times, and four ties. A marginally significant difference was found (Z = -1.965, p = .049) between pre and FW hyperactivity (M = 7.36, SD = 3.854) as well with FW hyperactivity scores ranking lower than pre scores in seven cases, FW ranking higher than pre scores in two cases, and two ties.

Significant differences were not found between the mid hyperactivity scores and post hyperactivity scores (Z = -1.703, p = .088); however, post scores ranked lower than mid scores seven times, post scores ranked higher than mid scores one time, and there were three ties. There was also no significant difference between mid and FW hyperactivity scores (Z = -1.138, p = .255), but FW scores ranked lower than mid scores in five cases, FW scores ranked higher than mid scores in four cases, and there were two ties. Finally, there was no significant difference in post and FW scores (Z = -.604, p = .546) with FW scores ranking lower than post scores in three cases, FW scores ranking higher than post scores in four cases, and four ties. See Table 5 for statistical data.

Table 5. Hyperactivity Statistical Data

Descriptive Statistics	X^2	p	Z	p	Neg. Ranks	Pos. Ranks	Ties
CAARS—Hyperactivity	10.151	.017*					
Pre – Mid			-2.512	.012*	8	1	2
Pre – Post			-2.375	.018*	7	0	4

Pre – FW	-1.965	.049*	7	2	2
Mid – Post	-1.703	.088	7	1	3
Mid – FW	-1.138	.255	5	4	2
Post – FW	-.604	.546	3	4	4

* $p < .05$; ** $p < .0083$

Effect sizes were interpreted by the magnitude of positive and negative ranks. On the CAARS hyperactivity scale, the lower the score, the lower the presence of symptomology. The largest effect size can be seen between the pre and mid assessment points with mid scores ranking lower than pre scores in eight cases and one case of pre scores ranking higher than mid scores. The largest effect size suggests that the largest decrease in hyperactivity scores occurred between the pre and mid assessment points.

Impulsivity

The *Conner's Adult ADHD Self-Report Scale* (CAARS; Conners et al, 1999) includes an impulsivity subscale which includes five items addressing problems with impulsivity and emotional lability (e.g., I have a short fuse/hot temper, I still throw tantrums). A Friedman ANOVA was conducted on the pre, mid, post, and follow up scores on the impulsivity subscale for the CAARS. No significant difference was found between impulsivity group scores over time ($X^2_{(3)} = 3.284$, $p = .350$). Mean ranks for each group were close with pre impulsivity scores at the highest rank ($MR = 3.00$), post impulsivity scores second highest ($MR = 2.36$), and Mid and FW impulsivity scores tied with the lowest scores ($MR = 2.32$; See Table 3). The lack of variance in the mean ranks and small sample size may have contributed to the lack of significant findings for the impulsivity dependent variable (Shadish, et. al., 2002). See Table 6 for statistical data.

Table 6. Impulsivity Statistical Data

Descriptive Statistics	X^2	p
CAARS—Impulsivity	3.284	.350

* $p < .05$

Self-Concept

The *Conner's Adult ADHD Self-Report Scale* (CAARS; Conners et al, 1999) includes a self-concept subscale which includes five items addressing problems with self-concept (e.g., I get down on myself, I wish I had greater confidence in my abilities). A Friedman ANOVA was conducted on the pre, mid, post, and follow up scores on the self-concept subscale for the CAARS. A significant difference was found for self-concept scores over time ($X^2_{(3)} = 11.745$, $p = .008$). Pre self-concept scores ranked the highest of all group ($MR = 3.41$) with mid scores ranking second highest ($MR = 2.68$), FW scores ranked third highest ($MR = 2.14$), and post scores ranked the lowest ($MR = 1.77$; See Table 3).

Post hoc Wilcoxon tests indicate a significant difference between pre self-concept ($M = 7.09$, $SD = 4.036$) and mid self-concept scores ($M = 4.91$, $SD = 2.700$; $Z = -1.973$, $p = .049$) with mid self-concept scores ranking lower than pre self-concept scores in seven cases, mid self-concept scores ranking higher than pre self-concept scores in one case, and three ties. Additionally, a significant difference exists between pre self-concept and post self-concept scores ($M = 3.45$, $SD = 2.544$; $Z = -2.609$, $p = .009$) with post scores ranking lower than pre scores in nine cases, post scores ranking higher than pre scores in one case, and one tie. A significant difference was found ($Z = -2.403$, $p = .016$) between pre and FW hyperactivity ($M =$

3.91, *SD* = 2.343) as well with FW self-concept scores ranking lower than pre scores in eight cases, FW ranking higher than pre scores in two cases, and one tie.

No significant differences were found between mid self-concept and post self-concept scores (Z = -1.690, p = .091). However, post self-concept scores ranked lower than mid scores in eight cases, post scores ranked higher than mid scores in two cases, and there was one tie. Moreover, there was no significant difference between mid and FW self-concept scores (Z = -1.502, p = .133); yet, FW scores ranked lower than mid scores in seven cases, FW scores ranked higher than mid scores in three cases, and there was one tie. Finally, there was no significant difference between post and FW self-concept scores (Z = -.843, p = .399) with FW scores ranking lower than post scores in two cases, FW scores ranking higher than post scores in four cases, and five ties. See Table 7 for statistical data.

Table 7. Self-Concept Statistical Data

Descriptive Statistics	X^2	p	Z	p	Neg. Ranks	Pos. Ranks	Ties
CAARS—Self-Concept	11.745	.008*					
Pre – Mid			-1.973	.049*	7	1	3
Pre – Post			-2.609	.009*	9	1	1
Pre – FW			-2.403	.016*	8	2	1
Mid – Post			-1.690	.091	8	2	1
Mid – FW			-1.502	.133	7	3	1
Post – FW			-.843	.399	2	4	5

* p < .05; ** p < .0083

Effect sizes were interpreted by the magnitude of positive and negative ranks. On the CAARS self-concept scale, the lower the score, the lower the presence of issues related to self-

concept. The largest effect size can be seen between the pre and post assessment points with post scores ranking lower than pre scores in nine cases and one case of pre scores ranking higher than post scores. The largest effect size suggests that the largest decrease in self-concept impairment scores occurred between the pre and post assessment points.

Depression

The *Beck Depression Inventory-II* (BDI-II; Beck, et. al., 1996) total scores were used to evaluate participants' levels of depression over time during a neurofeedback treatment. A Friedman ANOVA was conducted on the pre, mid, post, and FW BDI-II scores to investigate differences in scores between groups. A significant difference was found in depression scores over time ($X^2_{(3)} = 13.165$, $p = .004$) with pre BDI-II scores ranking highest ($MR = 3.45$), mid BDI-II scores ranking second highest ($MR = 2.64$), FW BDI-II scores ranking third highest (MR = 2.05), and post BDI-II scores ranking lowest ($MR = 1.86$; See Table 3).

Post hoc Wilcoxon tests were conducted to examine specific differences between groups. A significant difference existed between the pre BDI-II ($M = 10.55$, $SD = 9.658$) and mid BDI-II scores ($M = 7.09$, $SD = 8.584$; $Z = -2.196$, $p = .028$) with mid depression scores ranking lower than pre scores in seven cases, mid scores ranking higher than pre scores in two cases, and two ties. Pre depression scores were different from post depression ($M = 5.82$, $SD = 7.692$) scores as well ($Z = -2.194$, $p = .028$) with post scores ranking lower than pre scores in nine cases, post scores ranking higher than pre scores in one case, and one tie. The final significant difference was found between the pre and FW ($M = 5.64$, $SD = 6.860$) groups ($Z = -2.194$, $p = .028$), with FW scores lower than pre scores in nine cases, FW scores higher than pre scores in one case, and one tie.

No significant differences were found between the mid depression and post depression groups (Z = -1.612, p = .107); however, post scores ranked lower than mid scores in six cases, post scores ranked higher than mid scores in one case, with four ties. Further, no difference was found between mid scores and FW scores (Z = -.509, p = .611); yet, FW scores ranked lower than mid scores in five cases, FW scores ranked higher than mid scores in two cases, and there were four ties. Finally, no difference was found between post and FW scores (Z = -.135, p = .893) with FW scores ranking lower than post scores in two cases, FW scores ranking higher than post scores in three cases, and six ties. See Table 8 for statistical data.

Table 8. Depression Statistical Data

Descriptive Statistics	X^2	p	Z	p	Neg. Ranks	Pos. Ranks	Ties
BDI-II	13.165	.004*					
Pre – Mid			-2.196	.028*	7	2	2
Pre – Post			-2.194	.028*	9	1	1
Pre – FW			-2.194	.028*	9	1	1
Mid – Post			-1.612	.107	6	1	4
Mid – FW			-.509	.611	5	2	4
Post – FW			-.135	.893	2	3	6

* $p < .05$; ** $p < .0083$

Effect sizes were interpreted by the magnitude of positive and negative ranks. On the BDI-II, the lower the score, the lower the presence of depressive symptoms. The largest effect size can be seen between the pre and post, and pre and FW assessment points with post and FW scores ranking lower than pre scores in nine cases and one case of pre scores ranking higher than

post and FW scores. The largest effect size suggests that the largest decreases in depression scores occurred between the pre and post, and pre and FW assessment points.

Anxiety

The *Beck Anxiety Inventory* (BAI; Beck & Steer, 1990) total scores were analyzed to examine differences in participants' self-reported levels of anxiety over time. A Friedman ANOVA was conducted to investigate differences in anxiety scores between the pre, mid, post, and FW groups. A significant difference was found in anxiety scores over time ($X^2_{(3)} = 10.078$, $p = .018$) with pre BAI scores ranking highest ($MR = 3.45$), mid BAI scores ranking second highest ($MR = 2.55$), FW BAI scores ranking third highest ($MR = 2.09$), and post BAI scores ranking lowest ($MR = 1.91$; See Table 3).

Post hoc Wilcoxon tests were conducted to examine specific differences between groups. A significant difference existed between the pre BAI ($M = 13.18$, $SD = 13.273$) and mid BAI scores ($M = 8.91$, $SD = 10.737$; $Z = -2.501$, $p = .012$) with mid anxiety scores ranking lower than pre scores in nine cases, mid scores ranking higher than pre scores in one case, and one tie. Pre anxiety scores were different from post anxiety ($M = 6.91$, $SD = 7.176$) scores as well ($Z = -2.407$, $p = .016$), with post scores ranking lower than pre scores in nine cases, post scores ranking higher than pre scores in two cases, and no ties. The final significant difference was found between the pre and FW ($M = 8.18$, $SD = 12.552$) groups ($Z = -2.308$, $p = .021$) with FW scores lower than pre scores in eight cases, FW scores ranking higher than pre scores in two cases, and one tie.

No significant differences were found between the mid anxiety and post anxiety groups ($Z = -1.367$, $p = .172$); however, post scores ranked lower than mid scores in seven cases, post

scores ranked higher than mid scores in two cases, and there were two ties. Further, no significant difference was found between mid scores and FW scores (Z = -.665, p = .506); yet, FW scores ranked lower than mid scores in seven cases, FW scores ranked higher than mid scores in three cases, with one tie. Finally, no difference was found between post and FW scores (Z = -.178, p = .858), with FW scores ranking lower than post scores in four cases, FW scores ranking higher than post scores in five cases, and two ties. See Table 9 for statistical data.

Table 9. Anxiety Statistical Data

Descriptive Statistics	X^2	p	Z	p	Neg. Ranks	Pos. Ranks	Ties
BAI	10.078	.018*					
Pre – Mid			-2.501	.012*	9	1	1
Pre – Post			-2.407	.016*	9	2	0
Pre – FW			-2.308	.021*	8	2	1
Mid – Post			-1.367	.172	7	2	2
Mid – FW			-.665	.506	7	3	1
Post – FW			-.178	.858	4	5	2

* p < .05; ** p < .0083

Effect sizes were interpreted by the magnitude of positive and negative ranks. On the BAI, the lower the score, the lower the presence of symptomology. The largest effect size can be seen between the pre and mid assessment points with mid scores ranking lower than pre scores in nine cases and one case of pre scores ranking higher than mid scores. The largest effect size suggests that the largest decrease in anxiety scores occurred between the pre and mid assessment points.

Academic Self-Efficacy

The *Self-Efficacy for Learning Form-Abridged* (SELF-A; Zimmerman & Kitsantas, 2005) total scores were used to evaluate differences in participants' academic self-efficacy over time throughout the intervention. When inputting the SELF-A scores to the dataset, the researcher transformed the raw scores (each item was on a scale from 0-100%) to scores from 0-10. That is, if a participant reported 67% confidence on an item, the researcher input the score as 6.7 and total scores were computed by totaling the item responses for all 19 items. There was a significant difference in self-efficacy scores over time ($X^2_{(3)} = 18.361$, $p < .001$). The mean ranks for each group increased over time (Pre *MR* = 1.27, Mid *MR* = 2.45, Post *MR* = 2.68, FW *MR* = 3.59; See Table 3), suggesting that academic self-efficacy improved over time.

Post hoc Wilcoxon tests were conducted to examine specific differences between groups. A significant difference existed between the pre SELF-A ($M = 111.5$, $SD = 26.0356$) and mid SELF-A scores ($M = 123.545$, $SD = 31.7934$; $Z = -2.179$, $p = .029$) with mid efficacy scores ranking lower than pre scores in two cases, mid scores ranking higher than pre scores in nine cases, and no ties. Differences were also found between the mid and FW groups ($Z = -1.989$, $p = .047$), with FW scores ranking lower than mid scores in two cases, FW scores ranking higher than mid scores in eight cases and one tie. The final significant difference was found between the post and FW groups ($Z = -2.146$, $p = .032$), with FW scores ranking lower than post scores in two cases, FW scores ranking higher than post scores in nine cases, and no ties. Differences were found at the Bonferroni corrected alpha level of $p < .0083$ between pre efficacy and post efficacy scores ($M = 127.455$, $SD = 29.8743$; $Z = -2.759$, $p = .006$), with post scores ranking lower than pre scores in one case, and post scores ranking higher than pre scores in ten cases. Moreover, a

significant difference was found between pre and FW (M = 132.909, SD = 29.1563) groups (Z = -2.934, p = .003), with FW scores ranking higher than pre scores in all 11 cases.

No difference was found between the mid efficacy and post efficacy groups (Z = -1.176, p = .240); yet, post scores ranked higher than mid scores in six cases, post scores ranked lower than mid scores in four cases, and one tie. See Table 10 for statistical data.

Table 10. Academic Self-Efficacy Statistics

Descriptive Statistics	X^2	p	Z	p	Neg. Ranks	Pos. Ranks	Ties
SELF-A	18.361	.000					
Pre – Mid			-2.179	.029*	2	9	0
Pre – Post			-2.759	.006**	1	10	0
Pre – FW			-2.934	.003**	0	11	0
Mid – Post			-1.176	.240	4	6	1
Mid – FW			-1.989	.047*	2	8	1
Post – FW			-2.146	.032*	2	9	0

* $p < .05$; ** $p < .0083$

Effect sizes were interpreted by the magnitude of positive and negative ranks. On the SELF-A, the higher the score, the higher the level of academic self-efficacy. The largest effect size can be seen between the pre and FW assessment points with FW scores ranking higher than pre scores in all 11 cases. The largest effect size suggests that the largest increase in academic self-efficacy scores occurred between the pre and FW assessment points.

Conclusion

Chapter four has provided an overview of the study design, recruitment and sampling procedures, descriptive demographic statistics of the sample population, descriptive data on each of the instruments, and data analysis procedures and findings. The researcher found that there were significant changes in scores over time in the inattention, hyperactivity, self-concept, depression, anxiety, and academic self-efficacy constructs. No significant changes were found in the impulsivity construct. Post hoc analyses indicated differences between pre inattention, hyperactivity, self-concept, depression, anxiety, and academic self-efficacy scores and mid, post, and follow up scores for the same constructs. Differences in mid scores and post scores were found in the academic self-efficacy construct. Additionally, a significant difference between post and follow up academic self-efficacy scores was found. The implications of these findings and a thorough discussion of the findings is presented in chapter five.

