The Relationship Between Theta Binaural Beats and Well-Being

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Abstract

This paper is the final component of the master of science degree in psychology within the specialization of research, evaluation, and measurement at Capella University. It is a quantitative research study proposal aimed at examining the relationship between exposure to theta binaural beats and well-being. The overall research strategy is comprised of a repeated measures, double-blind, experimental design with random assignment. The expected results of the proposed study are identified and discussed as if the research were actually undertaken. The research question that guides this proposal is: To what extent does daily exposure to a 30 minute theta binaural beats session for a length of 45 days affect an individual's subjective sense of well-being?

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Chapter 1. Introduction

This paper is the final component of the master of science degree in psychology within the specialization of research, evaluation, and measurement at Capella University. This specialization puts a high level of emphasis upon research study design and should prepare one to enter the field of psychological research. For further clarification, the author of the following proposal intends to work in the field of consciousness research during her future career. To complement her educational and career goals, this paper will consist of a quantitative research study proposal aimed at examining the relationship between exposure to theta binaural beats and well-being.

A special note of the best practices in the field of psychological research will be made in the literature review section (Chapter 2). The overall research strategy will also be discussed (Chapter 3); this strategy will be comprised of a repeated measures, double-blind, experimental design with random assignment. Beyond this, the expected results of the proposed study will be identified and discussed as if the research were actually undertaken (Chapter 4-5).

To give the reader some background, binaural beats are "auditory brainstem responses" generated when tones of two different frequencies are played through stereo headphones so that a different frequency is playing in each ear (Padmanabhan, Hildreth, & Laws, 2005, p. 876). When an individual listens to binaural beats within a particular frequency range, his or her brainwaves tend to synchronize to that frequency range. This process is often called brainwave entrainment and is partly explained by the frequency-following response of one's brainwaves (Huang & Charyton, 2008).

For brevity, different levels of brainwaves are associated with various states of consciousness. Beta waves, between 14 and 100 Hz, are associated with the alert, waking state.

Alpha waves, between 8 and 13 Hz, are associated with relaxation, beginning meditation, and closed eyelids. Theta waves, between 4 and 8 Hz, are associated with advanced meditation and the initial stage of sleep/waking. Finally, delta waves at 4 Hz or less, are associated with deep, dreamless sleep (Padmanabhan, Hildreth, & Laws, 2005; Ulam, 1991).

Preliminary research has shown that listening to binaural beats can have positive psychological benefits. When studying the anxiety 108 patients' experienced before surgery, Padmanabhan, Hildreth, and Laws (2005) concluded that binaural beats have the "potential to decrease acute pre-operative anxiety significantly" (p. 874). Moreover, after assessing the psychological and physiological effects of 60 days of daily use of delta binaural beats, Wahbeh, Calabrese, and Zwickey (2007) found "...a decrease in trait anxiety" and "an increase in quality of life" (p. 25).

If one were to actually engage in the research described in the following proposal, the impending results would further extend the current knowledgebase regarding binaural beats. In particular, the proposed study would extend the knowledge regarding the relationship between daily exposure to theta binaural beats and well-being which, as of now, is thought to have never been studied.

Moreover, if the proposed research were carried out, the knowledge gained would prove to be useful in many fields throughout psychology. In particular, binaural beats could be helpful in the field of clinical psychology as a treatment protocol for depression, anxiety, and possibly even posttraumatic stress disorder.

For a moment, imagine a world where a patient diagnosed with depression would download their medication onto an iPod and listen to it for 30 minutes per day rather than

visiting a local drugstore. It sounds a bit like science fiction, yet these are the boundaries that psychologists in the field of consciousness research are currently pushing beyond.

Of course, much more investigation would be needed to provide further evidence for any of these clinical uses. Nonetheless, undertaking this study would assuredly move research in this area forward, and it would enhance the present knowledgebase. Accordingly, these are the primary reasons for the significance and importance of this proposed study.

The research question that will guide the following proposal is: To what extent does daily exposure to a 30 minute theta binaural beats session for a length of 45 days affect an individual's subjective sense of well-being?

Chapter 2. Literature Review

To begin our discussion, it is important to review the historical and current literature regarding binaural beats in order to provide support for the research question. As well, the following discussion will provide context for the proposal, and it will highlight the best practices in the field of psychological research.

History of Binaural Beats

Binaural beats were first discovered by H. W. Dove, a German experimenter in 1839. However, for many years this acoustical phenomena was assumed to be a rare form of monaural beats. This stems from the fact that binaural beats were studied by utilizing tuning forks that were placed near separate ears of the listener. At the time, researchers believed that study participants were detecting sounds that were intended for the other ear or that the sounds were being conducted by the human skull (Oster, 1973).

Nonetheless, by the early 1900s scientists started to hypothesize that binaural beats were not a rare form of monaural beats. Peterson (1916) undertook a study to examine how volunteers perceived binaural beats and monaural beats. In summation, the results of the Peterson (1916) study suggested that monaural beats could potentially originate in the basilar membrane whereas binaural beats could be cortical in origin. Accordingly, this research began to turn the tide in the direction of understanding the true nature of the human perception of binaural beats.

As decades passed, technology also began to aid researchers in studying binaural beats. These advances enabled scientists to replace the tuning forks of their predecessors with electronic oscillators that supplied tones with controlled pitch, intensity, and purity (Oster, 1973). Additionally, researchers began to recognize that the person listening to binaural beats was hearing the difference between the two frequencies, rather than hearing the frequencies

separately. This means that if 320 Hz is played in one ear and 332 Hz in the other, then the binaural beats would have a perceived frequency of 12 Hz.

Taking this discussion a step further, it must be noted that humans cannot normally hear sounds lower than 20 Hz (Bear, Connors, & Paradiso, 2007). This effect of perceiving low-frequency sounds is uniquely brought about by the human brain's perception of binaural beats. As well, Oster (1973) found that when a person listens to binaural beats, an illusion is created making the individual believe that the sounds are coming from somewhere inside of the head rather than outside of it.

As one would expect, animal studies were also undertaken with the aim of understanding how binaural beats affect neurons in the brain. In a study carried out by Kuwada, Yin, and Wickesberg (1979), the inferior colliculus neurons of cats were exposed to binaural beats. The authors, having performed the research within the department of Neurophysiology at University of Wisconsin, observed the cell response to be "phase-locked to the beat frequency" (Kuwada, Yin, & Wickesberg, 1979, p. 586). In other words, the cells periodically responded according to the rate of the frequency of the binaural beats. Accordingly, the authors concluded that their findings may be a potential neural correlate for the sensation of binaural beats in humans.

