

UNIVERSITY OF WISCONSIN-LA CROSSE

Graduate Studies

THE EFFECTS OF MUSIC TEMPO VS. PERCUSSION VS. BEAT FREQUENCY ON

EXERCISE INTENSITY

A Manuscript Style Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of  
Science in Clinical Exercise Physiology

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College of Science and Allied Health

Master of Science in Clinical Exercise Physiology

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THE EFFECTS OF MUSIC TEMPO VS. PERCUSSION. VS. BEAT  
FREQUENCY ON EXERCISE INTENSITY

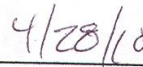
By Amy Kaphingst

We recommend acceptance of this project report in partial fulfillment of the candidate's requirements for the degree of Masters of Science Clinical Exercise Physiology

The candidate has met all of the project completion requirements.



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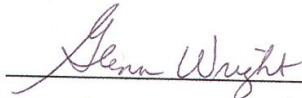
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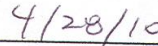
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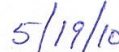


Date

Thesis accepted



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## ABSTRACT

Kaphingst, A.M., The effects of music tempo vs. percussion vs. beat frequency on exercise intensity. MS in Clinical Exercise Physiology. December 2010. 37 p. (C. Foster)

**Purpose:** This study was conducted to determine which component of music; percussion or beat was most influential on exercise intensity while cycling. **Methods:** Fifteen subjects (10 women, 5 men) performed four trials on a cycle ergometer with different musical conditions. The subjects listened to full music (FM), percussion (P), beat (B), and 0-Tempo (N) with varying tempo during four different 30 minute rides. The control condition was thrown out. Power output (PO), heart rate (HR), and Rating of Perceived Exertion (RPE) were measured during each ride. **Results:** The results found no significant differences in PO with FM, P, and B ( $p=0.236$ ). Heart rate was significantly higher with the FM ride compared to both P and B ( $p=0.012$ ). There was no significant difference in RPE between the three conditions ( $p=0.731$ ). PO, HR, and RPE all showed significant increase with the increase in tempo ( $p<0.001$ ). **Conclusion:** Power output did not differ significantly between FM, P, and B. Heart rate increases significantly more with FM than P or B. RPE does not show changes between conditions. These findings may be due mostly to synchronization of the music to pedal cadence. HR may increase more with FM due to increased arousal.

## ACKNOWLEDGEMENTS

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## **INTRODUCTION**

Music and exercise have become tightly linked partners in the last 40 years. This means people are using portable music devices frequently while exercising. Research studies have demonstrated increased exercise benefits with all types of music.

Karageorghis and Terry (1997) found three main reasons that music affects exercise are dissociation, synchronization, and arousal. Dissociation is when the mind focuses on an external cue, music, rather than focusing on internal cues such as fatigue.

Synchronization is when a person coordinates his/her movements to the music.

Karageorghis et al. (2009) found that both motivational and neutral synchronous music acted to increase exercise intensity compared no music. Finally, arousal is when one is either physically or mentally aroused by the music, contributing to an increased power output or duration. Karageorghis et al. (2008) studied the effects of medium tempo, mixed tempo, and fast tempo on music preference to test the arousal factor in subjects while walking on a treadmill. They found that there was a preference for the fast tempo that appeared to be attributable to physiological arousal (Karageorghis et al., 2008).

In many studies investigators have evaluated the effects of different styles and tempos of music, and how these variables affected the individual both mentally and



physically. Schwartzmiller (2003) found that with slow, medium, and fast tempo music, there was an effect on heart rate and power output. The faster tempo produced higher exercise intensities and heart rates (Schwartzmiller, 2003). Boutcher and Trenske (1990) did a study involving music and exercise as well as sensory deprivation. They had individuals ride a cycle ergometer with music, without music, and with earplugs and eye goggles. They found that with music there was a significant decrease in Rating of Perceived Exertion (RPE). It also showed an increased mood with the music (Boutcher & Trenske, 1990). Prieboy (2009) tested yoga music, self-selected music, and a stand-up comedy act and found a decrease in RPE with the self-selected music compared to no music. This suggests that distraction (yoga music and comedy) had relatively less influence (compared to music) on how exercise is perceived.

These studies provide evidence that music can affect both the physical and mental aspects of exercise, but it is still necessary to ask how it can be used. Research in this area has supported the idea that music will improve exercise performance (Boutcher & Trenske, 1990; Elliott et al., 2005; Karageorghis & Terry, 1997; Karageorghis et al., 2006; Mertesdorf, 1994; Prieboy, 2009; Schwartzmiller, 2003). It has also been shown that music with exercise will decrease RPE (Boutcher & Trenske, 1990; Gordon, 2007; Karageorghis & Terry, 1997; Karageorghis et al., 2009, Prieboy, 2009). This information is important because it allows fitness professionals to use music with exercise to their advantage. Since music has been shown to increase exercise intensity, experts can use high tempo music to intensify an exercise bout. However, it is important to know the population we are dealing with and how music can affect them. Gordon (2007) found

that high tempo music may increase exercise intensity to levels that may be more likely to cause cardiovascular complications in older adults with cardiac conditions.