CHAPTER FIVE: DISCUSSION

Chapter five presents a discussion about the results of the current study and implications for future research. The results of the study identified that after 16 sessions of neurofeedback, college student participants reported a significant decrease in their levels of inattention, hyperactivity, negative self-concept, depression, and anxiety. Further, participants' scores in academic self-efficacy increased significantly over time; however, no significant changes were identified in participants' impulsivity symptom scores. This chapter provides an overview of the study and presents the study's (a) discussion, (b) limitations, and (c) implications and recommendations for future research.

Overview

College students diagnosed with ADHD are at higher risk for depression, anxiety, and low academic achievement as compared to individuals without ADHD diagnoses (Buchannan, 2011; Gaultney, 2014). Further, college students with ADHD diagnoses face challenges to access and adherence when pursuing pharmacological intervention for their ADHD symptoms. Adverse side effects to stimulant medications used to treat ADHD symptoms include headache and changes in appetite. Consequently, college students may seek alternative treatment options to manage their symptoms including counseling and/or drugs such as marijuana to avoid the adverse side effects related to stimulant medication (Combs et. al., 2015; Cunill et. al., 2016). Neurofeedback is a drug-free, non-invasive intervention that has shown efficacy in reducing problematic symptoms associated with ADHD (i.e., inattention, hyperactivity) as well as depression and anxiety (Escolano et. al., 2014; Hammond, 2005; Moore, 2000). Further, the side effects of

neurofeedback are minimal to non-existent (Zengar, 2013). The Zengar Institute, the manufacturers of the NeurOptimal system used in the current study, report that side effects may include feeling tired after a session. Neurofeedback may be a promising intervention to use with college students with ADHD to decrease their ADHD symptoms as well as anxiety and depression, without severe adverse side effects. Therefore, neurofeedback may be a viable treatment option for college students with ADHD as an alternative to medication.

Summary of Study

The purpose of the current study was to examine the effects of 16 sessions of neurofeedback training on college students' (a) inattention, (b) hyperactivity, (c) impulsivity, (d) self-concept, (e) depression, (f) anxiety, and (g) academic self-efficacy. Eleven college students completed sixteen sessions of neurofeedback training and were assessed at four time points (i.e., pre, mid, post, and follow-up) throughout the study to evaluate changes in symptomology over time. The researcher used the *Conners Adult ADHD Rating Scale* (CAARS; Conners et al, 1999), *Beck Depression Inventory-II* (BDI-II; Beck et al, 1961), *Beck Anxiety Inventory* (BAI; Beck et al, 1996), and the *Self-Efficacy for Learning Form-Abridged* (SELF-A, Zimmerman & Kitsantas, 2005) to measure participants' levels of ADHD symptoms, depression, anxiety, and academic self-efficacy, respectively.

Constructs of Interest

ADHD

Characteristics of Attention Deficit-Hyperactivity Disorder include symptoms of inattention, hyperactivity, and impulsivity in children and adults (American Psychiatric

Association, 2013). Although ADHD is more prevalent in children (Faraone et.al, 2016), children with ADHD diagnoses often retain the symptoms of ADHD into adulthood (Karam et. al., 2015). College students with ADHD diagnoses are at higher risk of suicidality, depression, test anxiety, generalized anxiety, and substance use/dependence (Buchannan, 2011; Combs et. al., 2015; Gaultney, 2014). Research findings identify the efficacy of neurofeedback in mitigating ADHD symptoms in children (Escolano et. al., 2014); however, less research has examined the effects of neurofeedback on ADHD symptoms in early adulthood (college students). For the purposes of the current study, symptoms of ADHD were measured by the *Conner's Adult ADHD Rating Scale* (Conners, et. al., 1999).

Depression

Depression is a mood disorder characterized by persistent sadness and a notable lack of energy (American Psychiatric Association, 2013). College students with ADHD are more likely to suffer from symptoms of depression and suicidality (Harrison et. al., 2013). Further, suicidal ideations and behaviors have been shown to have a positive relationship with ADHD symptoms (Patros et. al., 2013). Existing research shows promise for the efficacy of neurofeedback in mitigating the symptoms of depression in adult samples (Hammond, 2005); however, the current study is unique in that it provides support of the efficacy of neurofeedback in a sample of college students diagnosed with ADHD.

Anxiety

Anxiety is often characterized by excessive fear or worry. College students with ADHD are more likely to suffer from anxiety. Specifically, adults and college students with ADHD have

higher prevalence of test anxiety or anxiety related to work or academic achievement. The *Beck Anxiety Inventory* (Beck et al, 1996) was used in the current study to measure participants' generalized symptoms of anxiety. Neurofeedback has shown positive results with individuals with anxiety (Moore, 2000). Existing literature on neurofeedback's efficacy with anxiety focuses on specific diagnoses related to anxiety (i.e., Obsessive Compulsive Disorder, Post Traumatic Stress Disorder, etc.) and do not specifically focus on anxiety symptoms in college students with anxiety.

Academic Self-Efficacy

Individuals with ADHD are at risk for exhibiting lower academic self-efficacy and consequently, lower academic achievement. Academic self-efficacy, for the purpose of the current study, is defined as individuals' belief in their ability to complete a list of academic related tasks (i.e., ratings on the SELF-A). Children with ADHD are more likely to struggle academically due to the inattention and hyperactivity associated with ADHD (Major et. al., 2012; Tabassam & Grainger, 2002). Therefore, low academic self-efficacy is reinforced in childhood by low academic achievement and persists into adulthood in college, leading to higher rates of failed classes, course withdrawal, and dropping out in college students with ADHD. The current study is unique in that it evaluates the effects of neurofeedback on academic self-efficacy, which has not before been evaluated.

Participants

Participants were recruited on the campuses of Southeastern United States Universities with flyers, and classroom announcements. The researcher was contacted by a total of 23

interested potential participants; however, 10 participants were either ineligible, did not show up for their initial sessions, or could not fit the sessions into their schedules. Of the 13 eligible participants, 11 participants completed all 16 sessions and all of the accompanying assessments. The 11 subjects who completed all stages of the study consisted of 3 males and 8 females. The majority of participants in the study identified as White (n = 9; 81%), with one (9.1%) participant identifying as Biracial, and one (9.1%) participant identifying as Hispanic. Participants' ages ranged from 18 to 27 with a mean age of 22.6.

Data Collection

Participants received 16 total sessions of NF during the course of the study. One participant was scheduled for a 17th session as the result of a scheduling error; therefore, completed 17 sessions. Participants were scheduled for two NF sessions each week. Due to unforeseen circumstances (i.e., inclement weather, scheduling issues), there were some weeks in which participants received only one session. Neurofeedback training lasted 15 minutes for participants' first sessions, and 33.5 minutes for each subsequent session. Further, in the initial session, participants were administered a psychosocial assessment, as well as the CAARS, BDI-II, BAI, and SELF-A. Participants completed assessments after the eighth and sixteenth sessions, as well as at a four-week follow-up after the last NF session. Participants received an incentive in the form of a $10 gift card at the first, eighth, sixteenth, and follow-up sessions. Funding for the current study was provided through the Association for Assessment and Research in Counseling (AARC) 2016 *Scholarship Grant*.

Discussion

Demographic Data

Participants in the current study included 11 total college students. Other studies incorporating NF with a college student population included larger populations (N = 32, Fritson et. al., 2007) and as few as one in case studies (i.e., Decker et. al., 2014). Small samples are common in studies incorporating NF as an intervention with adults; however, larger samples are seen mostly in randomized control trials with children with ADHD (i.e., N = 112, Jansen et al, 2016). The most reported reason for small sample sizes in NF studies is attrition (Bink et al, 2015). Adults and college students are likely to have less flexible schedules due to employment and class obligations and may be more likely to discontinue participating in a study due to scheduling conflicts. Moreover, asking college students to make a commitment to the NF research investigation for 12 weeks is significant and contributes to attrition. Shadish and colleagues (2002) explain that researchers may prevent attrition by changing the intervention to meet the expectations of the participants; that is, if participants are not expecting to spend a lot of time participating in the study, researchers can shorten the intervention to decrease the probability of attrition. However, in the current study, the length of the intervention (16 NF sessions) was inherent in the research question and could not be shortened as the researcher explained the expectations and time commitments of the participants at the outset of the study. Future research may offer larger amounts of monetary incentives to encourage participants to complete the study. In the current study, eight participants identified as females, and three participants identified as males. Gall and colleagues (2007) express that "females are more likely than males to volunteer for research in general" (p. 187). A majority female sample can be found

in similar studies investigating inattention within college student populations (i.e., Fritson, 2007). Further, Rasey and colleagues' study included an equal number of men (n = 2) and women (n = 2). NF investigations examining anxiety and depression often include more women than men (Baehr et. al., 2001; Cheon et. al., 2015; Kerson et. al., 2009; Kluetsch et. al., 2014). A rationale for the majority of the samples being female in studies examining depression and anxiety may be because females are diagnosed significantly more with depression and anxiety as compared to males (Nemeth, Harrell, Beck, & Neigh, 2013). Further, studies examining ADHD symptoms in which the targeted population is not college students includes fewer female participants (Mayer et al, 2016; White et. al, 2005), suggesting that females with ADHD are more likely to participate in a NF study if they are a college student. Thus, the population in the current study is similar to other studies incorporating NF as an intervention with college students.

Further, the majority (n = 9; 81%) of participants identified as White and female (n = 8, 73%), with one participant identifying as Biracial, and one participant identifying as Hispanic. Therefore, the sample for the current study was not as diverse as the student demographic makeup at the large Southeastern University in which the study was conducted. Although the majority (50%) of students at the Southeastern University identify as White, 23% of students identify as Hispanic/Latino and 11.1% of students identify as African-American. With a larger sample, the demographics in the current study sample may have more closely mirrored that of the student population at the large Southeastern University. As such, the results of the current study are not generalizable to students from backgrounds not represented in the current study (i.e., Black, Asian, etc.). Future research may include individuals from more diverse backgrounds and a larger sample size to improve the external validity and generalizability of the

study. However, a small sample of minority participants is not abnormal in research, with researchers examining ways to increase minority recruitment and retention in research (Levkoff & Sanchez, 2003; Shavers, Lynch, & Burmeister, 2002). Individuals from underrepresented backgrounds may be less likely to participate in research due to historical events (Corbie-Smith, 1999; Freimuth, Quinn, Thomas, Cole, & Duncan, 2001). For example, the Tuskegee Syphilis Study was a study in which hundreds of Black farmers were infected with Syphilis and not properly treated, resulting in the Syphilis-related deaths of over 100 Black men, thus negatively affecting African Americans' views of research. Green and colleagues (1997) found that African Americans who had knowledge of the Tuskegee Syphilis Experiment reported being less willing to engage in health related research or health education. Therefore, recruiting and retaining participants from minority backgrounds is difficult for researchers. Additionally, cultural considerations should be acknowledged when recruiting minority participants. Similar studies utilizing NF rarely reported racial demographic data-with most studies only reporting inclusion criteria (i.e., diagnosis) rather than racial demographic information. As such, future research should examine potential differences in the effects of NF based on race by implementing culturally sensitive recruitment strategies to retain participants from minority backgrounds.

All 11 participants in the current study had received ADHD diagnoses from a mental health professional (i.e., counselor, psychologist, psychiatrist, etc.). Similar studies confirmed ADHD symptom severity or ADHD diagnosis through a structured clinical interview or screening assessment (Mayer et. al., 2016; White et. al., 2005). As the participants in the current study had all received diagnoses and provided proof of the diagnoses, the researcher did not seek to validate participants' ADHD diagnoses further. Participants in the current study were also all

above the age of 18. Other research studies have been conducted with children (Escolano et. al., 2014; Gonzalez-Castro et. al., 2016) and adolescents (Duric et. al., 2012) including children as young as seven years old. The mean age of college students (M = 22.6) in the current study is similar to the ages of college student participants in similar studies (Fritson et. al., 2007). The current study sample differs from samples in similar investigations with college students in that the current study included both graduate students and undergraduate students. College student participants in similar studies (Fritson et. al., 2007; Rasey et. al., 1995) were all undergraduate students. Although, the current study includes graduate level students as well as undergraduate students, the mean age of the sample is similar to that of studies only including undergraduate students. Future research may investigate potential differences between ADHD symptomology and manifestation in undergraduate and graduate students.

Instrument Descriptive Statistics

CAARS

The *Conner's Adult ADHD Rating Scale* (Conners et. al., 1999) is a 26-item self-report measure of ADHD symptomology for adults. Items on the CAARS are four point Likert scale ranging from 0-Not at all, never; to 3-Very much, very frequently. Respondents select the number that corresponds to their level of experiencing the problem outlined in the item. The CAARS measures ADHD symptomology in the domains of inattention, impulsivity, hyperactivity, and self-concept through four subscales, each consisting of five items. Total scores for each subscale determine the intensity of symptomology in each area. That is, higher scores in each subscale indicate higher levels of symptomology. The *Conner's Adult ADHD Rating Scale* (Conners et. al., 1999) can be found in Appendix G.

When examining the reliability coefficients of the CAARS, the researcher identified adequate alpha coefficients for the overall total scores for pre (α = .922), mid (α = .899), post (α = .848), and FW (α = .892). According to Leech and colleagues (2011), reliability of scores on an instrument indicates how consistent the instrument will produce the same results over time and conditions. Internal consistency reliability refers to the likelihood of scores to be replicated across time, and conditions. That is, do the items on the scale measure the constructs across times, settings, and other conditions (Leech, et. al., 2011). In the current study, the researcher calculated Chronbach's α to determine the reliability of each of the subscales of the CAARS. Therefore, the following α coefficients represent the degree to which participants' scores on each subscale of the CAARS are likely to be replicated. Coefficients for the inattention subscale of the CAARS were moderate to strong (pre α = .916; mid α = .785; FW α = .678) with the post coefficient being the most questionable (α = .585). Therefore, the alpha coefficients for the CAARS inattention subscale suggest that participants answered more consistently in the pre assessment, and least consistently in the post assessment. A potential explanation for this phenomenon may be that participants' levels of inattention changed at an inconsistent rate over time, thus, creating inconsistencies in participants' reports of inattention. That is, participants may have experienced a high level of inattentive symptoms on each item of the inattention subscale at the outset of the study; however, as time went on, participants may have experienced changes in inattentive symptoms measured by certain items on the inattention subscale.

The reliability coefficients for the hyperactivity subscale of the CAARS were moderate to strong for the pre (α = .694), mid (α = .728), post (α = .840), and FW (α = .916) administrations of the CAARS; suggesting that respondents' scores became more consistent over time.

Reliability coefficients for the impulsivity subscale of the CAARS were moderate for the pre (α = .721), mid (α = .708), post (α = .681), and FW (α = .708) administrations of the CAARS; suggesting that respondents' scores remained moderately consistent at each administration of the assessment. Reliability coefficients for the self-concept subscale of the CAARS were strong for the pre (α = .838), mid (α = .817), and post (α = .881) administrations of the CAARS and moderate (α = .741) for the FW administration. Self-concept reliability coefficients remained relatively stable over time, suggesting that the current study participants' scores on the self-concept subscale of the CAARS were consistent at each administration.

