The Effect of Music Listening on Cold-Pressor Pain Perception, Tolerance, and Attention

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THE EFFECT OF MUSIC LISTENING ON COLD-PRESSOR PAIN PERCEPTION, TOLERANCE, AND ATTENTION

By

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A THESIS

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THE EFFECT OF MUSIC LISTENING ON COLD-PRESSOR PAIN PERCEPTION,
TOLERANCE, AND ATTENTION

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The effect of participant-selected music listening on pain perception, pain tolerance, and attention to pain was evaluated during a cold-pressor pain protocol. Participants ($N=50$) underwent two, ice-water hand immersions in a music condition and a silence condition. Participants were asked to engage in active music listening of their choice during the cold-pressor music condition. The researcher collected a pain tolerance hand-immersion time, while participants self-reported on pain perception and attention to pain. Results showed that participants reported significantly less pain perception and attention to pain, and greater pain tolerance time under the music condition than in the silence condition. The positive results are attributed to the ability of participant-selected music to effectively engage attention. The participant-selected music choices were analyzed for musical attributes that served as possible predictors for influencing attention to pain. Of the five attributes analyzed including activation, tempo, mood, lyrics, and preference, only preference yielded significant results in diminishing attention to pain. Conclusions are made as to the influence of music on attention, pain tolerance, and pain perception, and support is given for preferred music as an effective means to engage attention for pain management.
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Chapter 1

Introduction

Pain is defined as an unpleasant sensory and emotional experience associated with actual or potential tissue damage (International Association for the Study of Pain [IASP], 2005). Due to the advancement of neuroimaging technology, researchers are better able to understand the phenomenon of pain, including how it is perceived and tolerated. However, managing pain without relying heavily on pharmaceutical treatments is still an issue for healthcare practitioners and patients. The use of music to manage pain can be a valuable approach for this purpose, as research shows positive effects of utilizing music to diminish pain. Music can be applied as a medium to engage attention during a painful experience and in turn, reduce pain perception (Nilsson, 2008). This chapter will describe in detail the need for implementing alternative methods for pain management and how music can serve as an attention-based pain management stimulus.

Problem Statement

Pain management is a paramount concern in the American healthcare system. Pain is considered the fifth vital sign all physicians must assess in their patients (IASP, 2005). Currently, pain affects more patients than diabetes, heart disease, and cancer combined with 100 million Americans reporting chronic pain issues. (Committee on Advancing Pain Research, Care, and Education, Institute of Medicine [CAPRCE], 2011).

Pain issues account for a significant amount of physician visits yearly, because patients who seek relief from pain are often unable to effectively manage their
symptoms independently. Because of this dependence on the healthcare system to relieve pain, the United States spends approximately $635 billion dollars annually in direct medical treatment costs and loss of productivity because of disability, morbidity, and mortality related to pain. This expense estimate adds to the annual $300 billion dollar cost of health care, of which the Medicare program bears one quarter of the pain costs to the nation. In 2008, 14% of all Medicare costs were related to pain management (CAPRCE, 2011). These figures suggest that pain is a national health concern that if left unmanaged can bring not only serious economic burdens to the U.S., but also impact individuals on a personal level by diminishing quality of life.

**Current treatment.** Pain is an individual subjective experience that can be influenced by psychological, physical, and social factors (CAPRCE, 2011). Currently the most commonly accepted form of treatment in the United States for pain is the use of analgesics or “painkillers” which are meant to decrease the perception of pain, decrease the reaction to pain, and increase pain tolerance (CAPRCE, 2011). Pharmacological interventions are safe when used to treat acute, postoperative, and procedural pain; however a high risk of misuse and subsequent addiction to such opioids furthers the pain problem (CAPRCE, 2011). In 2010, one in twenty adults in the U.S. reported utilizing prescription painkillers for non-medical reasons (Center for Disease Control Prevention Analysis [CDCPA], 2011).

Painkillers also pose a high risk of possible biological side effects. According to one study, one in seven pain sufferers who used over-the-counter medicine reported they developed an ulcer or gastrointestinal problem as a result of the painkiller and one in four participants reported taking additional medication to manage the side effects (Painter,
Another survey revealed that prescription painkiller overdoses accounted for 15,000 deaths in the US in 2008, with the state of Florida showing the highest rate of prescription painkiller sales in the country (CDCPA, 2011).

With the high risk involved in prescription pain medication, alternative treatments to manage pain should be encouraged. Since pain produces psychological and cognitive effects, interdisciplinary treatments are the most promising in treating pain (CAPRCE, 2011). Although alternative treatments are not meant to replace pharmacological interventions, treatments that combine different approaches, such as medical, behavioral, and alternative therapies, are often considered the most successful in treating and managing acute to chronic pain (Gardea & Gatchel, 2000). In order to standardize the application of alternative therapies the methodologies applied must be based on empirical research that clearly supports the use of different therapies in conjunction with prescription drugs.

**Music in pain management.** The medical field requires research that can easily translate into effective therapies for pain (CAPRCE, 2011). One such method that can be applied in the medical field for managing pain is the use of music and/or music therapy (Standley, 2000; Tyler, 2000). A survey of nurses’ attitudes towards music therapy in the hospital setting revealed a positive attitude towards music therapy practices, with pain accounting for one of the most common reasons for referrals in this setting (Hillmer, 2003). Research shows positive results towards effective pain management through music in a variety of healthcare settings (Bradshaw et al., 2011; Bradt, 2010; Cepeda, Carr, Lau, & Alvarez, 2010; Kenntner-Mabiala, Gorges, Alpers, Lehmann, & Pauli, 2007; Mitchel & MacDonald, 2006; Mitchel, MacDonald & Brodie, 2006; Mitchel,
MacDonald, & Knussen, 2008; Mitchel, MacDonald, Serpell, & Knussen, 2007; Standley, 2000; Park, 2010).

With the frequent use of music and music therapy in the hospital setting, this practice should be further researched and standardized. A successful music therapy and pain management intervention must account for the multidimensional aspects of pain perception as well as the uniqueness of each subjective pain experience. Therefore, an understanding of the factors that influence pain perception should be at the forefront of music therapy. Pain can be influenced by mood, cultural values, context, perceived control, and cognitive state, among others (Melzack, 2001).

Research shows that cognitive engagement with a stimulus may diminish pain perception, by diverting attention away from the pain (Legrain et al., 2009; Nilsson, 2008; Silvestrini, Piguet, Cedraschi & Zentner, 2011; Van Damme, Legrain, Vogt, & Crombez, 2010). This thesis proposes that music is a medium for cognitive engagement and acts to capture and maintain attention, therefore diminishing pain perception and increasing pain tolerance (Bradshaw, Donaldson, Jacobson, Nakamura, & Chapman, 2011; Silvestrini et al., 2011). This thesis also emphasizes the success of utilizing music to capture attention and manage pain is based on shared neurologic processes of three main constructs: pain, attention, and music.

Need for the Study

**Theoretical relevance.** The existing research regarding the use of music as an attention medium to diminish pain is not comprehensive. Most of the current literature regarding the use of music to manage pain supports the emotional, mood enhancing or anxiolytic effects of music (Gfeller, 2008), yet few investigations address music’s ability
to engage attention during a painful event. There is limited research regarding music and attention for pain management. While music is often studied in the clinical setting, the mechanism behind how music is attaining success is still unclear (Cepeda, Carr, Lau, & Alvarez, 2010).

This thesis will strive to create a theoretical link between pain, attention, and music by articulating how the three constructs are connected. The three constructs share neurological processes, through common activation of regions of interest in the brain. In essence, this thesis provides a theoretical rationale as to how music maintains attention, and, in turn, can diminish pain perception.

**Practical relevance.** This thesis contributes to health professionals’ use of music to manage acute pain by establishing attention as a fundamental element in music and pain management interventions. Music therapy research that has focused on attention to music in pain management has yielded positive results (Fratianne et al., 2001; Tan, Youler, Super, & Fratianne, 2010) yet there is limited research that clarifies how music is able to influence attention to pain. This thesis will explore the attributes of self-selected music that influence attention to pain. An understanding of the efficacy of these attributes to reduce attention to pain, will allow music therapists to better structure music interventions when the goal is to diminish pain perception and increase tolerance to pain. For music therapists, this thesis also supports the use of recorded patient-selected music to manage pain, which can diversify treatment approaches in the case that live music making is not appropriate.
Purpose of the Study

The purpose of this thesis was to determine the effect of participant-selected music listening on pain perception, pain tolerance, and attention to pain. The author hypothesized that in the music condition participants would report less pain perception and attention to pain, while demonstrating greater pain tolerance. This thesis also attempted to establish the attributes of music that were significant in lowering attention to pain.
Chapter 2

Review of Related Literature

This chapter will present the literature in regard to the effect of music on attention and pain. Four main areas will be explored in the literature starting with the perception of pain including the neurological processing of pain. This section will explore pain theories as well as the role of attention in pain modulation. The second section will describe attention and the neural activation of attention and music. Third, the use of music as a stimulus for attention and the effect of music on pain is explored. The last section will explore the current state of music therapy research in pain management. A review of these four areas will provide a foundation for studying the use of music to manage pain.

Pain

The International Association for the Study of Pain defines pain as an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage (IASP, 2013). Pain can be organic when caused by physical tissue damage or psychogenic when resulting from psychological processes. Organic pain can be nociceptive which is a direct and immediate result of tissue damage or neuropathic when caused by nerve damage. A stimulus that is painful or harmful is referred to as a noxious stimulus (Warren, 2010).

Pain can also be categorized by its duration. Chronic pain is pain that lasts more than three to six months, while acute pain is usually associated with an event with immediate effects (Loeser & Melzack, 1999; Warren, 2010). Rating pain intensity in categories of mild, moderate, or severe helps to determine the impact on the individual (Backonja et. al., 2010). This study focused on organic acute pain that varied in intensity.
In order to understand more about pain perception and pain management, the sensory pathways of pain in the central nervous system are explored next.

**Neurology of pain perception.** The spinothalamocortical nociceptive projection system is involved in the perception of pain (Martin, 2012). This system is responsible for the projection of nociceptive stimuli from the body to the brain. The pathway begins at the injury site where the nerve receptors send the pain signal to the spinal cord, which then projects to the thalamus and on to the different cortical regions that further process pain. Nociceptive or noxious stimuli are mechanical, thermal or chemical sensory information that can cause actual or potential damage to tissue of the body (Martin, 2012). In the spinal cord, noxious stimuli activate nociceptive specific neurons or “pain receptors” located in the dorsal horn (Martin, 2012). The axons for these types of neurons ascend along the spinothalamic tract carrying the pain information from the injury site to the spinal cord and on to the thalamus (Martin, 2012). The pain perception is relayed in the thalamus and projected to a variety of cortical regions that process the different aspects of the pain signal (Schnitzler & Ploner, 2000).

Researchers have established that areas like the spinal cord, the thalamus, the primary somatosensory cortex (SI), the secondary somatosensory cortex (SII), the anterior cingulate cortex (ACC), and the insula, are involved in the processing of pain. This pathway of pain processing is referred to as the spinothalamocortical tract (Peyron, Laurent & Garcia-Larrea, 2000; Schnitzler & Ploner, 2000; Tracey, 2008; Lotsch et al, 2012). In a meta-analysis of brain imaging studies of pain, Peyron, Laurent and Garcia-Larrea (2000) suggest that activation of the contralateral thalamus, the primary somatosensory cortex (SI), and the secondary somatosensory cortex (SII) is associated
with the sensory-discriminative aspects of pain processing. Meanwhile, activation of the anterior cingulate cortex (ACC) reflects attention and memory networks triggered by noxious stimuli (Peyron, Laurent & Garcia-Larrea, 2000; Lotsch et al, 2012).

**Pain management theories.** Melzack and Wall (1960) established the gate control theory of pain to explain how pain is perceived and managed. This theory states that noxious input received by the primary afferent fibers of the peripheral nervous system is transmitted to three different regions of the spinal cord: 1) the substantia gelatinosa, 2) the dorsal column, and 3) the transmission cells, which transmit information up to the cortical regions. The gate control theory further states that the substantia gelatinosa acts as a gate that can inhibit or allow the transmission of the noxious input or pain signal from the afferent nerves to the transmission cells of the spinal cord. This inhibition or “closing of the gate” is triggered by activity of the large descending fibers, as well as activity descending from supraspinal regions (Melzack & Wall, 1970; Moayedi & Davis, 2013).

Melzack and Casey (1968) further expanded the gate control theory by outlining the multidimensional nature of pain experiences. They categorized pain into three main dimensions: 1) sensory-discriminative, which refers to pain intensity, location, quality, and duration; 2) affective-motivational, which refers to the degree of unpleasantness and the eventual flight response to avoid the pain; and 3) cognitive-evaluative, which refers to the appraisal of pain as well as cultural values, context, and the cognitive state which may impact the pain perception.

Melzack and Casey’s (1968) explanation of the multiple aspects of pain perception led to what is currently known as the pain neuromatrix concept (Tracey,
2008). The neuromatrix of pain states that pain is a subjective multimodal and multifactorial experience, and its understanding and treatment will vary by each pain experience. Moreover, widespread networks of neural regions are responsible for processing each instance of pain perception based on the different interactions of the dimensions of pain. In effect, there is no one center for pain in the brain as pain can activate different neural regions based on how it manifests (Derbyshire, 2000; Melzack, 2001; Tracey, 2008). Based on the knowledge and understanding of the spinothalamocortical nociceptive projection system, as well as the dimensions of pain, researchers can be informed as to how to modulate the pain experience.

