THE EFFECTS OF MUSIC GENRE ON SPONTANEOUS
EXERCISE AND ENJOYMENT

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ABSTRACT

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Musical tempo has been shown to have an effect on spontaneous exercise performance. As the music tempo increases, so does the intensity of the exercise. Is the tempo of the music the deciding factor, or is it the type of music? The effect of 3 music genres (Rock, Country, and Polka) were evaluated during 3 exercise bouts using a standard music tempo progression protocol. Nine apparently healthy adults (18-53 yr) who exercised regularly participated in 4 exercise bouts (Rock, Country, Polka, and No Music) on a cycle-ergometer equipped with a wind resistance unit attached to the rear of the bicycle and a computer mounted in the crank arm (SRM Training System) to record power output (W), heart rate (HR), cadence (RPM), and rating of perceived exertion (RPE) during the exercise bouts. Subjects were instructed to ride as they would normally with full control over the gearing of the bicycle. After each bout, subjects completed the Physical Activity Enjoyment Scale (PACES) to determine the enjoyment level of the exercise. No significant differences ($p < .05$) were found amongst music genres with the exception of more subjects preferring the Rock music to Polka music. Not even the preferred music genre elicited any significance during the exercise bout. Tempo appeared to be the driving force behind W, HR, RPM, and RPE ($p < .05$). Musical preference had no effect on the exercise bouts. When considering what type of music to use during exercise, it appears that any music is better than no music regardless of musical preference.

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THESIS FINAL ORAL DEFENSE FORM

Candidate Victor Johnson

We recommend acceptance of this thesis in partial fulfillment of this candidate's requirements for the degree:

Master of Science in Adult Fitness/Cardiac Rehabilitation

The candidate has successfully completed the thesis final oral defense.

Signature of Thesis Chairperson	ESS Department	4/15/04 Date
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Lev livet ditt, å være.

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INTRODUCTION

Today's health and fitness facilities resemble the audio/visual departments of certain electronics retailers: televisions hanging from the ceiling, high-end audio equipment strung throughout the building, and even personal audio hook-ups on the cardio machines. These techno-tools act as distracters from exercise. A distracter is a form of stimulation meant to avert one's attention from the effects of exercise. The distracter can be visual, audio, or a combination of the two. Health and fitness facilities around the country use distracters for many different reasons: member retention, to avoid boredom, or to have a positive affect on the members as they exercise.

Music seems to be the "distracter of choice" for a majority of people. Considering the technological advances in the recent years, music is not only the most convenient form of distraction; it is also the easiest to manipulate to suit individual tastes. Computers have helped people listen to music in ways that were not possible in the past. In the last couple of years, the MP3-playlist has replaced the old workout cassette tapes, CDs, and broadcast radio. People can download whatever music they wish from the Internet in MP3 form and either input the files into a personal MP3-player or create their own CD with the help of computer hardware. MP3 technology has allowed people to manipulate arrangements of music according to their moods or emotions.

Although personal MP3-players are relatively inexpensive and easy to use, not everyone has the luxury of being able to provide their own soundtrack of music to use while exercising. These people are obliged to use the distracter the health and fitness facility provides. Why is it important that the health and fitness facilities actively acknowledge the music preferences of its members? Simply stated, music can affect exercise performance.

Music can affect the performance of skills, attitudes, and contribute to the manipulation of certain physiologic responses during exercise. The type, or genre, of music can influence the listener to engage in active biofeedback. Even the volume of the music can be a factor when considering the effects of music on exercise.

The level of arousal is the primary focus when considering the effects of music on exercise; more specifically on skill performance. Different types of music have had a demonstrated effect during a test of physical strength (1). Grip strength was tested after listening to three different types of auditory stimulation: stimulative (Led Zeppelin's "Rock and Roll"), sedative (Michael Columbier's "Emanuel"), and silence. Grip strength was significantly lower while listening to the sedative music or silence. This would suggest that strength performance is negatively influenced by sedative music. If someone were to listen to classical music in the weight room, they would not perform at their maximum levels due to the relaxing effects of the sedative music. If, however, they were listening to their favorite music, greater gains could be made (2). Music has also had an effect when considering the performance of a combination of movements, a kata, in karate. Ferguson, Carbonneau, and Chambliss (3) had subjects with varying experience perform a selected kata after listening to different types of music. The music was classified as "positive," "negative," and white noise (ambient sounds). The trials, scored by two karate judges, were higher when the subjects had listened to both "positive" and "negative" music compared to the white noise. Music had a calming effect on the subjects before the trials and lowered their levels of arousal by making them more comfortable and relaxed. Another skill performance, dart throwing, showed no significant differences in performance related to music (4). Cycling, however, seems to be the activity most influenced by music. Schwartzmiller, et al (5) observed that while listening to tempo-controlled music, subjects spontaneously cycled at different power-outputs according to the tempo of the music. As the music tempo increased, the intensity of exercise increased. It seems that the music's tempo influenced the subjects' arousal level and that increase is reflected in the increased intensity of spontaneous cycling.

Yet another psychological aspect of exercise in which music has an influence is that of attitude toward exercise. Music can lower the arousal level of people preparing to perform a skill by relaxing them and making them feel more comfortable (3). By feeling more relaxed and comfortable, people may perform with more concentration on the skill itself rather than the end score. Gfeller (6) discovered that music played a vital role in the attitudes of participants in an aerobic class with 97% of those surveyed indicating that music made a difference in class performance. Style, tempo, rhythm, and extramusical associations (external emotions not directly related to the music) were listed as important factors in how well the music influenced the class' performance. The survey also reflected that 97% of the class thought music improves attitude toward activity. Gfeller stated: "Musical taste should be a primary consideration when selecting music for aerobic activities" (p 42), meaning musical preference may play a role in the attitudes of exercisers. In addition to music improving the attitudes of aerobic exercisers, weight lifters have also remarked about the positive effect music had during their workout (2). If the right music can improve attitude toward exercise, would the wrong music turn people away from exercise?