In another way, music can be used to make exercise more enjoyable. Boutcher and Trenske (1990) found an improved mood when exercising with music. Multiple studies found decreases in RPE with music, which shows that individuals do not feel as if they are working as hard (Boutcher & Trenske, 1990; Gordon, 2007; Karageorghis & Terry, 1997; Karageorghis et al., 2009; Prieboy, 2009). This may help fitness professionals find new ways to increase exercise adherence. If the right type of music can be found, it may be able to get more people to exercise regularly.

Since there is evidence that music generally has a positive effect on exercise, we were interested in how music influences exercise. Therefore, the purpose of this study was to explore the different components of music (full music, percussion, and beat frequency) to determine their effects on exercise intensity.

## **METHODS**

Following approval from the Institutional Review Board at the University of Wisconsin-La Crosse fifteen college-aged subjects (five men and ten women) provided written informed consent and participated. All of the subjects were currently active, defined as exercising at least three days per week for at least 30 minutes. The plan was to break down a single musical selection into separate components; beat frequency (B), percussion (P), and full music (FM); as well as a zero tempo track. This allowed a determination of what part of music was most likely to influence exercise intensity.

The subjects began with an incremental test on an electronically braked cycle ergometer to determine their maximal power output, oxygen uptake, and heart rate. The incremental test began at 50 Watts increasing by 25 Watts every three minutes to maximal effort. After maximal levels were found, each subject completed four trials on the Cycleops cycle ergometer (Saris Cycling Group, Madison, WI). The conditions were as follows: the full music selection, the percussion track extracted from the full music track, the dominant beat frequency provided by simple clicks, and a 0-tempo selection. The subjects used an MP-3 player to listen to the music during each trial.

The subjects rode a cycle ergometer while listening to six tracks of music with varying tempos as well as two 0-tempo tracks for each trial. The selections included a combination of slow (<100 bpm), medium (100-139 bpm), and fast tempo (>140 bpm) during each 30 minute trial (Table 1). The 0-tempo track selected was a white noise element which was the sound of a hair dryer. The musical selections were broken down into separate components using the Quartz Audiomaster Freeware 4.6 (Digital Sound Planet).

The Cycleops cycle ergometer recorded power output and heart rate every 30 seconds. The last minute of each song was used for analysis of power output and heart rate. Ratings of Perceived Exertion were recorded during the last minute each track using an RPE scale (Borg, 1998).

Table 1. List of songs with tempo.

<b>Track</b>	<b>Tempo</b>
Song 1	96 BPM
Song 2	86 BPM
Song 3	0-tempo control
Song 4	121 BPM
Song 5	110 BPM
Song 6	0-tempo control
Song 7	139 BPM
Song 8	146 BPM

### **Data Analysis**

Repeated Measures ANOVA was performed for 2 within subject factors (tempo and musical component) and three dependent variables (power output, heart rate, and RPE).

## RESULTS

During data collection and analysis it was noted that there was an unexpectedly high power output and heart rate during the 0-tempo condition. Several subjects voiced concern about the nature of these tracks. Many felt that although the track did not have any type of tempo, it was very agitating and distracted from the ride in a negative manner, potentially by increasing arousal. The decision was made by the investigator to eliminate this condition on the basis that previous research strongly supports the benefits of music with exercise (Boutcher & Trenkse, 1990; Elliott et al., 2005; Gordon, 2007; Karageorghis & Terry, 1997; Karageorghis et al., 2008; Karageorghis et al., 2009; Priebay, 2009; Schwartzmiller, 2003). Accordingly, the analysis was performed without a true control condition.

There was no significant difference in power output between the three conditions ( $p=0.236$ , Figure 1). The average power output values for full music (FM), percussion (P), and beat (B) condition were (mean  $\pm$  1 SD)  $124.9 \pm 45.0$ ,  $122.7 \pm 48.8$ , and  $115.9 \pm 45.2$  Watts, respectively. There was a significant difference in power output between songs ( $p<0.001$ ). Power output increased as music tempo increased with all conditions (Figure 2).