**Attention-based pain management.** An interaction between the different dimensions of pain such as sensory-discriminative, affective-motivational and cognitive-evaluative, significantly impact the pain experience (Tracey, 2008). This study will focus on the cognitive-evaluative dimension of pain, specifically the construct of attention, and its ability to impact pain perception and tolerance.

The positive effects of attention on diminishing pain have been extensively studied in the literature, and it is hypothesized that attending to cognitively engaging activities can impact pain perception by way of diverting attention away from the pain stimulus (Arntz & de Jong, 1991; Bantick et al., 2002; Cohen, 1993; Gracely et al., 2004; Legrain, 2005; Legrain et al., 2009; Levine et al., 1982; Miron et al, 1989; Nouwen, Cloutier, Kappas, Warbick & Sheffield, 2006; Rémy, Frankenstein, & Richter, 2001; Spence et al., 2002; Tracey, 2008; Van Damme et al., 2010; Verhoeven et al., 2010; Villemure & Bushnell, 2001).
By contrast, sustained attention to the pain stimulus will enhance and magnify the degree to which pain is experienced (Arntz & De Jong, 1991; Van Damme et al., 2010). The term “catastrophizing” refers to individuals’ augmenting pain perception by enhancing attention to the painful stimuli (Gracely et al., 2004; Van Damme et al., 2010).

Bantick et al., (2002) studied the effects of a cognitively engaging task on pain perception and neural activation. Participants received intermittent painful thermal stimuli while completing a challenging counting task and completing a less demanding cognitive task. Pain perception results showed that pain intensity scores were significantly reduced during the more challenging task. Neural activation results showed that regions associated with the spinothalamocortical pain system, such as the thalamus, insula, and anterior cingulate cortex showed less activation during the challenging cognition task. Hence, attention to engaging tasks can be effective in managing pain perception. Attention, specifically selective attention is recruited when the goal is to manage pain (Legrain et al., 2009). Next, the construct of attention is explored along with the underlying neural mechanisms of attention that help modulate pain.

**Attention**

Attention is defined as a concentration of the mind that is recruited to process one stimulus over another (McDowd, 2007). Attention is often associated with the metaphor of a spotlight, where attention is equated with a spotlight focused on a stimulus that is processed most efficiently (Stark, Grafman, & Fertig, 1997). Different kinds of attention include: a) sustained attention; b) selective attention; c) alternating attention; and d) divided attention (McDowd, 2007). For this thesis, the concept of selective attention will be described.
Selective attention. Selective attention is defined as the processing of one source of information, and not processing of other sources of information available in the environment (McDowd, 2007). Cherry (1953) introduced the “cocktail party” phenomenon in an effort to clarify selective attention. The cocktail party phenomenon reflects the ability to selectively attend to one speaker among a mixture of other conversations and background noise at a party. Maintaining selective attention is dependent on how much attention effort is allocated to a particular stimulus. Attention effort is the experience of paying more attention to a task that is challenging and does not elicit attention naturally. This attention effort is goal-oriented and is a conscious effort to attend to a task when it is difficult to inhibit a response (McDowd, 2007). Attention effort and selective attention both are found in pain management interventions. Eliciting these conscious processes is a successful approach utilized in pain management in order to lower pain perception (Legrain et al., 2009).

Neurology of auditory attention. In order to comprehend the role of selective attention in pain management, the neurology of this construct is explored. Dichotic listening strategies involve listening to different auditory stimuli simultaneously in each ear and are common practice in determining which brain areas are active during an auditory selective attention task. Utilizing an auditory discrimination task, Pugh et al. (1996) found that listeners who were asked to selectively attend to either similar or confounding auditory stimuli, showed activation in the posterior parietal attention system and the superior and inferior frontal regions of the brain. Other research conducted in visual and auditory domains highlight the roles of the parietal and frontal cortices as well
as the anterior cingulate cortex (ACC) in selective attention (Bush, Shin, Holmes, Rosen, & Vogt, 2003; Cohen, 1993; Pugh et al., 1996).

Pain stimuli have the ability to quickly capture attention and elicit an unconditioned response (Cohen, 1993). Conversely, directing attention away from the painful stimuli can diminish pain perception (Seminowicz & Davis, 2007; Verhoeven et al., 2010). This process of attention shifts to modulate pain is made possible by the parallel neural activation of the anterior cingulate cortex (ACC) during pain and the eliciting of selective attention. The neurology of pain management through selective attention, as well as the ACC’s role in this process is explored in the following section.

**Neurology of attention to modulate pain.** Engaging in a cognitive task can diminish pain perception (Petrovic & Ingvar, 2002; Seminowicz & Davis, 2007). Neurological research supports this approach by showing that areas commonly associated with pain processing diminish in activation when participants are asked to engage in a cognitive task (Bantick et al., 2002; Petrovic & Ingvar, 2002; Porro, 2003; Seminowicz & Davis, 2007). Parietal, insular, cingulate, and frontal cortical regions all show modulated activity when participants engaged in hypnosis, focused activities, or diverting attention (Porro, 2003). Moreover, pain regions like the anterior cingulate cortex (ACC), the insula, and the thalamus also show diminished activity when participants engaged in cognitive distraction tasks (Bantick et al., 2002).

The ACC is an important cortical area when considering the cognitive-evaluative aspects of pain. There are three main pain responses in the ACC: 1) pain perception activates the caudal part of the ACC; 2) pain modulation activates the rostral region of the ACC; and 3) attention tasks activate the adjacent anterior regions of the ACC.
(Petrovic & Ingvar, 2002). Therefore, while different ACC regions are activated during a pain and cognitive engagement task, the ACC proves to be a region of interest during activities that draw attention away from pain. Overall, directing attention away from painful stimuli may impact pain perception as evidenced by diminished activation of brain regions traditionally associated with pain during an engaging activity.

The gate theory has long been utilized as a way to explain the process by which attention can disrupt the pain processing pathway from the spine to the brain (Melzack & Casey, 1970). However at the time of its proposal, there was limited neurologic research to confirm these statements. Current research is now able to inform the gate theory of pain by providing neurological evidence for the ability of cognitive engagement to diminish pain perception as stated above (Bantick et al., 2002; Petrovic & Ingvar, 2002; Seminowicz & Davis, 2007). The gate control theory as well as the neurologic evidence of diminished activation of pain regions during attention-based activities both inform modern day practice in pain management. Therefore, for healthcare practitioners finding activities that can serve as cognitive engaging tasks to manage pain is of utmost importance. This thesis suggests that participant-selected music listening can serve as an engaging task, which can therefore reduce pain perception and increase pain tolerance. In order to explore this concept further, the role of music in maintaining attention is described.

**Music and Attention**

**Neurology of attention to music.** Selective attention to music listening engages the superior parietal lobes (Satoh, Takeda, Nagata, Hatazawa, & Kuzuhara, 2001) while sustained attention to music, is processed in the parietal and dorsolateral prefrontal cortex
(Ortuño et al., 2001). Consequently, attention to music is processed in the same areas that process non-musical attention (Janata, Tillmann, & Bharucha, 2002). Furthermore, areas like the temporal lobe (i.e. the superior temporal gyrus), the parietal lobe (i.e. the intraparietal sulcus), the frontal lobe (i.e the precentral sulcus, the inferior frontal sulcus and gyrus), and the frontal operculum are active during both selective and holistic listening of polyphonic music (Janata, Tillmann, & Bharucha, 2002).

Activation of the anterior cingulate cortex (ACC) is common in the processing of both pain and attention (Lotsch et al., 2012). The ACC has also been identified as the area of activation during individuals’ processing of emotional music (Blood & Zatorre, 2001). However, researchers of non-musical literature describe the anterior cingulate cortex’s (ACC) role as more closely related to processing of attention-based behaviors (Cole, Young, Freiwald, & Botvinick, 2009; Davis, Hutchison, Lozano, Tasker, & Dostrovsky, 2000; Koelsch, 2010; Petrovic & Ingvar, 2002). Since emotions capture attention, ACC activation during emotionally powerful music is attributed to increased attention on the stimulus, that is, an attention process under emotional influence (Petrovic & Ingvar, 2002).

Other research confirms the attention-based role of the ACC during vigilant-like states of music listening (Sridharan, Levitin, Chafe, Berger, & Menon, 2007). Furthermore, the ACC also shows activity during music listening tasks that require divided attention (Janata, Tillmann, & Bharucha, 2002) and selective attention (Satoh et al., 2001).

Past research shows neural activation of the anterior cingulate cortex (ACC) during the processing of pain, attention, and music. The construct of attention may
mediate ACC activation during pain and music as research supports its role in the
attention-based attributes of these two constructs (Bantick et al., 2002; Davis et al., 2000;
Davis et al., 1997; Janata et al., 2002; Koelsch, 2010; Petrovic & Ingvar, 2002; Satoh et
al., 2001; Sridharan et al., 2007). This thesis hypothesizes that, based on parallel areas of
neural activation music can influence how pain is processed in the ACC when mediated
by attention. Essentially, either pain or music will active the ACC depending on which
construct receives the most attention effort.

Although further neuroimaging research is needed to support this hypothesis, the
parallel activation of the anterior cingulate cortex (ACC) in these three domains creates a
scientific foundation for the use of music to effectively manage pain via engaging
attention.

**Music as a stimulus for attention.** The efficacy of music listening to capture
and maintain attention depends on attributes such as arousal level, complexity, volume,
tempo, style, and instrumentation of the music stimulus (Darrow, Johnson, Agnew,
Fuller, & Uchisaka, 2006). For example, Martin and Ludford (2009) determined that fast
tempo music negatively impacted visual selective attention of participants during a
driving task, while high volume music increased selective attention measures. Therefore,
attributes of music are able to influence selective attention to visual tasks.

Additional factors such as music’s cultural relevance, familiarity, preference, and
goal-driven selection are also salient when considering music that can capture and hold
attention. Zhu et al., (2009) found larger brain activation patterns with culturally relevant
music as opposed to non-culturally relevant music. In another study, Flowers (2001)
found that when participants focused on preferred music at the exclusion of external
distractors, they reported fewer distractions from the music. Furthermore, an inverse correlation was found between preference and distraction, as their music preference increased distractibility from the music decreased.

Essentially, cultural relevance, familiarity, and preference are important aspects in music meant to increase selective attention because they increase the saliency of the music for the participant. However there are few studies available that outline the influence of these aspects of music, that may be relevant in an attention-based pain management protocol.

**The Effect of Music on Pain**

Patients who experience pain often report feeling vulnerable, powerless, and dependent on nurses to manage their pain (Lam, Chan, Chen, & Ngan Kee, 2001). An effective pain management strategy empowers the patient to be an active participant in managing their pain. Music selection and music making can serve as this empowering medium (Fratianne et al., 2010). Mitchel et al., (2008) outlined that the success of music in managing a pain was dependent on music’s ability to: a) effectively shift attention, and b) allow perceived control over the pain. Many researchers have demonstrated the use of preferred and/or familiar music, to successfully manage pain in a variety of settings (Bradshaw et al., 2011; Bradt, 2010; Cepeda et al., 2010; Good et al., 1999; Kenntner-Mabiala et al., 2007; Locsin, 1981; Mitchel & MacDonald, 2006; Mitchel, MacDonald & Brodie, 2006; Mitchel, MacDonald, & Knussen, 2008; Mitchel, MacDonald, Serpell, & Knussen, 2007; Park, 2010).

Cepeda et al. (2010) conducted a systematic review of 51 studies that utilized music as a variable in treating pain. The meta-analysis showed that patients who had been
exposed to music listening during painful procedures had a 70% higher likelihood of experiencing pain relief and required less pharmacological interventions than those who were not exposed to music. However, the researchers reported that the reduction of pain yielded small effect sizes and therefore the clinical significance of the use of music for this purpose was still uncertain.

The variability between the study methods, types of pain, procedures and populations in Cepeda et al. (2010) can impact generalizability of these study findings. Variables like type of pain, musical selection criteria, and treatment periods can all impact the success of a pain management intervention. Mitchel, MacDonald, Serpell, and Knussen (2007) attempted to clarify the role of music for patients by surveying 318 chronic pain participants on their music listening behaviors to manage pain as well as their perceived importance of this practice. The results showed that the two main reasons participants utilized music to manage pain were for distraction and relaxation purposes.

Engaging in music listening to manage pain is a common practice not only among clinicians in the medical field but also among patients themselves, hence it is crucial to outline which type of music can be most effective for this goal. In order to effectively manage pain, the music selection must be meaningful for the person whether it triggers emotional associations or effectively engages their attention (Mitchel, MacDonald & Brodie, 2006).

The effect of music on cold-pressor pain. A common procedure used to study the effect of music on pain involves the use of the Cold Pressor Task (CPT), an established method for experimentally inducing pain in humans (Von Baeyer, Piira, Chambers, Trapanotto, & Zeltzer, 2005). The CPT consists of immersing a hand or a foot
in ice water or applying an ice pack to the forehead in order to study pain and its physiological responses. Some researchers have implemented the CPT to study cardiovascular responses to pain (Peckerman et al., 1994; Peckerman et al., 1998; Saab et al., 1993) while others utilize it to test the efficacy of pain management interventions (Birnie, Noel, Chambers, Von Baeyer, & Fernandez, 2010; Birnie, Petter, Boerner, Noel, & Chambers, 2012). The CPT is considered a safe procedure in pain studies with children and adults (Mitchell, MacDonald, & Brodie, 2004; Von Baeyer et al., 2005) and it is considered a reliable method for the study of pain (Edens & Gil, 1995).

