EFFECTS OF SELF-SELECTED MUSIC ON EXERCISE ENJOYMENT, DURATION, AND INTENSITY

BY

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THESIS

Submitted in the partial fulfillment of the requirements
for the degree of Master of Science in Kinesiology
in the Graduate College of the
University of Illinois at Urbana-Champaign, 2016

Urbana, Illinois

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ABSTRACT

Introduction/Aim: Physical inactivity rates continue to rise, creating a concerning number of health risk factors for those who do not exercise. Many cite lack of enjoyment as a reason why they fail to continue an exercise program once started. Music has been used to enhance affect and positive feelings in therapy, classrooms, and, more recently, during exercise. If music can positively influence the exercise experience it could potentially be used as a way to increase adherence. People react differently to music: individual differences can be due to gender, age, training level, etc. Such differences should be accounted for and should be taken into consideration when looking at the effectiveness of music on an individual. The effects of self-selected music, classical music, and a no music control on enjoyment, behavior, and affective responses during and following exercise were examined. **Methods:** Male (*n*=16) and female (*n*=13) participants, ages 18-45 (22.5±4.5 yrs) with an average height and weight of 174.01±8.95 cm and 73.63±13.67 kg, respectively, were recruited via social media, posters, word of mouth, and emails. Exercise history, health history, and individual trait differences were obtained during session one in addition to a submaximal graded exercise treadmill test during which the participants were brought to 85% of their predicted max heart rate. Sessions 2-4 were randomized and involved the participant exercising with self-selected music (SSM), classical music (CM), or no music (NM). Participants were allowed to exercise for as long as they chose (exercise duration), up to 60 min, at any speed and grade of their choosing (recorded throughout). Heart rate (HR), Feeling Scale (FS), Felt Arousal Scale (FAS), and Rating of Perceived Exertion (RPE) were measured and recorded at the beginning of each session, every 5 min during exercise, and 15 min post exercise. Enjoyment of exercise bout was assessed with the Physical Activity Enjoyment Scale (PACES) immediately upon cessation of the bout. Affective response to the exercise (pre, post) was measured using the Activation Deactivation Adjective Check List (AD ACL). **Results:** Exercise accompanied by SSM, compared to CM and NM, elicited significantly higher levels of enjoyment (PACES: SSM=102.5 (±14.5), NM=87.6 (±16.5), CM=86.2 (±19.7). SSM also resulted in significantly longer exercise duration, on average 5.5 min longer than both CM and NM conditions. Affective responses (FS, FAS), although not significant, were more positive during SSM compared to CM and NM. Affective responses (AD ACL) were again not significantly different across conditions, however there was a significant effect of Time on feelings of Energy, Tiredness, Tension, and Calmness. Finally, there were no significant differences across conditions for RPE. **Conclusion:** Self-selected music elicited the greatest improvements in exercise enjoyment and exercise duration compared to exercising with either classical music or no music at all. This information may be useful when prescribing exercise to those beginning an exercise program in order to increase their enjoyment of the activity and potentially exercise adherence. It may also be useful for the regular exerciser as a way of insuring that enjoyment of the activity remains high. How music, self-selected music in this case, helps to acheive these affective and behavioral changes remains unknown. From the present design the most likely explanation is the distraction the music might offer to the sensations of the activity itself (e.g., increased respiration, muscle fatigue), with the individual’s own music providing greater distraction than other kinds of music. It is also possible that the self-selected music offered a motivational boost to the individual, resulting in greater enjoyment of the activity and longer engagement in the activity.

ACKNOWLEDGMENTS

Dr. Steven Petruzzello – for believing in me, supporting my project, and guiding me since Freshman year

Tina Greenlee, Dan Greene, and Kate Rougeau- for being positive roles models, mentors, lab mates, and leaders

Exercise Psychophysiology Laboratory- for offering up your time and help without out you this project would not be complete

My parents – for your constant support, never ending encouragement, and unconditional love- without you my dreams wouldn't be coming true

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CHAPTER 1
INTRODUCTION

Music plays a significant role in our emotional and social lives, being used as a form of celebration, communication, and expression. Music captures attention, raises spirits, triggers a range of emotions, alters/regulates mood, evokes memories, increases work output, heightens arousal, induces states of higher functioning, reduces inhibitions, and encourages rhythmic movement. Thus, music is a powerful tool, is relatively cheap, and is easy to access. Music may also have considerable application in the exercise domain, related to issues like adherence to exercise, exercise enjoyment, duration, and intensity. Thus, it is of interest to determine the extent to which music influences these factors.

Lack of sufficient physical activity is a significant public health problem. If a positive relationship between music and exercise performance (e.g., duration, intensity) is found, this may suggest that music could help to increase exercise adherence/reduce exercise dropout. Significant findings may also indicate that music can increase the quality of exercise behavior (e.g., greater enjoyment, more pleasant affective response) which could also lead to better adherence. The potential for increased levels of exercise adherence would serve to provide exercisers, especially beginning exercisers, with the well documented health benefits associated with regular exercise.

The goal of the present study is to examine whether music (self-selected, investigator selected, none) influences the level of exercise intensity and duration chosen by the individual doing the exercise. This work may also provide evidence of the influence of music on affective responses, perceptions of effort, and level of enjoyment of the exercise bout. This information may provide some preliminary evidence of the extent to which music might influence regular exercise (i.e., increase adherence and/or reduce exercise dropout).

There is currently no theoretical framework or standardized protocol for how to deliver a music driven intervention. In addition, a wide range of research questions and methodologies have been used when examining the effects of music on exercise. However, the findings of this study may provide evidence to support the use of music as a positive influence on exercise behavior. Ultimately, this could have important implications for the prescription of exercise intensity and long-term adherence to regular exercise programs. The physical and mental health benefits to be gained from exercise are well documented; the problem lies in getting people to start and adhere to regular exercise programs.

CHAPTER 2

LITERATURE REVIEW

Many individuals listen to music while they exercise. Music has the ability to enhance one's psychological state, improve affect, generate motivation, decrease fatigue, and potentially enhance physical performance (Hutchinson & Sherman, 2014; Laukka & Quick, 2011; Mohammadzeh, Taribiyan, & Ahmadi, 2008; Priest & Karageorghis, 2008). Music has demonstrated such effects regardless of sex or age, with the effects seen in both males and females as well as across elementary school children, young adults, athletes, and the elderly (Barney & Prusak, 2015; Digeldis, Karageorghis, Papapavlou, & Papaioannou, 2014; Laukka & Quick, 2011; Ziv & Lidor 2011).

Music can be used in many different ways while exercising or performing. Laukka and Quick examined the emotional and motivational effects music has on athletes (2011). Their results showed that music influenced emotions in its listeners, with upbeat and loud music evoking arousal and energy. Many professional athletes utilize music to pump themselves up and prepare themselves psychologically for their event (Laukka & Quick). On the other hand, slow and relaxed music has the ability to reduce arousal and help to center one's self. Using music as a cool down tool is an effective way to de-stress and reduce one's felt arousal (Laukka & Quick). Depending on the type and tempo of a piece of music the type of affective state evoked varies, from a motivational effect while a fast tempo song is played to a relaxing and/or calming effect which during slower, more sedate music.

Music has the potential to significantly influence physical activity and exercise behavior. Karageorghis, Terry and Lane (1999) developed a model for explaining how music could impact motivation for exercise and ultimately exercise behavior itself (see Figure 1). Karageorghis et al. proposed that the motivational qualities of the music (e.g., lyrics, volume, tempo, etc.) can impact control of arousal, perceptions of effort, and mood. These motivational qualities are derived from both internal (i.e. properties of the music itself: rhythm response, musicality) and external (i.e., cultural impact, association) factors. The music's tempo, lyrics, volume, and other musical aspects (i.e., motivational qualities) thus influence how one feels while exercising (i.e., affective response) and/or how one responds to the physical demands of exercise (i.e., perceptions of effort), which would in turn influence enjoyment of the and ultimately exercise adherence. These motivational qualities impact a listener's arousal levels, RPE, and mood state. For example, greater volume would elicit greater arousal. An upbeat tempo of the music could elicit greater arousal, less perceived effort, and perhaps a more pleasant affective state for the listener. Engaging and entertaining music may provide a distraction from the physiological changes happening while exercising, in turn reducing effort and improving affect. According to Karageorghis et al., arousal control, reduced effort perception, and improved affect or mood should lead to increased exercise enjoyment and ultimately increased exercise adherence. These two responses may also influence one another. Increasing enjoyment has been hypothesized to increase adherence and increasing adherence could result in exercise becoming a habit and a pleasant experience. Increased exercise adherence will also result in improvements in health, fitness, and wellness which in turn motivate the exerciser to continue exercise.

