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The Impact of a Neurofeedback Training Intervention on College Students' Levels of Anxiety, Stress, Depression, and Cortisol

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THE IMPACT OF A NEUROFEEDBACK TRAINING INTERVENTION ON COLLEGE STUDENTS' LEVELS OF ANXIETY, STRESS, DEPRESSION, AND CORTISOL

by

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ABSTRACT

Anxiety, depression, and stress are three of the most common experiences that impact college student functioning and academic achievement. At least one in six college students struggle with anxiety, increasing risk for developing depressive symptoms or disorders that further impact wellness. However, as mental health concerns increase across campuses, universities are not equipped to meet the demand of mental health support for college students. Neurofeedback (NF) training presents as an innovative intervention to treat anxiety, depression, and stress as it is designed to regulate brain processes in an effort to increase more effective brain functioning.

A quasi-experimental, nonequivalent control group design was utilized to determine differences between treatment group and waitlist control group participants' anxiety, stress, and depression scores at four time points as measured by the: (a) *Beck Anxiety Inventory* [BAI] (Beck, Epstein, Brown, & Steer, 1988); (b) *Beck Depression Inventory, Second Edition* [BDI-II] (Beck, Steer, & Brown, 1996); (c) *Perceived Stress Scale* [PSS] (Cohen, Kamarck, & Mermelstein, 1983); and (d) *Social Anxiety Thought questionnaire* [SAT] (Hartman, 1984). Furthermore, cortisol testing was used through assessment of saliva samples using Salimetrics Enzyme-Linked Immunosorbent Assay (ELISA).

Key findings for the current investigation include: (a) a marginally significant ($p = .051$) difference between treatment group and control group participants' PSS (partial $\eta^2 = .093$), BDI-II (partial $\eta^2 = .089$), and SAT (partial $\eta^2 = .052$) scores over time; (b) no significance difference among participant demographics between treatment group and control group assessment scores over time; (c) no significance between treatment group and control group assessment scores and

salivary cortisol levels over time; and (d) a negative relationship between the control group participants' salivary cortisol levels at pre-test on the BAI, PSS, and SAT. Finally, results are compared to previous studies. Limitations and implications as well as areas for future research are explored.

Dedicated to my loving husband, Michael. You have been the best partner in this journey. Thank you for giving me purpose, strength, and motivation.

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LIST OF IMPORTANT ACRONYMS OR ABBREVIATIONS

ACTH	Adrenocorticotropin Hormone
ACHA	American College Health Association
ACHA-NCHA	American College Health Association – National College Health Assessment
ANS	Autonomic Nervous Systems
APA	American Psychiatric Association
CACREP	Council for Accreditation of Counseling and Related Educational Programs
BAI	Beck Anxiety Inventory
BDI-II	Beck Depression Inventory, Second Edition
CBT	Cognitive Behavioral Therapy
CNS	Central Nervous System
CRH	Corticotropic Releasing Hormone
DSM	Diagnostic and Statistical Manual of Mental Disorders
EEG	Electroencephalogram
ELISA	Enzyme-Linked Immunosorbent Assay
EMG	Electromyographic
fMRI	Functional Magnetic Resonance Imaging
GAD	Generalized Anxiety Disorder
GC	Glucocorticoids
GPA	Grade Point Average

GSR	Galvanic Skin Response
HPA	Hypothalamic-Pituitary-Adrencortical
LENS	Low Energy Neurofeedback Systems
LORETA	Low Resolution Electromagnetic Tomography
NAMI	National Alliance on Mental Illness
NCSR	National Comorbidity Survey Replication
NF	Neurofeedback
NIMH	National Institute of Mental Health
OCD	Obsessive-Compulsive Disorder
PNS	Parasympathetic Nervous System
PSS	Perceived Stress Scale
PTSD	Post-Traumatic Stress Disorder
qEEG	Quantitative Electroencephalogram
RA	Research Assistant
RM-MANOVA	Repeated Measures Multivariate Analysis of Variance
SAT	Social Anxiety Thoughts questionnaire
SNS	Sympathetic Nervous System
WHO	World Health Organization

CHAPTER ONE: INTRODUCTION

Anxiety is a physical, cognitive, and emotional experience that affects individuals' quality of life and functioning (American Psychiatric Association [APA], 2013). In the National Comorbidity Research Survey (Kessler, Chiu, Demler, & Walters, 2005b), anxiety disorders were found to impact 40 million (18%) adults in the United States each year. Additionally, anxiety has been one of the most reported mental health problems on college campuses, where one in six college students (15.8%) receive treatment for their anxiety (American College Health Association [ACHA], 2015). Due to the stress that accompanies beginning college, many students experience fear and anxiety, especially social anxiety (Campbell, Bierman, & Molenaar, 2016). Within the college student population, anxiety is also experienced on other levels, including test anxiety (e.g., Harrison, Alexander, & Armstrong, 2013; Nelson, Lindstrom, & Foels, 2014; Prevatt, Dehili, Taylor, & Marshall, 2015).

College students struggling with anxiety are at an increased risk for depression and suicidal ideation (Kitzrow, 2009). Students diagnosed with anxiety are also more likely to have lower grade point averages (GPAs); and those students diagnosed with comorbid depression are more likely to drop out of college due to the overwhelming nature of depressive and anxious symptoms (Eisenberg, Downs, Golberstein, & Zivin, 2009). College students also demonstrate increased levels of stress due to concerns of: (a) tuition and financial need; (b) academic success (Beiter et al., 2015); (c) balancing school, life, and other new responsibilities (Dyson & Renk, 2006); and (d) learning how to appropriately explore newfound independence (Arnett, 2000). The impact of stress can have negative consequences, leading to symptoms associated with anxiety and depression. If prolonged periods of stress are untreated or if students are unable to

cope, these symptoms may manifest into full anxiety (Vyas, Mitra, Rao, & Chattarji, 2002) and/or depressive disorder diagnoses (Popoli, Yan, McEwen, & Sanacora, 2012).

Despite the need for mental health services for college students (Hardy, Weatherford, Locke, DePalma, & D'Iuso, 2011), there have been limited services to meet the mental health concerns of these students. Thus, Neurofeedback training (NF), also known as brainwave training or electroencephalogram (EEG) biofeedback (Hammond, 2005), presents as a treatment option to support college students who struggle with anxiety, depression, and stress by increasing brain efficiency through training the electrical response patterns within the brain (Hammond, 2011). NF training is a drug-free process with no addictive components, which is appealing to use with the college student population who are more vulnerable to substance use disorders (Potter, Galbraith, Jensen, Morrison, & Heimberg, 2016). Furthermore, accreditation bodies such as the Council for Accreditation of Counseling and Related Educational Programs (CACREP, 2016) have called for counselors-in-training to receive education on innovative and effective treatments as well as understanding and integrating neurobiological practices into their work with clients (Myers & Scott, 2012), demonstrating the importance of integrating NF training as a proposed treatment to help college students in need.

Statement of the Problem

As noted, anxiety is a multidimensional experience that influences individuals' quality of life and functioning (APA, 2013) and at least one in six college students receive treatment for their anxiety-related symptoms (ACHA, 2015). Additionally, depression is often experienced for individuals who present with anxiety (Ressler & Nemeroff, 2000), including symptoms such as:

(a) difficulty concentrating; (b) irritability; (c) guilty feelings; (d) decreased motivation; (e) increased or decreased appetite; and (f) increased or decreased sleep patterns (APA, 2013). Furthermore, according to the Fall 2016 American College Health Association - National College Health Assessment (ACHA-NCHA), stress has been the highest reported challenge for college students, especially as it relates to impacts on academic success (ACHA, 2017). Additionally, stress experienced by college students can result in negative repercussions on overall emotional and mental health wellness, physiological health, and can cause long-term mental and physical consequences if not treated (Popoli et al., 2012; Vyas et al., 2002).

Despite the identified needs for mental health service and treatment for college students, their mental health issues have been minimally met (Hardy et al., 2011). Therefore, the current study aimed to determine if NF training, a non-invasive, drug-free approach, was an effective intervention for significantly improving symptoms of anxiety, stress, and depression in college students as measured by the following assessments: (a) *Beck Anxiety Inventory* [BAI] (Beck, Epstein, Brown, & Steer, 1988); (b) *Beck Depression Inventory, Second Edition* [BDI-II] (Beck, Steer, & Brown, 1996); (c) *Perceived Stress Scale* [PSS] (Cohen, Kamarck, & Mermelstein, 1983); and (d) *Social Anxiety Thought Questionnaire* [SAT] (Hartman, 1984). Furthermore, an objective measure of stress (i.e., cortisol levels) is used through the collection and testing of saliva samples using Salimetrics Enzyme-Linked Immunosorbent Assay (ELISA).

Significance of the Study

Overall, the literature on NF training and anxiety has limitations in the use of primarily subjective measures to report changes. Although a considerable amount of research has been

conducted to explore the effectiveness of NF training with adults experiencing anxiety or depression, few researchers have examined the influence of NF training on college student populations. Additionally, quasi-experimental and experimental designs (e.g., Walker, 2009) with control groups have been implemented in examining the influence of NF training and anxiety, but studies have often relied upon small sample sizes and lacked rigorous statistical analyses. Furthermore, no studies were found in the researcher's review of the literature that employed collecting participants' saliva samples as a measure to examine changes in participants' physiological levels of stress and anxiety via cortisol levels. Thus, the current study aimed to fill these gaps within the literature by using cortisol to serve as a biological, objective measure of stress within participants. Additionally, investigating the effectiveness of NF training on college students' levels of anxiety and stress, while assessing for comorbid depression, addressed gaps within the research.

Theoretical Foundations

There are several theoretical components that have been integrated into the present study. The following sections describe the common mental and physical experiences and their implications for college students (i.e., stress, anxiety, and depression) along with a brief overview of current research of the NF training intervention.

Stress

Stress is a psychological, biological, and environmental experience that many individuals encounter within their lives (Cohen & Kessler, 1997; Kopp et al., 2010). Lazarus and Folkman (1984) developed the transactional model of stress and coping to conceptualize the appraisal and

experience of stressors. As stress is often an individual experience, the way in which one determines if a situation or experience is stressful is important in the role of stress. Lazarus and Folkman (1984) also emphasized that the way in which one copes or takes actions (behavioral or cognitive) to help improve emotional implications of stress is also important in the stress process; that is, when individuals are better able to work through challenging situations, their stress experiences can improve.

As stress has biological implications (Kopp et al., 2010), the brain and body also play roles in the stress process. For example, the brain is the central communicator in the stress process and relays information to different brain parts during threatening or nonthreatening contexts (McEwen & Gianaros, 2011), activating the sympathetic nervous system (SNS) or parasympathetic nervous system [PNS] (Sapolsky, 2004). The SNS becomes engaged during stressful circumstances, activating bodily processes (i.e., heart beats faster and salivation decreases) and can also activate the fight, flight, or freeze response. The PNS is activated following stressful situations or during circumstances that are deemed safer, helping to regulate bodily processes (e.g., decreases heart rate and helps with digestion) that may have been activated due to stress (Sapolsky, 2004).

Stress hormones are also activated in stressful situations or in the perception of stress or harm. The hypothalamic-pituitary-adrencortical (HPA) circulatory system plays a central role in stress. The HPA activates the release of corticotropin (ACTH) and glucocorticoids (GC), which are major cortisol-based hormones released in the stress response process (Herman & Cullinan, 1997). In the stress-response process, stress and stressors can serve a detrimental role in development of and preservation of mental health disorders (Ehlert, Gaab, & Heinrichs, 2001). That is, when individuals experience heightened levels of stress, psychological disturbances,

such as anxiety and depression, are more likely to emerge (Popoli et al., 2012; Vyas et al., 2002). College students are susceptible to stress due to novel experiences from increased social contexts, pressure from academic performance, and increased financial and personal responsibilities (Beiter et al., 2015). The Fall 2016 ACHA-NCHA reviewed the experiences of 33,512 students and found that stress was the highest reported factor that contributed to academic struggles with 32.3% of respondents endorsing being academically impacted by stress (ACHA, 2017). However, despite knowledge of increased stress and mental health concerns for college students, as well as the need for a variety mental health services for the population (Hardy et al., 2011), universities and colleges have failed to meet the increased need in support, especially as the ratio of mental health professionals to college students is 1 to 1,527 (Gallagher, 2009).

Anxiety

Although the current study was focused on anxiety symptoms versus anxiety disorder diagnoses, research on anxiety disorders are discussed in the literature review, as the majority of the literature on anxiety is specific to anxiety disorders. Anxiety disorders have been the highest diagnosed mental health condition, impacting 18% of the adult population in the United States (Kessler et al., 2005b). Europe has reported similar findings, with 12% of adults endorsing an anxiety disorder diagnosis (Wittchen & Jacobi, 2005). Despite the high percentages of anxiety disorder diagnoses, the National Comorbidity Survey indicated that only 34% of the surveyed individuals believed they were in need of mental health support (Mojtabai, Olfson, & Mechanic, 2002).

As indicated, anxiety is an experience that often includes emotional (e.g., feeling overwhelmed, nervous, or fearful) and cognitive (e.g., having racing thoughts, having difficulty

concentrating) implications (APA, 2013). Anxiety can range on a spectrum from feelings, cognitions, and experiences of anxiety to official anxiety disorder diagnoses, which imply more severe impairment in overall functioning. Like stress, anxiety involves physiological and neurological interactions and underpinnings. For example, anxiety is often processed in two main areas of the brain, including the prefrontal cortex and amygdala. The amygdala is associated with faster occurring reactions to anxiety as it houses the fight, flight, or freeze response whereas the prefrontal cortex can take a more rational approach (Pittman & Karle, 2015).

Depression

Behind anxiety, depression is the second most common mental health condition (Kessler et al., 2005b), with over 300 million individuals suffering from depression globally (World Health Organization [WHO], 2017). Depressive disorders are accompanied by feelings of irritability, sadness, fatigue, difficulty concentrating, and the potential for suicidal ideations or completions of suicide (APA, 2013). The association between depression and suicidal ideation is concerning for college students as suicide is the leading cause of death for individuals between 15-29 years of age (WHO, 2017). A large amount of theory and research on depression has surrounded Beck's (1987) work in which he asserted that cognitive components of depression are said to involve a cognitive triad which includes automatic, negatively-charged thought patterns about: (a) the self; (b) the world; and (c) others (Haaga, Dyck, & Ernst, 1991). Several other theorists have asserted the main role that cognitions play in developing and maintaining depression (e.g., Abramson, Metalsky, & Alloy, 1989; Ellis, 1987). That is, individuals who experience depression are likely to have faulty, negative beliefs that reinforce their depression. Additionally, depression has neurobiological underpinnings; individuals with depression often

have atypical amounts of neurotransmitters such as serotonin, dopamine, and norepinephrine (Sapolsky, 2004).

Cortisol

As noted, anxiety is an experience that has physiological implications (APA, 2013) including the release of cortisol in the body. Cortisol is a hormone that is released when individuals experience stress and anxiety (Buchanan, l'Absi, & Lovallo, 1999; Melamed et al., 1999) and can be measured in saliva (Kirschbaum & Hellhammer, 1994). Because of the role of cortisol relating to stress and anxiety, saliva can serve as a biomarker or biological representation of stress levels within individuals (Vedhara et al., 1999). A common practice in social science research is to measure cortisol as a biomarker for stress, presenting as a unique measure of stress as compared to traditional paper assessment methods. Due to the interactive nature of stress, anxiety, and depression, the current study sought to measure these constructs using paper assessments in addition to the measurement of stress through salivary cortisol testing.

Neurofeedback Training

In order to better understand the NF training process, it is important to consider the development of NF training. From a historical perspective, researchers identified that alpha waves were associated with a state of relaxation and calmness can be trained to improve brain functioning (Kamiya, 1969). In the detection and observation of alpha waves, scientists also established the connection between brain wave patterns and specific neurological disorders, leading to the discovery of modifying brain wave activity to improve neurological functioning (Cleary, 2011). In addition to alpha waves, there are four other major brain wave patterns

including: (a) gamma, (b) beta, (c) theta, and (d) delta waves, all of which are measured in hertz (Hz; Hammond, 2011). Since the discovery of the ability to modify alpha waves, several types of NF training systems have been established, including: (a) slow cortical potentials training; (b) low energy NF system (LENS); (c) hemoencephalography; (d) live Z-score NF training; (e) low resolution electromagnetic tomography (LORETA) NF training; (f) functional magnetic resonance imaging (fMRI) NF (Hammond, 2011); and (g) alpha-theta training (Othmer, 2009).

In general, NF training is a drug-free, non-invasive process that is designed to increase brain efficiency while decreasing unhelpful neural processes (Hammond, 2011) and has been implemented with various populations since the 1970s (e.g., Garrett & Silver, 1976; Glueck, & Stroebel, 1975; Hardt & Kamiya, 1978; Passini, Watson, Dehnel, Herder, & Watkins, 1977). NF training has demonstrated effectiveness in improving symptoms associated with anxiety (e.g., Dreis et al., 2015; Moore, 2000; Scheinost et al., 2013) and depression (e.g., Cheon et al., 2005; Choi et al., 2009). Although NF researchers have reported improvement in symptomology, there has been minimal focus on the anxiety, stress, and depression levels of college students.

As indicated, several studies have been conducted to examine the use of NF training for anxiety symptoms and disorders (e.g., Cleary, 2011; Hammond 2011; Moore, 2000; Walker, 2009). Moore (2000) conducted a literature review and identified eight studies aimed at treating generalized anxiety disorder (GAD), obsessive-compulsive disorder (OCD), post-traumatic stress disorder (PTSD), and phobic disorder using NF training. The findings for four studies focused on participants with GAD (Hardt & Kamiya, 1978; Plotkin & Rice, 1981; Rice, Blanchard, & Purcell, 1993; Sittenfeld, Budzynski, & Stoyva, 1976) were promising, with significant decreases in anxiety scores. For example, Plotkin and Rice (1981) reported significant main effects for participants who received five to seven NF sessions from pre to post-test for scores on the (a)

State-Trait Anxiety Inventory A-Trait scale [STAI] (Spielberger, Gorsuch, & Lushene, 1970) $F_{(1, 8)} = 83.81$, $p < .001$; (b) *Welsh A* scale (Dahlstrom & Welsh, 1960) $F_{(1, 8)} = 20.27$, $p < .005$; and (c) *Taylor Manifest Anxiety* scale [TMAS] (Taylor, 1953) $F_{(1, 8)} = 25.71$, $p < .001$.

In the two studies focused on OCD and NF training, improvements were reported measured by a decrease in the frequency of ruminations (Mills & Solyom, 1974) or an increase in a relaxing state (Glueck & Stroebel, 1975). In one study measuring results of participants with PTSD (Peniston & Kulkosky, 1991) there was improvement in PTSD symptomology as indicated by decreases in participant scores on the *Minnesota Multiphasic Personality Inventory* [MMPI] (Dahlstrom & Welsh, 1960) scales. Finally, in the study reviewed on phobic disorders, specifically test anxiety (Garrett & Silver, 1976), there was a decrease in test anxiety scores for college students as measured by the *Debilitating Anxiety Scale* (Alpert & Haber, 1960).

Although the benefits of using NF training to treat anxiety were reported in the studies reviewed by Moore (2000), a main limitation was noted as no effect sizes were reported. Additionally, the studies revealed a discrepancy in the number of NF sessions used compared to the number of sessions implemented within clinical practice (Hammond, 2005). Specifically, the number of hours of NF sessions incorporated into the research studies were often less than recommended by practitioners; clinicians advocated for clients to receive between seven to 12 hours of NF training in order to more effectively treat anxiety symptoms (Hammond, 2005). Additional limitations in the aforementioned studies included small sample sizes, differences in the number of used electrodes, and sole usage of data collection via instruments (e.g., TMAS). Some of the studies also involved instruments or measures with questionable psychometric properties. Furthermore, as Moore published the literature review on NF training in 2000 and the studies reviewed ranged from the 1960s to the 1990s, the referenced studies included anxiety

disorder diagnoses from previous versions of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM); within the current version, the DSM-5 (APA, 2013) no longer classifies PTSD and OCD as anxiety disorders and are within their own diagnostic categories. The consideration of changes in diagnostic features and symptoms is imperative for researchers to be mindful of as studies and findings can influence the work and treatment implemented by helping professionals.

More recent studies have also been conducted to explore the impact of NF training on anxiety. For example, Dreis and colleagues (2015) administered seven to 28 NF training sessions to participants and reported significant improvement from pre-test to post-test scores on the *Zung Self-Rating Anxiety Scale* (Zung, 1971) $t(10) = 4.59$, $p < .001$) and *Achenbach System of Empirically Based Assessment* [ASEBA] (Achenbach, 2009) $t(17) = 8.75$, $p < .001$. However, when assessing the specific scales of the ASEBA, significance was not found for categories specific to anxiety ("Anxious/Depressed" and "Anxiety Problems"). The study also assessed for changes in quantitative electroencephalogram (qEEG), a process that provides visual representation of brainwave activity. However, data from pre-test to post-test revealed no significant differences or changes. Although the study implemented the use of an objective measure of change, similar to early studies, small sample sizes were utilized.

Depression is a common co-occurring mental health concern for those individuals who present with anxiety symptoms and disorders (Ressler & Nemeroff, 2000). Depressive symptoms include irritability, increased or decreased sleeping, increased or decreased appetite, feelings of guilt, difficulty concentrating, and decreased motivation (APA, 2013). NF training research studies have identified improvements in individuals' depressive symptoms (Baehr, Rosenfeld, & Baehr, 2001; Cheon, Koo, & Choi, 2016; Hammond, 2000).

For example, Cheon and colleagues (2016) studied 20 participants diagnosed with major depressive disorder who received eight weeks of NF training and completed five assessments at three time points (pre-test, week 4, and week 8). Significant decreases in scores were found for the *Beck Anxiety Inventory* [BAI] (Beck et al., 1988) $F = 12.01$, $p < .01$); *Beck Depression Inventory, Second Edition* [BDI-II] (Beck et al., 1996) $F = 10.10$, $p < .002$); *Hamilton Rating Scale for Depression* [HAM-D] (Hamilton, 1960) $F = 82.14$, $p < .0001$); *Hamilton Rating Scale for Anxiety* [HAM-A] (Hamilton, 1959) $F = 59.13$, $p < .0001$; and *Clinical Global Impression* scores [CGI] (Guy, 1976) $F = 14.90$, $p < .001$ scores. Although Cheon and colleagues (2016) reported statistical significance in scores from pre- to post-test and contributed to the literature on NF training and depression, limitations for this study were found in the small sample size, no report of effect sizes, lack of a control group, and the bulk of the participants receiving psychopharmacological care. Larsen and Sherlin (2013) also reported finding a limited number of NF training and depression studies, with concerns related to small sample sizes. Hence, additional studies of NF training for the treatment of depression are needed.

NeurOptimal

The current study used the NeurOptimal system, produced by Zengar Institute, Inc. (2017). As the Central Nervous System (CNS) is a system of electrical activity and networks, five sensors are applied to the user (two on the left side of the head and three on the right side of the head) with a neuroconductor gel to help capture electrical signals. The NeurOptimal system is designed to provide instant audiofeedback to help train the brain to become a more effective, efficient processing system through the use of mathematical algorithms that detect brain turbulence (Zengar Institute, Inc., 2017). However, information detailing the specific procedures

and interworkings of the NeurOptimal were not provided by the manufacturers.

College Students

College students present as a population vulnerable to an increase in mental health concerns including stress, anxiety, and depression (Andrews & Wilding, 2004; Bayram & Bilgel, 2008). Increases in the diversity of college students have created a heightened need for services (Choy, 2002). Counseling centers have noted a surge in presenting mental health conditions of the college student population, and 85% of counseling center directors in the National Survey of Counseling Directors endorsed a rise in more severe psychological concerns (Gallagher, Sysko, & Zhang, 2001). Furthermore, the ACHA-NCHA (2016) surveyed over 30,000 students regarding personal experiences in college, stress, anxiety, and depression were identified in the top five concerns related to academic difficulties. Stress (32.2% of respondents) and anxiety (24.9% of respondents) were reported as the top two, and depression (15.4% of respondents) was cited as the fourth greatest challenge (ACHA, 2017). Furthermore, Eisenberg et al. (2009) found that anxiety and comorbid depression influenced college students' ability to be successful in academic performance and was more likely to impact GPA negatively, increasing the potential for students to drop out of college.

Methods

This section presents the methods used to conduct the current study. Research methods include a discussion of the following: (a) research design; (b) research questions; (c) population and sampling; (d) NF training intervention; (e) data collection procedures; (f) instrumentation; and (g) data analysis.

Research Design

The present study was a quasi-experimental, nonequivalent control group design (Shadish, Cook, & Campbell, 2002). The study was quasi-experimental due to a lack of randomization for the treatment and control groups (Shadish et al., 2002). The study took place over a 12-week period per semester (three semesters total; spring 2017, summer 2017, and fall 2017). Participants in the treatment group attended, on average, two NF training sessions per week during the first eight weeks; all participants in the treatment group received a total of 16 NF training sessions. Four weeks after their final session (week 12), participants were asked to return for a follow-up appointment. Data were collected at four points within the study, including pre (before session one), mid (at session eight), final (at session 16), and follow-up (at week 12). Participants in the waitlist control group (fall 2017 semester) only participated in data collection and did not receive the NF training intervention.

Research Questions

The purpose of this study was to determine the effectiveness of NF training on college students' levels of anxiety, depression and stress through assessments) and physiological measures (i.e., cortisol levels). The researcher measured whether participants' scores decreased on five measures over time (i.e., four paper assessments and salivary cortisol tests), as measured at four study points. The study was focused on answering the following research questions:

Primary Research Question

Does Neurofeedback (NF) training reduce anxiety, depression, and stress scores over time for the treatment group as compared to the control group? If yes, how much do participants'

anxiety, depression, and stress scores decrease over time?

Exploratory Research Question 1

Does NF training reduce anxiety, depression, and stress scores for the treatment group over time? If yes, how much do treatment group participants' anxiety, depression, and stress scores decrease over time? Do control group participants' anxiety, depression, and stress scores decrease over time? If yes, how much do control group participants' anxiety, depression, and stress scores decrease over time?

Exploratory Research Question 2

Is there a significant difference in mean scores over time between the treatment group and control group depending on specific demographic variables?

Secondary Research Question

Is there a significant difference in cortisol levels over time between the treatment and control groups?

Exploratory Research Question 3

Is there a relationship between treatment group and control group participants' assessments scores and cortisol scores at each time point?

Population and Sampling

The target population for this study was college students; however, the accessible population studied for the current investigation consisted of college students (18 years of age or

older) attending any college or university located in a Southeastern state. In selecting participants, the researcher used convenience sampling with inclusion criteria (Gall, Gall, & Borg, 2007).

Neurofeedback Training Intervention

Prior to beginning the study, the researcher recruited and trained Undergraduate- and Masters-level Research Assistants (RAs) to assist in conducting the NF training sessions. This study took place over approximately a 12-week period (three semesters; spring 2017, summer 2017 and fall 2017), with a total of 16 NF training sessions (8.625 hours) per participant. Previous NF training studies have included a wide ranging number of sessions completed to help improve anxiety symptoms, including anywhere from 12 to 24 sessions; additionally, practitioners' provided support for clients to receive between seven to 12 hours of NF training to help with improvement in anxiety symptoms (Hammond, 2005). Because students were accessible during the semester, the study incorporated 16 sessions during the semester with the follow-up session occurring towards the end of the semester. The timing of the study was intended to help in the retention process, which was already challenging when having participants attend two NF training sessions over an eight-week period and an additional follow-up appointment four weeks after the last NF training session.

After participants were screened by the researcher and met all inclusionary criteria, they were scheduled to receive NF training during the 2017 spring, summer, or fall semester. During the first NF session, participants completed the following documents, prior to taking the paper assessments: (a) Informed Consent for Research; (b) Zengar Institute Informed Consent; and (c) Demographic Questionnaire.

After participants completed the informed consents and demographic questionnaire in the first session, they completed four assessments (BAI, PSS, BDI-II, and SAT). After the paper assessments were completed, the RA collected a saliva sample, which was immediately stored in a lab-grade freezer for appropriate storage temperatures. Following the collection of their saliva, the participants then began their first NF training session (15 minutes); all other NF training sessions were a total of 33.5 minutes. The specific times (i.e., 15 and 33.5 minute sessions) were regulated by the NF training system being used. During all three semesters, the four paper assessments were also administered at session eight, session 16, and the follow-up appointment. During the spring semester, saliva samples were collected at the initial appointment (pre; before receiving the first NF training session) and at the final session (post). However, saliva samples were collected at four points in the summer and fall semesters (before first session, at session eight, at session 16, at week 12). Since NF training can produce a calming effect (Hammond, 2005), the paper assessments and saliva collection were completed prior to administering the NF training.

Data Collection Procedures

Recruitment

Recruitment included creating flyers using the *Tailored Design Method* [TDM] (Dillman, Smith, & Christian, 2014). Flyers were disseminated to several offices on the campus of a large university in a Southeastern state, including student resource centers, first year advising offices, bulletin boards in high traffic areas on campus, student accessibility services, and via email to professors and campus staff members. The researcher also attended several courses to talk to undergraduate and graduate students about the study. Targeted classes included larger classes

and majors such as psychology, engineering and computer sciences, and career development courses. The researcher also posted information and flyers to social media outlets, including Facebook. Additionally, the researcher communicated with local mental health counselors and mental health counseling agencies who served college students in a counseling capacity. Therefore, an exact response rate could not be determined.

Study funding

The researcher applied for and received funding awards to support the current investigation, including the: (a) Southern Association for Counselor Education and Supervision *Supported Scholarship Research Grant* ($500); (b) American Counseling Association (ACA) *Ralph F. Berdie Memorial Research Award* ($300); (c) Association for Assessment and Research in Counseling (AARC) *Supported Scholarship Research Grant* ($1,528.64); and (d) Chi Sigma Iota (CSI) *Excellence in Counseling Research Grant* ($900). The awards funded participant incentives, printing costs, and equipment needed for the NF training system (e.g., neuroconductor gel; sensors; cleaning supplies, etc.). Furthermore, the co-chair (certified to administer NF training) of the investigation received permission from Zengar Institute to lease the NeurOptimal system for the sole purpose of conducting research.

Incentives

Incentives were provided to the participants as three $5.00 gift cards spread throughout the study. For example, participants received the first gift card after session one, the second after session eight, and the third after the follow-up session. Supplying gift cards throughout the study was incorporated in an attempt to help mitigate attrition (Dillman et al., 2014) that occurs within

research studies. The room in which the study took place also included a basket of candy for participants.

Screening

The researcher conducted a prescreening interview via telephone and asked questions to ensure participants met the following eligibility criteria: (a) 18 years of age or older; (b) enrolled as a college student (at least part-time) in the Southeastern state; (c) cannot be pregnant; (d) must be able to read, write, and understand English; (e) no hearing impairment; (f) no active psychosis; (g) no hospitalization, within the last month, due to a mental health concern; (h) no current suicidal or homicidal ideation (SI/HI) with plan or intent; (i) no pacemaker or any other implanted electronic devices; (j) no severe skin allergies to cosmetics or lotions; and (k) self-identification of experiencing anxiety, worry, or nervousness. If interested participants did not meet the eligibility criteria, they were not permitted to participate in the study and were provided with a list of local counseling services.

Data Collection Instruments

This study incorporated the use of four paper assessments and saliva collection to perform cortisol testing. Information about each of the four assessments and cortisol testing are introduced in the following paragraphs.

(a) *The Beck Anxiety Inventory* [BAI] (Beck et al., 1988) is designed to measure anxiety in adults. The BAI is a 21-item measure that uses a four-point Likert scale that asks participants to select their response based off of their symptoms over the past month, including the day of taking the assessment. The BAI endorses high internal consistency reliability ($\alpha = 0.92$) of the

sample data, moderate convergent validity with the *Hamilton Anxiety Rating Scale—Revised* [HARS-R] (Hamilton, 1959) $r = 0.51$; $p < .001$, mild convergent validity with the *Hamilton Depression Rating Scale—Revised* [HDRS-R] (Hamilton, 1960) $r = 0.25$, $p = .05$), and good test-retest reliability over a one week period ($r = .71$).

(b) The *Perceived Stress Scale* [PSS] (Cohen et al., 1983) is designed to measure the perception of stress individuals' experience. The PSS is a 10-item measure that includes a five-point Likert scale and asks participants to select their response in correspondence to their symptoms over the week, including the day of taking the test. The PSS demonstrates high internal consistency reliability ($\alpha = 0.84$ to $\alpha = 0.86$) of the sample data, moderate to high convergent validity ($r = 0.52$ to $r = 0.76$) with similar scales. Good test-retest reliability was found for the PSS over one, two, and four week periods ($r = .72$ to $r = .88$).

(c) *The Beck Depression Inventory, Second Edition* [BDI-II] (Beck et al., 1996) is designed to measure common symptoms associated with depression and depressive disorders. The BDI-II is a 21-item inventory that includes a four-point Likert scale and asks participants to select their response based off of their symptoms over the past two weeks, including the day of taking the test. The BDI-II also demonstrates high internal consistency reliability ($\alpha = 0.92$) of the sample data, satisfactory convergent validity with the HDRS-R (Hamilton, 1960) $r = 0.71$ and good test-retest reliability over a one week period ($r = 0.93$).

(d) The Social Anxiety Thoughts Questionnaire [SAT] (Hartman, 1984) is designed to measure thoughts or cognitions that often occur within socially anxious situations. Whereas the BAI focuses more on the physiological and emotional symptoms associated with anxiety, the SAT focuses on the cognitions or thoughts associated with anxious experiences that college students may encounter. The SAT is a 21-question inventory that uses a five-point Likert scale

and asks participants to select their responses based on their symptoms over the past month, including the day of taking the test. The SAT demonstrates high internal consistency reliability ($\alpha = .95$) of the sample data, and satisfactory convergent validity with Fear and Negative Evaluation Scale [FNE] (Watson & Friend, 1969), $r = .60$, $p < .0001$ and the Social Avoidance and Distress Scale [SAD] (Watson & Friend, 1969), $r = .58$, $p < .0001$. Test-retest reliability scores were not provided in the literature.

(e) The saliva samples were analyzed using Salimetrics Enzyme-Linked Immunosorbent Assay (ELISA), a method that measures quantitative levels of cortisol in samples of saliva (Salimetrics, Inc., 2017). Once saliva samples were collected, they were stored in a lab grade freezer at or below -80^{o}C to preserve until analysis. At time of analysis, samples were thawed and put in a centrifuge machine in order to remove any matter that could impact the saliva sample (Salimetrics, Inc., 2017). Once the samples reached room temperature, they were added to the Salimetrics assay plate and put in appropriate wells for analysis. For more specific information about the analysis process, please visit: https://www.salimetrics.com/assets/documents/1-3002n.pdf

Data Analysis

The Statistical Package for Social Science (SPSS) software package for Mac version 24.0 (IBM Corp., 2017) was used to analyze the study data. The identified continuous dependent variables for the study included the averaged total scores for the: (a) BAI; (b) PSS; (c) BDI-II; (d) SAT; and (e) cortisol scores; the independent variable was the group (i.e., treatment group or control group). Demographic variables were also incorporated into the analysis process, including: (a) age; (b) identified gender; (c) ethnicity; (d) college major; and (e) involvement in

personal counseling; these variables were examined prior to data analysis to ensure that analyses met all statistical assumptions. Furthermore, the data cleaning process was vital to ensure appropriateness of statistical results (Osborne, 2013), especially as research in the social sciences often results in missing or incomplete data (Gall et al., 2007).

Primary Research Question

A repeated measures multivariate analysis of variance (RM-MANOVA) was completed to determine if BAI, PSS, BDI-II, and SAT scores changed significantly over time for the treatment group compared to the control group. The RM-MANOVA was selected as it measures if there is statistical significance in the mean change of scores over time (Tabanchick & Fidell, 2013). In conducting a RM-MANOVA, several statistical assumptions were considered and checked, including: (a) sample size; (b) multivariate normality; (c) linearity among dependent variables; (d) homogeneity of variance; and (e) sphericity among dependent variables. Specifically, it was important to check for normality of data collected; however, social science data often includes non-normal distributions (Hair, Black, Babin, & Anderson, 2010). Additionally, the researcher assessed for any outliers. Next, linearity was checked through visual inspection of scatterplots to check for skewness. Homogeneity of variance was also assessed in order to determine legitimacy of results (Tabanchick & Fidell, 2013).

Exploratory Research Question 1

The first exploratory research question also utilized a RM-MANOVA to determine if there was a significant difference in assessment scores (BAI, PSS, BDI-II, and SAT) over time for the treatment group. Next, a RM-MANOVA was implemented to determine if significant

differences in assessments scores were found over time for the control group. If significance was found, pairwise comparisons were reported to determine the amount of change in assessment scores over time.

Exploratory Research Question 2

The second exploratory research question examined if there was a significant difference in assessment scores (BAI, PSS, BDI-II, and SAT) over time between the treatment group and control group, depending on specific demographic variables. Demographic variables included: (a) age; (b) race/ethnicity; (c) gender; (d) major; and (e) involvement in personal counseling.

Secondary Research Question

The secondary research question utilized a RM-MANOVA to determine if there was a significant difference in mean cortisol scores over time for the treatment group as compared to the control group.

Exploratory Research Question 3

Finally, the third exploratory research question sought to determine if there was a relationship between treatment group and control group participants' assessment scores (BAI, PSS, BDI-II, and SAT) and cortisol levels at each time point (pre-test, mid-test, final test, and follow-up).

Ethical Considerations

Throughout the entirety of the research process, ethical considerations were implemented. Ethical considerations included: (a) securing Institutional Review Board (IRB) approval; (b)

informing participants of their rights and the voluntary nature of the study through verbal instruction and paper consent forms; (c) providing participants with the limits of confidentiality that apply to the study; (d) removal of all identifiable information on study assessments and test tubes; and (e) ensuring all research personnel had completed necessary research training regarding ethics and study protocols in working with human subjects. Furthermore, in order to ensure fair treatment between the treatment and control groups (Gall et al., 2007), participants from the control group were offered the opportunity to receive NF training services following the completion of this research study.

Potential Limitations of the Study

Limitations of the investigation are considered in areas such as: (a) research design; (b) sampling; (c) instrumentation; and (d) treatment. Regarding research design, although the study incorporated the use of a waitlist control group, lack of random assignment could impact statistical conclusion validity. Additionally, if participants expected to receive benefits from the NF training intervention, it may have influenced their selected items on the assessments used. Researcher bias may have occurred in the primary investigator facilitating some of the NF training sessions for the treatment group and from facilitating the majority of assessment completion appointments for the control group. Although specific measures were taken to ensure treatment fidelity, threats are still plausible. For example, as the NF training sessions were facilitated by various RAs, the comfort level of participants (i.e., if participants established rapport with the RAs) may have influenced responses. Since the study took place over a 12-week period, a maturation effect could have occurred; history presents as another threat to validity,

with some participants (both treatment and control groups) reporting engagement in counseling or psychiatric interventions after beginning the participation in the study. Additional limitations may be found in the sampling. As convenience sampling was employed, generalizing study results is more difficult.

The four assessments (BAI, PSS, BDI-II, and SAT) utilized rely on participants self-identified experiences. However, social desirability is common within social science research, which may have influenced participants to select more favorable responses. Participants may have also experienced desensitization to assessments since they took each assessment at four different time points. Furthermore, all instruments present with some amount of measurement error. Regarding collection and analysis of salivary cortisol, limitations are noted in collection of saliva samples at different time periods and no information about extraneous factors (i.e., caffeine; alcohol; food; medication; etc.), both of which may impact the level of salivary cortisol found.

Chapter One Summary

Chapter one provided the rationale and importance of exploring the influence of NF training on college students' levels of stress, anxiety, and depression. The main constructs of stress, anxiety, depression, NF training, and the college student population were discussed and operational definitions listed. Additionally, an explanation of the use of a quasi-experimental, nonequivalent control group designed was provided. An overview of the methods of the study were provided, including: (a) research questions; (b) population and sampling; (c) data collection procedures; (d) data collection instruments; and (e) data analysis procedures. Finally, potential ethical considerations and potential study limitations were provided.

