LISTENING TO STEADY DRUMBEAT AS A METHOD TO REDUCE PSYCHOLOGICAL STRESS AND ANXIETY

A Thesis Presented to the Faculty
of
California State University, Stanislaus

In Partial Fulfillment
of the Requirements for the Degree
of Master of Arts in Psychology

By
Katie Moody
May 2020

CERTIFICATION OF APPROVAL

LISTENING TO STEADY DRUMEAT AS A METHOD TO REUDCE PSYCHOLOGICAL STRESS AND ANXIETY

by
Katie Moody

Signed Certification of Approval page
is on file with the University Library

Dr. Gary Williams Associate Professor of Psychology	Date
Dr. William Potter Professor of Psychology	Date
Dr. Victor Luevano Associate Professor of Psychology	Date

ACKNOWLEDGEMENTS

I want to thank Dr. Gary Williams for his patience and continued support through this entire process! I also want to thank Dr. William Potter and Dr. Victor Luevano for their support in helping me develop sound research. Additionally, I could not have completed this project without the help of my friend Ricardo Gonzalez II, who worked with me to create the drum tracks used in this study. Finally, thank you to my family and friends who were with me every step of the way.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Historically and in present time, humans have used drumming in conjunction with therapeutic or healing practices. Therapeutic drumming interventions are effective in facilitating many positive health outcomes. Typical drum therapy sessions involve multiple elements, including social togetherness, physical movement, and community involvement, which makes it difficult to assess exactly what part of drum therapy is most beneficial. We investigated how the sound of drums, just one component of drumming interventions, affects stress and anxiety levels using visual analog scales. Participants (N = 301) between the ages of 18 and 70 were recruited for the study. We compared the effect of listening to a steady drumbeat played at 60 beats per minute to an irregular, non-rhythmic drumbeat played at 60 beats per minute. Additionally, we included a group who listened to room tone silence. After being exposed to a mild psychological stressor, participants listened to one of the three sound conditions for one minute. ANOVA analysis indicated that compared to those who heard only silence, participants in the group who heard steady drumbeat scored significantly lower on both stress and anxiety assessments. No significant differences were found between listening to irregular drumbeat and the other two groups. The results partially explain how the sound component of drum interventions is beneficial to overall mental health. Implications of these results could contribute to utilizing sound in healthcare facilities as an accessible way to help reduce stress and anxiety in patients.

Keywords: drum therapy, drumming, stress, anxiety, mental health

CHAPTER I

Brief Overview

In the anthropological literature, drum use is heavily cited across cultures. Societies use drums for a variety of reasons, and often believe that drumming serves multifaceted functions. The prevalent, dynamic use of drumming as an important part of everyday life for many societies leads us to believe that there might be more to the drum than what we can hear. Though different societies hold distinct beliefs about what drumming can achieve, it seems apparent that drumming may affect psychological and physiological health. Current psychological research indicates that drumming may be associated with positive health benefits. I want to explore the effect that listening to drumming may have on psychological stress and anxiety.

Drum Use: Ancient to Contemporary

For centuries, drums have been used across cultures all over the world in rituals, ceremonies, and shamanic healing (Dean, 2012). Drum use in ancient societies acted as a tool that could help evoke desired emotions, alter states of consciousness, and aid in healing illnesses. For many societies, drums play an integral role in the community. In some African societies, special rhythms are used to rouse and excite people, especially in preparing for battles. These societies feel that a drumbeat is the heartbeat of their community (Bokor, 2014). For Indigenous peoples of Siberia, drumming is central to the practice of shamanism for evoking a sense of identity, as it helps the community feel connected with the Shaman, spirit world, and

each other (Walker, 2003). In many Native American healing practices, drums are integrated with singing and other musical instruments to elicit emotional and physiological responses. In Native American societies, the beat of a drum symbolizes the natural rhythm of the earth (Rybak & Decker-Fitts, 2009).

Today, many professionals, including occupational therapists, speech therapists, and mental health clinicians incorporate ancient drumming techniques into practice as a method of healing, rehabilitation, and therapy for diverse populations, including people with schizophrenia, substance use disorders, physical disabilities, and neurodegenerative diseases (Matney, 2015). Drum intervention techniques typically focus on rhythm and synchronization, and often involve drum facilitators (Friedman, 2011).

Stress

Stress is a biological function that prepares the body in response to a threat (Selye, 1965). It is necessary for survival, as stress can provide us with the energy needed to overcome a challenge. The body works to maintain a balanced physiological state, or homeostasis. When faced with a stressor, or stimulus that poses a threat to homeostasis, our evaluation of that stressor is critical in determining how we react. As we encounter various challenges throughout the day, some stress, called eustress, allows us to feel positive and motivated (Lazarus & Folkman, 1984; Selye, 1965). Lazarus and Folkman's Transactional Model of Stress and Coping (1984) explains how eustress works. In this model, when a stressor is detected, a person evaluates the threat level of the situation. The stressor may be perceived as either

threatening or not threatening. This is primary appraisal. In the secondary appraisal, a person determines whether he or she is able to overcome the threat or not. A person experiences eustress when he or she detects a threat but can overcome the challenge. Essentially, a person's perception of a threat is what establishes how stressful it is, and this varies based on people's individual differences. However, if a person appraises a situation and decides he or she cannot overcome the challenge, stress becomes negative. Negatively perceived stress exists in a few forms, including acute and chronic stress (Dhabhar & McEwen, 1997). Acute stress is brief and immediate, as opposed to chronic stress, which is long-term. If a person is about to take a difficult exam, that person may experience a jolt of energy and racing heartbeat, but will return to feeling normal (i.e., return to homeostasis) later on in the day. This person has determined that though the exam was challenging, he or she felt able to overcome it. This process is generally healthy and helps prepares the body for challenging situations, or, challenging exams. Of course, what determines a healthy amount of stress is subjective and based on an individual's unique appraisal.

Though some stress can be helpful, constant stress can be harmful. When a person persistently faces stressors, the body stays in a state of imbalance and hyperarousal, called chronic stress. Chronic stress has many negative health outcomes, as the body is designed to maintain homeostasis, rather than a state of hyperarousal (McEwen, 2008). When a person faces chronic stressors, his or her body responds with an influx of hormones that, when present for extended periods, can disrupt homeostasis and have harmful effects. Having high levels of these hormones

can result in increased susceptibility to cardiovascular disease, inflammation, autoimmune diseases, and mental illness (Mariotti, 2015).

Chronic stress may result from the frequent life hassles that we experience every day, including misplacing items, concerns about money, preparing meals, and waiting in line (Delongis et al., 1982). According to the American Psychological Association's (2017) annual survey, approximately 62% of Americans report feeling stressed about daily life hassles. The physiological reaction to too much chronic stress is associated with poorer health outcomes, including headache, nausea, fatigue, diabetes, viral infections, high blood pressure, depression, anxiety, and Alzheimer's disease (Baum & Polsusnzy, 1999; Muscatell & Eisenberger, 2012).

Physiology of the Stress Response

The autonomic nervous system (ANS) is responsible for controlling the body's automatic processes, such as breathing and digestion. It is comprised of the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). Both are involved in physiological processes that are not typically regulated consciously. Working together, the PNS maintains functions when the body is relaxed, or not in danger, while the SNS is more active when there is a perceived threat, or challenge, called the stress response. (Selye, 1965). The stress response is made up of two systems that work together: The Sympathomedullary system (SAM) and the Hypothalamic Pituitary Adrenal Axis (HPA axis).

The SAM System

The SAM system is activated in response to stress. First, the amygdala (the emotion center of the brain) processes sensory information from the environment and interprets if a situation is threatening or not. If a situation is threatening, the amygdala signals the hypothalamus, which activates the SNS. The activated SNS stimulates the adrenal glands, which secretes catecholamines, including norepinephrine and epinephrine (also known as adrenaline), into the body (Cannon, 1929). These hormones prepare the body for a 'fight or flight' response, causing physical effects such as pupil dilation, increased heart rate, release of energy, perspiration, and slowed digestion.

The HPA Axis

In addition to the SAM system, the HPA axis is also activated in response to stress. According to Tsignos and Chrousos (2002), the hypothalamus receives information of a persistent stressor(s) and releases corticotrophin-releasing hormones (CRH). This hormone triggers the pituitary gland to release adrenocorticotropic hormonse (ACTH). ACTH stimulates the adrenal cortex, which releases cortisol. Some cortisol helps regulate homeostasis in the body (Tsigos & Chrousos, 2002). However, too much cortisol in the bloodstream over an extended period of time is associated with exhaustion, weight gain, high blood pressure, inflammation, and memory problems (Hannibal & Bishop, 2014; McEwen, 2008)

Anxiety

While stress is the physiological response to a threat, anxiety is an emotional response that may have no identifiable cause (American Psychiatric Association [APA], 2013). Rather than being a direct reaction to something in real time, as stress is, anxiety can occur when no clear stressor is present. It is associated with feeling worried, overwhelmed, fearful, and out of control. Anxiety manifests physiologically as well, sometimes causing increased heart rate, muscle tension, and sleep disturbance (APA, 2013). It is estimated that one out of every three people will be affected by an anxiety disorder at some point in his or her lifetime, making anxiety the most commonly experienced mental disorder in the world (Bandelow & Michaelis, 2015). Specifically, in the United States, over six million adults have generalized anxiety disorder (GAD). GAD accounts for more missed days of work than any other disorder (APA, 2013). Panic attacks, often associated with anxiety disorders, are common; in the United States about 11% of the population will have a panic attack during the year. Though panic attacks and anxiety disorders alone are not life threatening, people who experience them are at a higher risk for suicide than people who do not (APA, 2013).