Music is supposed to take one's mind off of the main task at hand while exercising. That is the purpose of a distracter. But, how well does music accomplish this task? Two studies have found significant differences in ratings of perceived exertion (RPE) when exercising with music. The idea of exercising with music is that the exerciser will focus more on the music than on the sensations of exercise (sweating, fatigue, etc.). Lower RPE ratings were found by Boutcher and Trenske (7) when they experimented with sensory deprivation and exercise. Subjects were tested three different times with two different sensory stimulations: music and sensory-deprived, with a control group (no added or subtracted stimulus). The sensory-deprived test required the subject to exercise while blindfolded on a cycle ergometer with cotton balls in their ears. The RPE was lower with music compared to sensory-deprived exercise. This would reflect how well the music distracter actually works. It appears that the music diverted focus from the exercise-sensation to the music itself. During sensory deprivation, the subjects had nothing but the sensations of exercise to focus on, so it is reasonable that RPE would be higher. Boutcher and Trenske also observed significantly lower RPE scores with sensory-deprived exercise compared to the control group. The tempo and volume of the music was reported to have had a significant effect on RPE scores during exercise (8). Subjects exercised on a treadmill with two different types of music: loud, fast, exciting popular music (Type A) and soft, slow, easy-listening popular music (Type B), with a control of No Music. Lower RPE scores were reported for the Type B music. The findings seem to support the idea that music distracts an exerciser from the sensations of exercise on the body. Both of these studies (7, 8) used music that the exercisers preferred. What would have happened to the RPE had the experimenters chosen music the exercisers had not preferred?

The concept of biofeedback, using outside sensory stimulation to control involuntary body functions, was created with music in mind. Ellis and Brighouse (9) discovered that after the onset of music, respiratory rate (RR) increased 5-10% while lying down. Respiratory rate returned to normal levels when the music was stopped. While the RR increased during music, the logical conclusion would be that heart rate would also have been affected. According to biofeedback, the heart rate could be controlled using an outside stimulus such as lights flashing, physical contact (prodding), or music with the desired tempo. This is not the way the heart reacts to music. Studies have shown no significant differences in heart rates and exercising with or without music (1-4, 6-10). One study that did observe a significant difference (5) attributed the difference to lower heart rates in the beginning stages of testing due to short warm-up period. Another study (11) noted that heart rate changed with music while exercising, but the results were not statistically significant.

The idea that music affects exercise has not changed for decades. The types of music used in various studies have changed, however. All types, or genres, of music (classical, rock, jazz, instrumental, popular, new wave) and white-noises have been used. Studies chose the music according to the subjects' preferences or the experimenters' preferences. In most cases, the subjects enjoyed the music. What if the subjects were forced to listen to music they did not prefer or found to be obnoxious or annoying? The previously mentioned studies did not address this facet of the effect of music on exercise.

The purpose of this study is to determine if music genre has a direct effect on spontaneous exercise and enjoyability. Due to the fact that people tend to prefer one type of music over another, the hypothesis that the more preferred music will yield a lower RPE, higher power output, and higher enjoyment scores during exercise will be tested in this study.

METHODS

A sample of nine apparently healthy, active individuals volunteered and served as subjects for this study. The descriptive characteristics of the subjects are presented in Table 1. All subjects provided informed consent prior to participation (see Appendix A). The protocol was approved by the Institutional Review Board for the Protection of Human Subjects at the University of Wisconsin-La Crosse.

Table 1. Descriptive Statistics of the Subjects.

Subjects	Age	Height (in)	Weight (kg)	VO_{2peak} ($ml*min^{-1}*kg^{-1}$)
5 Female	27.8 $\pm$ 9.0	64..8 $\pm$ 3.6	60.2 $\pm$ 2.5	41.6 $\pm$ 9.3
4 Male	31.2 $\pm$ 13.2	69.0 $\pm$ 0	75.7 $\pm$ 4.3	53.0 $\pm$ 9.5

The subjects completed a maximal exercise test on an electronically braked cycle-ergometer to document maximum exercise levels and to habituate the subjects to the laboratory. The cycle-ergometer used during the experimental exercise bouts was equipped with a wind resistance unit attached to the rear of the bicycle. This allowed subjects to exercise at their own pace with full control of pedaling cadence and gearing. A strain gauge built into the chain ring (SRM Training System Science PM 353; Schoberer Rad Meßtechnik, Germany) allowed continuous measurement of power output.

Testing Protocol

The subjects were required to complete four randomly ordered exercise bouts (Country music, Rock music, Polka music, No Music) on a wind resisted cycle each lasting approximately one hour. The trials started with the subjects positioning themselves on the cycle and being given a personal audio device to listen to the selected music genre for the exercise bout. The subject had a warm-up period of approximately five minutes. The music was matched for tempo (5). The music was played on a commercially available CD-player with headphones which the subject used for the duration of the cycling bout. Volume could be adjusted by the subject throughout the exercise bout.

The rating of perceived exertion (RPE), heart rate (HR), and power-output were averaged during the last 30 seconds of each song for each of the three musical trials and at two-and-half minute intervals during the No Music trial. After each trial was completed, the subject completed the Physical Activity Enjoyment Scale (PACES) (12) (see Appendix B). The Music Survey (see Appendix C) was completed by all subjects following the final trial to determine the preferred music genre.

Statistical Analysis

Statistical analysis was performed using repeated measures ANOVA to test the hypothesis that music genre in addition to tempo has an effect on spontaneous exercise (α = .05).

RESULTS

There was a significant difference ($p < .05$) in tempo, heart rate, RPM, RPE, and PACES scores between the exercise bouts. Data were analyzed using the mean values of the last 30 seconds of each of the 15 tracks during each music selection and the last 30 seconds of a 3-minute interval during the control period (the control period lasted 45 minutes).