As a review of the history of binaural beats brings us closer to the present, one other notable technological advance occurred, Hans Berger's electroencephalography (EEG). EEG, which measures electrical activity within the brain by using electrodes placed upon the scalp, was utilized to study the auditory driving of brainwaves by the Monroe Institute in the mid-1970s. The Monroe Institute, developer of the Hemi-Sync brainwave entrainment device, studied research participants' subjective experiences with binaural beats alongside their EEG patterns (Ulam, 1991).

Granted, the scientific literature provided by the Monroe Institute may be biased seeing that the company developed the Hemi-Sync device. As well, the Monroe Institute's research studies were not carried out in a scientifically rigorous manner. Most of the studies did not include control groups or provide descriptions of the statistical analyses for confirmatory purposes (Ulam, 1991). Nonetheless, the Monroe Institute's research is significant in the sense that their studies were among the first to attempt to measure the psychological effects of human exposure to binaural beats and the consequent EEG patterns brought about by these changes in consciousness.

Psychological Effects of Binaural Beats

As touched upon in the introduction (Chapter 1), preliminary results have provided evidence to support the assertion that the use of binaural beats can produce psychological effects. Padmanabhan, Hildreth, and Laws (2005), having conducted their research at the Sunderland Royal Hospital's day surgery unit, examined the relationship between binaural beats and preoperative anxiety in a group of 108 patients who were undergoing general anesthesia. The authors utilized a 30 minute session of binaural beats that took the participants through a progressively slowing range of binaural beats until eventually reaching a 10 minute period of delta binaural beats. Listening to binaural beats decreased the patients' mean anxiety scores on the State-Trait Anxiety Inventory by 26.3%. These results led the authors to conclude that listening to binaural beats could potentially decrease preoperative anxiety.

Another study, conducted by Lane, Kasian, Owens, and Marsh (1998) at Duke University, recruited a group of subjects (N=29) to investigate how the combination of theta/delta range binaural beats affect vigilance performance and mood. The participants underwent three sessions which included one experimental session of beta binaural beats, one

experimental session of theta/delta binaural beats, and one training session where they only listened to pink noise that did not include binaural beats. The authors concluded that the beta binaural beat sessions were associated with a less negative mood and increased performance when compared to the theta/delta binaural beats.

Wahbeh, Calabrese, and Zwickey (2007) performed a pilot study to examine the psychological and physiological effects of 60 days of daily use of binaural beats within the delta range. A strength of the study was the authors' use of multiple psychological measures including the Beck Depression Inventory-2 and the World Health Organization-Quality of Life Inventory, among others. The authors also utilized multiple physiological measures. That said, the small number of participants (N=8) was a weakness of the study; it leads one to conclude that the results should not be generalized to the larger population.

Nonetheless, Wahbeh, Calabrese, and Zwickey (2007) found a "decrease in trait anxiety ($p = 0.004$), an increase in quality of life ($p = 0.03$), and a decrease in insulin-like growth factor-1 ($p = 0.01$) and dopamine ($p = 0.02$) observed between pre- and postintervention measurements" (p. 25). It also must be noted that the World Health Organization-Quality of Life Inventory is a measure of well-being. This means that, although this study did not have much statistical power, the results suggest that daily exposure to delta binaural beats could significantly increase an individual's well-being. In turn, this also begs the question, if delta binaural beats could potentially increase well-being, could theta binaural beats potentially increase well-being?

Leaving the reader with that question in mind, another study by Wahbeh, Calabrese, Zwickey, and Zajdel (2007) should also be considered. The researchers performed a blinded, randomized, placebo-controlled crossover study of the physiological, neuropsychological, and the electroencephalographic (EEG) effects of a 30 minute session of theta binaural beats. Since

theta binaural beats are the form of binaural beats this proposal aims to study, this article is of particular relevance.

Wahbeh, Calabrese, Zwickey, and Zajdel (2007) did not find a significant difference between the control and the experimental conditions on the EEG measures. This means that they found no evidence to support the assertion that theta binaural beats entrain brainwave activity to theta levels. The results also indicated an increase in depression and "poorer immediate recall after listening to binaural beats" (Wahbeh, Calabrese, Zwickey, & Zajdel, 2007, p. 199). Nevertheless, these results are suspect because of the small number of participants (N=4), the resulting low statistical power, and the consequent threat to statistical conclusion validity.

It also must be noted that a previous study undertaken by Stevens et al. (2003) found that exposure to theta binaural beats can induce theta brainwave activity. The authors, having performed the research at Northern Arizona University, sought to replicate a previous Northern Arizona University study that had found "significant increases in theta EEG activity" and "hypnotic susceptibility" after listening to theta binaural beats (Stevens et al., 2003, p. 295).

Stevens et al. (2003) utilized a repeated measures, double-blind design (N=27) and multiple 40 minute treatment sessions of theta binaural beats compared to pink noise control sessions without theta binaural beats. The authors found that the participants who took part in the control sessions experienced "increased theta power" independent of listening to the theta binaural beats (Stevens et al., 2003, p. 303). Essentially, this means that the authors found that listening to pink noise could induce a similar theta state as listening to theta binaural beats. Regardless, the authors did find confirmatory evidence that theta binaural beats elicit theta brainwave activity. Thus, these results are contradictory to the Wahbeh, Calabrese, Zwickey, and Zajdel (2007) results.

As this overview of the psychological effects of binaural beats comes to a close, the reader can begin to see the state of consciousness research in the area of binaural beats. Some researchers are studying delta binaural beats, while others are studying theta or beta binaural beats. There are also researchers studying a combination of the different types of binaural beats. Moreover, the manner in which the studies are controlled (i.e. pink noise versus ocean sounds) varies among different studies which could potentially confound the results. For these reasons, it is apparent that more research is needed in the area of binaural beats.