Methods to Reduce Stress and Anxiety

Because stress and anxiety are so prevalent, there is extensive research in attempting to find as many techniques as possible to help reduce and manage stress and anxiety. The following methods reflect options that people can do outside of standard medical practice, such as psychotherapy and medication. It is advantageous

to continue to examine a variety of methods that reduce stress and anxiety, in order to help the greatest number of individuals.

Exercise

Many physical activities, including aerobics and yoga, have been shown to have numerous health benefits. A meta-analysis found that exercise helped significantly reduce symptoms of anxiety for people with anxiety disorders (Stubbs et al., 2017). Results of another study indicated that yoga may be effective in helping to reduce stress and anxiety for women (Shohani et al., 2018). Yoga has also been shown to reduce stress-related physical symptoms such as headache and nausea (Yoshihara et al., 2014).

Miscellaneous Techniques

In order to reduce stress and anxiety, a person can implement various calming techniques with very little training, money, tools, or time. These include deep breathing exercises, progressive muscle relaxation, and meditation (Harvard Medical School, 2016). Simple, purposeful breathing (i.e., filling the lungs completely in and exhaling completely out) has been shown to improve physical symptoms of stress, such as muscle tension and fatigue, as well as reduce perceived stress in adults (Perciavalle et al., 2016). A study by Robb (2000) examined progressive muscle relaxation (PMR) (e.g. intentionally tensing up specific muscle groups and releasing them) and found that it significantly increased relaxation and reduced anxiety.

Mindfulness meditation is gaining popularity as a helpful intervention for treating many conditions (Hofmann et al., 2010). Hoge (2013) found that mindfulness

based stress reduction, a meditation technique, reduced symptoms of anxiety in people with clinically significant levels of anxiety (i.e., either diagnosed with GAD or scoring above 20 on the Hamilton Anxiety Rating Scale).

Listening to Music

Several studies have examined how music may be able to reduce stress and symptoms of anxiety. Many of these studies found positive results, in that listening to music does successfully reduce anxiety (Burns et al., 1999; Demarco et al., 2011; Thoma et al., 2014; Weaver et al., 2015). Some studies found that music helped decrease physiological symptoms associated with stress and anxiety, such as blood pressure, heart rate, and cortisol levels (Bradt et al., 2013; Khalfa et al., 2003).

Predictability. Results of several studies support the idea that listening to music is effective in reducing physiological and psychological indications of stress and anxiety (Bradt et al., 2013; Burns et al., 1999; Demarco et al., 2011; Weaver et al., 2015); however, researchers disagree about why music is found to be relaxing. One study proposed that some characteristics of music, such as repetition and simplicity, are more relaxing than others (Tan et al., 2012). These characteristics contribute to the degree of predictability in music. Whether something in the environment is predictable or not affects how anxious a person feels— the less predictable the environment, the more anxiety inducing it is (Lang et al., 2015). Lang et al., (2015) suggests that people engage in self-calming, repetitive behaviors (e.g., repetitive movements) as coping mechanisms for dealing with unpredictable

environments. Therefore, repetitive and predictable rhythm should simulate the repetitive behaviors we engage in when feeling stressed or anxious.

Music Preference. Listening to music with the specific goal of reducing anxiety and stress can be complex. Radstaak et al., (2014) found that if music is preferred, it tends to be perceived as more relaxing than non-preferred music. Even in the absence of previously stated relaxing characteristics, if music is preferred, it will still be perceived as relaxing (Jiang et al., 2013). This suggests that music be more intrinsically involved. Perception of music will be individual, thus emotionally affects people differently.

Emotional Regulation. Chords, melody, and harmony of a song are major components that contribute to the development of an emotional connection to music. Recall that activity in the amygdala initiates the first step of the stress response. In a systematic review, Moore (2013) examined how music affects emotional regulation and found that qualities such as predictability and consistency have been shown to decrease activity in the amygdala. In contrast, qualities such as minor keys, dissonance, or surprising fluctuations in music (e.g. music quickly alternating between loud and soft) increase activity in the amygdala (Moore, 2013).

Tempo. In music, tempo is the speed in which a song is played. It is measured in beats per minute (bpm). Alone, the tempo of a song is not likely to elicit an emotional response (e.g., happy, sad) (Khalfa et al., 2008). This is to say, if a person hears only the tempo of a song, he or she would likely not have an emotional connection to it. The emotional processes involved in listening to this ‘music’ would

be removed. However, the tempo can be manipulated to either reduce or evoke physiological stress and arousal. Compared to a faster tempo, a slow tempo can be associated with lower arousal and self-reported calm mood (Gomez & Danuser, 2007; Bresin & Friberg, 2011; Van Der Zwaag et al., 2011; Bradt et al., 2013).

Drumming as a Method to Reduce Stress and Anxiety

Research interest in drumming as a therapeutic intervention has increased over the past few decades (Matney, 2015). Though most studies conducted are within the field of music therapy, other areas, including occupational therapy and psychology, also investigate how drumming can be utilized for various domains (e.g. abuse and trauma, developmental disabilities, Alzheimer's, and dementia) (Matney, 2015).

A study by Fancourt et al. (2016) was conducted to investigate how group drumming affects mental health and immune response over the course of 10 weeks. A professional drummer worked with participants for 90-minute sessions once a week. Compared to the control groups who did not attend any drum sessions, participants showed a significant decrease in anxiety. In a similar study, drum circle interventions helped to significantly reduce anxiety in participants when compared to a pre-test. (Deraney et al., 2017).

A study by Bittman et al. (2011) found that group drumming has biological implications as well, and can affect the neuroendocrine system in a way that may reduce stress. This study found that when participants only listened to the sounds of group drumming, there was no significant increase in biological markers to reduce stress. Essentially, this means that perhaps the group aspect, or physical aspect of

drumming is responsible for reducing physiological indicators of stress and anxiety. However, Bittman et al. (2011) did not address these questions with their study, and did not test whether psychological variables were changed. Therefore, it is unclear whether listening to drumbeat could have an effect on psychological stress and anxiety.

One study investigated the effects of using the sound of steady drumbeat to reduce situational anxiety. Different from other studies and similar to a portion of Bittman's study, Gadberry (2011) did not have participants physically play drums. Instead, they only listened to either drumbeat or silence. The beat, played on a sub-contra *C* bass tone bar at 66 beats per minute significantly reduced anxiety in participants when compared to participants who did not listen to anything (Gadberry, 2011). A steady beat is also predictable and consistent, which are qualities that have been shown to reduce anxiety.

Elements of Drum Therapy Interventions Linked to Positive Health Outcomes

For centuries, drumming has been an intricate part of human culture, appearing in nearly every society (Dean, 2012). The anthropological literature explains that many cultures use drums for a myriad of purposes. Notably, music and drumming are used in conjunction with community gatherings, and to promote unification and group identity (Bokor, 2014). Many studies have found positive results from implementing group drumming practices to promote social processes (e.g., self-empowerment and group cohesion; Yap et al., 2016). Most research has investigated how effective group drumming or drum circles are, making it difficult to

distinguish if the motor activity involved in drumming, the sound of drumming, or the communal, collaborative effort of drum circles is what reduces anxiety and stress.

The Present Study

This study examined how listening to recordings of drumbeat influence a person's stress and anxiety. Drum circles and drum therapy are currently used today as a method of rehabilitation, recreational therapy, and psychotherapy. The research has primarily examined effects of drumming in combination with other factors, such as social interaction, physical movement, and teamwork. Few studies have examined how the sound of drums, isolated from the action and communal aspects of drumming, may be beneficial for psychological health. In an attempt to find what component of this holistic practice contributes to reducing stress and anxiety, the present study isolated drumbeat, as an auditory stimulus, to determine if steady drumbeat alone affects stress and anxiety.

Hypothesis 1: Self-reported scores of stress after listening to steady drumbeat played at 60 bpm will be lower than after listening to irregular drumbeat or silent room tone.

Hypothesis 2: Self-reported scores of anxiety after listening to steady drumbeat played at 60 bpm will be lower than after listening to irregular drumbeat or silent room tone.

CHAPTER II

Methods

Participants

Three hundred forty-eight adults were recruited through MTURK (Amazon Mechanical Turk). In order to participate in the study, adults needed to be located in the United States. Participants were compensated one US dollar for completion of the study. Forty-seven participants failed the manipulation check (see Appendix A) and were eliminated from the study. In total, 301 participants remained for valid data analysis.

Participants' ages ranged from 18 to 70 years old (M = 35.34, SD = 10.71). Two hundred and twenty-two participants, or 73.8% of the sample identified as White. Thirty-three participants, or 11%, identified as Black or African American. Twenty participants, or 6.6%, identified as Hispanic or Latino. Seventeen participants, or 5.6%, identified as Asian or Pacific Islander. Four participants, or 1.3%, identified as American Indian or Alaskan Native. Finally, five participants, or 1.7%, listed 'other' or preferred not to disclose their ethnic identity.

One hundred and sixty-one participants, or 56.8%, had a bachelor's degree or higher. One hundred and eight-five participants, or 61.5% were male. One hundred and ten participants, or 36.5% were female, and two participants, or 3% listed something else. Out of the sample, one hundred and thirty-seven participants, or 45.5% claimed to have no musical experience. One hundred and twenty-nine

participants, or 42.9% claimed to have some musical experience. Thirty-four participants, or 11.3% claimed to have quite a bit of musical experience. Two hundred and eighty-eight participants, or 95.7% denied any hearing impairment.