Figures 1-4 illustrate the effects of each music genre, as well as control (No Music), on power output, heart rate, RPM, and RPE. The tempo ranges are as follows: 0, no tempo; 1, <100 bpm; 2, 100-129 bpm; 3, >130 bpm.

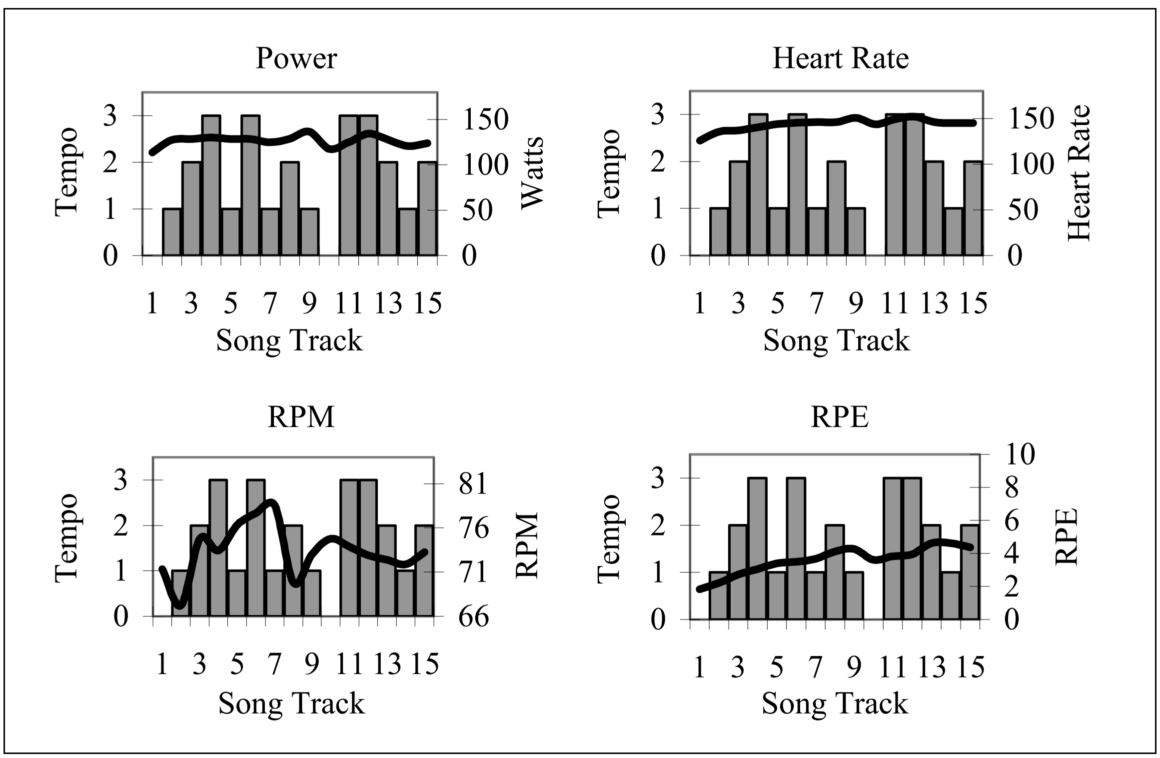

Figure 1. Power Output, Heart Tate, RPM, and RPE Responses to Polka music.