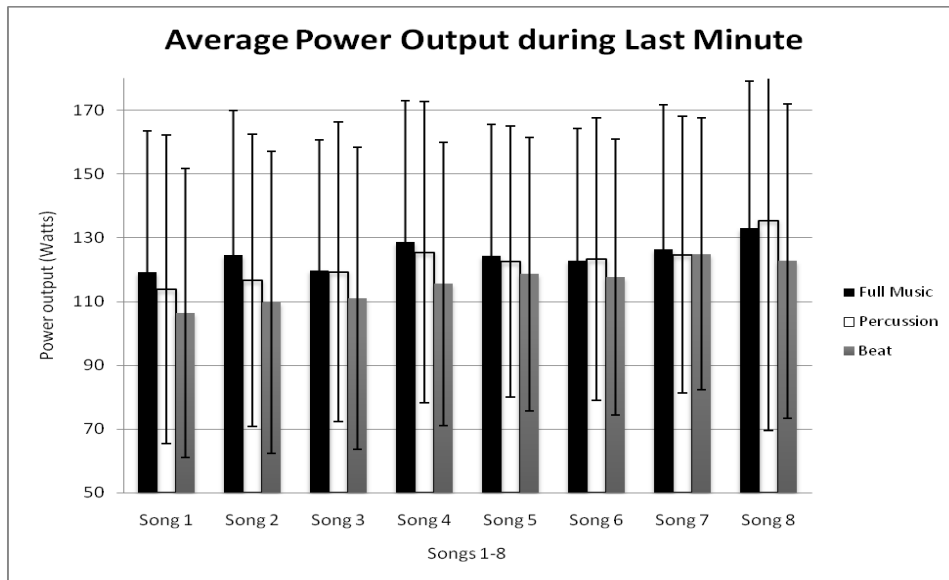


Figure 1. Average power output ( $\pm 1$  SD) during the last minute of each song for all conditions.

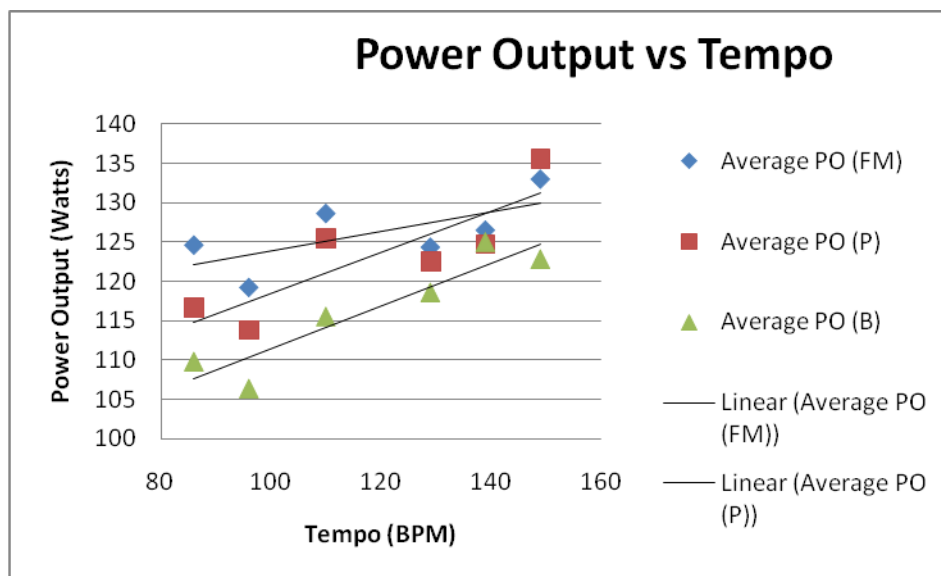


Figure 2. Relationship between average power output for each condition and tempo.

Heart rate was significantly different between the three conditions ( $p=0.012$ ).

Heart rate for FM, P, and B was (mean  $\pm$  1 SD)  $152 \pm 16$ ,  $144 \pm 16$ , and  $144 \pm 20$  beats per minute, respectively. The heart rate during the FM condition was significantly higher than the other two conditions (Figure 3). Heart rate increased significantly as music tempo increased in all conditions ( $p<0.001$ , Figure 4).

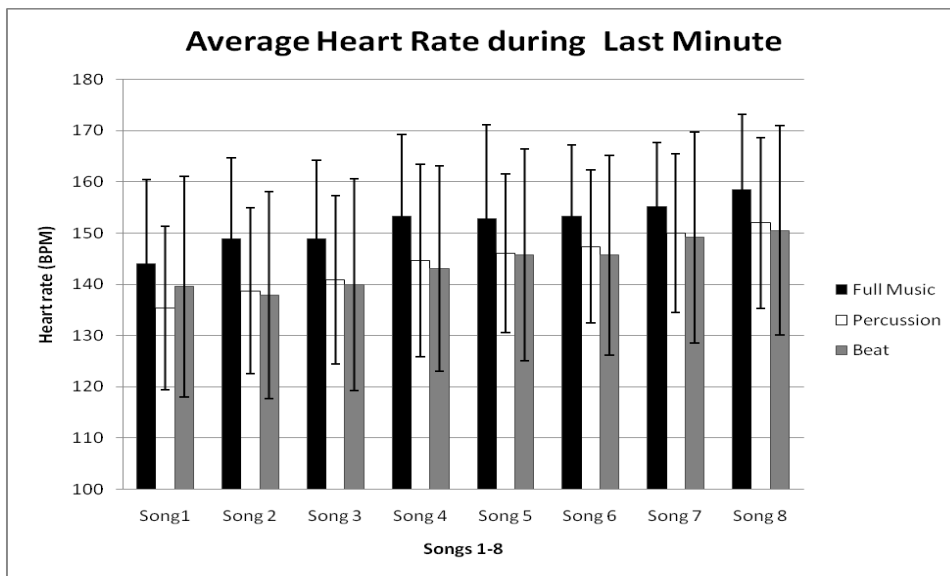


Figure 3. Average heart rate ( $\pm 1$  SD) during the last minute of each song for all conditions.