Materials

Demographics Questionnaire

We used a brief demographics questionnaire (see Appendix B). This questionnaire asked about the participant's age, education level, ethnicity, musical experience, hearing impairment, and gender.

The Modified Abbreviated Math Anxiety Scale

In order to assess a person's general level of math anxiety, we used the Modified Abbreviated Math Anxiety Scale (mAMAS; see Appendix C; Carey et al., 2017). The mAMAS is a 9-item scale used to measure a person's level of math anxiety. Each item on the scale is a statement regarding math, and the participant rates to what degree that event makes him or her feel anxious. Statements included phrases such as "listening to a lecture in maths class" and "thinking about an upcoming maths test 1 day before".

The participant rated each of these statements using a 5-point Likert scale anchored by a 1 for 'low anxiety' and a 5'high anxiety'. Overall, scores range from 9 to 45, and are calculated by summing the participant's responses. Higher scores indicate higher math anxiety, while lower scores indicate lower math anxiety. No items in the measure are reverse coded.

The original Abbreviated Math Anxiety Scale (AMAS) has good test-retest reliability (r = .85; Hopko et al., 2003) and high internal consistency (α = .90). When compared to other math anxiety measures, convergent validity was good (r = .70; Hopko et al., 2003). The mAMAS was found to be reliable and have high internal consistency (α = .89) as well.

For the purpose of this study, we further modified some of the words slightly to reflect Western dialect; for example, 'maths' was changed to 'math'. Additionally, we included text to ask the participant to think back to a time they were in math class.

Our modified mAMAS consisted of 9 items and was found to have high internal consistency (α = .93).

Visual Analog Scales

We used two Visual Analog Scales (see Appendix D), modeled after the VAS used in a study conducted by Lesage et al., (2012). They suggest that a VAS for stress is an adequate, fast way to collect non-clinical data on a person's perceived stress. The scale appeared as a line marked by 100 tick marks, anchored with zero being 'not stressed at all' to 100 being 'the most stressed I've ever felt'. Instructions for the VA scale read, "click the tick mark that best indicates exactly how stressed out you are feeling at this moment." Scores ranged from zero to 100, with higher numbers indicating higher stress.

To collect data on a person's self-reported level of anxiety, we used a similar VAS for anxiety as well. This scale looked identical to the VAS for stress. Scores ranged from zero to 100, with higher numbers indicating higher anxiety. To help the

participant differentiate between anxiety and stress, we provided a brief definition on each measure.

The Depression Anxiety Stress Scale- 21

We used the Depression Anxiety Stress Scale-21 (DASS-21; see Appendix E; Lovibond & Lovibond, 1995) to measure participants' levels of stress and anxiety. The DASS-21 has depression, anxiety, and stress subscales. Scores in each subscale can help determine a person's non-clinical level of depression, stress, or anxiety (Lovibond & Lovibond, 1995). Instructions on the DASS-21 ask the participant to indicate how much each phrase applied to them within the past week. For this experiment, we modified this to reflect how the participant felt in the present moment. The stress subscale includes phrases such as "I found myself getting agitated" and "I found it difficult to relax". The anxiety subscale includes phrases such as "I was aware of dryness in the mouth" and "I felt scared without any good reason". Each phrase was modified to reflect how the participant was feeling that day.

The rating scale ranges from zero to three, with zero indicating that the feeling does not apply, and three indicating that the feeling applied most of the time. No items are reverse coded. Items 1, 6, 8, 11, 12, 14, and 18 are part of the stress subscale. Items 2, 4, 7, 9, 15, and 19 are part of the anxiety subscale. Finally, items 3, 5, 10, 13, 16, and 21 are part of the depression subscale. When calculating a score for the DASS-21, there will be one independent score for each subscale. To calculate a score, start by summing the total score of one subscale, and then multiply by two. For each subscale, scores can range from zero to 42. Higher scores indicate higher levels

of the subscale construct. Though we are not analyzing scores on the depression subscale, we did not exclude it from the measure.

The DASS-21 is valid and reliable for measuring depression, anxiety and stress in non-clinical populations. According to a study by Antony et al. (1998) it has good internal consistency within each subscale ($r \geq .92$). The DASS-21 has good concurrent validity, with the anxiety subscale strongly correlating with the Beck Anxiety Inventory ($r = .85$). The stress subscale correlates with the State Trait Anxiety Inventory trait version ($r = .68$) and the depression subscale correlates with the Beck Depression Inventory ($r = .79$). The subscales correlated poorly with each other; therefore, the measure has high discriminant validity.

The modified DASS-21 was found to have high internal consistency. The stress subscale was reliable at $\alpha = .94$. The anxiety subscale was reliable at $\alpha = .93$. Finally, the depression subscale was reliable at $\alpha = .95$.

Stimuli

Recording of Drums

We used a recording of a West African djembe, traditionally crafted with wood and rawhide. We struck the drum using a mallet wrapped with leather. For the steady drumbeat condition, drumbeat was played rhythmically at 60 bpm. For the irregular drumbeat condition, drumbeat was played with no distinguishable tempo or pattern. Both drumbeats were digitally altered to ensure that exactly 60 beats played within the minute (see Appendix F).

Silent Room Tone

We used a one-minute sound clip of a recording of a silent, medium sized room (see Appendix F).

Test Tone

We used a one-minute sound clip of a 440 Hz tone as our test tone for the sound check (see Appendix F).

Math Word Problems

For the math portion of the study, we selected several typical eighth-grade word problems (Math Word Problems, n.d.; see Appendix G). Participants chose an answer using multiple choice (A-D). Directly before clicking start, participants were told that they would have 90 seconds to complete as many questions as possible.

Design

This was a between-subjects study, where there was one independent variable (sound) with three levels: steady drumbeat, irregular drumbeat, and silent room tone. Participants in the steady drumbeat condition listened to drumbeat played at 60 bpm for one minute. Participants in the irregular drumbeat condition listened to drumbeat played with no distinguishable pattern for one minute. The dependent variables were self-reported psychological stress and anxiety. Stress refers to the reaction to challenges and demands in which a person cannot cope within the duration of the study. To measure stress, we used the numeric score the participant received on our Visual Analog Scale for Stress. Anxiety refers to the feeling of worry or fear that a person has within the duration of the study. To measure anxiety, we used the numeric score that the participant received on our Visual Analog Scale for Anxiety. To control

for math anxiety, we used scores the participant received on the modified mAMAS. To control for pre-existing group differences in stress and anxiety, we used the participants' scores on the DASS-21.

Procedure

A participant began the procedure by finding the study on MTURK on the computer. Upon reading a brief description (see Appendix H) about the study, the participant clicked on a link that took him or her to Qualtrics, where the study was posted. The first screen displayed the informed consent form (see Appendix I). The participant read the form and decided to either not proceed with the study or give consent. If the participant did not consent to the study, he or she was thanked for his or her time and was prompted to close the test window. No further procedures occurred. If the participant consented to the study, he or she proceeded to the next window.

The next window included a sound check. The participant was instructed to put his or her headphones in at this time. He or she was instructed to click a button to play the sample tone, and then adjust the volume to be audible, but not deafening. Once the participant adjusted the sound on his or her computer accordingly, the participant clicked the 'next' button to proceed with the study.

The next window included a brief demographics questionnaire. The participant completed this questionnaire and clicked 'Continue' until he or she reached the DASS-21. The participant completed the measure.

The next window displayed the math task portion of the study. The participant clicked ‘start’ and proceeded with the math portion of the study.

When the participant completed the math portion, Qualtrics randomly assigned each participant to one of the three conditions— steady drumbeat, irregular drumbeat, or silent room tone. A window displayed text stating “please listen to the sound clip for one minute. While you listen, please focus on the sound and refrain from standing up, taking your headphones out, or beginning a new task”. Depending on which condition the participant was assigned to, the steady drumbeat, irregular drumbeat, or silent room tone played for one minute. When the sound clip finished playing, the next screen automatically displayed the VA scale for stress. Following this was the VA scale for anxiety. The participant completed the measures.

The next window displayed a manipulation check (see Appendix A).

Following the manipulation check, the participant took the mAMAS. Once the participant took the mAMAS, he or she clicked ‘Continue’ and arrived at the last window, which was the debriefing form (see Appendix J). The participant was thanked for his or her time. The participant was compensated for completion.

CHAPTER III

Results

Three one-way between subjects ANOVAs were conducted to compare subscale scores on the DASS-21, in anxiety, stress, and depression, across the three sound conditions. We wanted to make sure that all of our participants across the three sound conditions had relatively similar levels of anxiety, stress, and depression prior to the manipulation. No significant differences were found in the anxiety subscale scores [$F(2, 298) = 1.38$, $p = .254$], stress subscale scores [$F(2, 298) = 1.06$, $p = .349$], or depression subscale scores [$F(2, 298) = 2.52$, $p = .083$] across the three sound conditions (see Tables 1 and 2).

A one-way between subjects ANOVA was conducted to compare scores on the mAMAS to assess math anxiety levels in participants for all three groups. No significant differences were found [$F(2, 298) = .872$, $p = .419$; see Tables 3 and 4].