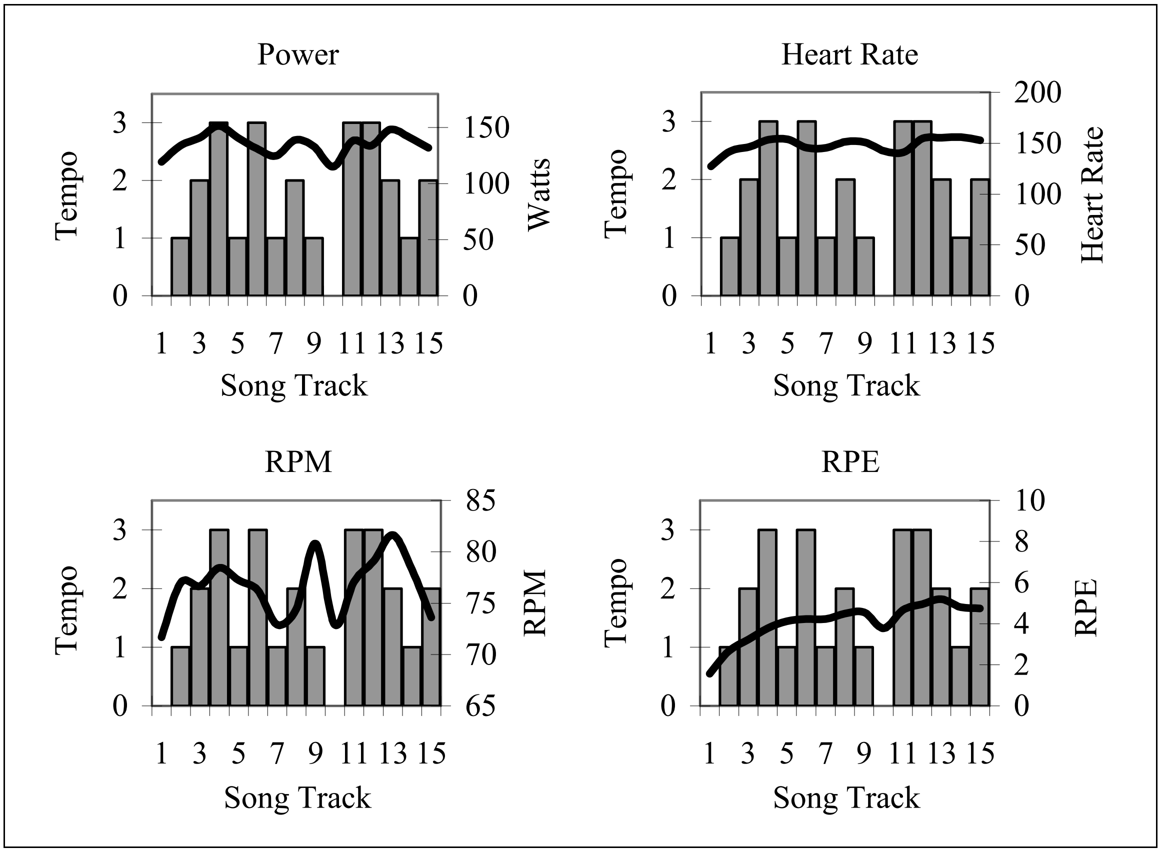

Figure 2. Power Output, Heart Tate, RPM, and RPE Responses to Rock music.

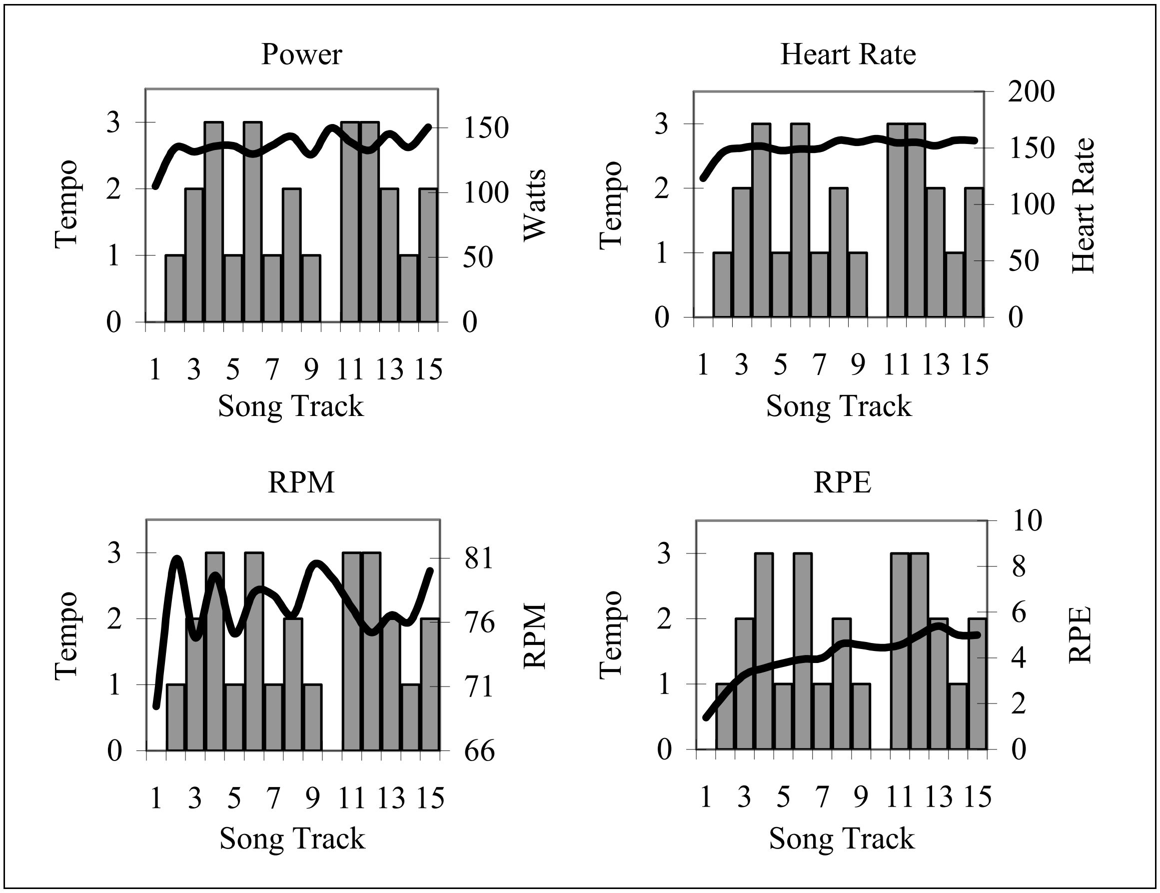

Figure 3. Power Output, Heart Tate, RPM, and RPE Responses Country music.