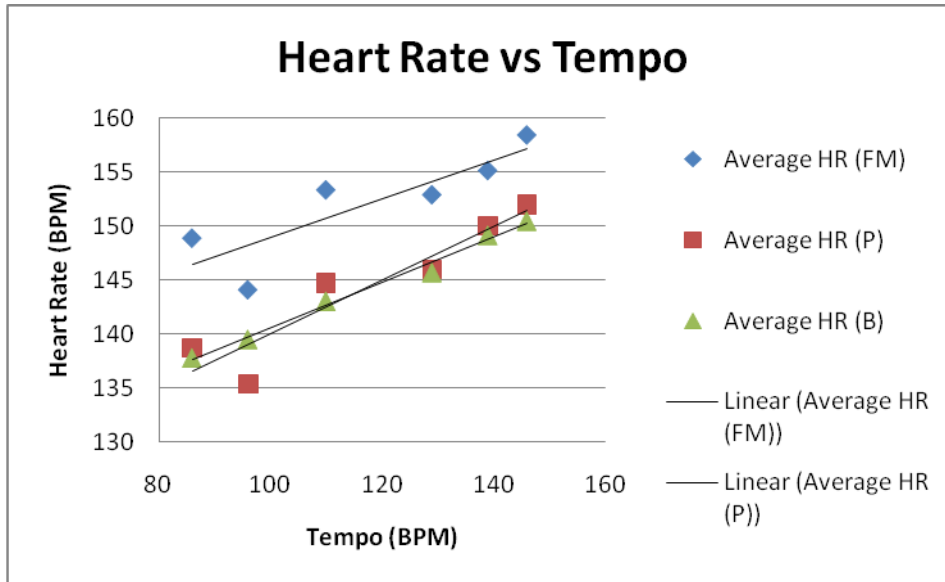


Figure 4. Relationship between average heart rate for each condition and tempo.

There was no significant difference in RPE between conditions ( $p=0.731$ , Figure 5). The average RPE for FM, P, and B was (mean  $\pm$  1 SD)  $12.1 \pm 1.8$ ,  $12.3 \pm 2.0$ , and  $12.1 \pm 1.8$  respectively. RPE increased as music tempo increased ( $p<0.001$ , Figure 6).



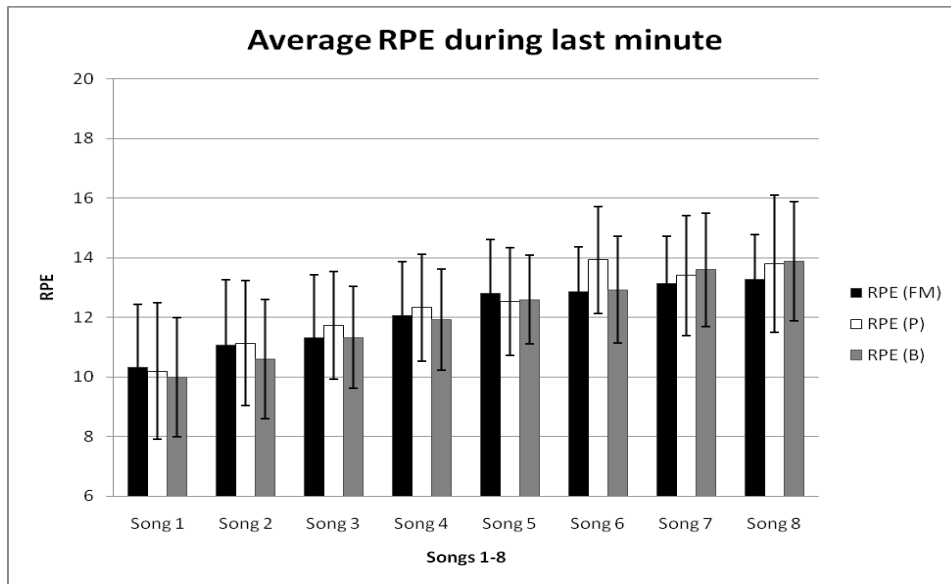


Figure 5. Average RPE ( $\pm 1$  SD) for each song with all conditions.