Anastopoulos and colleagues (2015) examined the impact of a group intervention on college students diagnosed with ADHD. The researchers included the inattention, hyperactivity, and total ADHD symptoms subscales of the CAARS Long version to determine changes in symptomology in the study sample ($N = 43$). The researchers found improvements in inattention ($t = 4.81$, $d = .76$, $p < .001$), hyperactivity ($t = 1.99$, $d = .31$, $p < .06$), and total ADHD scores ($t = 3.80$, $d = .60$, $p < .15$). The researchers failed to include reliability data in the article; however, the findings are congruent with the current study findings in that significant differences were found in the inattention and hyperactivity subscales of the CAARS. The sample in the Anastopoulos study was similar to the sample in the current study in that the majority of participants were female ($n = 27$; 63%). Participants in the Anastopoulos study (2015) had an average age of 20.3 years; whereas participants in the current study had a mean age of 22.6 years. Although the participants in the Anastopoulos study and the current study are similar in gender and age, the Anastopoulos study included more diversity in the sample, with 37% of the sample being of Hispanic, African American, or multiracial backgrounds. However, as both the

Anastopolous study and the current study produced similar findings, both studies increase the generalizability of the CAARS assessment.

Moreover, Anastopoulos and colleagues (2016) evaluated the prevalence of comorbidity in college freshmen with ADHD. The sample included college freshmen with ages ranging between 18 and 22 (M = 18.2). The researchers compared a group of freshmen with ADHD diagnoses to a comparison group without ADHD diagnoses. Mean T scores on the inattention and hyperactivity subscales of the CAARS for the ADHD group were 78.6 (SD = 12.4) and 63.5 (SD = 13.5), respectively. Participants presented with the following mean scores for inattention pre (M = 67.45; SD = 13.545), and hyperactivity pre (M = 61.91; SD =8.927); thus, the current study sample differed slightly from the clinical sample population of college students in the Anastopoulos (2016) study. Participants in the current study presented with lower levels of inattention and hyperactivity symptoms than the participants in the Anastopoulos study, suggesting that the current study sample was slightly less clinical than comparable samples. However, according to Conner's and colleagues (1999), T scores greater than 65 indicate significant problems with ADHD. Therefore, although the current study sample presented with lower scores on average than a comparable population, the participants still presented with clinically significant levels of distress related to their ADHD symptomology as evidenced by a T score higher than 65 in at least one of each of the subscales for each participant. Moreover, a floor effect is more likely to occur if scores at the outset of the study are lower than average; further supporting the treatment effect in the current study sample.

BDI-II

The *Beck Depression Inventory-II* (Beck, Ward, Mendelson, Mock, & Erbaugh 1961; Beck, Steer, & Brown, 1996) is a 21-item, self-report measure of depressive symptoms. Respondents complete the BDI-II by marking the appropriate number that corresponds with the statement with which they identify most. Items on the BDI-II include sadness, self-dislike, past failure guilty feelings, and loss of interest. Corresponding statements range from 0 – not experiencing the symptom, to 3 – severely experiencing the symptom. Higher scores on the BDI-II indicate higher levels of depressive symptoms. Sample items for the BDI-II can be found in Appendix H.

Internal consistency reliability for the sample in the current study were strong for the pretest ($\alpha = .934$), midpoint ($\alpha = .937$), posttest ($\alpha = .920$), and FW ($\alpha = .912$) administrations of the BDI-II. The consistent reliability coefficients suggest that participants responded consistently on the BDI-II at each administration of the assessment. Therefore, the probability that participants' scores on the BDI-II were a result of measurement error are low (Shadish et al, 2002).

Cheon and colleagues (2016) also examined the effects of NF on depressive symptoms in adults. Similar to the current study, the researchers found a significant decrease in BDI-II scores in an adult sample. Further, the sample in the Cheon study were similar in gender makeup to the current study sample in that there were 16 women in the study and 4 men. Although the sample was similar in gender to the current study, the sample in the Cheon study were significantly older with a mean age of 43.25, than the college students in the current study ($M = 22.6$). Choi and colleagues' (2011) sample was more comparable in age ($M = 28.46$) to that of the current study

and also included more females than males, similar to the current study. The current study's findings are consistent to similar studies conducted with alike samples.

The current study sample presented with lower levels of depression than similar studies. Scores on the BDI-II are categorized as minimal (0-13), mild (14-19), moderate (20-28), and severe (29-63). The sample in Cheon and colleagues' (2016) study presented with moderate levels of depression (M = 25.25, SD = 7.91), while the current study sample presented with minimal levels of depression (M = 10, SD = 9.658). Therefore, although current study participants' scores significantly decreased over time, the sample included in the study on average did not present with clinical levels of depression; suggesting that NF may be effective in decreasing depressive symptoms in clinical and subclinical populations.

BAI

The *Beck Anxiety Inventory* (BAI; Beck, & Steer, 1990) is a 21 item self-report Likert scale measure of symptoms of anxiety. Respondents complete the BAI by selecting the corresponding number to identify the extent to which they experience symptoms of anxiety such as numbness or tingling, hands trembling, and fear of dying. Answer options range from 0 – not at all, to 3 – severely, it bothered me a lot. Higher total scores on the BAI indicate more severe levels of anxiety symptoms. Sample items for the BAI can be found in Appendix I.

Internal consistency coefficients for the BAI scores were strong for pretest (α = .946), midpoint (α = .944), posttest (α = .895), and FW (α = .962), suggesting that participants in the current study responded consistently on the BAI at each administration of the assessment. Further, strong internal consistency coefficients suggest that the probability of participants'

scores being the results of measurement error are low. That is, participants' scores on the BAI are more likely to be consistent across time and settings.

Surprisingly, many studies examining the effect of NF on anxiety symptoms did not include the BAI; rather, researchers used the *State-Trait Anxiety Inventory* (STAI; Speilberger, 1983). Not using the BAI may be a result of researchers seeking to examine potential differences in state and trait anxiety over time with a NF intervention. Cheon and colleagues (2016), however, incorporated the BAI in their study examining the effects of NF on depressive symptoms in adults with Major Depressive Disorder. The sample in the Cheon study presented with moderate levels of anxiety (M = 19.75, SD = 12.76), while the current study sample presented with mild levels of anxiety (M = 13.18, SD = 13.27). However, the large standard deviations in both samples indicate that participants in both the current study and the Cheon study varied greatly in their levels of anxiety. Similar to the findings of the current study, Cheon and colleagues found a significant difference in BAI scores (p = .01); however, the researchers reported the difference in BAI scores as approaching significance as the p value failed to meet their Bonferroni adjusted significance value of .005. The current study adds to the anxiety and NF literature by providing support for the use of the BAI with college students with ADHD.

SELF-A

The *Self-Efficacy for Learning Form-Abridged* (SELF-A; Zimmerman & Kitsantas, 2005) is a 19 item self-report measure of academic self-efficacy in college students. The SELF-A assesses college students' perceived confidence in their ability to complete academic related tasks such as note taking, asking classmates for help, or practicing effective study habits.

Respondents provide a number on a scale of 0 - “I definitely cannot do this”, to 100 – “I definitely can do this”, higher total scores indicated higher academic self-efficacy.

Internal consistency coefficients for the SELF-A scores were strong for midpoint (α = .954), posttest (α = .951), and FW (α = .944), with pretest reliability as the most questionable (α = .483). These reliability coefficients indicate that participants’ scores on the pretest administration of the SELF-A were less consistent than the mid, post, and FW administration scores were. A potential explanation for the lower reliability in the pretest SELF-A scores may be that participants may have presented with varying levels of academic self-efficacy. That is, participants may have felt efficacious in some areas (i.e., note taking), but not in other areas (i.e., soliciting help from a classmate or instructor). Finally, self-efficacy is a construct that may vary within an individual, thus causing seemingly inconsistent scores on an assessment. It appears that participants’ scores on the SELF-A were more reliable at the mid, post, and FW assessments; suggesting that participants responded more consistently at the mid, post, and FW administrations of the SELF-A. The mid, post, and FW reliability coefficients are similar to the reliability reported in Major and colleagues’ (2012) examination of academic self-efficacy in adolescents with ADHD (α = .97). It should be noted that the researchers used the long version of the SELF, which included 57 items rather than the abridged version (used in the current study) which included only 19 items.

The sample in the current study presented with self-efficacy scores that are comparable to scores found in similar samples. Major and colleagues (2012) compared self-efficacy in adolescents with ADHD and a comparison group of adolescents without ADHD diagnoses. Female adolescents with ADHD diagnoses (n = 13) presented with a mean SELF score of 50.11

(*SD* = 14.62), with male adolescents (*n* = 18) presenting with a mean SELF score of 63.54 (*SD* = 12.97). Males in the current study (*n* = 3) presented with on average less academic self-efficacy (*M* = 49.83) than the adolescent males in the Major study. However, females in the current study (*n* = 8) presented with higher levels of academic self-efficacy than males in the current study and females in the Major study (*M* = 62.01). Further, both males and females in the current study presented with lower levels of academic self-efficacy than the comparison group of male (*M* = 68.63) and female (*M* = 76.42) adolescents without ADHD diagnoses in the Major study. The slight differences in scores between the sample in the Major study and the current sample may not be significantly different, and may be the result of measurement error rather than actual differences within the study samples.

Research Question

The research question guiding the current study was: Are there mean rank differences in college students' scores on: (a) the *Conner's Adult ADHD Rating Scale* (CAARS), (b) the *Beck Depression Inventory* (BDI-II), (c) the *Beck Anxiety Inventory* (BAI), and (d) the *Self Efficacy for Learning Form-Abridged* (SELF-A) over time when receiving a NF intervention? To answer the research question, the researcher compared scores on the aforementioned assessments from 11 participants who received 16 sessions of NF. Assessments were administered at four time points, allowing the researcher to observe changes in scores in four-week intervals (pre, mid, post, and four week FW). The researcher conducted a Friedman ANOVA on each of the constructs of interest (inattention, hyperactivity, impulsivity, self-concept, depression, anxiety, and academic self-efficacy) to examine if changes in scores occurred over time.

The results of the current study indicate that there were significant improvements in scores in inattention ($X^2_{(3)} = 10.268$, $p = .016$), hyperactivity ($X^2_{(3)} = 10.151$, $p = .017$), self-concept ($X^2_{(3)} = 11.745$, $p = .008$), depression ($X^2_{(3)} = 13.165$, $p = .004$), anxiety ($X^2_{(3)} = 10.078$, $p = .018$), and academic self-efficacy ($X^2_{(3)} = 18.361$, $p < .001$) over time. A significant difference in scores was not found in the participants' impulsivity scores ($X^2_{(3)} = 3.284$, $p = .350$).

On the inattention subscale of the CAARS, mean rank scores for each assessment point consistently declined (Pre *MR* = 3.14, Mid *MR* = 2.86, Post *MR* = 2.41, and FW *MR* = 1.59; See Table 2), suggesting that participants' scores steadily improved over time. Significant differences were found between the pre and post, pre and FW, mid and FW and post and FW assessment times. The largest effect size was found between the mid and FW assessment times, suggesting that the majority of participants had the most significant improvement in scores between the eighth session and four week FW assessments. Mayer and colleagues (2012) also found medium ($d = -.56$) to large ($d = -.73$) effect sizes when exploring the effects of a NF intervention on ADHD symptoms in adults.

Further, the participants' mean pretest score for the inattention subscale was the highest mean score for all of the CAARS subscales; indicating that the sample in the current study experienced the most distress in the domain of inattention. Rasey and colleagues (1995) found that three of four college students improved in attention scores as measured by the *Integrated Variables of Attention* (IVA). The current study builds upon the existing literature by including a larger sample in which, overall, mean scores for inattention decreased over time. Thus, similar to the findings of Rasey and colleagues, inattention improved after receiving a NF intervention over

time. Moreover, the measure of inattention used in the current study was designed to assess inattention in adults with ADHD – the study population. The population in the Rasey study were college students that had not been diagnosed with ADHD. Therefore, the significant difference in scores in the current study may have been the result of the sample presenting with clinical levels of inattention at the outset of the study. Nevertheless, the current study builds upon existing research, providing further support for NF in reducing inattention in college students with ADHD.

On the hyperactivity subscale of the CAARS, mean rank scores declined, yet FW scores increased slightly. Participants scores were highest at the outset of the study (Pre *MR* = 3.36), reduced significantly (p = .012) at the midpoint (*MR* = 2.5), reduced more from mid to post (*MR* = 1.86), and increased slightly at follow up (*MR* = 2.27). Although participants' scores increased slightly at the FW assessment point, the scores were not as high as they were at the midpoint assessment, suggesting that participants may have begun to experience hyperactivity symptoms after completing the NF sessions. However, the symptoms of hyperactivity were not as severe as they were at the outset or midpoint of the study. Another follow up assessment would allow the researcher to determine whether the participants' symptoms of hyperactivity increased, decreased, or plateaued after the participants finished the 16 sessions of NF. The largest effect size was found between the pre and mid assessment points, suggesting the largest change in scores occurred after the first eight sessions. These findings contribute to the hyperactivity and NF literature, identifying that after as little as eight sessions, adults with ADHD may experience significant changes in hyperactive symptoms.

Self-concept, as it relates to ADHD, has not been examined in the NF literature. Similar to symptoms of hyperactivity, participants' scores on self-concept improved from pre to mid and from mid to post; however, a slight increase was found between post and FW. Follow-up scores were not as high as midpoint scores, suggesting that participants experienced a slight increase in problems with self-concept after completing 16 sessions of NF, yet their problems with self-concept were significantly lower (p = .016) than they were at the outset of the study. Further, five of eleven participants' scores were the same from post to FW, suggesting that for almost half of the participants, problems with self-concept remained the same over four weeks after NF sessions ceased. The current study adds to the literature by providing support that college students with ADHD experienced a significant reduction in problems with their self-concept as it relates to their ADHD diagnoses over time with a NF intervention. Moreover, the findings of the current study provide empirical support to the assertions made by researchers that using neuroplasticity to alter brain physiology may change individuals' self-perception (Brenninkmeijer, 2010; Linden, 2008).

On the BDI-II, participants' scores declined from pre to mid, and mid to post, with a slight increase from post to follow up. Although participants' scores ranked slightly higher from post to FW, more than half (n = 6) of participants' scores remained the same from post to follow up, suggesting that more than half of participants reported neither higher nor lower levels of depression four weeks after NF sessions were over. The results of the current study differ slightly from Baehr and colleagues' (2001) findings. Participants in the Baehr study included three adults had received at least 27 sessions of NF and were assessed with the BDI (Beck, Steer, & Garbin, 1988) one, three, and five years post their final NF session. Participants' reports of their

depressive symptoms remained stable one, three, and five years after receiving NF, suggesting that NF may provide stable effects as long as five years. As the participants in the current study only received 16 sessions of NF, the slight increase in depressive symptoms may be a result of not receiving enough NF sessions for a sustained reduction in depressive symptoms. The current study supports the existing literature that identified that NF is effective in reducing depressive symptoms in adults (Baehr et al, 2001; Cheon et al, 2016; Cheon et al, 2015) and contributes to the literature that college students' scores on the BDI-II reduced significantly after 16 session of a NF intervention.

Participants' scores on the BAI reduced from pre to mid and from mid to post, with a slight increase from post to FW. As with other constructs in the current study (i.e., depression, hyperactivity, self-concept), scores at FW were still not as high as they were at the midpoint or at the outset of the study. However, almost half (n = 5) of participants' scores were higher at FW than they were at post, suggesting that almost half participants experienced an increase in symptoms of anxiety after concluding NF sessions. A longer FW assessment would allow the researcher to determine whether participants' reports of anxiety symptoms would steadily increase or plateau. The slight increase in reporting of anxiety symptoms after not having NF sessions may be due to the sense of calmness that the NF sessions provide. Gracefire and Durgin (2012) found that participants report feeling more calm as a result of as little as one session of NF; however, reports of symptoms of anxiety do not change after one session. That is, individuals may experience a calmness associated with receiving NF, which may interfere with reports of symptoms of anxiety. As the BAI includes items focusing on both somatic and emotional symptoms of anxiety, participants may have experienced a reduction in the somatic

symptoms of anxiety as a result of feeling calmer after NF sessions. However, after ending NF sessions, the somatic symptoms of anxiety may have returned. Further, Kerson and colleagues (2009) found that in eight subjects, both state and trait anxiety were significantly reduced as a result of an average of 28.75 sessions of a NF intervention. Kerson and colleagues found that after a six-month follow-up, participants' scores improved significantly from the pre assessment, suggesting that NF is effective in reducing anxiety in adults with lasting results. Again, as with depressive symptoms, the participants in the current study may have shown more lasting results at follow-up if they had received more NF sessions. The results of the current study add to the NF and anxiety literature by providing support for NF with college students with ADHD and comorbid anxiety symptoms.