Furthermore, the CPT is reported to be an ethically responsible procedure as most researchers and participants typically do not report adverse side effects from the method and have not yet reported any serious long-term side effects (Birnie, Noel, Chambers, Von Baeyer, & Fernandez, 2010; Birnie, Petter, Boerner, Noel, & Chambers, 2012). The CPT is suggested as a means of genuinely inducing pain responses which allows the researcher to study different treatments that may be the most effective in addressing pain management (Edens & Gil, 1995).

The CPT has also been successfully utilized to study the effects of different types of music on pain perception. Music researchers have utilized the CPT to study the pain-reducing effects of preferred versus non-preferred music (Hekmat & Hertel, 1993), preferred music versus relaxation music (Mitchel & MacDonald, 2006), music compared to arithmetic and humor (Mitchell, MacDonald, & Brodie, 2006), and music compared to art (Mitchel, MacDonald, & Kunssen, 2008).

In more recent literature, Silvestrini et al. (2011) implemented the CPT as a way to experimentally induce pain and determine the effect of “pleasant” and “unpleasant”
classical music, compared to silence and an auditory-discrimination attention task. The study required 20 healthy non-musicians to immerse their hand in a bowl of ice water, according to CPT protocol. A mesh fabric in the bowl separated the ice and water in order to prevent direct ice contact on the participants’ skin. While other pain methods were concurrently implemented such as a shock-induced knee reflex method, the CPT was the main protocol for obtaining a pain rating from the participant. The researchers recorded participants’ pain rating and pain tolerance, i.e. immersion duration times during the pain procedures.

Results showed that “pleasant” classical music significantly reduced participants’ pain ratings in the CPT as well as increased pain tolerance, over silence and “unpleasant” classical music. However, “pleasant” classical music and the auditory-discrimination task showed similar pain-reducing results. The researchers concluded that the pain-reducing effect of the auditory-discrimination task is attributed to its eliciting of selective attention, which also possesses effective pain-reducing attributes. The positive results of the auditory discrimination task highlight the role of attention in effective pain management. Moreover, the positive results from the “pleasant” music support the effectiveness of utilizing music to capture attention and manage pain. Overall, the results from Silvestrini et al. (2011) support the use of the CPT for effectively inducing pain in participants, as well as for studying the effects of music and auditory stimuli on pain perception and pain tolerance.

**Music Therapy and Pain Management**

It is important to clarify the difference between using music to manage pain and a music therapy pain management intervention. Music therapy is defined as the clinical and
evidenced-based use of music to accomplish individualized goals within a therapeutic relationship, with an individual who has completed an approved music therapy program (American Music Therapy Association [AMTA], 2014). Music therapy is a well-established healthcare profession, and music therapists often implement music in the clinical settings to manage pain (AMTA, 2014; Michel and Chesky, 1995). On the other hand, engaging in music listening or music performances in a clinical setting does not constitute music therapy. Many nurses and doctors implement music listening strategies with their patients to manage pain (Whitaker, 2010), yet this is not considered music therapy because of the absence of a certified therapist and an individualized treatment plan. Furthermore, a music therapy pain management intervention can be adapted to include active music making, active music listening, basic counseling, and/or music psychotherapy depending on the changing needs of the individual. While music research in pain management clearly informs music therapy practice, the two approaches are not considered equal and should be treated as separate entities.

Research on the use of music to manage pain has been performed in both clinical and laboratory settings. In music therapy, the use of music to manage pain is commonly applied in the clinical setting. Michel and Chesky (1995) conducted a survey to assess the use of music for pain relief in the field of music therapy. Results showed that 41% of music therapists surveyed utilized music with their clients specifically for pain relief. Of those clinicians, 60% reported working with the elderly while 41% worked in oncology. Regarding music selection criteria, 25% of therapists indicated they allowed patients to self-select music, while 24% of therapists selected the music themselves, yet 75% indicated that both patient preferences and therapist selections were used. Regarding the
rationale of music for pain management, 91% of therapists responded to utilizing music as a distraction tool. There are no current music therapy surveys located by the researcher conducted that update Michel and Chesky (1995).

Since pain is a common occurrence in the clinical setting, music therapy in hospitals is commonly applied as an intervention to manage pain. Locsin (1981) conducted one of the first studies that addressed the effects of music therapy on gynecologic surgery pain. Patients received music therapy sessions aimed at managing pain 30 minutes preoperatively and 2 hours after the operation, then for 15 minutes every 2 hours for two days postoperatively. Results showed that patients that engaged in music therapy needed less analgesia and had smaller increases in blood pressure and heart rate, than those in the no-music control group. Locsin (1981) utilized preferred music during the interventions and the positive effects of music therapy were attributed music’s ability to distract from the pain.

At the time of this groundbreaking study, there was limited empirical evidence to support the ability of music to effectively manage pain, despite its popularity in practice. More recently, a large number of studies support the use of music therapy interventions to effectively manage pain (Allred, Byers, & Sole, 2008; Bailey, 1986; Bradt, 2010; Fratianne et al., 2001; Good et al., 2010; Nilsson, 2008; Standley, 1986; Standley, 1992; Standley, 1995; Tan, Yowler, Super, & Fratianne, 2010; Voss et al., 2004).

Fratianne et al., (2001) examined the effectiveness of music therapy for pain management of burn patients. In this setting, pain management is a paramount goal for music therapy and its effectiveness is based on the successful engagement of selective attention and/or the successful induction of relaxation. The researchers compared self-
reported pain and anxiety scores of patients receiving music therapy to those who did not receive music therapy. Music-based imagery (MBI), meant to induce relaxation, and musical alternate engagement (MAE), meant to engage selective attention, were applied as methods to manage pain during the wound-care process of burn care. The results showed a significant reduction in the self-reporting of pain in those who received music therapy in contrast to those who did not receive music therapy.

Later, Tan et al., (2010) compared the efficacy of two different music therapy protocols to no-music-therapy control condition. The two protocols were also MBI and MAE as in Fratianne et al. (2001). Again the results showed significant decreases in self-reported pain perception during music therapy days when compared to control condition. The MAE protocol, which is based on engaging attention, showed a significant decrease in anxiety levels as well as self-reports of muscle tension during the debridement process. The fact that both types of protocols, music to elicit relaxation and music to elicit attention, were effective supports the continued use of music therapy to manage pain.

The goal of MAE is to distract the patient’s attention away from the painful stimuli by engaging patients in a music activity. This engagement can occur in five different ways: 1) through active music listening; 2) through therapeutic singing, 3) through responses to song cues; 4) through deep breathing exercise; and 5) through therapeutic instrumental playing (Tan et al., 2010). The effectiveness of the MAE protocol in Tan et al. (2010) provides a foundation for this thesis’ hypothesis. For this thesis active listening is further explored and defined as the active engagement in listening to music during the painful procedure.
Actively listening to music means to consciously focus on sound and music content by engaging in cognitive processes that relate to the musical stimulus (Volpe & Camurri, 2011). For this thesis, active listening to music occurred by: a) attending to music as one whole perception; b) focusing on one or more of the musical attributes of the song and their interaction with each other (i.e. melody, rhythm, harmony, and pitch); c) reflecting on the song’s context by analyzing the lyrics; or d) formulating mental representations of the lyrics. This definition of active listening to music is derived from past studies that have supported the use of engaging in a cognitively demanding task, like music, to decrease pain perception or manage pain (Bradshaw et al., 2011; Cepeda et al., 2010; Good et al., 1999; Kenntner-Mabiala et al., 2007; MacDonald et al., 2003; Mitchel & MacDonald, 2006; Mitchel, MacDonald & Brodie, 2006; Mitchel, MacDonald, Serpell, & Knussen, 2007; Park, 2010).

**Summary of Pain, Attention, and Music**

Attention can modulate pain and music can elicit attention, thus music has the potential to effectively manage pain. This conclusion is based on the overlap of cortical processing areas, which process aspects of attention, pain, and music. The main region of interest, which is activated by all three constructs, is the anterior cingulate cortex (ACC). During a painful experience, the ACC is activated in response to attention on the noxious stimuli and memories triggered by the painful event (Bantick et al., 2002; Lotsch et al., 2012). When attention modulates pain, the ACC is active in rostral, caudal, and adjacent regions (Petrovic & Ingvar, 2002). The ACC is also active during attention-based music listening activities (Sridharan et al., 2007) and music listening tasks that evoke different types of attention (Janata, Tillmann, & Bharucha, 2002; Satoh et al., 2001). In sum, the
ACC is activated during attention-based aspects of both pain and music. This common neural activation lays a foundation for the success of utilizing music to engage attention and manage pain.

The literature shows that music is successful in capturing and maintaining attention. Music can captivate attention through its relationship to the individual (i.e., familiarity, preference, and cultural relevance) and the interaction of its attributes (i.e., tempo, volume changes, instrumentation). Research highlights the use of music as a captivating stimulus to manage pain in both experimental and clinical settings (Cepeda et al., 2010). Music researchers have successfully utilized the cold pressor task (CPT) as a way to experimentally induce pain and study the effects of music (Silvestrini et al., 2011). In music therapy research, the success of utilizing music in pain management is common and the attention-capturing effects of music are promising (Fratianne et al., 2001; Tan et al., 2010). Updated research is needed to support the continued use of music as an attention medium to manage pain. Further research is also needed to clarify which attributes of music serve as an attention medium for pain management.

**Definition of terms.** Pain perception, pain tolerance, and attention to pain are the outcomes measured in this study. Pain perception is defined as the amount of perceived pain reported by the participants on a verbal rating scale (VRS) from 0 to 10, where 0 is no pain at all and 10 is extreme pain. Pain tolerance is defined as the duration in seconds from the time the participants immerse their hand in water to the time the participants remove their hand from the water after reaching their pain limit (Von Baeyer et al., 2005). Attention to pain is defined as the participants’ awareness of pain on a 10-point
verbal rating scale (VRS) where 0 is rarely noticing the pain and 10 is always noticing the pain.

Participant-selected music and active music listening are terms utilized in the music condition of this study. Participant-selected music is defined as music that is selected by the participants with the criteria that the music is able to engage attention during listening. Active music listening is defined as the listening of the participants’ music choice in a way that increases cognitive engagement on the music stimulus. It was implemented in this study as a set of instructions given to the participant for listening to their music choice (See Appendix H).

Research Questions

The following research questions were addressed in this thesis:

1. What is the effect of participant-selected music listening on pain perception as compared to a silence control condition?

2. What is the effect of participant-selected music listening on pain tolerance as compared to a silence control condition?

3. What is the effect of participant-selected music listening on attention to pain as compared to a silence control condition?

4. What attributes of participant-selected music are associated with changes in attention to pain?
Chapter Three

Method

Participants

For this thesis, participants ($N = 51$) were recruited from the Psychology Department at the University of Miami. The number of participants was determined by a prospective analysis of power conducted with the G Power 3.1.7 software, which determines the minimum number of participants that are required to achieve statistical significance based on the study design. Participants ranged from 18 to 23 years of age and the study included males and females. This thesis included healthy, undergraduate students who were not diagnosed with a pain condition or taking pain medication.

In order to objectively study a genuine pain response and protect the participants from harm, this thesis excluded participants who: a) were diagnosed with any chronic, pain-related illness; b) were currently taking prescription pain medication; c) were experiencing any kind of undiagnosed pain; d) had a history of cardiovascular disorders; e) had a history of fainting or seizures; f) had a history of frostbite; g) had an open sore or cut on either hand; h) had a history of Raynaud’s phenomenon, in which the hand changes color while exposed to different temperature, and finally; and i) had a history of fracture to the hands (Von Baeyer et al., 2005).

Recruitment was conducted through the Psychology department’s student pool. Students who participated in research studies through the research pool received course credit for the introduction to psychology class. This was the only incentive for participation for this thesis. The researcher posted flyers around the University of Miami campus in order to advertise the study. The study was also posted on the Psychology
Department’s list of available research studies. Participants signed up directly through the Psychology department’s website. Students scheduled a time for testing at their convenience through the Psychology Department’s online scheduling website

**Participant-Selected Music.** This study utilized musical selections that were chosen by the participants, i.e. participant-selected music. The participants were instructed select music with the criteria that it: a) was self-selected; b) effectively captured and maintained their attention; and c) was to be utilized for the purpose of active listening while experiencing painful stimuli. The participants were responsible for bringing a playback method for the music, i.e. on a smartphone or mp3 player, yet they were provided with headphones from the researcher. The participants were made aware of this requirement prior to the study.