In order to test our hypothesis, a one-way between subjects ANOVA was conducted to compare self-reported stress after the stressful intervention across the three sound conditions. We hypothesized that participants in the steady drumbeat conditions would have lower scores of self-reported stress than the other two groups. There was a significant, small effect of sound on self-reported stress [$F(2, 298) = 3.07$, $\eta^2 = .02$, $p = .048$; see Table 5]. *Post hoc* comparisons using the Tukey HSD test indicated that the mean score for the steady drumbeat condition ($M = 24.63$, $SD = 26.70$; $p = .037$) was significantly less than the mean score for the silent room tone

condition (M = 34.03, SD = 30.02; see Table 6). There were no significant differences between the irregular drumbeat condition (M = 29.08, SD = 24.80) and the steady drumbeat condition (p = .50) or room tone condition (p =.41; see Table 6 and Figure 1).

Table 1

Descriptive Statistics for DASS-21 Scores Across Sound

	Sound Condition	*N*	*M*	*SD*
Anxiety Subscale	Steady Drumbeat	101	3.28	4.73
	Irregular Drumbeat	93	3.31	4.32
	Silent Room Tone	107	4.27	5.47
	Total	301	3.64	4.9
Stress Subscale	Steady Drumbeat	101	4.37	5.22
	Irregular Drumbeat	92	5.33	5.36
	Silent Room Tone	107	5.36	5.86
	Total	300	5.01	5.5
Depression Subscale	Steady Drumbeat	101	3.61	5.7
	Irregular Drumbeat	93	4.69	5.65
	Silent Room Tone	107	5.42	6.1
	Total	301	4.59	5.9

Table 2

One-Way Analyses of Variance of DASS-21 Scores Across Sound

		df	*SS*	*MS*	*F*	*p*
DASS -21 Anxiety	Between groups	2	65.91	32.96	1.38	0.25
	Within groups	298	7127.34	23.92		
	Total	300	7193.25			
DASS-21 Stress	Between groups	2	63.78	31.9	1.06	0.35
	Within groups	297	8974.17	30.22		
	Total	299	9037.95			
DASS-21 Depression	Between groups	2	170.95	85.47	2.52	0.08
	Within groups	298	10125.97	33.98		
	Total	300	10296.92			

Table 3

Descriptive Statistics for Scores on the mAMAS Across Sound

Sound Condition	*N*	*M*	*SD*
Steady Drumbeat	101	22.64	9.45
Irregular Drumbeat	93	21.44	8.37
Silent Room Tone	107	23.03	8.4
Total	301	22.41	8.75

Table 4

One-Way Analysis of Variance of mAMAS Scores Across Sound

	df	*SS*	*MS*	*F*	*p*
Between groups	2	133.73	66.86	0.872	0.42
Within groups	298	22845.01	76.661		
Total	300	22978.74			

Table 5

One-Way Analysis of Variance of Scores on the Visual Analog Scale for Stress Across Sound

	df	*SS*	*MS*	*F*	*p*
Between groups	2	4595.23	2297.616	3.07	.048*
Within groups	298	223392.84	749.64		
Total	300	227988.07			

Table 6

Means and Standard Deviations for Scores on Visual Analog Scales Across Sound

	Sound Condition	*N*	*M*	*SD*
Stress	Steady Drumbeat	101	24.63	26.71
	Irregular Drumbeat	93	29.08	24.79
	Silent Room Ton	107	34.03	30.02
	Total	301	29.55	27.57
Anxiety	Steady Drumbeat	101	23.55	27.21
	Irregular Drumbeat	93	30.02	27.42
	Silent Room Ton	107	33.79	31.19
	Total	301	29.19	28.98

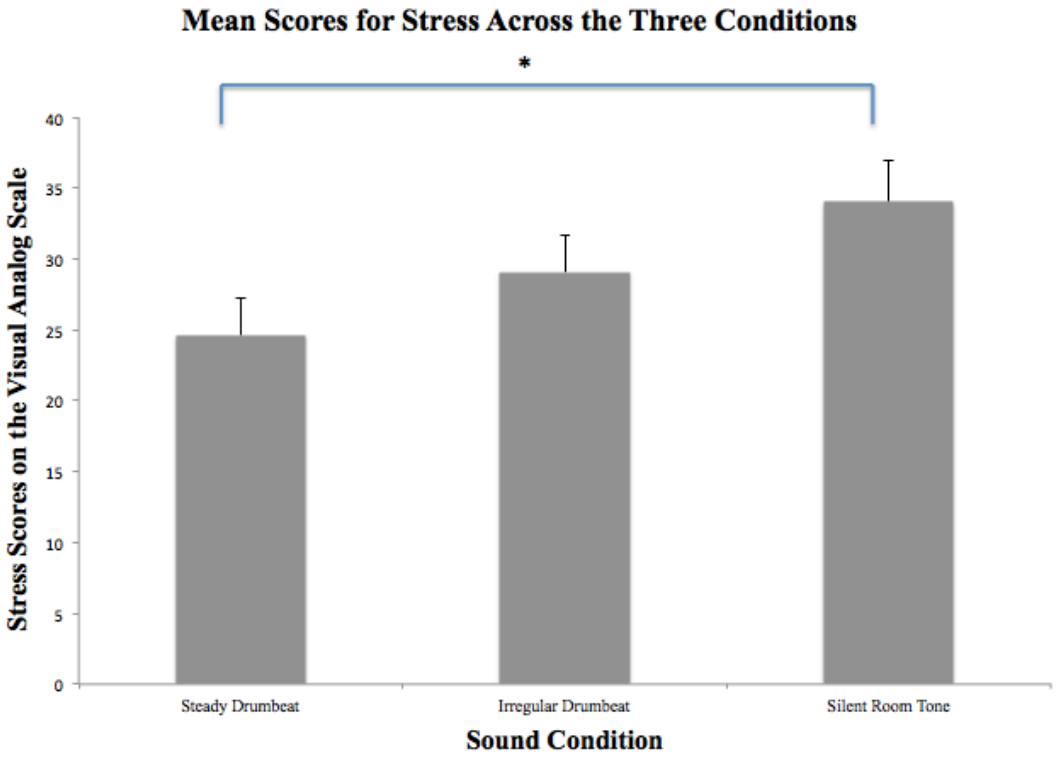


Figure 1. Bar Graph for Mean Scores for Stress Across Sound

Note: Error bars indicate SEM

A one-way between subjects ANOVA was conducted to compare the effect of sound of self-reported anxiety in silent room tone, irregular drumbeat, and steady drumbeat conditions. We hypothesized that participants in the steady drumbeat conditions would have lower scores of self-reported anxiety than the other two groups There was a significant, small effect of sound on self-reported anxiety [$F(2, 298) = 3.35$, $\eta^2 = .02$, $p = .036$; see Table 7]. *Post hoc* comparisons using the Tukey HSD test indicated that the mean score for the steady drumbeat condition ($M = 23.56$, $SD = 27.21$) was significantly less than the mean score for the silent room tone condition ($M = 33.80$, $SD = 31.20$; $p = .029$). There were no significant differences between the irregular drumbeat condition ($M = 30.02$, $SD = 27.42$) and the steady drumbeat condition ($p = .26$) or the room tone condition ($p = .63$; see Table 6 and Figure 2).

Table 7

One-Way Analysis of Variance of Scores on the Visual Analog Scale for Anxiety Across Sound

	df	*SS*	*MS*	*F*	*p*
Between groups	2	5540.44	2770.22	3.351	.036*
Within groups	298	246338.38	826.64		
Total	300	251878.82			

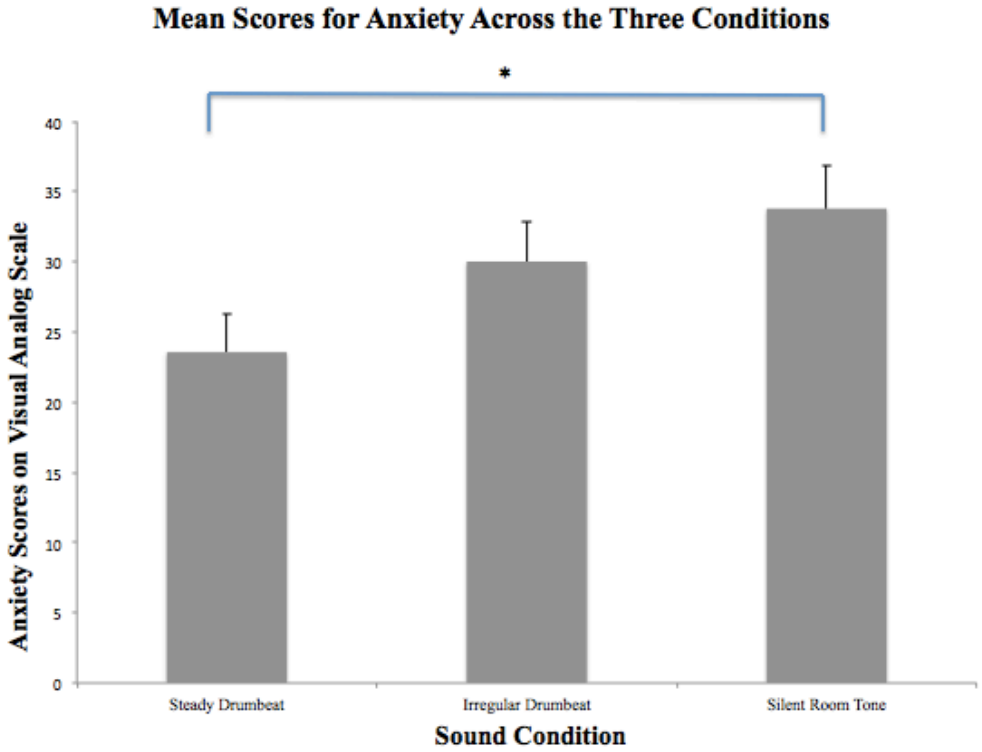


Figure 2. Bar Graph for Mean Scores For Anxiety Across Sound

Note: Error bars indicate SEM

CHAPTER IV

Discussion

We hypothesized that scores of self-reported stress would be lower in groups who listened to steady drumbeat than in groups who listened to irregular drumbeat or silent room tone. The data partially supports this hypothesis, in that stress levels were significantly lower in the group that listened to steady drumbeat compared to the group that listened to silent room tone. Participants who listened to steady drumbeat reported lower stress levels than those who listened to irregular drumbeat; however, the difference was not significant.