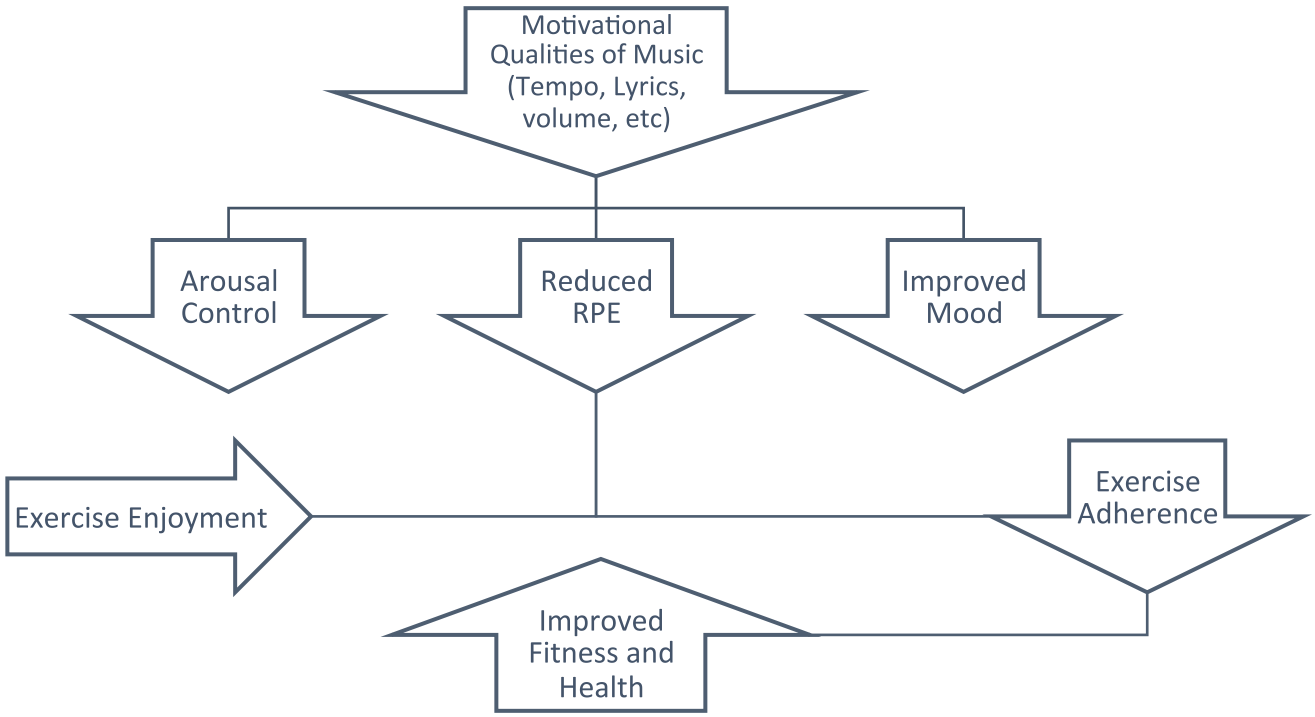

Figure 1. Proposed conceptual framework for the effects of music on exercise performance. *(Adapted from Karageorghis, Terry & Lane, 1999).*

Potential Mechanisms

There are many potential mechanisms that have been proposed to explain why music is such a useful tool in the exercise domain. Karageorghis and Priest (2012) discussed several of these reasons, including attentional processing, synchronicity of responding, and emotional response.

Attentional processing. One way music influences how one responds to exercise is attentional processing. The capacity of the nervous system is thought to have a limited amount of influence on the effects of music and attention. Because of the nervous system is limited, sensory signals or stimuli (e.g., music) can modify physiological signals associated with physical activity/exercise (Karageorghis & Priest). Studies have shown that the intensity of exercise can influence the effectiveness of music on processing other sensory signals/cues. Karageorghis and Priest note that at low (~40-60% HR_{max}) and moderate (~70% HR_{max}) intensities of physical activity, both internal (physical/kinesthetic) and external (music/stimuli) can be processed simultaneously. At higher intensities (~80% or above HR_{max}), physiological cues and sensations (fatigue, exhaustion, elevated HR, etc.) begin to dominate the way one processes information. At such higher intensities, therefore, negative feelings tend to predominate (Karageorghis & Priest). This is also consistent with the Dual-Mode Theory (Ekkekakis, 2003) wherein at moderate intensities of exercise [i.e., at or below the ventilatory threshold (VT)], physiological cues can be "overridden" by cognitive factors (e.g., music) and affective responses tend to be positive than negative. However, at higher intensities (e.g., above the VT), physiological sensations override any cognitive input and dominate the system, resulting in increasingly negative affect. While music will not eliminate the physiological sensations experienced during exercise, it is possible that music can modify how these sensations are perceived and can aid in a more positive evaluation of these sensations (Karageorghis & Priest).

Synchronous responding. Another possible explanation of why music aids in exercise is the synchronous response to music/rhythm. Karageorghis and Priest define rhythm response as a predisposition to synchronize movement with musical rhythms (2012). The rhythm response can be described as the innate human response to synchronize movement with the rhythm of the music. For example, if one is listening to music with a fast tempo they are more likely to execute their movements more quickly (Karageorghis & Priest). Studies dating back to the early twentieth century show credible neurophysiological responses to music tempo. Activity in the brain measured with electroencephalographic techniques have shown similarities/commonalities between movement frequency during exercise and music tempo (Karageorghis & Priest). Studies have shown that increased activity in the premotor and cerebellar brain sectors is associated with preferred music compared to non-preferred music. The ventral premotor cortex has been shown to be activated when listening to a preferred tempo music. Conclusions stating that these responses/mechanisms may aid in/facilitate the “tuning in”/synchronizing with a piece of music (Karageorghis & Priest). Using music to synchronize movement with music may improve metabolic cost by utilizing greater neuromuscular and metabolic efficiency.

Emotional responding. In addition to physical responses and mechanisms, there are numerous emotional responses to music that influence one’s response to exercise. Studies suggest there are three potential ways emotion is evoked while listening to music: memory, empathy and appraisal can all be used to evoke a response to exercise (Karageorghis & Priest, 2012). Memory can be used to recall or remember an event that evoked a powerful emotion via subcortical mechanisms. Empathy is one’s ability to recognize and relate with emotions of something else; in this case the performer or lyrics of a song. Lastly appraisal is when the listener has the ability to evaluate the personal significance of an emotion (Karageorghis &Priest). There are two potential peripheral routes in which music can evoke emotion. Proprioceptive feedback is the first potential route. This is defined as the coupling/pairing of internal rhythms with external factors (Karageorghis & Priest 2011). The second peripheral explanation is centered around the ability to express pre-existing emotions. This is executed by evoking or tapping into emotional control. Later work expanded on this potential route by stating that music is able to evoke aesthetic (artistic) emotions rather than utilitarian (practical, sensible, no-frills) (Karageorghis & Priest).

Types of Exercise and Music

How one connects with or reacts to music varies from person to person. The type of music also plays a role in how someone may or may not react to a piece of music based on one's personal experience and past. Exercise is similar to music in that some people have very strong experiences to exercise while others experience little to no connection or reaction to different types and intensities of exercise.

High intensity exercise. High intensity exercise has become an increasingly popular trend in the fitness industry over the last several years. As many people cite lack of time as a reason for not exercising, exercising at high intensities for a shorter durations has been shown to be a fast and effective way to see improvements in health. One issue with high intensity exercise is that many exercisers find such activity aversive (i.e., less pleasant/more unpleasant) and do not enjoy some of the sensations that often occur when exercising at such a high intensity (e.g., elevated HR, profuse sweating, increased lactate levels, muscular fatigue/soreness). Several studies have shown mixed results with using music as a tool to enable more positive/less negative responses to high intensity exercise.