Overall, college students are at an increased risk for anxiety, stress, and depression and are in need of various adjunctive services to intervene. Throughout the NF training literature, researchers have demonstrated positive results for treating anxiety and depression, yet the use of NF training with college students has been minimally explored. Additionally, the use of measuring cortisol levels while receiving NF training has not been studied, demonstrating the usefulness of the current study in addressing a void in the research literature as well as serving a population in need.

CHAPTER TWO: REVIEW OF THE LITERATURE

The primary purpose of this study was to investigate the effectiveness of Neurofeedback (NF) training on college students' levels of anxiety, depression and stress through the following measures: (a) *Beck Anxiety Inventory* (BAI); (b) *Beck Depression Inventory, Second Edition* (BDI-II); (c) *Perceived Stress Scale* (PSS); (d) *Social Anxiety Thought Questionnaire* (SAT); and (e) salivary cortisol levels through Salimetrics Enzyme-Linked Immunosorbent Assay (ELISA) testing. In studying the identified constructs and overall purpose of the study, the researcher reviewed the literature on the theoretical background and empirical support for the following constructs: (a) stress; (b) anxiety; (c) depression; (d) cortisol; (e) NF training; and (f) mental health needs of college students. The identified constructs are examined in the following sections with emphasis on the effects of stress and anxiety and empirical support for NF training.

Stress

According to the Anxiety and Depression Association of America (ADAA, n. d.), seven of ten adults endorse experiencing feelings of stress and anxiety every day, and indicate that these levels impact overall functioning within their lives. Stress is a universal concept that has received great attention throughout history, especially within medical and psychological literature (e.g., Caspi et al., 2003; Kopp et al., 2010; Lazarus, 1993; McEwen & Gianaros, 2011; Sapolsky, 1996; Vyas et al., 2002). Early stress research has been credited to Selye (1936), who described stress as a general reaction of the body due to any type of strain or demand that occurs. Lazarus and Folkman (1984) further described stress as an experience that occurs within or

toward individuals and impacts whether they are capable of coping or adapting. Overall, stress can be viewed from three different perspectives: (a) biological, focusing on physiological responses that occur as a result of stressors; (b) psychological, focusing on subjective experiences of stress and emotional outcomes; and (c) environmental, focusing on specific stressors or occurrences (Cohen & Kessler, 1997; Kopp et al., 2010).

Literature and reports of research on stress overlaps with symptoms and presentations of anxiety and anxiety disorders. However, it is important to differentiate between stress and anxiety. Stress can be seen as a more general term and experience that encompasses emotional, cognitive, and physiological experiences, all of which are explored in the following sections. Stress differs from psychological distress such as psychological challenges of anxiety and depression (Schroder, Dawood, Yalch, Donnellan, & Moser, 2015). Thus, stress and psychological distress (i.e., mental health illness such as anxiety and depression) represent two different constructs.

Stress Theories and Emotional Implications

Lazarus and Folkman (1984) described the transactional model of stress and coping; this conceptualizes how individuals interact with and respond to stress, which is found within internal and external structures. Stress involves factors such as negative interactions between individuals and their environment (i.e., interaction of personal attributes and environmental circumstances), cognitive judgements, and negative emotional experiences including fear and shame. The transactional model of stress and coping also involves three main structures in conceptualizing emotion: "(1) relationship or transaction; (2) process; and (3) a view of emotion as an interdependent system of variables" (Lazarus & Folkman, 1984, p. 142). Thus, the relationship

between individuals and their environment impacts how emotions are experienced. The relational process includes change or movement across a period of time, as individuals attempt to modify stressful emotions. Finally, emotions are derived using a systems approach in which they are interconnected to individuals' experiences and perceptions.

In addition to the person and environmental interactions with stress outlined by Lazarus and Folkman (1984), the stress experience also involves: (a) the ability of an individual to determine if a situation is threatening or safe; (b) the ability of the mind or body to cope with stress; and (c) the stress reaction or intricate processes of the influence of stress on the mind and body (Lazarus, 1993). Furthermore, Lazarus (1993) identified three main types of stress: (a) challenge, which refers to the ability to feel assured about overcoming difficult emotions by actively engaging in coping mechanisms; (b) threat or the anticipation of harm that may occur, but has not occurred; and (c) harm, which represents psychological harm that has occurred. Thus, experiences of psychological stress are induced by environmental or internal states, resulting in various outcomes. The experience of viewing an event as threatening, harmful, or challenging is also due to the appraisal or the degree to which one judges an event to be stressful (Lazarus, 1993). Ultimately, individuals are susceptible to experiencing heightened stress responses if their perception of an event is threatening or potentially harmful.

Lazarus and Folkman (1984) also emphasize the role of coping in its relation to stress; individuals who engage in mental processes to cope with stressful events are less likely to experience stress responses. Coping is done with the goal of improving situations and involves the ability of an individual to change their situation or their perspective of a situation (Lazarus, 1993). Coping can involve cognitions or specific actions to improve the challenging situations or difficult emotions experienced (Lazarus & Folkman, 1984). Coping is also dependent on

environmental contexts and can morph over time and among different stressful scenarios (Folkman & Lazarus, 1985). Lazarus (1993) identified two main types of coping: (a) emotion-focused coping, involving the ability of an individual to change their perspective on what is occurring and (b) problem-focused coping, involving specific actions that take place during the occurring stressful event.

Lazarus (1991) further discussed the role and implications of emotion in exploring his cognitive-motivational-relational theory of emotion. The cognitive components of emotions incorporate two factors: (a) appraisal, or the judgment of what is occurring within an individuals' environment and (b) knowledge, which includes the circumstantial and general beliefs of how things work. Motivational factors of emotions refer to feelings that arise from personal goals and daily interactions; and the relational component refers to emotions being infused into the person-environment relationships and interactions, which can involve positive feelings or negative feelings. Finally, Lazarus (1991) identified 15 primary emotions that individuals experience, including: anxiety, sadness, fright, guilt, envy, disgust, jealousy, anger, shame, happiness, relief, love, and pride. The role of emotions and the experiences that trigger such emotions result in either a stress-based response or the ability to cope in the face of adversity.

Overall, in considering the work of Lazarus (1991) and Lazarus and Folkman (1984) stress is a general experience or emotion that can lead to other emotional states, including anxiety and depression. Thus, stress has been viewed as an antecedent to anxiety and depression, which are quantifiably more emotionally-distressing than stress itself.

Impacts of Stress: Physical, Cognitive, and Emotional Consequences

Through Lazarus and Folkman's (1984) development of the transactional model of stress and coping, stress is described as an emotional and interactive experience that results in consequences for the well-being and functionality of individuals. Additionally, the influence of stress is apparent in its interaction with and impact on physiological functioning and brain systems.

The brain and body

The brain is responsible for communicating with the body about threats and situations happening within an individual's environment (McEwen & Gianaros, 2011) and is also one of the main organs threatened by stress (Liston et al., 2006; Vyas et al., 2002). Although there are many brain structures, hormones, and neural processes that are involved in the stress-response process, the information provided in this section provides an overview of the central processes pertinent to this study. In general, individuals' reactions to stress stem from the autonomic nervous system (ANS), which handles initiating or suppressing physiological responses through two additional systems: (a) the sympathetic nervous system (SNS) and (b) the parasympathetic nervous system [SNS] (Sapolsky, 2004).

The SNS is activated during situations in which crises or perceived crises occur; this results in signals being sent from the brain to other bodily organs, prompting reactions such as increased heart rate, decreased salivation, diminished digestive processes, dilated pupils, and the release of adrenaline or epinephrine (Sapolsky, 2004). The activation of the SNS is also responsible for triggering the fight, flight, or freeze response. For example, the SNS becomes activated if someone jumps out and startles another individual. Although that individual may not

actually be in immediate danger, the SNS turns on as it is designed to help individuals get out of dangerous situations (Sapolsky, 2004). The role of the PNS is opposite to that of the SNS in that it slows down physiological processes, resulting in a calmer state; thus, the PNS slows heart rate, constricts the pupils, and encourages helpful digestion. For example, the PNS becomes activated after eating a large meal as the body is working towards slowing down for appropriate digestion (Sapolsky, 2004).

In addition to the brain activating internal systems in response to stress, the brain also serves a role as the mediator in releasing accompanying stress hormones. Similar to the SNS, stress-response hormones are also activated in an actual crisis or when the brain thinks about a stress-provoking experience, even if the stressor is not present (Sapolsky, 2004). Glucocorticoids (GC) are a group of stress-hormones that are activated by the adrenal gland (Herman & Cullinan, 1997) where epinephrine (or adrenalin) also originates (Sapolsky, 2004). Sapolsky (2004) reported that when the brain processes an event as stressful, the following sequence occurs: (a) first, the hypothalamus (which activates the ANS and pituitary gland) releases a variety of hormones into the hypothalamic-pituitary-adrenocortical (HPA) circulatory system, including corticotropic releasing hormone (CRH); (b) next, the pituitary gland is prompted to release adrenocorticotropin hormone (ACTH) into the bloodstream which then enters into the adrenal gland; and (c) finally GC is released. Additionally, there are three levels of responses from GCs and stress: (a) neuroendangerment, compromising the functionality of neurons, making them vulnerable or susceptible to further damage as the result of continued stress; (b) neuronal atrophy, resulting in malfunctioning of neuron-processes that can be remedied; and (c) neurotoxicity, resulting in the death of neurons (Sapolsky, 1996).

Stress is also processed through specific brain parts, including the: (a) amygdala, housing memories associated with emotional (positive and negative feelings) and fearful situations; (b) hippocampus, responsible for spatial and declarative memory; and (c) prefrontral cortex, influencing the ability to engage in executive functions and rationally-process fear (Popoli et al., 2012). Thus, when individuals process stress through the amygdala, hippocampus, and/or the prefrontal cortex, functioning of these brain parts become impaired. For example, since the hippocampus plays a central role in inhibiting stress and in activating the HPA axis, it becomes vulnerable to the damage of stress and can malfunction in regulating itself (Herman & Cullinan, 1997; Jacobson & Sapolsky, 1991; Vyas et al., 2002).

Stress and anxiety

As indicated, stress is processed through different brain structures and systems, releasing a variety of stress-hormones and compromising the functioning of the accompanying brain parts. Although stress and anxiety are separate constructs and experiences, from a physiological perspective, anxiety is also processed through the same brain structures (e.g., prefrontal cortex and amygdala), as the body responds to anxiety similarly to stress (Maes et al., 1998; McEwen & Gianaros, 2011). For example, the prefrontal cortex serves a vital role in resolving the influence stress causes on cognitive abilities and mental health illnesses (Popoli et al., 2012) and, if not resolved, can lead to more severe or persistent anxiety symptoms or anxiety disorder diagnoses. Furthermore, anxiety and fear also induce stress responses processed within the HPA axis (Vyas et al., 2002).

Stress and depression

Due to the influence of stress and its resulting reaction of the body to release stress-related hormones, the psychological functioning of individuals is often compromised (Popoli et al., 2012). Although stress-responses are normal and are triggered to help the body adapt, this process can also cause pathophysiological responses (i.e., a response associated with illness) if the stress-response is consistently activated or impaired, leading to or worsening mental health concerns (Popoli et al., 2012), including mood disorders (Goto, Yang, & Otani, 2010). For example, individuals who are experiencing heightened rates of stress are susceptible to depression and those who are in their first episode of major depression are more than likely to have experienced a new, substantial level of stress (Sapolsky, 2004).

Furthermore, when an increased amount of GCs are released, an individual's risk for developing depression or depressive symptoms is heightened (Sapolsky, 2004). Caspi and colleagues (2003) also found that individuals who have a specific type of allele (5-HTT) are more susceptible to developing symptoms of depression and full depressive diagnoses when encountering stressful life and environmental experiences. The identification of alleles as well as other physiological experiences demonstrates the impact stress can have in developing and/or maintaining depression within individuals.

Stress and College Students

Stress is an inevitable experience during college, especially as students are exposed to new experiences, new stressors, and new pressures (Beiter et al., 2012). Common stressors that college students experience include financial strain from student loans and other college related expenses (Andrews & Wilding, 2004), learning to balance increased responsibilities (Dyson &

Renk, 2006), facing social anxiety within new environmental contexts (Campbell et al., 2016), and learning to adjust and individuate from previous contexts (Arnett, 2000).

The fall 2016 American College Health Association - National College Health Assessment (ACHA-NCHA) surveyed over 33,000 students about their behaviors and experiences related to a myriad of frequent health concerns (ACHA, 2017). Respondents were asked to identify a variety of circumstances that resulted in academic difficulties (e.g., dropping a class, earning a low grade on an assignment, experiencing substantial interruption in major courses). Although students were provided with many options from which to select in the assessment (ACHA, 2017), the five highest selected responses were as follows: (a) stress (32.2%); (b) anxiety (24.9%); (c) sleep difficulties (20.6%); (d) depression (15.4%); and (e) work (14.2%). These percentages demonstrate the impact mental health can have, especially in terms of anxiety, stress, and depression, on students' academic performance. The students were also asked in the ACHA (2017) assessment to rate levels of experienced stress over the past year (12 months) and findings were as follows: (a) 2.0% reported "no stress" (4.0% of male respondents and 0.9% of female respondents); (b) 6.7% reported "less than average stress" (12.1% of male respondents and 4.3 of female respondents); (c) 35.3% reported "average stress" (38.0% of male respondents and 34.5% of female respondents); (d) 43.7% reported "more than average stress" (37.7% of male respondents and 46.5% of female respondents); and (e) 12.2% reported "tremendous stress" (8.2% of male respondents and 13.7% of female respondents; ACHA, 2017). Additionally, students were also asked if, within the past 12 months, they "felt overwhelmed by all you had to do" and 86.0 % respondents (76.0% of male respondents and 90.7% of female respondents) responded "yes."

Andrews and Wilding (2004) recognized the increase in life-stress in United Kingdom based students and implemented a longitudinal study, which surveyed 351 undergraduate students one month prior to attending university and during the midpoint of their second year. Students were asked to complete the *Hospital and Anxiety Depression Scale* [HADS] (Zigmond & Snaith, 1983) and at the pre-study point and during the midpoint of their second year. Respondents also completed a modified version of the *List of Threatening Experiences* (Brugha, Bebbington, Tennant, & Hurry, 1985), which asks questions related to interpersonal concerns (e.g., separation from significant other; significant issue with friend), familial issues, loss of a loved one, financial concerns, and legal issues). A paired samples *t*-test was implemented to determine if there were significant changes in respondents' anxiety and/or depression scores; results indicated that mean scores for both anxiety and depression significantly increased from the pre-study point to the midpoint (anxiety, t [348] = 3.35, p <. 001; depression, t [348] = 6.1, p < .001). Overall, results indicated that the students who endorsed no anxiety symptoms and depressive symptoms before beginning college, 20% reported clinically significant anxiety and 9% indicated symptoms associated with depression (Andrews & Wilding, 2004).

Although the Andrews and Wilding (2004) study demonstrated the influence of stressors for undergraduate students and how stressors impact levels of anxiety and depression, limitations were found in the lack of diversity in gender and racial background of students who responded to the surveys (only 25% of respondents were male and 87% of respondents identified as white). The heightened level of response from females was consistent with the findings reported by previous researchers, as studies females are significantly more likely to respond to surveys (Surtees, Wainwright, & Pharoah, 2002).

Anxiety

Similar to stress, anxiety is a widespread and often experienced symptom and diagnosis across varying populations. The following sections explore different facets of anxiety, including: (a) prevalence; (b) theoretical constructs; (c) symptoms; (d) physiological implications; and (e) impacts of anxiety on college students.

Prevalence of Anxiety and Anxiety Disorders

According to Kessler and colleagues (2005b), anxiety disorders have been the most commonly diagnosed mental health conditions. Kessler and colleagues (2005b) examined the prevalence, severity, and comorbidity of DSM-IV (APA, 1994) diagnoses from the National Comorbidity Survey Replication (NCS-R) and found that out of 9,282 respondents, 18.1% met criteria for an anxiety disorder (adults in the US). Of the anxiety disorders reported, the top five were: (a) specific phobia (8.7%); (b) social phobia (6.8%); (c) PTSD (3.5%); (d) GAD (3.1%); and (e) panic disorder (2.7%). However, the current edition of the DSM (i.e., DSM-5) has removed PTSD from the Anxiety Disorder category and is now classified as a Trauma- and Stressor-Related Disorder (APA, 2013). Furthermore, anxiety disorders were found to have a lifetime prevalence of 28.8% and age-of-onset (11 years of age) occurred sooner than other disorders (Kessler et al., 2005a). Additionally, anxiety disorders are one of the most expensive mental health issues, resulting in a cost of $46.6 billion in 1990, accounting for 31% of mental health care costs (Rice & Miller, 1998).

Wittchen and Jacobi (2005) reviewed 27 epidemiological studies that took place in 16 countries within Europe to assess for prevalence and impact of mental health disorders in Europe

for 155,000 adults between the ages of 18 to 65. Overall, anxiety disorders were identified as the most commonly diagnosed disorder (12%; 36.3 million adults over a 12-month period), followed by mood disorders. Anxiety was also reported to likely occur in childhood, thereby negatively influencing overall development, including social and interpersonal abilities, achievement in school, and cognitive development (Wittchen & Jacobi, 2005). The National Comorbidity Survey also indicated that although anxiety disorders were the most diagnosed mental illness, only 34% of these persons viewed needing mental health services (Mojtabai et al., 2002). Thus, although anxiety and anxiety disorders have been vastly researched and diagnosed within adults, the number of individuals who have actually sought out treatment versus the number of individuals suffering from anxiety was vastly different (Ohayon, Shapiro, & Kennedy, 2000).

Theories and Treatment of Anxiety

Anxiety is a researched construct (e.g.., Coles & Coleman, 2010; Ferreri, Lapp, & Peretti, 2011; Kessler et al., 2005a, 2005b; Rice & Miller, 1998; Wittchen & Jacobi, 2005) that is often viewed through one of three lenses: (a) anxiety as a foundational human emotion and experience (Freud, 1926); (b) anxiety as an aspect of personality, often referred to as trait anxiety (Spielberger et al., 1970); or (c) anxiety as part of diagnosable anxiety disorders (Eysenck, 1997). Spielberger and colleagues (1970) coined the term trait anxiety, referring to the stable expression and experience of an individual's anxiety, worry, and fear over many situations or contexts; trait anxiety is a stable part of an individual's personality. Gray's (1982) theory of trait anxiety alluded to heredity and biological processes as the main factors that contribute to the trait anxiety that is experienced and expressed by individuals. Similarly, Eysenck (1967) identified neuroticism, a term used synonymously with trait anxiety which encompasses occurrences such

as fear, anxiety, and worry, as an experience that also has biological and hereditary underpinnings. Although theories of trait anxiety highlight the importance of heredity in its role in anxiety, they do not take into consideration the environment and other factors that influence anxiety (Eysenck, 1997).

Anxiety has also been conceptualized and treated through several different theoretical orientations and perspectives (Strongman, 1995). The National Institute of Mental Health (NIMH, 2018a) reported support of several therapeutic modalities in the treatment of anxiety disorders, including: (a) cognitive-behavioral therapy (CBT); (b) stress management strategies; (c) group therapy; and (d) medication. CBT is an evidenced-based therapy that is often used in treating anxiety and anxiety disorders. The main focus of CBT is to examine the influence of unhelpful thoughts and thought patterns, which impacts feelings and behaviors, with the goal of modifying thought processes in an effort to decrease negative feelings (Beck Institute for Cognitive Behavior Therapy, 2016).

Mindfulness-based treatments also demonstrate improvement for anxiety (Call, Miron, & Orcutt, 2014), as they promote the ability to be self-regulative of emotions (Davidson et al., 2003). Mindfulness is: "the awareness that emerges through paying attention, on purpose, in the present moment, and nonjudgmentally to the unfolding of experience" (Kabat-Zinn, 2003, p. 145). The practice of mindfulness emphasizes the use of intentional, present-focused awareness on environmental and physical processes (e.g., breathing) without becoming attached to these experiences (Ricard, Lutz, & Davidson, 2014). A common mindfulness-based practice includes mindful breathing. Mindful breathing encourages the individual to engage in purposeful breathing patterns that create calming effects while also promoting the ability to focus more on the present moment (Stahl & Goldstein, 2010).

Presentation of Anxiety and Anxiety Disorders

Anxiety falls on a continuum, ranging from mild anxious symptoms (i.e., feelings of nervousness) to formal anxiety disorder diagnoses that involve significant impairment in daily life and overall functioning. The DSM-5 (APA, 2013) has identified 11 anxiety disorders, including: (a) separation anxiety disorder; (b) selective mutism; (c) specific phobia; (d) social anxiety disorder (social phobia); (e) panic disorder; (f) agoraphobia; (g) GAD; (h) substance/medication-induced anxiety disorder; (i) anxiety disorder due to another medical condition; (j) other specific anxiety disorder; and (k) unspecific anxiety disorder. Anxiety disorders have overlapping characteristics, including heightened levels of anxiety and fear, which accompany behavioral challenges; however, differences among anxiety disorders are found in circumstances which bring about associated anxiety, fear, and maladaptive behaviors (APA, 2013). The current study focused on anxiety symptoms versus formal anxiety disorder diagnoses. However, because anxiety symptoms are present in anxiety disorders, it is important to explore the literature on anxiety disorders as they are the most diagnosed group of disorders (Kessler et al., 2005a).

Anxiety is a complex experience which involves symptoms associated with physiological, affective, and thought-related difficulties that interfere with overall functioning and well-being (APA, 2013). Anxiety is expressed physically through increased heart rate, changes in breathing pattern, perspiration, tightness in chest, fidgeting, and restlessness (APA, 2013). Cognitive aspects of anxiety include rumination over thoughts, difficulty concentrating or paying attention, faulty beliefs (i.e., all-or-nothing thinking; catastrophizing) and decreased ability for memory recall (Ferreri et al., 2011). Furthermore, diminished cognitive abilities are both a catalyst for and result of anxiety and anxiety disorders (Ferreri et al., 2011). Anxiety also

manifests on an emotional level, including fear, distress, feeling overwhelmed, worry, and nervousness (Pittman & Karle, 2015). Due to the invasive nature of anxiety symptoms, quality of life is impacted and can manifest in negatively impacting work and/or school performance; quality of sleep; appetite (APA, 2013); intrapersonal, interpersonal, and intimate relationships; increased risk for suicide (Garner, Möhler, Stein, Mueggler, & Baldwin, 2009); and heightened morbidity and mortality; and economic strain (Wittchen & Jacobi, 2005).

Anxiety and the brain

In order to better comprehend the implications and impacts of anxiety, it is important to understand its neurological underpinnings and processes. Often times, anxiety and fear are coupled together or used interchangeably when discussing experiences. However, although fear shares commonalities with anxiety and is processed in the same brain areas, they are two separate experiences: fear occurs when individuals are in present danger whereas anxiety occurs as a result of an event that is more future-oriented (Pittman & Karle, 2015). As indicated in the discussion of the neurological process involved in stress, anxiety also affects many parts of the brain and is processed through two main areas, including the amygdala and prefrontal cortex. The prefrontal cortex, located at the front of the brain, involves higher-order brain processes and is capable of rational thoughts, planning, imagination, and sensations (Pittman & Karle, 2015). The amygdala, two almond-shaped brain parts located more centrally in the brain, are responsible for the physiological effects of anxiety, including increased heart rate, sweaty palms, muscle tension, and release of adrenaline (Pittman & Karle, 2015). The amygdala is fast acting and occurs without conscious awareness of an individual, often making it feel as though anxiety responses or symptoms are out of control.

Anxiety and College Students

Due to anxiety disorders being the most frequently diagnosed and reported mental health concern for adults in the United States and Europe, it is not surprising that anxiety is prevalent within the college student population. The National Alliance on Mental Illness (NAMI) reported one in five college students struggle with mental health issues and that approximately 75% of mental health concerns occur by the age of 24 (NAMI, 2018). Anxiety is one of the most reported mental health problems on college campuses and has been treated for by one in six college students (ACHA, 2015). Transitioning into college is an anxiety-provoking experience. As college students are presented with unique stressors, they are also susceptible to several different types of anxieties and mental health experiences, including: (a) test anxiety (e.g., Harrison et al., 2013; Nelson et al., 2014; Prevatt et al., 2015); (b) social anxiety (Campbell et al., 2016); and (c) suicidal ideation and depression (Kitzrow, 2009), with comorbid anxiety and depression increasing the likelihood of dropping out of school. As the college and university experience involves several social contexts, effectively integrating into social situations and creating connections with peers is a crucial component in adjusting to and being successful in college (Campbell et al., 2016), as it relates to academic success (Gall, Evans, & Bellerose, 2000).

The fall 2016 ACHA-NCHA, reporting over the previous 12-month period, showed that more than half (56.1%) of college student respondents indicated receiving professional health services, with the highest percentages related to treatment for attention deficit hyperactivity disorder (ADHD; 7.8%) and other "psychiatric conditions" (7.6%). Students endorsed that anxiety (24.9%) was the second most concerning factor impacting academic success and ability (ACHA, 2017) and can also create negative consequences for academic success such as

decreased GPA (Eisenberg et al., 2009). Furthermore, respondents were also asked if they have "felt overwhelming anxiety" within the past two weeks to 12 months and 66.0% (55.9% of male respondents and 70.2% of female respondents) selected "yes." Specifically, 28.5% (19.1% of male respondents and 32.3% of female respondents) experienced overwhelming anxiety within the past two weeks; (b) 13.5% experienced overwhelming anxiety within the past 30 days (10.5% of male respondents and 14.8% of female respondents); and (c) 18.8% (17.0% of male respondents and 19.7% of female respondents) experienced anxiety in the last 12 months. Additionally, 19.1% (8.7% of male respondents and 22.8% of female respondents) of students reported being diagnosed with or receiving treatment from a mental health professional in the last 12 months. Moreover, it appears that female students were more likely to report experiencing symptoms of anxiety as well as seeking out appropriate services to treat anxiety (ACHA, 2017).

Additional studies have been conducted to explore the influence and experience of anxiety within the college student population. Schroder and colleagues (2015) explored the role of psychological distress, including anxiety and worry, within a college student population. The results from their study reported heightened rates of anxiety (M = 53.84, SD = 14.70) compared to the general population. That is, results indicated that 33% of the sample (n = 128) scored above 61 on the *Penn State Worry Questionnaire* [PSWQ] (Meyer, Miller, Metzger, & Borkovec, 1990), a questionnaire assessing trait worry; according to Behar, Alcaine, Zuellig and Borkovec (2003), college students who score above a 61 on the PSWQ are considered eligible to meet diagnostic criteria for GAD. Furthermore, the college student population from the Schroder and colleagues (2015) study also completed the *State Trait Anxiety Inventory-Trait version* [STAI-T] (Spielberger, Gorssuch, Lushene, Vagg, & Jacobs,1983) which assesses for the level of trait anxiety or anxiety that is typically stable or often present within an individual. The

sample of college students who completed the STAI-T during its development had similar scores: female students: *M* = 40.40, *SD* = 10.15; male students: *M* = 38.30, *SD* = 9.18 (Spielberger et al., 1983); to the college student population scores (female students: *M* = 42.36, *SD* = 11.25; male students: *M* = 38.58, *SD* = 9.03) from the Schroder and colleagues (2015) study. Overall, these findings indicate a heightened rate and presence of anxiety symptoms and anxiety disorders within the college student population. As indicated, although anxiety and anxiety disorders are the most common mental health concern in the US, individuals often experience difficulty in seeking out appropriate services or having appropriate insight into mental health experiences; this is also true for the college student population. Stigma associated with mental health concerns can create a barrier to students reaching out for needed services (Eisenberg et al., 2009). Increasing the opportunity for college students to have access to mental health care is critical, as almost 75% of lifetime mental health diagnoses are first experienced by age 24 (Kessler et al., 2005a).

Coles and Coleman (2010) surveyed 284 undergraduate students to determine their awareness and insight of anxiety disorders and depression. Students assessed varies case studies that provided symptoms associated with various DSM-IV (APA, 1994) anxiety disorder diagnoses such as panic disorder, OCD, social phobia, panic disorder, and GAD as well as one case study involving major depression. Students did well in identifying OCD (86.4% correct), social phobia (86.8% correct), and depression (88.2% correct); however, students' success rates in correctly identifying GAD (41.4%) and panic disorder (47.7% correct) were much smaller (Coles & Coleman, 2010). The researchers also identified specific variables which correlated to statistical significance in correctly identifying GAD and social phobia, including: (a) gender, with females identifying 47.6% correct for GAD ($x^2 = 5.41$, $p = .02$) and 92.6% correct for social

phobia ($x^2 = 10.28$, $p < .001$); and (b) experience with mental health, with 50.8% accurately selecting GAD ($x^2 = 6.40$, $p = .01$) and 93.3% accurately selecting social phobia ($x^2 = 6.45$, $p = .01$).

Depression

As with stress and anxiety, depression is one of the leading mental health concerns for adults. The following sections present different areas of depression, including: (a) prevalence; (b) theoretical constructs; (c) symptoms; (d) physiological implications; and (e) impacts on college students.

Prevalence of Depression and Depressive Disorders

Depression and depressive disorders are the second most commonly diagnosed mental health disorder in the US and Europe behind anxiety disorders (Kessler et al., 2005b; Wittchen & Jacobi, 2005). According to the World Health Organization (WHO, 2013) Mental Health Action Plan, "Depression alone accounts for 4.3% of the global burden of disease and is among the largest single causes of disability worldwide [11 % of all years lived with disability globally], particularly for women" (p. 8). Furthermore, mood disorders (previous classification of depression in the DSM-IV (1994), now referred to as Depressive Disorders in the DSM-5), were the second most common diagnoses found at 9.5% in the NCS-R and had the highest rate of cases classified as serious (Kessler et al., 2005b). Of the 9.5% identified, 6.7% met criteria for major depressive disorder (Kessler et al., 2005b). The WHO (2017) also stated that more than 300 million individuals around the world struggle with depression.

Theories and Treatment of Depression

A central theory to conceptualizing depression centers on cognitive theories of depression (Haaga et al., 1991). Beck has been acknowledged as being one of the prominent figures and researchers in cognitive aspects of depression (Haaga et al., 1991). Beck's Negative Cognitive Triad (Beck, 1976) conceptualized the influence of depression due to three main views and beliefs about: (a) the self; (b) the world; and (c) others. Theorists also maintained that thoughts associated with depression were connected to general beliefs of hopelessness, a negative outlook of the environment, and unhelpful perspective of self (Clark, Beck, & Brown, 1989). Cognitions were also believed to develop and sustain depression (e.g., Abramson et al., 1989; Ellis, 1987) as pessimistic thoughts of self, others, and the world were believed to reinforce depression.

At the time of the present study, NIMH (2018b) supported the use of psychotherapy and/or the use of medications in treating depression. Additionally, incorporating exercise and other physical activities can be helpful in working through depression. Similar to treatment of anxiety, CBT and mindfulness-based therapies have been successfully implemented in the treatment of depression. In considering Beck's Negative Cognitive Triad, CBT can focus on reframing negative thought patterns that perpetuate emotions and behaviors associated with depression (Beck Institute for Cognitive Behavior Therapy, 2016). Although medication can be effective in improving depression, side effects are common and can also impact quality of life and functioning (NIMH, 2018c).

Presentation of Depression and Depressive Disorders

Depression is characterized by sadness, irritability, feelings of emptiness, and physical and cognitive difficulties that impact overall functioning (APA, 2013). The DSM-5 (APA, 2013)

identified eight depressive disorders, including: (a) major depressive disorder; (b) disruptive mood dysregulation disorder; (c) premenstrual dysphoric disorder; (d) persistent depressive disorder; (e) substance/medication-induced depressive disorder; (f) depressive disorder due to another medical condition; (g) other specific depressive disorder; and (h) unspecific depressive disorder. Among these diagnoses, common depressive experiences include feelings associated with sadness, emptiness, and irritation (APA, 2013). Depression also involves physiological and cognitive components including fatigue, increased or decreased appetite, difficulty concentrating, and increased or decreased sleeping patterns (APA, 2013). Additionally, the term depression is used to describe changes in: (a) feelings (i.e., lowered mood); (b) thoughts (i.e., "I am not good enough"); and (c) behaviors (i.e., decreased engagement in previously enjoyable activities) that influence quality of life (Beck, 1967).

Depression and the brain

Several neurotransmitters have been hypothesized to serve important roles in depression, including: (a) dopamine; (b) norepinephrine; and (c) serotonin, with most empirical support pointing toward the role anti-depressants serve related to the three primary neurotransmitters responsible for depression; that is, it is believed atypical dopamine, norepinephrine, and serotonin contribute to depression as anti-depressants regulating and increasing their ability to communicate (Sapolsky, 2004). Furthermore, researchers also reported that the HPA axis is involved in the process of depression (Pariante & Lightman, 2008), as individuals diagnosed with depression were found to have increased levels of cortisol in their saliva (Nemeroff & Vale, 2005).

Different brain regions have also been determined to be responsible in interacting with depression. For example, the cortex, which plays a role in managing thought processes, can ruminate on a negative thought and induce feelings and experiences of depression even if the stressor is not actively happening (Sapolsky, 2004). Within the cortex, the anterior cingulate cortex (ACC) also interacts with depression from an emotional standpoint. Sapolsky (2004) reported that when individuals are shown photographs of friends or family who have passed away, the ACC becomes activated, but activation decreases in the ACC when shown a positive scenario. Thus, the ACC appears to be more connected and engaged when processing negative emotional experiences versus positive emotional experiences. Additionally, Davidson (2002) observed that the right side of the prefrontal cortex appeared to be connected to negative emotional states and is more active in individuals with depression.

Depression and College Students

As indicated, depression impacts overall functioning, and college students are not exempt from this experience. Specifically, depression can cause negative consequences for college students in areas such as: (a) GPA; (b) attending class regularly; (c) increased rates for drop out; (d) overall academic achievement (Eisenberg et al., 2009); and (e) increased rates of suicidal ideation and completion of suicide (Kitzrow, 2009). The increased rates of suicidal ideation and completion of suicide are alarming within the college student population as suicide is the second leading cause of death among 15- to 29-year-olds (WHO, 2017).

Of 31 options (including general health concerns, sexually transmitted diseases, familial stressors, etc.) depression (15.4%) was the fourth highest concern college students cited as interfering with academic success (ACHA, 2017). Students were also surveyed about various

symptoms and experiences related to depression, including: (a) feelings of hopelessness; (b) feelings of loneliness; (c) feeling exhausted (not due to physical activities); (d) feelings of sadness; (e) feeling so depressed that it interfered with ability to function; (f) seriously considering suicide; (g) attempting suicide; and (h) purposefully injuring self (ACHA, 2017). Table 1 provides an overview of these concerns. Female students appeared to endorse more symptoms associated with depression than males, with the exception of 'attempting suicide' (both males and females had equal percentages).

Table 1

College Student Concerns Interfering with Academic Success

Felt the following at any time over the past year (12 months):	Total Respondents (Out of 100%)	Total Males (Out of 100%)	Total Females (Out of 100%)
Exhausted (not from physical activity)	82.6%	73.2%	86.8%
Very sad	66.0%	55.9%	70.2%
Very lonely	60.6%	52.7%	63.7%
Hopeless	50.9%	42.7%	54.0%
So depressed that it interfered with ability to function	38.2%	31.3%	40.4%
Seriously considered suicide	10.4%	8.8%	10.4%
Purposefully injured self	6.9%	4.3%	7.5%
Attempted suicide	1.9%	1.7%	1.7%

Note. Adapted from the ACHA-NCHA Fall 2016 Executive Report.

Furthermore, 15.2% of respondents (9.0% of male respondents and 17.3% of female respondents) reported being treated for or diagnosed with depression by a mental health professional and 2.6% of students reported taking anti-depressant medication (2.1% of male

respondents and 2.7% of female respondents; ACHA, 2017). The total percentage of students who received mental health services for depression was significantly lower than the percentage of students who endorsed experiencing depression or symptoms associated with depression. The difference in these percentages appears congruent with the findings of researchers who have found decreased help-seeking from college students in need of mental health services, likely due to stigma (Eisenberg et al., 2009) as well as with adults who do not perceive being in need of mental health services, despite presenting concerns (Mojtabai et al., 2002).

In addition to exploring worry and anxiety in college students, Schroder and colleagues (2015) also measured depression using the BDI-II (Beck et al., 1996). The results demonstrated that 92 student participants (23.8%) scored higher (M = 10.72, SD = 10.01) than the clinical cutoff range for a major depressive episode (Sprinkle et al., 2002). The results found by Schroder and colleagues (2015) is comparable to related studies (Storch, Roberti, & Roth, 2004) in which depression within the college student population was also measured (M = 11.03, SD = 8.17). Thus, the percentage of college students who met criteria for a major depressive episode was also higher (6.7%)compared to the general population of 18- to 29-year-old adults (Kessler et al., 2005b).

Schroder and colleagues (2015) also collected additional data from their college student sample using the *Mood and Anxiety Symptom Questionnaire* subscale [MASQ] (Watson & Clark, 1991), assessing for levels of anxiety and depression. The researchers reported that scores on the MASQ *Anhedonic Depression* subscale [MASQ-AD] (M = 51.87, SD = 14.68) were also comparable (M = 57.39, SD = 13.73) to a similar study (Nitschke, Heller, Imig, McDonald, & Miller, 2001), revealing that 13.7% of the studied college student population surpassed the clinical cutoff for meeting criteria for depressive disorder (Bredemeier et al., 2010).

Cortisol

As noted, corticotropin-releasing hormone (CRH) or cortisol, is a hormone that is released during times of perceived or experienced stress (Sapolsky, 2004). Cortisol is also found within the saliva of individuals experiencing depression (Nemeroff & Vale, 2005). Although there are many systems and processes involved in stress responses, the main systems responsible for the production and release of cortisol is the CNS and outside systems, especially the hypothalamic-pituitary-adrenal (HPA) axis (Charmandari, Tsigos, & Chrousos, 2005).

Stress is often experienced in social contexts for many individuals (Düsing, Tops, Radtke, Kuhl, & Quirin, 2016), and college students are exposed to consistent social situations. Humans desire a sense of connection and acceptance within social situations and with others (Beckes & Coan, 2011), resulting in fear of negative evaluation or potential rejection (Dickerson & Kemeny, 2004). The process of perceived or actual negative evaluation from peers results in the activation of the hypothalamic–pituitary–adrenal (HPA) system (Dedovic, Duchesne, Andrews, Engert, & Pruessner, 2009; Sapolsky, Romero, & Munck, 2000) which releases glucocorticoid (GC) cortisol. Cortisol is used to help in the process of coping during times in which actual or perceived danger of an individual's social position is threatened (Denson, Spanovic, & Miller, 2009). Denson and colleagues (2009) noted that heightened levels of cortisol are found within individuals who engage in repetitive thought processes which often occurs in a variety of social contexts.

In addition to stress, other factors play a role in initiating the release of cortisol. For example, the circadian rhythm of the human body influences the production and release of cortisol (Nicolson, 2008); that is, cortisol levels are typically at their highest within the first 30

minutes of being awake, followed by a return to their baseline level about 1 hour after being awake, with steady decreases in cortisol levels as the day progresses (Clow, Thorn, Evans, & Hucklebridge, 2004). This regulatory process of cortisol is called the Cortisol Response to Awakening (CAR), which is overly active or inactive for individuals who experience depression and high levels of stress (Pruessner, Hellhammer, Pruessner, & Lupien, 2003).

Cortisol and College Students

Due to the increase in stress, anxiety, and depression experienced by college students, they are at an increased risk for higher levels of cortisol. Sladek, Doane, Luecken, and Eisenberg (2016) examined the perceived stress, coping, and salivary cortisol levels of 63 senior high school students transitioning into their first year of college (17 to 19 years of age, $M = 18.85$, $SD = 0.54$; 67% female, 23% male). Participants were instructed to provide five saliva samples for three days, while also providing five daily diary entries regarding any experienced stressors. Participants were also instructed to report any usage of caffeine, nicotine, or medication and to not brush their teeth, eat, or drink 30 minutes before collecting saliva samples. Results indicated that when participants perceived larger amounts of stress than normal, cortisol levels were significantly higher if they also endorsed more engagement in coping strategies ($\beta = 0.13$, $p < 0.01$). When looking at the patterns of individual participants, results also demonstrated significant increase in cortisol levels with perceived stress if participants were below average in reports of ability to effectively cope (Sladek et al., 2016). Therefore, research results provide data regarding how the perception of stress and ability to cope interact with cortisol levels.