Safety of Binaural Beats

From a safety standpoint, participants within previous studies have not reported any unusual side effects caused by exposure to binaural beats. According to Wahbeh, Calabrese, and Zwickey (2007), "There appear to be no adverse side effects attributed to listening to binaural beats for 60 days according to subject interview..." (p. 29). Nevertheless, it must be noted that low-frequency sounds could potentially cause nausea, headache, and dizziness (Bear, Connors, & Paradiso, 2007).

As well, inducing a state of theta brainwave activity could potentially bring about disturbing memories from the unconscious. According to Budzynski (1992), using binaural beats technology and/or photic stimulation to induce theta brainwave activity risks "...the possibility of uncovering unusually frightening repressed material" (p. 3). Budzynski (1992) offered the suggestion that individuals intending to use this technology should be warned that, if something of this nature should occur, they should seek the assistance of a mental health practitioner in order to integrate the experience.

Arguments for the Proposed Research Study

Emotions and well-being. There are various theoretical underpinnings regarding the proposed research. To begin, one should consider the emotional aspects of well-being. According to Friedman (1994), individuals who experience high levels of well-being usually experience more "positive emotions" than "negative emotions" (p. 31). Friedman (1994) went on to explain that "anger/hostility, sadness/depression, guilt/shame, vulnerability, and fear/anxiety" are all examples of negative emotions, while "serenity, joy, self-assurance, and attention" are examples of positive emotions (p. 31).

A meta-analysis of 51 interventions with 4,266 research subjects conducted by Sin and Lyubomirsky (2009) confirms Friedman's assertions regarding the connectedness of emotions and well-being. Sin and Lyubomirsky (2009) concluded that "...positive psychology interventions do indeed significantly enhance well-being (mean r =.29) and decrease depressive symptoms (mean r =.31)" (p. 467). To clarify, Sin and Lyubomirsky (2009) defined "positive psychology interventions" as treatment methods that are targeted toward "...cultivating positive feelings, positive behaviors, or positive cognitions" (p. 467).

Moreover, Friedman (1994) explained that individuals with moderate to high levels of well-being usually experience at least "5 or more times the number of positive emotions for every negative emotion" (p. 31). Therefore, it can be seen that if one decreases the number of negative emotions and/or increases the number of positive emotions, as a consequence, one could potentially increase his or her well-being.

This concept ties into the existing research with binaural beats technology in that it has been shown to reduce anxiety (Padmanabhan, Hildreth, & Laws, 2005; Wahbeh, Calabrese, & Zwickey, 2007). As discussed in the previous paragraph, anxiety is considered a negative

emotion (Friedman, 1994). Hence, one could make the cognitive leap that if an individual's level of anxiety were reduced, then he or she may develop a higher sense of well-being.

Biofeedback/neurofeedback. Another lens through which one can look at the situation exists within the context of biofeedback/neurofeedback research. It is widely accepted that neurofeedback techniques can induce theta brainwave activity (Budzynski, 1992; Budzynski, 2011; Myers & Young, 2012). An article by Henschen (1976), a counseling psychologist at the University of Illinois, described a qualitative case study of a woman who entered a theta state with the author's guidance. According to Henschen (1976), during the majority of the patient's sessions she experienced "reverie and hypnagogic imagery" (p. 327). Henschen (1976) also explained that the patient experienced a state of "deep relaxation" during her sessions (p. 327).

Although biofeedback/neurofeedback training is not the same modality as listening to binaural beats which is the focus of this proposal, the two can be seen as similar vehicles through which an individual might induce a state of theta brainwave activity. Moreover, one should consider that if an individual enters into a theta state, regardless of the catalyst through which that state was brought about, the individual may very well experience moments of reverie and a deep relaxation similar to that experienced by the patient described in this article. Additionally, these moments of reverie and deep relaxation can be viewed as the positive emotions discussed by Friedman (1994). As such, this article supports the theoretical basis for undertaking the proposed study.

Meditation. This brings us to a discussion regarding meditation, its relationship with theta brainwave activity, and well-being. Meditation has been extensively studied in regards to brainwave activity. According to Aftanas and Golocheikine (2001), the theta brainwave activity

brought about through meditation can induce a "blissful state" (p. 57). It is apparent that bliss would constitute a positive emotion as discussed by Friedman (1994).

It is also important to note that regular meditation can invoke temporary states along with lasting changes in traits (Cahn, & Polich, 2006). Cahn and Polich (2006) explained that some long-lasting trait changes among regular meditators are "...a deepened sense of calmness, increased sense of comfort, heightened awareness of the sensory field, and a shift in the relationship to thoughts, feelings, and experience of self" (p. 181). Accordingly, it can be seen that these long-lasting trait changes would also constitute a long-lasting increase in the positive emotions discussed by Friedman (1994).

Moving on, novice meditators often only achieve a state of alpha brainwave activity, whereas more experienced meditators usually experience theta brainwave activity (Lavallee, Koren, & Persinger, 2011). This understanding blurs the lines somewhat between which level of brainwave activity is precisely eliciting the effects on well-being found in the following studies. Nevertheless, the results are still relevant.

A study by Carmody and Baer (2008) carried out on patients (N=174) in a clinical mindfulness-based stress reduction program found that a formal practice of mindfulness meditation can lead to an improvement in well-being. Tae Sook, Jeong Sook, and Myung (2008) found confirmatory results, explaining that meditation could potentially "...facilitate power and well-being in the human and environmental field patterning process" (p. 49).

These studies regarding meditation are pertinent to the theoretical basis for the proposed study in a similar way to the biofeedback/neurofeedback research discussed previously. Although meditation is not the same modality as listening to binaural beats, the two can be seen as similar catalysts through which an individual might induce a state of theta brainwave activity.

Moreover, since meditation in the alpha/theta range can increase well-being, it is quite possible that binaural beats in the theta range could also increase well-being. Only further research will clarify the relationship between theta binaural beats and well-being; hence, the need for the research study outlined within this proposal.

Significance of the Proposed Research

The significance of this research proposal has been touched upon in the previous sections. Nonetheless, it is important to give further weight to the significance of this proposed study. To begin, most people throughout the world move through life with a goal of being happy and having a high sense of well-being. That said, not all individuals achieve this goal. Many people believe that they are "stuck in a rut", but they show no evidence of a mental disorder like depression (Fredrickson, 2008, p. 451). Thus, if significant results were found, this proposed study could lead to the development of self-help treatment modalities that people could utilize to enhance the quality of their lives.