**Study Design**

A repeated measures within-subjects experimental design was implemented to study the effect of the independent variable on the dependent variables, as it allowed the researcher to observe differences within the same participants related to the experimental condition (Privitera, 2011). Participants were assigned an order to undergo the cold pressor task (CPT) under the treatment condition (i.e. participant-selected music listening) or under the control condition (i.e. silence) in a counterbalanced manner. Participants took part in one 45 to 60 minute testing session where they completed both CPT conditions. During the CPT treatment condition, the participants were instructed to engage in active music listening of their musical selection. During the control condition, the participants underwent the CPT in silence.
**Study Personnel.** In order to allow for accurate recording of data and implementing of procedures, this thesis included a primary researcher and four undergraduate research assistants. The research assistants aided the primary researcher in maintaining the materials for the study, as well as assisting the participants in rating the dependent variables by displaying the VRS scales for pain perception and attention to pain (See Appendix A and B). The primary researcher was responsible for obtaining consent from participants, recording and coding data, as well as all verbal interactions with participants. All research assistants were CITI certified and were listed on the study protocol during the review board process. Research assistants were scheduled on a rotating basis, while the primary researcher was present for all of the testing sessions.

**Measures**

**Pain Perception.** A 10-point verbal rating scale (VRS) was utilized to measure the participants’ pain perception (See Appendix A). The 10-point scale ranged from 0-meaning “no pain” to 10-indicating “extreme pain”. The VRS quantified the pain experience by using a rating of pain intensity. A rating of 0 equals no pain; a rating of 1 to 3 equals mild pain; a rating of 4 to 6 equals moderate pain; a rating of 7 to 9 equals severe pain; a rating of 10 signifies extreme pain (Backonja et. al., 2010). The VRS scale has been utilized in many previous pain studies with success and its use for quantifying pain is supported by available research (Von Baeyer et al., 2005)

**Pain Tolerance.** During both CPT conditions the participants’ pain tolerance (i.e. the participant’s immersion duration time in seconds) was recorded. The researcher utilized a stopwatch application on the iPhone 5 to measure this variable. The researcher
began the stopwatch when the participant was cued to immerse the hand, and stopped the count when the participant said “Stop” and/or removed the hand from the ice.

**Attention to Pain.** A 10-point verbal rating scale (VRS) was utilized to measure the participants’ Attention to Pain (See Appendix B). The VRS scale for attention quantified the experience of awareness of pain by asking participants to rate how much they noticed the pain on a scale of 0 to 10. A rating of 0 equals rarely noticing the pain while a rating of 10 equals always noticing the pain.

**Musical Attributes.** There were 5 musical attributes outlined as predictors in influencing attention to pain. These attributed were determined by a review of the related literature on the use of music to influence attention (Darrow et al., 2006; Martin & Ludford, 2009; Flowers, 2001; Zhu et al., 2009). The participants were asked to rate their music selection on the music’s: 1) activation, ranging from inactive to extremely active; 2) tempo, ranging from very slow to very fast; 3) presence of lyrics; 4) mood, either negative, neutral or positive; and 5) preference, ranging from very non-preferred to very preferred. Statistically, these five attributes were considered the predicting model utilized to: a) analyze which attributes of participant-selected music influenced attention to pain; and b) analyze the content from an open-ended question from the participant questionnaire.

**Participant questionnaire.** The participants completed a researcher-designed questionnaire that collected demographic information including age, gender, hours spent listening to music a day, and information about the musical selection, including ratings on the musical attributes. The questionnaire was administered following both CPT
immersions (See Appendix C). The research assistants transcribed all answers from the questionnaire, and the primary researcher coded and analyzed all responses.

**Procedure**

Testing sessions took place in a temperature-controlled room (21-23°C) at the University of Miami’s Music Education and Music Therapy Department. The room contained a chair with armrests for the participants to sit in, along with extra chairs placed behind the participants’ chair for the researcher and the research assistant. One side table was placed next to the participants’ chair that contained a bowl containing ice water. A TruTemp digital thermometer was placed inside of the bowl to measure the temperature of the ice water. The research assistant was responsible for the maintenance of the ice bowl and added ice as needed to maintain the water temperature ranging from 1°C to 5°C. Inside the ice water bowl, a metal strainer was placed to separate the ice cubes from the immersion area, therefore preventing direct ice cube contact to the participants’ skin.

**Informed Consent and Instructions.** When the participants arrived for testing, the researcher read the consent form out loud to the participants and explained each section in detail. The consent form provided a detailed outline of the study including purpose, procedures, exclusion criteria, compensation, potential risks, option to withdraw from study, and other pertinent information (See Appendix H). Participants were not allowed to undergo the testing without giving written consent.

Once consent was obtained the participants were assigned a code, which was utilized to track data and assign them to a treatment order by alternating the order among participants. The participant was then read a script containing instructions on the CPT
procedures. The instructions explained the immersion process, how to engage in active music listening during the music condition, and other relevant instructions (See Appendix H). Once the participants understood the procedure and had all pertinent questions answered, the CPT began.

**Music condition.** Prior to the beginning of the music condition, the participants were asked to retrieve their music selection. In order to begin the CPT, the participants were asked to play their music selection and actively focus on it utilizing the method of active music listening of their choice. The researcher and research assistant sat behind the participants and did not engage the participants in conversation or any other type of interaction during the CPT. The participants experienced the procedure independently in order to control for demand characteristics. However, the participants did notify the researcher when the music playback had begun, usually through a non-verbal gesture.

The researcher then began the stopwatch while the participants engaged in active listening for 20 seconds. The researcher then re-set the stop watch and asked the research assistant to cue the participants to immerse their hand with a tap on the shoulder. The researcher measured the immersion duration with the stopwatch, from the start of the hand immersion to the end of the immersion when the participants said “Stop” and/or removed their hand from the ice water. The participants instinctively removed their headphones at this time. The researcher recorded the duration time on the data sheet while the research assistant requested a pain perception and attention rating from the participants at this time. The participants were provided with the VRS scale for pain and pointed to and verbalized their pain on a scale of 1 to 10 (See Appendix A). The research assistant then asked the participant to rate their attention to pain. The participants were
provided with the VRS scale for attention and pointed to and verbalized their awareness of pain on a scale of 1 to 10 (See Appendix B).

Participants were not allowed to leave their hand immersed longer than a 5-minute period, in order to protect them from any harm or thermal side effects (Birnie et al., 2010; Birnie et al., 2012; Von Baeyer et al., 2005). Participants were not informed of this time limit, to allow a genuine pain tolerance account and prevent the participants from counting down to the end of a specified time limit (von Baeyer et al., 2005). The research assistant then gave the participants a towel with which to dry their hand.

**Break time.** Following the first CPT immersion, participants were allowed a 10-minute break to allow their body temperature and pain perception to return to baseline. During the break period, participants were asked to engage in a cognitively-demanding memory game in order to avoid carryover effects from one CPT to another. Engaging in a memory task during the break period allowed a genuine period of disengagement from the previous pain perception and avoided participants anxiously awaiting the upcoming task (Fishel, Muth, & Hoover, 2007; Jennings, Kamarck, Stewart, Eddy, & Johnson, 1992).

The memory game was run on a MacBook computer in the testing room through a website called Lumosity which provides online cognitive games and training. The memory task consisted of a series of squares, which flashed a sequence of different colored squares for a period of 2 seconds. The task involved asking the participants to reproduce the sequence as best possible. Points were awarded for every correct answer and the number of squares increased with every correct answer. The participants were instructed to play the memory game for a 10-minute period without concern for success
or failure of the task. During the break period, the researcher assistant checked that the ice-water was still within the appropriate thermal threshold for the second immersion.

**Silence condition.** The silence condition followed the same procedures as the music condition except that no music was utilized. The silence condition was meant to serve as a control for the possible effects of participant-selected music on pain perception and pain tolerance scores of participants. Participants were instructed to immerse the opposite hand for the second CPT. The immersion of the opposite hand was meant to control for the participants’ memory of the past pain perception as this may have influenced the genuineness of the present pain. If the participants were to utilize the same hand, the second pain perception may have been influenced by the memory of the previous immersion as opposed to being a genuine perception caused by the actual physical stimuli presented during this immersion (Wiech, Ploner & Tracey, 2008).

**Ending the CPT.** Once the participants completed both immersions the researcher provided them with the participant questionnaire. The questionnaire collected demographic information, information about music training and music listening habits as well as information about the procedure, among other information (See Appendix C). At this time, the participants were finished with the testing session and were awarded full credit for their participation in the research study.

**Data Analysis**

This thesis utilized a counterbalanced within subjects repeated measures design as it contains the independent variable of treatment, CPT time one and time two, and the dependent variables, pain perception, pain tolerance and attention to pain. The within subject repeated measure design is associated with more power to detect effects than the
between subjects design (Privitera, 2011). Based on this design and the research questions, the most appropriate statistical analyses were: 1) three dependent sample t-tests, to compute the mean differences between treatment and control condition within the three dependent variables; 2) a linear multiple regression analysis to compute the predicting power of the music attributes on the attention to pain dependent variable within the music condition; 3) descriptive and frequency statistics to explore demographic information from the population sample and their music selections. Additionally, a content analysis was utilized to code open-ended questions from the questionnaire relating to the rationale of music selection (Creswell, 2009). Furthermore, in order to explore the possible influence of gender, music listening habits, musical training, and order effects on the dependent variables, independent samples t-tests and between subjects anovas were conducted utilizing mean differences scores among all variables.
Chapter 4

Results

In this chapter the statistical analyses of the data will be described. The chapter will present descriptive results regarding the sample, along with pertinent information regarding the participants’ music habits. Second, inferential statistics regarding the results from the study as they relate to the research questions will be presented. Finally, a content analysis for an open-ended question from the questionnaire will be explored.

Overview

The recruitment and data collection period lasted approximately four months from January 2014 to May 2014. The sole source of recruitment was the Psychology Department’s Introduction to Psychology class. The students were provided with two course credits for one hour of participation in the study. All participants were recruited, scheduled, and assigned credit through the department’s Research Participation (rEpr) website. All reports of pain, attention to pain and pain tolerance were collected and coded into nominal and continuous data points to allow for ease of analysis. All statistical analyses were computed using the software Statistical Package for Social Sciences (SPSS) version 20.0.

Participants

A total of 51 participants completed all tasks of this study and were allotted credit for participation. The data from one male participant was excluded, as he did not correctly follow the immersion instructions. Therefore, the total sample size consisted of 50 participants, 23 female and 27 males. The distribution of the sexes was almost equal and is fairly representative of the general population. The mean age of the total sample
was 19.4 years ($SD=1.27$) with ages ranging from 18 to 23 years. The participants were all university students enrolled in the Introduction to Psychology class at the University of Miami. There were no music majors included in this study.

The participants’ music habits are summarized as follows. Sixty-eight percent of the sample reported music listening habits of about one to four hours daily and 76% reported having some prior musical training. Of those with prior music training, 42% reported training that lasted from 0 to 2 years, while the remainder had training of two or more years. Ninety-eight percent of the participants reported utilizing music in their daily life for achieving non-musical goals, defined by this study as therapeutic music listening. When asked to rate their primary reason for therapeutic music listening, 32% of the participants reported utilizing music during exercise, while 30% of them reported utilizing it to reduce stress. Eighteen percent of participants stated they utilized therapeutic music listening to induce relaxation and 10% of them for emotional expression. No participants reported using music for pain management. (See Table 1).

Table 1

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Demographic Characteristics of Sample ($N=50$)
### Daily Music Listening Habits

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### Years Musical Training

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### Therapeutic Listening Habits

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### Primary Reason for Therapeutic Listening

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<tr>
<td>During Exercise</td>
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<td>32.7</td>
</tr>
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### Future Therapeutic Music Use for Pain

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</table>

**Participant-Selected Music.** The participants utilized music in the study with the criteria that the music was self-selected and able to capture their attention. This study asked participants to rate their music on five attributes of music in order to analyze the sample’s music selections. The five attributes of music were activation, tempo, presence of lyrics, mood, and preference. Fifty-two percent of the participants chose music that
was active, 34% of participants chose music that was moderately active, 8% chose music that was extremely active and 6% chose inactive music. No participants chose music that was extremely inactive. Regarding the tempo of the music selections, 48% of the participants chose music that they perceived as moderate in tempo, while 40% of participants chose music that was fast in tempo. Ten percent of the participants chose slow tempo music and 2% chose very fast tempo music. No participants chose music that was very slow in tempo. Ninety-two percent of the participants chose music with lyrics in them, and only 8% chose non-lyrical music. Regarding the mood of the music, 74% of participants chose music that had a positive mood, 16% of them chose music with a neutral mood and 10% of them chose music with a negative mood. The preference element was by far the most skewed with 70% of participants choosing music they considered very preferred and 30% of them choosing music they considered preferred. No participants chose music they deemed neutral, non-preferred, or very non-preferred (See Table 2).

Table 2

Attributes of Music Ratings (N=50)

<table>
<thead>
<tr>
<th>Activation</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely Inactive</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Inactive</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Moderate</td>
<td>17</td>
<td>34</td>
</tr>
<tr>
<td>Active</td>
<td>26</td>
<td>52</td>
</tr>
<tr>
<td>Extremely Active</td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tempo</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Slow</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Slow</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Moderate</td>
<td>24</td>
<td>48</td>
</tr>
<tr>
<td>Fast</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>Very Fast</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
Inferential Analysis Results

In order to explore the differences between experimental and control condition, three separate $t$-tests were conducted for each dependent variable in order to compare the mean differences between the two conditions.

**Research Question One.** What is the effect of participant-selected music listening on pain perception as compared to the silence control condition?