Neurofeedback Training

Neurofeedback (NF) training also known as brainwave training, EEG biofeedback (Hammond, 2005), neurotherapy, or quantitative electroencephalogram (qEEG) NF treatment (Cleary, 2011) is designed to increase brain efficiency through training the electrical response patterns within the brain (Hammond, 2011). The information presented in the following sections explores several aspects of NF training, including: (a) history and development; (b) various NF training systems and methods; (c) NF training to treat differing mental health concerns; and (d) the specific NF training system used for the current study.

History and Development of Neurofeedback Training

In order to better understand the science and implications of NF training, it is necessary to review its history, beginning with understanding brain wave activity. Berger (1929) conducted groundbreaking research regarding the electrical activity within the brain, which provided the opportunity for researchers to intentionally view brain waves. The foundational research conducted by Berger (1929) paved the way for researchers and clinicians to better understand brain activity through patterns of waves. Throughout years of continued EEG research, it was discovered that sinusoidal (sine waves that are smooth and continuous) were associated with inattention (Kaiser, 2005) and other irregular brain waves were connected to mental health and other disorders (Cleary, 2011).

Kamiya (1969) found that alpha waves could be trained or manipulated to improve brain functioning. Additional studies have demonstrated that alpha waves induce experiences such as enjoyable emotions, calm focus, and attention (Stoyva & Kamiya, 1968). With the ability to

observe and associate brain waves with differing neurological concerns, neuroscientists discovered the ability to modify or change brain wave activity (Cleary, 2011). There are various brain waves (i.e., gamma, beta, alpha, theta, and delta) found within neural electrical activity frequency of which are measured in hertz [Hz] (Hammond, 2011). Hammond (2011) explained the speed and effects of different brain waves, including: (a) Gamma brain waves which are the fastest, typically recorded above 30Hz, and associated with increased attention and ability to process multiple routes of information; (b) Beta brain waves are found at speeds between 13-30Hz, are fairly quick, and range from exhibiting calm attention to high attentiveness; (c) Alpha brain waves are bigger, yet slowed-down at 8 to 12 Hz and produce a sense of relaxation and calming state; (d) Theta brain waves are even slower (4-8 Hz) and produce a sensation of daydreaming with decreased abilities to concentrate; and (e) Delta brain waves are the slowest of all, between .5 and 3.5 Hz, and occur during deep sleeping-states.

Although the aforementioned brain waves produce general, common effects, the amount and type of brain waves can be different depending on the individual and presenting concern. For example, if an individual is experiencing increased levels of anxiety, high amounts of ineffective alpha waves may be present, impacting the ability for emotional control in the frontal cortex of the brain (Hammond, 2011).

Neurofeedback Training Systems and Methods

Several types of NF training systems have been established within the literature and across research studies. Commonly used NF training systems include: (a) alpha-theta training; (b) slow cortical potentials training; (c) Rosh; (d) low energy neurofeedback system (LENS); (e) live Z-score neurofeedback training; (f) low resolution electromagnetic tomography (LORETA);

(g) functional MRI neurofeedback; and (h) hemoencephalography (Hammond, 2011).

Alpha-theta training

Early NF training systems were centered on alpha and/or theta training and enhancement in which individuals are administered alpha and/or theta waves (Othmer, 2009). The alpha-theta training systems, also called alpha wave biofeedback, were designed in an effort to increase alpha waves, which are associated with relaxing states and theta waves, which are associated with inducing drowsy states (Othmer, 2009). NF training studies in the 1970s and 1980s often included the training of alpha and/or theta waves in which participants were administered alpha and/or theta waves (e.g., Garrett & Silver, 1976; Glueck, & Stroebel, 1975; Hardt & Kamiya, 1978; Passini et al., 1977; Plotkin & Rice, 1981; Rice et al., 1993; Sittenfeld et al., 1976) in an effort to train the brain to create similar patterns (Othmer, 2009). Although the alpha-theta training systems are outdated compared to more current systems, researchers have continued to implement alpha and/or theta NF training for PTSD (Peniston, & Kulkosky, 1991), GAD (Vanathy, Sharma, & Kumar, 1998), major depressive disorder (Cheo et al., 2016) and other various depressive disorders (Choi et al., 2011).

Slow cortical potential training

Slow cortical potential training involves individuals being active in modifying their positive or negative low-frequency EEG activity (Othmer, 2009) through focusing on a computer-based activity where they are asked to control the visual display (Hammond, 2011; Strehl, 2009). Within slow cortical potential training, researchers using slow cortisol potentials training have found success in treating migraines (Kropp, Siniatchkin, & Gerber 2002),

attention-deficit hyperactivity disorder [ADHD] (Drechsler et al., 2007; Leins et al., 2007) and epileptic seizures (Kotchoubey, Blankenhorn, Fröscher, Strehl, & Birbaumer, 1997; Kotchoubey et al., 2001).

Roshi

Roshi incorporates the use of both audio and visual techniques that are designed to meet the individual needs of the person receiving treatment (Hammond, 2000). For example, the Roshi system implements photic stimulation, or the use of visual stimuli, at different frequencies that align with the individuals' major brainwave activity (Hammond, 2000). With Roshi, one of the main features is to identify the main occurring EEG activity and send feedback to disrupt the pattern (Othmer, 2009), which helps to change unhelpful brainwave patterns (Ibric & Davis, 2007) and has been used to treat depression (Hammond, 2000).

Low energy neurofeedback systems (LENS)

LENS uses electromagnetic stimulation and, similar to Roshi, disrupts the brainwave activity (Othmer, 2009) in an effort to create change (Ochs, 2006). When individuals are receiving LENS NF, they do not have to actively engage in the process; rather, the system sends small electrical signals through each of the electrode sites (Ochs, 2006). Populations that have experienced success with LENS include mild traumatic brain injury, autism, fibromyalgia, ADHD, anxiety, depression, and trauma (Ochs, 2006).

Low resolution electromagnetic tomography (LORETA)

Low resolution electromagnetic tomography (LORETA) is a qEEG system, which

assesses the functioning of brain regions. LORETA targets the: (a) insula; (b) anterior cingulate (AC); and (c) fusiform gyrus (Hammond, 2011). The AC is thought to play a large role in cognitive, emotional, and attentional processes within the brain (Cannon, Congedo, Lubar, & Hutchens, 2009) with the intention of the LORETA system to improve these processes.

Live Z-score neurofeedback training

Live Z-score NF training tracks consistent calculations of brain functioning and compares the patterns to a database which includes average or more normalized/healthy activity patterns. As the calculations are made and compared, the system then sends feedback to the individual in an effort to provide more healthy patterns to the user (Hammond, 2011) with the goal of training the brain to become more effective as it relates to the normative database. In a pilot study for individuals experiencing insomnia, Hammer, Colbert, Brown, and Ilioi (2011) provided two types of Live Z-score NF: (a) sequential, quantitative EEG (sQEEG) and (b) modified sensorimotor (SMR) treatments. They found a significant difference in pre- and post-assessments for insomnia scores, including the following: *Quality of Life Inventory* [QOLI] (Frisch et al., 2005), $F\ [_{1,6}]= 9.6$, $p < .02$; *Pittsburgh Sleep Quality Inventory* [PSQI] (Backhaus, Junghanns, Broocks, Riemann, & Hohagen, 2002), global score ($F\ [_{1,6}] = 55.6$, $p < .0001$); and Sleep Efficiency scale [SE], $F\ [_{1,6}] = 15.8$, $p < .007$; and the *Insomnia Severity Index* [ISI] (Bastein, Vallieres, & Morin, 2001), $F\ [_{1,6}] = 18.2$, $p < .005$.

Functional magnetic resonance imaging (fMRI) neurofeedback

Functional magnetic resonance imaging (fMRI) is an advanced system which examines brain activity through neuroimages and can be used to examine the functioning of the brain

activity when exposed to or after NF training (Hammond, 2011). fMRI NF training has been used to capture images of specific brain regions that play a role in emotional-processing (e.g., amygdala and insula), providing additional insight into the modification of brain structures (Johnston, Boehm, Healy, Goebel, & Linden, 2010). Although fMRI can provide accurate and scientific imaging, the system is costly and often not practical in clinical and research settings (Hammond, 2011).

Hemoencephalography

Hemoencephalography (HEG) protocols are theorized to provide improvement in brain functioning through feedback that aims to increase cerebral blood flow (Toomim & Carmen, 2009). There are two main HEG systems, including: (a) near infrared HEG (nirHEG; Toomim, 1995) which uses an infrared technology and helps the brain to increase levels of oxygen in the blood, creating helpful changes for cerebral blood flow and (b) passive infrared HEG (pirHEG), providing modification to the thermal processes within the brain, also modifying the flow of cerebral blood (Toomim & Carmen, 2009).

NeurOptimal neurofeedback

The current study used the NeurOptimal NF system, created by the Zengar Institute, Inc. (2017). The NeurOptimal system is a dynamical, nonlinear system that uses mathematical algorithms to provide feedback to the user, helping to promote more effective brain processing (Zengar Institute, Inc., 2017). Additionally, the development of the NeurOptimal system is based on the premise that when humans learn new behaviors, neural connections began to take place within the brain and with time and consistent repetition, these connections are further established

and triggered (Zengar Institute, Inc., 2017). Because the CNS produces electrical activity, the sensors of NeurOptimal are able to detect the electrical activity through the neuroconductor gel that is used when adhering sensors to the scalp and ears. Overall, the system is designed to train the brain to obtain helpful processing and activity without using any invasive intervention. NeurOptimal promotes awareness of self in that the brain is learning about new experiences in the present moment. However, information regarding how exactly the NeurOptimal system works is not provided by the manufacturers.

As other NF training systems may focus on specific activity within or parts of the brain (i.e., LORETA) or may apply specific brain waves to the brain (i.e., alpha-theta training), NeurOptimal detects signals from the left and right brain hemispheres at the same time. As the system monitors the activity within both brain hemispheres at the same time, the system can detect areas of disturbance or turbulence at the exact moment it occurs which then prompts the system to send audiofeedback to the user in that moment to aid in the training process. The timing of the NeurOptimal system allows for the brain to receive the helpful feedback at the moment it is needed, allowing for it to reorganize itself in a healing, helpful way (Zengar Institute, Inc., 2017). The in-the-moment feedback allows for training of the CNS rather than specific brain regions or areas.

Neurofeedback Training with Various Populations

NF training has been implemented for a variety of mental health and neurological concerns, including ADHD (e.g., Arns, de Ridder, Strehl, Breteler, & Coenen, 2009; Fuchs, Birbaumer, Lutzenberger, Gruzelier, & Kaiser, 2003), epilepsy (e.g., Sterman, 2000), migraines (e.g., Walker, 2011), insomnia (e.g., Hoedlmoser et al., 2008), learning disabilities (e.g., Walker

& Norman, 2006) anxiety (e.g., Moore, 2000; Hammond, 2005), depression (e.g., Hammond, 2008; Young et al., 2014), substance abuse (e.g., Scott, Kaiser, Othmer, & Sideroff, 2005), PTSD (e.g., van der Kolk et al., 2016), and autism spectrum disorders (ASD; e.g., Thompson, Thompson, & Reid, 2010). However, Larsen and Sherlin (2013) identified a scale to rank the effectiveness of NF training studies based on the number of studies and rigor of study designs. The scale includes the following five levels: (a) level 1 denotes no empirical support due to weak study designs (e.g., case studies); (b) level 2 signifies decreased levels of usefulness due to lack of studies and small sample sizes; (c) level 3 includes likely effectiveness; (d) level 4 equates to efficacious treatment; and (e) level 5 detailed, with strong study designs that include effectiveness compared to a placebo effect (Larsen & Sherlin, 2013). The following sections focus on NF training studies that were relevant to the constructs to be measured, including anxiety (deemed a level 4 to 5 for efficacy), depression (deemed a level 2 for efficacy), and stress (not included in the efficacy ratings).

NF Training and Anxiety

Research studies exploring the use of NF training to treat anxiety disorders have been documented within the literature (e.g., Hammond, 2005; Moore, 2000). During the 1970s and 1980s, the NF training and anxiety literature appeared to increase in studies, following the discovery made by Kamiya (1969), in which alpha waves could be trained. For example, in the late 1970s, NF studies focused on providing various levels of brain waves (alpha and theta waves) to anxious participants. One study provided eight sessions of theta feedback to 20 men between 35 and 50 years of age who exhibited various levels of anxiety (Sittenfeld et al., 1976). Participants were randomly assigned to one of the following groups: (a) participants with high

electromyographic (EMG) levels, or the amount of electrical activity within skeletal muscles, received eight sessions of theta feedback; (b) participants with high EMG received four sessions of theta feedback and four sessions of EMG feedback; (c) participants with low EMG received eight sessions of theta feedback; or (d) participants with low EMG received four sessions of theta feedback and four sessions of EMG feedback. Sittenfeld and colleagues (1976) indicated a significant improvement in scores on baseline versus post-baseline for the group of subjects ($F_{(1, 6)} = 16.12$, $p < .001$), demonstrating a decrease in the amount of EMG levels. However, not all participant results indicated equal levels of relaxation.

Vanathy and colleagues (1998) employed a between-group design, with two treatment groups (received either alpha NF training [$n = 6$] or theta NF training [$n = 6$]) and a waitlist control group (received no NF training [$n = 6$]), for participants who met criteria for GAD. Participants in both treatment groups received 15 NF training sessions. All participants completed anxiety assessments, including the STAI (Spielberger et al., 1970) and the Global Quality of Life Questionnaire (GQL; Kaasa, Mastekaasa, & Naess, 1988). The HARS (Hamilton, 1959) was used as an observer measure. EEG spectral analysis was implemented to determine any change in brainwave activity. Compared to the control group, both treatment groups reported a significant decreased in observer-rated anxiety ($p < .01$) and self-reported anxiety ($p < .01$) from pre-test to post-test. Quality of life was only significant in the theta NF group ($p < .05$) from pre-test to post-test. Regarding objective measures with the EEG analyses, no significant change was found. Furthermore, the control group demonstrated an increase in anxiety ($p < .01$) from pre-test to post-test (Vanathy et al., 1998).

Agnihotri, Paul, and Sandhu (2007) implemented a between group design for 45 participants diagnosed with GAD, with two treatment groups (EMG biofeedback training or

alpha EEG biofeedback training) that received 12 NF training sessions and one control group (n = 15 per group). Participants completed the STAI (Spielberger et al., 1970) and galvanic skin resistance (GSR) at pre-test, post-test, and follow-up (two weeks later). For STAI State-Anxiety (STAI-S), both treatment groups demonstrated a significant reduction in scores (EMG group, t = 8.09, $p < 0.001$; EEG group, $t = 6.62$, $p < 0.001$), with no significant changes for the control group ($t = 0.15$, $p > 0.05$). The STAI Trait-Anxiety (STAI-T) demonstrated similar findings, with the treatment groups reporting significant decreases in scores (EMG group, $t = 7.47$, $p < 0.001$; EEG group, $t = 0.75$, $p < 0.001$) as compared to the control group ($t = 0.75$, $p > 0.05$). Regarding GSR, both treatment groups (EMG group, $t = 7.55$, $p < 0.001$; EEG group, $t = 6.75$, $p < 0.001$) reported significant increases in GSR values as compared to the control group ($t = 0.43$, $p > 0.05$), demonstrating increase in physical relaxation.

Walker (2009) provided qEEG NF training to participants diagnosed with PTSD, in an effort to treat anxiety-related symptoms. Nineteen participants received five to seven sessions and were asked to rate their level of anxiety on a scale from one to 10 at pre-test, post-test, and 1 month following NF training sessions; four participants served in a control group and were asked to rate their anxiety and pre-test and three months after. Participants in the treatment group reported decreases across time (e.g., at pre-test, anxiety was seven out of 10; at post-test, anxiety was two out of 10; at one month follow-up, anxiety was 2 out of 10); however, no statistical procedures were used to determine amount of change. Additionally, only the use of a scaling question for anxiety was used as opposed to anxiety assessments with established psychometric features. Walker (2009) also reported qEEG abnormalities of the total group, with significant improvements ($p < .05$) found for individuals with excessive high frequency beta waves. Although Walker's (2009) study reports improvement for the treatment group compared to the

control group, several limitations are found in the lack of use of rigorous assessments, lack of use of any statistical analyses for the self-identification of anxiety, and vague description of use of chi-square analyses to determine statistical significance for the qEEG data. That is, significance levels are reported, but no detail is provided about the actual statistical procedure. Additionally, the control group only provided data at pre-test and three months following the initial interview whereas the treatment group provided data at three different time points (pre-test, post-test, and one month after NF training).

Table 2 provides an overview of NF training studies that have been implemented with adults experiencing various anxiety symptoms and/or anxiety disorders. The table includes: (a) sample size used; (b) type of NF training used; (c) amount/duration of sessions; (d) instruments and/or measures used; (e) analysis used; and (f) study results.

Table 2

NF Training and Anxiety Studies

Author(s)/Year	*N*	Type of NF Training/Groups & Duration/Sessions	Instruments/ Measures	Analysis & Results
Sittenfeld, Budzynski, & Stoyva, (1976)	20 men between ages 35-50	EEG theta feedback; EMG feedback 8 sessions	Recordings of alpha EEG, theta EEG, heart rate, frontal EMG, forearm extensor EMG	Separate 3-Factor ANOVA with repeated measures on the 3rd factor for physiological variables *Frontal EMG*: sig. difference from baseline to post-baseline ($F_{(1, 16)} = 16.12$, $p < .001$); sig. interaction ($F_{(1, 16)} = 4.49$, $p < .05$) *Theta EEG*: sig. difference from baseline to post-basline ($F_{(1, 16)} = 9.86$, $p < .01$); sig. interaction $F_{(1, 16)} = 13.55$, $p < .01$) *Forearm EMG:* no sig. found *Alpha EMG:* no sig. found *Heart Rate*: sig. decrease over time ($F_{(1, 16)} = 5.61$, $p < .05$); sig. interaction ($F(1,16) = 8.75$, $p < .01$);
Passini, Watson, Dehnel, Herder, & Watkins, (1977)	50 (25 received intervention; 25 control group) males with alcoholism from St. Cloud VA Hospital	Alpha-wave biofeedback 3 weeks; 10 hours	STAI; MMPI; MAACL; Zuckerman's Sensation Seeking Scale, Watson's Anhedonia Scale, BPRS, Baseline alpha (eyes open and eyes closed)	Type I ANOVA (Results below only include interaction effects; see study for other results*)* *Alpha Eyes Open:* sig. interaction effect ($F_{(1, 48)} = 14.28$, $p < .05$) *Alpha Eyes closed:* sig. interaction effect ($F_{(1, 48)} = 22.83$, $p < .05$) *STAI - State Anxiety:* sig. interaction effect ($F_{(1, 48)} = 5.56$, $p < .05$) *STAI - Trait Anxiety:* sig. interaction effect ($F_{(1, 48)} = 12.42$, $p < .001$) *MAACL – all subscales*: no sig. interaction effect

Author(s)/Year	*N*	Type of NF Training/Groups & Duration/Sessions	Instruments/ Measures	Analysis & Results
				MMPI - Paranoia: sig. interaction effect ($F_{(1, 48)} = 5.57$, $p < .05$) *Sensation Seeking Scale - all subscales:* no sig. interaction effect *Anhedonia Scale*: no sig. interaction effect *MMPI - all other subscales*: no sig. interaction effect *BPRS – Suspiciousness*: ($F_{(1, 48)} = 5.81$, $p < .05$) *BPRS – all other subscales*: no sig. interaction effect
Plotkin & Rice (1981)	10 undergraduate students reporting chronic anxiety; 5 assigned to alpha group and 5 persons assigned to Beta group (both groups received same training)	Alpha enhancement and suppression At least 5 sessions	MMPI -Welsh Anxiety Scale; STAI A-Trait; TMAS; EEG recording	2 x 2 mixed ANOVA with repeated measures for pre-post *Welsh A*: significant main effect ($F_{(1, 8)} = 20.27$, $p < .005$) *TMAS*: significant main effect ($F_{(1, 8)} = 25.71$, $p < .001$) *STAI A-Trait:* significant main effect ($F_{(1, 8)} = 83.81$, $p < .001$)
Rice, Blanchard, & Purcell (1993)	45 volunteers with generalized anxiety (38 DSM-III GAD dx)	Frontal EMG biofeedback, biofeedback to increase EEG alpha, biofeedback to decreased EEG alpha, or pseudomeditation control group	STAI trait anxiety; Welsh-A anxiety scale; Psychosomatic Symptom Checklist (PSC)	MANOVA STAI, Welch-A, Psychosomatic ChecklistResults were not significant across the three time points (pre, post, and follow-up) for the STAI, Welch-A, or Psychosomatic Checklist Self-Report Measures ANOVA

Author(s)/Year	*N*	Type of NF Training/Groups & Duration/Sessions	Instruments/ Measures	Analysis & Results
		8 sessions		*STAI-Trait Anxiety*: sig. effect from pre to post ($F_{(1, 40)}$ = 29.7, $p < .0001$); no sig. interaction effect; sig. decrease for within group analysis ($p < .05$) *Welsh-A Scale:* sig. effect from pre to post ($F_{(1, 40)}$ = 21.8, $p < .000$); not sig. between groups *PSC*: sig. from pre to post ($F_{(1, 40)}$ = 21.8, $p < .000$); no sig. between group effects Physiological Measures ANOVA – *Heart Rate*: sig. main effect ($F_{(3, 111)}$ = 34.1, $p < .0001$) and interaction effect for group x phase x pre-post ($F_{(12, 111)}$ = 4.23, $p < .0001$) *EMG* (Skin temperature): no sig. change *EEG Alpha*: alpha-suppression group sig. changed (p = 0.45)
Thomas & Sattlberger (1997)	1 (case study) diagnosed with Anxiety Disorder	slow wave inhibit/fast wave increase EEG - alpha-decrease biofeedback training 15 sessions	MMPI	No statistical analyses reported
Vanathy, Sharma, & Kumar (1998)	18 diagnosed with GAD	alpha NF, theta NF, or waitlist control group 15 sessions	EEG spectral analysis; STAI; Global Quality of Life Questionnaire (GQL); Hamilton Anxiety Rating Scale (HARS)	One-way ANOVA with post-hoc comparisons and paired t-test *STAI-S*: sig. difference among groups at post-treatment ($F_{(2, 15)}$ = 6.19, p <.01) and between pre- and post-points for theta NF group (*df* 5, t = 2.98, $p < .05$) and for

Author(s)/Year	*N*	Type of NF Training/Groups & Duration/Sessions	Instruments/ Measures	Analysis & Results
				control group (*df* 5, $t = 4.46$, $p < .01$); no sig. difference for alpha group *STAI-T:* Sig. difference between pre- and post-test points for alpha neurofeedback group (*df* 5, $t = 2.64$, $p < .05$); no sig. found for post-test points for other groups *HARS:* Sig. difference among groups at post-test ($F_{(2, 15)} = 15.84$, $p < .01$) and between pre- and post-test values in alpha (*df* 5, $t = 4.11$, $p < .01$) and theta groups (*df* 5, $t = 6.87$, $p < .001$) *GQL:* Sig. difference among groups at post-test ($F_{(2, 15)} = 3.96$, $p < .05$); no sig. difference between pre- and post- for any group
Singer (2004)	2 female dancers	Brainmaster Neurofeedback 20 sessions (30 minutes each)	Performance Anxiety; STAI	Only reported improvement in STAI scores, but no analyses reported
Agnihotri et al., (2007)	45 adults diagnosed with GAD	Treatment group: EMG biofeedback or alpha EEG biofeedback Control group: none 12 sessions	STAI-S; STAI-T; GSR	*STAI-S*: Sig. difference for treatment groups (EMG group, $t = 8.09$, $p < 0.001$; EEG group, $t = 6.62$, $p < 0.001$); no sig. changes for control group ($t = 0.15$, $p > 0.05$). *STAI-I:* Sig. difference for treatment groups (EMG group, $t = 7.47$, $p < 0.001$; EEG group, $t = 0.75$, $p < 0.001$; no sig. changes for control group ($t = 0.75$, $p > 0.05$).

Author(s)/Year	*N*	Type of NF Training/Groups & Duration/Sessions	Instruments/ Measures	Analysis & Results
				GSR: Sig. difference for treatment groups (EMG group, $t = 7.55$, $p < 0.001$; EEG group, $t = 6.75$, $p < 0.001$); no sig. changes for control group ($t = 0.43$, $p > 0.05$)
Kerson, Sherman, & Kozlowski (2009)	28 adults diagnosed with GAD	earlobe temperature training (ETB), alpha suppression, and alpha symmetry training 23 to 48 sessions	STAI and Daily Anxiety Inventory (DAI; adapted to be administered every day from STAI)	One-way ANOVA and Pairwise comparisons *STAI-S:* sig. effect ($F_{(3, 21)} = 13.9$, $p < .001$); sig. differences between all conditions compared to follow-up only (HSD [.05] = 23.16; HSD [.01] = 29.34; p < .05) *STAI-T*: sig. effect ($F_{(3, 21)} = 15.51$, $p < .001$); sig. differences between all conditions compared to follow-up only (HSD [.01] = 24.63; p < .01) *DAI:* sig. effect ($F_{(2, 14)} = 4.66$, $p < .05$) from ETB to last NF session only; all other comparisons showed no sig.
Walker (2009)	19 adults diagnosed with PTSD (assessing anxiety symptoms associated with PTSD) 4 adults in control group	qEEG guided NF training 5 to 7 sessions	Self-report likert scale (1 to 10)	Chi-square analysis *Likert scale:* Results from study report 'overall improvement' in treatment group at $p < .05$ level; however, specific statistical analyses or results explicitly provided *qEEG*: Sig. improvements ($p < .05$) for participants with excessive high frequency beta waves

Author(s)/Year	*N*	Type of NF Training/Groups & Duration/Sessions	Instruments/ Measures	Analysis & Results
Scheinost et al. (2013)	20 adults with high contamination-related anxiety/OCD (10 exp. group and 10 control group)	fMRI neurofeedback 1 session (90 minutes)	fMRI images of emotional-based brain regions	Wilcoxon's rank-sum test NF group showed sig. decreases ($p < .05$) in brain emotion-based brain regions (e.g., insula, amygdala, brainstem, hippocampi)
Cheon et al. (2015)	77 adults diagnosed with variety of DSM-IV-TR disorders	Neurocybernetics models – SMR/Beta training protocol and alpha-theta training protocol 1 to 20+ sessions	Clinical Global Impression-Severity (CGI-S) scale; Hill-Castro checklist	Paired t-tests *CGI-S*: Sig. decrease in scores ($p < .001$) *Hill-Castro checklist*: Sig improvement in depression ($p < .001$), anxiety ($p < .001$), self- esteem ($p < .001$), hostility ($p < .001$), attention ($p < .001$), hyper- activity ($p < .001$); no significant changes for other scales
Dreis et al. (2015)	14 participants between 11-61 years of age with anxiety-spectrum disorders	qEEG guided amplitude NF 7 to 28 sessions	Zung Self-Rating Anxiety Scale; Screen for Child Anxiety Related Disorders (SCARED); Achenbach System of Empirically Based Assessment (ASEBA); qEEG	Paired t-tests *Zung*: $t(10) = 4.59$, $p < .001$ *SCARED*: $t(2) = 27.71$, $p < .001$ *ASEBA*: $t(17) = 8.75$, $p < .001$; no sig. found on subscales most specific to anxiety *qEEG*: no sig. found

Sig. = significance

Larsen and Sherlin (2013) indicated the treatment of anxiety with NF training to be at a level 4 or 5 for efficacy, demonstrating that previous studies reported significant improvement in anxiety symptoms. However, many of the listed studies have several limitations. Limitations include: (a) small samples sizes; (b) no report of effect sizes to determine amount of difference/change in study results; (c) inconsistent number of sessions/duration of sessions per participant; (d) use of instruments without psychometric features; (e) variation in rigor of statistical analyses used; and (f) minimal usage of control groups.

Thus, although there have been several studies conducted to explore the efficacy of NF training for various populations experiencing anxiety, there is a need for more rigorous research designs and more specific reporting on statistical analyses (i.e., need reporting of effect sizes) to determine overall effect of NF training.

NF Training and Depression

Although NF training studies have been more prevalent in addressing and exploring its efficacy with anxiety, minimal studies have been conducted to explore the influence of NF training for depression symptoms and depressive disorders. Because of limited studies and lack of rigorous study designs, NF training and depression-based studies have been ranked at a level 2 for efficacy (Larsen & Sherlin, 2013). However, studies have begun to emerge that demonstrate more rigor. For example, Cheon and colleagues (2015) conducted a study of the effectiveness of NF training on 20 participants who met DSM-IV-TR (APA, 2000) criteria for major depressive disorder. Participants received two to three sessions of beta and alpha/theta training over an eight-week period and completed the HAM-D (Hamilton, 1960), BDI-II (Beck et al., 1996), HAM-A (Hamilton, 1959), BAI (Beck et al., 1988), and Clinical Global Impression-Severity

(CGI-S) scores at three time points (pre, week 4 and week 8). Over time, mean scores significantly improved for the HAM-D ($F = 82.14$, $p < .0001$), HAM-A ($F = 59.13$, $p < .0001$), BDI-II ($F = 10.10$, $p < .002$) and CGI-S ($F = 14.90$, $p < .001$). However, BAI scores did not significantly improve.

Choi and colleagues (2009) conducted a similar study using randomized clinical trials (RCTs) with participants who met criteria for DSM-IV (APA, 1994) depressive disorder diagnoses. Twelve participants received an asymmetrical protocol (which provides alpha training to both the left and right midfrontal regions of the brain) over a five-week period and 11 were placed in a placebo control group. Participants in both groups completed the following assessments at pre- and post-study points, with approximately six weeks between completions: (a) BDI-II (Beck et al., 1996); (b) HAM-D (Hamilton, 1960); (c) *Automatic Thought Questionnaire-Negative* [ATQ-N] (Hollon & Kendall, 1980); and (d) *Automatic Thought Questionnaire-Positive* [ATQ-P] (Ingram & Wisnicki, 1988). A repeated measures ANOVA was implemented to look at changes in self-assessment scores for the experimental and control groups over time (pre and post). Results reported a significance for group and time interactions for the following scales: (a) HAM-D ($F_{[1, 20]} = 5.96$, $p < 0.05$); (b) BDI-II ($F_{[1, 20]} = 6.87$, $p < 0.05$); and (c) ATQ-N ($F_{[1, 20]} = 6.02$, $p < 0.05$), with the ATQ-P demonstrating no significant interaction. Furthermore, significant differences between the post-training scores for the control and experimental groups were found for all assessments: (a) HAM-D (t (21) = –2.70, $p < 0.05$); (b) BDI-II ($U = 31.00$, $p < 0.05$); (c) ATQ-N: t (21) = –2.27, $p < 0.05$; and (d) ATQ-P ($U = 32.50$, $p < 0.05$). Overall, Choi and colleagues (2009) found that half of the participants in the experimental group demonstrated improvement in depressive symptomatology per significant changes in assessment scores.

NF Training with NeurOptimal

Research using the NeurOptimal system has begun to surface. For example, a recent dissertation study was conducted with college students diagnosed with ADHD who received 16 NeurOptimal sessions and completed the *Conners Adult ADHD Rating Scale* [CAARS] (Conners, Erhardt, & Sparrow, 1991), BAI (Beck et al., 1996), BDI-II (Beck et al.,1996) and the *Self-Efficacy for Learning Form-Abridged* [SELF-A] (Zimmerman & Kitsantas, 2005) at four time periods (Harris, 2017). A Friedman's ANOVA was conducted to determine if there were significant changes in mean scores over the four time periods and the findings were: (a) the CAARS (Conners et al., 1999) demonstrated a significant difference in scores over time for hyperactivity ($X^2_{(3)} = 10.151$, $p = .017$) and self-concept ($X^2_{(3)} = 11.745$, $p = .008$), but significance was not found for impulsivity ($X^2_{(3)} = 3.284$, $p = .350$); (b) the BAI (Beck e al., 1988) demonstrated a significant difference in scores over time ($X^2_{(3)} = 10.078$, $p = .018$); (c) the BDI-II (Beck et al., 1996) reported a significant difference in scores over time ($X^2_{(3)} = 13.165$, $p = .004$); and (d) the SELF-A (Zimmerman & Kitsantas, 2005) reported a significant difference in scores over time ($X^2_{(3)} = 18.361$, $p = .001$). The results demonstrate the efficacy of NeurOptimal in improving symptoms of ADHD (hyperactivity and self-concept), anxiety, depression, and self-efficacy within the college student population. However, limitations should be noted within the small sample size of participants, non-parametric analyses, use of only psychological assessments (i.e., no physiological measures), and lack of control group.

Additional research has been conducted to explore the influence of NeurOptimal NF training, including a sample of 449 adults over the age of 18 with anxiety ($N = 214$) and depression ($N = 235$) who received eight sessions. The BAI (Beck et al., 1988) and BDI-II (Beck et al., 1996) were administered at pre and post points (i.e., prior to receiving the first session and

at the last session). Individuals who reported moderate depressive symptoms (N = 97) and severe depressive symptoms (N = 138) were found to have a significant change in scores (p = 0.00001) from pre (moderate, M = 23.40; severe, M = 38.49) to post (moderate, M = 16.66; severe, M = 26.89). Although the study reported significant improvements in participant anxiety and depression scores, several limitations were noted, including the specific data analysis procedures not being reported, minimal statistical findings reported, and the research study not being published within an empirically-reviewed journal (i.e., information was provided via PowerPoint slides).

Chapter Two Summary

Chapter two reviewed the constructs of interest for the investigation (stress, anxiety, depression, cortisol, college students, and NF training). The psychological and physiological (i.e., cortisol) components of stress, anxiety, and depression were explored, including common neurological processes and emotional challenges. The discussion of college students centered on the mental health needs of a vulnerable population who experience increased rates of stress, anxiety, and depression, negatively impacting overall functioning and academic success. Furthermore, the increase of mental health needs of college students demonstrates the need of efficacious treatments.

The literature on NF training was explored, including: (a) an overview of the various types of NF training systems; (b) the NF training system that was used in this study (i.e., NeurOptimal); and (c) the work of historical and current researchers who have implemented diverse NF training systems and processes for individuals struggling with various anxiety

symptoms and disorders and depressive symptoms and disorders. Overall, the identified NF training literature demonstrates that more studies have been successfully implemented for anxiety, and an increase in studies focused on depression are needed. However, an apparent gap in the literature was found in that the majority of NF training studies lack an objective measure to track participant change and progress.

CHAPTER THREE: METHODS

The purpose of this study was to investigate the influence of Neurofeedback (NF) training on college students' (18 years of age or older, enrolled full or part-time in a university or college in a Southeastern state) levels of anxiety (as measured by the BAI [Beck et al., 1988] and SAT [Hartman, 1984]), depression (as measured by the BDI-II [Beck et al., 1996]), and stress (as measured by the PSS [Cohen et al., 1983] and Salimetrics ELISA cortisol testing). Specifically, this study examined if participants' assessment scores and cortisol levels changed over four time periods.

Chapter three provides a detailed description of the study design (i.e., quasi-experimental, nonequivalent control group design) and also explores the identified threats to validity. In addition, the data collection methods (i.e., population, sample, recruitment, incentives, and screening procedures) are presented. Additionally, a description of the selected instruments are provided, including a description of the purpose of the assessments as well as the psychometric features. The NF training treatment process is also described along with the research questions and data analysis procedures. The chapter concludes with ethical considerations and limitations of the study.

Research Design

A quasi-experimental, nonequivalent control group design was used (Gall et al., 2007; Shadish et al., 2002). All participants in the treatment group received 16 NF training sessions over an approximately eight-week period, with a follow-up appointment four weeks after the

final session. Each NF training session (with the exception of the first session of 15 minutes) was 33.5 minutes in length. There were four assessment points in the study including pre (at session one), mid (at session eight), post (at session 16), and follow-up (four weeks after the final session). The four data collection assessments administered (i.e., BAI, PSS, BDI-II, and SAT), as well as the salivary cortisol test throughout the study served, as continuous dependent variables; group (i.e., treatment group or control group) served as the independent variable. The incorporation of multiple data collection points helped to serve to increase the power of the statistical analysis as well as to track participant outcomes that could have been influenced by extraneous variables.

Threats to Validity

It is vital to establish validity in research designs, thereby determining the extent to which researchers can claim their outcomes are truly due to the experiment or intervention in question (Shadish et al., 2002). Thus, threats to validity are vital to explore and become aware of as they can influence research findings. The following section explores four types of validity, including: (a) statistical conclusion validity; (b) construct validity; (c) internal validity; and (d) external validity. Different ways to mitigate threats to validity as well as to strengthen the overall research design are provided.

Statistical Conclusion Validity

Statistical conclusion validity refers to the amount of relationship between the study variables and study outcomes (Gall et al., 2007). Gall and colleagues (2007) indicated the strongest threat to internal validity of quasi-experimental, nonequivalent control group designs is

the statistical analysis itself. That is, there is a chance that the results on the post-test or final set of assessments could be due to previous differences between the treatment and control group participants rather than due to the NF training intervention itself (Gall et al., 2007). This threat to internal validity was addressed by ensuring that the use of RM-MANOVA used in this study met all statistical assumptions. Thus, the researcher used a list of statistical assumptions (Tabachnick & Fidell, 2013) that were checked for running a repeated measures multivariate analysis of variance (RM-MANOVA). After all data were collected, the researcher checked for missing data, normal distribution of the dependent variables, homogeneity of variance, and outliers (Tabachnick & Fidell, 2013). Moreover, the heterogeneity or variability of participants' demographics may effect statistical results. As such, the researcher implemented follow-up statistics to establish a knowledge-base of whether or not the demographic variables (i.e., gender, race/ethnicity, age, etc.) were related to or influenced statistical changes or results.

As study outcomes can be influenced by the implementation of study interventions (Shadish et al., 2002), the researcher provided structured, specific training to all Research Assistants (RAs) for each semester of data collection. Within the training, the RAs practiced applying the NF training sensors and starting the system correctly. Also, the researcher shadowed each RA if there was any uncertainty that the NF training process was not being completed correctly. Additionally, the NF training system used (NeurOptimal) is timed and does not need to be adjusted or manipulated; rather, the system is programmed to apply the necessary feedback, providing a simpler way of implementing NF training and reducing the likelihood of RAs influencing the intervention.

Extraneous variables have the potential to impact the study environment, and the level of comfort is dependent upon each individual participant. Extraneous variables can include: (a)

lighting; (b) sounds; (c) temperature; and (d) design of the room (Shadish et al., 2002). The researcher was intentional in addressing any distractions. For example, the temperature of the study room fluctuated. Because of this, the researcher provided multiple fans as needed. Outside noises were mitigated with a white-noise maker and lighting was adjusted to fit the need of the participants (i.e., the study room has both lamps and overhead lighting, and the participant was able to choose which was more comfortable). The layout and décor of the room was minimal in that there were no distracting images, and the room was not overly crowded.

Construct Validity

Construct validity relates to the use of measures or instruments that accurately depict the concepts or ideas being studied (Gall et al., 2007). Specific threats to validity that could be found in the current study include: (a) experimenter expectancies and (b) inadequate explication.

Experimenter expectancies

In order to recruit participants for the study, the researcher needed to provide some information about the purpose of NF training to not only recruit participants but also to inform them about the procedure that was being applied to them throughout the study. Furthermore, in order to recruit participants who met eligibility criteria (i.e., college students who were experiencing anxiety), the researcher informed potential participants that NF training may aid in the improvement of symptoms associated with anxiety. However, the researcher was intentional in not providing specific information about the NF training process as well as expressing limited symptoms that could improve in order to not influence participant responses. As researchers are hopeful in interventions improving participant symptomology, the use of RAs in facilitating the

vast majority of NF training sessions helped to mitigate the researcher's desire for the intervention to help participants improve. However, as the NF training system is guided by the system itself, neither the RAs nor the researcher had an impact on the intervention itself.