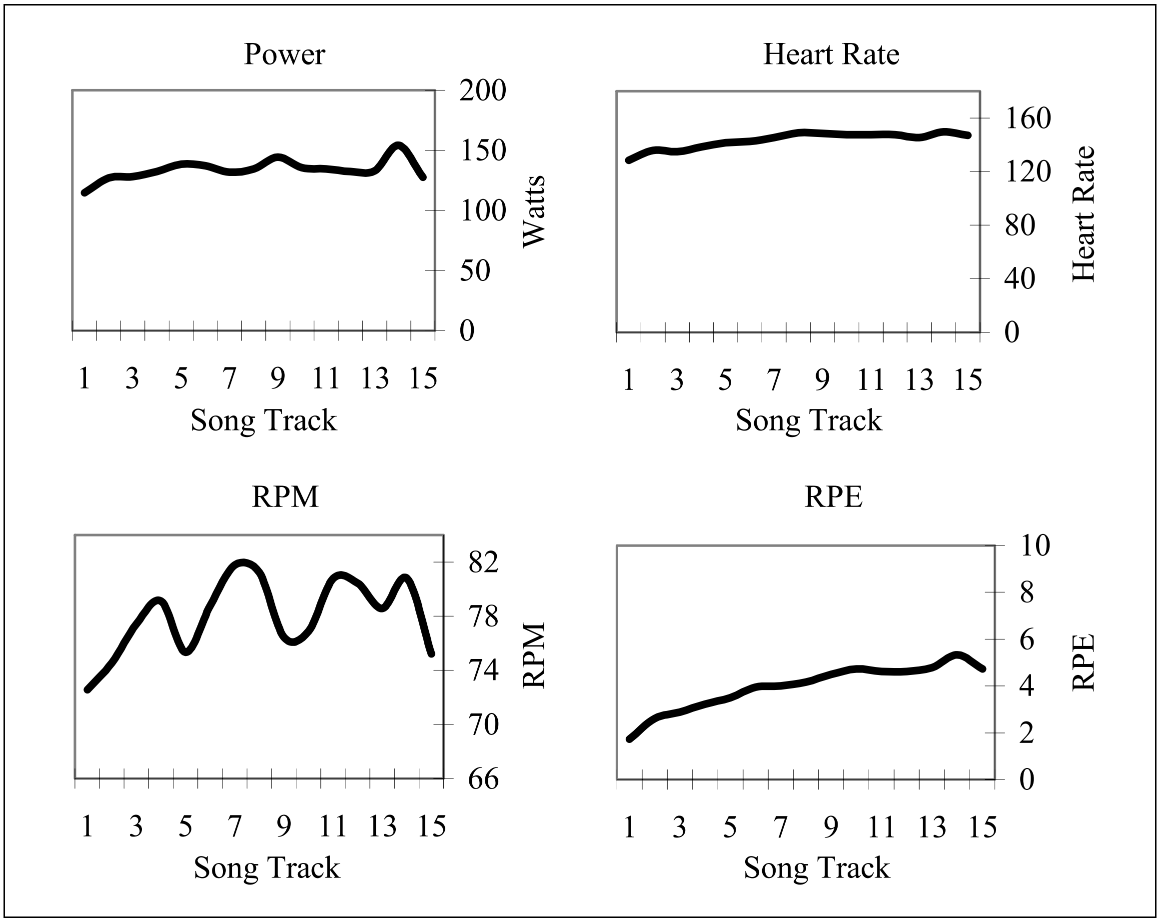

Figure 4. Power Output, Heart Tate, RPM, and RPE Responses to No music.

After all four of the exercises had been completed, all subjects completed The Music Survey (see Appendix C) which revealed the music genre they preferred over the others. Figure 5 illustrates the effects of the preferred music genre.

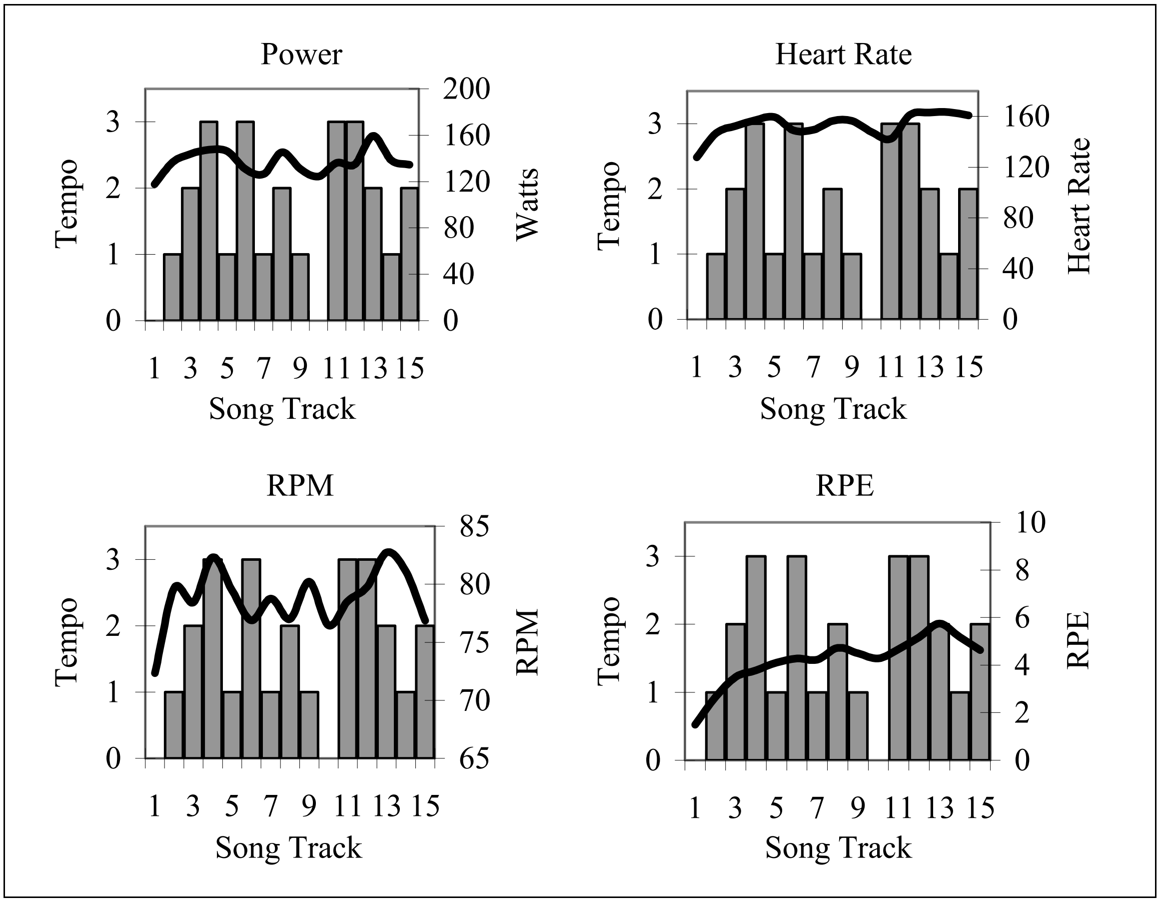

Figure 5. Power Output, Heart Tate, RPM, and RPE Responses to Preferred music.