The researcher also found a steady increase in mean rank scores over time in academic self-efficacy. An increase in scores on the SELF-A indicate an improvement in self-reported efficacy in academic tasks. Therefore, the study findings identified that participants' academic self-efficacy increased from pre to mid, mid to post, and post to FW. Specifically, the largest effect size was observed between the pre and FW assessment times as all 11 participants scored higher at FW than they did at the outset of the study. The results of the current study add to the literature on self-efficacy and NF as no other studies have examined differences in academic self-efficacy with a NF intervention in college students with ADHD. Fritson and colleagues (2007) included a self-efficacy scale in their study examining the effects of a NF intervention on cognitive abilities and emotions in a nonclinical college student sample. The researchers did not find a difference in self-efficacy scores based on their population and self-efficacy measures. The current study differs from Fritson and colleagues' study in that the sample included college

students who are at higher risk of having low academic self-efficacy, also, the measure used in the current study assessed academic self-efficacy rather than generalized self-efficacy in college students. Academic self-efficacy may be more relevant to the college student population; therefore, may be more accurately reported by the college student sample in the current study. The results of the current study add to the NF literature on college students and self-efficacy by providing support that academic self-efficacy can improve with 16 sessions of a NF intervention.

The researcher found that pre and post impulsivity scores ranked the highest, while mid and FW scores ranked the lowest. A significant difference was not found between scores at each assessment point, suggesting that participants' scores on impulsivity were not different from one another over time. Specifically, participants presented with a mean score of 3.36 (SD = 2.69) of a total possible 15 on the impulsivity subscale of the CAARS. The findings are consistent with research on impulsivity and hyperactivity in adults with ADHD as adults are less likely to report symptoms of hyperactivity or impulsivity than children (Millstein et al., 1997). Therefore, because the participants in the current study were all adults, they were inherently less likely to report symptoms of impulsivity. As such, a floor effect may have occurred with participants reporting low impulsivity scores at the outset of the study, leaving limited room for the scores to decrease.

Limitations of the Study

As is the case with all research, the current study contains inherent limitations. These limitations include issues with the research design and the population/study sample. Potential study limitations were hypothesized in the design phase of the study and the researcher attempted

to mitigate the possibilities of specific limitations. The following sections explore the limitations of the study, and how these limitations affect the interpretation of the study results.

Research Design

The current study implemented a one group, time series, quasi-experimental design. Inherent in a one group quasi-experimental design is the limitation of the lack of a control group. Shadish and colleagues (2002) note that designs without a comparison group lack the ability to state a causal relationship between the intervention and the results. Therefore, the researcher cannot state that the intervention in the current study (i.e., neurofeedback) caused a decrease in ADHD symptomology, depression, anxiety; or an increase in academic self-efficacy. With a control group, the researcher would be better able to assert that changes in scores were the result of the intervention rather than other external factors. Moreover, restriction of range is another limitation of the current study. Restriction of range is a type of threat to statistical conclusion validity in which the ability of the researcher to determine statistical significance is impeded by a lack of variance in scores in the data. Specifically, restriction of range was evident in the current study as the variance in scores on the impulsivity subscale was not large enough to determine statistical significance. That is, a floor effect occurred in which participants reported consistently low scores on the impulsivity subscale of the CAARS. A potential explanation for the consistently low scores on the CAARS involves the wording of the questions in the impulsivity subscale of the CAARS. Some items of the impulsivity subscale such as “I still throw temper tantrums”, may have been worded in a way that may have not been relatable to the participants in the sample. As adult college students, the study participants may not have identified with the “temper tantrum” terminology as it may have reminded participants of childish behaviors.

Although the CAARS was developed for adults, the term “temper tantrums” may be altered to be more relatable to adults. Additionally, a limitation of the study also includes the fact that all of the data collection instruments were self-report; therefore, limiting the data to self-report only measures. The CAARS comes in an observer report form, which may have yielded more substantial results, especially with ADHD symptomology as participants may not have noticed changes in their behaviors that observers may have noticed. Additionally, participants may have responded in a socially desirable manner.

Finally, history is a threat to internal validity in experimental research involving the possibility of alternative external factors contributing to the changes in the dependent variables. Thus, the researcher may not be able to attribute changes in the dependent variables to the intervention. In the current study, external events may have impacted participants’ responses on the instruments. For example, one participant began taking medication after being in the study for approximately two weeks. When asked about changes they noticed since beginning the study, they reported that they had noticed improvement; however, they were unsure as to whether the improvement was a result of the new medication regimen or the NF sessions. The researcher cannot determine whether the improvement in scores was due to the medication or the intervention, threatening the internal validity of the study.

Sampling

Participants in the current study were recruited by flyers posted on campus, emails sent to student listservs, and the researcher made announcements in undergraduate and graduate level classrooms explaining the study. Convenient sampling may be a limitation in the current study as

it reduces the researcher's ability to generalize the results of the study. Because the majority of the study participants were students at the large Southeastern University at which the researcher collected data (with one participant being a student from a nearby community college), the researcher cannot generalize the results of the current study to students outside of the two institutions represented.

Twenty-three individuals expressed interest in the study with 11 participants completing all of the required sessions and paperwork. The small sample in the current study is a limitation as studies with small sample sizes are likely to have low statistical power. That is, the probability of making Type II error (falsely accepting the null hypothesis) is higher in studies with low power. Nonparametric statistical procedures are often used in small sample sizes as nonparametric analyses are valid and as powerful as their parametric counterparts despite having minimal or weak assumptions (Gibbons & Chakraborti, 2011). However, although the sample size in the current study may not affect the power of the statistical analysis, small sample sizes make it difficult for the researcher to determine whether or not the sample is a representation of a normal distribution in the population. That is, the sample may not be an accurate representation of the population. Specifically, in the current study, a larger sample may have provided more variance in scores on the assessments, thus, providing different results and conclusions about a larger more accurate representation of the population.

Implications and Recommendations

Implications

The current study provides implications for the counseling profession, public policy, and counselor education. Recently, the counseling profession has gained an increased focus on neuroscience and neurocounseling, with increased focus on the physiological and biological aspects of psychotherapy (Myers & Young, 2012; Russel-Chapin, 2016). Researchers have found connections between talk therapy and neurophysiology; specifically, research findings identify that counseling has the potential to alter brain physiology through neuroplasticity (Linden 2008). Functional Magnetic Resonance Imaging (fMRI) studies have shown changes in neurophysiology as a result of engaging in psychotherapy (Brenninkmeijer 2012). The Neurocounseling Interest Network became an official interest network in ACA in March 2015 with the purpose of connecting counselors who use neurocounseling in their counseling work. Neurocounseling is described as the practice of incorporating neuroscience and brain-based concepts into individuals' practical counseling work (Russel-Chapin, 2016). Many practitioners utilize neuroscience in practice and scholars have stressed the importance of integrating neuroscience-based interventions and concepts in counseling practice (Badenoch, 2008; Marci, Ham, Moran, & Orr, 2007; Montgomery, 2013; Myers & Young, 2012; Wheeler & Taylor, 2016). The current study provides implications for the counseling profession by adding to the literature on neuroscience-based interventions that counselors may learn more about and implement into their clinical practice. Moreover, the current study contributes to the counseling outcome based intervention research. Ray and colleagues (2011) note that only six percent of

articles published in counseling journals explored the efficacy of counseling interventions; therefore, the current study contributes to the counseling literature on intervention efficacy.

Although there is much literature on integrating neurobiology and neuroscience-focused counseling techniques in counseling practice, limited literature exists on incorporating neurocounseling as a counselor educator. The Council for Accreditation of Counseling and Related Educational Programs (CACREP, 2016), however, stresses the importance of focusing on the "biological, neurological, and physiological factors that affect human development, functioning and behavior" (p. 9). Therefore, counselor education programs should be implementing neurocounseling and principles of neuroscience in the classroom. Miller and Barrio-Minton (2016) provide a framework by which counselor educators may integrate Interpersonal Neurobiology into their courses. Further, Russo and Stevens (2016) explained in a periodical how the University of Texas at San Antonio (UTSA) implements neurocounseling; specifically, neurofeedback information is integrated into their counselor course. The faculty and students at UTSA collect data on clients receiving NF sessions as part of the counseling students' practicum experience to expand the NF literature in counseling and provide practical experience with both research and NF for their students. The current study provides implications for counselor educators as the results of the study provide evidence that participants' maladaptive symptoms decreased after receiving a neurofeedback intervention. Counselor educators may use the results of the current study to expand counseling students' knowledge of brain-based interventions.

Public policy implications of this study begin with providing evidence of the efficacy of neurofeedback as a treatment for ADHD symptoms in college students. Empirical support for NF

as an intervention may lead to policy changes as neurofeedback may be offered as a viable supplement to counseling and medication for college students diagnosed with ADHD. Eventually, college students diagnosed with ADHD, anxiety, or depression may be offered an NF as an alternative intervention to manage their symptoms in conjunction with medication and/or counseling. Additionally, empirical evidence supporting NF as a treatment for ADHD symptoms in adults may provide an evidence base for insurance companies, which may allow counselors to be reimbursed for providing NF as an intervention. Moreover, providing further evidence for NF may increase the opportunities for children with ADHD to receive alternative services such as NF as the long term effects of stimulant medications on the developing brain are still unknown (Craig, et al, 2015).

Finally, the current study adds to the NF literature and the literature on college students with ADHD. As NF is a novel intervention in the counseling profession, and most research on NF and individuals with ADHD focus on children, the current study supports and builds upon the existing research in the field. Further, the current study provides a platform on which future research in the area of NF and neurocounseling may expand.

Recommendations for Future Research

There were numerous limitations to the internal and external validity of the current study. Some threats to validity may not have been controlled for (i.e., attrition), while others may have been intentionally sacrificed to increase other forms of validity in the study (i.e., sacrificing the ability to generalize across treatment outcomes for treatment fidelity). Future research may address the limitations of the current study by including a larger study sample. Although the

sample in the current study was sufficient to answer the research question posed, a larger, more diverse sample would allow the researcher to be able to generalize the results to a larger population. Further, a larger, more diverse sample would allow for further complex statistical analyses examining differences within characteristics of participants (i.e., gender race, education, SES, and other forms of managing symptoms). That is, the researcher would be able to examine whether differences exist in how ADHD symptoms change over time with a NF intervention or not between groups. Moreover, future research should include a control group for comparison. As the current study incorporated a one-group design and causality could not be asserted, incorporating a control group to the study design would allow the researcher to compare changes in scores over time between the treatment and control groups. Thus, the researcher would be able to assert causality with a treatment and control group.

Future research may also include multiple methods of defining the constructs of interest. A threat to validity that the current study possesses is the threat of monomethod bias, in which researchers use one operational definition of a construct of interest. In the current study, depression, anxiety, and academic self-efficacy were operationally defined as the total score of the respective assessments. The problem with defining a construct solely by scores on one assessment is that the assessments used may not encompass multiple aspects of the construct. For example, anxiety is a multifaceted construct; however, the BAI does not measure specific aspects of anxiety that may be more relevant to the participants in the study. As college students with ADHD are more likely to suffer with test anxiety (Nelson et. al., 2014; Prevatt et. al., 2015), future research should include an anxiety assessment that specifically measures test anxiety in college students. As academic self-efficacy was also a construct measured in the current study,

with results suggesting an improvement in academic self-efficacy over time, future research may expand these results by including students' grades, as an additional facet of an academic achievement construct. Including students' grades in future research may provide a connection between NF and academic achievement in addition to academic self-efficacy.

Moreover, future research may seek to explore differences in the effects of NF training based on the number of sessions provided to participants. For the constructs of interest examined in the current study, the largest effect sizes ranged between each of the assessment points. That is, participants experienced the largest changes in symptomology between different assessment points (i.e., pre to mid, pre to post, mid to FW…etc.) for each construct. Future research may examine changes in symptomology after eight, 16, and more sessions with follow up assessments to determine the ideal number of sessions needed to create long lasting changes as a results of NF training. Additionally, Fuchs and colleagues (2003) compared the effects of NF training to medication and found no differences between the groups. A lack of differences between the effects of NF and medication suggests that NF training is as effective as methylphenidate in managing ADHD symptoms in children. Future research may compare the effects of NF training to medication in adults to determine whether NF training is as effective as medication in adults as it is with children. Moreover, similar research may be conducted comparing the effects of NF training to other evidenced based counseling therapies (i.e., Cognitive Behavioral Therapy) to examine whether NF training is just as effective as current evidence based interventions.

The current study was novel and essential to the growing interest and research in the neurocounseling field. Due to the novelty of the intervention in the current study, future research in this area may take many forms. On a larger level, future research incorporating NF in

counseling may include studies examining counselors and counseling students' attitudes toward neurofeedback, counselor educators' use of neurocounseling in their courses, and more efficacy studies examining NF efficacy in various populations.

Conclusion

The purpose of the current study was to examine the effects of 16 sessions of a neurofeedback training intervention on college students' symptoms of ADHD (inattention, hyperactivity, impulsivity, and self-concept), depression, anxiety, and academic self-efficacy. A one-group time series design was implemented to explore changes in participants' symptomology over the course of 12 total weeks. Participants' scores on assessments measuring ADHD, depression, anxiety, and academic self-efficacy were analyzed to examine differences from the outset of the study, to after eight sessions, to after 16 sessions, to a four week follow up.

Key findings of the study identified that participants experienced significant reductions in symptomology for the constructs of (a) inattention, (b) hyperactivity, (c) self-concept, (d) depression, (e) anxiety, and (f) academic self-efficacy. No significant changes occurred in participants' self-reported levels of impulsivity. Further, results indicate that for inattention and academic self-efficacy, participants continued to experience a reduction in symptomology after ending NF sessions. A slight increase in symptomology occurred between the post and follow up assessment points for hyperactivity, self-concept, depression, and anxiety. Although participants reported a slight increase in symptoms after ending NF sessions, levels of symptomology were still lower at follow up than at the pre and midpoint assessments.

The results of the current study provide support for the efficacy of NF in reducing symptoms of ADHD, depression, and anxiety in college students with ADHD. Additionally, the results identified that NF is effective in increasing academic self-efficacy in college students with ADHD. These results provide implications for the counseling and counselor education professions by providing evidence of an intervention to assist adults and college students with ADHD, depression, anxiety, or issues with academic self-efficacy. Further, the results of the current study may provide implications for policy by providing empirical support for the efficacy of NF, thus increasing the likelihood that NF may become an evidence-based intervention that is reimbursable by insurance companies.

APPENDIX A:
UCF INSTITUTIONAL REVIEW BOARD APPROVAL

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Shaywanna Harris**

Date: **July 20, 2016**

Dear Researcher:

On 07/20/2016, the IRB approved the following minor modifications to human participant research until 12/01/2016 inclusive:

Type of Review:	IRB Addendum and Modification Request Form Expedited Review
Modification Type:	Addition of new flyer
Project Title:	An Investigation of the Effects of Neurofeedback Training on Attention Deficit Hyeractivity Disorder (ADHD) Symptoms and Coping in College Students.
Investigator:	Shaywanna Harris
IRB Number:	SBE-15-11703
Funding Agency:	
Grant Title:	
Research ID:	NA

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 12/01/2016, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

All data, including signed consent forms if applicable, must be retained and secured per protocol for a minimum of five years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained and secured per protocol. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 07/20/2016 11:58:40 AM EDT

IRB Manager

APPENDIX B:
INFORMED CONSENT

An Investigation of the Effects of Neurofeedback Training on Attention Deficit Hyeractivity Disorder (ADHD) Symptoms in College Students.