Secondly, the study outlined within this proposal could potentially be the starting point for the development of a new treatment for depression. According to the CDC (2012), 1 in 10 adults in the United States report depression. A common treatment for depression is the prescription of SSRI medications such as Prozac or Lexapro. In the Harvard Mental Health Letter, some of the side effects of using SSRI medications are listed including "insomnia, rashes, headaches, joint and muscle pain, stomach upset, nausea, or diarrhea" (Harvard, 2005, para. 2).

Not all patients can tolerate the side effects brought about by the use of SSRIs or other pharmacological interventions. Our world is full of diverse people with diverse needs; a treatment that helps one person may not be the right fit for another person. Moreover, some patients' conditions are not improved by the use of pharmacological interventions. For these

reasons, it is important to explore other modalities that could possibly prove to be effective in treating this public health concern.

Lastly, if undertaken, the proposed study has significance because the results would enhance the current knowledge base. In turn, these results would influence the future of consciousness research. As discussed in previous sections, researchers are actively studying the psychological effects of binaural beats (Lane, Kasian, Owens, & Marsh, 1998; Padmanabhan, Hildreth, & Laws, 2005; Stevens et al., 2003; Wahbeh, Calabrese, & Zwickey, 2007). As well, researchers have developed modalities that utilize theta brainwave activity in order to treat depression (Saxby & Peniston, 1995) and increase well-being (Carmody & Baer, 2008; Tae Sook, Jeong Sook, & Myung, 2008). Examining the relationship between daily exposure to theta binaural beats and well-being is the next logical step. If significant results are found, then more research in the field of theta binaural beats and well-being should be undertaken in order to provide confirmatory results.

Best Practices in the Field of Research

As discussed in Chapter 1, this paper is a requirement of the master of science degree in psychology within the specialization of research, evaluation, and measurement at Capella University. This specialization puts a high level of emphasis upon research study design and should prepare one to enter the field of psychological research. Accordingly, the best practices within the field of psychological research will be described.

Preview of the proposed research study design. Although methodology will be discussed thoroughly in a later portion of the paper (Chapter 3), a repeated measures, double-blind, experimental design with random assignment will be proposed in order to increase the reliability and validity of the results. Multiple instruments will also be utilized for this same

reason. In general, reliability and validity contribute to the scientific merit of research by ensuring that the study in question is accurate, meaningful, and credible (Leedy & Ormrod, 2010).

Ethics. Throughout history there have been many wrongs in the field research including the Nazi medical experimentation in World War II and the Tuskegee syphilis study. These studies harmed the participants and are stark examples of why researchers need to practice ethically. Essentially, researchers should adhere to ethical codes, employ informed consent, and utilize institutional review boards (Shadish, Cook, & Campbell, 2002).

Thus, the proposed study will be approved by an Institutional Review Board (IRB) before being carried out. According to Shadish, Cook, and Campbell (2002), "The IRB monitors research with human participants by reviewing the experimental and informed consent procedures for ethical problems" (p. 283). It also must be mentioned that IRB approval is not a requirement for all research; however, IRBs should be utilized when appropriate. For example, IRBs should be utilized during medical research (Shadish, Cook, & Campbell, 2002).

In the proposed study, participants will also read and sign informed consent documents prior to taking part in the study. These documents will explain the nature of study along with the potential side effects (APA, 2002a). The expected duration of the study and a description of the procedures will also be explained. Not providing informed consent could leave the experimenter unprotected against legal liability for any harm that the research might cause (Shadish, Cook, & Campbell, 2002).

Beyond this, all researchers involved in the proposed study will adhere to the Ethical Principles of Psychologists and Code of Conduct (APA, 2002a). One important area within the APA ethical code is the protection of study participants' confidential information. Not

complying with this guideline of the APA ethical code could potentially adversely affect study participants' lives. For example, consider a research situation where sensitive information regarding an individual's history of substance abuse were being collected. If made public, this information could adversely affect the study participants' employment and potentially cause harm to the participants. As such, this is one of the primary reasons for complying with this guideline within the APA ethical code.

Finally, the Belmont Report lists three basic ethical principles that should also be adhered to: respect for people, beneficence, and justice (Health and Human Services, 1979). Not complying with these ethical principles could potentially do harm to the research subjects. For this reason, the risks and benefits for the subjects should be assessed; the subjects should also be selected by incorporating moral guidelines that look out for the research subjects' individual justice as well as the justice of society as a whole (Health and Human Services, 1979).

Individual differences. Psychologists performing research should take into consideration the possible biases regarding various cultural groups and be aware of the importance of multicultural sensitivity. Additionally, researchers must "...recognize the importance of conducting culture–centered and ethical psychological research among persons from ethnic, linguistic, and racial minority backgrounds" (APA, 2002b, p. 36). If these differences are not taken into account, the study results may not be generalizable to the larger population. Hence, this would affect the external validity of the results (Sue, 1999).

When developing research questions, psychologists should be aware of their possible cultural biases as one's worldview "helps to shape the questions one has about behavioral phenomena" (APA, 2002b, p. 40). Likewise, when analyzing and interpreting study results,

researchers should look at cultural hypotheses as potential explanations for the findings as well as moderator effects (APA, 2002b).

The proposed study, if carried out, would attempt to recruit participants from varied cultural and ethnic backgrounds; participant recruitment will be discussed in more detail in Chapter 3. That said, the sample demographics would also be collected and reported on regarding ethnic, cultural, and racial characteristics. Additionally, the cultural limitations of the research and their effect on the generalizability of the results would be explained (APA, 2002b). The potential results will be discussed in more detail in Chapters 4-5.

Chapter 3. Methodology

The following discussion will describe the methodology for this research study proposal. The purpose of the proposal will be summarized. Beyond this, the target population, sampling strategy, and experimental study design will be explained.

Purpose of the Study

As discussed in the previous chapters, the purpose of this research study proposal, if undertaken, would be to examine the extent to which daily exposure to 30 minutes of theta binaural beats for a length of 45 days affects an individual's subjective sense of well-being. A quantitative design will be utilized in order to best serve this end.

Using a quantitative design that incorporates established measures of well-being will enable the researchers to examine this relationship from an empirical and objective standpoint. A quantitative design is also a good fit for the proposed study because the research procedures and statistical analyses can be replicated in future studies (Bryman, 1984). Beyond this, quantitative methodology is an appropriate approach to utilize when testing hypotheses and examining cause-and-effect relationships (Sukamolson, 2007).