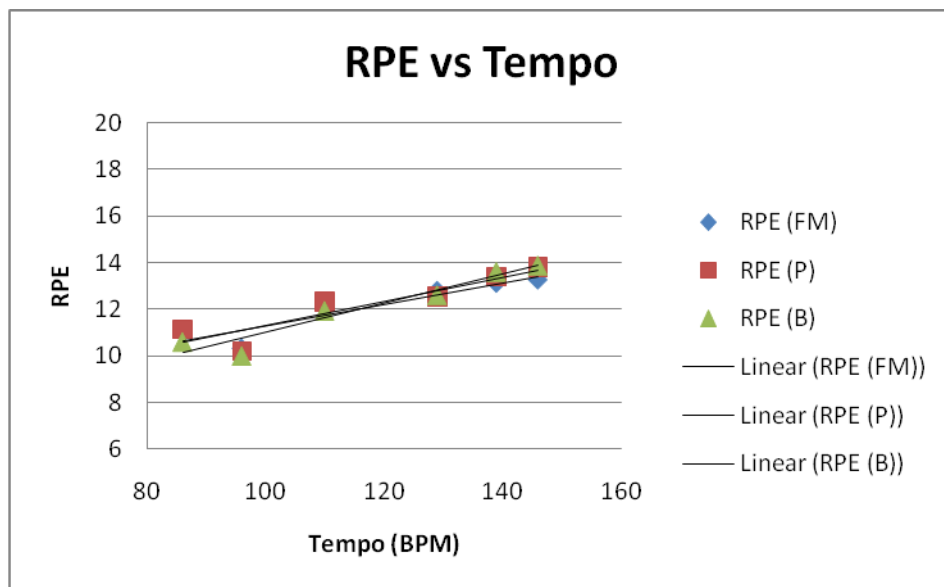


Figure 6. Relationship between average RPE for each condition and tempo.

## **DISCUSSION**

Past research has shown the effect music can have on exercise intensity (Boutcher & Trenske, 1990; Elliott et al., 2005; Gordon, 2007; Karageorghis & Terry, 1997; Karageorghis et al., 2006; Karageorghis et al., 2008; Karageorghis et al., 2009; Mertesdorf, 1994; Prieboy, 2009; Schwartzmiller, 2003). This is potentially caused by synchronization, dissociation, and mental or physical arousal (Karageorghis & Terry, 1997). There has been a strong linear relationship demonstrated between music tempo and power output (Boutcher & Trenske, 1990; Elliott et al., 2005; Gordon, 2007; Karageorghis et al., 2009; Mertesdorf, 1994; Prieboy, 2009; Schwartzmiller, 2003). Many studies similarly have shown an increase in heart rate as music tempo increases (Gordon, 2007; Karageorghis et al., 2006; Karageorghis et al., 2009; Schwartzmiller, 2003). Other studies have shown that RPE is affected by musical tempo as well (Boutcher & Trenske, 1990; Gordon, 2007; Karageorghis & Terry, 1997; Karageorghis et al., 2008; Karageorghis et al., 2009; Prieboy, 2009). All of this information has helped to enhance fitness professionals' ability to provide accurate exercise prescription and improve exercise adherence.

The present study was designed to examine the specific element of music which leads to these changes in power output, heart rate, and RPE. The results showed that there was no significant difference between the three conditions; FM, P, or B, on power output. Although the different conditions showed little change, the data was consistent with past studies in showing that power output is directly related to musical tempo

(Gordon, 2007; Karageorghis et al., 2006; Karageorghis et al., 2009; Mertesdorf, 1994; Prieboy, 2009; Schwartzmiller, 2003).

When testing the affects the different conditions had on heart rate there was a significant difference found. Full music had a greater impact on heart rate than the other two conditions. Also an increase in the music tempo resulted in an increase in heart rate, similar to that seen with power output. These findings are consistent with previous research (Gordon, 2007; Karageorghis et al., 2006; Karageorghis et al., 2009; Mertesdorf, 1994; Prieboy, 2009; Schwartzmiller, 2003). These data suggest that, in addition to the effect synchronization has on exercise intensity, the content of FM added an effect on heart rate, potentially through arousal.

Ratings of Perceived Exertion were also tested with the three conditions finding no significant differences. This shows that RPE remains at a similar level between all of the conditions. Significant differences in RPE were found when testing the change of tempo. An increase in tempo elicited an increase in RPE, which has been shown previously (Boutcher & Trenske, 1990; Gordon, 2007; Karageorghis & Terry, 1997; Karageorghis et al., 2008; Karageorghis et al., 2009; Prieboy, 2009). These findings support the overall effect of synchronization as the dominant effect of music on exercise intensity.

There were some limitations with this study. First, although the investigator attempted to control for external noise, there was no way to avoid some noise from others in the laboratory setting. Second, the 0-tempo control was not tested adequately, making it unusable for the study. In future studies of this kind, it would be advantageous to

minimize the amount of activity in the lab setting. Another positive change might be to use a less offensive (e.g. non-arousing) 0-tempo track or, if it is possible, to eliminate noise in the setting, to not use any type of track at all.

Although the hypothesis of a uniquely musical effect on exercise intensity was not fully supported, this study still provided beneficial information. It supports other research in the field stating that increases in music tempo will increase heart rate, power output, and RPE (Boutcher & Trenske, 1990; Elliott et al., 2005; Karageorghis & Terry, 1997; Karageorghis et al., 2006; Karageorghis et al, 2008; Karageorghis et al, 2009; Mertesdorf, 1994; Priebay, 2009; Schwartzmiller, 2003). It also suggests that the effect of music on exercise is intrinsically simple, synchronization with a dominant tempo in the environment.