Twenty moderately active male and female college aged (22 ±4 yrs) participated in a study that examined the effects of music on performance and enjoyment during sprint (i.e., high-intensity) interval training (Stork, Kwan, Gibala, & Ginis, 2015). The participants were exposed to two different conditions: music and no music. On each of the experimental days the participants performed a 2-min warm up and then were asked to perform a 30-s "all-out" bout of cycle ergometer exercise. They rested for 4 min and then were asked to perform this same process again three additional times for a total of four, 30-s cycling trials at their maximal effort. Results indicated that there were no differences in RPE, affect, or task motivation between the music and no music conditions. Although not significant, affective responses via the FS were consistently higher in the music condition compared to the no music condition. In addition, it was found that enjoyment was higher in the music condition in spite of the fact that perceived exertion responses were the same between conditions. Furthermore, enjoyment of the completed activity increased over time during the 60 min recovery period. There were also significant differences in mean and peak power scores between conditions, with the music trials resulting in significantly higher scores (Stork et al.). This study demonstrated that music could produce increased performance scores/outcomes (i.e., peak power) in individuals during high intensity exercise, as well as being perceived as more enjoyable than the same exercise without music. Stork et al. speculated that music could make high intensity exercise more enjoyable and perhaps be useful for encouraging participation in, and adherence to, such high intensity protocols.

Simpson and Karageorghis examined the effects of synchronous music on 400-m sprint performance (2006) in 36 Caucasian males (age= 20.4±1.4 yrs). Participants were exposed to three different conditions: (a) motivational, (b) neither motivating nor demotivating music (i.e., oudeterous) music, and (c) no music (white noise), completing a 400-m sprint in each condition. Results showed that time trial scores during the synchronous music (both motivational and outdeterous) were faster when compared to no music (Simpson & Karageorghis). These results contradicted most current literature, which have claimed that motivational music is superior to oudeterous in regards to exercise performance. Mood was also assessed, but only pre-exercise, so no conclusions can be made regarding the influence of the different conditions on mood.

Attentional manipulation, namely dissociation or distraction, has been proposed as a mechanism for the beneficial effects of music on exercise. As a way of examining this idea, Jones, Karageorghis and Ekkekakis (2014) compared higher intensity exercise to exercise at a more moderate intensity. Relatively fit men and women (*N*=34) completed 10 min of cycling in four separate conditions (music only, video only, music+video, no music/visually sterile) at either an intensity 10% below their ventilatory threshold (VT) or 5% above their VT. Affect, attentional focus, and enjoyment were the primary outcome measures. Affect was assessed during the exercise (min 4 and 8) as well as following the exercise. Significant effects were shown for affect, namely affective valence was more positive during and following the music only and music+video conditions as well as being more positive in the 10% below VT condition compared to the 5% above VT condition. Participants also experienced the music only and music+video conditions as more enjoyable and the 10% below VT condition was more enjoyable than the 5% above VT condition. Jones et al. discuss these findings in terms of how the typically negative affective experienced during exercise at higher intensities may be attenuated using some type of music intervention (i.e., music alone, music in combination with video).

A final study examining the effects of music on performance, specifically distance covered in a particular time frame, was done by Cole and Maeda (2015). In a sample of 35 participants (*n*=20 women), listening to preferred music (as determined by sampling preferred music genres in undergraduate students) resulted in significantly greater distance covered in 12 min compared to both no music and non-preferred music, but only for females; distance covered was almost identical across the three music conditions for males.

Resistance Exercise. While the majority of the exercise-music literature has focused on endurance and aerobic exercise (Karageorghis & Terry, 1997), there is relatively little research exploring the effects of music on resistance training. However, more studies have appeared recently which examine the effects of music on resistance exercise.

Bartolomei, DiMichelle, and Merni examined the effects of self-selected music on maximal bench press strength and strength endurance (2015). Resistance trained males (*N*=40, age 24.7 ±5.9 yrs; trained $3 \cdot wk^{-1}$ for >3 yrs) were assigned to either a music group or a no music control group. Both groups attended two separate sessions, which occurred at the same time of day, separated by 2 weeks (Bartolomei et al.). Session 1 involved baseline testing that included a 1 repetition maximum (1-RM) bench press test and a strength endurance task during which the participants performed as many repetitions until failure at 60% of their 1-RM. Session 2 included the same tests, but they were either performed with music or without music. The majority of the participants chose either rock or dance music; all songs had a tempo of at least 120 $b \cdot min^{-1}$ (Bartolomei et al.). There were no significant differences between the two groups for 1-RM scores during Session 2 nor were there differences in 1-RM scores from Session 1 to Session 2. There was a significant difference in scores for strength endurance between conditions. Those who listened to music had 5.8% better endurance performance (~1 repetition increase) than those in the no music group. These results suggest that perhaps music is more effective and more influential for endurance type exercises.

Biagini et al. (2012) set out to examine the effects of self-selected music on strength, explosiveness, and mood. College-aged men (*N*=20) participated in three separate sessions: Session 1 included a 1-RM bench press and 1-RM back squat; Sessions 2 and 3 were identical with the exception of either having self-selected music or the absence of music. These sessions included measures of mood (via Profile of Mood States, POMS; McNair et al., 1971), squat jump performance, and bench press repetitions to failure. The bench press assessment included 3 sets of repetitions performed to failure at 75% 1-RM, separated by 2 min of rest between sets. Three squat jumps (@ 30% back squat 1-RM, 1 min between jumps) were performed on a force plate that measured take off velocity, rate of velocity development, relative ground reaction force, and rate of force development; jump height was also assessed. There was no difference in the number of bench press repetitions to failure or RPE during bench press across the two conditions (Biagini et al.). Take off velocity, rate of force development, and rate of velocity development were greater for the self-selected music condition compared to the no music condition; RPE scores were also greater during the no music condition. The POMS scores showed no difference in Fatigue, Anger, Confusion, and Depression scores across the two conditions. However, Tension and Vigor were greater during the self-selected music condition and Fatigue was greater following the self-selected music condition (Biagini et al.). Although there were no differences in the number of repetitions of bench press to failure, there were significant effects of music on measures of squat jump explosiveness (i.e., rate of velocity) along with increased Vigor and Tension and lower RPE.

The effect of music on circuit-type strength training exercise also been examined (Karageorghis, Priest, Williams, Hirani, & Bates, 2010). Six circuit-type exercises were performed by 26 participants (*n*=13 men, 18.7±0.8 yrs; *n*=13 women, 18.9±0.8 yrs) under 3 conditions (counterbalanced): motivational music, oudeterous (i.e., motivationally neutral) music, and a metronome control. Pretesting included as many repetitions of each exercise (press behind the neck, sit-ups, standing squats with barbells, jumping jacks with hand weights, heel raisers on a bench, step ups) at a tempo of 120 b·min^{-1} until the cadence could no longer be maintained (Karageorghis et al.). These same six exercises were performed during the experimental conditions as well. In terms of performance, the motivational music condition resulted in the greatest number of total repetitions. The only difference between men and women was that men performed more total repetitioins in the no music condition compared to the outdeterous condition (Karageorghis et al.). Affective responses were not different across the three conditions, but females experienced less negative affect than men in the two music conditions; this was reversed in the control condition (i.e., men experienced less negative affect).

Endurance exercise. Endurance athletes put in hundreds of miles and thousands of minutes while training and music is often used by these athletes while they train. It has been shown that music has ergogenic (e.g., improved metabolic efficiency), psychological (e.g., reduced perceptions of effort, enhanced affect), and psychophysiological (e.g., increased oxygen consumptioin) effects.