Inadequate explication

In the process of researching identified constructs, definitions of constructs need to be explicitly stated. For the current study, the researcher was intentional in selecting instruments that demonstrated sound psychometric features in order to appropriately define and explore the studied constructs. However, inadequate explication can occur if the constructs are confounding or too broad (Shadish et al., 2002). For example, symptoms of anxiety and depression share common features including difficulty in concentrating, changes in sleep patterns, and irritability; thus anxiety instruments frequently correlate to instruments that measure depression (Nitschke et al., 2001). Due to the overlap in similar symptoms of anxiety and depression, the researcher was intentional in selecting instruments such as the BAI which was developed with the intention of reliably differentiating between symptoms of anxiety and depression and was tested for construct validity against different depression measures (Beck et al., 1988).

Internal Validity

Internal validity refers to the degree to which the treatment influences or covaries with the statistical outcomes of a study, while controlling for any extraneous variables (Shadish et al., 2002). Extraneous variables refer to an outside factor that can impact the results of research. Thus, controlling for extraneous variables is an important and challenging task within quasi-experimental designs (Gall et al., 2007). Several types of threats to internal validity can occur

within quasi-experimental designs; threats related to the present study include (a) treatment fidelity; (b) history; (c) maturation; (d) attrition; (e) testing; and (f) instrumentation are explored in the following sections.

Treatment fidelity

Treatment fidelity refers to the trustworthiness in which the outcomes of an intervention are due to the intervention itself (Gall et al., 2007). Thus, the researcher implemented the following procedures as outlined by Gall and colleagues (2007): (a) the researcher provided specific and hands-on training to RAs; (b) RAs were given a detailed outline of a summary of their training as well as NF training procedures; and (c) the researcher communicated with all RAs at least one time per week (or more, as needed) to ensure that all research protocol are followed.

History

History refers to any events that occur simultaneously with the treatment, potentially influencing the study results (Shadish et al., 2002). Because this investigation occurred across time, the likelihood that external events would happen was high and posed a threat; thus, due to the time period of the study (12 weeks), externally occurring events were important to consider in interpreting the results of the study. For example, during the fall 2017 data collection period, Hurricane Irma caused the campus to close, and study sessions were cancelled. Although participants did receive their total 16 sessions, the sessions extended over the 12-week period. However, the use of assessments over multiple (four) time periods served as a way to measure participant outcomes as they related to the NF training treatment. Assessment responses also

needed to be interpreted with caution as participants may have experienced an increase in feelings of anxiety and/or stress due to Hurricane Irma. Although the fall 2017 semester exceeded the 12-week period, the majority of participants began and ended the study at the same time during each semester.

Maturation

Maturation refers to any growth or change that organically happens for individuals, regardless of whether or not individuals are receiving treatment, and if this growth influences treatment outcomes (Shadish et al., 2002). In order to address maturation, all participants were enrolled in at least one college course, demonstrating similar levels of academic involvement. However, maturation was taken into consideration when interpreting the results of this study as participants varied in age and academic status (i.e., seeking a bachelor's or graduate degree).

Attrition or experimental mortality

Attrition refers to participants not completing study assessments, often due to dropping out of the study (Shadish et al., 2002). When participants drop out of studies, the results can then be impacted in the data analysis process, as individuals who typically present with more severity in symptoms may be more likely to drop out of studies. To address attrition, the data of any participant who dropped out of the study were not analyzed. Additionally, participants received three $5.00 gift cards at three points in the study, to help provide an incentive for participation. The researcher also provided occasional appointment reminders, especially during times in which sessions needed to be rescheduled and between the final session and follow-up session.

Testing

Testing refers to the influence of participants selecting scores based on recollection of taking assessments, especially in studies that include a pre-test (Shadish et al., 2002). Within the current study, participants completed the four paper assessments at the following points: pre-test, at session eight (four weeks after pre-test), at session 16 (four weeks after session eight), and at the follow-up session (four weeks after session 16). Incorporating longer periods of time between each testing point helps to address issues related to testing effect; however, longer intervals between tests may be preferred (Menard, 1991).

Instrumentation

Instrumentation refers to any change in used assessments or interventions that can influence treatment outcomes (Shadish et al., 2002). To mitigate issues with instrumentation, the same research assessments were implemented throughout the study and at each data collection point (four points over a 12-week period). Additionally, instrumentation fatigue is likely to occur when participants complete several assessments. During the data collection periods, participants were instructed to take their time in recording their responses to provide adequate time and to encourage a decrease in rushing to complete or in potential boredom.

External Validity

Another threat to experimental and quasi-experimental designs is external validity, which determines whether the identified results are applicable to external settings, including to other populations, treatments, and outcomes (Shadish et al., 2002). Three types of external validity are

explored in the following sectionsas they relate to the current study (a) population validity; (b) ecological validity; and (c) representative design validity.

Population validity

Population validity involves the ability to apply identified study outcomes to specific populations outside of the sample being studied (Gall et al., 2007). However, as the current study was unique in that providing NF training to college students has been minimally researched, it was challenging to generalize findings from this study to other college populations. Future studies that explore the efficacy of NF training for college students are needed in order to increase population validity.

Ecological validity

Whereas population validity refers to the application of results from the study population to a population outside of the study, ecological validity refers to the applicability of the study environment to environments or environmental conditions outside of the study itself (Gall et al., 2007). In the following sections, the researcher provides detailed information regarding the procedure of the study, allowing for a clear understanding of the structured steps followed.

Within the current study, the environment in which participants received NF training was quiet, and the NF training system included relaxing music that played through earbuds, which could produce feelings of calmness. Thus, the NF training environment could be interpreted as a calming environment. In order to mitigate the environment and relaxing nature of the NF training music from influencing selection of items on assessments, the NF training was administered after completion of assessments. However, if the study environment is associated with a relaxing

space, participants may be more likely to endorse feeling less stressed or anxious on data collection assessments. Furthermore, the study room air conditioning unit provided a challenge. The researcher integrated fans to help maintain a more comfortable room temperature. However, it is worth noting that some NF training session days experienced increases in temperature compared to others.

Additionally, participants were likely to have more than one RA facilitate their NF training sessions, as sessions were attended two times per week. The perceptions of the RAs could have influenced participants' selection of items when completing the assessments. The Hawthorne effect, or likelihood of participants to modify their behavior as they are being observed by research personnel (Gall et al., 2007) is another factor of ecological validity. Participants may have modified their responses on their assessments due to RAs being in the room while assessments were being completed. The adaptation of selecting items on assessments may also be due to social desirability, in which individuals select responses or engage in behaviors that are perceived as more socially acceptable (Gall et al., 2007).

Experimenter effect, in which the experimenter or RAs administering the NF training could impact study outcomes, was also important to consider in this study (Gall et al., 2007). However, all RAs received the same training and the NF training was administered in the same way, regardless of who was setting up the NF training equipment. Thus, by standardizing the NF training system and the structured training, the RAs received help to mitigate any experimenter effect.

Representative design validity

Representative design validity is the extent to which the environment of the experiment is similar to or representative of the natural environment (Gall et al., 2007). Incorporating the use of a structured, manualized treatment intervention, implementing the same intervention, implementing assessments at pre-, mid-, final, and follow-up time points, with an average of four weeks between each data collection point, helped to increase the representative design validity of this study.

Procedures

Prior to recruitment or beginning the study, the researcher obtained approval from their university's Institutional Review Board (IRB). The application for the IRB included two main documents, the informed consent and human research protocol, which included areas such as (a) purpose of the study; (b) population; (c) data collection process; (d) analysis of data; (e) setting for research; (f) ethical considerations; (g) obtaining consent; (h) benefits and risks of participation; and (i) storage of data. Additional materials such as the recruitment flyer, data collection instruments, and recruitment emails were provided.

Population and Sampling

The target population for this study was college students attending any college and/or university in a Southeastern State. According to the National Center for Education Statistics (NCES; 2015), approximately 20.5 million students were predicted to attend a college or university in Fall 2016, which was an approximate increase of 5.2 million students over a 16-

year period. According to NCES (2015), the traditional age for students comprising the majority of college enrollment was 18 to 24 years of age. However, in 2014, 8.2 million students 25 years of age or older were enrolled in colleges and universities across the US (NCES, 2015), demonstrating a large number of non-traditional students seeking college degrees.

Recruitment

A flyer was created for advertising purposes to aid in the recruitment process. Using Dillman's (2014) *Tailored Design Method* (TDM), the flyers were designed for the purposes of attracting interested participants while also providing a brief overview of the study. Flyers were distributed through several outlets including campus organizations such as the Student Academic Resource Center (SARC), First Year Advising and Exploration (FYAE), Graduate Studies, Wellness and Health Promotion Services (WHPS) and bulletin boards in building common areas. Additionally, flyers and study information were sent via email to faculty and professors to distribute to students. Study information was also posted via Webcourses for undergraduate and graduate education courses. The study flyer and information was posted on Facebook groups for mental health counselors to distribute to any potential clients. The researcher attended and spoke to several on-campus course classes for majors such as psychology and engineering.

Incentives

As with all intervention investigations, it is common for attrition or treatment mortality to occur in which participants discontinue participation (Shadish et al., 2002). In order to help mitigate the potential for treatment mortality, incentives were provided throughout the study (Dillman et al., 2014). Incentives were provided over time in the form of three $5.00 electronic

gift cards and were given immediately following session one, session eight, and at follow-up, for a total of $15.00. Candy was also placed in the study room throughout the duration of the study for participants.

Screening

Any interested participants reached out to the researcher via email or telephone as instructed by the recruitment materials. The researcher conducted prescreening telephone calls with each interested participant to ensure eligibility and fit for the study. All interested participants met the following eligibility criteria prior to participation: (a) 18 years of age or older; (b) must be enrolled part- or full-time in a university or college in the Central Florida area; (c) cannot be pregnant; (d) must be able to understand, read, and write in English; (e) no hearing impairment; (f) no active psychosis; (g) no hospitalization, within the last month, due to a mental health or emotional concern; (h) no current suicidal or homicidal ideation (SI/HI) with plan or intent; suicidal ideation is a common presenting concern within the anxious college student population (Kitzrow, 2009); however, participants were excluded if their SI included intent and/or plan; appropriate referrals would be made to ensure of their safety); (i) no pacemaker or any other implanted electronic devices; (j) no severe skin allergies to cosmetics or lotions; and (k) self-identification of currently experiencing anxiety, worry, stress, or nervousness. All participants who did not meet the eligibility criteria were provided with referral resources for counseling services in the local community.

Neurofeedback Training Intervention

Before the study began, the researcher trained undergraduate- and masters-level students to serve as RAs. RAs served an important role in the study; thus, training was mandatory. Training is described in the following sections.

Training research assistants

A mandatory component of the training process required RAs to complete the Collaborative International Training Institute (CITI) training for studies that involve the social/behavioral sciences and human subjects; this online training focuses on modules and topics including ethical research (consent, confidentiality, no harm, and appropriate data collection) and working with human subjects. Once RAs completed the CITI training and passed the accompanying modules (need to score at least an 80% on all tests), the researcher conducted a formal, in-person training. In the training, RAs learned: (a) the background and history of NF training; (b) how NF training works; (c) how to appropriately turn on and set up the NF training system; (d) how to apply NF sensors to participants; (e) how to appropriately go over the informed consent documents; (f) how to administer the four paper assessments; (g) how to screen and assess for suicidal ideation, including appropriate referral and ensuring participant safety; (h) how to collect a saliva sample; and (i) how to build helpful rapport with participants.

In learning how to effectively apply the NF sensors, RAs practiced applying the sensors to other RAs in order to gain hands-on, direct exposure to the process. Appropriately applying the sensors is a crucial step in the NF training intervention, as the effectiveness of the intervention is dependent on the setup. RAs were also trained on the importance of obtaining written consent from the participants in order to meet the ethical guidelines. Additionally,

because the anxious college student population often experiences suicidal ideation (Kitzrow, 2009), RAs were trained on how to assess for suicide using the SLAP (suicidality; lethality; access; proximity) assessment and how to intervene in the event that participants reported suicidal thoughts. Finally, RAs were trained on how to collect and store saliva samples. Because the saliva samples required freezing until the analysis process, RAs placed saliva samples in a lab-grade (-80^{o}C) freezer for appropriate storage immediately following collection. RAs wrote down the participant ID, day, and time of saliva collection to effectively track samples.

Setting

The NF training sessions were conducted at a community counseling and research center (CCRC) located on the campus of a large public university in a Southeastern state. The CCRC is a free-of charge counseling clinic, offering counseling services to individuals, couples, and families from the community. The CCRC provides convenience for interested participants as it is located on the main campus and was easily accessible for any participants recruited from this area. Free parking was provided to participants who were recruited from other local colleges or universities. Participants entered the clinic and were welcomed in the main waiting room. For the NF training sessions, a designated study room was reserved throughout the three semesters. Within the room, seating and a desk space was provided.

Set up of Sessions

As stated, the study occurred over three approximately 12-week periods during the spring 2017, summer 2017, and fall 2017 semesters. During each semester, participants in the treatment group received a total of 16 sessions over eight weeks (two sessions per week) and returned at

week 12 for a follow-up appointment. Previous research has ranged in the recommended number of NF training sessions provided. Hammond (2005) advocates for individuals experiencing anxiety to receive between 12 to 24 sessions, although researchers have reported participants noticing changes in as little as three sessions (Moore, 2000). Thus, the current study incorporated the use of 16 sessions. Furthermore, due to the accessibility of students at colleges and universities during the semester, the study began the second week of each semester. Beginning the study during the second week of the semester allowed for participants to complete their sessions and follow-up appointment prior to the break between semesters to help mitigate potential attrition.

During the first session, participants in both the treatment and control groups completed the following documents, prior to taking the paper assessments: (a) IRB Informed Consent; (b) Zengar Institute Informed Consent; and (c) demographic questionnaire. The first consent form is required by the IRB in order for participants to fully understand their voluntary role in the study. Participants were also asked to complete an informed consent provided by the maker of the NF system (as required by the Zengar Institute). The demographic questionnaire included questions about necessary background information, including: (a) age; (b) race/ethnicity; (c) college experiences; (d) mental health history; and (e) family history.

After participants completed the informed consent documents and the demographic questionnaire, they were provided with the assessment packet. For the first session and the three other data collection points (at session eight, at session 16, and at the follow-up session) the following assessments were provided: (a) BAI; (b) PSS; (c) BDI-II; and (d) SAT. Immediately following the completion of the assessments at all data collection points (for the summer 2017 and fall 2017 semesters), participants were instructed to expectorate into a sterile vial, which

were then placed in a lab-grade freezer. During the spring 2017 semester, participants only provided saliva samples at pre- and final (at session 16) time points.

For session one (treatment group participants only), the NF training began following the collection of the saliva sample and lasted 15 minutes. For all other NF training sessions, the NF training was a total of 33.5 minutes. The times for each session are set by the NeurOptimal system, which allowed each session to be administered in a manualized and consistent manner. The NeurOptimal system includes five sensors, which was applied using a neuroconductor gel, which helps to detect the electrical activity within the brain. Two sensors were placed on the left side of the head, with one at the top of the ear and the second approximately two inches above the ear. Three sensors were applied to the right side of the head, one at the bottom of the ear (on the ear lobe), one at the top of the ear, and the third approximately two inches above the ear. As NF training can create feelings of relaxation (Hammond, 2005), the data collection assessments and saliva collection were conducted prior to administering the NF training session in order to reduce the NF training itself as a confounding variable (Gall et al., 2007).

Intervention timeline

Table 3 provides a visual representation of the timeline during the three semesters.

Table 3

Intervention Timeline

Time	Session Information
Week 1	Session #1 *(data collection point #1)* • Complete IRB informed consent, Zengar informed consent, Demographic questionnaire • Complete 4 assessments (BAI; BDI-II; PSS; and SAT) • Collect saliva sample • NF Training – 15 minutes • Send 1st gift card Session #2 • Check in questions • NF Training – 33.5 minutes
Week 2	Session #3 • Check in questions • NF Training – 33.5 minutes Session #4 • Check in questions • NF Training – 33.5 minutes
Week 3	Session #5 • Check in questions • NF Training – 33.5 minutes Session #6 • Check in questions • NF Training – 33.5 minutes
Week 4	Session #7 • Check in questions • NF Training – 33.5 minutes Session #8 *(data collection point #2)* • Complete 4 assessments (BAI; BDI-II; PSS; and SAT) • Collect saliva sample *(summer and fall semesters only)* • Check in questions • NF Training – 33.5 minutes • Send 2nd gift card
Week 5	Session #9 • Check in questions • NF Training – 33.5 minutes Session #10 • Check in questions • NF Training – 33.5 minutes

Time	Session Information
Week 6	Session #11 • Check in questions • NF Training – 33.5 minutes Session #12 • Check in questions • NF Training – 33.5 minutes
Week 7	Session #13 • Check in questions • NF Training – 33.5 minutes Session #14 • Check in questions • NF Training – 33.5 minutes
Week 8	Session #15 • Check in questions • NF Training – 33.5 minutes Session #16 *(data collection point #3)* • Complete 4 assessments (BAI; BDI-II; PSS; and SAT) • Collect saliva sample • Check in questions • NF Training – 33.5 minutes
Week 12	Follow-Up Session • Complete 4 assessments (BAI; BDI-II; PSS; and SAT) • Collect saliva sample *(summer and fall semesters only)*

Instrumentation

The data collection packet included the following four assessments: (a) *Beck Anxiety Inventory* [BAI] (Beck et al., 1988); (b) *Beck Depression Inventory, Second Edition* [BDI-II] (Beck et al., 1996); (c) *Perceived Stress Scale* [PSS] (Cohen et al., 1983); and (d) *Social Anxiety Thoughts* questionnaire [SAT] (Hartman, 1984). Throughout the study, the data collection packets were administered prior to receiving the NF session at four different times: (a) session one, (b) session eight, (c) session 16, and (d) follow-up. At each data collection point (for summer 2017 and fall 2017 semesters, saliva samples were only collected at pre- and final test

points for the spring 2017 semester), a saliva sample was also collected to test for cortisol levels using Salimetrics Enzyme-Linked Immunosorbent Assay (ELISA) kit. During the first session, a demographic questionnaire was also administered prior to the data collection packet and saliva collection. APA (2010) stated that studies need to: ‘‘Provide information on instruments used, including their psychometric and biometric properties’’ (p. 31). Thus, the following information presented is related to the instruments used including overall background and psychometric features.

Demographic Questionnaire

A demographic questionnaire was created to gather demographic and historical information related to participants’ age, ethnicity, major, personal experiences with anxiety, history of counseling and related experiences, and educational background. All participants completed the questionnaire prior to completing their first packet of data collection instruments. The demographic questionnaire was reviewed and approved by the researcher’s dissertation committee members and by the university’s IRB.

Beck Anxiety Inventory

The BAI (Beck et al., 1988) was created to measure the anxiety levels of adolescents and adults. The items chosen in the creation of the BAI were adapted from three previous anxiety measurement instruments, including: (a) the *Anxiety Check List* [ACL] (Beck, Steer, & Brown, 1985) which measures anxiety symptoms commonly experienced by individuals with depression; (b) the *Situational Anxiety Check List* [SAC] (Beck, 1982), which measures the intensity of physiological and cognitive aspects of anxiety; and (c) the *Physician’s Desk Reference Check*

List [PDR] (Beck, 1978), which measures the severity of typical side effects that result from anti-depressant and anti-anxiety medications.

The BAI contains 21-items and includes a four-point Likert scale that ranges from: "Not at all" to "Severely – it bothered me a lot." When completing the BAI, individuals are to select their responses based on experienced symptoms that have occurred over the past month, including the day of completing the assessment. Self-administration of the BAI can take from five to 10 minutes to complete. The total score can range from 0 to 63, with the following classifications: (a) scores from 0 to 7 represent "minimal" anxiety; (b) scores from 8 to 15 represent "mild" anxiety; (c) scores from 16 to 25 represent "moderate" anxiety; and (d) scores from 26 to 63 represent "severe" anxiety. Example items from the BAI include: "difficulty breathing," "fear of losing control," "feeling hot," and "unable to relax."

Psychometric properties of BAI data

Since the BAI was developed in 1988, the clients discussed in this section received diagnoses from older editions of the Diagnostic and Statistical Manual of Mental Disorders (DSM), including the DSM, Third Edition [DSM-III] (1980) and DSM, Third Edition—Revised [DSM-III-R] (1987). The diagnostic criteria are vital to consider as characteristics, classifications, and symptomology for anxiety disorders have changed with research and within the newest edition, the DSM, Fifth Edition (DSM-5). Clients (N = 1,086; 456 men and 630 women) receiving services from psychiatric outpatient facilities served as the sample for the development of the BAI scales with the mean age for men at 36.4 and for women at 35.7 years of age. The populations were diagnosed with various anxiety and mood disorders, as well as psychotic disorders, although this made up less than 1% of the population. The final subsample

of clients included 160 individuals with various diagnoses including major depression, atypical depression, panic with agoraphobia, social phobias, generalized anxiety, and adjustment disorders.

Two additional clinical groups of clients diagnosed with anxiety disorders were studied in assessing the psychometric properties of the BAI. The first group involved 40 clients with the following anxiety disorders: (a) panic disorder with agoraphobia (52.5%); (b) panic disorder without agoraphobia (22.5%); (c) OCD (7.5%); (d) GAD (2.5%); and (e) not-otherwise-specified anxiety disorder (2.5%); 53% of the sample was female and 47% was male (Fydrich, Dowdall, & Chambless, 1992). The second group was made up of 71 individuals receiving outpatient services with the following anxiety disorders: (a) panic disorder with agoraphobia (69.0%); (b) panic disorder without agoraphobia (15.5%); (c) simple phobia (9.9%); (d) OCD (2.8%); (e) GAD (1.4%); and (f) not-otherwise-specific anxiety disorder (1.4%); 65% of the sample was female and 35% was male (Fydrich et al., 1992). Furthermore, the BAI was tested on three samples of individuals (n = 243) from nonclinical settings (i.e., college students; non-college students) in England (Dent & Salkovskis, 1986).

Beck and colleagues (1988) reported high internal consistency of the BAI ($\alpha = 0.92$) for the 160 clients. Fydrich and colleagues (1992) report similar findings ($\alpha = 0.94$), with a sample of 40 clients who met criteria for anxiety disorders. Test-retest reliability was good ($r = 0.75$), with 83 clients taking the BAI after a one week period. As indicated, the items selected for the BAI are representative of symptoms of anxiety disorders (from the DSM-III-R), characteristics common in GAD and panic disorder (Beck & Steer, 1993). For example, when considering clients diagnosed with a social phobia diagnosis (n = 44), high content validity was found (r =

.91), with a total score average of 17.77; clients diagnosed with GAD (n = 90) also reported adequate content validity (r = .85), with a total score average of 18.83.

The BAI has been correlated with several anxiety measures (Beck & Steer, 1993), including: (a) *Hamilton Anxiety Rating Scale—Revised* [HARS-R] (Hamilton, 1959); (b) *State-Trait Anxiety Inventory* [Form Y; STAI] (Spielberger et al., 1983); and (b) *Cognition Check List-Anxiety* [CCL-A] (Beck, Brown, Steer, Eidelson, & Riskind, 1987). In establishing concurrent validity, the sample population of 160 clients also completed the HARS-R (Hamilton, 1959) and the anxiety subscale found in the CCL-A (Beck et al., 1987). The CCL-A assessed for the amount of unhelpful thoughts or cognitions associated with anxiety. Beck and colleagues (1988) reported both of the correlation scores for the CCL-A and HARS-R as the same (r = .51; p < .001). Additionally, the BAI was also found to be significantly correlated with the Form Y of the STAI (Spielberger et al., 1983) for both the State (r = .47; p < .01) and Trait (r = .58; p < .001) subscales (Fydrich et al., 1992). Fydrich and colleagues (1992) also tested the BAI with the *Weekly Record of Anxiety and Depression* [WRAD] (Barlow & Cerny, 1988) and found a significant correlation (r = .54; p < .001).

The intention of creating the BAI was to help reliably differentiate anxiety and depressive symptoms (Beck et al., 1988); however, anxiety measures often report higher rates of correlation to depression measures (Nitschke et al., 2001). Thus, the BAI was tested for construct validity against different depression measures, including: (a) HDRS-R (Hamilton, 1960; r = .25, p = .05); (b) *Cognition Check List-Depression* [CCL-D] (Beck et al., 1987; r = .22, p < .05); and (c) and *Hopelessness Scale* [HS] (Beck, Weissman, Lester, & Trexler, 1974; r = .15). However, the highest correlation was found between the BAI and BDI (Beck & Steer, 1987); r = .48, p < .001).

For nonclinical samples, correlations were also reported as significant between the BAI and BDI ($r = .61$, $p < .001$; Dent & Salkovskis, 1986).

Beck Depression Inventory, Second Edition

The BDI-II (Beck et al., 1996) was designed to measure levels of depression in individuals 13 years of age or older. The BDI-II has been used for identifying depression in clients and is one of the most recognized depression inventories (Archer, Maruish, Imhof, & Piotrowski, 1991; Piotrowski & Keller, 1992) and is implemented in outcome-based studies of depression (Muller & Erford, 2012). The items on the BDI-II assess for symptoms common to depressive disorders found in the DSM-IV (APA, 1994).

The BDI-II contains 21-items and includes a four-point Likert scale that ranges from 0 to 3. The responses that correspond to the scale for the assessment items varies depending on the area being assessed (e.g., ranges from 0 = "I feel the same about myself as ever" to 3 = "I dislike myself" in assessing for "Self-Dislike;" whereas 0 = "I don't cry anymore than I used to" and 3 = "I feel like crying, but I can't" in assessing for "Crying"). When completing the BDI-II, individuals are to select their response for each item, based on how they have felt over the past two weeks, including the day of completing the assessment. Examples of areas that are assessed include: (a) sleep; (b) sadness; (c) eating habits; (d) crying; and (e) feelings of guilt. In assessing for sleep and eating patterns, items include additional responses to determine if patterns and habits have increased or decreased for individuals experiencing depressive symptoms (APA, 2013). For example, the item "Changes in Sleeping Pattern" includes two options for 1, 2, or 3: "1a: I sleep somewhat more than usual" or "1b: I sleep somewhat less than usual."

The BDI-II is scored by totaling the selected scores (e.g., 0 = 0, 1 = 1, 2 = 2, and 3 = 3). Scores can range from 0 to 63, with the following ranges: (a) 0 to 13 representing minimal symptoms; (b) 14 to 19 representing mild symptoms; (c) 20 to 28 representing moderate symptoms; and (d) 29 to 63 representing severe symptoms.

Psychometric properties of BDI-II data

As the BDI-II was developed in 1996, the samples presented in this section received diagnoses from older editions of the DSM, including the DSM-III-R (1987) and DSM-IV (1994). The BDI-II was developed using five different samples, including one group of college students and four groups of clients receiving services from outpatient psychiatric facilities. The college student sample included 120 (53 males and 67 females) students, with a mean age of 19.58 years, who were attending university in Canada (Beck et al., 1996). The college sample lacked racial diversity as most students identified as white; this sample was included to make up the comparative normal sample.

The four outpatient samples included 500 individuals, with samples in urban and suburban locations within New Jersey, Pennsylvania, and Kentucky. The combined samples included the following demographics: (a) ranged in years of age from 13 to 86 (M = 37.20 years); (b) 183 men and 317 women; (c) lacking in racial diversity as 454 identified as White, 21 African American, 18 Asian American, and 7 Hispanic. The outpatient samples presented with various diagnoses, including: (a) anxiety disorders; (b) adjustments disorders; (c) mood disorders; (d) and other disorders. Over half of the those in the outpatient sample were diagnosed with mood disorders (n = 264), including: (a) major depressive disorder, single and recurrent episodes; (b) bipolar disorder; (c) dysthymic disorder; and (d) depressive disorders not otherwise

specified (NOS). The diagnostic criteria and identified disorders were made based on two versions of the DSM; the individuals receiving treatment in Pennsylvania received diagnoses based on the DSM-III-R (1987) and the individuals from Kentucky and New Jersey were diagnosed using the DSM-IV (1994).

Beck and colleagues (1996) reported that the BDI-II report had satisfactory reliability; high levels of internal consistency were identified in both the college student sample ($\alpha = 0.93$) and outpatient client sample ($\alpha = 0.92$; Beck et al., 1996). Additionally, test-retest reliability ($\alpha = 0.93$) was determined using 26 of the outpatient clients who received the BDI-II about one week after completing the first. Regarding content validity, the items on the BDI-II were adjusted to meet the needs for identifying accurate symptoms of depression, as they aligned with the DSM-IV (Beck et al., 1996). Convergent and discriminant validity of the BDI-II were established (Beck et al., 1996), respectively, using the following measures: (a) *Scale for Suicide Ideation* [SSI] (Beck, Kovacs, & Weissman, 1979; $r = .37$) and (b) *Beck Hopelessness Scale* [BHS] (Beck & Steer, 1988; $r = .68$).

Erford, Johnson, and Bardoshi (2015) conducted a meta-analysis, which sought to collate studies that explored the psychometric properties of the BDI-II, leading to the identification of 144 studies completed between the years of 1996 to 2013. The meta-analysis focused on the main psychometric features from studies using the BDI-II, including: (a) internal consistency; (b) test-retest reliability; (c) convergent validity; and (d) nonclinical sample characteristics.

Internal consistency ranged from .75 (Nobles, 2011) to .96 (King, Colella, Faris, & Thompson, 2009) among 31,413 participant results (from 99 studies) that were weighted and then averaged. Non-clinical samples of participants had a slightly lower range ($\alpha = .75$ to $\alpha = .94$) than clinical samples ($\alpha = .81$ to $\alpha = .96$). Satisfactory test-retest reliability was established

(*r* = .75), by weighting 1,562 participant results (from 12 studies), with ranges from .44 (Cukrowicz & Joiner, 2007) to .98 (Leigh & Anthony-Tolbert, 2001). Convergent validity was established between the BDI-II and 43 other depression assessments, with all comparisons at *r* > 0. Scores ranged from .45 for the *Positive and Negative Symptoms Scale* [PANSS] (Kay, Fiszbein, & Opler, 1987) to .88 for the *Glasgow Depression Scale for People with Learning Disabilities* [GDS-LD] (Cuthill, Espie, & Cooper, 2003). However, out of the 43 inventories, the most popular compared assessments included the: (a) HAM-D (Hamilton, 1960), with a weighted average of *r* = .53 for 1,393 participants from eight studies; (b) *Zung Depression Rating Scale* [ZDRS] (Zung, Richards, Gables, & Short, 1965), with a weighted average of *r* = .74 for 762 participants from four studies; and (c) and *Center for Epidemiological Studies–Depression* [CES-D] (Radloff, 1977), with a weighted average of *r* = .72 for 3,209 participants from 11 studies (Erford et al., 2015).

Additionally, Erford and colleagues (2015) reported on the distribution scores for nonclinical samples who completed the BDI-II. Twenty-four studies (*n* = 13,723), which included population sample statistics, were identified. After combining and weighing the total raw scores, a mean of 8.39 (*SD* = 6.87) was identified. Additionally, six of the 24 studies differentiated female (*n* = 3,560) and male (*n* = 2,006) nonclinical population samples. After combining and weighing the raw scores of these six studies, a reported mean of 7.71 (*SD* = 6.23) was identified for females and a mean of 6.43 (*SD* = 6.05) was identified for males (Erford et al., 2015). Overall, the reported mean for the combined 24 studies was 0.68 and 1.96 points higher compared to the male and female samples, respectively.

Perceived Stress Scale

The PSS (Cohen et al., 1983) is used to assess for and measure the perceptions of experienced stress as identified by individuals and is a psychological measure of stress (Kopp et al., 2010). Furthermore, the creation of the PSS is based on the theory of stress appraisal (Lazarus & Folkman, 1994) The items on the PSS assess for the level at which individuals find their current situations to be overwhelming and potentially unmanageable. The PSS is appropriate to administer to those who have, at a minimum, a middle school education. It is worded to allow for users to easily understand the concepts being conveyed (Cohen et al., 1983). The original PSS included 14-items but was later modified to include 10-items which have demonstrated stronger psychometric features than the original 14-item measure (Lee, 2012). The PSS uses the following five-point Likert scale: 0 = Never, 1 = Almost Never, 2 = Sometimes, 3 = Fairly Often, and 4 = Very Often. Items from the PSS are worded to include generalities, to allow for administration to individuals experiencing a variety of stressors. Examples of items include: “In the last month, how often have you felt that things were going your way?”; “In the last month, how often have you felt nervous and ‘stressed’?”; and “In the last month, how often have you found that you could not cope with all the things that you had to do?” Because the PSS does not serve as a diagnostic tool, cutoff scores were not included in its development (Kopp et al., 2010).

Psychometric properties of PSS data

The PSS-14 was developed using three samples, including one sample of individuals engaged in a smoking-cessation program and two samples of college students (Cohen et al., 1983). The sample of individuals from the smoking-cessation program included 64 individuals

(37 females and 27 males), with a mean age of 38.4 years (*SD* = 11.57*)*. The first sample of college students (*n* = 332) included 209 females (121 males, 2 unspecified gender), had a mean age of 19.01(*SD* = 2.75), and attended the University of Oregon. The second sample of college students consisted of 114 students (60 males, 53 females, and one unspecified gender) and had a mean age of 20.75 (*SD* = 4.41). The PSS reported acceptable internal consistency across all three samples (α = 0.84, 0.85, and 0.86). Regarding test-retest reliability, 82 students from the first sample of college students completed the PSS after two days (*r* = .85), and 64 individuals from the smoking-cessation program completed the PSS after six weeks (*r* = .55); thus, the PSS presented with sufficient test-retest reliability (Cohen et al., 1983).

The PSS demonstrates appropriate to high levels of concurrent validity with other measures of similar symptomatology (Cohen et al., 1983). For example, as research supports that the perception of stress likely increases when other stressors intensify, the PSS is likely to be associated with the number of life events that occur (Cohen et al., 1983). It is important to note that the three samples used in the development of the PSS lacked representation of the overall population; that is, the sample mostly consisted of individuals who were younger in age, had obtained higher levels of education, and were not ethnically-diverse (Cohen et al., 1983). The demographic features of the population are important to take into consideration when interpreting results of the PSS.

Cohen and Williamson (1988) further assessed the psychometric features of the PSS-14 and found that four items revealed low factor loadings, leading to the removal of four items. Cohen and Williams administered the 10-item PSS to US participants (*N* = 2,387). Over half of the participants were women (*n* = 1406) who ranged in age from 18 to 69 years of age. The majority of participants identified as White (*n* = 1924, 80.6%), with smaller percentages of Black

(*n* = 176, 7.0%) and Hispanic (*n* = 98, 4.1%) participants. Additionally, Roberti, Harrington and Storch (2006) further assessed the psychometric features of the 10-item PSS with a sample of college students (*n* = 285, 225 women and 60 men), with a mean age of 23.8 (*SD* = 21.0). The participants ranged in identified racial background: (a) Caucasian/White (82.1%); (b) Hispanic (4.2%); (c) African American (4.2%); (d) Asian (2.1%); (e) Native American (0.7%); and (f) Other (6.7%). Acceptable internal reliability consistency was found (α = 0.89) for the sample (Roberti et al., 2006). Furthermore, convergent validity was explored using several measures. A high correlation was found for the: (a) STAI (Spielberger et al., 1983) total score (*r* = .73); (b) STAI-T Anxiety Factor (*r* = .59); (c) STAI-T Depression Factor (*r* = .72); a low to moderate correlation was found for the: (a) *Multidimensional Health Locus of Control* [MHLC] (Wallston, Wallston, & Devellis, 1978) Chance subscale (*r* = .20) and (b) MHLC Powerful Others subscale (*r* = .18). Divergent validity was assessed using several measures. Correlations were not significant on three measures, including: (a) *Sensation Seeking Scale* [SSS] (Zuckerman, Eysenck, Eysenck, 1978) Form V (*r* = -.04) and (b) *Santa Clara Strength of Religious Faith Questionnaire–Short Form* [SCSRFQ-SF] (Plante, Vallaeys, Sherman, & Wallston, 2002; *r* = .02).

Furthermore, Lee (2012) analyzed 19 different studies that reviewed the psychometric features of the PSS, 12 of which used the PSS-10. Satisfactory internal consistency was reported for all 12 studies (α = .74-.91) and satisfactory test-retest reliability (*r* = .72 -.88) was also established in the four studies which reviewed test-retest reliability (Lee, 2012). Table 4 provides a sample of the studies of the PSS-10 from Lee's (2012) review.

Table 4

Psychometric Features of PSS-10 Studies

Study	Internal Consistency	Test-Retest Reliability	Criterion Validity	Correlations	Population
Andreou et al., 2011	α =.82	Not reported	Not reported	Convergent validity using the DASS-21 subscale scores: meaning stress (r = .64, p < .001), depression (r = .61, p < .001), and anxiety (r = .54, p < .001)	N = 941 (570 females and 371 males); general Greek population
Chaaya, Osman, Naassan, & Mahfoud, 2010	α =.74	r = .74; 1-week interval	Not reported	General Health Questionnaire (GHQ-12; Goldberg & Williams, 1991; r = .59); all participants, EPDS (r = .49); postpartum and pregnant women only), Life Events (r = .30)	N = 268 (58 female college students; 97 postpartum women; 113 women in third trimester; Arabic women)
Örücü & Demir, 2009	α =.84	Not reported	Not reported	Convergent validity using GHQ-12 (r -.61)	N = 508 (Middle East Technical University students; Mean age = 18.57; 306 males and 199 females

Note. As adapted from Lee (2012)

Social Anxiety Thoughts Questionnaire

The SAT (Hartman, 1984) is designed to measure the level of thoughts or cognitions that occur within socially distressing contexts. The rationale behind the creation of the SAT is based

off of the role that cognitions or thoughts play in the development or continuation of social anxiety, especially as it relates to fear of negative feedback from others and negative self-perception. Additionally, a factor analysis of the 21 items of the SAT identified four factors: (a) others' awareness of distress; (b) fear of negative evaluation; (c) autonomic arousal; and (d) concerns about social inadequacy (Hartman, 1984). The SAT includes 21-items on a five-point Likert scale ranging from "Never" to "Always." When completing the SAT, individuals are asked to provide their responses based on the specific types of thoughts that occurred during the last week. Examples of items on the SAT include: "Maybe I sound stupid," "What are they thinking of me?" "I will freeze up," and "Now they know I am nervous." Scores for the SAT are calculated by totaling the responses and can range from 21 to 105, with higher scores indicating increased experiences with anxiety-based cognitions in social situations.

Psychometric properties of SAT data

In the development of the SAT, 117 statements were populated from 100 college students who were prompted to write their thoughts that accompanied socially distressing experiences (Hartman, 1984). Overall, 102 undergraduate students (74 females and 28 males) served as the normative sample for the SAT; the sample also completed the *Fear and Negative Evaluation Scale* [FNE]] (Watson & Friend, 1969) and *Social Avoidance and Distress Scale* [SAD] (Watson & Friend, 1969). After completion of factor analysis, the SAT was edited to include 21-items that were most likely to predict social distress and avoidance behaviors (Hartman, 1984). The total mean of the SAT for the sample was 42.3 (SD = 15.2) with a high level of internal consistency (α = .95). Additionally, Hartman (1984) found the SAT was moderately correlated with the FNE (r = .60, p < .0001) and SAD (r = .58, p < .0001). Although the SAT reported

helpful internal consistency and concurrent validity, there were no studies that further explore its psychometric properties or use with diverse populations.

Salimetrics Enzyme-Linked Immunosorbent Assay (ELISA) Cortisol Testing

The current study implemented the Salimetrics Cortisol Enzyme-Linked Immunoassy (ELISA) Kit to test for quantitative salivary cortisol levels (Salimetrics, Inc., 2017). Overall, cortisol is the primary GC released from the adrenal cortex (Herman & Cullinan, 1997) and is released during times of actual or perceived stress (Sapolsky, 2004). Cortisol levels are typically higher in the morning hours and lower in the evening hours as it is regulated through the circadian rhythm (Salimetrics, Inc., 2017). The Salimetrics ELISA Kit was created with the intention to "standardize the quantitative determination of free cortisol concentrations in saliva samples" (Salimetrics, Inc., 2017).