The experimental nature of the design (i.e. incorporating a control group and random assignment) will also further the understanding of this cause-and-effect relationship (Leedy & Ormrod, 2010). It will enable the researchers to have a basis through which to draw conclusions about what effect, if any, daily exposure to 30 minutes of theta binaural beats could potentially have on subjective well-being.

Research Question and Hypotheses

The research question that guides this proposal is: To what extent does daily exposure to a 30 minute theta binaural beats session for a length of 45 days affect an individual's subjective

sense of well-being?

If this proposed study were carried out, the following hypotheses would be tested. H_0: Daily exposure to 30 minute sessions of theta binaural beats for a length of 45 days will not lead to a significant ($p < .05$) increase in an individual's subjective sense of well-being. H_1: Daily exposure to 30 minute sessions of theta binaural beats for a length of 45 days will lead to a significant ($p < .05$) increase in an individual's subjective sense of well-being.

Participants

Target Population and Participant Selection. Adults in the United States are the population of interest. A sample of respondents will be recruited through a purposive sampling strategy to volunteer to take part in the study over the Internet. The participants will be from varied age ranges, ethnic groups, social classes, occupations, educational backgrounds, and geographic locations throughout the United States.

The sample will be recruited through a purposive sampling strategy for reasons of feasibility. Purposive sampling is a form of nonprobability sampling which means that its representativeness of the population "cannot depend upon the rationale of probability theory" (Trochim & Donnelly, 2007, p. 48).

Regardless, the sample should still be somewhat representative of the population. In principle, it is very difficult for researchers to know whether or not a sample is in fact representative of the population unless random sampling is employed (Trochim & Donnelly, 2007, p. 48). That said, even though random sampling is preferred, it is not always feasible. In this study, there is not a list of every adult in the United States from which to undertake random sampling. Additionally, finding individuals who are interested in volunteering for a study of this nature further narrows the field. Therefore, a purposive sampling strategy is necessary.

Moving on, there are some exclusion criteria for participation. There will be a prescreening examination consisting of a telephone interview. Individuals who are under the age of 18, have a history of seizure disorders, have major medical conditions, and/or have a history of mental health disorders including substance abuse disorders will be excluded. Moreover, participants who have taken prescription medications in the last two months will be excluded. Beyond this, only individuals residing within the United States will be allowed to participate.

Sample size. An adequate sample of participants (N=250) will be recruited in order to ensure sufficient statistical power and enhance the statistical conclusion validity of the results (Shadish, Cook, & Campbell, 2002). The sample size was determined after an a priori power analysis utilizing the program G*Power with an effect size of .20 and a 95% confidence level (Buchner, Erdfelder, Faul, & Lang, 2010).

Random assignment. After the participants are recruited and pass the pre-screening interview, they will be randomly assigned to groups. Restricted random assignment will be undertaken in order to force equal sample sizes; this tends to maximize the power for testing the main effects of treatment in most research designs (Shadish, Cook, & Campbell, 2002). Group 1 (N=125) will act as the control group, and Group 2 (N=125) will act as the treatment group.

Variables

The variables within this proposed study are subjective sense of well-being (dependent), exposure to binaural beats (independent), and prerecorded ocean sounds (control). Both Groups 1 and 2 will listen to prerecorded ocean sounds, while Group 2 will also listen to theta binaural beats embedded within the ocean sounds. These sessions will be 30 minutes in length and will be utilized daily for a period of 45 days.

Subjective sense of well-being, the dependent variable, will be measured utilizing the instruments discussed in the following section. All instruments will be administered in a pretest-posttest design.

Instruments

Instruments of both affective and cognitive well-being will be utilized to measure the dependent variable. This will enable the researchers to gather data regarding both aspects of subjective well-being (Pavot & Diener, 1993). Moreover, the following instruments were also selected, in part, because they were created to be administered in a self-report format. As such, these instruments can be adapted to be administered online which is necessary to fit the needs of the proposed study.

The Friedman Well-Being Scale. The Friedman Well-Being Scale is one of the instruments that will be utilized to measure affective well-being (Appendix A). The Friedman Well-Being Scale is comprised of 20 bipolar adjectives (i.e. angry/calm, tense/relaxed, nervous/at ease) in which respondents rate themselves where 1=1 and 10=10 (Friedman, 1994). This measure has established reliability and validity through a number of different methods including test-retest reliability (scores ranging from 0.81 to 0.85), Spearman-Brown split half reliability (scores ranging from 0.69 to 0.96), and convergent validity (correlations ranging from 0.47 to 0.71) (Friedman, 1994).

The Subjective Happiness Scale. The Subjective Happiness Scale is the second instrument that will be utilized to measure affective well-being (Appendix B). The Subjective Happiness Scale consists of 4 items with responses on a seven point continuum going from "not at all" to "a great deal" that are intended to measure an individual's global subjective happiness (Lyubomirsky, n.d.). This instrument shows a high level of internal consistency reliability with

tests of Cronbach's alpha demonstrating results ranging from 0.79 to 0.94; good to excellent test-retest reliability has also been shown with tests of Pearson's r producing results ranging from 0.55 to 0.90 within a three-week to one-year timeframe (Lyubomirsky & Lepper, 1999). As for validity, this measure has been established through construct validity studies regarding its convergent validity with correlations in the range of 0.52 to 0.72 (Lyubomirsky & Lepper, 1999).

The Satisfaction with Life Scale. The Satisfaction with Life Scale is an instrument comprised of 5 items that are intended to measure a person's cognitive judgments regarding the satisfaction with his or her life (Appendix C). The Satisfaction with Life Scale is seen to complement measures that focus on emotional well-being for the reason that "...it assesses an individuals' conscious evaluation of his or her life by using the person's own criteria" (Pavot & Diener, 1993, p. 164).

The Satisfaction with Life Scale has established convergent validity through correlations (ranging from 0.34 to 0.82) with other self-report measures as well as measures that are not self-report (Pavot & Diener, 1993). This scale also shows a high internal consistency reliability along with being moderate to highly correlated (Cronbach's alpha ranging from 0.82 to 0.87) with other well-being scales (Diener, Emmons, Larson, & Griffin, 1985).