The effects of synchronous music on both submaximal and exhaustive treadmill running performance (i.e., time to exhaustion, running economy) was examined in 11 elite triathletes (Terry, Karageorghis, Saha, & Auria, 2012). Participants (*n*=6 males, *n*=5 females; 19.5±2.3 yrs) VO_{2peak} scores ranging from 58.6-72.6 $ml \cdot kg^{-1} \cdot min^{-1}$, befitting their elite athlete status. Baseline testing included assessing aerobic capacity, blood lactate levels, and individual stride rates. Mood responses (using the Brunel Mood Scale, BRUMS), affect (using the Feeling Scale) and RPE were also measured during experimental days. On separate days, participants completed three trials (no music, oudeterous music, motivational music) during three, 4-min running bouts of increasingly faster velocities (2-min rest between bouts; equivalent to ~76%, 82%, 87% VO_{2peak}), followed by a run to exhaustion at near maximal intensity (99% VO_{2peak}). Results showed that times to exhaustion were longer during both music conditions (motivational: 18.1%, d= 0.50; neutral: 19.7%, d= 0.54) when compared to the no music condition. The same held for running economy, with motivational music (d= 0.29) and oudeterous music (d= 0.64) being associated with greater running economy compared to no music. Affective (in-task) and mood (pre-post) responses were similar. Affect became increasingly negative in the oudeterous and no music conditions, even becoming negative during the run to exhaustion, but remained positive throughout the motivational music condition. Mood responses were also generally more positive/less negative for the motivational music condition compared to other two conditions. Specifically, motivational music resulted in greater reductions in Tension, smaller increases in Depression, Anger, Fatigue, and Confusion, and increases in Vigor. These findings demonstrate the effects music can have, even on elite endurance athletes.

While most research examining the effects of music has used land-based activities, Karageorghis et al. (2013) examined the psychological, psychophysical, and ergogenic effects of motivational, oudeterous, and no music on swimming performance. A sample of 26 male and female collegiate club swimmers (20.0±1.4 yrs) participated in three, 200-m freestyle swimming trials differing in the type of music employed during the trial, following a habituation period and baseline 200-m trial performance assessments. Karageorghis et al. found that participants swam significantly faster, had higher state motivation, and had more dissociative thoughts in both music conditions compared to the no music control ($d_s \approx 0.15$). As such, regardless of its motivational qualities, music had positive effects on performance and motivation while facilitating dissociative thoughts.

An individual's training status (i.e., trained, untrained) may influence responses to exercise, whether it be perceptions of exertion, preferred intensity, or how they respond to different mood regulators such as music. Brownley, McMurray, and Hackney (1995) examined the effects of music on physiological and affective responses to varying intensities of treadmill exercise in 16 (n=12 women, 19-28 yrs old) trained (n=8; VO_{2max}> 52 $ml \cdot kg^{-1} \cdot min^{-1}$) and untrained ($n$=8; VO_{2max}< 50 $ml \cdot kg^{-1} \cdot min^{-1}$) participants. Three different music conditions were used (no music, sedative music, and fast music) along with three different exercise intensities (low: HR=120±10 b·min^{-1}; moderate: HR=140±10 b·min^{-1}; high: HR=160±10 b·min^{-1}). Each music trial (counterbalanced) involved successive 10-min stages of walking/running, beginning eith the low intensity, separated by 60-s at the end of each bout; following the high-intensity bout, participants continued to exercise with treadmill incline being increased very 2 min by 2% until the participant reached voluntary exhaustion. No significant effects of music were seen for RPE, HR, blood pressure, respiration frequency, skin temperature, or time to exhaustion (Brownley et al). Affective responses differed as a function of intensity, with progressively less positive FS scores as intensity increased; FS scores were also generally higher in the untrained group relative to the trained group for both intensity and music condition. Plasma cortisol, although unaffected by training status, showed differences following the high intensity exercise such that fast music resulted in the largest cortisol levels, with the no music and sedative music conditions resulting in similar cortisol levels. Brownley et al. concluded that music may be more beneficial for an untrained individual, at least in terms of affective response, whereas it seems to be counterproductive the trained individual.

Karageorghis and Priest reviewed several studies examining the effects of music on low-to-moderate endurance (2011). While some studies have indicated that music can result in reduced percpetions of effort, at least during lower intensity exercise, other studies have shown that moderate intensity exercise is strongly influenced by music. Most studies have shown the ideal tempo for music while exercising is 125-140 bpm (Karageorghis & Priest). Music during exercise often results in greater work being performed, higher HRs, higher oxygen consumption and minute ventilation, along with higher levels of enjoyment and lower levels of exertion compared to no music control conditions. It is believed that music allows the participanst to relax and reduce muscular effort, which leads to increased blood flow and muscle recovery

(Karageorghis & Priest). Overall music leads to more positive feelings and reduced perceptions of effort during low to moderate intensity exercise.

Karageorghis and Priest also reviewed studies that looked at the effects of music during high intensity exercise. Results generally show that music doesn't seem to elicit the same positive effects seen with low-to-moderate intensity exercise. Despite this conclusion, several studies have shown that music can result in improved time to volitional exhaustion (i.e., longer exercise duration). Karageorghis and Priest concluded that music during high intensity exercise results in much less consistent findings than low and moderate endurance exercise, with the conclusion that the stressors from high intensity exercise likely overshadow and/or override any potential ergogenic effects of music.

Aims and Objectives

As rates of physical inactivity continue to rise, there is an increasing level of concern over the number of health risk factors for those who do not exercise. In addition to lack of time, many people cite lack of enjoyment as a reason why they fail to adopt and exercise routine or for why they fail to continue an exercise program once they start. Music has been used to enhance affect and positive feelings in therapy, classrooms, and, more recently, during exercise. If music can be shown positively influence the exercise experience, it could potentially be used as a way to increase adherence to an exercise regimen. People react differently to exercise and people also react differently to music, yet these individual differences are often overlooked. Such differences should be accounted for and should be taken into consideration when looking at the effectiveness of music on an individual.

The present study sought to examine the effects of different kinds of music on the enjoyment of exercise, duration of that exercise, and affective responses during and following exercise. Specifically, three different types of music were examined: self-selected (SSM) music, classical (CM) music, and a no (NM) music control. It was hypothesized that:

1. Enjoyment would be greater in the SSM condition compared to either the CM or NM conditions.
2. Exercise duration would be longer in the SSM condition compared to either the CN or NM conditions.
3. Affect, as assessed with the Activation Deactivation Adjective Check List (AD ACL), from before exercise to after the bout would be more positive/less negative in the SSM condition compared to either CM or NM conditions. Specifically, SSM would result in increased Energy and Calmness and ecreased Tiredness and Tension compared to the CM and NM conditions.
4. Affect, as assessed with the Feeling Scale (FS) and Felt Arousal Scale (FAS), would be more positive/less negative both during as well as following the SSM condition compared to either CM or NM conditions.
5. Perceptions of effort, as assessed with the Borg Rating of Perceived Exertion (RPE) scale, would be lower in the SSM condition compared to either the CM or NM conditions.

CHAPTER 3
METHODS

Participants

Potential participants were recruited from flyers placed on campus bulletin boards and via an e-mail blast explaining the opportunity for individuals to participate in the study. All participants were members of the Univerisity of Illinos community (*N*=29; 16 males, 13 females). The average age of the participants was 22.46 ± 4.54 yrs (males: 22.13 ± 3.93 yrs; females 22.85 ± 5.31 yrs); all other biometric information is shown in Table 1. Participants exercised on average 4.2 ± 1.9 d-wk^{-1} (males: 4.7 ± 1.4 d-wk^{-1}; females: 3.7 ± 2.3 d-wk^{-1}) at an average duration of 59.7 ± 25.2 minutes (males: 64.4 ± 20.0 min; females: 53.9 ± 30.2 min). Using the Borg CR-10 RPE scale (Borg, 1998), participants rated their usual exercise intensity at 5.3 ± 2.2 (5=”Hard”; males: 5.4 ± 1.8; females: 5.2 ± 2.7). The only significant difference between males and females was for height, with males being taller than females; no other differences were present.

Table 1
Descriptive Information for the Sample

	Male (*n*=16)		Female (*n*=13)		Total (*N*=29)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Age	22.1	3.8	22.9	5.3	22.5	4.5
Height (cm)*	180.01	5.59	166.57	6.26	174.01	8.95
Weight (kg)	77.01	15.73	69.47	9.64	73.63	13.67
BMI	23.61	4.17	25.10	3.65	24.28	3.95
Frequency (d·wk^{-1})	4.7	1.4	3.7	2.3	4.2	1.9
Duration (min·session^{-1})	64.38	20.00	53.85	30.22	59.66	25.18
Intensity	5.4	1.8	5.2	2.7	5.3	2.2

Note: *$p < 0.001$ difference between males and females. See text for specifics.