Cortisol testing procedures

As stated, all saliva samples were placed in a lab-grade (-80^{o}C) freezer for appropriate storage. On analysis days, the samples were removed from the freezer and thawed. Once samples were thawed to room temperature, they were placed on a vortex blender, which mixes the saliva sample together. Then, the vials were placed in a centrifuge for 15 minutes. The centrifuge spun the saliva samples at a high speed in order to pull the mucins (other particles or substances that are not cortisol) to the bottom, which allowed for cortisol concentration levels to be shifted to the top of the sample. Once the samples were finished spinning in the centrifuge, they rested for approximately 45 minutes. After resting, the saliva was transferred to microcentrifuge tubes and, using a pipette, were dropped into wells and tested with various enzymes. Once samples were

placed into the appropriate wells, they were placed on a shaker for 5 minutes, followed by an hour incubation period. For more specific information regarding the specific steps followed in the cortisol testing process, please visit: https://www.salimetrics.com/assets/documents/1-3002n.pdf.

Research Questions

The purpose of this study is to determine the effectiveness of NF training on treatment group and control group college student participants' anxiety, depression, stress, and cortisol scores over time. The BAI, PSS, BDI-II, SAT, and cortisol levels served as continuous dependent variables. The group (treatment group or control group) served as the independent variable.

Primary Research Question

Does NF training reduce anxiety, depression, and stress scores over time for the treatment group as compared to the control group? If yes, how much do participants' anxiety, depression, and stress scores decrease over time?

Exploratory Research Question 1

Does NF training reduce anxiety, depression, and stress scores for the treatment group over time? If yes, how much do treatment group participants' anxiety, depression, and stress scores decrease over time? Do control group participants' anxiety, depression, and stress scores decrease over time? If yes, how much do control group participants' anxiety, depression, and stress scores decrease over time?

Exploratory Research Question 2

Is there a significant difference in mean scores over time between the treatment group and control group depending on specific demographic variables?

Secondary Research Question

Is there a significant difference in cortisol levels over time between the treatment and control groups?

Exploratory Research Question 3

Is there a relationship between treatment group and control group participants' assessments scores and cortisol scores at each time point?

Data Analysis

In order to analyze the data, the researcher used the Statistical Package for Social Science (SPSS) software package for Mac version 24.0 (IBM Corp., 2017). The data for the current study had one independent variable (group) and five continuous dependent variables: (a) BAI (Beck et al., 1988) scores; (b) BDI-II (Beck et al., 1996) scores; (c) PSS (Cohen et al., 1983) scores; (d) SAT (Hartman, 1984) scores; and (e) cortisol levels. Furthermore, prior to analyzing the dataset, demographic information from the demographic questionnaire (i.e., gender, ethnicity, age, major, and participation in personal counseling) served as variables to examine in an effort to ensure that statistical assumptions have not been violated.

Primary Research Question

A repeated-measures Multivariate Analysis of Variance (RM-MANOVA) was implemented to show whether there were significant differences in treatment group participants' BAI, PSS, BDI-II, and SAT scores over time and compared to a control group (Tabachnick & Fidell, 2013). A MANOVA is also used when the data includes at least one categorical independent variable and two or more continuous dependent variables and when dependent variables are related (Pallant, 2016). The use of an RM-MANOVA resulted in: (a) providing differences not available for ANOVAs (Tabachnick & Fidell, 2013) and (b) strengthening the research design through usage of multiple data collection points.

Ethical Considerations

The researcher included several measures to ensure ethical considerations were addressed, including: (a) securing approval from the IRB; (b) providing verbal and written information regarding rights of the participants, including their participation as voluntary; (c) providing verbal and written information regarding the limits of confidentiality; (d) ensuring that all research personnel involved in the study have received appropriate CITI training; and (e) de-identifying all participant information on assessment packets and salivary cortisol samples. As the study included college students experiencing anxiety, which presents as a population with an increased risk for suicidal ideation, all research personnel were also trained on how to assess for suicide, to intervene, and provide referrals for additional support or counseling, if necessary. Additionally, as the NF training literature supports improvements in anxiety and depression, there could be risk of unfair treatment towards the control group (Gall et al., 2007). In order to

mitigate the concern of unfair treatment, the control group participants were offered the opportunity to receive NF training services after completion of this study.

Potential Limitations of the Study

Threats to validity are common within quasi-experimental designs and were presented in the prior corresponding sections of this chapter. Other areas of limitation for the study include (a) research design; (b) sampling; (c) instrumentation; (d) treatment; and (e) treatment fidelity, which are presented in the following section.

Research Design

Quasi-experimental research designs are not exempt from limitations (Shadish et al., 2002). The current study incorporated the use of a control group; however, neither the treatment group nor the control group involved the use of randomization. The lack of randomization between groups creates a challenge in establishing whether any change in scores is due to the independent variable or if it is due to pre-existing differences between both groups (Shadish et al., 2002). However, descriptive data and statistics of the treatment and control groups are provided in Chapter 4, providing information related to similarities and differences between the groups.

Sampling

The current study used convenience sampling with inclusion criteria. Convenience sampling was implemented to help in recruiting an appropriate sample size. Although convenience sampling can be helpful in obtaining a desired number of participants, limitations

are noted due to potential bias, making it difficult to generalize results to a specific population and outliers (Gall et al., 2007). Participants were from both undergraduate and graduate programs, with the majority of participants seeking undergraduate degrees. However, the experiences of undergraduate versus graduate stressors may differ and influence results. Furthermore, although the age range of participants varied, it also presented as a limitation in generalizing results to more traditional aged-college students versus students who may be non-traditional.

Instrumentation

The instruments were selected for the current study due to: (a) their psychometric features and (b) ability to measure the specific constructs explored. However, despite the psychometric rigor of the implemented instruments, limitations were unavoidable. Assessments present with various limitations but were used to measure and track any participant changes. Incorporating the use of salivary cortisol testing serves as a biological representation of participant stress, thus demonstrating the use of objective measures. Additionally, the current study is the only study that included the use of cortisol testing for individuals receiving NF training.

Treatment

As there are many steps and facets to the intervention, treatment fidelity was important to maintain throughout the intervention (Gall et al., 2007). Factors that were included to help maintain treatment fidelity included the formal and procedural training of the RAs; this helps to ensure that all RAs are following and completing the same steps to help ensure that all

participants are receiving the NF training in the same way (e.g., administering assessments at the same time and in the same order; collecting and storing saliva samples accordingly; applying sensors correctly).

Since NF training is innovative and presents as a new-age intervention, participants may be biased in believing that they will achieve results. Any bias from participants may have caused them to select responses on the assessments that indicated improvements, despite whether they felt improvements in anxiety, stress, or depression. Although participants may have biases, the NeurOptimal system is programmed to run the NF training program in the same way, with the same time-period, each time; this allowed for the NF training in this study to be manualized to help with treatment fidelity. Additionally, the subjective nature of assessments was combated through the use of salivary cortisol testing which served as an objective measure of physiological stress. For example, if participants experience a placebo effect and respond favorably on the assessments, despite not experiencing benefits of the NF training, the cortisol level cannot be manipulated by the participants based on their belief system. However, cortisol can be impacted by many external factors including time of day (i.e., individuals typically have higher levels of cortisol in the morning hours versus evening hours), caffeine intake (Lovallo et al., 2005), and amount of sleep (Leproult, Copinschi, Buxton, & Van Cauter, 1997). However, the researcher is unaware of caffeine intake, amount of sleep, or other external factors that may have contributed to the found cortisol levels. Nevertheless, objective measures are less common practices within the counseling studies; thus, collecting and measuring salivary cortisol levels presents as a contribution to the counseling-research field.

Chapter Three Summary

Chapter three contains a report of the research methods that were implemented for the current study, which explores the influence of NF training for college students' levels of anxiety as measured by the BAI and SAT questionnaire, depression as measured by the BDI-II, and stress as measured by the PSS, and Salimetrics ELISA salivary cortisol testing. The chapter also described the research design (quasi-experimental, nonequivalent control group design) and methods implemented. Identified threats to validity (i.e., construct, internal, and external) as well as ways to address these threats were further explored. Data collection procedures, including: (a) population; (b) sample; (c) recruitment; (d) incentives; (e) screening; (f) setting; and (g) intervention timeline were detailed. The rationale and psychometric properties of the selected instruments are discussed. Furthermore, research questions were explored, and the data were described. The chapter concluded with an explanation of ethical considerations as well as potential limitations to the study.

CHAPTER FOUR: RESULTS

Chapter four presents the results of the current study that examined the impact of a NF training intervention on college students' levels of anxiety, depression, and stress. The main research hypothesis for the study tested the postulation that treatment group participant scores on the four data collection instruments would significantly decrease over time as they participated in 16 NF training sessions, as compared to the control group. The researcher implemented a quasi-experimental, nonequivalent control group research design to measure the change in scores over time between the treatment group and control group. Furthermore, the relationship between participants' demographic variables and their anxiety, stress, and depression scores were investigated. The following areas of the study are also reviewed: (a) research design; (b) sampling and data collection methods; (c) participants' descriptive data; (d) preliminary data analysis procedures and assumption testing; (e) data analyses; and (f) results for the primary, secondary, and exploratory research questions.

Research Design

The researcher implemented a quasi-experimental, nonequivalent control group research design. Quasi-experimental studies that use a nonequivalent control group may have threats to internal validity relating to selection bias. However, the inclusion of a pretest assessment provides the opportunity to understand if and how the groups are different from one another and that if the pretest scores differences are small, the less likely there are high initial selection biases for the pretest; that is, the pretest can inform about the direction and strength of the relationship

related to selection biases (Shaddish et al., 2002). The use of data collection at four time points (pretest, midtest [at session 8], final test [at session 16], and follow-up test) were implemented to provide information about changes over time. Furthermore, to mitigate selection-instrument threat, the nonequivalent control group participants were administered the pretest assessments at the same time point (Shaddish et al., 2002) as the treatment group participants during the third semester (fall 2017) of data collection. Although the specific time of year differs from the first and second (spring 2017 and summer 2017) data collection periods, all pretests were administered during the second week of the semester.

Recruitment of participants took place through various modalities, including: (a) attending and presenting at undergraduate and graduate courses; (b) sending emails to faculty and staff members; (c) posting flyers in various common areas in buildings on campus; and (d) posting flyers and information on various social media platforms. To ensure fit for the study, all participants completed a structured prescreening process via telephone call with the primary investigator. Interested participants were considered ineligible if they were: (a) under 18 years of age; (b) not enrolled at least part-time in a college or university within the Southeastern state; (c) currently pregnant; (d) could not read, write, and/or understand English; (e) have any hearing impairment; (f) have current, active psychosis; (g) have had a hospitalization, within the last month, due to a mental health issue; (h) current suicidal or homicidal ideation (SI/HI) with plan or intent; (i) a pacemaker or any other implanted electronic devices; (j) any severe skin allergies to cosmetics or lotions; and (k) denied any self-identified, current experiences of anxiety, worry, or nervousness. NF training sessions were provided at a university's (in a Southeastern state) community counseling and research center (CCRC).

Data Collection

The researcher of the current investigation received Institutional Review Board (IRB) approval in November of 2016. Data was collected over three semesters, from January 2017 to December 2017. Each semester had four time points of data collection, including: (a) before the first NF session (pre-test); (b) at NF session number eight, (mid-test); (c) at NF session number 16 (final session); and (d) four weeks after the final NF session (follow-up). Although the second and third data collection points were at the eighth and sixteenth session respectively, the assessments (BAI, PSS, BDI-II, and SAT) were administered and saliva samples collected prior to receiving NF training to mitigate a confounding variable of increased relaxation that can occur after receiving NF training (Hammond, 2005). Thus, data collected at the mid-test point reflects participants instrument scores and cortisol levels after having completed seven sessions, fifteen NF sessions at the final session, and sixteen NF sessions at the follow-up session. Prior to participants receiving the NF intervention, the primary investigator assigned random identification (ID) numbers; all participant assessments, folders, and saliva collection vials were tracked using the random ID numbers to maintain confidentiality. As assessments were not virtual (i.e., hardcopy), all information was stored in a locked file cabinet within a locked room. Data was entered into corresponding password protected, digital databases and on password protected computers.

Sampling Procedures

Sampling

The target population for this investigation included college students over 18 years of age. The researcher recruited an accessible population of college students in a central location in a Southeastern state that included both state colleges and a large university. For recruitment, the researcher attended courses in programs such as psychology, engineering and computer sciences, and health sciences. Additionally, flyers were posted in centralized locations on a university campus including: (a) graduate student affairs offices; (b) advising for undergraduate students; and (c) bulletin boards in areas of high traffic. The researcher also emailed the recruitment flyer and detailed study information to university staff members, including a director of an engineering-based program. Furthermore, the researcher posted the recruitment flyer on a social media page that provides resources for counselors to disseminate to clients.

Response Rates

The researcher attended the following courses during recruitment: (a) six sections of a large undergraduate engineering course; (b) one graduate health sciences course; (c) one undergraduate career course; and (d) nine undergraduate psychology courses. The number of students present in each class were not calculated as attendance was not taken in each course and course rosters were not provided. A total of 143 individuals inquired about participating in the study. Although students inquired about the study, many students did not schedule a screening call or were not able to meet the required timeline (i.e., attending biweekly sessions over an eight-week period, with a follow-up appointment four weeks later). One interested student was

ineligible to participate due to developmental delays. All 89 participants who began the study completed the first initial packet (100% response rate); however, 20 participants dropped out due to: (a) scheduling conflicts; (b) family emergencies; (c) personal illness; (d) discomfort with the NF training process; or (e) unknown reasons. Through inspection of the demographic questionnaire, the demographic features of the 20 participants who dropped out of the study (i.e., age; gender; college major; race/ethnicity) were similar to the treatment and control groups retained in the study; thus, it does not appear as though the 20 participants presented with any unique features that may have contributed to their dropping out. Nevertheless, if a participant dropped out or withdrew from the study, the researcher removed their data from the study to mitigate having large sets of missing data. Overall, 69 participants completed the study. Pallant (2010) purports that a sample size needs to be at least more than the number of dependent variables used. Thus, the sample size for this investigation is sufficient. Furthermore, observed power for the current study ranged from .74 to 1.00. Power refers to the likelihood that the used statistical procedure will find a statistically significant difference when a difference actually exists; ultimately, power assists in avoiding a type II error (Shadish et al., 2002). Power detected at .80 is large (Hair et al., 2010); therefore, observed power for the current investigation ranged from moderate to high.

Descriptive Statistics

Although 89 participants began the study, 69 participants were retained throughout, with the treatment group receiving a total of 16 sessions (over approximately 12 weeks) and the control group completing the assessments and saliva samples during the 12-week period. The

sections below provide the descriptive statistics for: (a) the total group (N = 69); (b) treatment group (n = 49); and (c) control group (n = 20).

Total Group Demographic Statistics

The research collected data regarding participants' personal demographics. Participants ranged in age from 18 to 39 years of age (M = 22.36, SD = 5.34, Mdn = 21, Mode = 18). Regarding gender, 46 identified as female (66.7%), 22 identified as male (31.9%), and one identified as genderqueer (1.4%). Participants reported identifying as various racial backgrounds, including: (a) Caucasian/White (n = 38, 55.1%); (b) Black/African American (n = 9, 13.0%); (c) Hispanic/Latino (n = 7, 10.1%); (d) Biracial/Bicultural (n = 7, 10.1%); (e) Asian (n = 2, 2.9%); (f) Native American (n = 1; 1.4%); and (g) Other (n = 5, 7.2%).

The researcher also collected data related to specific college demographics and experiences. Participants reported their highest grade completed, including: (a) high school diploma (n = 19, 27.5%); (b) some college (n = 17, 24.6%); (c) Associate's (AA/AS) degree (n = 18, 26.1%); (d) Bachelor's degree (n = 5, 7.2%); and (e) Master's degree (n = 10, 14.5%). The majority of participants were seeking undergraduate degrees (n = 55; 79.7%), with 14 pursuing graduate degrees (20.3%). The most common majors reported were: (a) engineering and computer science (n = 25, 36.2%); (b) psychology (n = 18, 26.1%); and (c) counseling (n = 13, 18.8%).

Participants were also asked to rate their overall current college experience on a Likert scale from one ("Very Negative") to five ("Very Positive"). Thirty-one participants indicated "Positive" (44.9%), 25 participants selected "Average" (36.2%), 10 reported "Very Positive"

(14.5%), and three reported "Negative" (4.3%) college experiences. No participants reported having a "Very Negative" current college experience.

In order to gain a better understanding of participants' mental health history, the researcher collected additional data related to personal mental health demographics. Participants were asked to report if they have ever participated in counseling or are currently receiving counseling services; 30 indicated "yes" to having participated in counseling (43.5%), 23 indicated "no" to not ever receiving counseling (33.3%), and 16 reported currently receiving counseling services (23.2%). Additionally, participants were asked to report if they are currently taking any medication(s) for emotional reasons; 58 participants reported "no" (84.1%) and 11 participants reported "yes" (15.9%). Participants were also asked to indicate if they have even been hospitalized for emotional or psychiatric issues. The majority of participants reported "no" hospitalization ever (n = 64, 92.8%) while five reported hospitalization in the past (7.2%). Participants shared responses about alcohol and drug behaviors, including: (a) no usage; (b) alcohol only; (c) other drugs only; or (d) both. Over half of the participants (n = 38, 55.1%) reported not using any alcohol or drugs, 19 participants reported using only alcohol (27.5%), nine participants reported using both alcohol and other drugs (13.0%), and three participants reported using only drugs (4.3%).

Finally, participants were asked to report familial information. Participants reported whether their parents or caregivers had a formal anxiety disorder diagnosis. Over three-quarters of the participants indicated "no" (n = 54, 78.3%), 14 indicated "yes" (20.3%), and one did not respond (1.4%). Similarly, participants were asked to report if they would describe their parents or caregivers as anxious. Forty-three participants (62.3%) reported "yes" and 26 reported "no" (37.7%).

Treatment Group and Control Group Demographic Statistics

Table 5 presents the participants' age per treatment and control groups.

Table 5

Descriptive statistics for age of participants

Age	*M*	*SD*	*Mdn*	Mode	Range	Min.	Max.
Treatment Group (*n* = 49)	22.92	5.02	22.00	18.00	20.00	18.00	38.00
Control Group (*n* = 20)	21.00	5.97	18.00	18.00	21.00	18.00	39.00

Table 6 presents the participants' additional demographic data. For both the treatment and control groups, the majority of participants identified as female, with the percentage slightly higher for the treatment group (69.4%) compared to the control group (60.0%). Similarly, over half of the participants in both groups identified as Caucasian (treatment group 55.1%; control group 55.0%). Both the treatment and control group endorsed various grade and education levels completed, with the treatment group presenting with more variation in education level. Both the treatment group and control group presented with a variety of majors. Over half of the participants in the treatment group majored in either Counseling (*n* = 13, 26.5%) or Engineering majors (*n* = 13, 26.5%), with an Engineering-related major being selected by the majority of participants in the control group (*n* = 12, 60.0%). Over half of the participants in both the treatment (53.1%) and control group (60.0%) endorsed not using alcohol or other drugs. Data was also collected regarding familial characteristics. For example, 61.2% of participants in the treatment group described their parents or caregivers as anxious, with 65.0% of participants in the control group reporting the same.

Table 6

Descriptive statistics of participants on various demographic variables

Demographics	Treatment Group		Control Group	
	n	%	*n*	%
Gender				
Female	34	69.4	12	60.0
Male	14	28.6	8	40.0
Genderqueer	1	2.0	0	0
Race/Ethnicity				
Caucasian	27	55.1	11	55.0
Biracial	6	12.2	1	5.0
Black/African American	5	10.2	4	20.0
Other	5	10.2	0	0
Hispanic/Latino	4	8.2	3	15.0
Asian	2	4.1	0	0
Native American	0	0	1	5.0
Highest Grade Completed				
HS Diploma	8	16.3	11	55.0
Some College	13	26.5	4	20.0
AA/AS	13	26.5	5	25.0
Bachelors	5	10.2	0	0
Masters	10	20.4	0	0
Rate Your Overall College Experience	6	12.2	4	20.0
Very Positive	23	46.9	8	40.0
Positive	20	40.8	5	25.0
Average	0	0	3	15.0
Negative	0	0	0	0
Very Negative				
College Major				
Counseling	13	26.5	0	0
Engineering/Comp Science	13	26.5	12	60.0
Psychology	12	24.5	6	30.0
Health Sciences/Pre-Clinical	2	4.1	0	0
Undecided	2	4.1	0	0
Math	1	2.0	0	0
Interdisciplinary Studies	1	2.0	0	0
Biomedical Sciences	1	2.0	2	10.0
Comm. Sciences/Disorders	1	2.0	0	0

Demographics	Treatment Group		Control Group	
	n	%	*n*	%
Accounting	1	2.0	0	0
Hospitality Management	1	2.0	0	0
Biology	1	2.0	0	0
Even Been Hospitalized for Psychiatric Concerns				
Yes	2	4.1	3	15.0
No	47	95.9	17	85.0
Ever Had Counseling Services				
Yes	24	49.0	6	30.0
No	15	30.6	8	40.0
Currently in Counseling	10	20.4	6	30.0
Current Alcohol/Other Drug Use	16	32.7	3	15.0
Alcohol	1	2.0	2	10.0
Drugs	6	12.2	3	15.0
Both	26	53.1	12	60.0
None				
Current Meds for Emotional Concerns	9	18.4	2	10.0
Yes	40	81.6	18	90.0
No				
Parents or Caregivers Have Anxiety Disorder Diagnosis	10	20.4	4	20.0
Yes	38	77.6	16	80.0
No	1	2.0	0	0
No Response				
Describe Parents or Caregivers as Anxious	30	61.2	13	65.0
Yes	19	38.8	7	35.0
No				

Instrument Data

The following section presents an overview of the data collection assessments used. Missing data is a common and challenging issue in data analysis (Tabachnick & Fidell, 2013). Due to missing responses in the current study, the researcher conducted a missing values analysis in SPSS to determine the percentage of missing data and to ensure data is missing completely at random (MCAR; Tabachnick & Fidell, 2013). Analyses determined that for all cases, missing data was less than 5% and was MCAR. Due to missing items, averaged scores were used when conducting analyses. Thus, the total scores and averaged scores of each instrument are reported below. Furthermore, in order to understand whether any threats to internal validity impacted the power of statistical analyses used, internal consistency reliability scores for the data from the instruments used are explored (Leech, Onwuegbuzie, & Conner, 2011).

Anxiety

The current study used two measures to assess for anxiety, including the: (a) *Beck Anxiety Inventory* (BAI; Beck et al., 1988) and *Social Anxiety Thoughts* questionnaire (SAT; Hartman, 1984). A brief description of the BAI and SAT and reliability scores of the current study are provided below. Descriptive statistics of the participant responses for the BAI and SAT are also provided in Tables 7 and 8.

BAI

The BAI (Beck et al., 1988) is a 21-item measure designed to assess for anxiety in both adolescents and adults. Items are assessed on a four-point Likert scale with responses of: (a) "Never;" (b) "Mildly – but it didn't bother me much;" (c) "Moderately – it wasn't pleasant at

times;" and (d) "Severely – It bothered me a lot." Sample items include: (a) "heart pounding/racing;" (b) "terrified or afraid;" (c) "dizzy or lightheaded;" (d) "indigestion;" and (e) "face flushed." The total score of the BAI can range from 0 to 63, with the mean score ranging from 0 to 3. The total score corresponds to specific anxiety ranges, including: (a) "minimal" anxiety for total scores from 0 to 7 (0 to 0.33 for average scores); (b) "mild" anxiety for total scores from 8 to 15 (0.38 to 0.71 for average scores); (c) "moderate" anxiety for total scores from 16 to 25 (0.76 to 1.19 for average scores); and (d) "severe" anxiety for total scores from 26 to 63 (1.23 to 3 for average scores). For the current sample (N = 69), anxiety levels at pre-test varied, with: (a) six participants endorsing scores for "mild" anxiety; (b) 19 participants endorsing scores for "minimal" anxiety; (c) 27 participants endorsing scores for "moderate" anxiety; and (d) 17 participants endorsing scores for "severe" anxiety. Examining the BAI scores at pre-test demonstrate that the majority of participants met criteria for moderate to severe anxiety (n = 44, 63.8%).

When investigating internal consistency reliability scores (Cronbach's alpha): (a) .8 and above demonstrate high reliability; (b) .7 to .8 demonstrate acceptable reliability; and (c) scores below .7 demonstrate low reliability of the sample data (Pallant, 2016). Furthermore, internal reliability consistency refers to the reliability of the data itself; that is, "reliability is a function of the data, not the instrument" (Leech et al., 2011, p.118). In developing the BAI, Beck and colleagues (1988) reported high internal consistency reliability ($\alpha = 0.92$) for the data collected. Cronbach's alpha scores on the BAI for the current study data demonstrated high internal consistency at all assessment points: (a) pre-test ($\alpha = 0.90$); (b) mid-test ($\alpha = 0.89$); (c) final test ($\alpha = 0.88$); and (d) follow-up ($\alpha = 0.92$). For group comparison studies, Leech and colleagues (2011) also recommend reporting internal consistency reliability for each group. For the current

study, alpha coefficients for the treatment group were high at all assessment points: (a) pre-test (α = 0.90); (b) mid-test (α = 0.90); (c) final test (α = 0.88); and (d) follow-up (α = 0.92). Alpha coefficients for the control group also demonstrated high internal consistency reliability: (a) pre-test (α = 0.92); (b) mid-test (α = 0.86); (c) final test (α = 0.85); and (d) follow-up (α = 0.89). A similar Cronbach's alpha score was identified for the Osman and colleagues (1997) study (α = 0.90), demonstrating congruent levels of internal consistency reliability for data from the current study sample and samples from previous studies.

Furthermore, Osman and colleagues (1997) administered the BAI to undergraduate students (*N* = 350) enrolled in psychology courses. More than half of the participants were women (*n* = 205, 58.5%). Both men (*n* = 145, 41.4%, *M* age = 20.95, *SD* = 3.52) and women reported similar mean ages, with the mean age of women being slightly higher (*M* age = 21.64, *SD* = 5.58). The current investigation demonstrated comparable percentages of women (66.7%) and men (31.9%) and a similar average age studied (*M* = 22.36, *SD* = 5.34). Additionally, the majority of participants identified as White (92.6%), with the current study having a lower percentage (55.1%) of white participants.

The mean BAI score was 13.41 (Osman et al., 1997), which equates to an average score of .64. At pre-test, the mean BAI score of the current college student sample was .96, which is higher than the Osman and colleagues (1997); however, the higher mean score is congruent with the current study sample as one of the main criteria for participant was self-identified anxiety, whereas Osman and colleagues (1997) did not seek out college students with self-identified anxiety. Similarly, Lovibond and Lovibond (1995) administered the BAI to 717 (486 females, 67.8%; 231 males, 32.2%) enrolled in psychology courses, with a mean age of 21.0. The mean BAI score was 9.15, which equates to an average score of .44, which is different from the pre-

test scores of the total group (*M* = .96). Although the participant demographics (mean age and percentage of female to male students) of the Lovibond and Lovibond (1995) study resembles the age and gender of the current study population, the mean BAI score is lower. The difference between the current participants and participants from previous studies may be due to the current investigation seeking out participants with self-identified anxiety; the aforementioned study did not.

SAT

The SAT questionnaire (Hartman, 1984) is a 21-item measure designed to assess for anxiety-based thoughts that are associated with social situations. The SAT items are assessed on a five-point Likert scale with responses of: (a) "Never;" (b) "Rarely;" (c) "Sometimes;" (d) "Often;" and (e) "Always." Items on the SAT include: (a) "I don't know what to say;" (b) "Can they tell I am nervous?" and (c) "Will others notice my anxiety?" The total score of the SAT can range from 21 to 105 (1 to 5 for average scores). The SAT does not have categories or ranges of scores; however, a higher score indicates an increased experience of anxiety-based cognitions in social contexts. Overall, the total score of the SAT ranges from 21 to 105 (1 to 5 for average scores). The SAT was normed on a sample of 102 college students (74 females, 28 males; *M* age = 21.6), with a mean total score of 42.3 (average score of 2.01). At pre-test, the mean score of the current population (*N* = 69) was 2.70. As indicated, the current study sought participants who self-identified as anxious, resulting in a higher level of anxiety compared to a general population of college students as used in Hartman's (1984) study. However, the mean score at follow-up was 2.07, which is similar to the college student population used to serve as the norm population for the development of the SAT. The SAT also demonstrates high internal consistency reliability

(α = .95; Hartman, 1984) for the data. For the current investigation at four data collection points, the internal consistency reliability scores for the SAT data were similar to Hartman's (1984) investigation, including: (a) pre-test, α = .92; (b) mid-test, α = .92; (c) final test, α = .94; and (d) follow-up, α = .95. For the treatment group, the internal consistency reliability scores were similar: (a) pre-test, α = .92; (b) mid-test, α = .92; (c) final test, α = .94; and (d) follow-up, α = .95. Furthermore, the control group demonstrated high Cronbach's alpha scores at all four data collection points: (a) pre-test, α = .93; (b) mid-test, α = .92; (c) final test, α = .92; and (d) follow-up, α = .94

Depression

As individuals who experience anxiety are at an increased risk for depressive symptoms and/or diagnoses (Ressler & Nemeroff, 2000), the current study used the BDI-II (Beck et al., 1996) to measure depression. A brief description of the BDI-II is provided below, with the BDI-II descriptive data of participant responses presented in Tables 7 and 8.

BDI-II

The BDI-II (Beck et al., 1996) is one of the most widely used inventories for depression (Archer et al., 1992). It is a 21-item measure designed to assess for depression symptoms associated with depressive disorders found in the DSM-IV (APA, 1994) and can be used for individuals 13 years of age and older. Items are assessed on a four-point Likert scale that ranges from 0 to 3; the responses per item depend on the item itself. For example, when assessing for "Pessimism," responses include: (a) "0 - I am not discouraged about my future;" (b) "1 – I feel more discouraged about my future than I used to be;" (c) "2 – I do not expect things to work out

for me;" and (d) "3 – I feel my future is hopeless and will only get worse." Other examples of items on the BDI-II include: (a) "Sadness;" (b) "Past Failure;" and (c) "Guilty Feelings." The total score of the BDI-II ranges from 0 to 63 (0 to 3 for average scores). The total score corresponds to specific depressive ranges, including: (a) "minimal" depression for scores from 0 to 13 (0 to 0.62 for mean scores); (b) "mild" depression for scores 14 to 19 (0.67 to 0.90 for mean scores); (c) "moderate" depression for scores 20 to 28 (0.95 to 1.33 for mean scores); and (d) "severe" depression for scores 29 to 63 (1.38 to 3 for mean scores). For the current investigation, the total study population (N = 69) varied on depression ranges at pre-test, including: (a) 31 endorsing "minimal" depression; (b) 10 endorsing "mild" depression; (c) 19 endorsing "moderate" depression; and (d) nine endorsing "severe" depression.

Storch and colleagues (2004) assessed the psychometric features of the BDI-II using data collected from 414 undergraduate students from two Southeastern universities (n = 414), with ages ranging from 17 to 39 (M = 20.52, SD = 2.55), similar to the age range of the current college student population (18 to 39; M = 22.36, SD = 5.34). Overall, the total mean score for participants was 11.03 (Storch et al., 2004), equating to an average mean score of .53. The average mean score on the BDI-II for the current population is higher, at all test points (.82 to .60 from pre-test to post-test, respectively). However, as the current study sought students with self-identifying as anxious, the likelihood of increased levels of depression is expected. Overall, the development of the BDI-II demonstrated high internal consistency reliability for its data (α = 0.92; Beck et al., 1996). Storch and colleagues (2004) reported similar internal consistency reliability for their studied college student population (α = 0.90). For the current investigation, high internal consistency reliability was also identified at all four data collection points, including: (a) pre-test, α = .91; (b) mid-test, α = .91; (c) final test, α = .94; and (d) follow-up, α =

.95. Similar alpha coefficients were found for the treatment group: (a) pre-test, α = .92; (b) mid-test, α = .92; (c) final test, α = .94; and (d) follow-up, α = .95. Additionally, the control group demonstrated high internal consistency reliability: (a) pre-test, α =.84; (b) mid-test, α = .87; (c) final test, α = .94; and (d) follow-up, α = .93.

Stress

The current study used two measures for stress, including the PSS (Cohen et al., 1983) and salivary cortisol levels through the use of Salimetrics Enzyme-Linked Immunosorbent Assay (ELISA) testing, which serves as an objective measure of stress. A brief description of the PSS and Salimetrics ELISA are described below. Additionally, the PSS descriptive data is presented in Tables 7 and 8. Cortisol level descriptive data is presented in Tables 9 and 10.

PSS

The PSS (Cohen et al., 1983) is the most used assessment to measure perceived stress (Cohen et al., 1994) and includes 10-items. Items are assessed on a five-point Likert scale of: (a) 0 = "Never"; (b) 1 = "Almost Never"; (c) 2 = "Sometimes"; (d) 3 = "Fairly Often"; and (e) 4 = "Very Often." The PSS item examples include: (a) "In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?" and (b) "In the last month, how often have you felt that you were on top of things?" As the PSS is not used for the purpose of diagnoses, cutoff or grouping scores are not used (Kopp et al., 2010); however, the higher the PSS score, the more likely individuals experience perceived stress. The total score of the PSS ranges from 0 to 40 (0 to 4 for average scores). Cohen and colleagues (1983) found high internal consistency reliability in the development of the PSS with two samples of college

students, ranging from $\alpha = .84$ to $\alpha = .86$ for the data. The internal consistency reliability scores for the current study data varied across times, but were all acceptable to high and comparable to Cohen and colleagues' (1983) findings, including: (a) pre-test $\alpha = .78$; (b) mid-test $\alpha = .86$; (c) final test $\alpha = .90$; and (d) follow-up $\alpha = .91$. When reviewing internal consistency reliability scores for each group (treatment group and control group), the treatment group indicated acceptable to high Cronbach's alpha scores: (a) pre-test, $\alpha = .75$; (b) mid-test, $\alpha = .86$; (c) final test, $\alpha = .89$; and (d) follow-up, $\alpha = .92$, with the control group demonstrating high alpha coefficients: (a) pre-test, $\alpha = .81$; (b) mid-test, $\alpha = .88$; (c) final test, $\alpha = .91$; and (d) follow-up, $\alpha = .85$, at all four data collection points.

Table 7

BAI, SAT, BDI-II, and PSS descriptive data for the total group (N = 69)

Descriptive Statistics	*M*	*SD*	*Mdn*	Mode	Range	Min.	Max.
BAI							
Pretest	.96	.52	.81	.81	2.29	.00	2.29
Midpoint	.73	.45	.71	.38	1.76	.05	1.81
Final	.64	.43	.52	.48	1.95	.00	1.95
Follow-up	.65	.50	.57	.29	2.33	.00	2.33
SAT							
Pretest	2.70	.75	2.67	2.29	3.29	1.10	4.38
Midpoint	2.36	.73	2.33	1.76	3.10	1.14	4.24
Final	2.14	.74	1.95	1.90	2.95	1.00	3.95
Follow-up	2.07	.78	1.95	1.62	3.48	1.00	4.48
BDI-II							
Pretest	.82	.50	.81	.81	2.48	.05	2.52
Midpoint	.70	.47	.62	.24	1.95	.05	2.00
Final	.60	.52	.52	.05	2.62	.00	2.62
Follow-up	.61	.54	.48	.14	2.33	.00	2.33
PSS							
Pretest	2.21	.54	2.30	2.00	2.70	.60	3.30
Midpoint	2.03	.64	2.10	1.70	2.60	.60	3.20
Final	1.84	.74	1.80	1.80	3.10	.40	3.50
Follow-up	1.89	.77	1.80	1.60	3.20	.20	3.40

Table 8

BAI, SAT, BDI-II, and PSS descriptive data per treatment and control groups

Instrument	Descriptive Statistics	*M*	*SD*	*Mdn*	Mode	Range	Min.	Max.
	Treatment Group (*n* = 49)							
	Pretest	.92	.51	.81	.81	2.19	.10	2.29
	Midpoint	.66	.44	.52	.38	1.71	.05	1.76
	Final	.54	.40	.48	.48	1.95	.00	1.95
BAI	Follow-up	.56	.47	.43	.10	2.33	.00	2.33
	Control Group (*n* = 20)							
	Pretest	1.04	.57	.88	.38	2.00	.00	2.00
	Midpoint	.92	.40	.81	.76	1.62	.19	1.81
	Final	.88	.41	.93	.48	1.33	.29	1.62
	Follow-up	.90	.47	.86	.29	1.62	.14	1.76
	Treatment Group (*n* = 49)							
	Pretest	2.67	.74	2.62	2.29	3.10	1.29	4.38
	Midpoint	2.26	.72	2.14	1.76	3.10	1.14	4.24
	Final	2.00	.71	1.86	1.90	2.95	1.00	3.95
SAT	Follow-up	1.93	.75	1.71	1.62	3.48	1.00	4.48
	Control Group (*n* = 20)							
	Pretest	2.77	.80	2.83	3.62	3.00	1.10	4.10
	Midpoint	2.60	.69	2.64	2.62	2.57	1.19	3.76
	Final	2.49	.72	2.43	2.43	2.43	1.10	3.52
	Follow-up	2.42	.77	2.29	1.14	2.71	1.14	3.86
	Treatment Group (*n* = 49)							
	Pretest	.85	.55	.76	.62	2.48	.05	2.52
	Midpoint	.67	.50	.57	.24	1.95	.05	2.00
	Final	.52	.49	.38	.05	2.62	.00	2.62
BDI-II	Follow-up	.53	.53	.38	.14	2.33	.00	2.33
	Control Group (*n* = 20)							
	Pretest	.74	.38	.81	.81	1.33	.05	1.38
	Midpoint	.77	.39	.86	.10	1.38	.10	1.48
	Final	.82	.55	.71	.67	2.00	.05	2.05
	Follow-up	.81	.51	.79	.24	1.76	.10	1.86
	Treatment Group (*n* = 49)							
	Pretest	2.25	.55	2.30	1.70	2.30	1.00	3.30
	Midpoint	1.98	.63	1.90	1.70	2.20	.90	3.10
	Final	1.68	.70	1.60	1.20	2.90	.40	3.30
PSS	Follow-up	1.80	.82	1.70	1.40	3.20	.20	3.40

Instrument	Descriptive Statistics	*M*	*SD*	*Mdn*	Mode	Range	Min.	Max.
	Control Group (*n* = 20)							
	Pretest	2.11	.53	2.10	1.80	2.20	.60	2.80
	Midpoint	2.15	.65	2.30	1.70	2.60	.60	3.20
	Final	2.22	.72	2.15	1.80	3.00	.50	3.50
	Follow-up	2.10	.60	2.25	1.70	2.20	.70	2.90

Salimetrics ELISA

Salimetrics ELISA testing was used to measure quantitative levels of salivary cortisol (Salimetrics, Inc., 2017). Cortisol is released during times of actual or perceived stress (Sapolsky, 2004) and have a diurnal pattern, with individuals exhibiting higher cortisol levels in the morning and decreased levels in the evening (Nicolson, 2008; Salimetrics, Inc., 2017). Because of the time of day can influence cortisol levels, Table 5 provides the specific times of day per collection point for each participant. Researchers assayed samples in duplicate using the Salimetrics High Sensitivity Cortisol Assay Kit, without modifications to the manufacturers' protocol. The average coefficient of variation for all samples tested was 2.42 to 4.66, meeting the manufacturers' criteria for accuracy and repeatability in Salivary Bioscience and exceeds the applicable National Institute of Health (NIH) guidelines for Enhancing Reproducibility through Rigor and Transparency. Sample test volume was 25 µL of saliva per determination. The assay has a lower limit of sensitivity of 0.007 µg/dL, standard curve range from 0.012 µg/dL to 3.0 µg/dL. Prior to analyzing the saliva samples, the samples were stored at -80^{O}C for one to seven months prior to testing.