Field pretesting the online versions. The measures will need to be adapted from their original paper-and-pencil versions for online administration. As such, prior to full-scale administration the online versions of the measures will be field pretested in order to ensure accuracy and usability in the data collection process. The results from the field pretest can be used to improve the instrument. If it turns out that there are items with high rates of missing data, items with inconsistencies, or items that are unclear to the participant, then the instrument could be restructured before large-scale administration (Groves et al., 2009).

Materials

A 30 minute, 5 Hz binaural beats audio session will be created with the Gnaural 1.0.20110606 program (Logan, 2011). Gnaural gives the user the option to add different tracks to the background of the binaural beats. This feature will be utilized to add the ocean sounds to both the binaural beats session as well as the control (no binaural beats) session.

Additionally, this study will utilize a high-quality audio format output for the sessions consisting of .flac files rather than the standard .mp3 files (Lavallee, Koren, & Persinger, 2011), cassette tapes (Lane, Kasian, Owens, & Marsh, 1998), compact disks (Padmanabhan, Hildreth, & Laws, 2005; Wahbeh, Calabrese, & Zwickey, 2007; Wahbeh, Calabrese, Zwickey, & Zajdel, 2007), or combination of compact discs and cassette tapes (Stevens et al., 2003) used in other studies. This type of lossless file format will be utilized in order to provide the best sound quality for the listener. Thus, it has been incorporated into the study with the intention of technologically improving upon past research to provide the best conditions for evoking a state of theta brainwave activity.

Participants in the studies will play the binaural beats and/or ocean sounds using an iPod and a set of over-the-ear, noise-canceling, stereo headphones provided for them at the beginning of the study. The iPod will contain either the binaural beats session or the control session, a music player, and no other programs. As with the .flac output format, the noise-canceling headphones are incorporated into the study with the intention of providing the best conditions for evoking a state of theta brainwave activity.

Lastly, an online website will be created for this proposed study. This website will contain a five-minute tutorial video that will explain to the participants how to listen to their

sessions. This website is also where the participants will go to submit their pretest and posttest (see Procedures for a more extensive description of the online website and tutorial video).

Experimental Design

As discussed previously, the strategy of the proposed research study consists of a repeated measures, double-blind, experimental design with random assignment. The study will also utilize multiple instruments. The primary rationale behind using this design strategy is to increase the reliability and validity of the results. As a general rule, reliability and validity contribute to the scientific merit of research by ensuring that the study in question is accurate, meaningful, and credible (Leedy & Ormrod, 2010).

For a more in-depth understanding, the incorporation of random assignment to either the control group or the treatment group will eliminate selection bias while also reducing "the plausibility of other threats to internal validity" (Shadish, Cook, & Campbell, 2002, p. 61). Multiple instruments will be utilized in order to avoid a threat to construct validity in the form of "mono-operation bias" (Shadish, Cook, & Campbell, 2002, p. 75).

Repeated measures will be utilized for several reasons. First, the pretest is necessary because the results will give the researchers data about "the magnitude of initial group differences" regarding the subjective well-being of the participants (Shadish, Cook, & Campbell, 2002, p. 136). The pretest data will also help during the statistical analysis process, in the examination of selection bias, and in the examination of attrition (Shadish, Cook, & Campbell, 2002).

Lastly, the blinding of participants will make them more likely to comply with treatment protocols. It will decrease the likelihood of participants having biased physical or psychological responses to treatment, seeking additional interventions, leaving the study without completing it,

or transferring their attitudes onto other participants (Schulz & Grimes, 2002). The blinding of the study investigators will decrease the likelihood of the administration of different co-interventions between participants and encouraging/discouraging different participants to continue on with study (Schulz & Grimes, 2002).

Procedures

Ethics were discussed in a previous portion of the paper (Chapter 2). Regardless, it is important to note that before the study is undertaken IRB approval will be in place. As well, the study's website will be designed in a manner that will protect the participants' confidentiality. Data obtained from the online surveys will be secured by Secure Sockets Layer (SSL) encryption, restricted/sign in access, and hosted on secure servers. Furthermore, it is necessary to utilize web-based data collection for the proposed study because it allows for visual presentations, it has a low-cost and no need for staff or facilities, it gives access to samples that are dispersed, and it allows respondents ample time to formulate their answers (Trochim & Donnelly, 2007).

Recruitment. The participants will be recruited over a 30 day time period utilizing advertisements on Facebook, YouTube videos, and Google pay-per-click ads disseminated throughout the Internet in the United States. For an incentive, the participants who successfully complete the study will be entered into a drawing for a free iPad.

Those interested in participation will be directed to the study's website where they will fill out a short form to collect their name, e-mail address, phone number, demographic information, and the best time to call. The potential candidates will be informed that they will be receiving a prescreening phone call to discuss their participation in the study. By submitting the form online, the participants will agree to receive this call.

Prescreening. As discussed previously, there will be a prescreening examination consisting of a 5 to 10 minute telephone interview. Individuals who are under the age of 18, have a history of seizure disorders, have major medical conditions, and/or have a history of mental health disorders including substance abuse disorders will be excluded. Moreover, participants who have taken prescription medications in the last two months will be excluded. Beyond this, only individuals residing within the United States will be allowed to participate.

Informed consent. Once it is determined that the participant does not meet any of the exclusion criteria, the participant will be referred back to the website in order to read and digitally sign informed consent documents. These documents will explain the purposes of the research, confidentiality, the duration of expected participation, and the study procedures that will need to be followed. The potential side effects of listening to binaural beats will be described. As well, the benefits to the participants and others as a result of the study will also be explained. Lastly, it will be made clear that participation is voluntary, and the participants can stop participating in the study at any point without losing their chance to win the iPad (Shadish, Cook, & Campbell, 2002).

Implementation. After the required number of participants (N=250) are recruited and have digitally sign the informed consent documents, they will be randomly assigned to groups. The iPods, stereo headphones, and either the treatment sessions or control sessions will be mailed to the participants using the United States Postal Service. Neither the participants nor the researchers will know which participants are receiving the treatment sessions with binaural beats, making the study double-blind.

Upon receiving the materials in the mail, the participants will be directed to the study's website where they will complete the 29 item pretest consisting of the Friedman Well-Being

Scale, the Subjective Happiness Scale, and the Satisfaction with Life Scale. After completion, the participants will be instructed to watch the tutorial video.