Repeated measures ANOVA revealed a significant difference ($p < .05$) in power output between the white noise (WN) and the slow (ST), medium (MT), and fast (FT) music tempos. Power output was lower in WN than in ST, MT, and FT. There were no statistically significant differences in power output between the three music genres and the preferred music genre. A comparison of power output during each music genre is presented in Figure 6.

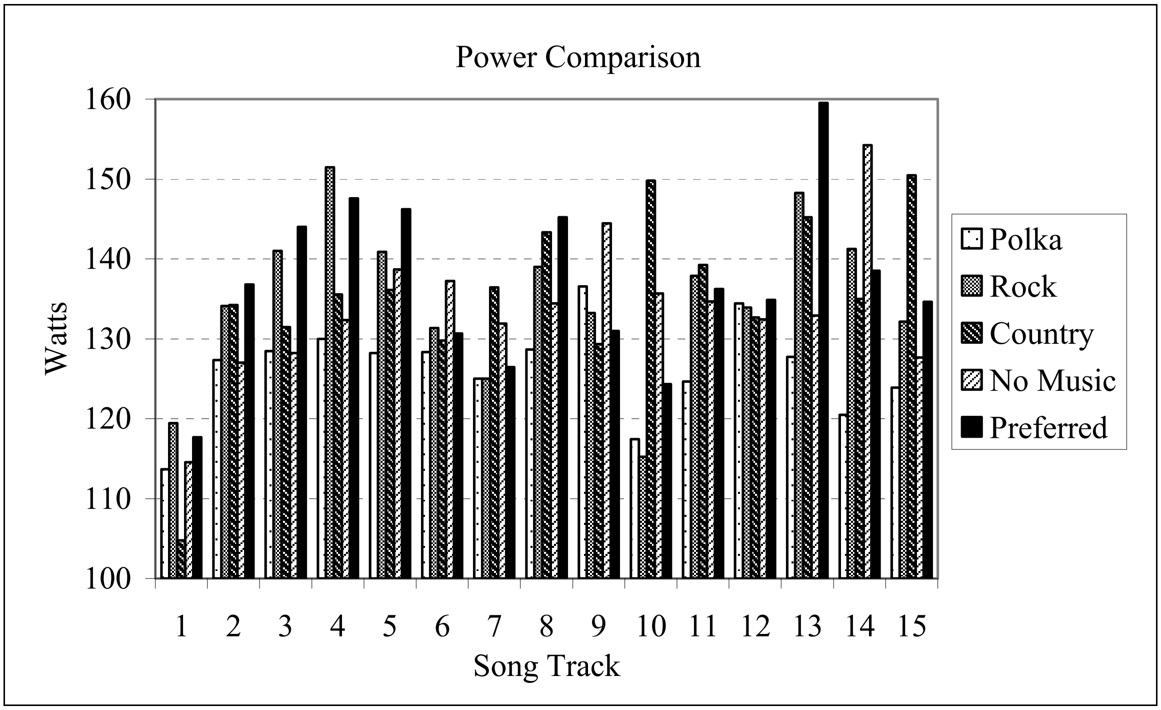

Figure 6. Power Output vs Genre.

Statistically significant differences (p < .05) were found in heart rate response among the four musical tempos. Heart rate during WN was lower than ST and MT. Again, statistically significant differences were not found between music genres, only between musical tempo. The response of power output to music genre is illustrated in Figure 7.

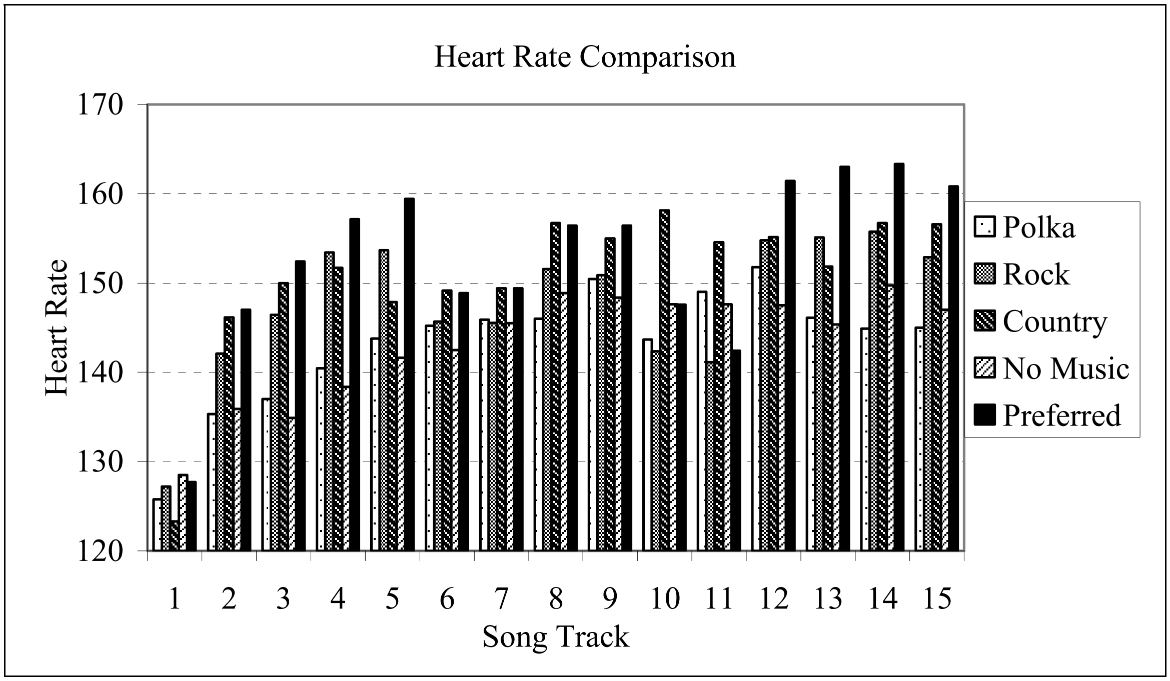

Figure 7. Heart Rate vs Genre.