Table 9

Times of day of saliva collection for participants per treatment and control groups

ID/Group	Pretest	Midpoint	Final	Follow-up
Treatment Group (*n* = 29)				
200	2:45pm	2:26pm	2:19pm	3:12pm
201	6:45pm	6:00pm	4:48pm	4:43pm
202	4:45pm	4:22pm	4:13pm	9:10pm
203	2:45pm	12:02pm	1:13pm	3:23pm
204	10:45am	10:02am	10:15am	10:08am
206	6:45pm	6:06pm	6:21pm	5:30pm
207	5:45pm	5:17pm	5:35pm	5:10pm
208	12:45pm	12:15pm	10:35am	12:04pm
210	3:45pm	3:22pm	3:06pm	1:12pm
211	4:45pm	9:00am	4:35pm	10:40am
212	8:30am	8:14am	11:53am	11:22am
213	11:30am	11:20am	11:19am	4:50pm
214	9:30am	1:20pm	4:14pm	10:50am
215	11:45am	10:48am	9:48am	11:08am
216	1:45pm	1:00pm	1:10pm	1:04pm
217	2:45pm	3:57pm	2:30pm	11:25am
218	9:58am	12:32pm	12:26pm	5:35pm
219	10:10am	9:38am	9:30am	2:22pm
302	11:20am	4:05pm	4:15pm	11:48am
303	12:45pm	12:14pm	12:48pm	1:50pm
304	2:22pm	1:05pm	1:15pm	1:25pm
305	6:00pm	2:15pm	2:12pm	5:05pm
311	9:47am	9:20am	9:21am	3:27pm
313	1:34pm	1:18pm	1:09pm	1:10pm
315	1:45pm	12:20pm	12:10pm	12:24pm
317	4:08pm	3:30pm	3:15pm	1:57pm
318	4:36pm	4:10pm	4:05pm	3:20pm
321	8:12pm	7:20pm	7:06pm	10:20am

ID/Group	Pretest	Midpoint	Final	Follow-up
323	3:44pm	3:05pm	3:07pm	3:14pm
Control Group (*n* = 18)				
325	5:00pm	2:13pm	9:22am	10:28am
326	6:35pm	9:29am	2:28pm	10:25am
328	2:43pm	11:49am	3:00pm	11:46am
329	12:15pm	12:16pm	1:36pm	12:00pm
330	4:35pm	10:53am	4:20pm	1:56pm
331	9:55am	12:02pm	3:20pm	9:50am
334	8:55am	12:15pm	2:30pm	5:38pm
337	10:10am	9:48am	2:01pm	11:03am
339	10:55am	10:16am	6:30pm	2:28pm
340	11:09am	10:21am	4:50pm	12:05pm
341	12:41pm	1:08pm	3:49pm	11:25am
342	12:40pm	1:34pm	2:10pm	1:20pm
344	5:31pm	1:45pm	5:20pm	9:30am
345	1:56pm	9:52am	3:30pm	1:30pm
346	12:10pm	1:54pm	2:40pm	12:20pm
347	3:11pm	10:48am	1:59pm	10:35am
349	2:40pm	10:37am	10:05pm	10:30am
350	1:34pm	2:22pm	10:45am	12:20pm

The researcher structured the study to include analysis of saliva samples to occur in one lab. However, the initial lab for analysis could no longer analyze all saliva samples. Thus, due to samples being analyzed in two separate facilities, participants' saliva data from spring 2017 (*n* = 16) were removed to ensure all saliva samples were analyzed with the same procedures (summer 2017 and fall 2017 samples). Additionally, participants who had samples that resulted in high concentration levels (any score exceeding 3.149) or incomplete data (i.e., missing a time point) were removed from the analysis. Additionally, once the researcher began checking statistical assumptions, two major outliers were found and removed (specific details are provided in

sections below). Thus, 47 participants remained (treatment group = 29; control group = 18) for analysis. Table 10 provides the descriptive statistics of the cortisol levels for both the treatment and control groups.

Table 10

Descriptive statistics of cortisol levels

Cortisol	*M*	*SD*	*Mdn*	Mode	Range	Min.	Max.
Treatment Group (*n* = 29)							
Pre	.19	.10	.15	.05	.35	.05	.39
Mid	.27	.27	.17	.10	1.22	.05	1.27
Final	.21	.13	.17	.05	.51	.05	.56
Post	.28	.25	.21	.12	1.34	.03	1.37
Control Group (*n* = 18)							
Pre	.23	.14	.20	.05	.60	.05	.65
Mid	.25	.13	.22	.10	.52	.10	.61
Final	.24	.15	.20	.21	.51	.08	.59
Post	.35	.23	.26	.19	.71	.10	.82

When analyzing salivary cortisol levels, each laboratory is responsible for establishing their own range (Salimetrics, 2017). However, Aardal and Holm (1995) established reference ranges for morning (collection at 8:00am) and evening (collection at 10:00pm) salivary cortisol levels for adult males and females. For individuals 21 to 30 years of age, males were found to have overall lower morning ranges (*n* = 26, 0.112 to 0.743 μg/dL) compared to females (*n* = 20, 0.272 to 1.348 μg/dL). Evening levels were more similar between males (0.308 μg/dL) and females (0.359 μg/dL) 21 to 30 years of age. For individuals 31 to 50 years of age, males were found to have a higher overall morning range (*n* = 67, 0.122 to 1.551 μg/dL) as compared to females (*n* = 31, 0.094 to 1.515 μg/dL). Additionally, evening levels were also higher for males (0.359 μg/dL) as compared to females (0.181 μg/dL) 31 to 50 years of age. The identified levels of cortisol for Aardal and Holm's (1995) are within similar ranges of the current investigation;

however, the current study did not account of time of day, age, and gender, creating difficulty in comparing results.

Data Analysis

The purpose of this study was to determine whether anxiety, depression, and stress levels for college students who received NF training would demonstrate: (a) decreased levels of anxiety as measured by the BAI and SAT; (b) decreased levels of stress as measured by the PSS and salivary cortisol levels; and (c) decreased levels of depression as measured by the BDI-II as compared to a control group. The study also examined whether there was a relationship between participants' demographic variables and the four assessment scores (BAI, SAT, PSS, and BDI-II). Furthermore, the investigation sought to determine if participants who received NF training experienced decreases in salivary cortisol levels as compared to a control group and if there was a relationship between participants' assessment scores and salivary cortisol levels.

Primary Research Question

The researcher implemented a repeated measures multivariate analysis of variance (RM-MANOVA) to determine whether the NF training intervention influenced mean scores on the four assessments (BAI, PSS, SAT, and BDI-II) for the treatment group as compared to a control group who did not receive NF training. A RM-MANOVA is used: (a) in examining research designs that include one or more independent variables to determine if there is an impact on two or more dependent variables; (b) when data is collected at various points in time throughout a study (Tabachnick & Fidell, 2013); (c) in helping to adjust for the risk of a Type 1 error; and (d) in comparing scores of treatment and control groups and determining if the mean differences

among the groups on combined dependent variable scores are due to chance or the treatment (Pallant, 2016).

Prior to testing statistical assumptions, the researcher implemented a missing values analysis. For all cases, missing data accounted for less than 5% of values and was MCAR; thus the amount of missingness was acceptable (Tabachnick & Fidell, 2013). Due to missing values, the researcher used average scores (instead of total scores) in the data analysis process. Using the mean scores allows for the inclusion of participants' data in the main analyses, without having to exclude participant data (Lambie & Vacarro, 2011). Furthermore, using mean scores allows for score estimates to be more accurate as variability is decreased among the responses of participants (Tabachnick & Fidell, 2013).

Next, the research addressed statistical assumptions prior to running data analyses, including: (a) sample size; (b) multivariate normality; (c) linearity among dependent variables; (d) homogeneity of variance; and (e) sphericity among dependent variables. According to Pallant (2016), a dataset should include more cases than dependent variables. For MANOVAs, Tabachnick and Fidell (2013) also assert that a sample size needs to be at least 10 plus the number of dependent variables. Both of these recommendations for sample size were satisfied in the current study (N = 69). Normality was tested through visual inspection of histogram plots for the current data. Normality was found for the experimental group within the following assessments and time points: (a) BAI pre; (b) PSS pre, mid, final, and follow-up; (c) BDI-II pre and mid; and (d) SAT pre, mid, and follow-up. For the control group, normality was evident at the: (a) BAI pre, mid, and follow-up; (b) PSS final; (c) BDI-II pre, final, and follow-up; and (d) SAT pre, mid, and post. Remaining assessment time points were found to violate normality. However, non-normal distribution of data is a common occurrence within social science research

studies (Hair et al., 2010; Micceri, 1989). To further assess for multivariate normality, the researcher conducted a Mahalanobis distances test and found that the value (42.40) exceeded the critical value (39.25). Upon further inspection, two cases exceeded the critical value. However, a MANOVA is robust to violations of multivariate normality (Pallant, 2016; Stevens, 2007) and the two cases were included in the final analyses.

The research confirmed linearity through visual inspection of the dependent variables via scatterplots. Furthermore, homogeneity of variance was determined through Box's M Test of equality (p = .006). Pallant (2016) asserts that significance values great than .001 do *not* violate homogeneity of variance; thus, this assumption was not violated. Finally, Mauchly's Test of Sphericity was violated for some assessments; thus, in order to correct for this violation, the Greenhouse-Geiser was selected when examining the tests within-subjects effects for assessments that demonstrated violation of sphericity and are reported below.

Assessments for anxiety, depression, and stress were administered to the treatment group at four time points: (a) prior to the first NF training session (pre-test); (b) at the eighth session, after seven total NF training sessions were administered (mid-test); (c) at the sixteenth session, after fifteen total NF training sessions were administered (final-test); and (d) four weeks after the sixteenth session (follow-up test). The control group also completed the assessments at four time periods, congruent with the time period of the treatment group (i.e., approximately once every four weeks, over a 12 week period).

The researcher implemented a RM-MANOVA to determine whether there were significant differences in mean scores between the treatment group and control group over time. A marginally significant multivariate effect was found across the within-subjects interaction between time and group: Wilks' $\lambda = .708$, $F_{(12, 56)} = 1.92$, $p = .051$, partial $\eta^2 = .292$,

demonstrating a significant difference between the scores of groups over time. Observed power to detect these changes in scores was high (.85). Mauchly's Test of Sphericity was violated for the all four assessments; therefore, the Greenhouse-Geisser was used when reporting the univariate tests for these measures. When interpreting the univariate between-group analysis, results identified significant differences between the groups on three of the measures. Specifically, compared to the control group, the treatment group showed significant differences on mean scores for the: (a) PSS ($F_{(3, 201)} = 6.836$, $p < .001$, partial $\eta^2 = .093$); (b) BDI-II ($F_{(3, 201)} = 6.563$, $p = .001$, partial $\eta^2 = .089$); and (c) SAT ($F_{(3, 201)} = 3.641$, $p = .019$, partial $\eta^2 = .052$). Thus, for the PSS, BDI-II, and SAT scores, the treatment group demonstrated statistically significant lower mean scores over time as compared to the control group (presented in Table 11). However, there were no statistically significant differences identified in scores between the treatment and control groups for the BAI ($F_{(3, 201)} = 1.822$, $p = .153$, partial $\eta^2 = .026$). In addition, observed power to detect these changes in the participants' scores ranged from moderate for the SAT (.74) to high for the BDI-II (.93) and PSS (.96). The mean scores on the four assessments (BAI, PSS, SAT, and BDI-II) are presented in Figures 1 to 4.

Effect sizes are important to note as they establish the strength of a relationship (Shadish et al., 2002); for the current study, effect sizes can determine the practical significance of the NF training intervention. Cohen (1988) reports the following ranges for effect sizes when using multivariate eta squared: (a) a small effect size is found at the 0.01 level; (b) a medium effect size is found at the 0.06 level; and (c) a large effect size is 0.14 and above. Thus, a moderate effect size was found for both the PSS and BDI-II, demonstrating practical significance for the impact of the NF training intervention on participants' stress and depression scores. A small

effect size was found for participants' improvement in their anxiety levels as measured by the SAT scores.

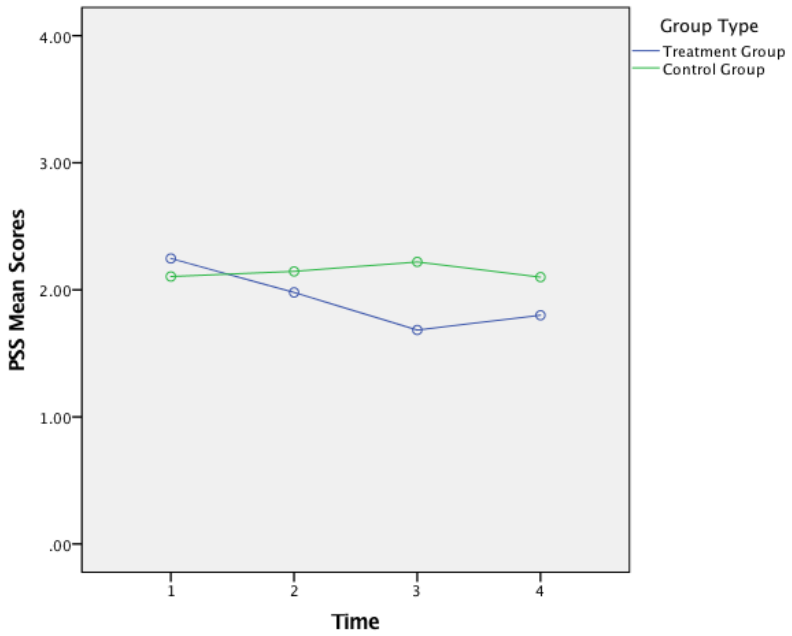


Figure 1: Mean scores for PSS

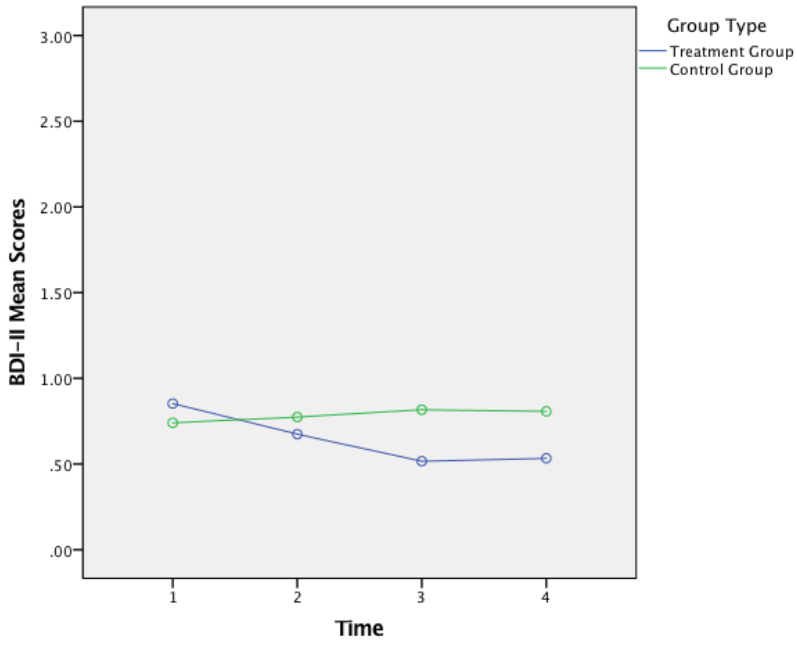


Figure 2: Mean scores for BDI-II

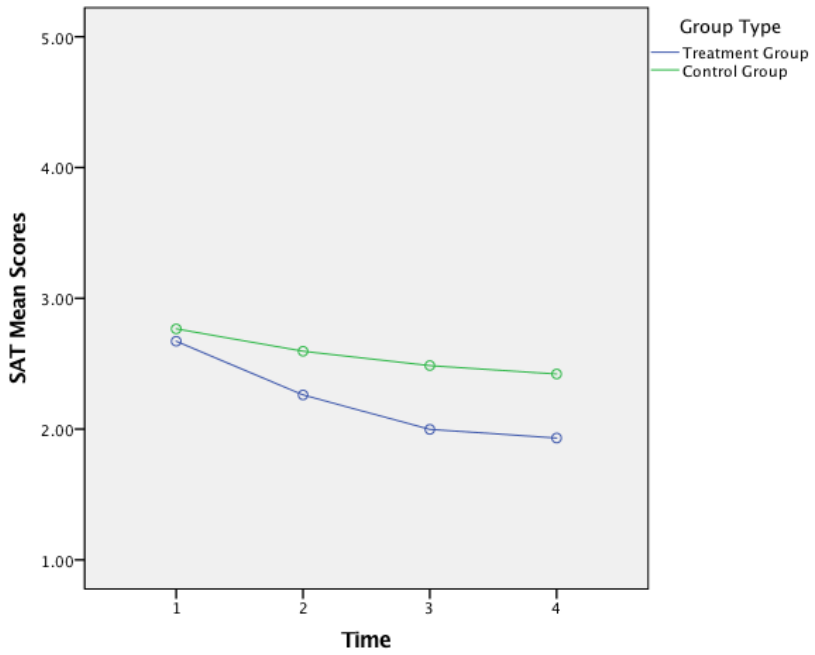


Figure 3: Mean scores for SAT

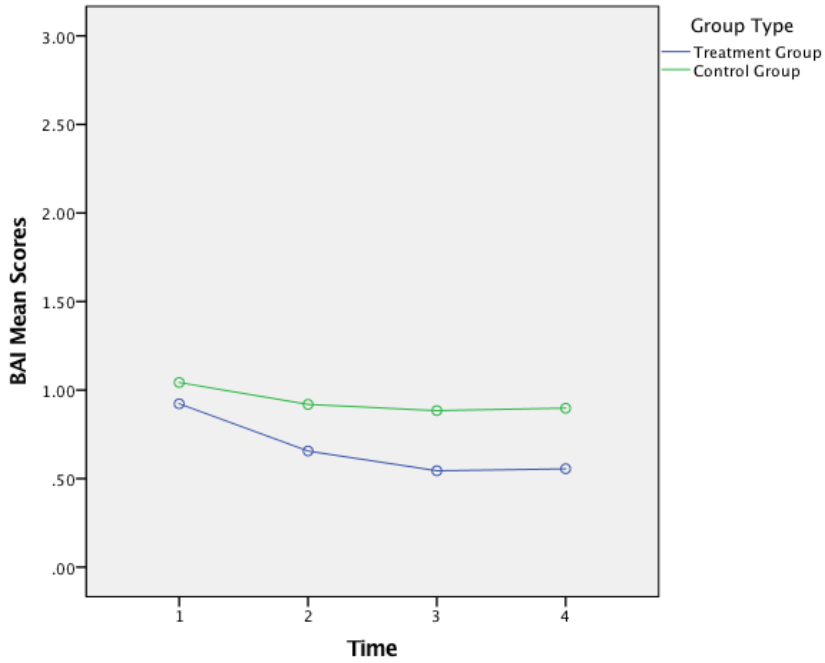


Figure 4: Mean scores for BAI

Table 11

Mean and standard deviation scores for the treatment and control groups across time

Assessment and Time	Group Type	*M*	*SD*
PSS Pre	Treatment Group	2.25	.55
	Control Group	2.11	.53
PSS Mid	Treatment Group	1.98	.63
	Control Group	2.15	.65
PSS Final	Treatment Group	1.68	.70
	Control Group	2.22	.72
PSS Follow-up	Treatment Group	1.80	.82
	Control Group	2.10	.60
BDI-II Pre	Treatment Group	.85	.55
	Control Group	.74	.38
BDI-II Mid	Treatment Group	.67	.50
	Control Group	.77	.39
BDI-II Final	Treatment Group	.52	.49
	Control Group	.82	.55
BDI-II Follow-up	Treatment Group	.53	.53
	Control Group	.81	.51
SAT Pre	Treatment Group	2.67	.74
	Control Group	2.71	.80
SAT Mid	Treatment Group	2.26	.72
	Control Group	2.60	.69
SAT Final	Treatment Group	2.00	.71
	Control Group	2.49	.72
SAT Follow-up	Treatment Group	1.93	.75
	Control Group	2.42	.77
BAI Pre	Treatment Group	.92	.51
	Control Group	1.04	.57
BAI Mid	Treatment Group	.66	.44
	Control Group	.92	.40
BAI Final	Treatment Group	.54	.40
	Control Group	.88	.41
BAI Follow-up	Treatment Group	.56	.47
	Control Group	.90	.47

As the treatment group demonstrated statistically significant lower mean scores over time (for the PSS, BDI-II, and SAT) as compared to the control group, Cohen's *d* effect sizes were calculated for each time point using an effect size calculator. The American Psychological Association's (APA, 2010) *Publication Manual* emphasizes that reporting effect sizes is critical in order to better understand the strength of the change. Table 12 presents specific information regarding calculated effect sizes for the PSS, BDI-II, and SAT scores.

Table 12

Effect size for the treatment and control groups across time

Assessment and Time	Group Type	Cohen's *d*
PSS Pre to Mid	Treatment Group	.46
	Control Group	.07
PSS Mid to Final	Treatment Group	.45
	Control Group	.10
PSS Final to Post	Treatment Group	.16
	Control Group	.18
BDI-II Pre to Mid	Treatment Group	.34
	Control Group	.08
BDI-II Mid to Final	Treatment Group	.30
	Control Group	.10
BDI-II Final to Post	Treatment Group	.02
	Control Group	.02
SAT Pre to Mid	Treatment Group	.56
	Control Group	.15
SAT Mid to Final	Treatment Group	.36
	Control Group	.16
SAT Final to Post	Treatment Group	.10
	Control Group	.09

Exploratory Research Question 1

The researcher implemented a RM-MANOVA to determine if there were significant differences in mean scores for the treatment group over time. The RM-MANOVA demonstrated a significant multivariate effect for treatment group participants over time (on combined BAI, PSS, BDI-II, and SAT scores): Wilks' $\lambda = .290$, $F_{(12, 37)} = 7.534$, $p < .001$, partial $\eta^2 = .71$. As Mauchly's Test of Sphericity was violated for the PSS and BDI-II, Greenhouse-Geisser was used when reporting the univariate tests of those measures. The univariate tests identified a significant difference in mean scores over time for the four measures, including: (a) BAI ($F_{(3, 144)} = 21.24$, $p < .001$, partial $\eta^2 = .31$); (b) PSS ($F_{(3, 144)} = 14.66$, $p < .001$, partial $\eta^2 = .23$); (c) SAT ($F_{(3, 144)} = 40.61$, $p < .001$, partial $\eta^2 = .46$); and (d) BDI-II ($F_{(3, 144)} = 13.547$, $p < .001$, partial $\eta^2 = .22$). As all reported effect sizes exceed the 0.14 level for the treatment group over time, there was large practical significance for the impact of the NF training intervention on participants' anxiety, stress, and depression over time. Observed power to detect these changes was high at .99 to 1.00. The mean scores on the four assessments (BAI, PSS, SAT, and BDI-II) are presented in Figures 5 to 8.

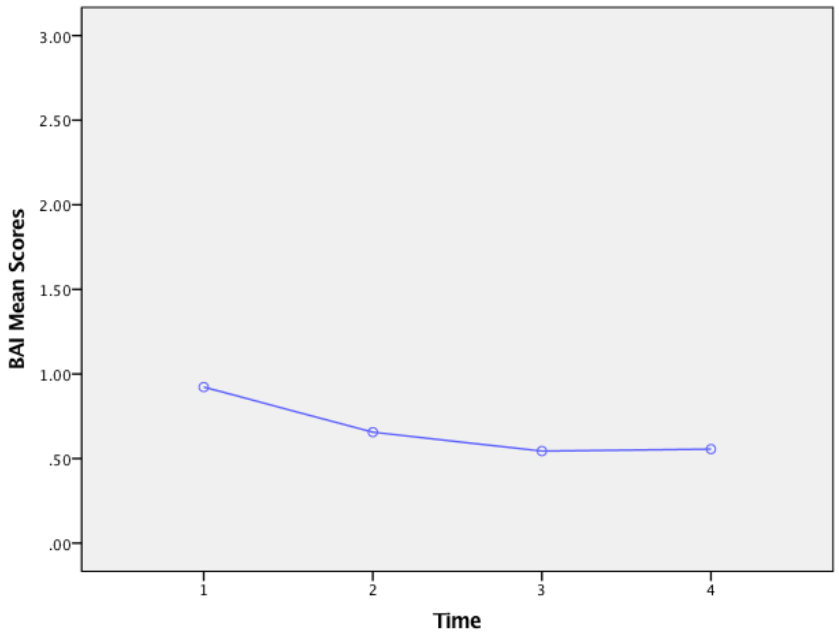


Figure 5: Mean scores for BAI

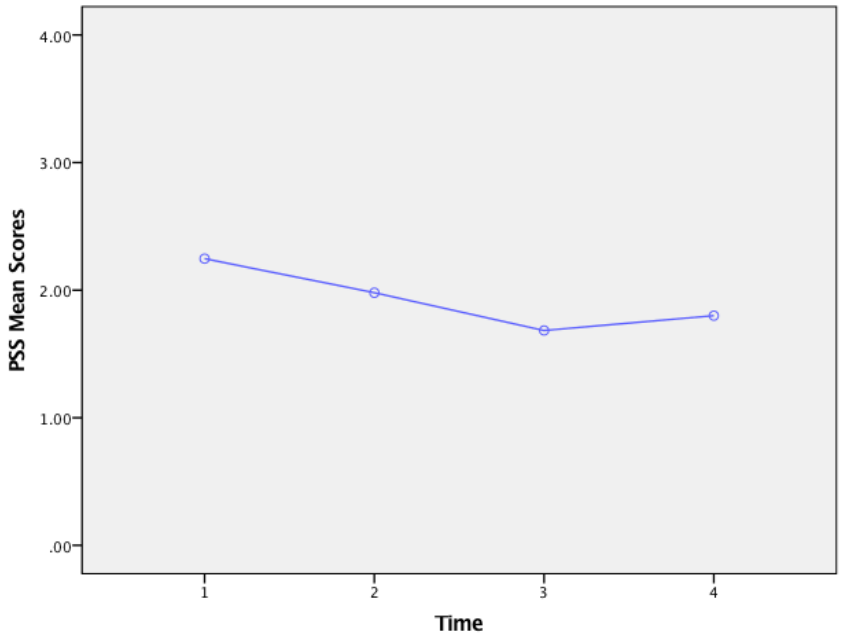


Figure 6: Mean scores for PSS

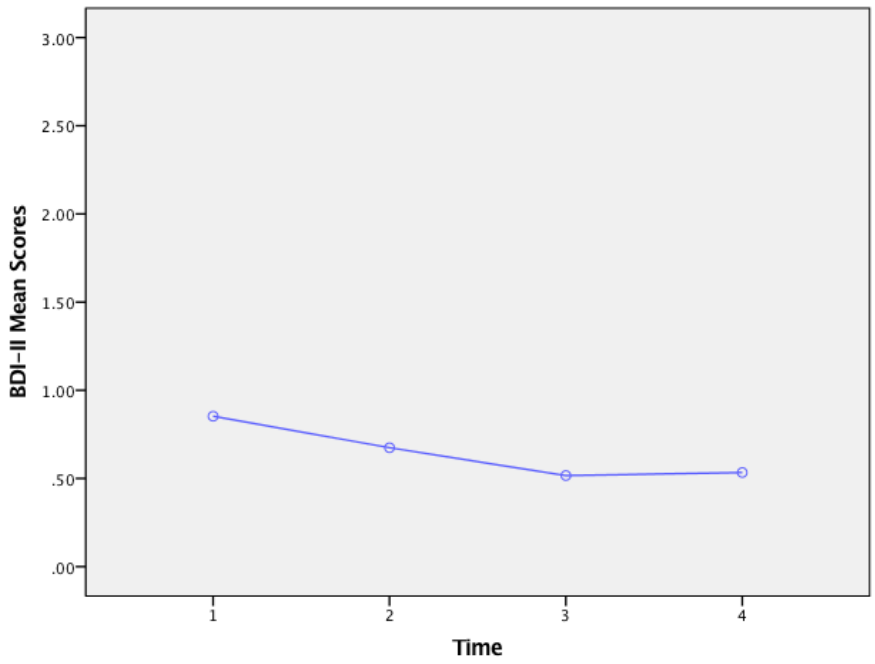


Figure 7: Mean scores for BDI-II

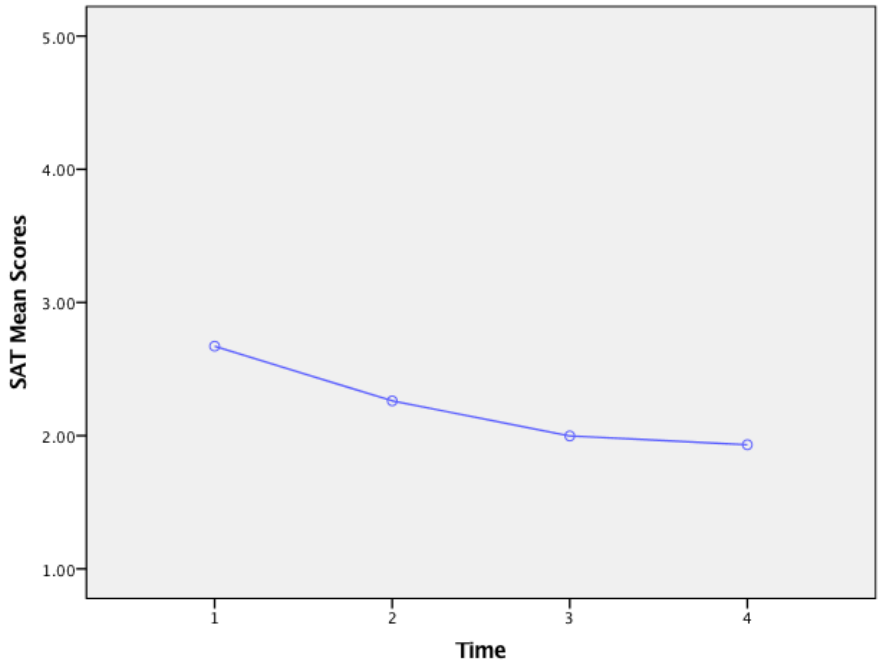


Figure 8: Mean scores for SAT

An examination of pairwise comparisons offered additional detail regarding change over time through comparison of mean scores for each time period. A significant difference was found for the four assessments (BAI, PSS, BDI-II, and SAT) when comparing pre-test mean scores to mean scores at all other time points (mid-test, final test, and post-test). Additionally, the pairwise comparisons revealed no statistically significant differences in mean scores for the assessments at final test to post-test, demonstrating no significant changes after receiving 16 sessions to four weeks after completion of receiving NF training sessions. Table 13 provides specific details about significance levels for the four assessments (BAI, PSS, BDI-II, and SAT) at each time point.

Table 13

Pairwise comparisons of the treatment group on all measures across time

Measure	(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	*p*
BAI	Pre (1)	Mid (2)	.267*	.055	< .001
		Final (3)	.378*	.058	< .001
		Follow-up (4)	.367*	.060	< .001
	Mid (2)	Pre (1)	-.267*	.055	< .001
		Final (3)	.112*	.040	.007
		Follow-up (4)	.100	.056	.077
	Final (3)	Pre (1)	-.378*	.058	< .001
		Mid (2)	-.112*	.040	.007
		Follow-up (4)	-.012	.053	.828
	Follow-up	Pre (1)	-.367*	.060	< .001
	(4)	Mid (2)	-.100	.056	.077
		Final (3)	.012	.053	.828
PSS	Pre (1)	Mid (2)	.267*	.079	.001
		Final (3)	.563*	.087	< .001
		Follow-up (4)	.447*	.112	< .001
	Mid (2)	Pre (1)	-.267*	.079	.001
		Final (3)	.296*	.068	< .001
		Follow-up (4)	.180	.100	.078
	Final (3)	Pre (1)	-.563*	.087	< .001
		Mid (2)	-.296*	.068	< .001
		Follow-up (4)	-.116	.092	.210
	Follow-up	Pre (1)	-.447*	.112	< .001
	(4)	Mid (2)	-.180	.100	.078
		Final (3)	.116	.092	.210
BDI-II	Pre (1)	Mid (2)	.178*	.045	< .001
		Final (3)	.337*	.066	< .001
		Follow-up (4)	.319*	.076	< .001
	Mid (2)	Pre (1)	-.178*	.045	< .001
		Final (3)	.158*	.054	.005
		Follow-up (4)	.141*	.063	.030
	Final (3)	Pre (1)	-.337*	.066	< .001
		Mid (2)	-.158*	.054	.005
		Follow-up (4)	-.017	.051	.738

Measure	(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	*p*
	Follow-up	Pre (1)	-.319*	.076	< .001
	(4)	Mid (2)	-.141*	.063	.030
		Final (3)	.017	.051	.738
SAT	Pre (1)	Mid (2)	.410*	.072	< .001
		Final (3)	.673*	.073	< .001
		Follow-up (4)	.740*	.088	< .001
	Mid (2)	Pre (1)	-.410*	.072	< .001
		Final (3)	.263*	.067	< .001
		Follow-up (4)	.329*	.077	< .001
	Final (3)	Pre (1)	-.673*	.073	< .001
		Mid (2)	-.263*	.067	< .001
		Follow-up (4)	.066	.071	.355
	Follow-up	Pre (1)	-.740*	.088	< .001
	(4)	Mid (2)	-.329*	.077	< .001
		Final (3)	-.066	.071	.355

The researcher also conducted a RM-MANOVA to determine if there was a significant difference in mean scores over time for the control group. No significant multivariate effect was found for control group participants over time (on combined BAI, PSS, BDI-II, and SAT scores): Wilks' $\lambda = .404$, $F_{(12, 8)} = .985$, $p = .526$; partial $\eta^2 = .60$. As Mauchly's Test of Sphericity was violated for the SAT and BDI-II, Greenhouse-Geisser was selected when reporting the univariate tests of those measures. The univariate tests revealed a significant difference in mean scores over time for the SAT ($F_{[3, 57]} = -3.565$, $p = .046$; partial $\eta^2 = .16$). However, for all the other three assessments (BAI, PSS, and BDI-II), no significant differences were found. An examination of pairwise comparisons (Table 14) for the SAT offered additional insight into marginal significance found; a significant difference was found only between scores from pre-test to follow-up, despite the control group not receiving the intervention.

Table 14

Pairwise Comparisons of the control group on SAT across time

Measure	(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	*p*
SAT	Pre (1)	Mid (2)	.171	.094	.083
		Final (3)	.281	.145	.067
		Follow-up (4)	.345*	.150	.033
	Mid (2)	Pre (1)	-.171	.094	.083
		Final (3)	.110	.093	.251
		Follow-up (4)	.174	.104	.112
	Final (3)	Pre (1)	-.281	.145	.067
		Mid (2)	-.110	.093	.251
		Follow-up (4)	.064	.071	.379
	Follow-up (4)	Pre (1)	-.345*	.150	.033
		Mid (2)	-.174	.104	.112
		Final (3)	-.064	.071	.379

Exploratory Research Question 2

The second exploratory research question examined if there was a significant difference in mean scores over time between the treatment group and control group, depending on specific demographic variables. The specific demographic variables explored were: (a) age; (b) race/ethnicity; (c) gender; (d) major; and (e) involvement in personal counseling. To create more even groups, age, race/ethnicity, and major were re-coded into two or three groups including: (a) age (two groups; 18 to 25 and 26 to 39); (b) race/ethnicity (two groups; persons of color and white/Caucasian); and (c) major (three groups; Counseling/Psychology; Science, Technology, Engineering, or Mathematics [STEM]; or Other). Due to the brain (i.e., prefrontal cortex) not being completely developed until 25 years of age (Office of Adolescent Health, 2017; Siegel, 2013), the ages were grouped into the two aforementioned categories. Involvement in personal

counseling included three groups: (a) participants have received counseling ("yes"); (b) participants have never received counseling ("no"); and (c) participants are currently receiving counseling services ("in counseling now"). Furthermore, as only one participant identified as genderqueer, their data was removed from the analysis (n = 68).

The researcher conducted a RM-MANOVA to determine if there were significant differences between the treatment and control groups, over time, depending on specific variables. The results indicated no significant differences in scores over time between the treatment and control groups and specific demographic variables including: (a) age (Wilks' $\lambda = .585$, $F_{(24, 84)} = 1.075$, $p = .389$; partial $\eta^2 = .235$); (b) race/ethnicity (Wilks' $\lambda = .521$, $F_{(24, 84)} = 1.347$, $p = .161$; partial $\eta^2 = .278$); (c) gender (Wilks' $\lambda = .553$, $F_{(24, 84)} = 1.207$ $p = .261$; partial $\eta^2 = .256$); (d) major (Wilks' $\lambda = .446$, $F_{(36, 125)} = 1.091$, $p = .353$; partial $\eta^2 = .236$); and (e) involvement in personal counseling (Wilks' $\lambda = .546$, $F_{(48, 164)} = .581$, $p = .985$; partial $\eta^2 = .140$). Thus, the results demonstrate that the demographic variables did not interact with treatment and control group participants change in scores over time.

Secondary Research Question

The researcher implemented a RM-MANOVA to determine if there were significant differences in mean cortisol scores between the treatment group and control group over time. The spring 2017 saliva samples were analyzed in a separate lab, with different equipment and by different personnel. Because of inconsistent analysis processes, which presents as a threat to internal validity, the research removed the spring 2017 sample (n = 16) from the sample prior to the statistical analysis. Additionally, incomplete data (i.e., saliva was not collected at all four time points) and saliva samples that demonstrated out of range concentration levels (levels above

3.149) were also removed from the study population, totaling in cortisol samples from 49 participants. As the cortisol scores present with a different data set, the researcher conducted assumption testing for the following areas: (a) sample size; (b) multivariate normality; (c) linearity among dependent variables; (d) homogeneity of variance; and (e) sphericity among dependent variables. As indicated, Pallant (2016) asserts that a dataset needs to include more cases than dependent variables, which is satisfied. Regarding multivariate normality, the researcher conducted a Mahalanobis distances test and found that the value (27.72) exceeded the critical value (18.46). Upon further inspection, three cases exceeded the critical value. Due to large differences in two cases compared to the critical value, the researcher removed the two cases to address the issue of outliers. Thus, the sample size reduced (N = 47; treatment group n = 29; control group n = 18) for this analysis; removal of the two cases was also less than 5% of total cases. Linearity among dependent variables was assessed through visual inspection of scatterplots, which provide information as to whether variables are related in a linear direction (Pallant, 2016). Visual inspection confirmed linearity. Homogeneity of variance was conducted through Box's M Test of equality (p = .096). Pallant (2016) asserts that significance values great than .001 do *not* violate homogeneity of variance; thus, this assumption was not violated. Finally, Mauchly's Test of Sphericity was violated for time; thus, in order to correct for this violation, the Greenhouse-Geiser was selected when examining the tests within-subjects effects and is reported below.

The RM-MANOVA revealed no significant multivariate effect among groups across time: Wilks' λ = .981, $F_{(3, 43)}$ = .277, p = .841, partial η^2 = .019. Thus, there were no significant differences between the treatment group and control group cortisol mean scores over time. The

mean scores are presented in Figure 9, with mean scores and standard deviations provided in Table 15.