Informed Consent

Principal Investigator(s): *Shaywanna Harris, M.A.*
Gulnora Hundley, M.D., Ph.D.
Glenn Lambie, Ph.D.

Investigational Site(s): *University of Central Florida Community Counseling and Research Center (CCRC)*

Introduction: You are being invited to take part in a research study which will include about 15 people at UCF. You have been asked to take part in this research study because you are a college student with a diagnosis of ADHD. You must be 18 years of age or older to be included in the research study. The individuals conducting this research are faculty members and graduate students in the UCF Department of Child, Family, and Community Sciences.

What you should know about a research study:

- A research assistant will explain this research study to you.
- A research study is something you volunteer for.
- Whether or not you take part is up to you.
- You should take part in this study only because you want to.

- You can choose not to take part in the research study.
- You can agree to take part now and later change your mind.
- Whatever you decide it will not be held against you.
- Feel free to ask all the questions you want before you decide.

Purpose of the research study: Neurofeedback is a drug free, non invasive training process that may increase brain efficiency. Several research studies provide encouragement that Neurofeedback has the potential to reduce ADHD symptoms in college students. The purpose of this study is to further the research on therapeutic outcomes of Neurofeedback Training and explore the efficacy of Neurofeedback Training on ADHD symptoms in college students.

What you will be asked to do in the study: In this study, you will be asked to complete an initial intake paperwork session which includes reviewing this consent form and completing the psychosocial inventory and the 4 study assessments. Assessment of your eligibility in the study will be continuous in that if you show evidence of meeting exclusion criteria at any time during the study, you may be informed that you are no longer eligible to participate in the study.

Baseline Visit:

Each participant will attend a baseline initial visit at the CCRC. In this session, you will be given an overview of the study process and sign the informed consent. Additionally, you will complete the psychosocial inventory, 4 assessments, and 15 minutes of neurofeedback training. This may take approximately one hour.

Neurofeedback training sessions will be conducted as follows:

- In each session, you will be seated in a chair in a private room in the CCRC. A trained research assistant will then attach tiny sensors near your scalp and on your

ears with medical grade adhesive. Much like an EKG or ECG, the sensors are simply reading the electric signals from your brain activity, there is nothing invasive involved with the training process. The Neurofeedback system being used does not "push" the brain in any particular direction rather, it merely cues the central nervous system to do what is naturally most efficient for the brain. During the training session, the research assistant will provide you with earbuds and begin the program. You will then listen to music during which you may notice a brief pause in the sound. The precise timing of these interruptions give the brain the vital information it needs to operate optimally. You need not do anything else during these sessions, you may read or close your eyes, but nothing else is required of you during the neurofeedback training sessions. After the session, it is highly unlikely that you will experience any side effects but due to the relaxing nature of the session, you may feel tired. To address this, you are encouraged to remain in the waiting room for 10 minutes after each session. In sessions when you will complete paperwork, you will do so before beginning the neurofeedback training session.

Location: The UCF Community Counseling and Research Center

Time required: We expect that you will commit to participate in this research study for 12 weeks. You will be required to come to the UCF Community Counseling and Research Center twice a week for approximately one hour sessions. Total, you will be asked to complete 8 weeks of neurofeedback training for a total of 16 sessions with a follow up assessment 4 weeks after the final neurofeedback session. Every 4 weeks you will be asked to complete 4 assessments; these

assessments should take approximately 20 minutes to complete. Four weeks after your last Neurofeedback session, you will be asked to complete a follow up assessment packet including the same assessments you completed during your neurofeedback sessions.

Audio or video taping: Although there are cameras in the CCRC rooms for training purposes, the Neurofeedback sessions for this study will **not** be recorded.

Risks: Risks in this study are minimal. Participants may feel tired following a neurofeedback session. To mitigate risks involved, we will recommend each participant stay in the waiting room for approximately 10 minutes following a session. If participants experience emotional discomfort throughout the process, the researchers will provide referrals to the UCF Counseling Center, Counseling and Psychological Services (CAPS), or Crisis Services for the participants at the client's request or at the clinical discretion of the research assistant. As the research assistants are also trained counselors, they will be available to minimize risks associated with immediate emotional discomfort during session. Taking part in this research study may lead to added costs to you as you will be required to provide your own transportation to and from the UCF Community Counseling and Research Clinic. However, participants are **not** required to pay nor will you be asked to pay to participate in research related activities. In rare occasions, some individuals with severe skin allergies to cosmetics or lotions may experience irritation as a result of using the conductor paste. If you have a severe skin allergy, please inform the research team.

Benefits: We are unable to promise any benefits to you or others from your taking part in this research. However, possible benefits include reduced stress, increased relaxation and optimism, and increased focus and concentration.

Compensation or payment: You will be given a $10 gift card at your first, 8th, 16th, and follow up sessions.

Confidentiality: We will limit the personal data collected in this study to people who have a need to review this information, for example the IRB and other representatives of UCF may have access to the data collected in this study however, your participation in this study is confidential. Your name or other identifying information will not be attached to any of the information gathered in this project. All electronic data will be password protected on laptops and stored with your documentation in a locked file cabinet, behind a locked door, in the CCRC which is password locked at all times. The only document that will contain your name is your treatment summary as proof of an ADHD diagnosis. However, your treatment summary will have your name redacted and a client identification number will replace it to ensure privacy, all materials will be locked in a locked file cabinet, behind a locked door, in the CCRC which is locked. The data collected will be used for statistical analyses and no individuals will be identifiable from the pooled data. The information obtained from this research may be used in future research and published. However, your right to privacy will be retained, i.e. your personal details will not be revealed. Results of assessments will be stored in a password protected computer accessible only by the research team. Per UCF IRB policy, human resesearch records will be stored for 5 years after the study has closed. Your identifiable information will **not** be attached to these records.

The information provided during the research process will be kept strictly confidential, except for those reasons required by law. These exceptions include the following:

1. When there is a serious threat to your health and safety or the health and safety of another individual or the public. Information will only be shared with a person or organization that is able to help prevent or reduce the threat.
2. When there is suspected abuse or neglect of a child, elderly person, resident of an institution, or a disabled person.

3. As a result of any lawsuit against the counselor and/or legal/court proceedings.
4. If a law enforcement official requires a release.
5. When you (the client) explicitly request in writing that information be shared with a third party.

(ACA Code of Ethics [2005], Section B.2; Chapter 491, state of Florida law governing the practice of Clinical, Counseling, and Psychotherapy Services [2010], Section 491.0147)

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints, or think the research has harmed you, talk to Shaywanna Harris, Doctoral Student and Principal Investigator, College of Education and Human Performance, (407) 823-4778, s.harris@knights.ucf.edu or Gulnora Hundley, Co-Investigator, College of Education and Human Performance, (407) 823-1652 or by email at Gulnora.hundley@ucf.edu.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901. You may also talk to them for any of the following:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You want to get information or provide input about this research.

Withdrawing from the study: Your participation in this research project is entirely voluntary. You do not have to participate. You do not have to answer any question(s) that you do not wish to answer. Please be advised that you may choose not to participate in this research study, and may withdraw from the study at any time without consequence. Whatever you decide will not be held against you in any way. If at any time within the duration of the study you meet any of our exclusion criteria, you may be disqualified from participating in the study.

Results of the research: You may be informed of the results of the research if you inquire.

APPENDIX C:
ZENGAR INFORMED CONSENT

NEUROPTIMAL®
POWERED BY ZENGAR®

CLIENT INFORMED CONSENT

I _____understand that NeurOptimal® is not a medical treatment, device or methodology. It is not used to diagnose medical disorders nor is it used as a medical treatment for disorders and has not been approved for any medical purpose by the FDA, Health Canada or any other governing agency. While Zengar trainers may or may not be licensed health care practitioners, their use of NeurOptimal® is solely as a tool for brain training and optimization and not as a means of diagnosis or as a medical intervention.

I am satisfied with the information I have been provided (verbal, written or otherwise) by my trainer on the effects I can expect during my NeurOptimal® training and my questions have been answered to my satisfaction. I understand that it is not possible to predict what my central nervous system will do with the information it is offered and consequently there can be no guarantee as to the results of my training.

I agree to cease training if I am less than happy with the results I am getting. I understand NeurOptimal® is purely a source of information and does not direct the response of the central nervous system. Consequently I agree to not hold Zengar Institute Inc or any of its users and trainers responsible for a less than desired outcome or any outcome that may be considered negative.

_____ _____

Your Signature Today's Date

_____

Your Printed Name

APPENDIX D:
RECRUITMENT FLYER

UCF Community Counseling and Research Center

Neurofeedback Training Study for College Students with ADHD.

Are you a College Student with an ADHD diagnosis?

Do you experience any of the following?

Test Anxiety
Sadness
Lack of Concentration
Sleep Disturbances

If so, you may be eligible to participate in this study!

What is Neurofeedback???

Neurofeedback training is a **non-invasive**, **drug free** intervention that measures EEG brainwaves and provides audio feedback to improve brain-functioning.

What: The first NF training will last 15 minutes, subsequent trainings will last 33.5 minutes twice a week. Total appointment time may be approximately one hour.

When: September 12th-November 28th, 2016
(8 weeks of neurofeedback sessions, with a 4 week follow up)

Whom: Current College Students with an ADHD diagnosis
You must be 18 years of age or older to participate

Cost: No cost to you.

Gift Card Incentives Provided

Interested? Contact Us!

Phone: (407) 823-4778

APPENDIX E:
RECRUITMENT EMAIL

Hello!

My name is Shaywanna Harris, I'm a doctoral student in the Counselor Education program at UCF. I'm currently working on my dissertation study using an intervention that previous research has shown may potentially mitigate symptoms of ADHD in college students. This study will be held in the Community Counseling and Research Center in the Education Complex on UCF's Campus. The purpose of this study is to explore the impact of neurofeedback training on Attention Deficit Hyperactivity Disorder (ADHD) symptoms in college students. Neurofeedback works by "listening" to your brains waves and notifying your brain when the waves are out of the mean range of functioning by providing a small interruption in the music playing. There have been numerous studies showing the efficacy of neurofeedback in children with ADHD, this study seeks to expand these results to an adult population. Participant incentives will be provided in the form of gift cards.

If you have an ADHD diagnosis and are interested in participating, please see the attached flyer and contact me (Shay) at 407-823-4778.

APPENDIX F:
PSYCHOSOCIAL INVENTORY

PSYCHOSOCIAL INVENTORY

Information Given Below is For Research Purposes Only

The information supplied below is for use in our research study only and will be kept confidential. Please answer each question as fully and honestly as you can. If you have any questions at any time, feel free to ask the research assistant and they will be happy to assist you or provide clarification.

PERSONAL IDENTIFICATION DATA

Today's Date: _____

Best Phone Number to Reach You: _____ May We Leave a Message at This Number?_____

Best Time to Contact You: Mornings:___ Afternoons:____ Evenings:_____

Email Address: _____Gender: _____ Date of Birth: _____

Age: _____

Primary racial/cultural background:

___ Asian **___ Black/African American** **___ White/Caucasian** **___ Native American**

___ Hispanic/Latino **___ Biracial/bicultural** **___ Other: _____**

BRIEFLY ANSWER THE FOLLOWING QUESTIONS **(use the back of this page if necessary)**

1. What are your main concerns as it pertains to your ADHD (what brings you here)?

_____

_____

2. What have you done about it up to this point?

_____

_____

3. What are your expectations in participating in this study?

_____

_____

4. Is there any information you would like us to know that may help us better serve you?

_____

_____

PERSONALITY INFORMATION

Circle any of the following words which you feel best describe you:

active ambitious self-confident persistent nervous hardworking impatient impulsive moody excitable imaginative calm serious easygoing shy good-natured introvert often-blue extrovert likeable leader quiet hard-boiled submissive self-conscious lonely sensitive passive indifferent

Pick 3-5 words that others would use to describe you (list here):

_____

HEALTH INFORMATION

Physical Health

Rate your physical health: ___Very Good ___Good ___Average ___Declining ___Other (please explain below):

_____

List all important present or past physical illnesses, injuries, or handicaps:

_____

_____

_____

_____

Do you currently have a pacemaker or other electric medical implanted device? ___Yes ___No (If yes, please describe)_____

_____

Have you used drugs for other than medical purposes? ___Yes ___No (If yes, please describe)

_____

Are you presently taking any medication(s) for <u>physical</u> reasons? ___Yes ___No (If yes, please describe)

_____

What <u>positive things</u> do you do that impact your physical health (e.g., exercise, eat nutritious meals, take vitamins, etc.)?

_____

_____

<u>Emotional Health</u>

Have you ever had a severe emotional upset that resulted in hospitalization? ___Yes ___No (If yes, please explain)

_____

Have you ever had any psychotherapy or counseling? ___Yes ___No (If yes, list counselor(s)/location(s) and date(s))

_____

_____

What was the outcome of any prior counseling?

_____

_____

How many supportive people (those on whom you can depend) do you currently have in your life?

___ None (0) ___Some (1-5) ___ Many (5+)

Are you presently taking any medication(s) for <u>emotional</u> reasons? ___Yes ___No (If yes, please describe)

_____

Have you ever been hospitalized for emotional/psychological concerns? ___Yes ___No (If yes, please explain)

_____

_____

Do you experience such things as (check all that apply):			**Is this current or in the past (or both)?**	
Migraines	**___Yes**	**___No**	**___ Current**	**___ Past**
Stomach Problems	**___Yes**	**___No**	**___ Current**	**___ Past**
Trouble Sleeping	**___Yes**	**___No**	**___ Current**	**___ Past**
How many hours of sleep do you get each night? _____				
Sexual Difficulties	**___Yes**	**___No**	**___ Current**	**___ Past**
Frequent Crying	**___Yes**	**___No**	**___ Current**	**___ Past**
"Blue" moods	**___Yes**	**___No**	**___ Current**	**___ Past**
Anxiety/panic attacks	**___Yes**	**___No**	**___ Current**	**___ Past**
Difficulties concentrating	**___Yes**	**___No**	**___ Current**	**___ Past**
Hallucinations (visual/auditory/tactile)	**___Yes**	**___No**	**___ Current**	**___ Past**
Lack of energy	**___Yes**	**___No**	**___ Current**	**___ Past**
Racing thoughts	**___Yes**	**___No**	**___ Current**	**___ Past**
Angry outbursts	**___Yes**	**___No**	**___ Current**	**___ Past**
Eating related issues	**___Yes**	**___No**	**___ Current**	**___ Past**
Feelings of inferiority	**___Yes**	**___No**	**___ Current**	**___ Past**
Flashbacks (Reliving traumatic events)	**___Yes**	**___No**	**___ Current**	**___ Past**
Avoiding places, activities or people that remind you of a traumatic event	**___Yes**	**___No**	**___ Current**	**___ Past**

Overwhelming Guilt or Shame	**___Yes**	**___No**	**___ Current**	**___ Past**
Memory Problems	**___Yes**	**___No**	**___ Current**	**___ Past**
Always Being on Guard	**___Yes**	**___No**	**___ Current**	**___ Past**
Addictive behaviors	**___Yes**	**___No**	**___ Current**	**___ Past**
Other _____	**___Yes**	**___No**	**___ Current**	**___ Past**

Abuse History

Have you ever been physically, sexually, emotionally, or mentally abused? ___ Yes ___No (If yes, please describe)

_____

_____

Substance Use

Do you drink alcohol or use any drugs?