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APPENDIX A  
INFORMED CONSENT

**Informed Consent**  
**The Effects of Music Tempo vs. Percussion**  
**vs. Beat Frequency on Exercise Intensity**

Principal Investigator: Amy Kaphingst  
550 Braund St. # 3  
Onalaska, WI 54650

Study Advisor: Dr. Carl Foster  
133 Mitchell Hall  
608-785-8687

**Purpose & Procedures**

- The purpose of this study is to find which component of music affects exercise intensity.
- You will be asked to perform an initial test on a cycle ergometer to exhaustion. During this test you will need to wear a snorkel-like mouth piece to assess breathing.
- Following this initial test, you will perform four trials on a cycle ergometer which will take approximately 60 minutes each trial. These trials will be performed at your desired speed, and you can increase or decrease the speed or work level at any time.
- The trials will be performed in the Human Performance Lab, room 225 in Mitchell Hall at the University of Wisconsin-La Crosse.

**Potential Risks**

- There are minimal risks involved in this study. Foreseeable risk may be muscle discomfort while performing the trials. The intensity of the cycling trials is your choice, so if you are feeling discomfort, you can decrease the intensity.
- Also there is a possibility of muscle soreness following the trials. There will be at least 48 hours between each trial in order to allow time for muscle recovery.

**Possible Benefits**

- You will be able to have an understanding of your exercise ability.
- Another benefit is to better the ability of fitness professionals to prescribe exercise. We will also be able to determine what part of the music is most beneficial, allowing us to use music more effectively.
- This study may become a reference for other investigators in the future.

## Rights & Confidentiality

- All personal information will be kept confidential.
  - The information collected will be kept in the lab in which the tests are done, and any names will be changed to a numbering system.
  - Your participation in this study is 100% voluntary. You are free to decline participation. You also have the right to withdraw from the study at any time. There will be no penalty if you wish to decline or withdraw from the study.
  - There will be no costs to you to participate in the study. There will also be no compensation.
- 
- If you have any questions about this study please contact the principal investigator, Amy Kaphingst at 920-470-3086 or by email at [kaphings.amy@students.uwlax.edu](mailto:kaphings.amy@students.uwlax.edu) or Dr. Carl Foster at 608-785-8687. Any questions regarding the protection of human subjects may be addressed to the UW-La Crosse Institutional Review Board for the Protection of Human Subjects at 608-785-8124 or [irb@uwlax.edu](mailto:irb@uwlax.edu).

Participant \_\_\_\_\_ Date \_\_\_\_\_

Researcher \_\_\_\_\_ Date \_\_\_\_\_



## APPENDIX B

### RATING OF PERCEIVED EXERTION

## **RATING OF PERCEIVED EXERTION SCALE**

<b>6</b>	<b>no exertion at all</b>
<b>7</b>	<b>extremely light</b>
<b>8</b>	
<b>9</b>	<b>very light</b>
<b>10</b>	
<b>11</b>	<b>light</b>
<b>12</b>	
<b>13</b>	<b>somewhat hard</b>
<b>14</b>	
<b>15</b>	<b>hard (heavy)</b>
<b>16</b>	
<b>17</b>	<b>very hard</b>
<b>18</b>	
<b>19</b>	<b>extremely hard</b>
<b>20</b>	<b>maximal exertion</b>

APPENDIX C  
REVIEW OF LITERATURE

In our society music and exercise have become common partners over the last 40 years. It began with the invention of aerobic dance in the 1970's. This combined the enjoyment of dance with more intense music to create a workout. Then in the 1980's, Rocky movies inspired us with the song "Eye of a Tiger." Even today, if going to a sporting event, it is likely one will hear this motivational song over the loud speaker before the game. In the last twenty years, portable music has been the main focus. The walkman, MP-3 players, and iPods all have their common place in a gym bag. These devices allow individuals to listen to any type of music they want while they are exercising, even outdoors. It is no wonder that all of these new gadgets sparked a lot of interest about the effects music might have on exercise.

In 1997, Karageorghis and Terry reviewed many studies done on music and exercise. From these studies they formulated three main reasons music affects exercise; dissociation, synchronization, and arousal (Karageorghis & Terry, 1997). Dissociation is when the mind focuses on an external cue, such as music, rather than focusing on internal cues, such as fatigue. Mertesdorf (1994) did a study about synchronization to music while cycling. The subjects had a preset tempo for pedaling speed in one trial, while in another trial they were in control of the music tempo with their movements. Although two-thirds preferred the movement controlled tempo, the individuals who chose the preset tempo were quoted saying they enjoyed "cycling steadily without much thinking" (Mertesdorf, 1994). Synchronization is the second and most common effect of music on exercise, and it has also been shown in many studies. Schwartzmiller (2003) found that with slow, medium, and fast tempo music that pedaling cadence changed as a result of the tempo. Karageorghis et al. did a study in 2009 on motivational synchronous music,