We observed a similar pattern in self-reported levels of anxiety. We hypothesized that participants in the steady drumbeat condition would report lower levels of anxiety than participants in the irregular drumbeat or silent room tone condition. We found that, when compared to silent room tone, those who listened to steady drumbeat reported significantly lower levels of anxiety. Participants who listened to irregular drumbeat reported higher levels of anxiety than participants who listened to steady drumbeat, but the difference was not significant.

Isolated Drumming

The present study attempted to discern if the sound component, isolated from other factors of drumming, can have an effect on stress and anxiety. Previous research has examined the effectiveness of drumming modalities as a whole, such as group drumming and drum circles (Deraney et al., 2017; Fancourt et al., 2016; Matney,

2015). The literature supports that group drumming can be therapeutically beneficial to many populations across various domains; however, group drumming and drum circles include many components, which makes it difficult to distinguish exactly what part of drumming has therapeutic benefits. We discussed that benefits could be attributed to social togetherness, communal effort, and physical movement (Bokor, 2014; Yap et al., 2016).

Specifically, many studies have investigated how drumming is effective at reducing stress and anxiety. Several studies indicate that group drumming is effective in reducing stress and anxiety (Fancourt et al., 2016; Deraney et al., 2017). Fewer studies have investigated the effect of drum sound, isolated from group drumming aspects, and found conflicting results. In a study conducted by Gadberry (2011), steady beat played at 66 bpm significantly reduced self-reported anxiety in participants when compared to participants who listened to silence. Our research supports this data with similar results: we found that participants who listened to steady drum beat played at 60 bpm reported lower anxiety and lower stress levels than participants who listened to silent room tone.

Gadberry did not include a comparison group to assess the difference between a steady drumbeat and an irregular drumbeat. We included a third group who listened to irregular drumbeat in order to discern if drumbeat had stress-reducing qualities due to steady rhythm, or due to sound alone. We observed a trend in how sound might affect stress and anxiety. Silent room tone resulted in the highest levels of stress and anxiety, while steady drumbeat resulted in the lowest levels of stress and anxiety. We

hypothesized that irregular drumbeat would be just as unnerving as silence, as we stated that steady drumbeat should result in significantly less anxiety and stress than the other two groups. Interestingly, listening to irregular drumbeat still resulted in lower scores of stress and anxiety than listening to silent room tone, though the difference was not significant.

A study by Bittman et al. (2011) attempted to isolate the sound of drumming and study the effects it had on physiological indicators of stress and anxiety. His study included groups that actively participated in group drumming interventions as well as a group that only listened to the sound of group drumming. Bittman suggested that group drumming interventions could reduce production of biological markers of stress and anxiety, but he did not find the same results in the group that only listened to drumming. His study did not examine the psychological effects of listening to drums alone. Though the current study did not examine physiological variables, this research could supplement Bittman's study, in that psychological stress and anxiety was affected by listening to drums alone. Together, the research indicates that listening to drums may have a small effect on psychological stress and anxiety, but does not strongly impact the neuroendocrine system or increase biological markers of stress reduction. Further research is needed to determine if a greater effect could be found in listening to drums in person, rather than from a recording. In an acute study, biological markers of stress reduction may not be present, even in an in person study; however, over time there may be an effect. More research is needed to understand

what mode of drumming could the most beneficial, both psychologically and biologically.

Overall, our data helps explain how drum therapy is beneficial. The sound component of drum therapy, or as we modeled in our study, a steady drumbeat, has a positive effect on mental health. This is to say that the benefits gained from drum therapy are in part due to hearing the sound of drums, in addition to physical movement, social togetherness, and community membership.

Characteristics of Music

We discussed many components of music, and how rhythm, tempo, predictability, and consistency might play a role in reducing anxiety and stress. We attempted to create our independent variable following the guidelines that research in music has provided. From the music literature, we concluded that predictability, consistency, and repetitive rhythm affects emotional regulation and can help reduce activity in the amygdala (Moore, 2013). In addition, a slower tempo was associated with lower arousal (Gomez & Danuser, 2007; Bresin & Friberg, 2011; Van Der Zwaag et al., 2011; Bradt et al., 2013). Using these qualities as a guideline, we created a slow, rhythmic drumbeat for our steady drum condition, concluding that this would result in the lowest scores of stress and anxiety. Conversely, we altered the rhythm for the irregular drum condition so that it would be unpredictable and inconsistent, concluding that this would not effectively result in lower scores of stress and anxiety. Compared to each other, the drumbeats performed similarly. Steady drumbeat was more relaxing than irregular drumbeat; however, the difference was not

significant. Compared to silence, listening to steady drumbeat resulted in the lowest scores of anxiety and stress in participants. Because the differences between the irregular drumbeat condition and silent room tone condition were not significant, we might conclude that there is a quality to steady drumbeat that reduces more stress than the other sounds. It may also be concluded that hearing any sound was more relaxing than hearing silence, though hearing the steady drumbeat was ultimately the most relaxing.

Limitations

We attempted to minimize the limitations in this study; however, this study was not without shortcomings. The study was conducted online, giving us little control over the participants' environment. Though we asked participants to free themselves of distractions and reduce surrounding noise, it is unlikely that this was the adhered to 100% of the time. Unknown extraneous variables could have impacted the study due to having little control over the participants' environment. We measured stress and anxiety using only methods of self-report. We believed that participants would accurately appraise their own level of stress and anxiety; however, there was no clinical assessment or physiological data to support the scores. To further validate the data, a clinical assessment or physiological data would be beneficial.

We attempted to elicit mild psychological anxiety using math problems. We included a measure of math anxiety after participants completed the math problems. Participants did not differ significantly from each other in math anxiety among the

three groups. However, there was no measure included to confirm if the math problems successfully induced anxiety.

Our participant sample partially represented racial demographics in the United States, according to the US 2010 Census. The percentage of those who identified as White was similar to the census data (our sample, census data; respectively; 73.8%, 72.4%). The percentage of those who identified as Black or African American was similar to the census data (11%, 12.6%). The percentage of those who identified as Hispanic or Latino in our sample was not representative of the general population (6.6%, 16.3%). The percentage of those who identified as Asian or Pacific Islander was similar to the census data (5.6%, 5%). The percentage of those who identified as American Indian or Alaskan Native was similar to the census data (1.3%, 0.9%).

Our participant sample disproportionately represented males, as 61.5% of the participants identified as male and 36.5% of the participants identified as female.

Finally, the measures we used to collect data on self-reported stress and anxiety were simple analog scales and resulted in similar means across sound conditions. We do expect stress and anxiety to be correlated, however, the constructs may have been too similar for participants to discern.

Future Research

Future studies should investigate the effect of drumbeat when played in person, rather than online with headphones. There could be an audible difference of experience when listening to a percussion instrument in person. Additionally, it would help eliminate individual differences of sound delivery with the varying types

of headphones that people use at home. Because of the more controlled environment of an in person study, as well as a richer experience of listening to drums and hearing the vibration of the percussion instrument, the effect may be greater. Research conducted in person additionally could include collecting data on physiological variables. No studies have examined if listening to steady drumbeat in person, rather than using a recording, affects physiological markers of stress or anxiety. Future research should incorporate clinical assessments of psychological variables, and include physiological measures of data if possible to help validate the data.

To elicit mild psychological anxiety, we asked participants to complete a series of math problems. Future researchers may want to investigate if listening to a steady drumbeat is still effective in reducing stress and anxiety levels with a more stressful task, such as being asked to prepare a speech. This could be both more easily assessed and accomplished during an in-person study.

If listening to drums in person was found to have a large effect in reducing stress and anxiety, it could be a beneficial addition to have drum therapists visit in many mental health settings, retirement homes, or hospitals. The data shows that this could be especially beneficial to those who are not physically able to play the drums or participate in drum therapy, but could still attend drum therapy sessions and gain benefits by simply hearing the sounds. If drum therapy is not a viable option, the data shows that hearing a recording of drums is still beneficial, though the effect is small. An in-person study is needed to confirm that the stress-reducing and relaxing effect may be greater in a more controlled setting.

Conclusion

Drums have been used ubiquitously across societies for thousands of years. Traditionally, they may be used to elicit emotional states or to foster healing practices. Today, drum therapy is well known in many health care facilities to be effective in enhancing people's overall mental health. The current study investigated how hearing the sound of steady drumbeat, isolated from the communal and physical aspects of drum therapy or drum circles, affected self-reported stress and anxiety. We found that listening to steady drumbeat was effective and resulted in the lowest levels of stress and anxiety in participants. Because the effect was small, we may have a better understanding of how sound contributes to the wellbeing associated with drum therapy, in that in may be a small component to the process. Other factors, including physical touch, group membership, and social togetherness may contribute to the process as well, but when combined in total, drum therapy has been shown to be highly effective in positive health outcomes. This study shows the possibility that in lieu of a drum therapist or a patient's physical capability to participate in drum therapy, healthcare facilities may still use steady drumbeat sound to elicit a more relaxing mood in patients, which can contribute to improved overall health.