___Alcohol ___Drugs ___Both ___I do not drink alcohol or use drugs

If you use alcohol or drugs, what kind do you use? Check all that apply.

___ Beer/Wine	**___ Liquor**	**___ Amphetamines/Speed/Meth/etc**
___ Marijuana/Pot/Hash/etc	**___ Cocaine/Crack/etc**	**___ Hallucinogens/Acid/Ecstasy/etc**
___ Inhalant/Huffing/Whipits/etc	**___ Opioids/Heroin/Opium/etc**	
___ Phencyclidine/Mushrooms/etc	**___ Sedatives/valium/etc**	
___ Over the counter/prescription medications		**___ Other: _____**

If you use alcohol or drugs, how often do you use them?

___ Every day **___ Several times per week**

___ Several times per month **___ Once or twice a month**

___ Several times per year **___ Once a year**

___ Other: _____

<u>If one of the above substances has been checked:</u>

Have you ever felt like you should cut down on your alcohol or other drug use (including prescription drugs)? ___Yes ___No (If yes, please describe)

_____

_____

Has a friend or relative discussed concerns about your use? ___Yes ___No (If yes, please describe)

_____

Have you ever felt guilty about your drinking or drug use? ___Yes ___No (If yes, please describe)

_____

Have you ever had to take a drink or use a drug the next day to steady your nerves? ___Yes ___No (If yes, please describe)

_____

Are you in recovery from <u>any</u> addictive behavior? ___Yes ___No (If yes, please describe)

_____

Is there a history of problems with alcohol or drug use in your family (immediate or extended)?

___Yes ___No (If yes, please describe)

_____

Do you engage in any of the following behaviors in such a way that it may be an issue for concern?

___ Gambling **___ Sexuality**

___ Spending **___ Eating (overeating, restricting, binging/purging)**

___ The Internet **___ Exercise**

___ Other: _____

Sometimes when people feel depressed or overwhelmed, they think that they'd be better off dead. Have you ever thought about suicide? ___Yes ___No (If yes, explain)

_____

_____

**** What <u>positive things</u> do you do that impact your emotional health (e.g., meditation, read, exercise, hobbies, etc.)?**

_____

_____

<u>EDUCATIONAL HISTORY</u>

What is the highest grade you have completed?

___ Some high school ___ GED ___ Special High School Diploma

___ High School Diploma ___ Some College ___ AA/AS Community College

___ Bachelor's degree ___ Master's degree ___ Specialist's degree

___ Doctorate degree

<u>RELATIONSHIP INFORMATION</u>

Relationship Status: ___Single ___Engaged ___Married ___ Cohabitating and unmarried

___ Partnered ___Separated ___Divorced ___Widowed

Name of spouse/partner: _____

Spouse's/partner's occupation: _____

Have either of you ever filed for divorce? ___Yes ___No (if yes, please describe when):

_____

Have you ever been separated? ___Yes ___No (if yes, describe when and for how long)

_____

Rate your satisfaction in your current relationship: ___Unhappy ___Average ___Happy ___Very Happy

Do you have any children? ___Yes____No

If so, how many? _____

This concludes the psychosocial portion of your intake process. Thank you for taking the time to complete this Inventory. We look forward to serving you!

APPENDIX G:
CONNERS ADULT ADHD RATING SCALE

CAARS–Self-Report: Short Version (CAARS–S:S)

by C. K. Conners, Ph.D., D. Erhardt, Ph.D., & E. P. Sparrow, M.A.

Client ID:_____ **Gender:** M F (Circle One)

Birthdate: ___/___/___ (Month Day Year) **Age:**_____ **Today's Date:** ___/___/___ (Month Day Year)

Instructions: Listed below are items concerning behaviors or problems sometimes experienced by adults. Read each item carefully and decide how much or how frequently each item describes you recently. Indicate your response for each item by circling the number that corresponds to your choice. Use the following scale: 0 = Not at all, never; 1 = Just a little, once in a while; 2 = Pretty much, often; and 3 = Very much, very frequently.

	Not at all, never	Just a little, once in a while	Pretty much, often	Very much, very frequently
1. I interrupt others when talking.	0	1	2	3
2. I am always on the go as if driven by a motor.	0	1	2	3
3. I'm disorganized.	0	1	2	3
4. It's hard for me to stay in one place very long.	0	1	2	3
5. It's hard for me to keep track of several things at once.	0	1	2	3
6. I'm bored easily.	0	1	2	3
7. I have a short fuse/hot temper.	0	1	2	3
8. I still throw tantrums.	0	1	2	3
9. I avoid new challenges because I lack faith in my abilities.	0	1	2	3
10. I seek out fast paced, exciting activities.	0	1	2	3
11. I feel restless inside even if I am sitting still.	0	1	2	3
12. Things I hear or see distract me from what I'm doing.	0	1	2	3
13. Many things set me off easily.	0	1	2	3
14. I am an underachiever.	0	1	2	3
15. I get down on myself.	0	1	2	3
16. I act okay on the outside, but inside I'm unsure of myself.	0	1	2	3
17. I can't get things done unless there's an absolute deadline.	0	1	2	3
18. I have trouble getting started on a task.	0	1	2	3
19. I intrude on others' activities.	0	1	2	3
20. My moods are unpredictable.	0	1	2	3
21. I'm absent-minded in daily activities.	0	1	2	3
22. Sometimes my attention narrows so much that I'm oblivious to everything else, other times it's so broad that everything distracts me.	0	1	2	3
23. I tend to squirm or fidget.	0	1	2	3
24. I can't keep my mind on something unless it's really interesting.	0	1	2	3
25. I wish I had greater confidence in my abilities.	0	1	2	3
26. My past failures make it hard for me to believe in myself.	0	1	2	3

APPENDIX H:
BECK DEPRESSION INVENTORY-II SAMPLE ITEMS

Beck Depression Inventory® (BDI®) and Beck Depression Inventory®–II (BDI®-II) Simulated Items

Unhappiness

0 I do not feel unhappy.
1 I feel unhappy.
2 I am unhappy.
3 I am so unhappy that I can't stand it.

Changes in Activity Level

0 I have not experienced any change in activity level.
1a I am somewhat more active than usual.
1b I am somewhat less active than usual.
2a I am a lot more active than usual.
2b I am a lot less active than usual.
3a I am not active most of the day.
3b I am active all of the day.

Information concerning the *BDI®-II* is available from:
NCS Pearson, Inc.
Attn: Customer Service
19500 Bulverde Road, Suite 201
San Antonio, TX 78259
Phone: (800-627-7271
Fax: (800) 232-1223
Web site: http://www.pearsonclinical.com/psychology/products/100000159/beck-depression-inventoryii-bdi-ii.html?origsearchtext=BDI-II
Email: clinicalcustomersupport@pearson.com

APPENDIX I:
BECK ANXIETY INVENTORY SAMPLE ITEMS

Beck Anxiety Inventory® (BAI®)
(Sample Items)

	NOT AT ALL	MILDLY It did not bother me much	MODERATELY It was very unpleasant, but I could stand it.	SEVERELY I could barely stand it
1. Frightened.				
2. Heart feels like it is skipping a beat.				
3. Legs like jelly.				

Information concerning the BAI is available from:
Customer Services in the United Kingdom

Tel: 0845 630 88 88 (Monday to Friday, 8am to 5pm)
Fax: 0845 630 55 55
Email: info@psychcorp.co.uk
Post:
Pearson Assessment
80 Strand
London, WC2R 0RL
United Kingdom

APPENDIX J:
SELF-EFFICACY FOR LEARNING FORM-ABRIDGED

Self-efficacy for Learning Form - Abridged (SELF-A)

Zimmerman and Kitsantas (2005, 2007)

Instructions: For each of the following 19 items, choose a percentage to indicate the degree to which you feel you are able to do the activity.

Definitely *cannot* do it			**Probably *cannot***		**Maybe**		**Probably *can***		**Definitely *can* do it**	
0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

_____1. When you miss a class, can you find another student who can explain the lecture notes as clearly as your teacher did?

_____2. When your teacher's lecture is very complex, can you write an effective summary of your original notes before the next class?

_____3. When a lecture is especially boring, can you motivate yourself to keep good notes?

_____4. When you had trouble understanding your instructor's lecture, can you clarify the confusion before the next class meeting by comparing notes with a classmate?

_____5. When you have trouble studying your class notes because they are incomplete or confusing, can you revise and rewrite them clearly after every lecture?

_____6. When you are taking a course covering a huge amount of material, can you condense your notes down to just the essential facts?

_____7. When you are trying to understand a new topic, can you associate new concepts with old ones sufficiently well to remember them?

_____8. When another student asks you to study together for a course in which you are experiencing difficulty, can you be an effective study partner?

_____9. When problems with friends and peers conflict with schoolwork, can you keep up with your assignments?

_____10. When you feel moody or restless during studying, can you focus your attention well enough to finish your assigned work?

_____11. When you find yourself getting increasingly behind in a new course, can you increase your study time sufficiently to catch up?

_____12. When you discover that your homework assignments for the semester are much longer than expected, can you change your other priorities to have enough time for studying?

_____13. When you have trouble recalling an abstract concept, can you think of a good example that will help you remember it on the test?

_____14. When you have to take a test in a school subject you dislike, can you find a way to motivate yourself to earn a good grade?

CONTINUE ON BACK

Definitely			**Probably**		**Maybe**		**Probably**			**Definitely**
***cannot* do it**			***cannot***				***can***			***can* do it**
0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

_____15. When you are feeling depressed about a forthcoming test, can you find a way to motivate yourself to do well?

_____16. When your last test results were poor, can you figure out potential questions before the next test that will improve your score greatly?

_____17. When you are struggling to remember technical details of a concept for a test, can you find a way to associate them together that will ensure recall?

_____18. When you think you did poorly on a test you just finished, can you go back to your notes and locate all the information you had forgotten?

_____19. When you find that you had to "cram" at the last minute for a test, can you begin your test preparation much earlier so you won't need to cram the next time?

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE

REFERENCES

Adler, L. A., Goodman, D. W., Kollins, S. H., Weisler, R. H., Krishnan, S., Zhang, Y., & Biederman, J. (2008). Double-blind, placebo-controlled study of the efficacy and safety of lisdexamfetamine dimesylate in adults with attention-deficit/hyperactivity disorder. *Journal of Clinical Psychiatry*, *69*(9), 1364.

Advokat, C., Lane, S. M., & Luo, C. (2011). College Students With and Without ADHD Comparison of Self-Report of Medication Usage, Study Habits, and Academic Achievement. *Journal of Attention Disorders*, 15(8), 656-666.

Agnew-Blais, J. C., Polanczyk, G. V., Danese, A., Wertz, J., Moffitt, T. E., & Arseneault, L. (2016). Evaluation of the persistence, remission, and emergence of attention-deficit/hyperactivity disorder in young adulthood. *JAMA Psychiatry*. *73*(7), 713-720.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5®)*. American Psychiatric Pub.

Anastopoulos, A. D., DuPaul, G. J., Weyandt, L. L., Morrissey-Kane, E., Sommer, J. L., Rhoads, L. H., ... & Gudmundsdottir, B. G. (2016). Rates and patterns of comorbidity among first-year college students with ADHD. *Journal of Clinical Child & Adolescent Psychology*, 1-12.

Anastopoulos, A. D., & King, K. A. (2015). A cognitive-behavior therapy and mentoring program for college students with ADHD. *Cognitive and Behavioral Practice*, *22*(2), 141-151.

Badenoch, B. (2008). *Being a Brain-Wise Therapist: A Practical Guide to Interpersonal Neurobiology (Norton Series on Interpersonal Neurobiology)*. WW Norton & Company.

Baehr, E., Rosenfeld, J. P., & Baehr, R. (2001). Clinical use of an alpha asymmetry neurofeedback protocol in the treatment of mood disorders: Follow-up study one to five years post therapy. *Journal of Neurotherapy*, *4*(4), 11-18.

Bakhshayesh, A. R., Hänsch, S., Wyschkon, A., Rezai, M. J., & Esser, G. (2011). Neurofeedback in ADHD: A single-blind randomized controlled trial. *European Child & Adolescent Psychiatry*, 20(9), 481-491.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191.

Barkley, R. (1997). *Defiant Children: A Clinician's Guide to Assessment and Parent Training*. New York.

Barlow, D., & Cerny, J. (1988) *Psychological Treatment for Panic*. New York: Guilford.

Barry, T. D., Lyman, R. D., & Klinger, L. G. (2002). Academic underachievement and attention-deficit/hyperactivity disorder: The negative impact of symptom severity on school performance. *Journal of School Psychology*, *40*(3), 259-283.

Beck, A. T., Brown, G., Steer, R. A., Eidelson, J. I., & Riskind, J. H. (1987). Differentiating anxiety and depression: A test of the cognitive content-specificity hypothesis. *Journal of Abnormal Psychology*, *96*(3), 179.

Beck, A. T., Epstein, N., Brown, G., & Steer, R. A. (1988). An inventory for measuring clinical anxiety: Psychometric properties. *Journal of Consulting and Clinical Psychology*, *56*(6), 893.

Beck, A. T., & Steer, R. A. (1990). *Manual for the Beck Anxiety Inventory*.

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Beck Depression Inventory-II Manual.* San Antonio, TX.

Beck, A. T., Steer, R. A., & Garbin, M. G. (1988). Psychometric properties of the Beck Depression Inventory: Twenty-five years of evaluation. *Clinical Psychology Review*, 8(1), 77-100.

Beck, A. T., Ward, C., & Mendelson, M. (1961). Beck depression inventory (BDI). *Arch Gen Psychiatry*, 4(6), 561-571.

Biederman, J., Monuteaux, M. C., Doyle, A. E., Seidman, L. J., Wilens, T. E., Ferrero, F., ... & Faraone, S. V. (2004). Impact of executive function deficits and attention-deficit/hyperactivity disorder (ADHD) on academic outcomes in children. *Journal of Consulting and Clinical Psychology*, *72*(5), 757.

Biederman, J., Petty, C. R., Evans, M., Small, J., & Faraone, S. V. (2010). How persistent is ADHD? A controlled 10-year follow-up study of boys with ADHD. *Psychiatry Research*, *177*(3), 299-304.

Bink, M., van Nieuwenhuizen, C., Popma, A., Bongers, I. L., & van Boxtel, G. J. (2015). Behavioral effects of neurofeedback in adolescents with ADHD: A randomized controlled trial. *European Child & Adolescent Psychiatry*, 24(9), 1035-1048.

Birbaumer, N., Elbert, T., Canavan, A. G., & Rockstroh, B. (1990). Slow potentials of the cerebral cortex and behavior. *Physiological Reviews*, *70*(1), 1-41.

Blase, S. L., Gilbert, A. N., Anastopoulos, A. D., Costello, E. J., Hoyle, R. H., Swartzwelder, H. S., & Rabiner, D. L. (2009). Self-reported ADHD and adjustment in college cross-sectional and longitudinal findings. *Journal of Attention Disorders*, *13*(3), 297-309.

Brams, M., Giblin, J., Gasior, M., Gao, J., & Wigal, T. (2011). Effects of open-label lisdexamfetamine dimesylate on self-reported quality of life in adults with ADHD. *Postgraduate medicine*, *123*(3), 99-108.

Brown, M. B. (2000). Diagnosis and treatment of children and adolescents with attention-deficit/hyperactivity disorder. *Journal of Counseling and Development*, 78(2), 195.

Buchanan, T. (2011). Attention deficit/hyperactivity disorder and well-being: Is social impairment an issue for college students with ADHD?. *Journal of Postsecondary Education and Disability*, 24(3), 193-210.

Caprara, G. V., Fida, R., Vecchione, M., Del Bove, G., Vecchio, G. M., Barbaranelli, C., & Bandura, A. (2008). Longitudinal analysis of the role of perceived self-efficacy for self-regulated learning in academic continuance and achievement. *Journal of Educational Psychology*, *100*(3), 525.