Measures

Affect. Affective responses to exercise were measured in several ways. The Feeling Scale (FS; Hardy & Rejeski, 1989) in conjunction with the Felt Arousal Scale (FAS; Svebak & Murgatroyd, 1985), and the Activation Deactivation Checklist (AD ACL); Thayer, 1986) were used to measure affective responses to the exercise conditions. The FS is an 11-point, single-item, bipolar measure of pleasure-displeasure ranging from 'Very Good' (+5) to 'Very Bad' (-5), with verbal anchors provided at zero (Neutral) and at all odd integers. The FS has been commonly used for the assessment of affective responses before and after, but especially during, exercise (Ekkekakis & Petruzzello, 1999). The FAS is a 6-point, single-item measure for assessing perceived arousal states, ranging from 1 (Low Arousal) to 6 (High Arousal). The FAS is strongly correlated with valid single-item measures used to assess perceived activation. The FS and FAS, used in combination, allow for examining affective responses following the dimensional approach (Ekkekakis & Petruzzello, 2002). The Activation Deactivation Adjective Check List (AD ACL; Thayer, 1986) was also used for assessment of affect before and following exercise. The AD ACL is comprised of 20-items, with five items for each of four subscales: Energy, Tiredness, Calmness, and Tension. Each item is rated on a 4-point rating scale (definitely feel=4, feel slightly=3, cannot decide=2, definitely do not feel=1; Thayer, 1986).

Perceived exertion. Perceptions of effort were assessed using Borg's 15-point Rating of Perceived Exertion (RPE; Borg, 1998) scale. The psychophysical scale ranges from a value of 6 (no exertion at all) to 20 (maximal effort).

Enjoyment. The Physical Activity Enjoyment Scale (PACES; Kendzierski & DeCarlo, 1991) was used to assess enjoyment following each condition. The PACES contains 18 bipolar statements that anchor the ends of a 7-point response scale. Participants choose the number that most closely corresponds to the way they feel at the moment about the physical activity they have just been doing [e.g., "I enjoy it (1) .... I hate it (7)"; "I dislike it (1) …. I like it (7)"]. Scores on the PACES range from 18 to 126. Kendzierski and DeCarlo (1991) demonstrated that the PACES was valid and had acceptable internal consistencies in two separate studies (Cronbach's alphas = 0.93 in both).

Protocol

Flyers describing the study were placed on campus bulletin boards and an e-mail explaining the opportunity for individuals to participate in the study was sent to the campus community. The study recruited males and females ranging in age from 18 to 45 years of age. To be included, participants (a) could not have any contraindications for physical activity (i.e., they should be physically healthy) and (b) had to be able to perform moderate intensity physical activity. Respondents to the flyers or email were contacted via phone or e-mail to set up a meeting day/time to go over the testing procedures. Meetings took place in the Exercise Psychophysiology Laboratory (357 Freer Hall). At this initial meeting, potential participants completed the Physical Activity Readiness Questionnaire (PAR-Q) as well as a Physical Activity and Health History Inventory to confirm that they did not possess any contraindications for physical activity (which would preclude their further participation).

All study procedures were explained to the participants and all questions were answered as fully as possible so that participants were as fully informed about the experimental procedures as possible. When all questions were answered, participants read and signed an informed consent form approved by the University's Institutional Review Board. Participants were reminded that they could choose to withdraw from the study at any time without prejudice or penalty and that if any questions came up during the course of their participation, they were encouraged to utilize the contact information displayed on the consent form.

Upon meeting inclusion criteria, participants were scheduled for four additional testing sessions. The initial session lasted approximately 2 hours. During this session, participants completed an exercise test to determine predicted aerobic capacity (VO_{2peak}). The exercise test allowed the determination of the self-selected intensity for each participant in the subsequent conditions. This initial test involved successive 3-min bouts of treadmill jogging/running until the participant's heart rate (HR) reached ~85% of their age-predicted maximal HRe (calculated as 220 - age). During this submaximal exercise test, affect [using the the Feeling Scale (FS) and the Felt Arousal Scale (FAS)] and perceived exertion [using the Rating of Perceived Exertion (RPE) scale] were assessed every minute until completion of the test. Participants were also instrumented with a Polar heart monitor, to allow for continuous assessment of HR, as well as a noseclip and mouthpiece connected to a metabolic cart. Oxygen uptake was measured continuously with expired gases being sampled and data recorded every 30 s using open-circuit spirometry (Parvomedics TrueOne 2400, Sandy, UT, USA). The metabolic cart was calibrated prior to each test using gases of known concentrations as per manufacture specifications. Upon completion of testing, the participant were scheduled for the subsequent 3 sessions.

For each of the 3 experimental trials (performed on separate days), the participant was tested individually in the ExPPL with each trial taking up to 2 hrs to complete. The 3 conditions were: [1] Self-Selected Music (SS; participant selected his or her own music to listen to over the course of the exercise bout); [2] Classcial Music (CM; participant listens to pre-selected music chosen by the experimenter over the course of the exercise bout); and [3] No Music (NM; participant wore earplugs that attenuated ambient sound). For the SS condition, the participant was instructed to bring their own music on an audio device. For the CM condition, participants listened to a low intensity soundtrack (e.g., elevator music, classical, relaxing instrumentals). For the NM condition, participants wore earplugs for the duration of the trial. In the two music trials, participants began playing the music when the treadmill run began. Participants brought their own headphones and audio device; headphones were provided if the participant did not own a pair.

Each experimental trial began with the participant jogging on the treadmill at a comfortable pace. After 3 min at the warm-up pace, the participant increased the intensity (i.e., either speed and/or incline of treadmill) to whatever level they desired. They were was also told that they could modify the intensity (i.e., increase or decrease) at any time and they could run as long as they wanted to, up to a maximum of 1 hr. At the initiation of the trial, every 5 min during the trial, at the termination of the exercise, and 15 min after terminating the exercise bout, the participant's HR (via the Polar heart rate monitor), affect (using the FAS and FS), and perceived exertion (using the RPE scale) were recorded. The duration of the exercise bout was also noted along with the speed and incline of the treadmill at that time.

Upon completion of the exercise bout, participants removed the earphones/earplugs and were offered water and a towel as needed. After a 15 min seated recovery, participants again completed the AD ACL, the FS and FAS, had their HR recorded, and were asked to complete the Physical Activity Enjoyment Scale (PACES). The experiementer then arranged a testing time with the subject for the remaining exercise trials. At each of the subsequent trials, the same protocol was followed except for the manipulation of the music condition. The participant's task during each session was the same.

Analysis/Data Collection

Statistical analysis was conducted using SPSS 22.0.0.0. Repeated measures analyses of variance (RM ANOVA) with Condition and Time as factors were used to examine main effects and interactions for the main outcomes variables (affect, HR, RPE, enjoyment).

CHAPTER 4

RESULTS

It was hypothesized that exercise accompanied by self-selected music would yield greater levels of enjoyment when compared to classical music and a no music control. The self-selected music condition yielded the highest level of enjoyment, with a PACES score of 102.5 ± 14.5 (*M*±*SD*), followed by the no music control with 87.6 ± 16.5, and then the classical music condition with 86.2 ± 19.7. Comparison of enjoyment levels between conditions using paired *t*-tests showed that the self-selected music condition resulted in significantly greater enjoyment than classical music (M_{diff}=17.64, 95% CI: 8.13, 27.15, $t(27)= 3.81$, $p= .001$; $d= 1.04$, 95% CI: -3.43, 5.50), self-selected was more enjoyable than no music (M_{diff} =15.04, 95% CI: 9.78, 20.29, $t(27)= 5.92$, $p< .001$; $d= 1.09$, 95% CI: -2.83, 5.00), and the no music and classical music conditions were the same ($M_{diff}= 1.33$, $t(26)= -0.75$, $p= .70$). It was hypothesized that classical music would yield greater levels of enjoyment when compared to the no music control, but this hypothesis was not supported. The graphical representation of these findings appears in Figure 2.