The tutorial video will explain how each participant is supposed to take part in the sessions. It is suggested for the participants to use their bedroom. Prior to listening to their daily audio, participants should close their blinds or draperies in order to reduce the ambient light in the room. After which, the participants should lay flat on the bed and get into a position where they can comfortably relax for 30 minutes. Next, the participants should secure the headphones in place and press play on the iPod. As the sounds begin to play, the participants should close their eyes and try their best not to move during the duration of the session. The participants should also try to relax their mind and avoid concentrating on any specific problem-solving tasks.

There are several reasons behind structuring the sessions in this manner. To begin, muscle contractions cause beta brainwave activity (Baker, 2007). For this reason, it is important for the participants to avoid moving while listening to the sessions in order to produce theta brainwave activity. Moreover, past psychological research with binaural beats that incorporated a quiet room and closed eyelids as a part of the treatment produced a significant effect (Padmanabhan, Hildreth, & Laws, 2005). As well, a high correlation has been shown to exist between beta brainwaves and cognitive problem-solving tasks (Fenwick, 1987). Thus, the participants will be instructed to relax their minds and avoid problem-solving tasks.

Moving on, it must be noted that weekly phone call and email reminders about complying with the participation requirements will be ongoing throughout the duration of the experiment. A support phone number will also be provided so that participants can receive further guidance regarding the study if needed. Additionally, a psychologist will be on staff to

provide over-the-phone counseling to any participants that happen to experience the disturbing memories noted by Budzynski (1992).

Once the 45th day of listening to the sessions has concluded, the participants will return to the study's website to complete the posttest. It must be mentioned that it is common for research examining the relationship between meditation and well-being to have an extended duration as exemplified in the Carmody and Baer (2008) and the Tae Sook, Jeong Sook, and Myung (2008) studies. However, within binaural beats research this is not always practiced, as can be seen in the studies by Wahbeh, Calabrese, Zwickey, and Zajdel (2007) and Ulam (1991). Accordingly, this proposal will address this potential area of weakness in binaural beats research by requiring the participants to take part in the sessions for the aforementioned length of time.

At the end of the study, the participants will be instructed to put their research materials, including the iPod and headphones, into a prepaid envelope and mail them back to the research study. At this point, one participant will also be randomly selected to win the free iPad. The participant will be notified via e-mail, and the iPad will be mailed to him or her via the United States Postal Service.

Areas of concern. In light of the length of the study, attrition is a potential area of concern. Attrition threatens internal validity when a portion of the participants "fail to complete the outcome measures" (Shadish, Cook, & Campbell, 2002, p. 259). To combat this during the study, the participants will receive weekly phone and e-mail communication regarding their participation as reminders of what is required of them throughout the study. Nonetheless, it is predicted that some participants who complete the pretest will not complete the posttest.

Therefore, once the study is complete, the researchers will need to address this potential threat to internal validity. One strategy, explained by Shadish, Cook, and Campbell (2002), is

that researchers could undertake "...multigroup structural equation models to estimate the effects in the presence of missing data" (p. 338).

Another area of concern exists within treatment implementation. For some reason, if a portion of the participants do not adhere to the session guidelines explained in the video tutorial, this could potentially affect the statistical conclusion validity of the results (Shadish, Cook, & Campbell, 2002). The tutorial video would be created in order to preemptively combat this issue. Nevertheless, during the weekly phone and e-mail communications, researchers will verify that the participants are complying with the treatment session guidelines. If a participant is not complying with one aspect of the guidelines, he or she will be reminded of the importance of compliance.

Chapter 4. Results

The following discussion will summarize the data analysis procedure that should be performed on the data collected within the proposed study. As well, various hypothetical results for this study will be discussed. Beyond this, recommendations will be made for what should be included in this study's final report if this research were actually carried out. The purpose of this exercise is to inform the reader about the research study design process.

Data Analysis

Since the proposed study design is comprised of independent groups and repeated measures, a one-way between-S ANOVA fits the needs of the study. As such, the SPSS statistical analysis program should be utilized to analyze the results with a repeated measures ANOVA using the General Linear Model (GLM) procedure (Warner, 2007).

This data analysis procedure will be utilized to test the null hypothesis that daily exposure to 30 minute sessions of theta binaural beats for a length of 45 days would not lead to a significant ($p < .05$) increase in an individual's subjective sense of well-being. Alongside null hypothesis testing, the researchers will also calculate effect sizes at a 95% confidence level. Any significant results that are found should be included in the final report of the study. Moreover, the demographic data collected on the participants should also be included in the final report.

Treatment Fidelity

If this study were undertaken, evidence would need to be provided in the final report detailing the extent to which participants adhered to the treatment guidelines (APA, 2010). For example, it can be speculated that some participants within this study might skip listening to a few sessions. As well, participants might also choose to listen to the sessions while sitting upright with open eyelids rather than following the instructions provided in the tutorial video.

The researchers will be calling and e-mailing participants with reminders regarding their participation. If the researchers discover that a participant is not complying with the guidelines, the researcher should make note of it. When writing up the final report, the researchers should describe these occurrences so that the reader may understand the extent to which the participants adhered to the treatment guidelines.

Missing Data

If this study were undertaken, nonresponse error would most likely be encountered. Nonresponse error is a type of error that can occur from inferences based on the participant's responses to survey items. Nonresponse has implications for survey research in that it can have an effect on the quality of a study's results. In particular, it can affect both analytic statistics and descriptive statistics. Sometimes, if the rate of nonresponse is high, the amount of error can be severe (Groves et al., 2009).

There are two types of nonresponse error that can occur: unit nonresponse and item nonresponse. Unit nonresponse occurs when researchers fail to get a potential respondent to complete his/her survey (Groves et al., 2009). In this proposal, this translates into a participant volunteering to take part in the study and choosing not to complete the pretest or the posttest. Item nonresponse happens when respondents fail to answer questions within a survey (Groves et al., 2009). For this study, item nonresponse may take place when a participant only completes a portion of the pretest or the posttest.

The extent of the missing data from unit nonresponse and item response should be described in detail in the final report (APA, 2010). Nonetheless, the researchers can take some preventive action to lessen the chances of nonresponse error. Throughout the online pretest/posttest questionnaire, prompts can be integrated into the submission form; this will

encourage the participants to complete all of the questions (Strickland, 2003). The study's website will also be set up with a login system so that participants can return to complete the questionnaire at another time if they get fatigued (Strickland, 2003).