Carlson, C. L., & Mann, M. (2002). Sluggish cognitive tempo predicts a different pattern of impairment in the attention deficit/ hyperactivity disorder, predominantly inattentive type. *Journal of Clinical Child and Adolescent Psychology*, *31*(1), 123-129

Chabot, R. J., & Serfontein, G. (1996). Quantitative electroencephalographic profiles of children with attention deficit disorder. *Biological Psychiatry*, *40*(10), 951-963.

Chapin, T. J., & Russell-Chapin, L. A. (2013). *Neurotherapy and Neurofeedback: Brain-based Treatment for Psychological and Behavioral Problems*. Routledge.

Chase, M. H., & Harper, R. M. (1971). Somatomotor and visceromotor correlates of operantly conditioned 12–14 c/sec sensorimotor cortical activity. *Electroencephalography and Clinical Neurophysiology*, *31*(1), 85-92.

Cheon, E. J., Koo, B. H., Seo, W. S., Lee, J. Y., Choi, J. H., & Song, S. H. (2015). Effects of neurofeedback on adult patients with psychiatric disorders in a naturalistic setting. *Applied Psychophysiology and Biofeedback*, *40*(1), 17-24.

Cheon, E. J., Koo, B. H., & Choi, J. H. (2016). The efficacy of neurofeedback in patients with major depressive disorder: An open labeled prospective study. *Applied Psychophysiology and Biofeedback*, *41*(1), 103-110.

Choi, S. W., Chi, S. E., Chung, S. Y., Kim, J. W., Ahn, C. Y., & Kim, H. T. (2010). Is alpha wave neurofeedback effective with randomized clinical trials in depression? A pilot study. *Neuropsychobiology*, *63*(1), 43-51.

Choobforoushzadeh, A., Neshat-Doost, H. T., Molavi, H., & Abedi, M. R. (2015). Effect of neurofeedback training on depression and fatigue in patients with multiple sclerosis. *Applied Psychophysiology and Biofeedback*, *40*(1), 1-8.

Christy, A., Stiles, P. G., & Shanmugam, S. (2007). The Florida mental health act (Baker Act) 2007 annual report.

Coben, R., Linden, M., & Myers, T. E. (2010). Neurofeedback for autistic spectrum disorder: A review of the literature. *Applied Psychophysiology and Biofeedback*, 35(1), 83-105.

Cohen, J. (1995). The earth is round ($p < .05$). *American Psychologist*, *50*(12), 1103.

Cohen, J. A., Mannarino, A. P., & Deblinger, E. (2006). *Treating Trauma and Traumatic Grief in Children and Adolescents*. Guilford Press.

Combs, M. A., Canu, W. H., Broman-Fulks, J. J., Rocheleau, C. A., & Nieman, D. C. (2015). Perceived stress and ADHD symptoms in adults. *Journal of attention disorders*, *19*(5), 425-434.

Conners, C. K., Erhardt, D., & Sparrow, E. P. (1999). *Conners' Adult ADHD Rating Scales (CAARS): Technical Manual*. North Tonawanda: MHS.

Corbie-Smith, G. (1999). The continuing legacy of the Tuskegee Syphilis Study: Considerations for clinical investigation. *The American journal of the medical sciences*, *317*(1), 5-8.

Costello, C. A., & Stone, S. L. (2012). Positive psychology and self-efficacy: Potential benefits for college students with attention deficit hyperactivity disorder and learning disabilities. *Journal of Postsecondary Education and Disability*, *25*(2), 119-129.

Council for Accreditation of Counseling and Related Educational Programs (2015). *2016 CACREP Standards*. Retrieved from: http://www.cacrep.org/wp-content/uploads/2012/10/2016-CACREP-Standards.pdf

Craig, S. G., Davies, G., Schibuk, L., Weiss, M. D., & Hechtman, L. (2015). Long-term effects of stimulant treatment for ADHD: What can we tell our patients?. *Current Developmental Disorders Reports*, 2(1), 1-9.

Cunill, R., Castells, X., Tobias, A., & Capellà, D. (2016). Efficacy, safety and variability in pharmacotherapy for adults with attention deficit hyperactivity disorder: A meta-analysis and meta-regression in over 9000 patients. *Psychopharmacology*, 233(2), 187-197.

Daniel, W. W. (1990). *Applied nonparametric statistics*. Boston, MA: PWS-KENT Publishing Company.

Davidson, R. J. (1998). Affective style and affective disorders: Perspectives from affective neuroscience. *Cognition & Emotion*, *12*(3), 307-330.

Decker, S. L., Roberts, A. M., & Green, J. J. (2014). LORETA neurofeedback in college students with ADHD. In: Thatcher, R. W., & Lubar, J. F. (Eds.). (2014). *Z Score Neurofeedback: Clinical Applications*. Academic Press.

DuPaul, G. J., Weyandt, L. L., Rossi, J. S., Vilardo, B. A., O'Dell, S. M., Carson, K. M., ... & Swentosky, A. (2011). Double-blind, placebo-controlled, crossover study of the efficacy and safety of lisdexamfetamine dimesylate in college students with ADHD. *Journal of Attention Disorders*, 1087054711427299.

Duric, N. S., Assmus, J., Gundersen, D., & Elgen, I. B. (2012). Neurofeedback for the treatment of children and adolescents with ADHD: A randomized and controlled clinical trial using parental reports. *BMC Psychiatry*, 12(1), 1.

Egner, T., & Gruzelier, J. H. (2003). Ecological validity of neurofeedback: Modulation of slow wave EEG enhances musical performance. *Neuroreport*, 14(9), 1221-1224.

Egner, T., & Gruzelier, J. H. (2004). EEG biofeedback of low beta band components: Frequency-specific effects on variables of attention and event-related brain potentials. *Clinical Neurophysiology*, 115(1), 131-139.

Erhardt, D., Epstein, J. N., Conners, C. K., Parker, J., & Sitarenios, G. (1999). Self-ratings of ADHD symptoms in adults: Reliability, validity, and diagnostic sensitivity. *Journal of Attention Disorders*, *3*(3), 153-158.

Escolano, C., Navarro-Gil, M., Garcia-Campayo, J., Congedo, M., & Minguez, J. (2014). The effects of individual upper alpha neurofeedback in ADHD: An open-label pilot study. *Applied Psychophysiology and Biofeedback*, 39(3-4), 193-202.

Faraone, S. V., Biederman, J., & Mick, E. (2006). The age-dependent decline of attention deficit hyperactivity disorder: A meta-analysis of follow-up studies. *Psychological Medicine*, 36(02), 159-165.

Faraone, S. V., Biederman, J., Spencer, T., Wilens, T., Seidman, L. J., Mick, E., & Doyle, A. E. (2000). Attention-deficit/hyperactivity disorder in adults: An overview. *Biological Psychiatry*, *48*(1), 9-20.

Faraone, S. V., Spencer, T. J., Kollins, S. H., Glatt, S. J., & Goodman, D. (2011). Dose response effects of lisdexamfetamine dimesylate treatment in adults with ADHD: an exploratory study. *Journal of attention disorders*, 1087054711403716.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39, 175-191

Fedele, D. A., Lefler, E. K., Hartung, C. M., & Canu, W. H. (2010). Sex differences in the manifestation of ADHD in emerging adults. *Journal of Attention Disorders*, 1087054710374596.

Freimuth, V. S., Quinn, S. C., Thomas, S. B., Cole, G., Zook, E., & Duncan, T. (2001). African Americans' views on research and the Tuskegee Syphilis Study. *Social Science & Medicine*, *52*(5), 797-808.

Friedman, M. (1937). The use of ranks to avoid the assumption of normality implicit in the analysis of variance. *Journal of the American Statistical Association*, *32*(200), 675-701.

Findling, R. L., Childress, A. C., Cutler, A. J., Gasior, M., Hamdani, M., Ferreira-Cornwell, M. C., & Squires, L. (2011). Efficacy and safety of lisdexamfetamine dimesylate in

adolescents with attention-deficit/hyperactivity disorder. *Journal of the American Academy of Child & Adolescent Psychiatry*, *50*(4), 395-405.

Florida Therapy Services (n.d.) Assessment scales. Retreived from: http://www.flatherapy.com/therapy/wp-content/uploads/2010/06/Assessment-Scales.pdf

Frazier, T. W., Youngstrom, E. A., Glutting, J. J., & Watkins, M. W. (2007). ADHD and achievement meta-analysis of the child, adolescent, and adult literatures and a concomitant study with college students. *Journal of learning disabilities*, 40(1), 49-65.

Fritson, K. K., Wadkins, T. A., Gerdes, P., & Hof, D. (2008). The impact of neurotherapy on college students' cognitive abilities and emotions. *Journal of Neurotherapy*, *11*(4), 1-9.

Fuchs, T., Birbaumer, N., Lutzenberger, W., Gruzelier, J. H., & Kaiser, J. (2003). Neurofeedback treatment for attention-deficit/hyperactivity disorder in children: A comparison with methylphenidate. *Applied Psychophysiology and Biofeedback*, *28*(1), 1-12.

Gall, M. D., Gall, J. P., & Borg, W. R. (2006). *An Introduction to Educational Research (Eighth Edition).* New York: Pearson Education Inc.

Garrett, B. L., & Silver, M. P. (1976). The use of EMG and alpha biofeedback to relieve test anxiety in college students. In: Wickramasekera, I. E. (1976). *Biofeedback, Behavior Therapy and Hypnosis: Potentiating the Verbal Control of Behavior for Clinicians.* Chicago, IL: Nelson-Hall.

Gau, S. S., Shen, H. Y., Chou, M. C., Tang, C. S., Chiu, Y. N., & Gau, C. S. (2006). Determinants of adherence to methylphenidate and the impact of poor adherence on maternal and family measures. *Journal of Child & Adolescent Psychopharmacology*, *16*(3), 286-297.

Gaultney, J. F. (2014). College students with ADHD at greater risk for sleep disorders. *Journal of Postsecondary Education and Disability*, 27(1), 5-18.

Gibbons, J. D., & Chakraborti, S. (2011). *Nonparametric statistical inference* (pp. 977-979). Springer Berlin Heidelberg.

Glueck, B. C., & Stroebel, C. F. (1975). Biofeedback and meditation in the treatment of psychiatric illnesses. *Comprehensive Psychiatry*, *16*(4), 303-321.

González-Castro, P., Cueli, M., Rodríguez, C., García, T., & Álvarez, L. (2015). Efficacy of neurofeedback versus pharmacological support in subjects with ADHD. *Applied Psychophysiology and Biofeedback*, 1-9.

Gotlib, I. H., & Cane, D. B. (1989). Self-report assessment of depression and anxiety. In: Kendall, P. Watson, D., *Anxiety and Depression: Distinctive and Overlapping Features*. Academic Press; 1989, pp. 131-169.

Gould, O. N., & Doucette, C. (2016). Self-management of adherence to prescribed stimulants in college students with ADD/ADHD. *Journal of Attention Disorders*, doi:1087054716638509.

Gracefire, P., & Durgin, G. (2012). Combining sLORETA and 19-channel live z-score training: Targeting hibeta in brodman areas to reduce symptoms of anxiety. *Journal of Neurotherapy*, 30-33.

Green, B. L., Maisiak, R., Wang, M. Q., Britt, M. F., & Ebeling, N. (1997). Participation in health education, health promotion, and health research by African Americans: Effects of the Tuskegee Syphilis Experiment. *Journal of Health Education*, *28*(4), 196-201.

Hamilton, M. (1959). The assessment of anxiety states by rating. *British Journal of Medical Psychology*, *32*(1), 50-55.

Hammond, D. C. (2000). Neurofeedback treatment of depression with the Roshi. *Journal of Neurotherapy*, *4*(2), 45-56.

Hammond, D. C. (2003). QEEG-guided neurofeedback in the treatment of obsessive compulsive disorder. *Journal of Neurotherapy*, *7*(2), 25-52.

Harrison, A. G., Alexander, S. J., & Armstrong, I. T. (2013). Higher reported levels of depression, stress, and anxiety are associated with increased endorsement of ADHD symptoms by postsecondary students. *Canadian Journal of School Psychology*, doi: 0829573513480616.

Hartman, C. A., Willcutt, W. G., Rhee, S. H., & Pennington, B. F. (2004). The relation between sluggish cognitive tempo and DSM IV ADHD. *Journal of Abnormal Child Psychology*, 35(2), 491-503.

Heiligenstein, E., Guenther, G., Levy, A., Savino, F., & Fulwiler, J. (1999). Psychological and academic functioning in college students with attention deficit hyperactivity disorder. *Journal of American College Health*, *47*(4), 181-185.

Heinrich, H., Gevensleben, H., & Strehl, U. (2007). Annotation: Neurofeedback–train your brain to train behaviour. *Journal of Child Psychology and Psychiatry*, 48(1), 3-16

Henriguez, J. B., & Davidson, R. J. (1990). Regional brain electrical asymmetries discriminate between previously depressed and healthy control subjects. *Journal of Abnormal Psychology*, *99*, 22-31.

Henriques, J. B., & Davidson, R. J. (1991). Left frontal hypoactivation in depression. *Journal of Abnormal Psychology*, *100*(4), 535.

Jarrett, M. A. (2016). Attention-deficit/hyperactivity disorder (ADHD) symptoms, anxiety symptoms, and executive functioning in emerging adults. *Psychological Assessment*, 28(2), 245.

Karam, R. G., Breda, V., Picon, F. A., Rovaris, D. L., Victor, M. M., Salgado, C. A. I., ... & Caye, A. (2015). Persistence and remission of ADHD during adulthood: A 7-year clinical follow-up study. *Psychological Medicine*, 45(10), 2045-2056.

Kerson, C., Sherman, R. A., & Kozlowski, G. P. (2009). Alpha suppression and symmetry training for generalized anxiety symptoms. *Journal of Neurotherapy*, *13*(3), 146-155.

Kluetsch, R. C., Ros, T., Théberge, J., Frewen, P. A., Calhoun, V. D., Schmahl, C., ... & Lanius, R. A. (2014). Plastic modulation of PTSD resting-state networks and subjective wellbeing by EEG neurofeedback. *Acta Psychiatrica Scandinavica*, 130(2), 123-136.

Langberg, J. M., & Becker, S. P. (2012). Does long-term medication use improve the academic outcomes of youth with attention-deficit/hyperactivity disorder?. *Clinical Child and Family Psychology Review*, *15*(3), 215-233.

Leddick, K. H. (2011). Letting go of performance anxiety and optimizing musical performance in a case of traumatic loss. *Biofeedback*, 39(1), 35-39.

Leech, N. L., Onwuegbuzie, A. J., & O'Conner, R. (2011). Assessing internal consistency in counseling research. *Counseling Outcome Research and Evaluation*, *2*(2), 115-125.

Leins, U., Goth, G., Hinterberger, T., Klinger, C., Rumpf, N., & Strehl, U. (2007). Neurofeedback for children with ADHD: A comparison of SCP and theta/beta protocols. *Applied Psychophysiology and Biofeedback*, 32(2), 73-88.

Levkoff, S., & Sanchez, H. (2003). Lessons learned about minority recruitment and retention from the Centers on Minority Aging and Health Promotion. *The Gerontologist*, *43*(1), 18-26.

Lipsey, M. W., & Wilson, D. B. (1993). The efficacy of psychological, educational, and behavioral treatment: Confirmation from meta-analysis. *American Psychologist*, *48*(12), 1181.

Loe, I. M., & Feldman, H. M. (2007). Academic and educational outcomes of children with ADHD. *Journal of Pediatric Psychology*, *32*(6), 643-654.

Loo, S. K. (2003). EEG and neurofeedback findings in ADHD. *The ADHD Report*, 11(3), 1-6.