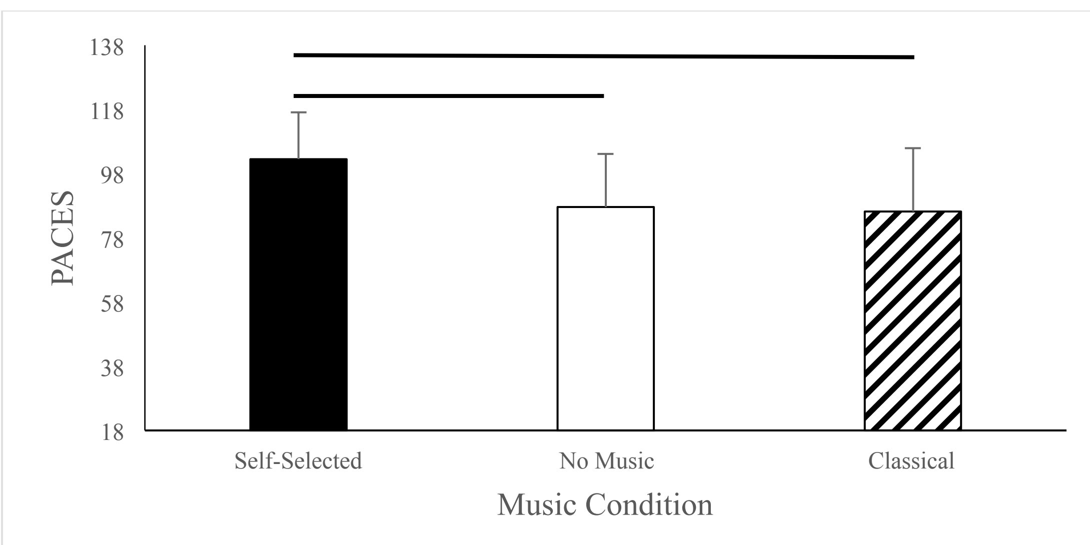

Figure 2. Mean PACES scores for the 3 experimental music conditions: self-selected, classical, and no music. Bars refer to significant differences between conditions.

It was hypothesized that participants would exercise longest in the self-selected music condition, followed by the classical music condition, and the shortest exercise time would be seen in the no music control. To address this hypothesis, exercise duration was compared across the three conditions using paired *t*-tests. The mean exercise duration was 31.04 ± 14.2 min, 25.63 ± 15.5 min, and 25.10 ± 15.1 min for the self-selected, classical, and no music conditions, respectively. When comparing exercise duration between conditions, the self-selected music condition resulted in significantly longer than classical music (M_{diff}=5.41, 95% CI: 1.96, 8.85, $t(26)$= 3.23, p= .003; d= 0.37, 95% CI: -3.52, 4.26), self-selected was longer than no music (M_{diff} =5.93, 95% CI: 1.98, 9.88, $t(28)$= 3.07, p= .005; d= 0.42, 95% CI: -3.24, 4.08), and the no music and classical music conditions resulted in the same durations (M_{diff} = 0.41, $t(26)$= -0.27, p= .79). Thus, exercise duration was slightly over 5.5 min longer for the self-selected music condition, significantly longer than either of the other conditions. These results support the original hypothesis regarding exercise duration.

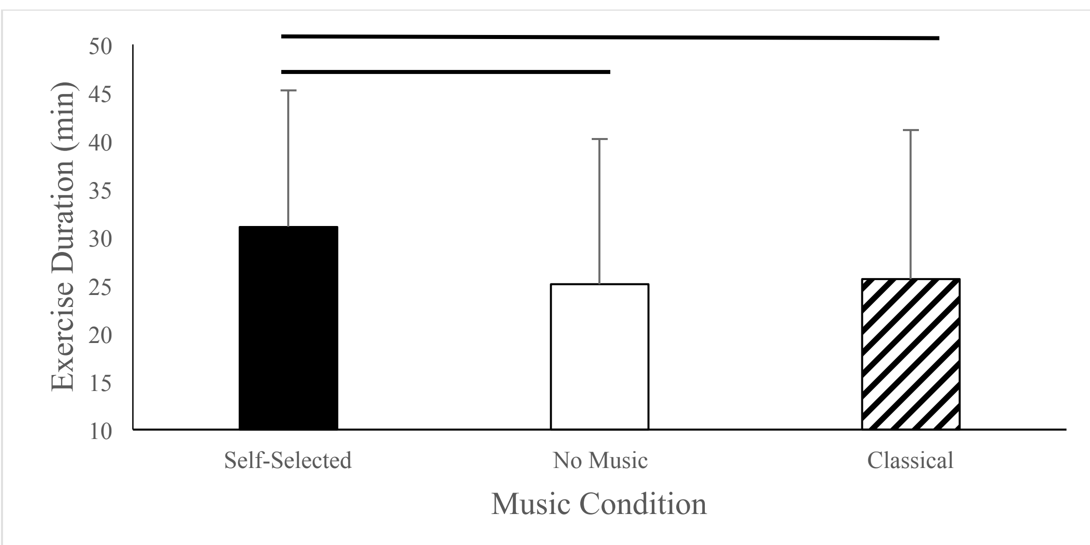

Figure 3. Mean exercise duration (min) across the 3 experimental music conditions. Bars refer to significant differences between conditions.

It was hypothesized that affective responses (Energy, Tiredness, Tension, and Calmness) would be positively influenced by the music conditions compared to the no music control. Means (±*SD*) for the AD ACL subscales are shown in Table 2. To examine this hypothesis, a Condition (3: Self-Selected, Classical, No music) x Time (3: Pre, Post-0, Post-15) repeated measures ANOVA was conducted. This revealed no Condition main effect (p= 0.19) or Condition x Time interaction (p= 0.61), but there was a significant Time main effect [Wilks' λ=0.261, F(8, 50)=5.99, p< 0.001, η_p^2=0.49]. Examination of the pre, post, and post-15 affective responses were done, collapsing across Condition. There were significant Time main effects for Energy [F(1.4, 19.2)=19.02, p< .001, η_p^2=.58, Huynh-Feldt ε=0.69], Tiredness [F(1.9, 25.96)=16.44, p< .001, η_p^2=.54, Huynh-Feldt ε=0.93], Tension [F(1.5, 20.8)=4.03, p= .044, η_p^2=.22, Huynh-Feldt ε=0.74], and Calmness [F(2, 28)=10.02, p= .001, η_p^2=.42, Huynh-Feldt ε=1.0].

Follow-up post hoc tests to delineate the changes in affect over time were done next. For Energy, there was a significant increase from Pre to Post-0 (M_{diff}= 4.13, 95% CI: 1.90, 6.36), p= .001; d= 1.66, 95% CI: 0.76, 2.55), a significant decrease from Post-0 to Post-15 (M_{diff} = -1.56, 95% CI: -2.52, -0.60), p= .002; d= -0.59, 95% CI: -1.53, 0.35), and a significant increase from Pre to Post-15 (M_{diff} = 2.58, 95% CI: 0.52, 4.64), p= .013; d= 1.01, 95% CI: 0.10, 1.92). For Tiredness, there was a significant decrease from Pre to Post-0 (M_{diff}= 4.24, 95% CI: 2.16, 6.33), p< .001; d= 1.77, 95% CI: 0.90, 2.63), no change from Post-0 to Post-15 (M_{diff} = -0.89, 95% CI: -2.57, 0.79), p= .52; d= 0.40, 95% CI: -0.39, 1.20), and a significant decrease from Pre to Post-15 (M_{diff} = 3.36, 95% CI: 0.84, 5.88), p= .008; d= 1.19, 95% CI: 0.19, 2.20). For Tension, the only significant change was a decrease from Post-0 to Post-15 (M_{diff} = 0.98, 95% CI: 0.40, 1.56), p= .001; d= 0.41, 95% CI: -0.44, 1.26). Finally, for Calmness, there was a significant decrease from Pre to Post-0 (M_{diff}= -2.58, 95% CI: 0.79, 4.37), p= .005; d= 0.93, 95% CI: -0.07, 1.92), an increase from Post-0 to Post-15 (M_{diff} = 1.76, 95% CI: -3.05, 0.46), p= .007; d= 0.61, 95% CI: -0.41, 1.63), and no change from Pre to Post-15 (M_{diff} = 0.82, 95% CI: -0.85, 2.50), p= .61.