Results showed that participants reported significantly less pain during the music condition ($M=6.02$, $SD=1.77$) than during the silence condition ($M=6.94$, $SD=1.49$), ($M_{Diff}=-.92$, $SE=.23$, $t=-3.97_{(49)}$, $p<.001$). Therefore, participants perceived less pain during the music condition than during the silence (See Table 3 and Figure 1). Furthermore, Cohen’s $d$ effect size was calculated to determine practical significance of the mean differences within the conditions (Privitera, 2011). The effect size value for pain perception ($d=.57$) suggests a medium level of practical significance.
Table 3
*Paired sample t-test means and standard deviations for Pain Perception*

<table>
<thead>
<tr>
<th>Immersion Condition</th>
<th>$M$</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Music</td>
<td>6.02*</td>
<td>1.77</td>
</tr>
<tr>
<td>Silence</td>
<td>6.94</td>
<td>1.49</td>
</tr>
</tbody>
</table>

*Note: *Difference significant at $p < .001$ level.

![Figure 1](image)

**Research Question Two.** What is the effect of participant-selected music listening on pain tolerance as compared to the silence control condition?

Participants were able to immerse their hand in the ice-water significantly longer during the music condition ($M=190.68 \text{ SD}=99.61$) than during the silence condition ($M=124.72 \text{ SD}=95.78$), ($M_{\text{Diff}}= 65.96$, $SE=12.30$, $t= 5.36_{(49)}$, $p <.001$) (See Table 4 and Figure 2). In other words, the participants were able to tolerate pain significantly longer during the music condition than during the silence. Cohen’s effect size value ($d = .75$) suggests a medium to large level of practical significance for the pain tolerance variable.
Table 4
Paired sample t-test means and standard deviations for Pain Tolerance in seconds

<table>
<thead>
<tr>
<th>Immersion Condition</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Music</td>
<td>190.68*</td>
<td>99.61</td>
</tr>
<tr>
<td>Silence</td>
<td>124.72</td>
<td>95.78</td>
</tr>
</tbody>
</table>

Note: *Difference significant at p < .001 level.

Figure 2. Means of pain tolerance in music and silence condition in seconds.

Research Question Three. What is the effect of participant-selected music listening on attention to pain as compared to the silence control condition?

Participants reported significantly lower attention to pain scores during the music condition (M=4.86 SD=2.01) than the silence condition (M=7.90 SD=1.61), (M_Diff=-3.04, SE=.286, t=-10.64(49), p < .004). Therefore, participants reported awareness of pain less frequently during the music condition than during the silence condition (See Table 5 and Figure 3). Cohen’s effect size value (d = -1.5) suggests a large level of practical significance, making the mean differences between the conditions in this variable the most practically significant of the three dependent variables.
Table 5
*Paired sample t-test means and standard deviations for Attention to Pain*

<table>
<thead>
<tr>
<th>Immersion Condition</th>
<th>$M$</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Music</td>
<td>4.86*</td>
<td>2.01</td>
</tr>
<tr>
<td>Silence</td>
<td>7.90</td>
<td>1.61</td>
</tr>
</tbody>
</table>

*Note:* *Difference significant at $p < .004$ level.*

![Bar chart showing means of attention to pain in music and silence condition.](chart)

Figure 3. *Means of attention to pain in music and silence condition.*

**Research Question Four.** What attributes of participant-selected music were significant in influencing attention to pain?

A multiple linear regression analysis was conducted in order to explore the relationship between five musical attributes and attention to pain. This multiple linear regression describes how much variability in attention to pain can be predicted by the established musical attributes. In order to run the multiple regression analysis, all assumptions were met including, normality, homoscedasticity, and multicolinearity. Linearity was met as established and independence of data pairs was also assured. Based on the literature on the use of music to capture attention (Darrow, Johnson, Agnew,
Fuller, & Uchisaka, 2006) the model of attributes of music was properly specified. Multicolinearity was met since all VIF values were lower than 10 and all Tolerance values were more than .1, no multicolinearity problems were observed. Finally, the data points were normally distributed and homoscedastic.

The results from the regression showed a multiple correlation coefficient of .387, which indicates a small to medium relationship between observed values and predicted values. The adjusted r-squared value of .053 indicates that 5% of observed variability in attention to pain, was explained by the overall musical attributes model. The overall musical attributes model was found to not be statistically significant ($F(4, 44)=1.553, p >.05$). The musical attributes when analyzed as a model or as a group, did not show to be significant in influencing attention to pain (See Table 6). However, the element of preference was found to be significant in predicting a change in attention to pain.

The standardized slope of the musical element of preference on attention to pain was $.371, t(44) = -2.50, p < .05$, after controlling for other predictors in the model. This indicates an expected change in attention to pain of -.37 sd units, associated with an increase in the musical preference by 1 standardized unit when holding the other musical attributes constant. Therefore, as the preference rating of the music increased by 1 unit the attention to pain rating decreased by .37 units.
Table 6

Linear Multiple Regression for Music Attributes and Attention to Pain

<table>
<thead>
<tr>
<th>Music Attributes Model</th>
<th>Beta</th>
<th>t</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activation</td>
<td>-.029</td>
<td>-.160</td>
<td>.874</td>
</tr>
<tr>
<td>Tempo</td>
<td>-.066</td>
<td>-.361</td>
<td>.720</td>
</tr>
<tr>
<td>Lyrics</td>
<td>.033</td>
<td>.227</td>
<td>.821</td>
</tr>
<tr>
<td>Mood</td>
<td>-.026</td>
<td>-.156</td>
<td>.876</td>
</tr>
<tr>
<td>Preference</td>
<td>-.371</td>
<td>-2.503</td>
<td>.016*</td>
</tr>
</tbody>
</table>

Note: * Significant result.

After a significant result was found in the linear multiple regression, a Pearson’s Correlation analysis was conducted between attention to pain and preference. The results from this analysis were again significant in correlating the two variables ($r=-.375 \ N=50 \ p=.007$).

Content Analysis

Question eight from the participant questionnaire asked the participants to state the reason for choosing music to use in the study. The narrative answers were coded relating to the musical attributes model, i.e. answers were coded as they contained references to activation (A), tempo (T), lyrics (L), mood (M), and preference (P) of music as a reason for their choice. Additionally, many responses included triggering of memories (Me) as a rationale for music selection, therefore this element was included in this section. The results from the rationale for music selection questionnaire item are summarized below.

A total of 60 references to the musical attributes model were found in the responses. This number is higher than the number of participants because some participants made more than one reference to the musical attributes in their response. Out of these 60 references, four responses related to the activation of the music, twelve to its
tempo, ten related to lyrical content, six responses related to mood elicited by the music, seventeen related to preference, and eleven to memories elicited by the music. The frequency and distribution of words relating to music attributes within the participants’ responses are summarized below (See Table 7). Complete responses to question eight along with their assigned code are found in Appendix D. Additionally, a more detailed table of the coded responses can be found in Appendix E.

Table 7
Summative Content Analysis Results for Music Selection Rationale

<table>
<thead>
<tr>
<th>Music Attributes</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activation</td>
<td>4</td>
<td>6.66</td>
</tr>
<tr>
<td>Tempo</td>
<td>12</td>
<td>20.00</td>
</tr>
<tr>
<td>Lyrics</td>
<td>10</td>
<td>16.66</td>
</tr>
<tr>
<td>Mood</td>
<td>6</td>
<td>10.00</td>
</tr>
<tr>
<td>Preference</td>
<td>17</td>
<td>28.33</td>
</tr>
<tr>
<td>Memories</td>
<td>11</td>
<td>18.33</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>60</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

**Additional Results**

Although they were not outlined in the research questions, other analyses were conducted to determine trends among the dependent variables analyzing by order of conditions, gender, music listening habits, and music training in years. These additional results highlight different relationships within the data that are outside of the scope of this thesis but may be utilized as a base for future research.

**Order Effects.** Three independent samples t-tests were conducted to determine if the order of conditions had an influence on the dependent variables. The results showed that there were no significant mean differences between the first and the second immersion for the participants’ pain perception \( t(49) = -1.69, p = .096 \), pain tolerance \( t(49) = .659, p = .682 \), and attention to pain \( t(49) = -.932, p = .356 \). Therefore, the
order of conditions did not significantly impact the participants’ pain perception, pain tolerance, and attention to pain scores.

**Gender Differences.** Descriptive statistics show that females reported lower pain perception and attention to pain scores within the music condition only, while males were able to tolerate pain for longer periods in both the silence and music condition (See Table 8).

Table 8
*Pain Perception (PP), Pain Tolerance (PT) and Attention to Pain (AP) Means and Standard Deviations by Gender (N=50)*

<table>
<thead>
<tr>
<th>Source</th>
<th>Sex</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain Perception – music</td>
<td>Males (n=27)</td>
<td>6.19</td>
<td>1.90</td>
<td>5.83</td>
<td>1.64</td>
</tr>
<tr>
<td></td>
<td>Females (n=23)</td>
<td>6.85</td>
<td>1.53</td>
<td>7.04</td>
<td>1.46</td>
</tr>
<tr>
<td>Pain Perception – silence</td>
<td>Males (n=27)</td>
<td>6.85</td>
<td>1.53</td>
<td>7.04</td>
<td>1.46</td>
</tr>
<tr>
<td></td>
<td>Females (n=23)</td>
<td>7.04</td>
<td>1.46</td>
<td>7.85</td>
<td>1.63</td>
</tr>
<tr>
<td>Pain Tolerance – music</td>
<td>Males (n=27)</td>
<td>202.11</td>
<td>95.76</td>
<td>177.26</td>
<td>104.48</td>
</tr>
<tr>
<td></td>
<td>Females (n=23)</td>
<td>140.30</td>
<td>101.69</td>
<td>106.43</td>
<td>86.97</td>
</tr>
<tr>
<td>Attention to Pain – music</td>
<td>Males (n=27)</td>
<td>5.28</td>
<td>2.34</td>
<td>4.45</td>
<td>1.90</td>
</tr>
<tr>
<td></td>
<td>Females (n=23)</td>
<td>8.00</td>
<td>1.60</td>
<td>7.85</td>
<td>1.63</td>
</tr>
</tbody>
</table>

To determine if these mean differences were significant three independent samples t-test were conducted utilizing mean difference scores between the conditions for the males and females. The results showed no significant mean differences between males and females’ scores on pain perception \[ t(48) = -1.18, p = .240 \], pain tolerance \[ t(48) = .362, p = .719 \] or attention to pain \[ t(48) = -1.43, p = .159 \].

**Music Listening Habits.** The results for the amount of hours spent listening to music in a day show that pain perception and attention to pain means decreased and pain tolerance increased, as the amount of music listening hours was greater (See Table 9). Participants who listen to music on average 4-8 hours per day showed the lowest pain perception and attention to pain as well as highest pain tolerance ratings. However, this
effect was only seen in the music condition, as the silence condition did not appear to show any clear trends and the pain means varied within the categories.

Table 9
*Pain Perception (PP), Pain Tolerance (PT) and Attention to Pain (AP) Means and Standard Deviations by Music Listening Habits (N=50)*

<table>
<thead>
<tr>
<th>Amount of daily hours spent listening to music</th>
<th>&lt;1 Hour</th>
<th>1-4 Hours</th>
<th>4-8 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Pain Perception – music</td>
<td>6.50</td>
<td>1.51</td>
<td>6.26</td>
</tr>
<tr>
<td>Pain Perception – silence</td>
<td>6.17</td>
<td>1.16</td>
<td>7.29</td>
</tr>
<tr>
<td>Pain Tolerance – music</td>
<td>122.00</td>
<td>65.79</td>
<td>191.59</td>
</tr>
<tr>
<td>Pain Tolerance – silence</td>
<td>112.00</td>
<td>95.39</td>
<td>111.26</td>
</tr>
<tr>
<td>Attention to Pain – music</td>
<td>6.50</td>
<td>2.12</td>
<td>4.86</td>
</tr>
<tr>
<td>Attention to Pain – silence</td>
<td>7.50</td>
<td>2.12</td>
<td>8.18</td>
</tr>
</tbody>
</table>

To determine if these mean differences were significant, a between-subject ANOVA was conducted. The results showed that there were no significant differences among the participants’ reported music listening habits in pain perception \[F(4, 45)=1.11 \ p= 0.361\] or attention to pain \[F(4, 45)=1.39 \ p= 0.253\] scores, yet there was a significant difference in the pain tolerance variable \[F(4, 45)=2.91 \ p= 0.032\]. In order to determine where this difference in pain tolerance occurred a post hoc test was conducted, which failed to indicate significant mean differences between the categories.

**Music Training in Years.** Even though no music majors were included in this study, prior music education among the participants was expected. This music training was defined as private instrument lessons or school-based music classes. The participants were asked to rate the length of any prior music training in years. The results show that in the music condition, pain perception means were the lowest among participants who had
0 to 2 years of music training, while in the silence condition the lowest pain perception mean was found in the 5 to 10 year category. Regarding pain tolerance, the results show that participants who had 5 to 10 years of music training had the highest rating in both conditions. For attention to pain, results show the lowest means in the 10 to 15 year training category, while the lowest mean in the silence condition was found in the 2 to 5 year category (See Table 10).