Lowry, R. (n.d.). The Friedman test for 3 or more correlated samples. In *Concepts and Applications of Inferential Statistics* (15a). Retrieved from http://vassarstats.net/textbook/ch15a.html

Lubar, J. F., & Shouse, M. N. (1976). EEG and behavioral changes in a hyperkinetic child concurrent with training of the sensorimotor rhythm (SMR). *Biofeedback and Self-regulation*, *1*(3), 293-306.

Major, A., Martinussen, R., & Wiener, J. (2013). Self-efficacy for self-regulated learning in adolescents with and without attention deficit hyperactivity disorder (ADHD). *Learning and Individual Differences*, *27*, 149-156.

Marci, C. D., Ham, J., Moran, E., & Orr, S. P. (2007). Physiologic correlates of perceived therapist empathy and social-emotional process during psychotherapy. *The Journal of nervous and mental disease*, *195*(2), 103-111.

Marshall, P. A., Lafond, S. E., & Valente, J. G. (2012). Do students learn in summer school college majors classes? Grade comparison and student self-assessment indicate in the affirmative. *Journal of the Arizona-Nevada Academy of Science*, *43*(2), 61-66.

Mayer, K., Blume, F., Wyckoff, S. N., Brokmeier, L. L., & Strehl, U. (2015). Neurofeedback of slow cortical potentials as a treatment for adults with Attention Deficit-/Hyperactivity Disorder. *Clinical Neurophysiology*. 16, 174-188. DOI: 10.1186/s13063-015-0683-4

Mayer, K., Wyckoff, S. N., Schulz, U., & Strehl, U. (2012). Neurofeedback for adult attention-deficit/hyperactivity disorder: Investigation of slow cortical potential neurofeedback—preliminary results. *Journal of Neurotherapy*, 16(1), 37-45.

McCarthy, S. (2014). Pharmacological interventions for ADHD: how do adolescent and adult patient beliefs and attitudes impact treatment adherence?. *Patient Preference & Adherence*, *8,* 1317-1327.

Meaux, J. B., Hester, C., Smith, B., & Shoptaw, A. (2006). Stimulant medications: A trade-off? The lived experience of adolescents with ADHD. *Journal for Specialists in Pediatric Nursing*, *11*(4), 214-226.

Merrell, C., & Tymms, P. B. (2001). Inattention, hyperactivity and impulsiveness: their impact on academic achievement and progress. *British Journal of Educational Psychology*, *71*(1), 43-56.

Miller, R. M., & Barrio Minton, C. A. (2016). Experiences learning interpersonal neurobiology: An interpretative phenomenological analysis. *Journal of Mental Health Counseling*, *38*(1), 47-61.

Mills, G. K., & Solyom, L. (1974). Biofeedback of EEG alpha in the treatment of obsessive ruminations: An exploration. *Journal of Behavior Therapy and Experimental Psychiatry*, *5*(1), 37-41.

Montgomery, A. (2013). *Neurobiology Essentials for Clinicians: What Every Therapist Needs to Know (Norton Series on Interpersonal Neurobiology)*. WW Norton & Company.

Moore, N. C. (2000). A review of EEG biofeedback treatment of anxiety disorders. *Clinical EEG and Neuroscience*, *31*(1), 1-6.

Murnane, R. J., & Willett, J. B. (2010). *Methods Matter: Improving Causal Inference in Educational and Social Science Research*. Oxford University Press.

Myers, J. E., & Young, J. S. (2012). Brain wave biofeedback: Benefits of integrating neurofeedback in counseling. *Journal of Counseling & Development*, 90(1), 20-28.

Nelson, J. M., & Gregg, N. (2012). Depression and anxiety among transitioning adolescents and college students with ADHD, dyslexia, or comorbid ADHD/dyslexia. *Journal of Attention Disorders*, *16*(3), 244-254.

Nelson, J. M., Lindstrom, W., & Foels, P. A. (2014). Test anxiety and college students with attention deficit hyperactivity disorder. *Journal of Psychoeducational Assessment*, 32(6), 548-557.

Nemeth, C. L., Harrell, C. S., Beck, K. D., & Neigh, G. N. (2013). Not all depression is created equal: Sex interacts with disease to precipitate depression. *Biology of Sex Differences*, *4*(1), 8.

Norwalk, K., Norvilitis, J. M., & MacLean, M. G. (2009). ADHD symptomatology and its relationship to factors associated with college adjustment. *Journal of Attention Disorders*, *13*(3), 251-258.

Olfson, M., Gameroff, M. J., Marcus, S. C., & Jensen, P. S. (2003). National trends in the treatment of attention deficit hyperactivity disorder. *American Journal of Psychiatry*, *160*(6), 1071-1077.

Pagan, J. L., Eaton, N. R., Turkheimer, E., & Oltmanns, T. F. (2006). Peer-reported personality problems of research nonparticipants: Are our samples biased?. *Personality and Individual Differences*, 41(6), 1131-1142.

Pallant, J. (2010). SPSS survival manual, 4th. England: McGraw-Hill Education.

Patros, C. H., Hudec, K. L., Alderson, R. M., Kasper, L. J., Davidson, C., & Wingate, L. R. (2013). Symptoms of attention-deficit/hyperactivity disorder (ADHD) moderate suicidal behaviors in college students with depressed mood. *Journal of Clinical Psychology*, *69*(9), 980-993.

Peniston, E. G., & Kulkosky, P. J. (1991). Alpha-theta brainwave neurofeedback for Vietnam veterans with combat-related post-traumatic stress disorder. *Medical Psychotherapy*, *4*(1), 47-60.

Peniston, E. G., Marrinan, D. A., Deming, W. A., & Kulkosky, P. J. (1993). EEG alpha-theta brainwave synchronization in Vietnam theater veterans with combat-related Post-

Traumatic Stress Disorder and alcohol abuse. *Medical Psychotherapy: An International Journal*, 6, 37-50.

Philipsen, A. (2006). Differential diagnosis and comorbidity of attention-deficit/hyperactivity disorder (ADHD) and borderline personality disorder (BPD) in adults. *European Archives of Psychiatry and Clinical Neuroscience*, *256*(1), i42-i46.

Preston, J., O'Neal, J. H., & Talaga, M. C. (2010). *Handbook of Clinical Psychopharmacology for Therapists*. New Harbinger Publications.

Prevatt, F., Dehili, V., Taylor, N., & Marshall, D. (2015). Anxiety in college students with ADHD relationship to cognitive functioning. *Journal of Attention Disorders*, 19(3), 222-230.

Prince, J. B., Wilens, T. E., Spencer, T. J., & Biederman, J. (2006). Pharmacotherapy of ADHD in adults. In R. A. Barkley (Ed.), *Attention-Deficit/Hyperactivity Disorder: A Handbook for Diagnosis and Treatment* (3rd ed., pp. 704-736). New York, NY: Guilford.

Raghavarao, D., & Padgett, L. (2014). *Repeated Measurements and Cross-Over Designs*. Hoboken, New Jersey: John Wiley & Sons.

Rasey, H., Lubar, J. F., McIntyre, A., Zoffuto, A., & Abbott, P. L. (1995). EEG biofeedback for the enhancement of attentional processing in normal college students. *Journal of Neurotherapy*, *1*(3), 15-21.

Rogers, M., Hwang, H., Toplak, M., Weiss, M., & Tannock, R. (2011). Inattention, working memory, and academic achievement in adolescents referred for attention deficit/hyperactivity disorder (ADHD). *Child Neuropsychology*, *17*(5), 444-458.

Rosenfeld, J. P. (1997). EEG biofeedback of frontal alpha asymmetry in affective disorders. *Biofeedback*, *25*(1), 8-25.

Russell-Chapin, L. A. (2016). Integrating neurocounseling into the counseling profession: An introduction. *Journal of Mental Health Counseling*, *38*(2), 93-102.

Russo, G. M., & Stevens, S. (2016, February). Neurocounseling: Bridging brain and behavior. *Counseling Today,* 14-16.

Safren, S. A., Otto, M. W., Sprich, S., Winett, C. L., Wilens, T. E., & Biederman, J. (2005). Cognitive-behavioral therapy for ADHD in medication-treated adults with continued symptoms. *Behaviour Research and Therapy*,*43*(7), 831-842.

Salomone, S., Fleming, G. R., Shanahan, J. M., Castorina, M., Bramham, J., O'Connell, R. G., & Robertson, I. H. (2015). The effects of a Self-Alert Training (SAT) program in adults with ADHD. *Frontiers in Human Neuroscience*, *9*.

Schoenberg, P. L., & David, A. S. (2014). Biofeedback for psychiatric disorders: A systematic review. *Applied Psychophysiology and Biofeedback*, 39(2), 109-135.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. Boston, MA: Houghton Mifflin & Company.

Shavers, V. L., Lynch, C. F., & Burmeister, L. F. (2002). Racial differences in factors that influence the willingness to participate in medical research studies. *Annals of Epidemiology*, *12*(4), 248-256.

Sokhadze, T. M., Cannon, R. L., & Trudeau, D. L. (2008). EEG biofeedback as a treatment for substance use disorders: Review, rating of efficacy and recommendations for further research. *Journal of Neurotherapy*, 12(1), 5-43.

Speilberger, C. D. (1983). *Manual for the State-Trait Personality Inventory STAI (Form Y)*. Palo Alto: Consulting Psychologists Press.

Spencer, T., Biederman, J., Wilens, T., Doyle, R., Surman, C., Prince, J., ... & Faraone, S. (2005). A large, double-blind, randomized clinical trial of methylphenidate in the treatment of adults with attention-deficit/hyperactivity disorder. *Biological psychiatry*, *57*(5), 456-463.

Steer, R. A., & Clark, D. A. (1997). Psychometric characteristics of the Beck Depression Inventory-II with college students. *Measurement and Evaluation in Counseling and Development*, *30*(3), 128.

Sterman, M. B., & Egner, T. (2006). Foundation and practice of neurofeedback for the treatment of epilepsy. *Applied Psychophysiology and Biofeedback*, 31(1), 21-35.

Still, G. F. (1902). The Goulstonian Lectures. *Some Abnormal Psychical Conditions in Children*, 1008-1012.

Storch, E. A., Roberti, J. W., & Roth, D. A. (2004). Factor structure, concurrent validity, and internal consistency of the beck depression inventory—second edition in a sample of college students. *Depression and Anxiety*, *19*(3), 187-189.

Streiner, D. L. (2003). Starting at the beginning: An introduction to coefficient alpha and internal consistency. *Journal of Personality Assessment*, *80*(1), 99-103.

Tabachnick, B., & Fidell, L. (2007). *Using Multivariate Statistics*. Boston, MA: Pearson/Allyn & Bacon.

Tabassam, W., & Grainger, J. (2002). Self-concept, attributional style and self-efficacy beliefs of students with learning disabilities with and without attention deficit hyperactivity disorder. *Learning Disability Quarterly*, *25*(2), 141-151.

Tannock, R., Ickowicz, A., & Schachar, R. (1995). Differential-effects of methylphenidate on working-memory in ADHD children with and without comorbid anxiety. *Journal of the American Academy of Child & Adolescent Psychiatry*, 34, 886-896.

The MTA Cooperative Group. (1999). Moderators and mediators of treatment response for children with attention-deficit/hyperactivity disorder. *Archives of General Psychiatry*, 56, 1088-1096.

Thomas, M., Rostain, A., Corso, R., Babcock, T., & Madhoo, M. (2015). ADHD in the college setting current perceptions and future vision. *Journal of Attention Disorders*, 19(8), 643-654.

Thompson, L., Thompson, M., & Reid, A. (2010). Neurofeedback outcomes in clients with Asperger's syndrome. *Applied Psychophysiology and Biofeedback*, 35(1), 63-81.

Toplak, M. E., Connors, L., Shuster, J., Knezevic, B., & Parks, S. (2008). Review of cognitive, cognitive-behavioral, and neural-based interventions for Attention-Deficit/Hyperactivity Disorder (ADHD). *Clinical Psychology Review*, 28(5), 801-823.

Van Eck, K., Ballard, E., Hart, S., Newcomer, A., Musci, R., & Flory, K. (2015). ADHD and suicidal ideation: The roles of emotion regulation and depressive symptoms among college students. *Journal of Attention Disorders*, 19(8), 703-714.

Vernon, D., Frick, A., & Gruzelier, J. (2004). Neurofeedback as a treatment for ADHD: A methodological review with implications for future research. *Journal of Neurotherapy*, 8(2), 53-82.

Walker, J. E. (2009). Anxiety associated with Post Traumatic Stress Disorder-The role of quantitative electro-encephalograph in diagnosis and in guiding neurofeedback training to remediate the anxiety. *Biofeedback*, 37(2), 67-70.

Ward, M. F., Wender, P. H., & Reimherr, F. W. (1993). The Wender Utah Rating Scale: An Aid in the Retrospective. *American Journal of Psychiatry*, *1*(50), 885.

Weiss, M. D., & Weiss, J. R. (2004). A guide to the treatment of adults with ADHD. *Journal of Clinical Psychiatry*, *65*, 27-37.

Weyandt, L. L., & DuPaul, G. J. (2008). ADHD in college students: Developmental findings. *Developmental Disabilities Research Reviews*, 14(4), 311-319.

Weyandt, L. L., & DuPaul, G. J. (2013). *College Students with ADHD: Current Issues and Future Directions*. New York, NY: Springer.

Weyandt, L., DuPaul, G. J., Verdi, G., Rossi, J. S., Swentosky, A. J., Vilardo, B. S., ... & Carson, K. S. (2013). The performance of college students with and without ADHD: Neuropsychological, academic, and psychosocial functioning. *Journal of Psychopathology and Behavioral Assessment*, *35*(4), 421-435.

Weyandt, L. L., Linterman, I., & Rice, J. A. (1995). Reported prevalence of attentional difficulties in a general sample of college students. *Journal of Psychopathology and Behavioral Assessment*, 17(3), 293-304.

Weyandt, L. L., Oster, D. R., Marraccini, M. E., Gudmundsdottir, B. G., Munro, B. A., Zavras, B. M., & Kuhar, B. (2014). Pharmacological interventions for adolescents and adults with ADHD: Stimulant and nonstimulant medications and misuse of prescription stimulants. *Psychology Research and Behavior Management*, *7*, 223.

White, J. N., Hutchens, T. A., & Lubar, J. F. (2005). Quantitative EEG assessment during neuropsychological task performance in adults with attention deficit hyperactivity disorder. *Journal of Adult Development*, *12*(2-3), 113-121.

Williams, J. M. (2010). Does neurofeedback help reduce attention-deficit hyperactivity disorder?. *Journal of Neurotherapy*, 14(4), 261-279.

Wilens, T. E., McDermott, S. P., Biederman, J., Abrantes, A., Hahesy, A., & Spencer, T. J. (1999). Cognitive therapy in the treatment of adults with ADHD: A systematic chart review of 26 cases. *Journal of Cognitive Psychotherapy*, *13*(3), 215-226.

Wilson, V. E., Peper, E., & Moss, D. (2006). "The Mind Room" in Italian soccer training: The use of biofeedback and neurofeedback for optimum performance. *Biofeedback*, 34(3).

Yin, P., & Fan, X. (2000). Assessing the reliability of Beck Depression Inventory scores: Reliability generalization across studies. *Educational and Psychological Measurement*, *60*(2), 201-223.

Zengar Institute. (2016). NeurOptimal advanced brain training systems. Retrieved from http://www.zengar.com.

Zimmerman, B. J. (1995). Self-efficacy and educational development. *Self-efficacy in Changing Societies*, 202-231.

Zimmerman, B., & Kitsantas, A. (2007). Reliability and validity of self-efficacy for learning form (SELF) scores of college students. *Zeitschrift für Psychologie/Journal of Psychology*, 215(3), 157-163.