Table 2
Energy, Tiredness, Tension, and Calmness Scores from the Activation Deactivation Adjective Check List (AD ACL), Separated by Condition and Collapsed Across Conditions

	Self-Selected Music		Classical Music		No Music		Combined	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Energy Pre	9.73	3.06	9.67	3.99	9.20	3.14	9.53	2.50
Energy Post	14.87	4.07	13.47	3.16	12.67	3.62	13.67	2.67
Energy Post-15	12.53	2.75	12.20	2.81	11.60	3.64	12.11	2.76
Tiredness Pre	12.27	4.80	13.07	4.51	13.33	4.48	12.89	3.07
Tiredness Post	7.93	2.31	8.67	1.80	9.33	3.54	8.64	1.73
Tiredness Post-15	9.53	3.80	9.40	3.07	9.67	3.48	9.53	2.75
Tension Pre	7.07	2.46	7.33	1.99	7.33	3.75	7.24	2.10
Tension Post	7.60	3.00	7.53	2.13	7.60	2.64	7.58	2.29
Tension Post-15	6.80	2.27	6.80	2.15	6.20	1.78	6.60	1.90
Calmness Pre	12.40	2.95	12.00	3.59	12.33	3.35	12.24	2.18
Calmness Post	8.93	3.41	10.00	3.91	10.07	3.92	9.67	3.43
Calmness Post-15	11.80	3.90	11.80	2.62	11.20	3.61	11.42	2.87

Note: Due to missing data, the data in this analysis is for 15 participants.

In order to examine the affective responses across the entire exercise session, a 3 (Condition) x 5 (Time: pre, mid-during, end-during, post-0, post-15) RM ANOVA was conducted for FS and FAS responses. Means (±*SD*) for the FS and FAS are shown in Table 3. The overall multivariate analysis resulted in significant Condition [Wilks' ƛ=0.737, F(4, 62)=2.55, p= 0.048, η_p^2=0.14] and Time [Wilks' ƛ=0.283, F(8, 126)=13.85, p< 0.001, η_p^2=0.47] main effects, but no interaction (p= 0.91). Examination of the univariate repeated measures analysis revealed that the Condition main effect was not significant for FS (p= 0.11) and only approached significance for FAS (p= 0.061). Because the main effects approached significance in both cases, effect size differences across the 3 conditions were examined. As hypothesized, the Self-Selected condition resulted in greater overall FS when compared to the Classical (d= 0.64) and No Music conditions (d= 0.44); Classical and No Music were not different (d= -0.20). The same pattern emerged for FAS, with Self-Selected Music resulting in greater FAS compared the Classical (d= 0.50) and No Music conditions (d= 0.67); Classical and No Music were not different (d= 0.17). The Time main effect was driven by a significant effect for FAS [F(2.7, 43.8)=30.65, p< .001, η_p^2=.66, Huynh-Feldt ε= 0.69], but not FS [F(1.5, 24.2)=3.25, p= .068, η_p^2=.17, Huynh-Feldt ε=0.38]. There were significant increases in FAS from Pre to both time points during exercise (M_{diff}= 1.41, 95% CI: 0.99, 1.83, p< .001; M_{diff}= 1.47, 95% CI: 0.93, 2.01, p< .001) and immediately post-exercise (M_{diff}= 0.96, 95% CI: 0.53, 1.39, p= .003); FAS had returned to Pre-exercise levels by 15 min following the bout (p= 0.40). During exercise FAS was also significantly higher than both post-exercise time points (M_{diffs} = 0.45 – 1.33, $p_s \leq$ .003).

Examination of the perceptions of exertion (RPE) was done using a 3 (Condition) x 2 (Time: mid-during, end-during) RM ANOVA. Means (±SD) for RPE are shown in Table 4. The overall multivariate analysis resulted only in a significant Time [Wilks' λ=0.848, F(1, 26) =4.66, p= 0.04, η_p^2=0.15] main effect. Examination of the univariate repeated measures analysis revealed that the Condition main effect approached significance (p= 0.089), so effect size differences across the 3 conditions were examined. The Self-Selected condition resulted in greater RPE when compared to the Classical (d= 0.43) music condition. Self-Selected was not different from the No Music condition (d= 0.28); Classical and No Music were not different (d=

0.13). Examination of the Time main effect showed a significant increase in RPE from the middle to the end of the exercise bout (M_{diff}= 0.78, 95% CI: 0.37, 1.52, p= .04).

Table 3

Feeling Scale (FS) and Felt Arousal (FAS) Scores, Separated by Condition and Collapsed Across Conditions

	Self-Selected Music		Classical Music		No Music		Combined	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
FS Pre	2.59	2.37	2.00	2.09	2.06	1.68	2.22	1.71
FS mid-during	2.59	1.12	2.24	1.25	2.47	1.23	2.43	0.88
FS end-during	2.35	1.54	2.00	1.58	2.12	1.69	2.16	1.28
FS Post-0	3.06	1.20	2.29	1.31	2.53	1.66	2.63	0.98
FS Post-15	3.82	0.95	2.94	1.44	3.29	1.11	3.35	0.86
FAS Pre	1.94	0.97	1.76	1.03	1.71	0.77	1.80	0.58
FAS mid-during	3.59	0.87	3.12	0.99	2.94	1.03	3.22	0.66
FAS end-during	3.59	1.18	3.00	0.94	3.24	1.30	3.28	0.79
FAS Post-0	3.00	1.46	2.76	0.90	2.53	0.87	2.77	0.68
FAS Post-15	2.24	1.30	1.94	0.75	1.65	0.70	1.94	0.72

Table 4

Ratings of Perceived Exertion (RPE) Responses During Exercise, Separated by Condition and Collapsed Across Conditions

	Self-Selected Music		Classical Music		No Music		Combined	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
RPE mid-during	13.33	1.88	12.89	1.65	12.81	1.98	13.01	1.39
RPE end-during	14.37	2.66	13.22	2.68	13.78	2.56	13.79	2.22

CHAPTER 5
DISCUSSION

The present study sought to examine the effects of different kinds of music on the enjoyment of exercise, duration of that exercise, and affective responses during and following exercise. Specifically, three different types of music were examined: self-selected (SSM) music, classical (CM) music, and a no (NM) music control. As noted earlier, it was hypothesized that:

1. Enjoyment would be greater in the SSM condition compared to either the CM or NM conditions.
2. Exercise duration would be longer in the SSM condition compared to either the CM or NM conditions.
3. Affect, as assessed with the Activation Deactivation Adjective Check List (AD ACL), from before exercise to after the bout would be more positive/less negative in the SSM condition compared to either CM or NM conditions. Specifically, SSM would result in increased Energy and Calmness and ecreased Tiredness and Tension compared to the CM and NM conditions.
4. Affect, as assessed with the Feeling Scale (FS) and Felt Arousal Scale (FAS), would be more positive/less negative both during as well as following the SSM condition compared to either CM or NM conditions.
5. Perceptions of effort, as assessed with the Borg Rating of Perceived Exertion (RPE) scale, would be lower in the SSM condition compared to either the CM or NM conditions.

The results of the present study supported the intial hypothesis, namely, that self-selected music (SSM) would elicit significantly higher enjoyment compared to classical music (CM) and no music (NM) during exercise. These findings were consistent with previous research that found motivational music yields higher levels of overall enjoyment (Miller, Swank, Manire, Robertson, & Wheeler, 2010; Stork et al., 2014). The participants were allowed to pick their own music during the self-selected music condition. It is likely the participants chose music that they found appealing in terms of tempo and lyrics, thereby creating a motivational and positive effect and thereby greater enjoyment. Previous research has found that athletes and exercisers use music to self-motivate and mentally prepare for sport and activity (Karageorghis & Priest, 2012a; Laukka & Quick, 2011; Priest & Karageorghis, 2008). The CM condition could have had counterproductive effects on exercise performance because it lacked some of the typical musical qualities (e.g., lack of lyrics) often included in contemporary music. Lyrics can often provide a motivational lift during exercise, and music lacking such lyrics may have led to the reduced enjoyability relative to the SSM condition. It may have also been difficult for the individuals to connect and emotionally respond to the classical music (Karageorghis & Priest). Karageorghis et al. suggests that cultural impact and association play a role on the impact a piece of music has on an individual. In today's mainstream society, classical music is rarely played and when it is it is sometimes associated with boring, mundane tasks (e.g., waiting on hold on the telephone, riding an elevator, sitting in a doctor's office). The participants may have invoked these memories to make associations with the pieces of classical music used, resulting in less enjoyment compared to the SSM condition. The fact that classical musical did not provide any difference in enjoyment relative to the NM condition further suggests that, at least in this sample, music did not provide any particularly salient distraction from the exercise tasks itself. The notion that distraction of attention may have helped influence enjoyment could still be a partial explanation for the SSM condition, but this isn't the sole explanation.