neutral synchronous music, and no music when walking on a treadmill. They found that with the music the subjects had an increased endurance while walking (Karageorghis et al, 2009). This shows evidence that the subjects may have used the music to influence their movement. The third effect is arousal. This can be either a physical or mental arousal to the stimulus of music during exercise. Prieboy (2009) studied the effects of three different audio variables on exercisers as well as a 0-tempo music control. She looked at self-selected music, yoga music, and a stand-up comedy act. Her results showed a lower rating of perceived exertion (RPE) with the self-selected music (Prieboy, 2009). This shows that the self-selected music may have elicited a greater effect on mental arousal than the other two variables (Prieboy, 2009). Gordon (2007) explored the differences in music tempo during chair aerobics in older adults with cardiac conditions. In her study she concluded that the increase in physiological arousal, such as increased heart rate, could have negative effects in an older population with cardiac conditions (Gordon, 2007). This shows that physiological arousal may occur with music, but it might not always be safe for all populations.

Research has shown that music can affect exercise in several ways. It is important to look further to see what affect it has on the individual exercising. Studies have been conducted to examine how music affects the body and mind of an individual. In 2003 Schwartzmiller used different tempos to find how music affected exercise intensity. He found that with slow, medium, and fast tempo music, the heart rate response corresponded with the tempos (Schwartzmiller, 2003). For example, heart rate was highest during the fast tempo music and slowest when there was a 0-tempo track (Schwartzmiller, 2003). He also saw slight increases in power output and pedaling

cadence with the faster tempos (Schwartzmiller, 2003). Johnson (2004) studied different genres of music on exercise intensity. He did trials with rock, polka, country, and no music. With these trials he found there was no significant difference in exercise intensity between genres of music (Johnson, 2004). Although he did not find different results between genres, he found that there were significant differences due to tempo (Johnson, 2004). Power output was higher in all of the tempo categories compared to no music (Johnson, 2004). Similar to Schwartzmiller, he discovered that with no music, heart rate remained lower (Johnson, 2005). With the fast tempo music there was an increase in pedaling cadence compared to the other tempos (Johnson, 2005). Copeland and Franks (1991) did a study on the effects of different types and intensities of music on exercise. They investigated the effects of slow/soft music compared to loud/fast music along with a control variable, no music. They found that heart rate was lower with the soft/slow music selections than with the fast/loud music (Copeland & Franks, 1991). Copeland and Franks (1991) also measured time to exhaustion in these trials, and they found that with the slow/soft music time to exhaustion was longer than the other variables.

Although these studies found increases in heart rate due to music, this particular physiological response is still unclear with music. Szabo, Small, and Leigh (1999) tested the hypothesis that the use of music will not increase exercise performance. They had participants perform a maximal exercise test on a cycle ergometer using different musical variables. The trials consisted of no music, classical music with a slow tempo, a fast tempo, a slow tempo which switched to fast tempo, and a fast tempo switching to slow tempo. The results showed that heart rate was not affected by the music in any of the trials (Szabo, Small, & Leigh, 1999). Heart rate was consistent between trials, but there

was a significant increase in workload with the slow to fast tempo selection (Szabo, Small, & Leigh, 1999). This shows that there may be an efficiency factor with music since the heart rate was unaffected by this increase in workload. Boutcher and Trenske (1990) investigated the effects of music, no music, and sensory deprivation on individuals during exercise. They found that heart rate was similar during all three trials (Boutcher & Trenske, 1990). Tenenbaum and colleagues (2004) studied the effects of music on running at high intensities. They tested this on an indoor treadmill and on an outdoor course with three types of music as well as a trial without music. The three different genres of music used were dance, rock, and inspirational. In this study they found music had no affect on the heart rate of the individual either running indoors or outdoors (Tenenbaum et al, 2004). However, they did find that with the inspirational music running time was increased by a large amount (Tenenbaum et al, 2004). Also results showed with the dance music subjects finished significantly faster than without music (Tenenbaum et al, 2004). Prieboy found in her 2009 study of self-selected music, yoga music, and stand-up comedy that there were no significant changes in heart rate between variables. A study on indoor cycling with variations in music and lighting was done by Shaulov and Lufi in 2009. They found that with or without music, heart rate did not differ significantly (Shaulov & Lufi, 2009).