Table 15

Mean and standard deviation scores for the treatment and control groups across time

Time	Group	*M*	*SD*
Pre	Treatment Group	.194	.101
	Control Group	.230	.136
Mid	Treatment Group	.266	.273
	Control Group	.255	.135
Final	Treatment Group	.208	.128
	Control Group	.236	.155
Follow Up	Treatment Group	.280	.248
	Control Group	.351	.228

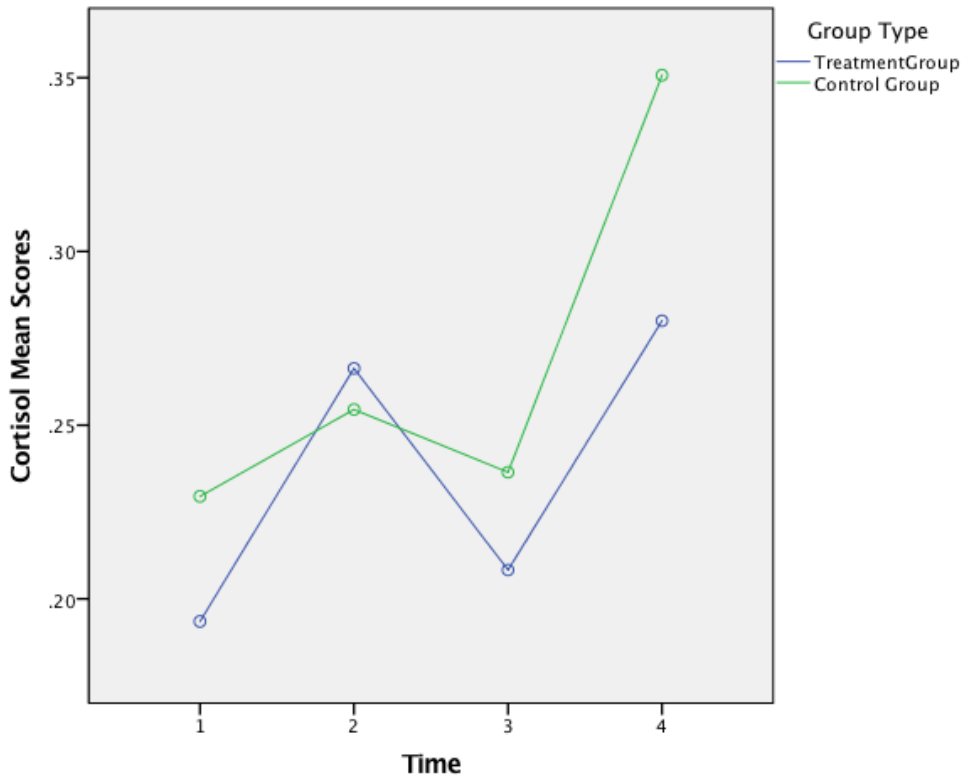


Figure 9: Mean scores for Cortisol Levels over time

Exploratory Research Question 3

The final exploratory research question sought to determine whether there was a relationship between participants' BAI, PSS, BDI-II, and SAT scores and their cortisol levels for the treatment group and control group. The researcher used a Pearson Product Moment Correlation (two-tailed) to calculate whether there was a significant relationship between participants' assessment scores (BAI, PSS, BDI-II, and SAT) and cortisol scores per time point (pre, mid, final, follow-up). All assumptions were satisfied except for normality; the researcher identified outliers in visual inspections of scatterplots and as assessed by Shapiro-Wilk's test ($p < .05$). The researcher moved forward using Pearson's Product Moment Correlation (two-tailed), which is robust to deviations from normality (Laerd Statistics, 2013). For the treatment group, no relationships were found between participants' assessment scores and their cortisol levels at each time point. For the control group, significant relationships were found only for pre-test point variables, including: (a) BAI score and cortisol level ($r = -.502$, $p = .034$); (b) PSS score and cortisol level ($r = -.744$, $p < .001$); and (c) SAT ($r = -.497$, $p = .036$), all of which demonstrate a negative relationship. Thus, a statistically significant difference was found between control group participants' mean pre-test scores for the BAI, PSS, and SAT and their mean cortisol levels significantly; that is, as control group participants BAI, PSS, and SAT pre-test scores were high (increase), cortisol levels were low (decrease). The findings demonstrate that although assessment scores of anxiety and stress were high, physiological stress (cortisol) was low.

Summary

Chapter four provided detailed results for the statistical analyses conducted. The main findings included: (a) a marginally significant difference in assessment scores over time for the treatment group as compared to the control group; (b) no significant difference for specific demographic variables between the treatment group and control group scores over time; (c) no significant difference in cortisol scores over time between the treatment group and control group; and (d) overall, no relationship between participants' assessment scores and their cortisol levels at each time point, with the exception of three assessments at pre-test for the control group only. Chapter five provides a detailed discussion of the results from the current chapter, including implications for counseling and counselor education, limitations of the current investigation, and directions for future research.

CHAPTER FIVE: DISCUSSION

Chapter Five provides an overview of the completed study. Additionally, a discussion of the results is presented, including: (a) interpretation of results; (b) comparison of results to previous research; (c) limitations of the study design; (d) implications of the findings for counselor education, counseling, and healthcare policy; and (e) areas for future research.

Overview

Anxiety disorders are the most diagnosed mental health issue in both the US (Kessler et al., 2005b) and Europe (Wittchen & Jacobi, 2005). College students are at an increased risk for stress, anxiety, and depression, which impact their overall functioning, academic success, and wellness (ACHA, 2017). Additionally, anxious college students are more likely to experience depression and suicidal ideation as compared to their non-anxious peers (Kitzrow, 2009). As anxiety and depressive symptoms can be debilitating and challenging to manage, anxious students are at an increased risk of failing to complete their education (Eisenberg et al., 2009). College students are at an increased risk for substance use, as anxious students may use in an effort to cope with feelings of anxiety, stress, and depression (Potter et al., 2016). Furthermore, college campuses struggle to meet the mental health needs of students, identifying the need for additional supports to aid in mental wellness (Hardy et al., 2011). NF training, a drug-free, non-invasive treatment process, presents as an adjunctive intervention to support college students with anxiety (e.g., Dreis et al., 2015; Hammond, 2005; Kerson et al., 2009; Moore, 2000) and depression (e.g., Cheon et al., 2015; Choi et al., 2009). Thus, NF training presents as an

innovative intervention, with minimal side effects (e.g., feeling drowsy; Zengar, 2013), that aims to treat symptoms associated with anxiety, stress, and depression within the college student population.

Study Summary

The purpose of this investigation was to identify the impact of 16 NF training sessions on college students' levels of anxiety, stress, and depression levels through both psychological assessments (i.e., paper instruments) and physiological (i.e., salivary cortisol levels) measures as compared to a control group that did not receive the NF training intervention. Additionally, the researcher investigated the relationship between participants' demographic variables and their anxiety, stress, and depression scores. Sixty-nine individuals participated in the study; all participants were assessed using the: (a) BAI (Beck et al., 1988); (b) PSS (Cohen et al., 1983); (c) BDI-II (Beck et al., 1996; and (d) SAT (Hartman, 1984) at four time points (i.e., pre-test, mid-test, final test, and follow-up). The treatment group (n = 49) received 16 NF training sessions and the control group received no intervention (n = 20). Furthermore, participants provided saliva samples at each test point, which were analyzed using Salimetrics Enzyme-Linked Immunosorbent Assay (ELISA; Salimetrics, Inc., 2017). After removing samples that were deemed invalid due to different analysis procedures and two outliers, data from 47 participants were included in the analysis.

Constructs of Interest

The study focused on theory and research related to: (a) stress (as measured by the PSS and Salimetrics ELISA); (b) anxiety (as measured by the BAI and SAT); and (c) depression (as measured by the BDI-II) as it relates to college students. The next section provides a brief overview of the three constructs on interest.

Stress

Stress is an environmental, psychological, and biological experience (Cohen & Kessler, 1997; Kopp et al., 2010) that influences individuals' abilities to adapt or cope (Lazarus & Folkman, 1984). Stress is used interchangeably with anxiety to describe emotional experiences; however, stress is a broader term that includes physical, cognitive, and emotional experiences. Conditions such as anxiety are more accurately depicted as psychological distress, which stress can often lead to or exacerbate. Lazarus and Folkman (1984) established the transactional model of stress and coping that describes the processes in which individuals experience and respond to stress; involving three main components in understanding emotion, including: "(1) relationship or transaction; (2) process; and (3) a view of emotion as an interdependent system of variables" (Lazarus & Folkman, 1984, p. 142). Overall, the three components in understanding emotion emphasize how the environment, change and attempts to cope, and connectivity to emotional experiences play a large role in the way stress is experienced.

On a physiological level, stress impacts individuals' overall functioning and the brain. In general, the autonomic nervous system (ANS) is responsible for activating two systems when dealing with stress, including: (a) the sympathetic nervous system (SNS), which is initiated

during times of actual or perceived stress and activates different physical reactions (i.e., increased heart rate) and (b) the parasympathetic nervous system (PNS), which slows physiological processes to help mitigate reactions to actual or perceived stressors, resulting in a more relaxed state (i.e., decreased heart rate; Sapolsky, 2004). Similarly, in times of crises or perceived crises, stress-hormones such as glucocorticoids (GC) and corticotropin-releasing hormone (CRH) or cortisol are released (Herman & Cullinan, 1997; Sapolsky, 2004).

When stress-hormones such as cortisol are continually released or become chronic, not only is brain functioning compromised (Herman & Cullinan, 1997; Jacobson & Sapolsky, 1991; Vyas et al., 2002), individuals are also at an increased risk for developing other mental health concerns including anxiety (Popoli et al., 2012) and depression (Goto, Yang, & Otani, 2010; Sapolsky, 2004). Furthermore, college students are at an increased risk of stress due to novel experiences such as: (a) navigating new social and environmental situations (Campbell et al., 2016); (b) adjusting to increase in responsibilities (Dyson & Renk, 2006); and (c) financial concerns due to student loans and new expenses (Andrews & Wilding, 2004). Sladek and colleagues (2016) also found that college students who reported increased perceptions of stress were more likely to have higher levels of cortisol.

Anxiety

Anxiety disorders are prevalent in the US (Kessler et al., 2005b). Furthermore, anxiety is on a continuum, ranging from mild anxious symptoms (i.e., feeling fearful) to official anxiety disorder diagnoses (i.e., Generalized Anxiety Disorder) that results in substantial impairment in functioning. Anxiety is experienced on three common levels, including: (a) physical expressions (i.e., rapid heart rate); (b) cognitive expressions (i.e., rapid thoughts; memory impairment); and

(c) emotional expressions (i.e., feeling nervous or worried; APA 2013). On a brain-based level, anxiety is processed in similar brain regions such as the amygdala (responsible for activating stress responses such as increased heart rate) and prefrontal cortex (responsible for rational thought processes). College students are also susceptible to anxiety symptoms and experiences. For example, students (24.9%) report that anxiety is the second most impactful concern for academic success in college, with stress being the number one concern (ACHA, 2017). Additionally, college students were found to have increased ratings and experiences of anxiety as compared to the general population (Schroder et al., 2015). The prevalence and impact of anxiety within the college student population has significant implications as almost 75% of lifetime mental health diagnoses are first experienced by age 24, with early interventions and treatment needed to result in more positive mental health outcomes (Kessler et al., 2005a).

Depression

Behind anxiety, depressive disorders are the second most prevalent mental health concern in the US (Kessler et al., 2005b). Similar to anxiety, depression is experiences on physical (feeling tired), cognitive (difficulty concentrating), and emotional (sadness) levels (APA, 2013). Beck (1976) is cited as one of the main theorists for conceptualizing depression, with the Negative Cognitive Triad serving as a theory to understand depression through beliefs related to: (a) the self; (b) the world; and (c) others. That is, negative beliefs associated with these three levels can create and maintain depression (Beck, 1976). Specific brain regions that play a role in depression include: (a) the prefrontal cortex, managing thought processes and (b) the anterior cingulate cortex (ACC), responsible for becoming activated when processing more negative emotions (Sapolsky, 2004). Depression is cited as the fourth most concern that impacts academic

success of college students (ACHA, 2017). Additionally, college students struggling with depression have experienced negative impacts in overall functioning and academic success, including: (a) difficulties in attending class; (b) decreased GPA; (c) increased likelihood of dropping out (Eisenberg et al., 2009); and (d) heightened levels of experiencing and acting upon suicidal thoughts (Kitzrow, 2009). The increased experiences of suicidal ideation among college students is a great concern as the WHO (2017) cites suicide as the second highest cause of death for individuals aged 15 to 29. Overall, college students present with heightened levels of anxiety, stress, and depression that impact their overall functioning and academic success, with barriers of stigma and lack of resources preventing students from receiving treatment. The current investigation sought to determine if NF training could serve as a viable intervention to treat college students' increased anxious, stress, and depressive symptoms.

Participants

Participants included college students, 18 years of age or older, attending a college or university in a Southeastern state. Interested participants were prompted to reach out to the researcher to complete a screening call; a total of 143 contacted the researcher via email, text message, or telephone call. However, 54 participants did not participate due to: (a) schedule conflicts; (b) ineligibility; or (c) withdrawing/not attending their initial session. A total of 89 participants began the study, with 20 dropping out due to: (a) schedule conflicts; (b) personal and familial issues; (c) eventual disinterest; or (d) unstated reasons (i.e., discontinued sessions without information researcher). Forty-nine participants were in the treatment group, thus completing 16 NF training sessions and all assessments and saliva samples at the four time

points (with the exception of participants from the spring 2017 semester [*n* = 16] who only provided saliva samples and pre-test and final test). Twenty participants participated in the control group and completed all assessments and saliva samples at the four time points.

Data Collection

The researcher secured permission from the Institutional Review Board (IRB) prior to beginning the study. Data collection occurred during the spring 2017, summer 2017, and fall 2017 semesters. Participants in the treatment group received a total of 16 sessions, with sessions occurring biweekly; however, for some participants, the number of sessions per week differed due to unforeseen issues (e.g., participant sickness; conflicts in scheduling). All participants completed the four assessments (i.e., BAI, PSS, BDI-II, and SAT) at four time points during each semester, including: (a) initial session (before receiving the first NF training session); (b) midpoint session (at the beginning of their eighth session); (c) final session (at the beginning of their 16th session); and (d) follow up session. All assessments were completed prior to receiving NF training to mitigate any influence of NF training on their selected responses. Participants in the control group (fall 2017 semester) only completed the assessments and provided saliva samples; the control group participants also followed the same time schedule as the treatment groups. During the first semester of the study (spring 2017), saliva samples were only collected at pre (initial session) and final (at session 16) time periods; participants from the subsequent semesters (summer 2017 and fall 2017) provided saliva samples at all four time points. All participants received a $5.00 gift card at after their first, eighth, and follow-up sessions, for a total of $15.00.

Discussion

Demographic Data

A total of 69 college students completed this study, with 49 participants receiving the NF training treatment and 20 participants being placed in the waitlist control group. Incorporating a control group can help establish validity in order to help researchers attribute identified outcomes to the intervention itself (Shadish et al., 2002). However, several studies examining the influence of NF training on anxiety lack the use of control groups (e.g., Cheon et al., 2015; Dreis et al., 2015; Kerson et al., 2009; Thomas & Sattlberger, 1997; Vanathy et al., 1998), demonstrating a strength to the research design of the current investigation.

Additionally, sample sizes for studies investigating the influence of NF training on anxiety have varied, including sample sizes ranging from one (Gomes, Ducos, Akiba, & Dias, 2016) to 77 (Cheon et al., 2015). Although the current investigation began with 89 participants, attrition is a common experience in research, especially studies that occur over longer periods of time (Gall et al., 2007). For example, the time commitment required for the current study (12 weeks) as well as changing schedules of college students presented as a challenge in retaining all participants. However, the time period selected was necessary to ensure the desired number of NF training sessions (16 total sessions) did not fall outside of the semester as students often are away from campus in between semesters.

The age of participants from the current study ranged from 18 to 39 years (M = 22.36, SD = 5.34), with 46 participants identifying as female (66.7%), 22 identifying as male (31.9%), and one identifying as genderqueer (1.4%). The Fall 2016 ACHA-NCHA reported similar findings for gender (female 67.1%; male 30.4%; non-binary 2.5%). Over half of the participants

identified as Caucasian (n = 38, 55.1%), with Black/African American students making up the second largest group (n = 9, 13.0%). The identified racial background of participants from the current study is also similar to the ACHA (2017) findings (white/Caucasian, 68.2%; Black/African American 6.9%). Furthermore, the racial background of the current participants aligns with percentages of White/Caucasian (49.2%) and Black/African American (11.1%) students from the main university of recruitment as well as the city in which the study took place 61.0%; United States Census Bureau, 2016). The inclusion of a representative percentage of Black/African American participants is beneficial, especially as Black/African American individuals are less likely to participate in research due to traumatic, exploitative, historical research practices such as the Tuskegee Syphilis Study (Gamble, 1997). Thus, the participants who identified as white/Caucasian and Black/African American for the current investigation is congruent with locations from which they were sampled and may help in reporting generalizability of results for those populations. However, the percentage of Hispanic/Latino and Asian participants are smaller than the percentage of Hispanic/Latino and Asian students from the large university. The university had dissimilar classifications of ethnicity/race as compared to the current investigation; thus, the researcher could not compare percentages of Biracial/Bicultural, Native American, and Other to the university. Nonetheless, as individuals from minority backgrounds are often less likely to participate in research, the current investigation provides value to the literature with the inclusion of a more diverse background of participants.

For the current investigation, the mean age (M = 22.36) of college students is similar to investigations implementing NF training for college students. For example: (a) Harris (2017)

reported a mean age of 22.6; (b) Fritson, Wadkins, Gerdes, and Hof (2007) reported a mean age of 21.3; and (c) Buckelew and colleagues (2013) reported a mean age of 21.85.

For the current investigation, 46 participants identified as female (66.7%), 22 identified as male (31.9%), and one identified as genderqueer (1.4%). The ACHA (2017) reported similar findings for gender (female 67.1%; male 30.4%; non-binary 2.5%). The university from which the majority of participants were recruited also reported more female (54.9%) than male (45.1%) students. Although the ratio of female to male students is slightly higher for the current study compared to the university, female students are more likely to seek out services for presenting concerns such as anxiety (ACHA, 2017).

Psychology/Counseling (*n* = 31; 44.9%) and STEM (*n* = 30, 43.5%) majors were the most reported among the participant population. The percentage of psychology/counseling college students is smaller than percentages from other studies exploring constructs such as stress and anxiety within the college student population. For example: (a) Lovibond and Lovidbond (1995) recruited 717 psychology undergraduate students; (b) Campbell and colleagues (2016) recruited 532 undergraduate students; and (c) Coles and colleagues (2015) recruited 284 undergraduate students. Recruitment from psychology courses may be due to ease of access for researchers interested in exploring specific psychological-based constructs (i.e., anxiety, stress, depression); however, in order to better generalize results, studies would benefit from including students seeking other college majors. Finally, the ACHA (2017) reported that approximately 19.1% of college students sought mental health services for anxiety over a 12-month period, which is similar to the percentage of college students from the current study (23.2% indicated receiving current counseling services).

Instrument Descriptive Statistics

BAI

The BAI (Beck et al., 1988) is a 21-item assessment that uses a four-point Likert scale (i.e., "never;" "mildly – but it didn't bother me much;" "moderately – it wasn't pleasant at times;" and "severely – it bothered me a lot") to measure anxiety, especially as it relates to physical symptoms of anxiety (e.g., sweating, heart racing, etc.). Higher BAI total scores correspond to higher anxiety levels. The BAI also categorizes levels of anxiety, depending on score, and ranges from: (a) "minimal" anxiety (0 to 0.33 for average scores); (b) "mild" anxiety (0.38 to 0.71 for average scores); (c) "moderate" anxiety (0.76 to 1.19 for average scores); and (d) "severe" anxiety (1.23 to 3 for average scores). Table 16 provides the descriptive statistics for the treatment and control groups. In considering the anxiety ranges (from "minimal" to "severe") of the BAI for the study population, the treatment group (M = .92) and control group (M = 1.04) both met criteria for "moderate" anxiety at pre-test. Additionally, for the treatment group, at mid-test (M = .66), final-test (M = .54), and follow up (M = .56), the treatment group met criteria for "mild" anxiety, demonstrating an overall decrease in mean score. However, the control group remained within the "moderate" anxiety range at all other time points (mid-test, M =.92; final-test, M = .88; and follow up, M = .90). As the participants provided their self-identified levels of anxiety for eligibility to participate in the investigation, participants' scores at pre-test that met the criteria for "moderate" anxiety demonstrate an appropriate fit for the study. Thus, although recruitment of anxious participants was based on self-identification, the study population met criteria for "moderate anxiety" per the BAI.

Table 16

Descriptive statistics for the BAI

Instrument	Descriptive Statistics	*M*	*SD*	*Mdn*	Mode	Range	Min.	Max.
	Treatment Group (*n* = 49)							
	Pretest	.92	.51	.81	.81	2.19	.10	2.29
	Midpoint	.66	.44	.52	.38	1.71	.05	1.76
	Final	.54	.40	.48	.48	1.95	.00	1.95
BAI	Follow-up	.56	.47	.43	.10	2.33	.00	2.33
	Control Group (*n* = 20)							
	Pretest	1.04	.57	.88	.38	2.00	.00	2.00
	Midpoint	.92	.40	.81	.76	1.62	.19	1.81
	Final	.88	.41	.93	.48	1.33	.29	1.62
	Follow-up	.90	.47	.86	.29	1.62	.14	1.76

The current study revealed high Cronbach's alpha scores at all assessment points for the total group: (a) pre-test (α = 0.90); (b) mid-test (α = 0.89); (c) final test (α = 0.88); and (d) follow-up (α = 0.92). Internal consistency reliability for the treatment group demonstrated high scores at all assessment points: (a) pre-test (α = 0.90); (b) mid-test (α = 0.90); (c) final test (α = 0.88); and (d) follow-up (α = 0.92). Likewise, the control group reported high internal consistency reliability: (a) pre-test (α = 0.92); (b) mid-test (α = 0.86); (c) final test (α = 0.85); and (d) follow-up (α = 0.89). Internal consistency reliability scores are also similar in previous studies with college students, including: (a) Beck and colleagues (1988), α = 0.92 and (b) Osman and colleagues (1997), α = 0.90. Overall, the reliability coefficients reported for the current study show consistency in responses from the total group of participants, the treatment group participants, and control group participants, as compared to previous studies.

The current study reported higher BAI scores for college student participants compared to other studies. For example, Osman and colleagues (1997) and Lovibond and Lovibond (1995) reported lower mean scores for college student participants (*M* = .64 and *M* = .44, respectively).

However, the current investigation sought out participants with anxiety whereas the aforementioned studies did not. Recruiting participants with self-identified anxiety may have contributed to the higher scores of participants from the current study. Additionally, the treatment group reported a similar mean score as Osman and colleagues' (1997) study at midpoint (M = .66), after participants received seven sessions; however, the control group demonstrated higher mean scores on the BAI at all test points. The higher mean score for the control group at all test points could also be contributed to recruitment of college students with self-identified anxiety whereas the decrease in the treatment group scores at midpoint (compared to Osman and colleagues' [1997] study) could be attributed to the NF training intervention.

SAT

The SAT (Hartman, 1984) is a 21-item assessment that uses a five-point Likert scale ("never;" "rarely;" "sometimes;" "often;" and "always") to measure anxiety-based cognitions related to social contexts. Higher SAT scores correspond to higher socially-based anxiety thoughts (average scores from 1 to 5); however, the SAT does not include ranges or categories of scores. Table 17 provides descriptive statistics of the SAT for the current population. During its development, item responses of the SAT demonstrated high internal consistency (α = .95; Hartman, 1984). Cronbach's alpha scores for the current study population were similar and demonstrated high internal consistency at all data collection points: (a) pre-test, α = .92; (b) mid-test, α = .92; (c) final test, α = .94; and (d) follow-up, α = .95. Additionally, the treatment group ([a] pre-test, α = .92; [b] mid-test, α = .92; [c] final test, α = .94; and [d], follow-up α = .95) and control group ([a] pre-test, α = .93; [b] mid-test, α = .92; [c] final test, α = .92; and [d] follow-up, α = .94) had comparable internal consistency reliability scores at all four data collection points.

Hartman's (1984) sample of college students scored lower (*M* = 2.01) than the current population at pre-test (*M* = 2.67). The current investigation recruited college students with self-identified levels of anxiety whereas the aforementioned investigation recruited college students in general, which may have contributed to higher levels of the current population. However, the mean score (*M* = 2.00) of the treatment group at the final test point is almost identical to the sample population of Hartman's (1984) study, demonstrating a change in score over time. The decrease of the treatment group participants' scores over time may be attributed to the NF training intervention, decreasing their scores to be more comparable to a general population of college students.

Table 17

Descriptive statistics for the SAT

Instrument	Descriptive Statistics	*M*	*SD*	*Mdn*	Mode	Range	Min.	Max.
	Treatment Group (*n* = 49)							
	Pretest	2.67	.74	2.62	2.29	3.10	1.29	4.38
	Midpoint	2.26	.72	2.14	1.76	3.10	1.14	4.24
	Final	2.00	.71	1.86	1.90	2.95	1.00	3.95
SAT	Follow-up	1.93	.75	1.71	1.62	3.48	1.00	4.48
	Control Group (*n* = 20)							
	Pretest	2.77	.80	2.83	3.62	3.00	1.10	4.10
	Midpoint	2.60	.69	2.64	2.62	2.57	1.19	3.76
	Final	2.49	.72	2.43	2.43	2.43	1.10	3.52
	Follow-up	2.42	.77	2.29	1.14	2.71	1.14	3.86

BDI-II

The BDI-II (Beck et al., 1996) is a 21-item instrument that uses a four-point Likert scale to assess for symptoms congruent with DSM-IV (APA, 1994) depressive disorders. The response options vary per question; for example, when assessing for irritability, response options include:

(a) “0 - I am no more irritable than usual;” (b) “1 – I am more irritable than usual;” (c) “2 – I am much more irritable than usual;” and (d) “3 – I am irritable all the time.” Higher BDI-II total scores correspond to higher depression levels. The BDI-II also categorizes levels of depression, depending on score, and ranges from: (a) “minimal” depression (0 to 0.62 for mean scores); (b) “mild” depression (0.67 to 0.90 for mean scores); (c) “moderate” depression (0.95 to 1.33 for mean scores); and (d) “severe” depression (1.38 to 3 for mean scores). Table 18 provides the descriptive statistics for the treatment and control groups. In considering the depression ranges (from “minimal” to “severe”) of the BDI-II for the study population, the treatment group (M = .85) and control group (M = .74) both met criteria for “mild” depression at pre-test. Additionally, for the treatment group, at mid-test (M = .67), final-test (M = .52), and post-test (M = .53), the treatment group met criteria for “minimal” depression, demonstrating an overall decrease in mean score. However, the control group remained within the “mild” depression range at all other time points (mid-test M =.77, final-test M = .82, and post-test M = .81). Thus, as the treatment group received the NF training intervention and the control group did not, a decrease in overall mean BDI-II scores may be attributed to the NF training intervention.

Table 18

Descriptive statistics for the BDI-II

Instrument	Descriptive Statistics	*M*	*SD*	*Mdn*	Mode	Range	Min.	Max.
	Treatment Group (*n* = 49)							
	Pretest	.85	.55	.76	.62	2.48	.05	2.52
	Midpoint	.67	.50	.57	.24	1.95	.05	2.00
	Final	.52	.49	.38	.05	2.62	.00	2.62
BDI-II	Follow-up	.53	.53	.38	.14	2.33	.00	2.33
	Control Group (*n* = 20)							
	Pretest	.74	.38	.81	.81	1.33	.05	1.38
	Midpoint	.77	.39	.86	.10	1.38	.10	1.48
	Final	.82	.55	.71	.67	2.00	.05	2.05
	Follow-up	.81	.51	.79	.24	1.76	.10	1.86

Furthermore, the BDI-II reveals high internal consistency (α = 0.92; Beck et al., 1996). Regarding the current study, high internal consistency reliability was also demonstrated at all data collection points, including: (a) pre-test, α = .91; (b) mid-test, α = .91; (c) final test, α = .94; and (d) follow-up, α = .95. Comparable Cronbach's alpha scores were found for both groups (treatment group: (a) pre-test, α = .92; (b) mid-test, α = .92; (c) final test, α = .94; and (d) follow-up, α = .95. Additionally, the control group demonstrated high internal consistency reliability: (a) pre-test, α =.84; (b) mid-test, α = .87; (c) final test, α = .94; and (d) follow-up, α = .93). Additionally, a similar Cronbach's alpha score was reported for a group of college students who also completed the BDI-II (α = 0.90; Storch et al., 2004). Storch and colleagues (2004) administered the BDI-II to a sample of undergraduate students with similar demographics as the current population; their total score was lower (*M* = .53) compared to the current study (*M* = .82). BDI-II scores decreased over time for the current study's treatment group, with the final test (*M* = .52) and follow-up test (*M* = .53), congruent with the mean score from Storch and colleagues (2004). The similarity between the mean score for the treatment group at final and

follow-up time points as compared to Storch and colleagues' (2004) study demonstrates that the treatment group was more comparable to a general population of college students after receiving 16 sessions of NF training.

PSS

The PSS (Cohen et al., 1983) is a 10-item assessment that assesses the self-perception of stress on a five-point Likert scale ("never;" "almost never;" "sometimes;" "fairly often;" and "very often"). The PSS is not a diagnostic tool; thus, cutoff or grouping scores were not included in its development (Kopp et al., 2010). The higher the PSS score corresponds to increased experiences of perceived stress; table 19 provides the descriptive statistics for the treatment and control groups. The PSS demonstrates high internal consistency with two samples of college students ($\alpha = .84$ to $\alpha = .86$). For the current investigation, Cronbach's alpha scores were similar and ranged from acceptable to high, including: (a) pre-test, $\alpha = .78$; (b) mid-test, $\alpha = .86$; (c) final test, $\alpha = .90$; and (d) follow-up, $\alpha = .91$. The reliability coefficients for each individual group were also similar, including: the treatment group at (a) pre-test, $\alpha = .75$; (b) mid-test, $\alpha = .86$; (c) final test, $\alpha = .89$; and (d) follow-up, $\alpha = .92$) and control group at: (a) pre-test, $\alpha = .81$; (b) mid-test, $\alpha = .88$; (c) final test, $\alpha = .91$; and (d) follow-up, $\alpha = .85$. Roberti and colleagues (2006) reported lower PSS scores for female ($M = 1.84$) and male ($M = 1.74$) college students compared to the current investigation (pre-test, $M = 2.21$). However, the treatment group reported comparable mean scores at final ($M = 1.68$) and follow-up ($M = 1.80$) assessment points. Thus, the treatment group reporting similar mean PSS scores at final and follow-up as compared to Roberti and colleagues' (2004) findings demonstrate a change over time, which may be attributed to the NF training intervention.

Table 19

Descriptive statistics for the PSS

Instrument	Descriptive Statistics	*M*	*SD*	*Mdn*	Mode	Range	Min.	Max.
	Treatment Group (*n* = 49)							
	Pretest	2.25	.55	2.30	1.70	2.30	1.00	3.30
	Midpoint	1.98	.63	1.90	1.70	2.20	.90	3.10
	Final	1.68	.70	1.60	1.20	2.90	.40	3.30
PSS	Follow-up	1.80	.82	1.70	1.40	3.20	.20	3.40
	Control Group (*n* = 20)							
	Pretest	2.11	.53	2.10	1.80	2.20	.60	2.80
	Midpoint	2.15	.65	2.30	1.70	2.60	.60	3.20
	Final	2.22	.72	2.15	1.80	3.00	.50	3.50
	Follow-up	2.10	.60	2.25	1.70	2.20	.70	2.90

Salimetrics ELISA

As individuals release cortisol during times of stress (Sapolsky, 2004), Salimetrics ELISA testing was utilized to determine the quantitative levels of participants' salivary cortisol (Salimetrics, Inc., 2017). Samples were assayed in duplicate using the Salimetrics High Sensitivity Cortisol Assay Kit, without modifications to the manufacturers' protocol. The researcher included samples from 47 participants (treatment group = 29; control group = 18) for analysis; 22 participants were removed from the statistical analysis due to: (a) incomplete data (i.e., missing at least one time point); (b) saliva samples being analyzed in a different lab; (c) high concentration levels (3.149 or higher); and (d) extreme outliers.

Aardal and Holm (1995) established reference ranges for morning (8:00am) and evening (10:00pm) salivary cortisol levels for adult females and males, among individuals 21 to 50 years of age. Although the range of mean cortisol levels of the current investigation are within the established reference ranges from Aardal and Holm's (1995) study, the cortisol levels from the current investigation do not account for time of day or gender, making it challenging to compare

levels and identified ranges. Limitations of the cortisol levels are further explored in the limitation section presented later in this chapter.

Research Questions

Primary Research Question

The purpose of the current investigation was to determine whether college students who received 16 sessions of NF training would report significant decreases in: (a) anxiety (as measured by the BAI and SAT); (b) depression (as measured by the BDI-II); and (c) stress (as measured by the PSS and salivary cortisol levels) over time as compared to a control group. The primary statistical procedure selected was the RM-MANOVA and has benefits, including: (a) helping to adjust the risk of Type I error and (b) determining if mean scores between groups (treatment and control group) on merged dependent variables scores are due to chance or the NF training intervention (Pallant, 2016). Thus, the researcher utilized a RM-MANOVA to determine if there were significant differences in mean scores between the treatment group and control group over time. As indicated, a marginally significant multivariate effect was found across the within-subjects interaction between time and group: Wilks' $\lambda = .708$, $F_{(4, 64)} = 1.92$, $p = .051$; partial $\eta^2 = .292$, indicating marginal significant difference between the scores of groups over time. In addition, the observed power to detect changes in the scores within this analysis was high (.85), demonstrating that there was a high likelihood that the RM-MANOVA analysis found statistical significance for differences that actually exist. Additionally, the large effect size indicates practical significance of the intervention; that is, approximately 29% of the difference in scores between groups is due group placement (i.e., treatment group versus control group).

Therefore, the results identified strong practical significance for the impact of NF training on the participants' combined anxiety, depression, and stress scores.

Furthermore, the univariate between-group analysis results demonstrated statistically significant differences between the treatment and control groups on three of the measures, with the treatment group reporting significant decreases in scores for the: (a) PSS ($F_{(3, 201)} = 6.836$, $p < .001$; partial $\eta^2 = .093$); (b) BDI-II ($F_{(3, 201)} = 6.563$, $p = .001$; partial $\eta^2 = .089$); and (c) SAT ($F_{(3, 201)} = 3.641$, $p = .019$; partial $\eta^2 = .052$). Thus, as compared to the control group, participants in the treatment group significantly decreased on their PSS, BDI-II, and SAT scores over time. However, there were no significant differences identified in scores between the treatment and control groups for the BAI ($F_{(3, 201)} = 1.822$, $p = .153$; partial $\eta^2 = .026$). In addition, the observed power to detect these changes in the participants' scores ranged from moderate for the SAT (.74) to high for the BDI-II (.93) and PSS (.96); thus, the likelihood that the RM-MANOVA would identify statistical significance for existing differences between groups ranged from moderate to high. The univariate between-group analysis revealed a range of effect sizes per instrument, with a small effect size found for the SAT (partial $\eta^2 = .052$) and moderate effect sizes for the PSS (partial $\eta^2 = .093$) and BDI-II (partial $\eta^2 = .089$). Therefore, practical significance of the intervention ranged from small to moderate the treatment groups' SAT, PSS, and BDI-II scores, respectively.

Studies of and theory surrounding NF training purport that the treatment helps to improve symptoms associated with anxiety, depression, and stress (Hammond, 2011). Additionally, the current findings were similar to previous research that utilized control groups. For example, Walker (2009) provided qEEG NF training to participants diagnosed with PTSD, in an effort to treat anxiety-related symptoms. Participants in the treatment group reported decreases across

time whereas control group participants did not report improvements; however, no statistical procedures were used to determine amount of change. Similarly, the current study reported significant decreases in anxiety in the treatment group as compared to the control group, over time. However, diagnostic features of the participants from the current investigation were not recruited for anxiety symptomology related to PTSD, differing from Walker's (2009) investigation.

Vanathy and colleagues (1998) employed a between-group design, with two treatment groups (received either alpha NF training or theta NF training) and a waitlist control group for participants who met criteria for GAD. Compared to the control group, both treatment groups reported a significant decrease in observer-rated anxiety ($p < .01$) and self-reported anxiety ($p < .01$). Quality of life was only significant for one of the treatment groups ($p < .05$). Furthermore, the control group demonstrated an increase in anxiety ($p < .01$) from pre-test to post-test (Vanathy et al., 1998). Agnihotri, Paul, and Sandhu (2007) also implemented a between group design for participants diagnosed with GAD, with two treatment groups and one control group. Both treatment groups demonstrated a significant reduction in scores on the STAI-S and STAI-T, with no significant change in scores for the control group. Although the current investigation implemented different assessments for anxiety (i.e., BAI and SAT), the current findings are similar regarding a significant decrease in anxiety over time (SAT) as compared to the control group. Thus, the current investigation adds to the research literature regarding improvement in anxiety as measured by the SAT for college students who received NF training compared to college students who did not receive NF training.

Additionally, Choi and colleagues (2011) findings are comparable to the current investigation in that participants in the treatment group significantly improved in BDI-II scores

over time as compared to the control group. Overall, the results of the current study and similar investigations (e.g., Agnihotri et al., 2007; Choi et al., 2011; Vanathy et al., 1998; Walker, 2009) offer support for the effectiveness of NF training to treat participants' levels of anxiety, stress, and depression.

Moreover, when looking at the univariate results, the current investigation reported no significant differences between the treatment and control group on the change of BAI scores over time. The lack of significance presents as incongruent to other studies that used anxiety instruments. As the BAI includes many items that are related to the physiological aspects of anxiety (e.g., "Numbness or tingling;" "Wobbliness in legs;" "Hands trembling;" "Face flushed;" "Hot/Cold Sweats;" Beck et al., 1988), some participants may lack self-awareness related to the physical implications of their anxiety or may experience anxiety on more cognitive (i.e., racing thoughts) and/or emotional (i.e., feeling nervous) levels. Therefore, the potential lack of awareness regarding physiological experiences of anxiety may have contributed to the BAI results.

Exploratory Research Question 1

The first exploratory research question sought to gain more understanding into the influence of 16 sessions of NF training for the treatment group; that is, to understand if there is a significant change in scores on the four assessments over time (pre-test, mid-test, final test, and follow-up). A RM-MANOVA identified a significant multivariate effect for treatment group participants over time (on combined BAI, PSS, BDI-II, and SAT scores): Wilks' $\lambda = .290$, $F_{(12, 37)} = 7.534$, $p < .001$; partial $\eta^2 = .71$. Additionally, the univariate tests identified a significant difference in mean scores over time on the four data collection instruments: (a) BAI ($F_{(3, 144)} =$

21.24, $p < .001$; partial $\eta^2 = .31$); (b) PSS ($F_{(3, 144)} = 14.66$, $p < .001$; partial $\eta^2 = .23$); (c) SAT ($F_{(3, 144)} = 40.61$, $p < .001$; partial $\eta^2 = .46$); and (d) BDI-II ($F_{(3, 144)} = 13.547$, $p < .001$; partial $\eta^2 = .22$). Observed power to detect these changes in the participants' score was high at .99 to 1.00. The results identified that the treatment group participants' scores significantly improved over time when receiving NF training. In addition, the identified effect sizes for the results were high, supporting strong practical significance of the NF training intervention: (a) anxiety (BAI partial $\eta^2 = .31$; SAT partial $\eta^2 = .46$), (b) depression (BDI-II partial $\eta^2 = .22$.), and (c) stress (PSS partial $\eta^2 = .23$; Cohen, 1988). Thus, a statistically significant decrease in BAI, SAT, BDI-II, and PSS scores over time, high observed power, and large effect sizes provide support for the use of NF training to treat symptoms associated with anxiety, stress, and depression in the college student population.

The researcher also reviewed the pairwise comparisons to provide more insight to reports of change. For the four data collection assessments, significant differences in scores were found for pre-test points as compared to all other time points; for the BAI, SAT, BDI-II, significance levels at $p < .001$ were found when comparing pre-test to mid-test, final test, and follow-up. For the PSS, significance levels were $p = .001$ when comparing change from pre-test to mid-test and $p < .001$ when comparing change from pre-test to final test and follow-up. When comparing mid-test scores to final and follow-up test scores, (a) the BAI revealed significance ($p = .007$) from mid to final test, but no significance from mid to follow-up ($p = .077$); (b) PSS revealed significance ($p < .001$) from mid to final test, but was not significant ($p = .078$) from mid to follow-up; (c) BDI-II demonstrated significance ($p = .005$) from mid to final test and from mid to follow-up ($p = .030$); and (d) the SAT demonstrated significance ($p < .001$) from mid to final and from mid to follow up ($p < .001$). For the four data collection assessments, no statistically

significant differences in scores were identified when comparing final test scores to post-test scores. Thus, these findings indicate that no statistical change in scores was found four weeks treatment group participants received their final NF training session. The changes in mean scores for all assessments are found in Figures 5 to 8.