Table 10
*Pain Perception (PP), Pain Tolerance (PT) and Attention to Pain (AP) Means and Standard Deviations by Musical Training in Years (N=50)*

<table>
<thead>
<tr>
<th>Source</th>
<th>Musical TrainingYears</th>
<th>0-2 Years</th>
<th>2-5Years</th>
<th>5-10 Years</th>
<th>10-15 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>PP – Music</td>
<td>5.44</td>
<td>1.36</td>
<td>6.30</td>
<td>2.21</td>
<td>5.71</td>
</tr>
<tr>
<td>PP – Silence</td>
<td>6.75</td>
<td>1.69</td>
<td>6.90</td>
<td>1.66</td>
<td>6.71</td>
</tr>
<tr>
<td>PT – Music</td>
<td>170.56</td>
<td>92.54</td>
<td>212.00</td>
<td>121.54</td>
<td>234.71</td>
</tr>
<tr>
<td>PT – Silence</td>
<td>121.13</td>
<td>101.77</td>
<td>104.30</td>
<td>68.99</td>
<td>172.14</td>
</tr>
<tr>
<td>AP – Music</td>
<td>5.25</td>
<td>2.34</td>
<td>4.50</td>
<td>2.05</td>
<td>5.14</td>
</tr>
<tr>
<td>AP – Silence</td>
<td>8.00</td>
<td>1.50</td>
<td>7.40</td>
<td>1.64</td>
<td>8.14</td>
</tr>
</tbody>
</table>

To determine if these mean differences were significant, a between subject ANOVA was conducted among the dependent variables and the categories of musical training in years. These results show that there were no significant differences between the participants’ ratings of pain perception \[F(3, 34) = .578, p = 0.633\], pain tolerance \[F(3, 34) = .951, p = 0.427\] or attention to pain scores \[F(3, 34) = 1.39, p = 0.261\] when these variables were analyzed by ratings of musical training in years.
Chapter Five

Discussion

An interpretation of the results will be presented in this chapter by reviewing each research question as well as participant demographic information. Additionally, the clinical and theoretical implications of these results are discussed, as well as the study’s limitations and future recommendations.

Overview

The purpose of this study was to determine the effects of participant-selected music listening on pain perception, pain tolerance, and attention to pain in healthy individuals during an ice-water hand immersion protocol. Data were analyzed to compare mean differences within subjects’ ratings of pain and attention to pain, as well as tolerance of pain in a silence and music condition. Additionally, participants were asked to rate their chosen music selection based on five musical attributes, which included activation, tempo, lyrics, mood, and preference. The statistical analyses showed significant differences between music and silence conditions with participants reporting higher ratings of pain tolerance and lower ratings of pain perception and attention to pain. Results also showed a significant correlation between preference of the music and attention to pain.

Demographic Information

Fifty healthy young adult male and female students from the University of Miami participated in this study. Of these fifty, 68% of them reported listening to music on average one to four hours per day, while 98% of them reported utilizing music listening for therapeutic purposes. Of this 98%, the two main reasons reported for therapeutic
music listening were for stress reduction and for use during exercising. No participants reported utilizing music for pain management purposes, indicating that the method of this study was not a well-known approach for pain management within this sample. This familiarity with music listening but unfamiliarity with its use in pain management made this sample appropriate candidates for the study, as they did not show bias to the protocol, this allowed the researcher to genuinely study if music listening had an effect on pain. The results from this study clearly indicate the success of utilizing music to manage pain and establish this approach as valuable for this sample. In a follow-up question, 74% of participants stated they would utilize music to manage acute pain in the future.

Review of Research Questions

Effect of Music on Pain Perception. Participants reported a significant difference in the mean ratings of pain perception between the music and the silence conditions with the music condition yielding significantly lower pain perception scores. These results support past research on the use of music for pain management that showed that participants who engaged in music making or music listening reported less pain than those who did not (Locsin, 1981; Cepeda et al., 2010). This study adds to the extensive literature regarding the use of music to manage pain, and supports its continued use for this purpose (Bradshaw et al., 2011; Cepeda et al., 2010; Good et al., 1999; Kenntner-Mabiala et al., 2007; MacDonald et al., 2003; Mitchel & MacDonald, 2006; Mitchel, MacDonald & Brodie, 2006; Mitchel, MacDonald, Serpell, & Knussen, 2007; Park, 2010).
Past research, that utilized the same protocol, did not find significant results in diminishing pain perception as did this study. The researcher attributes these differences in results to the music selection protocol. The protocol allowed participants to self-select the music, while past studies have utilized researcher-selected music (Hekmat & Hertel, 1993; Silvestini et al., 2012). The results suggest that when utilizing music for pain management, the music selected must be of significant meaning to the individual, as it will be better able to engage attention and diminish pain perception. Past research was based on the premise that a particular type of music may be more effective, or that someone who is well versed in music is more qualified to select music for pain management. However, this approach is fundamentally flawed because it does not treat the individual as an active participant in their pain management, an approach that has been supported in non-musical pain research (Lam et al., 2001).

**Effect of Music on Pain Tolerance.** The results showed a significant difference in the mean hand immersion duration times between the music and the silence condition. The immersion duration was termed pain tolerance, for the participants’ ability to tolerate the pain over time. The participants were able to leave their hand immersed in the ice water for significantly longer during the music listening than during the silence condition. These results support music and music therapy research on the use of music engagement to tolerate painful medical procedures. Past studies have established that music and music therapy can serve as a tool to increase pain tolerance by engaging the participants’ attention (Fratianne et al., 2001; Mitchel, MacDonald & Brodie, 2006; Silvestrini et al., 2012; Tan et al., 2010). This study continues to support the use of music listening for
increasing pain tolerance, while also including a measure of attention to support it as an effective construct in pain-management.

**Effect of Music on Attention to Pain.** The results showed a significant difference between the participants’ attention to pain score in the music and silence condition; participants reported lower attention to pain scores during the music condition. Asking participants how much they noticed the pain on a scale of one to ten assessed the attention to pain variable. These results support part research that have established engaging attention as an effective tool in diminishing pain perception (Arntz & de Jong, 1991; Bantick et al., 2002; Cohen, 1993; Gracely et al., 2004; Legrain, 2005; Legrain et al., 2009; Levine et al., 1982; Miron et al, 1989; Nouwen, Cloutier, Kappas, Warbick & Sheffield, 2006; Rémy, Frankenstein, & Richter, 2001; Spence et al., 2002; Tracey, 2008; Van Damme et al., 2010; Verhoeven et al., 2010; Villemure & Bushnell, 2001). Furthermore, the results establish participant-selected music listening as a medium that can effectively engage attention to decrease pain perception. This study also establishes those attributes of music, which are most salient in engaging attention away from pain.

**Music Attributes and Attention to Pain.** The positive effects of music to engage attention and manage pain have been explored (Fratianne et al., 2001; Mitchel, MacDonald & Brodie, 2006; Silvestrini et al., 2012; Tan et al., 2010), however, there is limited research that addresses how music is able to effectively engage attention during pain, as well as which attributes of music are salient in this purpose. In order to address this issue, this study focused on five musical attributes that were analyzed as possible predictors in influencing attention to pain. These five predictors were determined utilizing past research that has explored similar attributes of music that were relevant
when influencing attention (Darrow et al, 2006; Flowers, 2001; Martin & Ludford, 2009; Zhu et al., 2009). The five attributes for this protocol were defined as: activation, tempo, lyrics, mood, and preference.

The five musical attributes were analyzed as a group to determine if all five had an influence on the attention to pain scores. Results showed that ratings of activation, tempo, lyrics, mood, and preference of the music varied too much from participant to participant and therefore, were not significant in influencing attention to pain scores. However, when attributes were analyzed separately, a significant negative correlation was found between preference and attention to pain. Results showed that as the preference rating increased, attention to pain scores decreased significantly. In sum, while the tempo, activation, lyrics and mood of music varied between participants, preference of the music was scored either preferred or very preferred among the participants. These results establish the importance of music preference to engage attention during a pain experience, by highlighting preference as a significant element to consider for this purpose. This study suggests that when utilizing music to capture attention and manage pain, some attributes of music, that is tempo, mood, activation, and lyrics, are of little importance and their variability may not impact attention to pain. However, preference stands out as the one salient element to consider in effectively engaging attention to manage pain.

This finding challenges prior research that attempted to establish classical music (Silvestrini, et al.2011) and researcher-selected music (Hekmat & Hertel, 1993) as the paramount choices for managing pain. This study supports past research that has utilized preferred music to manage pain successfully over relaxation music (Mitchel &
MacDonald, 2006), visual distractions (Mitchel, MacDonald & Kunssen, 2008) and silence (Mitchel, 2009). Moreover, when additional attributes such as positive mood and high emotional content are found in music that is preferred, the effectiveness of the use of music for pain management is enhanced (Knox, Beveridge, Mitchel, & MacDonald, 2011). This study creates a basis for future research by continuing to support attention as a successful method for pain management, and preferred participant-selected music as an effective tool in engaging this attention.

**Content Analysis of Music Selection Rationale**

This researcher conducted a content analysis of an open-ended question from the participant questionnaire. The question namely “In your own words, please state which music selection you chose as captivating and why you chose this specific music selection. What about it made you choose it?”. The researcher coded the narrative responses as they made reference to the musical attributes to determine if these statements supported the quantitative results regarding the effectiveness of preference. The results from the content analysis support the finding that preference is an important music element, with 28.33% of the responses making reference to preference as the main reason for choosing their music. Therefore, preference was not only significant in the quantitative data analysis, but the participants also commonly reported it as a reason for their choice. This makes preference an important element to consider when attempting to engage attention to manage pain. Other common reasons for choosing music related to the music’s tempo and ability to elicit memories, the latter a criterion that was not initially included in the questionnaire of this study.
Theoretical Implications

**Pain perception, pain tolerance, and music.** Significant differences emerged between the music condition and the control condition in both pain perception and pain tolerance, as well as in attention to pain. The findings also reveal an interaction between preferred participant-selected music, attention, and pain. The researcher concludes that the significant difference between conditions found in all the dependent variables is attributed to the high degree of preference of music reported by participants. Participants were simply more attentive to the music than to the pain in the music condition. These results align with past theories of pain management that state that noxious input can be inhibited by activity that engages the spinothalamocortical pathway, as well as cognitive-based activities that are processed in supraspinal regions (Melzack & Wall, 1970; Melzack, 1996; Moayedi & Davis, 2013).

The gate control theory of pain (Melzack & Casey, 1968; Melzack, 1996) as well as the pain neuromatrix concept (Tracy, 2008) both state that pain can be managed by engaging in cognitive activities that inhibit the transmission of painful stimuli. Furthermore, this inhibition of pain signals is made possible by the conscious process of selective attention. Selective attention is at play when an individual is focusing on one stimulus at the expense of another (McDowd, 2007). This type of attention aligns with the neuroanatomical processes behind how pain perception is diminished through cognitive engagement on a stimulus as outlined in the gate control theory.

The results from this study provide empirical evidence to confirm the previously stated theories and connections. The results imply that music, specifically preferred music, serves as a cognitive activity that inhibits the transmission of pain signals along
the spinothalamocortical pain pathway, therefore diminishing pain perception and increasing pain tolerance. Moreover, preferred music can also be effective at engaging selective attention (Darrow, 2006) and its use during pain management can be effective for this purpose.

**Neurology of attention to pain and music.** The goal behind utilizing music to engage attention should be to activate the neurological regions that process attention and pain. Past research states that areas associated with the processing of pain diminish in activation during attention-based activities (Bantick et al., 2002; Davis et al., 2000; Seminowicz & Davis, 2007). One such pain area is the anterior cingulate cortex (ACC) which is suggested to process a variety of stimuli that relate to attention (Lotsch et al., 2012). Activation of the ACC during both pain and music listening translates to the ability of both stimuli to elicit attention. The theoretical foundation behind how music can impact pain perception is found in this shared activation of the ACC. Both pain and music may not be processed simultaneously in the ACC therefore, one stimulus will be perceived over the other depending on the attention effort provided by the individual.

Past research supports this alternating activity in the ACC during pain and cognitive distraction tasks (Bantick et al., 2002) and during hypnosis, focused activities, and diversion tasks (Porro, 2003). This neurology-based theory of pain, attention, and music is proposed as the mechanism behind the positive results of this study, however it has yet to be demonstrated in contemporary neuroimaging research and further studies should be conducted to investigate the authenticity of these claims. However, the results from this study provide a foundation for future neuro-imaging research aimed at investigating the role of the ACC during a pain, attention, and music intervention.
Clinical Implications

**Music in Pain Management.** This study contributes to applied research in music psychology and music therapy that have also found support for the use of preferred music to effectively manage pain (Allred, Byers, & Sole, 2008; Bailey, 1986; Bradt, 2010; Cepeda et al., 2010; Fratianne et al., 2001; Good et al., 2010; Nilsson, 2008; Standley, 1986; Standley, 1992; Standley, 1995; Tan, Yowler, Super, & Fratianne, 2010; Voss et al., 2004). The results suggest that the success in utilizing music for pain management can be attributed to the music selection protocol. With the common use of music in clinical settings to manage pain this study provides a rationale for selecting music for this purpose.

Music use in the clinical setting has often been dependent on the researcher or clinician determining the music they deem to be relaxing or soothing for the patient (Knox et al., 2011). This study suggests that when utilizing music to engage attention and manage pain, the fundamental criteria to consider is individual preference. This statement is of particular importance for music therapists, who utilize live and recorded music as a way to manage pain in a variety of healthcare settings (Michel & Chesky, 1995).