The second hypothesis proposed that exercise duration would be longer during the SSM condition compared to both CM and NM conditions. This hypothesis was also supported by the data. Previous research suggests that performance and endurance can be positively influenced when exercise is accompanied by motivational/self-selected music (Crust & Clough, 2006; Karageorghis et al., 2012a; Bartolomei, Di Michele & Merni, 2015; Mohammadzadeh et al., 2008; Simpson & Karageorghis, 2006). The SSM condition had an average exercise duration that was 5.5 minutes longer than both CM and NM conditions, which were of similar duration. Previous research suggests that exercise performance and duration can be influenced for at least two reasons. First, Karageorghis et al. (2012a) and Pottegier, Schroeder, and Goff (2000) suggest that listening to motivational music can help the exerciser exerperience more dissociative thoughts, taking the focus off of the potential discomfort of exercise and internal cues (e.g., self-talk). Second, it is possible that the self-selected music provided higher levels of state motivation, thereby increasing exercise performance and endurance in the SSM as opposed to the CM or NM conditions.

The present results did not support the hypotheses related to affective responses, either for the AD ACL with pre-to-post exercise scores or for the FS/FAS for pre-during-post exercise scores. For the AD ACL, it was hypothesized that there would be more positive/less negative affect in the SSM and CM conditions compared to the NM condition. While the results did reveal a significant time effect on AD ACL subscale scores, there was not a condition main effect or an interaction. Specifically, there was a significant pre-post exercise increase in Energy along with significant pre-post exercise decreases in Tiredness and Calmness, all of which had sizable effect sizes (d_s= 0.93 – 1.77). These findings are consistent with a majority of previous research which shown that exercise can be a useful tool in regulating affective responses

(Ekkekakis, Hargreaves, & Parfitt, 2013; Ekkekakis, Parfitt, & Petruzzello, 2011). It was also found that, during the 15 min recovery period following exercise, Energy and Tension decreased (d_s= -0.59, 0.41), Tiredness did not change (maintaining the reduced level seen immediately post-exercise), and Calmness increased (d= 0.61). Thus, while music had no discernible effect on affect following exercise, there was an overall effect of exercise on affective improvement.

Energy and tiredness are often cited as reasons for why people don't exercise. However, exercise has a positive impact on both dimensions of affect. The present study showed significant increases in Energy immediately following exercise (compared to pre-exercise), which is consistent with previous research. Research has shown that regular exercise and other active behaviors have positive impacts on perceptions of energy (Ekkekakis, Hall, Van Landuyt, & Petruzzello, 2000; Thayer, 1987; Thayer et al., 1994; Yeung, 1996). Tiredness was also significantly decreased immediately post-exercise and remained attenuated during the recovery period. This is also a consistent finding in much of the prior research, which has found that feelings of fatigue or tiredness is often decreased after acute exercise, especially if it is not done at a high intensity (Bartholomew, Morrison, & Ciccolo, 2005; Dishman, Thom, Puetz, O'Connor, & Clementz, 2010; Lane & Lovejoy, 2001; Thayer, 1987).

Negative aspects of affect, such as high levels of stress and tension, are often associated with an overall lack of well-being (Bryne & Bryne, 1993; Lane & Lovejoy, 2001; Thayer et al., 1994; Yueng, 1996). Decreasing feelings of tension and moderating or improving calmness is an important aspect of regulating affect and mood disorders. Exercise has been shown to be an effective technique in such affective regulation. The current results showed significant changes in both feelings of tension and calmness. Tension was significantly reduced only during the 15-min recovery period, but Calmness increased during the same time period after having been decreased immediately post-exercise. Once again, these findings are consistent with previous research showing exercise to be an effective and powerful tool at decreasing tension scores (Ekkekakis, Hall, & Petruzzello, 2008).

Beyond the pre-to-post affective change, the responses during exercise are also important to examine. As such, it was also hypothesized that both affective valence (via the Feeling Scale, FS) and activation (via the Felt Arousal Scale, FAS) would be more positive/less negative during and following the SSM condition compared to both CM and NM conditions. This hypothesis was somewhat supported, but it is important to note that the lack of a significant Condition main effect ($p= 0.11$) precludes too much to be made of this finding. FS was higher in the SSM condition compared to both the CM ($d= 0.50$) and NM conditions ($d= 0.67$). Hutchinson et al. (2014) found similar results when examining the effects of music-only and music+video compared to a no music control, showing that music-only and music+video elicited higher FS (i.e., more pleasant) and FAS (i.e., greater activation) scores during treadmill running compared to no music. The training status of the sample used could be one possible reason for the lack of significant effects for the SSM condition. The mean number of days exercised per week was 4.2 (±1.91) and the average duration of each training session was 59.64 (±25.6) minutes. Thus, the majority of the participants were regular exercises. Training routines varied from traditional forms of exercise such as running, weight-lifting, swimming, and biking to ultra endurance atheltes and triathletes. Trained athletes tend to rely more on internal cues (e.g., self-talk, motivation) than external cues (e.g., music, outside encouragement) when compared to noice exercisers (Jarraya et al., 2012; Terry et al., 2012). Brownley et al. (1995) found that upbeat, fast music during exercise was more beneficial for untrained participants compared to trained exercisers. Thus, the present sample may have found all sessions to be relatively pleasant, leading to the lack of signifcant differences in for both FS and FAS scores.

A potential explanation as to why we did not see significant condition differences in both AD ACL scores and FS/FAS scores is the intensity at which the participants exercised at. Ekkekakis et al. (2008) found that exercising at intensities higher than one's ventilatory threshold appears to reduce pleasure/enjoyment and could lead to negative effects on adherence rates. Participants of the present study were allowed to select the intensity they exercised and change it at any time during the session. It is most likely that the participants chose a speed/intensity that was below their ventilatory threshold and if at any point during exercise the session became too challeneging or lacked enjoyment they either stopped before those feelings became powerful or adjusted to the exercise intensity to reduce the feelings of discomfort/pleasure. Further analysises will need to be run in order to prove significance.

The final hypothesis was that perceptions of effort (RPE) would be lower in the SSM condition compared to either the CM or NM conditions. While there was not a significant main effect for condition, SSM actually resulted in higher perceptions of effort than either the CM or NM conditions. Although counterintuitive, it could very well be that listening to one's own music may have increased motivation and resulted in putting forth greater effort during the exercise session. This would be consistent with the greater duration of the SSM condition relative to the other two conditions. It would have been instructive to see if this also translated into greater distance covered in the SSM condition, which would support the greater perceived effort. If HR data had been available throughout all sessions for all of the participants, this would also have provided corroborating evidence.

Many of the study hypotheses were supported and are consistent with the available literature. The present findings highlight the benefits of exercising with music. Self-selected music was perceived as more enjoyable, resulted in longer exercise duration, and tended toward greater positive affect/less negative affect than either running with classical music or no music. This information could be helpful when prescribing exercise to novice exercisers. Music could make exercise more enjoyable, particularly if it is chosen by the exerciser, and more enjoyable exercise could lead to better exercise adherence. Greater adherence to regular program of exercise generally leads to healthier individuals, both physiologically and psychologically. Trained athletes and regular exercisers can also use this information to improve training and performance. By accompanying their training and regular exercise with music, they may be able to increase the amount of time they exercise, enjoy their exercise more, and potentially become more physically fit. Further research should continue to focus on the specific mechanisms for the (generally) positive impact of music on exercise (e.g., examining step rate compared to music tempo, examining brain activity while listening to music during exercise to see what areas are stimulated/engaged). The present study adds to the previous literature in suggesting that music has a positive impact on exercise performance and enjoyment of that exercise. Taken together, exercise is a useful, effective, and cost-effective to increase exercise patterns and potentially adherence rates.

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