Faster pedaling rates (RPM) were recorded during FT when compared with the other three tempos ($p < .05$). The pedaling rate recorded during ST was also statistically significantly different than WN. Although significant differences were found between tempos, there were no significant differences in pedaling rate between genres (see Figure 8).

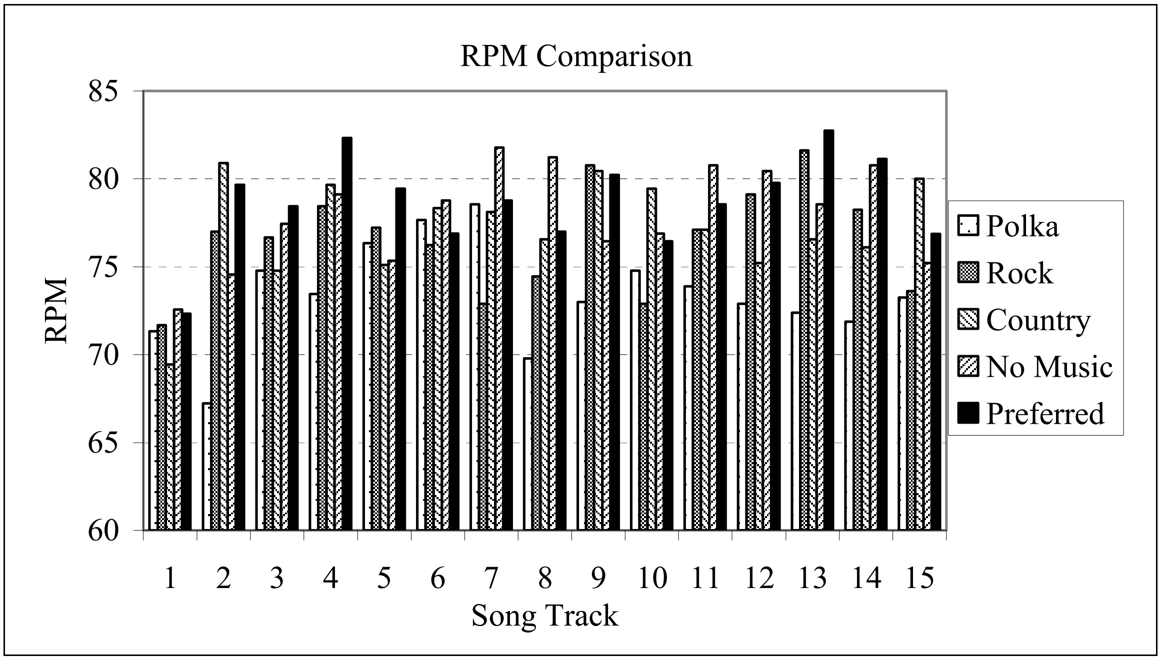

Figure 8. RPM vs Genre.

The tempo of music had a significant effect on RPE ($p < .05$). The RPE recorded during WN was lower than during the other three tempos. MT and FT elicited higher RPE compared to ST and WN. Figure 9 demonstrates the lack of significant difference between RPE and music genre.

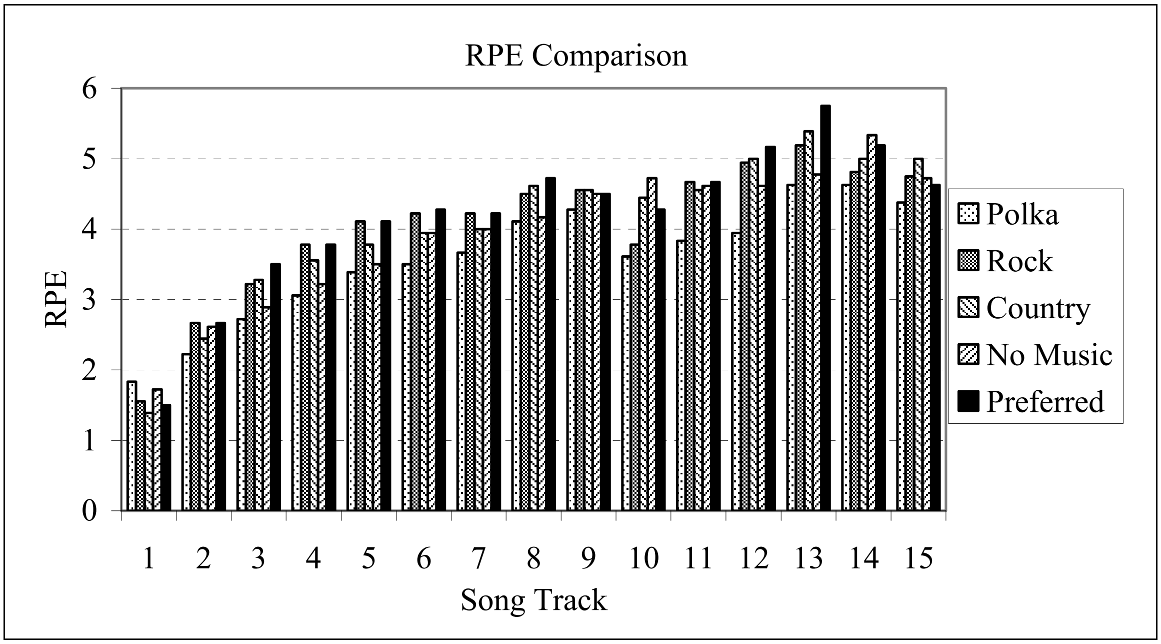

Figure 9. RPE vs Genre.