Furthermore, music therapists who wish to engage individuals in an attention-based pain management intervention should consider preference a vital component of pain management. Past research has shown that music utilized to manage pain should be able to trigger emotions or engage attention in order to be effective (Mitchel, MacDondald & Brodie, 2006). This research suggests that utilizing preferred music will effectively engage attention and successfully manage pain.
Limitations and Recommendations

A few limitations may impede this study’s generalization to the greater population and that should be addressed in future research studies such as: a) a small sample size with a limited age range; b) lab controlled pain conditions; c) structured directions for pain management; d) limited theoretical support for preference; e) absence of musical element of memory; and f) limited support for theoretical foundations. These limitations are described next.

Fifty healthy young adult participants were included in this study and although statistical significance was found with all the dependent variables, a larger sample size could have strengthened its generalization and provided a stronger foundation for the statements made. Future studies that replicate or expand on the methods utilized in this study should include larger samples in order to be able to: a) explore different study designs that may strengthen the results more than the control and experimental conditions utilized in this study; and b) conduct different statistical analyses that may highlight different relationships within the data sets in more depth. Additionally, it is difficult to generalize the results of this study due to the young adult age of the sample size. The results can be easily translatable to similar aged samples, however it is unclear how these results can apply to either younger or older aged populations. In order to confidently generalize these results the age, health, and the type of pain experienced by the individual should be considered.

It is important to consider that the participants in this study experienced acute pain under experimental conditions. In clinical conditions, management of acute pain brings with it more challenging obstacles, such as feelings of stress and anxiety related to
treatment that can complicate a pain management intervention. Additionally, different types of pain that vary in intensity and duration can prove more challenging to manage effectively (Warren, 2010). Although these obstacles were not present during this study, the results still provide a solid basis for the use of preferred music listening to manage acute pain by engaging attention. This hypothesis should be replicated in clinical research conditions. If this hypothesis were to be replicated in a clinical setting, such as in oncology settings where pain is common symptom, an important aspect to consider is the structured nature of the active music listening directions.

The participants in this study were instructed on how to engage in active music listening prior to the hand-immersion during the music condition. Therefore they practiced a goal-oriented process of pain management, shown to be successful to help manage pain (Tracy, 2008). The researcher directed the participants as to how to engage in active music listening which increased the attention placed on the music. The results may have been different if the participants were not directed to interact with the music or given directions of active music listening. Therefore, future research is suggested to ascertain the success of music listening to manage pain by exploring a non-directed protocol. Moreover, either directed or non-directed, the music utilized in any follow-up study should be preferred by the participants.

The results from this study show that musical preference was an important element in engaging attention to manage pain. However, there was limited support for its saliency within the literature review of this study. While the researcher did not hypothesize that preference would be a significant element, the results clearly make a case for it. Future research should be conducted to explore the role of preference as an
attention medium for pain management. An effective study may be to determine effects of preferred music as compared to researcher-selected, unfamiliar, or non-preferred music.

The absence of the memories music element in the statistical analysis is another limitation of this study. The ability of the music to elicit past memories was a common reason reported by the participants as to why their chose their music. This study did not initially include memories as a musical element to be analyzed therefore its significance within the statistical analysis is unknown. Future studies that attempt to replicate this one should include and quantify the degree to which music can trigger memories and its possible effect on attention during pain.

Another limitation to consider refers to the theoretical assumptions made in this study. This thesis makes the claim that the activation of the anterior cingulate cortex (ACC) during all three constructs of attention, pain and music acts as the mechanism by which the positive results of this study were attained. However, neuroimaging was not included in the protocol and no neuroimaging variables were measured to support the theoretical foundations (e.g. the role of the anterior cingulate cortex). Therefore it is uncertain that the behavioral results obtained by the protocol are informed by the neurologic connections made by the literature review. Further research should be conducted that replicates the method of this study along with a neuroimaging measure in order to support the theory of parallel neurologic processing of pain, attention, and music.

Summary and Conclusions

The purpose of this study was to determine the effect of participant-selected music on pain perception, pain tolerance, and attention to pain during an ice-water hand
immersion task. This study attempted to highlight the attributes of music that had the most influence on the attention to pain variable. By studying 50 healthy young adult students, the researcher collected self-reported measures of pain and attention during a cold-pressor task method, and asked participants to rate the activation, tempo, lyrics, mood, and preference of their music choice. The results showed significant mean differences between the silence and the music condition in pain perception, pain tolerance, and attention to pain, with the music condition yielding significant positive outcomes for pain management. The relationship between the attributes of music ratings and attention to pain showed that preference was the most salient musical element to significantly influence attention to pain.

The success of music listening in engaging attention to diminish pain perception and increase pain tolerance is attributed to three things. First, self-selected music is theorized to be more meaningful to the participant therefore, increasing how much attention effort is allocated to the stimulus. Since individuals attend better to preferred or familiar music (Flowers, 2001; Zhu et al., 2009) self-selected music will engage attention effectively during a painful experience. Secondly, an effective pain management strategy empowers and involves the individual in the management process (Lam et al., 2001). Therefore, utilizing music that has been selected by the individual increases their involvement and perceived control over the pain management process, allowing for a greater likelihood of success.

Thirdly, the highly structured nature of this study allowed participants to be aware that the pain they were about to experience was manageable. This study prepared individuals on the type of pain they were about to experience and also gave them
strategies to engage in active music listening to manage this pain. Although engagement in active listening was outlined in past research (Volpe & Camurri, 2011), this study proposed that active music listening can be implemented to manage pain. Active music listening was responsible for engaging attention to the music stimulus, therefore diminishing the attention to pain more successfully than the silence condition. This goal-oriented approach during the music condition significantly influenced the way that participants perceived and tolerated the painful stimuli.

Overall the results from this study support previous research on the use of attention to manage pain and propose preferred participant-selected music as an effective tool in engaging attention for this purpose. These findings inform clinical practice in music therapy and other related pain management fields as well as theoretical foundations on the use of music to manage pain. To conclude, the use of music for pain management is a valid practice and these results support its continued use, while making recommendations for the use of preferred music, which can be most effective for this purpose.
References


APPENDIX A: VRS PAIN PERCEPTION SCALE

Please rate your pain on this scale

VRS Numeric Pain Scale

0 1 2 3 4 5 6 7 8 9 10
None Mild Moderate Severe Extreme
APPENDIX B: VRS ATTENTION TO PAIN SCALE

Please rate your attention to pain on this scale:
*How much did you notice the pain throughout the immersion before it became unbearable?*

<table>
<thead>
<tr>
<th>VRS Attention to Pain Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>Rarely</td>
</tr>
</tbody>
</table>
APPENDIX C: PARTICIPANT QUESTIONNAIRE

Please provide a response for each of the following questions:

What is your age? __________

What is your sex? O Female  O Male  O Other

How much time do you typically spend listening to music each day?
O Less than 1 hour
O 1-4 hours
O 4-8 hours
O 8-10 hours
O 10 hours or more

Do you have any previous music training? (i.e. high school band, private music lessons, etc)
O Yes  O No

If yes, how long did your training last?
O 0-2 years  O 2-5 years  O 5-10 years  O 10-15 years

Do you listen to music in non-musical aspects of life other than enjoyment? (i.e. stress reduction, working out, expressing emotions)
O Yes  O No

If yes, what are your top 3 reasons for listening to music other than enjoyment? (Please rate 1,2,3)
___ Stress reduction
___ Emotional expression
___ Relaxation
___ To increase motivation
___ During exercise
___ Pain management
___ To learn new material
In your own words, please state which music selection you chose as captivating and why you chose this specific music selection. What about it made you choose it?

Name: ____________________________________________________________

Artist: ____________________________________________________________

Genre: ___________________________
________________________________________
________________________________________
________________________________________
________________________________________

When choosing your captivating music selection, what level of activation did it have?
☐ Extremely Inactive (very low energy)
☐ Inactive (low energy)
☐ Moderate (mild energy)
☐ Active (high energy)
☐ Extremely Active (very high energy)

When choosing your captivating music selection, what tempo did it have?
☐ Very Fast
☐ Fast
☐ Moderate
☐ Slow
☐ Very Slow

Does your captivating music selection contain lyrics?
☐ Yes
☐ No

When choosing your captivating music selection, what mood did it have?
☐ Positive (happy, cheery, uplifting…)
☐ Neutral (calm, serene, mellow…)
☐ Negative (melancholic, sad…)

How would you rate your preference of your captivating music?
☐ Very preferred (I love this song!!)
☐ Preferred (I like this song)
☐ Neutral (I’m indifferent to this song)
☐ Non-preferred (I don’t care for this song)
☐ Very non-preferred (I hate this song!!)
In your opinion, was music able to distract you from the pain better than in the silence condition?
○ Yes
○ Slightly
○ No

If no, please tell us how the music DID NOT captivate your attention better than the silence condition.
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

If yes or slightly, what was it about your captivating music selection that was able to engage you best? (Choose all that apply)
○ The musical elements (melody, harmony, rhythm and their interaction)
○ The content of the music (theme of the music)
○ Production value of the music
○ Tempo of the music
○ Familiarity with the music
○ Preference of the music
○ Enjoyment value of the music
○ Other: _________________________

Please elaborate on your choice:
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

In your opinion, under which CPT condition were you able to better ignore the pain?
○ Silence Condition
○ Music Condition
○ Neither

In your opinion, to what degree did the music hold your attention away from pain?
○ Completely (I only noticed the pain once it became intolerable)
○ Slightly (I noticed the pain but could ignore it until it became intolerable)
○ Neutral (I noticed the pain more than once or twice once it became intolerable)
○ Barely (I noticed the pain multiple times until it became intolerable)
Not at all (I couldn’t ignore the pain throughout the whole time.)

How did you engage in active music listening?
- Focused on song as a whole
- Focused on musical elements and their interaction
- Focused on lyrics and content
- Made mental images of song/lyrics
- Other: ______________________________

Based on your experience today, if you were to have a painful procedure done, would you use music to help you get through it?
- Yes
- No
- Depends on the situation.

Please elaborate on your choice:
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Feel free to add any comments:
______________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
APPENDIX D: SUMMARY OF MUSIC SELECTIONS AND RATIONALE

Open Ended Responses To Item #8 Of Questionnaire: “In your own words, please state which music selection you chose as captivating and why you chose this specific music selection. What about it made you choose it?”

1. Counting Stars – One Republic & Lazy Song – Bruno Mars: My favorite song at the moment. The next song on my playlist. (P)
2. In the End – Linkin Park: One of my favorite songs. (P)
3. Lazy Song – Bruno Mars: I chose it because it has a fun uplifting beat also I love Bruno Mars and enjoy listening as well as singing his song. (T)
5. Ball – T.I: It’s an upbeat song with a lot of lyrics. (T) (L)
6. The Boxer – Simon & Garfunkel: The song is soft, the lyrics have good meaning and grab your attention, the chorus is also captivating. (A)(L)
7. Insane – Flume Ft. Moon Holiday: I choose this song because I love working out to it, especially when I run. I also just love flume and the sound of his beats. (A) (T)
8. Kettering – The Antlers: I really like this song, I’m not sure why it’s just good music. (P)
9. Don’t You Know You’re Beautiful – Seabird: I choose it because of the lyrics, beat and the memories that it brings up for me. I find it very applicable to moments in my life. (T)(L)(Me)
11. Revolution-Diplo & The Heart of Dixie - Danielle Bradbery: These are two songs I’ve heard before and liked so I just put them on my phone last night and wanted to listen/pay attention to them more. (P)
12. Free Falling - John Mayer: Because he uses his guitar and it make me relax more. (M)
13. Hold On, We're Going Home - Drake: One of my favorite songs. Has a great beat and good lyrics. (P) (T) (L)
14. Chasing Cars - Snow Patrol: It's a slow but loud song. I really like the lyrics. I focus most on the lyrics during the CPT. It can capture my attention. (L)
15. Fast Lane – Eminem: I used it because it motivates me and makes me think of the fruits of my labor. (Me)
16. Bound 2 – Kanye West: I chose this song because it reminds me of my girlfriend (Me)
17. Coming Home – P.Diddy ft. Skyler Gray: When I hear the chorus, it reminds me of Paul Walker from Fast and the Furious. It was his tribute song when he passed away. I feel as if he is a part of my life - watched the series FF and I love cars. (Me)
18. Soundtrack to my life – Kid Cudi: I was at a happy time in my life when I discovered this song. (Me)
20. The Dog Days are Over – Florence and the Machine: It's a song about the feeling of escaping slavery and running for the sake of one's family.
21. By the Way – Red Hot Chilli Peppers: The song was one that I thought I could effectively listen "actively" to. Good beat, Lyrics. (T) (L)
22. Spring Waltz - Johann Strauss: This music selection is a prime example of how well orchestral sounds can come together to create a masterpiece. One can listen to the music as a whole or pick out the individual contributions of each instrument.
24. Don’t Need Your Love – The Game: I really enjoy heartfelt music that speaks volume to one’s inner psyche and personality. The Game is very passionate about his lyrics, and it’s great to hear someone who cares. (P) (L)
25. Red Air - Vergil Denati: As a drummer, I find his music amazing. Specially this song
26. Not a Bad Thing – Justin Timberlake: I was listening to that song as I was signing up for the experiment.
27. Hurricane Drunk - Florence and the Machine: The song has an overall good vibe and Florence is one of my favorite music artists. It's a good song to listen to when I want to feel good. (P) (M)
28. Trophies – Drake: Enjoy the trumpet and chorus. Often listen to the song while studying because its mostly instrumental. (P)
29. With You – Jessica Simpson: This song played constantly when I was a kid and I would always sing it along with friends. (Me)
30. Take Me home – Cash Cash: It has an uplifting beat, I know all the words so I could mouth along. (T) (L)
31. If I Lose Myself - One Republic: This is one of my favorite songs at the moment. I also just heard this song live at Ultra. (P)
32. Oh Nah! – Ty$: It is my favorite song right now so I knew it would be captivating. I really like his voice and the beat. (P)
33. Weightless - Becca Stevens Band: Catchy melody and rhythm that helps keep my attention from other things.
34. Enjoy the Ride - Kzueella: I really like the bass and her voice (P)
35. Let’s Go – Trick Daddy: Very good at pumping me up and keeping my mind off the pain (A)
36. Reverse Skydiving – Hot Natured: I chose it because it makes me feel relaxed (M)
37. Sweet Child O’ Mine - Guns N’ Roses: I chose this because it is my favorite song and has a perfect blend of instrumentals and lyrics. (P)
38. Best Day-Atmosphere: This has always been a very upbeat and fun song to me. It helps me get through stressful days, so I figured it would help me to take my mind off of the pain of the ice water. (T) (M)
39. Hiii Power-Kendrick Lamar: The music was upbeat to help keep my mind off the ice water. (T)
40. Hannah Montana - Migos: One of my favorite songs in the club lol. (P)
41. Unbelievers - Vampire Weekend: The song is very upbeat and catchy so I was able to focus on the hook instead of my hand. (T)
42. Loft Music - The Weekend: Well, I haven't listened to the song in a while but a lot of memories were associated with that song. I chose the song in hopes that it
would provoke the recollection of these memories instead of focusing on the ice bath. (Me)