REFERENCES

REFERENCES

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.) Arlington, VA

American Psychological Association (2017, November 1) *Stress in America survey: US at lowest point we can remember*; *Future of nation most commonly reported source of stress.* Retrieved from: http://www.apa.org/news/press/releases/2017/11/lowest-point.aspx

Antony, M. M., Bieling, P. J., Cox, B. J., Enns, M. W., & Swinson, R. P. (1998). Psychometric properties of the 42-item and 21-item versions of the Depression Anxiety Stress Scales in clinical groups and a community sample. *Psychological Assessment,10*, 176-181. doi:10.1037//1040-3590.10.2.176

Bandelow, B., & Michaelis, S. (2015). Epidemiology of anxiety disorders in the 21st century. *Dialogues in clinical neuroscience*, *17*, 327-35.

Baum, A., & Posluszny, D. M. (1999). Health psychology: Mapping biobehavioral contributions to health and illness. *Annual Review of Psychology, 50*, 137-163. doi:10.1146/annurev.psych.50.1.137

Beck, A. T., Rush, A. J., Shaw, B. F, & Emery, G. (1979). *Cognitive therapy of depression: A treatment manual.* New York: Guilford Press.

Beck, A. T., & Steer, R. A. (1990). *Beck Anxiety Inventory manual.* San Antonio, TX: Psychological Corporation.

Bittman, B., Berk, Lee., Felten, D., Westengard, J., Simonton, C., Pappas, J., & Ninehouser, M. (2001). Composite effects of group drumming music therapy on modulation of neuroendocrine-immune parameters in normal subjects. *Alternative Therapies in Health and Medicine*, 7, 38-47.

Bokor, M. (2014). When the Drum Speaks. *Rhetorica: A Journal of the History of Rhetoric, 32*, 165-194. doi:10.1525/rh.2014.32.2.165

Bradt, J., Dileo, C., & Potvin, N. (2013). Music for stress and anxiety reduction in coronary heart disease patients. *Cochrane Database of Systematic Reviews*, *12*, 1-104. doi:10.1002/14651858.cd006577.pub3

Bresin, R., & Friberg, A. (2011). Emotion rendering in music: Range and characteristic values of seven musical variables. *Cortex*. *47*, 1068–1081. https://doi.org/10.1016/j.cortex.2011.05.009

Burns, J.L., Labbé, E., Williams, K., McCall, J. (1999) Perceived and physiological indicators of relaxation: as different as Mozart and Alice in Chains. *Applied Psychobiology and Biofeedback*. *24*, 197-202. https://doi.org/10.1023/A:1023488614364

Cannon, W. B. (1929). *Bodily changes in pain, hunger, fear and rage*. New York: D. Appleton.

Carey, E., Hill, F., Devine, A., & Szűcs, D. (2017). The Modified Abbreviated Math Anxiety Scale: A valid and reliable instrument for use with children. *Frontiers in Psychology, 8*. https://doi.org/10.3389/fpsyg.2017.00011

Dean, M. (2012). *The drum: A history*. Lanham, MD: Scarecrow Press.

Delongis, A., Coyne, J., Dakof, G., Folkman, S., & Lazarus, R. S. (1982) Relationship of daily hassles, uplifts, and major life events to health status. *Health Psychology*, 1, 119-136. https://doi.org/10.1037/0278-6133.1.2.119

Delongis, A., Folkman, S., & Lazarus, R. S. (1988). The impact of daily stress on health and mood: psychological and social resources as mediators. *Journal of Personality and Social Psychology*, *54*, 486-495. https://doi.org/10.1037//0022-3514.54.3.486

Demarco, J., Alexander, J. L., Nehrenz, G., & Gallagher, L. (2011). The benefit of music for the reduction of stress and anxiety in patients undergoing elective cosmetic surgery. *Music and Medicine, 4*, 44-48. https://doi.org/10.1177/1943862111424416

Deraney, J., Davis, M., Evers, H. B., German, K., Hamill, J. C., Karas-Irwin, B. S., . . . Shaw, R. E. (2017). Drumming effect on anxiety. *Archives of Psychiatric Nursing, 31*, 528-529. https://doi.org/10.1016/j.apnu.2017.05.001

Dhabhar, F. S., & Mcewen, B. S. (1997). Acute stress enhances while chronic stress suppresses cell-mediated immunity in-vivo: A potential role for leukocyte trafficking. *Brain, Behavior, and Immunity, 11*, 286-306. https://doi.org/10.1006/brbi.1997.0508

Dileo C., Bradt J. Music therapy: applications to stress management. *Principles and Practice of Stress Management*. 3rd Edition. New York: Guilford Press, 2007.

Everly, J., and Lating, J. M. (2013). *Clinical guide to the treatment of the human*

stress response (pp 17-51). New York: Springer. https://doi.org/10.1007/978-1-4614-5538-7_2

Fancourt, D., Perkins, R., Ascenso, S., Carvalho, L. A., Steptoe, A., & Williamon, A. (2016). Effects of group drumming interventions on anxiety, depression, social resilience and inflammatory immune response among mental health service users. *Plos One, 11*, 1-16. https://doi.org/10.1371/journal.pone.0151136

Friedman, R. L. (2011). *The healing power of the drum: A journey of rhythm and stories*. Gilsum, NH: White Cliffs Media.

Gadberry, A. L. (2011). Steady beat and state anxiety. *Journal of Music Therapy, 48*, 346-356. https://doi.org/10.1093/jmt/48.3.346

Goldstein, D. S. (2010). Adrenal responses to stress. *Cellular and Molecular Neurobiology, 30*, 1433-1440. https://doi.org/10.1007/s10571-010-9606-9

Gomez, P., & Danuser, B. (2007). Relationships between musical structure and psychophysiological measures of emotion. *Emotion, 7*, 377-387. https://doi.org/10.1037/1528-3542.7.2.377

Hannibal, K. E., & Bishop, M. D. (2014). Chronic stress, cortisol dysfunction, and pain: A psychoneuroendocrine rationale for stress management in pain rehabilitation. *Physical Therapy, 94*, 1816-1825. https://doi.org/10.2522/ptj.20130597

Harvard Medical School. (2016). *Stress Management: Enhance your well-being by*

reducing stress and building resilience (pp. 1-53, Publication) (Fricchione, G., MD, Ed.). Boston, MA: Harvard Health Publications. Retrieved from: www.health.harvard.edu

Hofmann, S. G., Sawyer, A. T., Witt, A. A., & Oh, D. (2010). The effect of mindfulness-based therapy on anxiety and depression: A meta-analytic review. *Journal of Consulting and Clinical Psychology, 78*, 169-183. https://doi.org/0.1037/a0018555

Hoge, E. A., Bui, E., Marques, L., Metcalf, C. A., Morris, L. K., Robinaugh, D. J., . . . Simon, N. M. (2013). Randomized controlled trial of mindfulness meditation for generalized anxiety disorder. *The Journal of Clinical Psychiatry, 74*, 786-792. https://doi.org/10.4088/jcp.12m08083

Hopko, D. R., Mahadevan, R., Bare, R. L., & Hunt, M. K. (2003). The Abbreviated Math Anxiety Scale (AMAS). *Assessment, 10*, 178-182. https://doi.org/10.1177/1073191103010002008

Jiang, J., Zhou, L., Rickson, D., & Jiang, C. (2013). The effects of sedative and stimulative music on stress reduction depend on music preference. *The Arts in Psychotherapy, 40*, 201-205. https://doi.org/10.1016/j.aip.2013.02.002

Khalfa, S., Bella, S. D., Roy, M., Peretz, I., & Lupien, S. J. (2003). Effects of relaxing music on salivary cortisol level after psychological stress. *Annals of the New York Academy of Sciences, 999*, 374-376. https://doi.org/10.1196/annals.1284.045

Khalfa, S., Roy, M., Rainville, P., Bella, S. D., & Peretz, I. (2008). Role of tempo

entrainment in psychophysiological differentiation of happy and sad music? *International Journal of Psychophysiology, 68*, 17-26. https://doi.org/10.1016/j.ijpsycho.2007.12.001

Lang, M., Krátký, J., Shaver, J. H., Jerotijević, D., & Xygalatas, D. (2015). Effects of anxiety on spontaneous ritualized behavior. *Current Biology*, *25*(14), 1892–1897. doi: 10.1016/j.cub.2015.05.049

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. New York, NY: Springer Publishing Company.

Lesage, F. X., Berjot, S., & Deschamps, F. (2012). Clinical stress assessment using a visual analogue scale. *Occupational Medicine, 62*, 600-605. https://doi.org/10.1093/occmed/kqs140

Lovibond, P.F, & Lovibond, S. H. (1995). The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour Research and Therapy, 33,* 335-342. https://doi.org/10.1016/0005-7967(94)00075-U

Lovibond, S.H. & Lovibond, P.F. (1995). Manual for the Depression Anxiety & Stress Scales. (2nd Ed.) Sydney: Psychology Foundation.