Improvement in assessment scores of the current investigation were consistent with similar studies assessing for treatment group participants' anxiety, stress, and depression. Specifically, Harris (2017) conducted a similar study in which college students diagnosed with ADHD (n = 11) received 16 sessions of NeurOptimal NF training; although the study was specific to college students diagnosed with ADHD, the BDI-II and BAI were included as anxiety and depression can be common experiences and symptoms associated with ADHD (Buchanan, 2011). Using a Friedman ANOVA to investigate any change in scores, the study revealed that participant scores significantly decreased over time for the BDI-II ($X^2_{(3)} = 13.165$, $p = .004$) and BAI ($X^2_{(3)} = 10.078$, $p = .018$). In assessing change in BDI-II scores over time, Harris (2017) reported change in participants scores from pre-test to mid-test and mid-test to final-test, with a small increase in scores from final-test to post-test. These findings are congruent with the current study at all data collection points for the treatment group participants. Additionally, Harris (2017) noted a parallel process for the BAI in changes across time points (improvement from pre-test to mid-test and mid-test to final-test, with slight increase in scores from final test to follow-up). The same experience occurred for the current investigation on the BAI, demonstrating that participants' scores do not significantly improve four weeks after ending NF training sessions. The lack of significant change from final test to follow-up may indicate that the NF training resulted in a reduction of anxiety; however, once the NF training intervention is removed, change in anxiety may not occur.

The first exploratory research question also sought to determine if there was a significant difference in mean scores over time for the control group. A RM-MANOVA revealed no statistically significant multivariate effect for control group participants over time: Wilks' λ = .404, $F_{(12, 8)}$ = .985, p = .526; partial η^2 = .60. The univariate tests revealed a statistically significant difference in mean scores over time for the SAT: $F_{[3, 57]}$ = -3.565, p = .046; partial η^2 = .16. No significant differences were found for the BAI, PSS, and BDI-II assessments. An examination of pairwise comparisons revealed a significant difference between scores from pre-test to follow-up for the control group, with no significance when comparing all other time points. As the SAT assesses for cognition-based anxiety within social contexts, participants in the control group may have experienced reported improvement in scores due to adjusting to social experiences within the college setting. That is, participants may have become better adjusted to exposure of more social contexts (i.e., attending classes with many students; navigating campus groups; making new friends), influencing their socially-anxious thoughts (Campbell et al., 2016).

Exploratory Research Question 2

The second exploratory research question sought to determine whether there were significant differences between the treatment groups and control groups, over time, depending on demographic variables of: (a) age; (b) race/ethnicity; (c) gender; (d) major; and (e) involvement in personal counseling. The researcher conducted a RM-MANOVA and found no significant difference between the two groups over time for all demographic variables: (a) age (Wilks' λ = .585, $F_{(24, 84)}$ = 1.075, p = .389; partial η^2 = .235); (b) race/ethnicity (Wilks' λ = .521, $F_{(24, 84)}$ = 1.347, p = .161; partial η^2 = .278); (c) gender (Wilks' λ = .553, $F_{(24, 84)}$ = 1.207, p = .261; partial

η^2 = .256); (d) major (Wilks' λ = .446, $F_{(36, 125)}$ = 1.091, p = .353; partial η^2 = .236); and (e) involvement in personal counseling (Wilks' λ = .546, $F_{(48, 164)}$ = .581, p = .985; partial η^2 = .140). The results indicated that the demographic variables did not impact change in scores over time between the treatment and control groups; thus the demographic characteristics assessed did not influence whether participants' scores changed across time. As demographic variables did not influence participants' scores, NF training could be administered to populations with a variety of presenting demographics, such as different races/ethnicities and age groups. NF training then presents as an intervention to meet the needs of multiple populations.

Secondary Research Question

The secondary research question utilized a RM-MANOVA to understand if there were significant differences in mean cortisol levels over time between the treatment group and control group. Due to potential differences in saliva analysis processes, incomplete data, questionable concentration levels, and identified outliers, the researcher reduced the sample to 47 participants (treatment group n = 29; control group n = 18). No significant multivariate effect was found between the treatment and control groups over time: Wilks' λ = .981, $F_{(3, 43)}$ = .277, p = .841; partial η^2 = .019. Thus, the groups did not significantly differ on cortisol levels over time. However, research on cortisol levels and implementation of stress-reduction therapies differ from the current investigation. For example, Marcus and colleagues (2003) reported significant decreases in salivary cortisol levels from pre-test to post-test (p < .001) for participants who participated in a mindfulness-based stress reduction (MBSR) intervention. Although MBSR and NF training are two different interventions, research supports the calming effect of both NF

training (Hammond, 2011) and MBSR, with inferences that the calming effects would influence the activation and release of cortisol levels.

After an extensive review of the literature, no studies were found that incorporate the use of cortisol as a physiological measure of stress. However, the use of physiological measures has been explored in NF training research, including the use qEEG (e.g., Dreis et al., 2015; Walker 2009) to measure brainwave activity, real-time functional magnetic resonance imaging (fMRI) to take images of emotional-processing systems in the brain (e.g., Johnston et al., 2009; Scheinost et al., 2010) and galvanic skin resistance to measure muscle tension (e.g., Agnihotri et al., 2007). For example, in an effort to regulate emotional-based brain regions (e.g., amygdala and insula), Johnston and colleagues (2010) implemented a fMRI protocol in order to capture live images of the brain for participants receiving NF training. The researchers reported significant differences in participants ability to regulate brain regions when prompted (t (12) = 3.98, p = .002); however, follow up research is warranted to determine if the NF training provided longer last effects on participants abilities to regulate emotional-based brain regions.

Furthermore, mixed results have been found in measuring qEEG for individuals receiving NF training. Dreis and colleagues (2015) examined qEEG brainwave activity for anxious participants from pre-test to post-test, with no significant differences or changes. Similarly, Vanathy and colleagues (1998) did not find significant differences in EEG activity of treatment group participants compared to control group participants. However, Walker (2009) reported significant improvements ($p < .05$) found for individuals with excessive high frequency beta waves in a study examining anxiety-based symptoms associated with PTSD. Regarding other physical measures, Agnihotri and colleagues (2007) reported improvements in GSR for participants receiving NF treatment compared to a control group. Overall, establishing empirical

evidence that demonstrates the effectiveness of NF training on a physiological level demonstrates promise. The results of the current investigation may have been due to measurement error and inconsistency regarding time of day for saliva collection. For example, individuals are found to have higher levels of cortisol in the waking hours as compared to evening hours (Salimetrics, Inc., 2017). Furthermore, factors including caffeine consumption (Lovallo et al., 2005) and hours of sleep (Leproult et al., 1997) can also influence the release of cortisol. As behaviors such as amount of sleep and intake of substances (i.e., caffeine) was not tracked in the current investigation, the reported cortisol levels over time are difficult to interpret.

Exploratory Research Question 3

The final exploratory research question was implemented to determine if there was a relationship between salivary cortisol levels and assessment scores of participants at each time point (pre, mid, final, and follow-up) from the treatment and control groups. The researcher utilized a Pearson Product Moment Correlation (two-tailed); for the treatment group, no relationships were found between participants' cortisol levels and assessment scores at each time point. Significant relationships were only found for the control group at pre-test for three assessments: (a) pre BAI score and cortisol level (r = -.502, p = .034); (b) pre PSS score and cortisol level (r = -.744, p < .001); and (c) pre SAT (r = -.497, p = .036). The identified significant relationships were negative; thus, a significant relationship was found between the high pre-test assessment scores and low cortisol levels.

Several research studies have supported the connection between increased mental health concerns and heightened cortisol levels (e.g., Sapolsky, 2004; Popoli et al., 2012; Vyas et al., 2002). Specific to college students, Sladek and colleagues (2016) studied the perceived stress,

coping, and salivary cortisol levels of senior high school students transitioning into their first year of college. Participants were instructed to provide five saliva samples for three days, while also providing five daily diary entries regarding any experienced stressors. Participants were also instructed to report any usage of caffeine, nicotine, or medication and to not brush their teeth, eat, or drink 30 minutes before collecting saliva samples. Results indicated that when participants perceived greater amounts of stress than normal, cortisol levels were significantly higher if they also endorsed more engagement in coping strategies ($\beta = 0.13$, $p < 0.01$). Results also demonstrated significant increase in cortisol levels with perceived stress if participants were below average in reports of ability to effectively cope (Sladek et al., 2016).

The findings from the current investigation differ from significance between perceived stress and physiological stress (i.e., salivary cortisol levels) as compared to Sladek and colleagues (2016) study. However, measurement errors regarding the cortisol samples (i.e., time of day and no knowledge of participants' behaviors that could impact cortisol levels) may have impacted the lack of relationship or identified relationship. Additionally, gender can increase or decrease salivary cortisol ranges (Aardal & Holm, 1995). Regarding collection of saliva samples, Nicolson (2008) purports:

> …collecting several samples over the course of a day is good practice; differences between groups being compared may be restricted to a certain time of day, which often cannot be predicted on theoretical grounds. For this reason, studies with only a single diurnal sampling time will inevitably raise questions about how results generalize to the rest of the day. (p. 40)

Thus, there are several factors that were not controlled for that could impact the reported cortisol ranges for the current investigation. However, the inclusion of salivary cortisol in NF training

research for college students is a novel approach to better understanding the physiological implications of NF training on experiences of stress and anxiety and warrants further investigation.

Limitations of the Study

As is the nature of research, the current study has limitations that are important to explore in order to better inform future research. Specifically, limitations related to: (a) research design; (b) sampling; (c) instrumentation; (d) data analysis; and (e) treatment are explored below.

Research Design

The quasi-experimental, nonequivalent control group design presents with threats to validity. The current investigation employed the use of a treatment group and a waitlist control group. As the ACA's (2014) ethical codes require that all participants are offered the intervention, the waitlist group was offered the NF training intervention following completion of the study. However, the lack of random assignment may threaten statistical conclusion validity. That is, although a control group was implemented, the lack of random assignment makes it more challenging to infer that the specific outcomes (i.e., decrease in participant scores) is due to the intervention itself. Furthermore, as participants may have expected to receive benefits from NF training, it is plausible that a novelty effect occurred in which participants may have respond favorably (Shadish et al., 2002) to assessments over time. Additionally, the researcher facilitated a small portion of the NF training sessions for the treatment group, but facilitated the majority of appointments for the control group (completing assessments only); thus, researcher bias may have been present and influenced participant responses.

Many steps were taken to ensure treatment fidelity (i.e., training for RAs, standardization of NF training intervention, same setting when receiving NF training; etc.). However, threats to treatment fidelity could be found in the use of multiple RAs; that is some participants may have felt more comfortable with one RA compared to another, which could influence response on assessments. As the study took place over about a 12-week period, a maturation effect could have occurred. Specifically, participants may have become more experienced, familiar, or better adjusted with their experiences of anxiety, stress, and depression, which could influence responses. History presents as another threat to validity as some participants (in both the treatment and control groups) reported beginning psychopharmacological or therapeutic interventions after the study began. Engagement in other forms of therapy could have influenced participants' responses on their assessments.

Sampling

The researcher recruited participants through several outlets, including: (a) attending undergraduate and graduate-level courses at a large, Southeastern University; (b) posting flyers in common areas on campus; (c) sending flyers and study information to faculty and staff members; and (d) posting the flyer and study information on social media. The use of convenient sampling, with inclusionary criteria, makes it challenging to generalize results of the study. Furthermore, as the bulk of participants were recruited from one large Southeastern university, it difficult to generalize the results to college students from other universities and/or colleges.

During the initial session, over 20% of participants reported receiving current counseling services. While the percentage of participants receiving counseling services is similar to college students across the US (ACHA, 2017), individuals struggling with anxiety and depression often

experience better improvement in symptoms from a combination of mental health services such as psychotherapy and psychiatric medications (NIMH, 2018b). Thus, results may have been influenced by the combination of NF training and counseling services. Finally, the lack of random sampling and a small sample size ($N = 69$) makes it more difficult for generalizing the results (Gall et al., 2007), especially as there were also unequal numbers of participants per group ($n = 49$ for the treatment group; $n = 20$ for the control group); however, observed power was high for the primary research question.

Instrumentation

The four data collection assessments used relied on participants' self-identified experiences with anxiety, stress, and depression. Although each instrument scores demonstrated sound psychometric features (BAI, PSS, BDI-II, and SAT), social desirability bias or lack of self-awareness may have influenced selected responses of participants. That is, for the treatment group, participants may have responded more favorably to improvements over time as it would be more socially desirable; conversely, participants from the control group may have reported no improvement to meet social desirability. Furthermore, participants may have experienced boredom or fatigue when completing the multiple data collection assessments, impacting their scores. Desensitization to assessments may have also occurred since participants received the same assessments at four different times throughout the investigation (Shadish et al., 2002). Finally, all assessments present with some degree of measurement error, influencing the results.

Several limitations are noted in the collection and analysis process of salivary cortisol. The current investigation did not account for time of day when collecting samples; that is, not all saliva samples collected were done at the same time of day. As more cortisol is found in the

waking hours as compared to evening hours, this presents as a threat to validity. Furthermore, the researcher did not gather information related to other substances that can impact cortisol levels. For example, caffeine, nicotine, drinks, food, and oral contraceptives can influence cortisol levels.

Data Analysis

Although the researcher implemented assumption checking for each research question and analysis, the assumption of normality was violated for the data at some of the assessment points. It is common for social science studies to have data sets that are not normally distributed (Hair et al., 2010). However, the non-normal distribution presents as a limitation as the data collected may be skewed.

Treatment

Although NF training was developed in the late 1960s, the use of NF training within the college student population is novel and innovative. The interest from participants to be involved in an innovative research study may have biased their response to the NF training intervention. Although the NF training intervention is consistent (i.e., the system requires the same setup and time allotment for each participant), some participants may have been influenced by the RAs or researcher (researcher bias). Likewise, a Hawthorne effect could have occurred if the presence of the researcher was influential. Furthermore, during the NF training sessions, the NeurOptimal system plays instrumental music while participants are receiving audiofeedback. Although participants completed assessments prior to receiving their NF training session, the music may also have caused participants to feel calm throughout the study.

Implications of the Findings

Although the current study presents with limitations, the results from the investigation provide promising results and implications for counselor educators, counseling professionals, healthcare policy, and clients in need.

Implications for Counselor Education

As counselor educators, it is important to conduct sound research and disseminate findings to practitioners and counselors-in-training; allowing for the promotion of evidence-based approaches to working with clients and NF training may be an effective adjunctive service with counseling. Accreditation bodies such as CACREP (2016) call for the integration of novel and effect interventions into training curriculum as well as students gaining insight and skillsets to learn how to integrate neurobiological practices into their clinical work (Myers & Scott, 2012). Findings from the current investigation support integrating NF training into the counselor educator curriculum in order to better inform counselors-in-training about new, evidenced-based treatment modalities.

Furthermore, prior to the study, limited research was found that explored the influence of NF training on the college student population, as it relates to constructs of anxiety, stress, and depression. Thus, the current investigation adds to the literature regarding an effective treatment method to address common mental health concerns found in the college student population. Furthermore, although NF training research studies have integrated the use of objective measures such as fMRI, qEEG, and galvanic skin response, no studies were found that incorporated the use of salivary cortisol to determine physiological levels of stress. While the current study presented

limitations regarding the collection of salivary cortisol (i.e., time of day of collection), it presents as a unique, innovative method of measuring participant stress.

Implications for Counseling

The use of innovative procedures that focuses on brain health also presents as unique way to meet the mental health needs of individuals while also reducing stigma. For college students, Eisenberg and colleagues (2009) reported stigma as one of the main obstacles to reaching out and receiving appropriate mental health care. Educating college students about the functioning of the brain as it relates to experiences such as anxiety, stress, and depression versus students feeling as though something is "wrong" with them allows for opportunities to remove barriers. Breaking down these barriers can help students feel more confident and comfortable in seeking out a service that can improve the overall functioning of their brain. Furthermore, NF training parallels the counseling process; thus, counselors serve as mirrors for their clients, reflecting back what they are receiving. Likewise, NF is a mirror: it receives information from the user quickly and reflects back to their brain what just happened, helping their brain to respond more effectively.

Furthermore, the findings from the current investigation provide support for the use of NF training for college students with self-identified anxiety. Currrent results included moderate to large effect sizes for the treatment group, demonstrating practical significance for NF training to provide support for experiences related to social anxiety (SAT), depression (BDI-II), and perceived stress (PSS).

Implications for Healthcare Policies

Anxiety and depressive disorders are the highest diagnosed and most expensive mental health concerns. The findings identified the effectiveness of NF training in treating college students' anxiety, depression, and stress, opening the doors for insurance companies and other policy-based organizations to choose whether they would like to cover NF training in healthcare plans, similar to other treatment modalities that have been established within research (e.g., using CBT to treat anxiety disorders). Furthermore, individuals taking anti-anxiety and anti-depressant medications may find themselves in need of additional medical care to mitigate unpleasant side effects, resulting in additional costs to insurance providers and decreased quality of life. Additionally, some anti-anxiety medications have addictive properties, which may lead to substance abuse concerns. As NF training presents with minimal side effects and no physiologically addictive properties, healthcare providers and insurance companies are able to mitigate the likelihood of accruing continual coverage costs. Moreover, establishing NF training as an effective modality to treat the common mental health care needs of students could also create opportunities to institutionalize NF training on college campuses, thus increasing diverse treatment services and modalities.

Recommendations for Future Research

The current investigation attempted to mitigate research-related limitations; however, there are recommendations for future research. Generalizability of results would benefit from randomization of groups as well as a larger sample size, which would also strengthen the overall research design. In acquiring a larger sample size, there is also opportunity to implement more

advanced statistical procedures. For example, latent growth curve modeling (LGM) would be an appealing procedure to implement as it: (a) uses structural equation modeling (SEM) methods to provide a model regarding individual change; (b) evaluates the effects of treatment and relationship between several outcomes at once; and (c) addresses model measurement errors (Stull, 2007). Although the RM-MANOVA provides information related to the changes in mean scores between the groups through comparison of the group mean over time, it does not provide information related to the course of change for scores of each individual participant. Thus, LGM could provide more information related to the growth of individual participants and provide additional context for their change over time. Having data and projections on the growth of individual participants would also be helpful in the analysis of salivary cortisol level as there are many factors (i.e., caffeine; time of day; gender; medication; etc.) that can impact cortisol. Additionally, addressing the issue of non-normal distribution of data through transforming variables would add strength to the data analysis process and decrease the likelihood of skewed data.

Furthermore, as the current population includes both undergraduate students and graduate students, studies could benefit from focusing more on mental health concerns of undergraduate students versus graduate students. That is, undergraduate students and graduate students present with different and unique experiences; for example, undergraduate students are more likely to experience with moving away from home for the first time as compared to graduate students who may be facing stressors related to financial loans for both undergraduate and graduate studies. The different types of stressors and life experiences require further exploration for both undergraduate and graduate students.

Stress and chronic stressors can have negative impacts on the human body, including difficulty healing of wounds and viruses and an overall compromised immune system, which can exacerbate illnesses (Littrell, 2008). Stress can also increase experiences of psychological distress, leading to more pervasive and challenging mental health concerns (Goto, Yang, & Otani, 2010; Popoli et al., 2012; Sapolsky, 2004). As stress plays a large role in the appropriate functioning and wellness of college students, future research would benefit from adding more rigorous procedures in collecting and analyzing salivary cortisol to serve as an objective, physiological measure of change. Specifically, as cortisol is on a diurnal pattern, with higher cortisol levels found in the morning hours compared to evening hours, saliva samples would need to be collected at the same time of day per participant. Additionally, studies utilizing salivary cortisol levels advocate for the collection of several cortisol samples throughout.

Researchers should also provide more screening questions and processes when including collection and analysis of salivary cortisol. For example, as caffeine, food, alcohol, nicotine, and sugary drinks can influence cortisol levels, participants should be provided with specific instructions about abstaining from these substances prior to providing a saliva sample. Salimetrics (2017) recommends having participants gently rinse their mouth with water at least 10 minutes prior to provide a saliva sample as a way to mitigate some of these influential factors/substances.

Specific medications such as oral contraceptives (Dorn et al., 2007) can also cause differences in cortisol levels; thus, researchers would benefit from creating a more detailed screening process to gain a better understanding of any factors or substances that may impact participants' cortisol levels. Additionally, Dorn and colleagues (2007) advocate for incorporating

the collection of several samples to account for circadian patterns of the body; however, the inclusion of multiple saliva collection points can also be challenging for research.

Conclusion

The current investigation examined the impact of 16 NF training sessions on college students' levels of anxiety, stress, and depression. A quasi-experimental, nonequivalent control group design was utilized to determine if there were significant differences between the treatment group and waitlist control group participants' BAI, PSS, BDI-II, and SAT scores. Furthermore, the researcher investigated whether there was a difference between specific participant demographics (i.e., age, gender, major, race/ethnicity, and involvement in personal counseling) among the treatment group and control group participants over time. The investigation also sought to determine if treatment group and control group participants' salivary cortisol levels were significantly different and if there was a relationship between treatment group and control group participants' assessment scores and salivary cortisol levels at each time point (pre, mid, final, and follow-up).

Main findings included a significant difference between treatment group and control participants' PSS, BDI-II, and SAT scores over time. Furthermore, no significance was found among participant demographics between the treatment group and control group self-assessment scores over time, demonstrating that demographic variables did not impact the difference in scores. No significance was found between treatment group and control group participants psychological assessment scores and their salivary cortisol levels over time. When assessing the relationship between treatment group and control group participants' psychological assessment

scores and cortisol levels at each time point, a negative relationship was only found for the control group participants' salivary cortisol levels at pre-test on the BAI, PSS, and SAT.

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: **Caitlyn R. McKinzie** and Co-PIs: **Glenn William Lambie, Gulnora F. Hundley**

Date: **August 29, 2017**

Dear Researcher:

On 08/29/2017 the IRB approved the following modifications to human participant research until 11/28/2017 inclusive:

Type of Review:	IRB Addendum and Modification Request Form Expedited Review
Modification Type:	Population updated to 120, addition of "control group" with new timeline in order to accommodate additional participants, updated consent and protocol.
Project Title:	Anxiety and Cortisol Levels Amongst College Students: An Exploratory Investigation of the Effectiveness of Neurofeedback Training
Investigator:	Caitlyn R. McKinzie
IRB Number:	SBE-16-12626
Funding Agency:	
Grant Title:	
Research ID:	N/A

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 11/28/2017, 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 signed and dated 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 Gillian Amy Mary Morien on 08/29/2017 11:06:23 AM EDT

IRB Coordinator

APPENDIX B:
INFORMED CONSENT

Anxiety and Cortisol Levels Amongst College Students: An Exploratory Investigation of the Effectiveness of Neurofeedback Training

Informed Consent

Principal Investigator: *Caitlyn McKinzie Bennett, MA, LMHC, NCC*

Co-Investigators: *Gulnora Hundley, MD, PhD, LMHC*
Glenn W. Lambie, PhD, NCC, NCSC, CCMHC
Chrysalis Wright, PhD

Faculty Advisor: *Gulnora Hundley, MD, PhD,*

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

Introduction: Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being invited to take part in a research study which will include about 120 people from college and universities in the Central Florida area. You have been asked to take part in this research study because you are a college student who experiences anxiety. You must be 18 years of age or older to be included in the research study.

The person doing this research is Caitlyn McKinzie Bennett of the College of Education and Human Performance Because the researcher is a doctoral student, she is being guided by Gulnora Hundley, MD, PhD, LMHC, a UCF faculty advisor from the College of Education and Human Performance.

What you should know about a research study:

- Someone 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 anxiety 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 anxiety 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 5 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.

***Please Note:* Due to the high amount of interest in participation, the Fall 2017 schedule to receive the Neurofeedback Intervention is full, resulting in the waitlist group. If you are a participant on the waitlist, you will not be receiving the neurofeedback training during the Fall 2017 semester and will be eligible to receive the neurofeedback training during the Spring 2018 semester. However, you will be asked to attend four different appointments to fill out the 5 study assessments and to collect the 4 saliva samples.**

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, 5 assessments, a non-invasive cortisol test that involves expectorating (spitting) into a sterile test tube, and 15 minutes of neurofeedback training. This will take approximately one hour.

Neurofeedback training sessions will be conducted as follows:

- Participants are asked to complete 2 Neurofeedback sessions per week, for 8 weeks.
    - At the 4th and 8th week, participants are asked to complete the same 5 assessments completed at the baseline session as well as the cortisol test.
    - At the 8th week (final session), participants will also be asked to complete a final cortisol test.
- In each session, you will be seated in a chair in a private room in the CCRC.
- A trained research assistant will then place 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.
    - However, 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.
- You will also be asked to participate in a focus group that asks you questions about your experience in the study. This group should last approximately 60 minutes.

Neurofeedback Training Group versus Waitlist Group

Neurofeedback Training Group	***Waitlist Group***
• 12 Week Timeline • Attend 16 sessions (over 8 week period) • Return 4 weeks after final session for follow-up	• 12 Week Timeline • Only attend 4 times over 12 weeks (once every 4 weeks)
• At each assessment point (4 times in the 12 weeks): complete 5 paper assessments and cortisol test	• At each assessment point (each appointment you attend): complete 5 paper assessments and cortisol test
• Receive $5 gift card at session 1, session 8, and follow-up session (total of $15)	• Receive $5 gift card at appointment 1, appointment 2, and appointment 4 (total of $15)
• Sessions will last approximately 1 hour	• Appointments will last approximately 30 to 45 minutes
• Participation complete for the Fall semester; no sessions in the Spring 2018 semester	• Waitlist participation complete at the end of Fall semester; participant will be offered Neurofeedback session in the Spring 2018 semester

Location: University of Central Florida 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. 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 5 assessments and a cortisol test; these assessments should take approximately 25 minutes to complete and the cortisol test will only take 1 minute. 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 as well as one final cortisol test. During the follow up appointment, a focus group that explores your experiences with neurofeedback training will take place and last approximately 60 minutes.

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

Funding for this study: The primary investigator has received a small grant from the Southern Association for Counselor Education and Supervision (SACES) and the Association for Assessment and Research in Counseling (AARC) to fund part of this research.

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 Community Counseling and Research 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. 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. Additionally, the cortisol test involved in this study is non-invasive and involves gently swabbing the inside of the mouth. Slight discomfort may arise in mouth feeling dry. If this occurs, please inform the research assistant and we can provide you with water.

Benefits: We are unable to promise any medical or personal 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. The neurofeedback training being conducted is for research purposes and may help participants learn more about the stressors they are experiencing, but it is not designed to be a medical treatment.

Compensation or payment: This research study involves four phases of data collection. Amazon gift cards will be given three times throughout the study for participation: one ($5) at the end of

the first session, one ($5) at week 4 following the midpoint assessments, and one ($5) following the final session. Thus, if you are receiving Neurofeedback training and complete all of the neurofeedback sessions or if you are on the waitlist and attend all four of the assessment points, the total amount would be three $5 Amazon gift cards (total of $15). If you signed up to participate in the study via the SONA system, you will also receive extra credit for your course.

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 data collected will be used for statistical analyses and no individuals will be identifiable from the pooled data. The information obtained from this research including demographic information, assessments, and cortisol sample results may be used in future qualitative and/or quantitative research and published in counseling or related journals. 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. Cortisol samples will also be labeled with unique identifiers and will not include participant names or other identifiable information. 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.

Regarding maintaining confidential data for this study, please check the box next to the corresponding statement (only one) you prefer:

☐ ☐ Researchers may keep my confidential data after the study is completed and use it for future research.

☐ ☐ I do not want researchers to keep my confidential data after the study is completed. (*please note that selecting this option still allows you to participate in the current study and that your data will be destroyed once the study is completed*) ☐

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 Caitlyn McKinzie, Doctoral Student and Principal Investigator, College of Education and Human Performance, (321) 348-7833, cmckinzie@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 opt out of 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: If you are interested in the results of this research, please inquire with the primary investigator.

Your signature below indicates your permission to take part in this research.

DO NOT SIGN THIS FORM AFTER THE IRB EXPIRATION DATE BELOW

_____

Name of participant

_____ _____

Signature of participant Date

Signature of person obtaining consent	Date

Printed name of person obtaining consent

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.

_____ _____

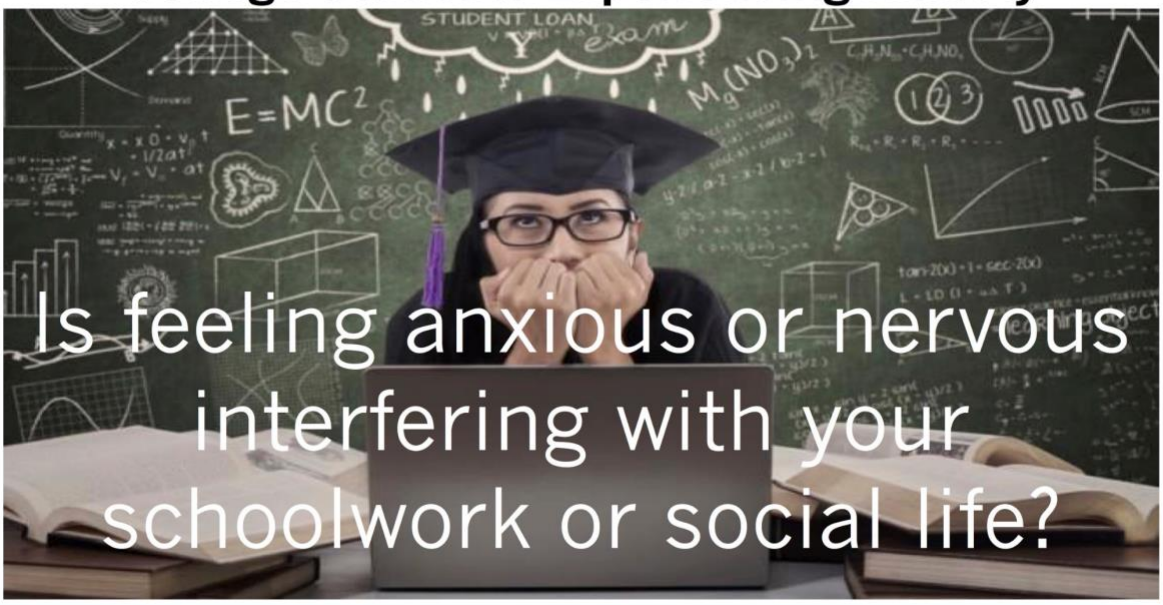
Your Signature Today's Date

_____

Your Printed Name

APPENDIX D:
RECRUITMENT FLYER

Neurofeedback Training Study for College Students Experiencing Anxiety



What is Neurofeedback Training?

Anxiety is a normal part of the college experience. However, it can also impact your ability to do work and feel okay. Neurofeedback training is a non-invasive, drug free approach that measures brainwaves and provides audio feedback to help improve brain function.

What You Need to Know

What is the time required?

- **Fall** (August – November)
- 8 weeks of NF sessions and a 4 week follow up appointment.
- Each session is scheduled for 1 hour (total of 2 hours per week).

What does this look like?

- You are able to read, browse your phone, study, or simply relax during these sessions.

Other Important Information

Who can participate?

- You must be 18 years of age or older,
- Be enrolled as a college student who is experiencing anxiety, worry, and/or nervousness
- AND complete eligibility process

Is there a cost?

- There is no cost to you.
- Gift card incentives will be provided for participation.

UCF Community Counseling and Research Center

Interested or have Questions?

Call or email us at:

321-348-7833 or **cmckinzie@knights.ucf.edu**

APPENDIX E:
RECRUITMENT EMAIL

Hello,

My name is Caitlyn McKinzie Bennett and I am a Doctoral Candidate here at the University of Central Florida. ***Do you currently experience anxiety, stress, worry, or nervousness***? We are recruiting eligible participants for the Summer or Fall semesters who would potentially benefit from this opportunity.

What is Neurofeedback Training?

- **Anxiety is a normal part of the college experience. However, it can also impact your ability to do work and feel okay.**
- **Neurofeedback training is a non-invasive, drug free approach that measures EEG brainwaves and provides instant audio feedback to help improve brain function.**

Purpose and Potential Benefits of Neurofeedback Training

- **The purpose of this study is to further the research on therapeutic outcomes of Neurofeedback Training and explore the efficacy of Neurofeedback Training on anxiety symptoms in college students.**
- ***Although we cannot guarantee benefits of Neurofeedback training*, several research studies provide encouragement that Neurofeedback has the potential to reduce anxiety symptoms in college students.**
- **3 Gift Card incentives will be provided throughout the study.**

Who is eligible to participate?

- Individuals must be 18 years of age or older,
- Be enrolled as a student at a college/university in the Central Florida area,
- Experience anxiety, worry, or nervousness,
- AND be willing to complete an initial screening session to ensure appropriate fit for the study.

Where will this study take place?

This study will take place at the University of Central Florida Community Counseling Research Center (CCRC)

Attached to this email, you will also find a flyer with additional information.

If you are interested in participating or have any questions about this opportunity, please feel free to contact me directly at 321-348-7833 or cmckinzie@knights.ucf.edu.

Thank you for your time!

Be well,
Caitlyn McKinzie Bennett, MA, LMHC, NCC
Doctoral Candidate, Counselor Education
College of Education and Human Performance
University of Central Florida
Email: cmckinzie@knights.ucf.edu

***This study is being completed under the direct supervision of my faculty advisor, Gulnora Hundley, MD, PhD, LMHC

APPENDIX F:
DEMOGRAPHIC QUESTIONNAIRE

PSYCHOSOCIAL INVENTORY

Information Given Below is For Research Purposes Only

The information supplied below is for the use of the neurofeedback training study and will be kept confidential. Please help your research assistant by answering each question as fully and honestly as you can.

PERSONAL IDENTIFICATION DATA

Name: _____ Today's Date: _____

Address: -

_____

_____

Home Phone: _____ Cell Phone: _____ Work Phone: _____

Email Address: _____Gender: _____ Birthday: _____ Age: _____

Primary racial/cultural background:

___ Asian ___ Black/African American ___ 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 about your anxiety (what brings you here)?

_____

_____

_____

_____

_____

_____

HEALTH INFORMATION

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

Do you have any severe skin allergies? ___Yes ___No (If yes, please describe)_____

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

Emotional Health

Have you ever had any psychotherapy or counseling? ___Yes ___No ____ Currently in counseling

If so, How many sessions have you have? _____

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

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

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 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) _____

_____

_____

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, please explain.

_____

_____

_____

_____

EDUCATIONAL HISTORY

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

What is your current major?

_____

How would you rate your overall current college experience on a scale from 1-5, where 1 is Very negative and 5 is Very positive?

___1 ___ 2 ___ 3 ___ 4 ___ 5
Very Negative Average Very Positive

What do you like about college?

_____

_____

_____

_____

_____

What do you dislike about college?

_____

_____

_____

FAMILY BACKGROUND

Did your parents or caregivers have a formal anxiety disorder diagnosis? ___Yes ___No

Would you describe your parents or caregivers as anxious? ___Yes ___No

This concludes the psychosocial portion of your intake process. Thank you for taking the time to complete this Inventory with your research assistant. The information that you have supplied will help us to provide you with the best service possible. We look forward to serving you!

APPENDIX G:
LIST OF COUNSELING REFERRALS

Counseling Services/Resources/Referrals			
Name of Location	**Address**	**Phone Line Number**	**Specialty**
UCF Counseling and Psychological Services (UCF Students Only)	**UCF Campus; Counseling Center Room 101**	407-823-2811	**Variety of services**
The Zebra Coalition	911 N Mills Ave, Orlando, FL 32803	407-228-1446	LGBTQ Services
Life Psychiatric Associates	670 N. Orlando Ave. Suite 103, Maitland, Florida 32751	407-622-1770	Psychiatric medication management/Psychopharmacology, Psychotherapy and family therapy, Clinical consultation and second opinions, Dual diagnosis treatment and substance treatment therapy, Diagnosis and management of childhood and adult ADHD, Self esteem improvement and trauma survival, Suboxone induction and treatment.
Hispanic Family Counseling	6900 Orange Blossom Trail, Orlando, FL 32809	407-382-9079	
Forward Momentum Counseling	1414 Gay Rd, Suite #203 Winter Park, FL 32789	407-216-9032	LGBT related issues and concerns, Depression, Anxiety, Discernment Counseling, Couples/Marriage Therapy, Grief Counseling, Work and Career related issues, Stress & Anger Management, Addiction & Recovery, Conflict Resolution, PTSD, Traumatic Brain Injury (TBI), Sexual Trauma
Counseling Professionals of Orlando, LLC	Downtown Orlando 1216 E. Concord St. Orlando, FL 32803	Office: 407-896-8380	Wide variety of specialties
Mental Health Association of Central Florida		407-898-0110	Free information and referral service database of nearly 800 providers, with resources in counseling, psychiatric services, assisted living facilities, and insurance information
National Alliance on Mental Illness of Greater Orlando		407-253-1900	Provides referral services including health insurance, housing, rehabilitation, and jobs for people with mental illnesses and their families, educational classes and local support groups.
Jennifer Guerriero	7635 Ashley Park Ct #503, Orlando, FL 32835	(407) 456-7379	Abuse & Trauma, Career Counseling, Couples Christian Counseling, Grief and Bereavement Christian Counseling, Life Coach Counseling and Consultation, Marriage and Family Christian Counseling, Stress Anxiety

			Depression Christian Counseling, Teen Christian Counseling
Jennifer Sigman, LMFT	940 N. Maitland Ave	407-415-9017	Anxiety, Abuse, Grief, Depression, Trauma, Post-Traumatic Stress, Parenting Issues, Separation Stabilization, Infidelity Stabilization, Separation Counseling, Pre-marital Counseling, Marital / Relationship Rehabilitation
Positive Behavioral Solutions LLC	235 S. Maitland Ave. Suite 215 Maitland, FL 32751	407-629-1775 or 321-299-9415	Wide variety of specialties

Crisis Referrals/Resources							
Facility	**Phone Number**	**Address**	**Spanish Speaking**	**Sliding Scale**	**Accept Insurance?**	**Specialty**	**Website**
Lifeline	407-425-2624; Teens: 407-841-7413		Yes	Free	Free	Crises handled: suicide, financial, general mental health	
National Suicide Prevention Lifeline/ Self-Mutilation Hotline	1-800-273-8255		yes	Free	Free		
Lakeside- 4 locations	407-875-3700	434 W. Kennedy Blvd Orlando, Fl 32810	Yes	Yes	Yes	Crisis screening	www.lakesidecares.org
Florida Hospital 24 hour helpline	1-800-869-1616		Yes	No	No		
Florida Abuse Hotline (Child Abuse Registry)	1-800-962-2873		Yes	Free	Free		
Safe House of Seminole	407-330-3933;		Yes	Free	Free		

(Both numbers are 24 hour hotlines)	855-655-7233						
Park Place Behavioral - Osceola County	407-846-0023	206 Park Pl Blvd, Kissimmee, Fl 34741	Yes	Financial Assistance Program for Osceola County Residents			ppbh.org
Crisis Text Line	Text "START" to 741741			Free	Free	Crises Handled	

APPENDIX H:
PRESCREENING QUESTIONS

Screening Questions

1. How old are you? (*need to be over 18 years of age*)

2. Are you a full time or part time student? (*need to be at least part of full time*)

3. Do you have any history of severe skin allergies to cosmetics or lotions? (allergic to iodine)

4. Are you currently pregnant?

5. Do you have any hearing impairment?

6. Do you have a pacemaker or any other implanted electronic devices?

7. Have you been hospitalized in the past month for mental illness or a mental health concern?

8. Are you currently or have you recently experienced thoughts of hurting yourself or thoughts of hurting others?

9. Do you currently experience any anxiety, worry, nervousness, or stress?

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