Adverse Events

If this study were undertaken, there may be a chance of adverse events. For example, a participant receiving the treatment condition could potentially develop headaches as a side effect. Another example could be a participant who experienced frightening hypnagogic imagery as a result of the theta brainwave activity evoked by listening to the sessions. In the final report, these adverse events should be described in detail for the reader (APA, 2010).

Chapter 5. Discussion

Although this is merely a research study proposal and data has not been collected, one can speculate on the outcomes of the study. One surety is that evidence will be found to either support the null hypothesis or refute the null hypothesis. Accordingly, the implications of these outcomes will be discussed.

Findings in Support of the Null Hypothesis

Findings that are in support of the null hypothesis would cause the researchers to conclude that daily exposure to 30 minute sessions of theta binaural beats for a length of 45 days does not lead to a significant ($p < .05$) increase in an individual's subjective sense of well-being. In the final report, any potential reasons for these findings should be discussed.

For example, these findings might be caused by the participants' inability to induce a state of theta brainwave activity as a result of listening to the binaural beats. As discussed in Chapter 2, past research regarding binaural beats and theta brainwave activity has been on both sides of the fence. Some researchers have found evidence to support the assertion that exposure to binaural beats causes a state of theta brainwave activity (Stevens et al., 2003), whereas other researchers have found evidence that refutes it (Wahbeh, Calabrese, Zwickey, & Zajdel, 2007).

If results supporting the null hypothesis are found, future studies could be improved by incorporating an EEG measurement of the participants' brainwave activity in order to ensure that a state of theta activity has been reached. Granted, this may or may not impact the results of future studies regarding theta binaural beats and well-being. However, this would improve the study design and make the results less confounded.

Findings that Refute the Null Hypothesis

Findings that refute the null hypothesis would cause the researchers to conclude that daily

exposure to 30 minute sessions of theta binaural beats for a length of 45 days does lead to a significant ($p < .05$) increase in an individual's subjective sense of well-being. As well, it is important to note that the effect sizes indicating this significant increase should be noted and discussed in the final report.

Although the relationship of theta binaural beats and well-being is thought to have never been studied, these results would still be somewhat congruous with past binaural beats research. As discussed in Chapter 2, Wahbeh, Calabrese, and Zwickey (2007) examined the psychological and physiological effects of 60 days of daily use of binaural beats within the delta range; their results suggest that daily exposure to delta binaural beats could significantly increase an individual's well-being. Hence, if results that refute the null hypothesis are found, it will mean that both delta and theta binaural beats could potentially increase an individual's well-being. That said, additional studies would be needed to provide further confirmatory evidence for such a conclusion.

Moreover, these results could be explained by the brain's physiological mechanism of neuroplasticity. Neuroplasticity occurs when new neuronal connections are grown within the brain in response to experience (Davidson & Lutz, 2007). More studies would be needed in order to determine the exact neuronal growth that is stimulating the effect of increased well-being. Nonetheless, this is a possible physiological explanation for the results as well as a potential area for future study.

Limitations of the Research

As with all research, there are limitations within this proposed study design. As discussed in Chapter 3, attrition is a potential area of concern that could affect the study's internal validity (Shadish, Cook, & Campbell, 2002). Nonresponse error, discussed in Chapter 4, could

also occur. Moreover, the occurrence of treatment infidelity or poor treatment implementation, discussed in Chapters 3 and 4, could impact the statistical conclusion validity of the results (Shadish, Cook, & Campbell, 2002).

Lastly, all the data for this proposed study will be collected via an online, self-report format. Thus, this method of data collection might cause a possible threat to the construct validity of this study in the form of mono-method bias (Shadish, Cook, & Campbell, 2002). To address this in future studies, the researchers could incorporate a measure of well-being that is not administered via self-report.

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Appendix A

Friedman Well-Being Scale

By Philip H. Friedman

Due to the terms of copyright, only 5 items within the scale can be listed.

Please use this list of common human traits to describe yourself as accurately as possible. Describe yourself as you see yourself *at the present time*, not as you wish to be in the future. Describe yourself as you are typically, as compared with other persons you know of the same gender and roughly the same age. Please circle *only* one number in each line.

Very			**Moderately**		**Neither**			**Moderately**			**Very**	
angry	0	1	2	3	4	5	6	7	8	9	10	calm
tense	0	1	2	3	4	5	6	7	8	9	10	relaxed
nervous	0	1	2	3	4	5	6	7	8	9	10	at ease
insecure	0	1	2	3	4	5	6	7	8	9	10	secure
joyless	0	1	2	3	4	5	6	7	8	9	10	jovial

Appendix B

Subjective Happiness Scale

By Sonja Lyubomirsky, Ph.D.

Instructions: For each of the following statements and/or questions, there is a continuum which has 1 as the least degree and 7 as the greatest degree. Please circle the point on the scale that you believe is most appropriate in describing you.

1). In general, I consider myself:

1	2	3	4	5	6	7
not a very happy person						a very happy person

2). Compared to most of my peers, I consider myself:

1	2	3	4	5	6	7
less happy						more happy

3). Some people are generally very happy. They enjoy life regardless of what is going on, getting the most out of everything. To what extent does this characterization describe you?

1	2	3	4	5	6	7
not at all						a great deal

4). Some people are generally not very happy. Although they are not depressed, they never seem as happy as they might be. To what extent does this characterization describe you?

1	2	3	4	5	6	7
not at all						a great deal

Appendix C

Satisfaction with Life Scale

By Ed Diener, Robert A. Emmons, Randy J. Larsen, and Sharon Griffin

Below are five statements that you may agree or disagree with. Using the 1 - 7 scale below, indicate your agreement with each item by placing the appropriate number on the line preceding that item. Please be open and honest in your responding.

- 7 - Strongly agree
- 6 - Agree
- 5 - Slightly agree
- 4 - Neither agree nor disagree
- 3 - Slightly disagree
- 2 - Disagree
- 1 - Strongly disagree

____ In most ways my life is close to my ideal.

____ The conditions of my life are excellent.

____ I am satisfied with my life.

____ So far I have gotten the important things I want in life.

____ If I could live my life over, I would change almost nothing.