Mariotti, A. (2015). The effects of chronic stress on health: New insights into the molecular mechanisms of brain–body communication. *Future Science OA, 1*. doi:10.4155/fso.15.21

Math Word Problems with Answers - Grade 8. (n.d.). Retrieved from https://www.analyzemath.com/middle_school_math/grade_8/problems.html

Matney, B. (2015). The use of percussion in therapy: A content analysis of the literature. *Nordic Journal of Music Therapy, 25*, 372-403. https://doi.org/10.1080/08098131.2015.1084027

Mcewen, B. S. (2002). Introduction: Protective and damaging effects of stress mediators: The good and bad sides of the response to stress. *Metabolism, 51*, 2-4. https://doi.org/10.1053/meta.2002.33183

Mcewen, B. S. (2008). Central effects of stress hormones in health and disease: Understanding the protective and damaging effects of stress and stress mediators. *European Journal of Pharmacology, 583*, 174-185. https://doi.org/10.1016/j.ejphar.2007.11.071

Moore, K. S. (2013). A systematic review on the neural effects of music on emotion regulation: Implications for music therapy practice. *Journal of Music Therapy, 50*, 198-242. https://doi.org/10.1093/jmt/50.3.198

Muscatell, K.A., & Eisenberger, N.I. (2012) A social neuroscience perspective on stress and health. *Social & Personal Psychology Compass*, *6*, 890–904. https://doi.org/10.1111/j.1751-9004.2012.00467.x

Perciavalle, V., Blandini, M., Fecarotta, P., Buscemi, A., Corrado, D. D., Bertolo, L., . . . Coco, M. (2016). The role of deep breathing on stress. *Neurological Sciences, 38*, 451-458. https://doi.org/10.1007/s10072-016-2790-8

Radstaak, M., Geurts, S. A., Brosschot, J. F., & Kompier, M. A. (2014). Music and psychophysiological recovery from stress. *Psychosomatic Medicine, 76*, 529-537. https://doi.org/10.1097/psy.0000000000000094

Robb, S. L. (2000). Music assisted progressive muscle relaxation, progressive muscle relaxation, music listening, and silence: A comparison of relaxation techniques. *Journal of Music Therapy, 37*, 2-21. https://doi.org/10.1093/jmt/37.1.2

Rybak, C., & Decker-Fitts, A. (2009). Understanding Native American healing practices. *Counselling Psychology Quarterly, 22*, 333-342. https://doi.org/10.1080/09515070903270900

Selye, H. The stress syndrome. *The American Journal of Nursing*, *65*, 3 (1965), 97–99. https://doi.org/10.2307/3453119

Shohani, M., Badfar, G., Nasirkandy, M., Kaikhavani, S., Rahmati, S., Modmeli, Y., . . . Milad, A. (2018). The effect of yoga on stress, anxiety, and depression in women. *International Journal of Preventive Medicine, 9*, 21. https://doi.org/10.4103/ijpvm.ijpvm_242_16

Stubbs, B., Vancampfort, D., Rosenbaum, S., Firth, J., Cosco, T., Veronese, N., . . . Schuch, F. B. (2017). An examination of the anxiolytic effects of exercise for people with anxiety and stress-related disorders: A meta-analysis. *Psychiatry Research, 249*, 102-108. https://doi.org/10.1016/j.psychres.2016.12.020

Tan, X., Yowler, C.J., Super, D.M.,& Fratianne, R.B. (2012).The interplay of preference, familiarity and psychophysical properties in defining relaxation music. *Journal of Music Therapy, 49*, 150–179. https://doi.org/10.1093/jmt/49.2.150

Thoma, M. V., Zemp, M., Kreienbühl, L., Hofer, D., Schmidlin, P. R., Attin, T., . . .

Nater, U. M. (2014). Effects of music listening on pre-treatment anxiety and stress levels in a dental hygiene recall population. *International Journal of Behavioral Medicine, 22*, 498-505. https://doi.org/10.1007/s12529-014-9439-x

Tsigos, C., & Chrousos, G. P. (2002). Hypothalamic–pituitary–adrenal axis, neuroendocrine factors and stress. *Journal of Psychosomatic Research, 53*, 865-871. https://doi.org/10.1016/s0022-3999(02)00429-4

Van Der Zwaag, M. D., Westerink, J. H., & Broek, E. L. (2011). Emotional and psychophysiological responses to tempo, mode, and percussiveness. *Musicae Scientiae, 15*, 250-269. https://doi.org/10.1177/102986491101500207

Walker, M. (2003). Music as knowledge in shamanism and other healing traditions of Siberia. *Arctic Anthropology, 40*, 40-48. https://doi.org/10.1353/arc.2011.0039

Weaver, C. E., Dwiggins, A., Mccormick, K., Fesler, M., & Goyal, S. D. (2015). Rhythmic entrainment: A music therapy intervention to elicit relaxation and decrease anxiety for the bone marrow transplant recipient. *Biology of Blood and Marrow Transplantation, 21*, https://doi.org/10.1016/j.bbmt.2014.11.261

Yap, A. F., Kwan, Y. H., & Ang, S. B. (2017). A systematic review on the effects of active participation in rhythm-centered music making on different aspects of health. *European Journal of Integrative Medicine, 9*, 44-49. https://doi.org/10.1016/j.eujim.2016.11.011

Yoshihara, K., Hiramoto, T., Oka, T., Kubo, C., & Sudo, N. (2014). Effect of 12 weeks of yoga training on the somatization, psychological symptoms, and stress-related biomarkers of healthy women. *BioPsychoSocial Medicine, 8*, 1. https://doi.org/10.1186/1751-0759-8-1

APPENDICES

APPENDIX A

MANIPULATION CHECK

Recall the second sound that you listened to (not the tone that you used to adjust the volume). What did you hear? Try to pick the answer that sounds the closest to what you heard.

- A guitar solo
- Birds chirping outside
- Nothing
- Someone hitting a drum

Two people talking

APPENDIX B

DEMOGRAPHICS QUESTIONNAIRE

1. How old are you (in years)?

2. What is your highest level of education?
    - Some high school
    - High school diploma
    - Some college
    - Bachelor's degree
    - Some graduate school
    - Master's or doctoral degree

3. What ethnicity do you most closely identify with?
    1. Black/ African- American
    2. Hispanic/ Latino
    3. Asian/ Pacific Islander
    4. American Indian/ Alaska Native
    5. White
    6. Prefer not to say

4. What is your gender?
    1. Male
    2. Female
    3. Specify in the space provided ‘_____‘
    4. Prefer not to say

5. Indicate to what degree you feel you have musical experience (e.g., playing music, writing music, performing music, teaching about music, participating in events where there are interactive music or rhythm based acts)
    1. I have no musical experience
    2. I have some musical experience
    3. I have quite a bit of musical experience

6. Do you have any hearing impairment that you are aware of?
    1. Yes
    2. No
    3. Unsure

APPENDIX C

MODIFIED ABBREVIATED MATH ANXIETY SCALE (ALTERED)

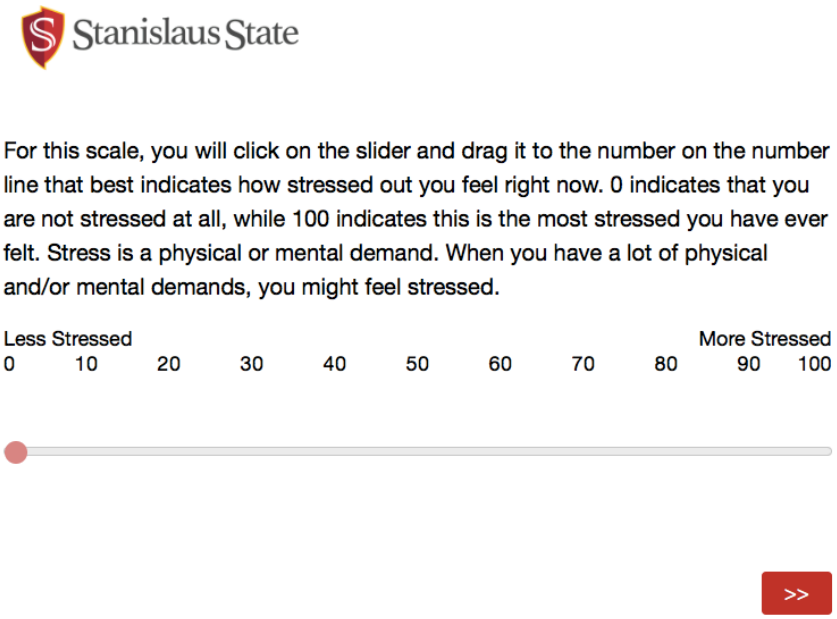
Please rate each item below in terms of how anxious you would feel during the event specified.