43. Un Beso - Wi-g 21 Plus: I chose this song because I like the lyrics and the beat, it brings me memories of my summer vacation. (L) (T) (Me)

44. Reality - Toby Keith: It's one of my favorite stress relieving songs. Whenever I listen to it, I also think and focus on home. (P) (Me)

45. All of Me - John Legend: It's my favorite song at the moment. (P)

46. Loved You Tonight - John West: I chose it because it's relatively mellow. I've only recently heard it, so I wanted to listen to it more. Also, it's light-hearted, fun, relaxing, and makes me think of positive memories, like summer, love, beaches, vacation and John West has a very suave, groovy vibe. (A) (Me) (M)

47. Symphony No.7 – Beethoven: One of my favorite pieces this allows me to focus on and moves me, providing good distraction (P)

48. Immigrant Song - Led Zeppelin: I like this song (P)

49. Knights of Cydonia - Muse: String instruments, good beat, variations in melody and lyrics. (T) (L)

50. Set it Off - Tube and Burger: Soothing bass line helps me relax. Vocals as well. I enjoy a mellow electronic drum kick to help reduce stress. (M)
### APPENDIX E: SUMMARY OF CODING ANALYSIS OF MUSIC SELECTION RATIONALE

Words and references utilized to code narrative rationale into music attributes model.

<table>
<thead>
<tr>
<th>Music Attributes</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activation (A)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reflected to movement elicited by music</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Reflected to activation of music</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Tempo (T)</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>Reflected to beat of music</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Lyrics (L)</td>
<td>10</td>
<td>16.66</td>
</tr>
<tr>
<td>Mention of lyrics</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Mood (M)</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Reflected to mood elicited by music</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Preference (P)</td>
<td>17</td>
<td>28.34</td>
</tr>
<tr>
<td>Used word “Favorite”</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Used word “like” or stated like for song</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Memories (Me)</td>
<td>11</td>
<td>18.34</td>
</tr>
<tr>
<td>Reflected to memories</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Used word “Reminded”</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Used words “Think of”</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>60</td>
<td>100</td>
</tr>
</tbody>
</table>
Join the **Ice-Ice Baby** study.

Combining your two favorite things: **Ice** and **Music**!

This study will look at how music impacts your ability to tolerate ice-water. If you are a student enrolled in PSY110 or are interested in seeing how much your music impacts your pain perception and pain tolerance, sign up for THIS study!

*(Disclaimer: students who are or have experienced any chronic pain conditions or treatments in the past might not be eligible to participate.)*

For more info email: [m.rodriguezwolfe@umiami.edu](mailto:m.rodriguezwolfe@umiami.edu)

Text or Call: 617-549-2960

**Study Location:** Music Therapy and Music Education Department @ 1552 Brescia Ave, Coral Gables, FL

**Time requirement:** 45 mins – 1 hour.

(Vanilla-Ice would want you to)
CONSENT TO PARTICIPATE IN RESEARCH:
THE EFFECTS OF MUSIC LISTENING ON COLD-PRESSOR PAIN PERCEPTION AND PAIN TOLERANCE

You are asked to participate in a research study conducted at the University of Miami by Dr. Teresa Lesiuk and Marlén Rodríguez-Wolfe. Your participation in this study is completely voluntary. You should read the information below and ask questions about anything you do not understand before deciding whether or not to participate.

PURPOSE OF THE STUDY
The purpose of this study is to determine the effects of music that is considered captivating on influencing pain perception, pain tolerance, and attention during cold pressor pain.

PROCEDURES
If you volunteer to participate in this study, we would ask you to do the following things:

Guidelines:

1. Choose music that you consider "captivating" meaning a song that you feel is able to capture and hold your attention despite other competing distractors.
2. Come in for the experiment where you will sit for the Cold Pressor Task (CPT).
3. During the music listening section of the CPT the researcher will ask you to listen to your music selection for 20 seconds and then immerse your hand in a bowl of ice-water when you are cued to begin.
4. You will be asked to leave your hand in the ice water for as long as you can while engaging in active music listening of your song selection.
5. When you have reached your pain limit, you may remove your hand and will be asked to give the researcher a pain score from 1-10.
6. The researcher will also ask you to rate how much attention you paid to the pain on a scale of 1-10.
7. You will then be allowed a 10-minute break to allow the temperature to return to your hand, at which point you will be asked to play a memory game.
8. You will then be asked to undergo the same CPT procedure with your opposite
hand in silence.

9. You will then be asked to complete a post-immersion questionnaire after which you will be finished with the experiment.

• The order of which CPT (the silent or the music condition) will be assigned at random. The researcher will inform you which condition you will undergo first.

• You may bring your music selection on any music-playing device you posses (iPod, Smartphone, tablet, etc.) It is your responsibility to bring with you your music selection to the experiment.

POTENTIAL RISKS AND DISCOMFORTS Guidelines:

• You may experience some discomfort as a result of the ice-water hand immersion, this is normal as the CPT is meant to experimentally induce pain. This procedure has been proven to be safe and non-threatening with no long-term effects.

• However, if at any time you feel unwell or feel like you cannot complete the procedures as they may pose psychological or physical damage to yourself you are free to withdraw from the study with no prejudice.

ANTICIPATED BENEFITS TO SUBJECTS

• No direct benefits are anticipated from your participation in the study.

• Participants who successfully complete the procedures outlined above will receive credit (1 credit per half hour) towards their Introduction to Psychology class at the University of Miami. The researcher will comply with procedures to give credit to participating students as outlined by the Psychology Department.

• Participants who successfully complete the procedures outlined above will receive a list of the song selections from all the recruited students who participated in the study.

EXCLUSION FROM STUDY

Please review the following guidelines, if you answer “Yes” to any of these questions, you are not allowed to participate in this study. These guidelines are for your own protection, so please review carefully. Please answer the following questions:

a) Have you ever been diagnosed with any chronic pain related illness;

b) Are you currently taking pain medication;

c) Are you experiencing any kind of undiagnosed pain;
d) Do you have a history of cardiovascular disorders?

e) Do you have a history of fainting or seizures?

f) Do you have a history of frostbite of the hands?

g) Do you have an open sore or cut on either hand?

h) Do you have a history of Raynaud's phenomenon?

i) Do you have a history of fracture to the hands?

CONFIDENTIALITY

The results of this research study are purely for education purposes. Your answers and experience will be utilized to inform a Masters level thesis at the University of Miami. If the results of the research are published or discussed in conferences, no information will be included that would reveal your identity. If photographs, videos, or audiotape recordings of you will be used for educational purposes, your identity will be protected or disguised.

Guidelines:

- Each participant will be assigned a number to track data with. So "John Smith" will be assigned number 5 and will be referred to as participant 5 during data analysis and reporting of results.

- Individual responses to survey questionnaires will be destroyed, following analyses of the data.

PARTICIPATION AND WITHDRAWAL

Your participation in this research is voluntary. If you choose not to participate, that will not affect your standing at the University of Miami. If you decide to participate, you are free to withdraw your consent and discontinue participation at any time without prejudice.

CONSEQUENCES OF WITHDRAWAL

If you decide to withdraw from this study you will not receive credit for participation even if you show up for the experiment and are unable to complete both immersions. It is your responsibility to find another study that you may fulfill for credit. Only students who successfully complete the procedures outlined above will receive credit.

WITHDRAWAL OF PARTICIPATION BY THE INVESTIGATOR
The investigator may withdraw you from participating in this research if circumstances arise which warrant doing so. If you experience numbness or pain in the hands that does not dissipate after the 15-minute break or if you become ill during the research, you may have to drop out, even if you would like to continue. The investigator will make the decision and let you know if it is not possible for you to continue. The decision may be made either to protect your health and safety, or because it is part of the research plan that people who have abnormal reactions to the CPT may not continue to participate.

**IDENTIFICATION OF INVESTIGATORS**

If you have any questions about the research, please feel free to contact:

- **Marlén Rodriguez-Wolfe** MT-BC
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  Ress Project Coordinator
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- **Teresa Lesiuk, Ph.D., MT-BC**
  Associate Professor and Clinical Training Director
  Department of Music Education and Music Therapy
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  Coral Gables, FL 33146
  Tel. 305-284-3650

**RIGHTS OF RESEARCH SUBJECTS**

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, you may contact:

The University of Miami - Human Subjects Research Office
1500 NW 12th Avenue, Ste. 1002, Miami, FL 33136
Tel. 305-243-3195

**SIGNATURE OF RESEARCH SUBJECT**

I have read the information provided above. I have been given an opportunity to ask questions and all of my questions have been answered to my satisfaction. I have been
CPT INSTRUCTION SCRIPT

Hello, and thank you for participating in this study at the University of Miami. This study will look at how captivating music may impact your attention to pain, pain perception and pain tolerance. In order to study pain, you will be participating in the cold pressor task or CPT. The CPT is a reliable and safe method for studying pain in humans that has not shown any threat to its participants. The method consists of immersing your hand in ice water until you notice the presence of pain and then leaving your hand immersed in the water until the pain becomes intolerable.

In order for you to successfully complete this study you will need to undergo the CPT twice. Here are your instructions.

1. You are to remain seated in this chair for the CPT. Please sit comfortable and let your hand dangle from the chair’s armrests.
2. You will undergo two ice water immersions, one while listening to your musical selection and one in silence.
3. During the music CPT you are asked to actively listen to the music with these headphones.
4. Actively listening to the music means that you may:
   a) Attend to the song as a whole;
   b) Focus on one or more of the musical elements of the song and their interaction (i.e. melody, rhythm, harmony, and pitch);
   c) Reflect on the song’s context by analyzing the lyrics; or
   d) Make mental pictures in your head of the lyrics.
5. You will listen to the music until the researcher taps you on the shoulder.
6. This is your cue to dip your hand in the water.
7. You will naturally notice the sensations in your hand as you dip the hand in the water, but we ask you to re-focus on the song for the duration of the immersion.
8. You are asked to leave your hand in the water until you notice pain, then see how long you can leave it in there for until the pain becomes unbearable.
9. The researchers will be standing behind you at all times during the procedure if you need assistance, but are not allowed to engage you in any conversation during the immersion.
10. When the pain becomes too intense or uncomfortable you will say STOP! And remove your hand from the water. You may also remove your headphones at this time.
11. At this point, the researcher will ask you to rate your pain on a scale of 1-10, where 1 is no pain and 10 is extreme-unbearable pain.
12. Then, the researcher will ask you to rate how much attention you paid to the pain on a scale of 1-10, where 1 is did not notice pain and 10 is could not ignore pain.
13. The researcher will then give you a towel to dry your hand with and you will be allowed a 10-minute break.
14. During the break you will exercise your memory skills by playing a memory game on Lumosity.com.
15. After the break, you will undergo another CPT immersion, this time in silence.
16. For this CPT, you will immerse your opposite hand in the ice water.
17. Remember, you may remove your hand at any time as long as you try to leave it in for as long as you can.
18. Once you think the pain is too much then you will again say STOP and remove your hand.
19. The researcher will again ask you to rate your pain from 1-10.
20. The researcher will again ask you to rate how much attention you paid to the pain from 1-10.
21. At this point you will be given a brief questionnaire to fill out with your thoughts on both immersions.
22. After you have successfully completed both immersions you have successfully completed the study.
23. Remember you are free to withdraw from the study at anytime. It will not affect your grades or standing in class.
24. If you have any questions, please feel free to ask.
25. Let's begin.