These studies may not have shown effects on heart rate due to music, but there still seems to be a preference to listening to music during exercise. Karageorghis et al. (2006) studied the relationship between heart rate and the preferred tempo of exercise music in individuals. They looked at 40%, 60%, and 75% of the maximum heart rate reserve of their subjects while listening to slow, medium, and fast tempo music. The

results showed that with all intensities medium and fast music was the preferred tempo (Karageorghis et al, 2006). In 2008 Karageorghis et al. did another study on tempo preference during exercise. They used medium and fast tempo music and a combination of the two while the participants walked at 70% of their maximum heart rate. They found that there was a preference for the medium tempo music compared with the fast and mixed tempo conditions (Karageorghis et al, 2008). Szabo, Small, and Leigh (1999) investigated the effects of different tempos with exercise as well as changes between tempos during exercise. They found in their study that heart rate was unchanged with music of varying tempos (Szabo, Small, & Leigh, 1999). Even though heart rate was unaffected between trials, the subjects reported preference to the slow to fast tempo as well as the fast tempo (Szabo, Small, & Leigh, 1999). These studies show the reasons music is preferred may not be a direct link to the physical changes it creates but possibly the mental.

Music can affect exercise intensity by altering how the mind perceives it, and also possibly by affect mood, either in a positive or negative way. Boutcher and Trenske (1990) tested the effects of music, sensory deprivation, in which the subjects wore earplugs and goggles, and no music on exercise intensity in cycling. They used low (60% of maximal heart rate), moderate (75% of maximal heart rate), and hard (85% of maximal heart rate) intensities with each of the variables. The trials began at the low intensity and increase to hard by the end. The results showed that RPE was lower with the music than with the deprivation in low intensity exercise (Boutcher & Trenske, 1990). Also it was found that at moderate intensity music elicited a lower RPE than with the control of no music (Boutcher & Trenske, 1990). They also used a ten point scale to



evaluate mood or the affect of music during each stage of the trial. This showed that with the music compared to the control, subjects had a greater level of affect, or elicited a better mood, during the moderate and hard portions of the trials (Boutcher & Trenske, 1990). Shaulov and Lufi (2009) studied the effects of music and lighting on indoor cycling. They composed a questionnaire to assess satisfaction and feelings about activity, which subjects took after the cycling session. The results of the questionnaire found the participants received more pleasure during exercise with music than without (Shaulov & Lufi, 2009). Also the subjects reported feeling less tired after the sessions with the music compared to those without music (Shaulov & Lufi, 2009). Prieboy (2009) studied the effects of self-selected music compared to yoga and stand-up comedy on exercise intensity and RPE. She found that with the self-selected music RPE was lower than with the other trials (Prieboy, 2009). She also found that with the yoga music and stand-up comedy RPE had occasionally lower RPE results compared to the 0-tempo selection (Prieboy, 2009). This may be due to dissociation or arousal factors of auditory stimulation, but without the familiarity of the self-selected tracks the RPE fluctuated.

Several other studies examined RPE and affect with music during exercise, but they found slightly different results. Elliott et al. (2005) studied the effects of music during sub-maximal testing. They had participants do each test on a cycle ergometer with motivational music, neutral music, and without music. They found with music the subjects reported a higher RPE than without music after eight minutes of riding (Elliott et al, 2005). Although they found an increase in RPE, this did not affect subjects' mood. Subjects indicated during the trials that with both music variables they had a better level of affect than with no music (Elliott et al, 2005). Karageorghis and colleagues (2009)

studied music and exercise, by examining the psychological and ergogenic effects music has on exercise. The subjects walked on a treadmill under three conditions; motivational music, neutral music, and without music. They found that RPE was unaffected by the music, but they discovered that mood changed (Karageorghis et al, 2009). They found that affect was greater in the trial with the motivational music compared to the no music trial (Karageorghis et al, 2009). So although the music did not alter the perception of exercise, it increased mood during the exercise. Tenenbaum et al. (2004) had subjects perform running trials, both indoors and outdoors, with and without music. The subjects listened to different genres for each trial; rock, inspirational, and dance. The fourth condition was without music. They found that RPE did not change as a result of the music (Tenenbaum et al, 2004).

Music and exercise seem to be closely linked in many ways. Research has identified that music causes distractions while exercising, it allows people to move in time with the beat, and it arouses both mental and physical responses. Although some results are still inconclusive, there seems to be a positive reaction to music during exercise. In many cases it has been shown to increase power output or workload during exercise bouts. Johnson (2004) arrived at the conclusion that an increase in power output was not dependent on the genre of music used. His findings of increase power output seem to be consistent with other findings. The effects on heart rate are still being determined, but most studies have not indicated negative results to heart rate with music. Gordon (2007) did note that an increase in heart rate with music may impact individuals with cardiac disease. This is important to consider when using music during exercise for such populations. Music also has a strong influence on the psychological factors of

exercise. Studies have observed that exercise is perceived differently with music. Boutcher and Trenske (1990) concluded that at low and moderate intensities, music reduced RPE significantly compared to sensory deprivation and no music. This shows that people may feel they are not working as hard during exercise, which may encourage more adherences to an exercise routine. Also with a lower RPE, people may have a better mood during exercise. Shaulov and Lufi (2009) found that their subjects thought exercise was more pleasurable, and they felt less tired with music than without music during exercise. If exercise is enjoyable it may inspire more people to exercise more frequently. With each study we are closer to determining exactly how music can affect exercise. There are still more questions to be answered, but overall the results have shown how effective music can be on exercise intensity.

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