	Low Anxiety	Some Anxiety	Moderate Anxiety	Quite a bit of Anxiety	High Anxiety
Having to complete a worksheet by yourself	○	○	○	○	○
Thinking about an upcoming math test the day before you take it	○	○	○	○	○
Watching the teacher work out an equation on the board	○	○	○	○	○
Taking a test in math class	○	○	○	○	○
Being given math homework with lots of difficult questions that you have to hand in the next day	○	○	○	○	○
Listening to a math lecture	○	○	○	○	○
Listening to another student in your class explain a math formula	○	○	○	○	○
Finding out that you are going to have a surprise math quiz when you start class	○	○	○	○	○
Starting a new topic in math	○	○	○	○	○

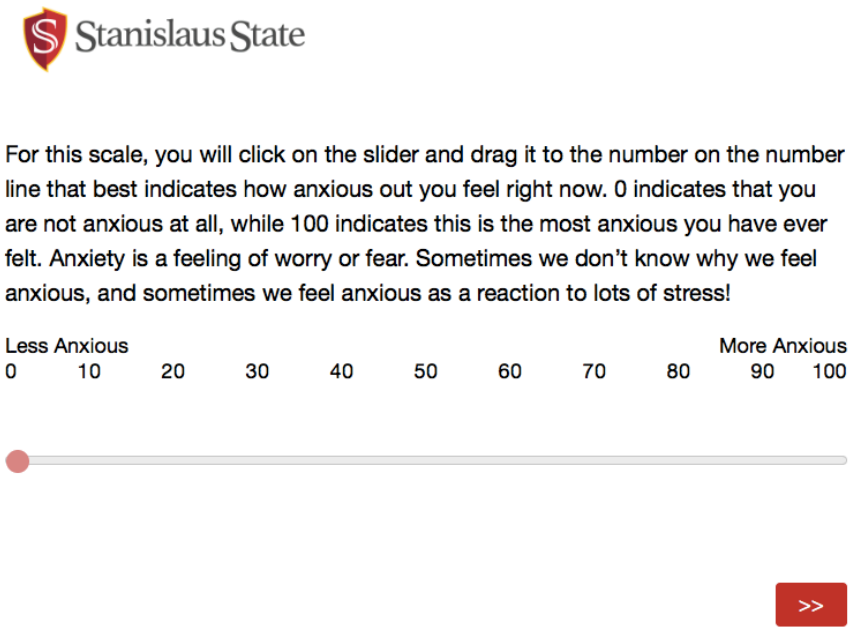
APPENDIX D

ANALOG SCALES

Visual Analog Scale for Stress



Visual Analog Scale for Anxiety



APPENDIX E

DEPRESSION ANXIETY STRESS SCALE 21 (MODIFIED)

Stanislaus State

Please read each statement and choose a number- 0, 1, 2 or 3, to indicate how much the statement applies to you today. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

0 Does not apply to me at all
1 Applies to me to some degree
2 Applies to me to a considerable degree
3 Applies to me very much

	0	1	2	3
I feel that I have nothing to look forward to	○	○	○	○
I am finding myself getting agitated	○	○	○	○
I am finding it difficult to relax	○	○	○	○
I feel down-hearted and blue	○	○	○	○
I am finding myself intolerant of anything that keeps me from getting on with what I am doing	○	○	○	○
I feel that I am close to panic	○	○	○	○
I am unable to become enthusiastic about anything	○	○	○	○
I feel I am not worth much as a person	○	○	○	○
I feel that I am rather touchy	○	○	○	○
	0	1	2	3

	0	1	2	3
I am finding it hard to wind down	○	○	○	○
I am aware of dryness of my mouth	○	○	○	○
I can't seem to experience any positive feeling at all	○	○	○	○
I am experiencing breathing difficulty (e.g. excessively rapid breathing, breathlessness in the absence of physical exertion)	○	○	○	○
I am finding it difficult to work up the initiative to do things	○	○	○	○
I am tending to over-react to situations	○	○	○	○
I am experiencing trembling (e.g. in the hands)	○	○	○	○
I feel that I am using a lot of nervous energy	○	○	○	○
I am worried about situations in which I might panic and make a fool of myself	○	○	○	○
I am aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase, heart missing a beat)	○	○	○	○
I feel scared without any good reason	○	○	○	○
I feel that life is meaningless	○	○	○	○

>>

APPENDIX F

SOUND STIMULI

Steady Drumbeat Stimulus
https://drive.google.com/open?id=1hxo0a67lKtodj3b3OGal12iRR2h-jf6X

Irregular Drumbeat Stimulus

Sample Tone Stimulus

Room Tone Stimulus

APPENDIX G

MATH QUESTIONS

1. In a group of 120 people, 90 have an age of more 30 years, and the others have an age of less than 20 years. If a person is selected at random from this group, what is the probability the person's age is less than 20?

a) ○ p = .30

b) ○ p = .23

c) ○ p = .25 x

d) ○ p = .20

2. A six-sided die is rolled once. What is the probability that the number rolled is an even number greater than 2?

a. ○ 1/4

b. ○ 1/5

c. ○ 1/2

d. ○ 1/3 x

3. Pump A can fill a tank of water in 5 hours. Pump B can fill the same tank in 8 hours. How long does it take the two pumps working together to fill the tank? (round your answer to the nearest minute).

a. ○ 3 hours and 10 minutes

b. ○ 3 hours and 20 minutes

c. ○ 3 hours and 5 minutes x

d. ○ 2 hours and 55 minutes

4. Joe drove at the speed of 45 miles per hour for a certain distance. He then drove at the speed of 55 miles per hour for the same distance. What is the average speed for the whole trip?

a. ○ 50 miles per hour

b. ○ 49.5 miles per hour x

c. ○ 51.5 miles per hour

d. ○ 49 miles per hour

APPENDIX H

BRIEF DESCRIPTION

A portion of this study uses sound! Please ensure that you have working headphones nearby that you will be able to use before agreeing to partake in this study.

APPENDIX I

INFORMED CONSENT FORM

INFORMED CONSENT FORM

1. **Summary:** This research study will examine how sound may have an effect on our mental health. If you agree to participate, you will be asked to answer survey questions that ask about your emotions and how you are feeling currently.

2. **Your right to withdraw/discontinue:** You are free to discontinue your participation at any time without penalty. You may also skip any survey questions that make you feel uncomfortable. Even if you withdraw from the study, you will receive any entitlements that have been promised to you in exchange for your participation, including compensation.

3. **Benefits:** Participation in this research study does not guarantee any benefits to you. However, possible benefits include the fact that you may learn something about how research studies are conducted and you may learn something about this area of research (i.e., how sound may be beneficial for mental health)

4. **Additional information:** You will be given additional information about the study after your participation is complete.

5. **Time commitment:** If you agree to participate in the study, it may take up to 20 minutes to complete the survey.

6. **Guarantee of Confidentiality:** All data from this study will be kept from inappropriate disclosure and will be accessible only to the researchers and their faculty advisor. Data collected will be stored on a password-protected website and de-identified for analyses. The researchers are not interested in anyone's individual responses, only the average responses of everyone in the study.

7. **Risks:** The present research is designed to reduce the possibility of any negative experiences as a result of participation. Risks to participants are kept to a minimum. However, if your participation in this study causes you any concerns, anxiety, or distress, please contact the Treatment Referral Helpline at 1-800-662-HELP (4357), or go online to http://www.nimh.nih.gov/health/find-help/index.shtml.

8. **Researcher Contact Information:** This research study is being conducted by Katie Moody. The faculty supervisor is Dr. Gary Williams, Assistant Professor,

Department of Psychology and Child Development, California State University, Stanislaus. If you have questions or concerns about your participation in this study, you may contact the researchers through Dr. Williams at (209) 667-3065.

9. **Results of the Study:** You may obtain information about the outcome of the study by the end of August 2019, by contacting Dr. Williams.

10. **Psychology Institutional Review Board Contact Information:** If you have any questions about your rights as a research participant, you may contact the Chair of the Psychology Institutional Review Board of California State University Stanislaus, Dr. Kelly Cotter at PsychologyIRB@csustan.edu or (209) 667-3865.

11. **Personal Copy of Consent Form**: You may print a blank, unsigned copy of this consent form at the beginning of the study by clicking this link.
    By clicking "Yes, I give my consent" below, you are indicating that you are both 18 years or older and have freely consented to participate in this research study.

    ○ Yes, I give my consent

    ○ No, I do not give my consent

APPENDIX J

DEBRIEFING FORM

DEBRIEFING FORM

Thank you for participating in this study! We are interested in finding out if listening to drumbeat can reduce anxiety and stress. Prolonged exposure to stress is taxing on the immune system, and can result in various health problems. Several studies have found that participating in group drumming sessions can help reduce symptoms of stress and anxiety. We wanted to determine if listening to steady drumbeat alone could have similar effects. We divided participants into three groups: one group listened to a slow, steady drumbeat. One group listened to an irregular drumbeat with no detectable pattern or rhythm. The final group listened to a silent room tone. Our goal was to examine the effect drumbeat has on stress and anxiety. Current research is conflicting as to whether listening to a steady drumbeat has any effect on anxiety and stress levels at all.

All the information we collected in this study will be kept safe from inappropriate disclosure, and there will be no way of identifying your responses in the data archive. We are not interested in anyone's individual responses; rather, we want to look at the general patterns that emerge when all of the participants' responses are put together. We ask that you do not discuss the nature of the study with others who may later participate in it, as this could affect the validity of our research conclusions. If you have any questions about the study or would like to learn about the results of the study, you may contact me (Katie) through my research supervisor, Dr. Gary Williams, at (209) 667-3065.

If you have questions about your rights as a research participant, you may contact the Chair of the Psychology Institutional Review Board, Dr. Kelly Cotter, at PsychologyIRB@csustan.edu or (209) 667-3965.

If participating in this study caused you any concern, anxiety, or distress, please contact the Treatment Referral Helpline at 1-800-662-HELP (4357), or go online to http://www.nimh.nih.gov/health/find-help/index.shtml.

For more information on this topic, please visit:

https://www.ncbi.nlm.nih.gov/pubmed/22097102

https://www.ncbi.nlm.nih.gov/pubmed/11191041

https://www.tandfonline.com/doi/abs/10.1080/08098131.2015.1084027