All significant differences occurred between tempos. Figure 10 demonstrates the significant effects of tempo on exercise whereas Figure 11 demonstrates the lack of significant effect of music genre on exercise ($p < .05$).

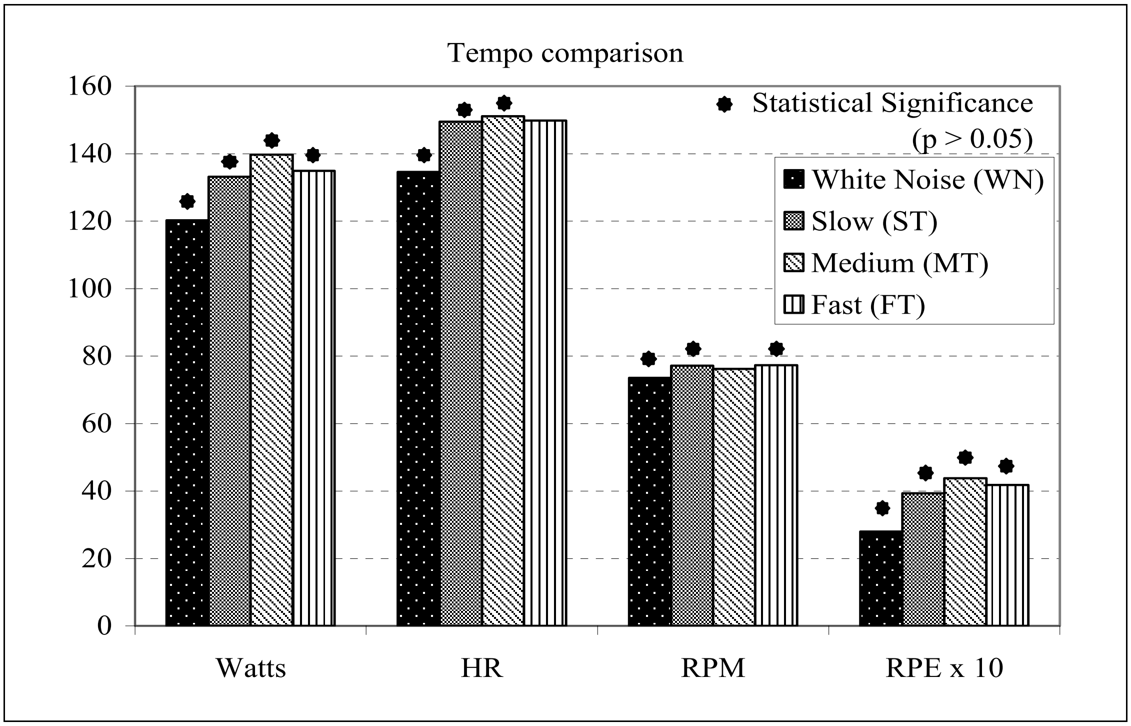

Figure 10. Significance Summary for Music Tempo Effects.

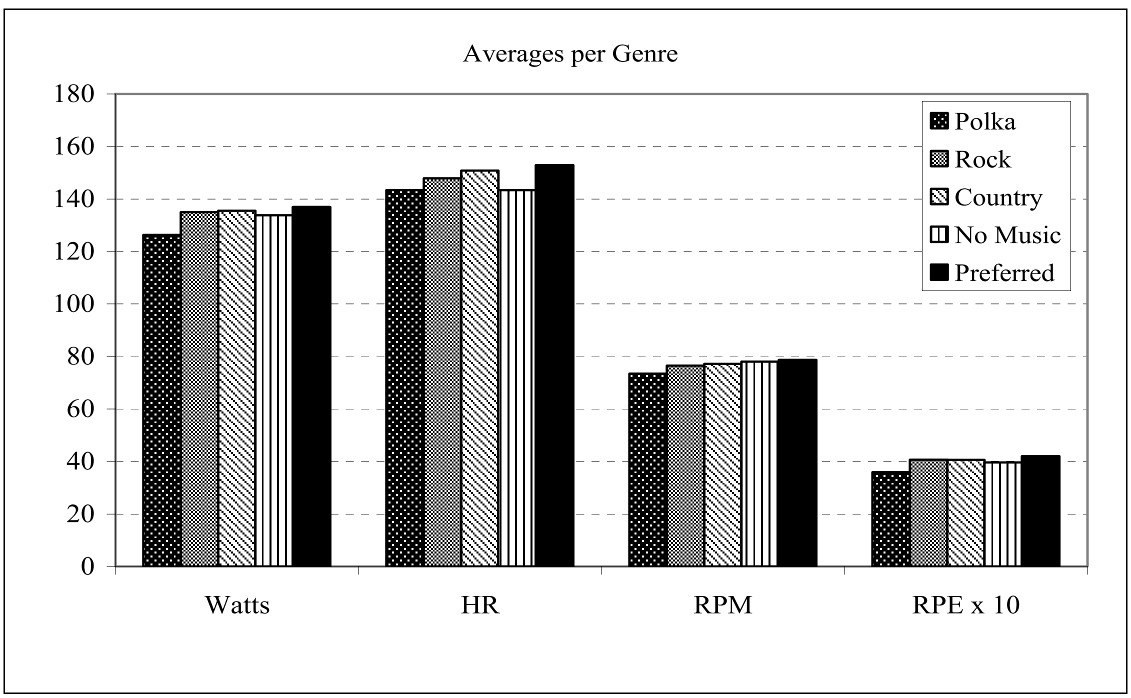

Figure 11. Significance Summary for Music Genre Effects.

Each subject's (N = 9) responses to all three genres in regard to tempo are represented by Figure 12. A polynomial trendline was used to understand the differences between subjects (height, weight, gender, age, and fitness levels).

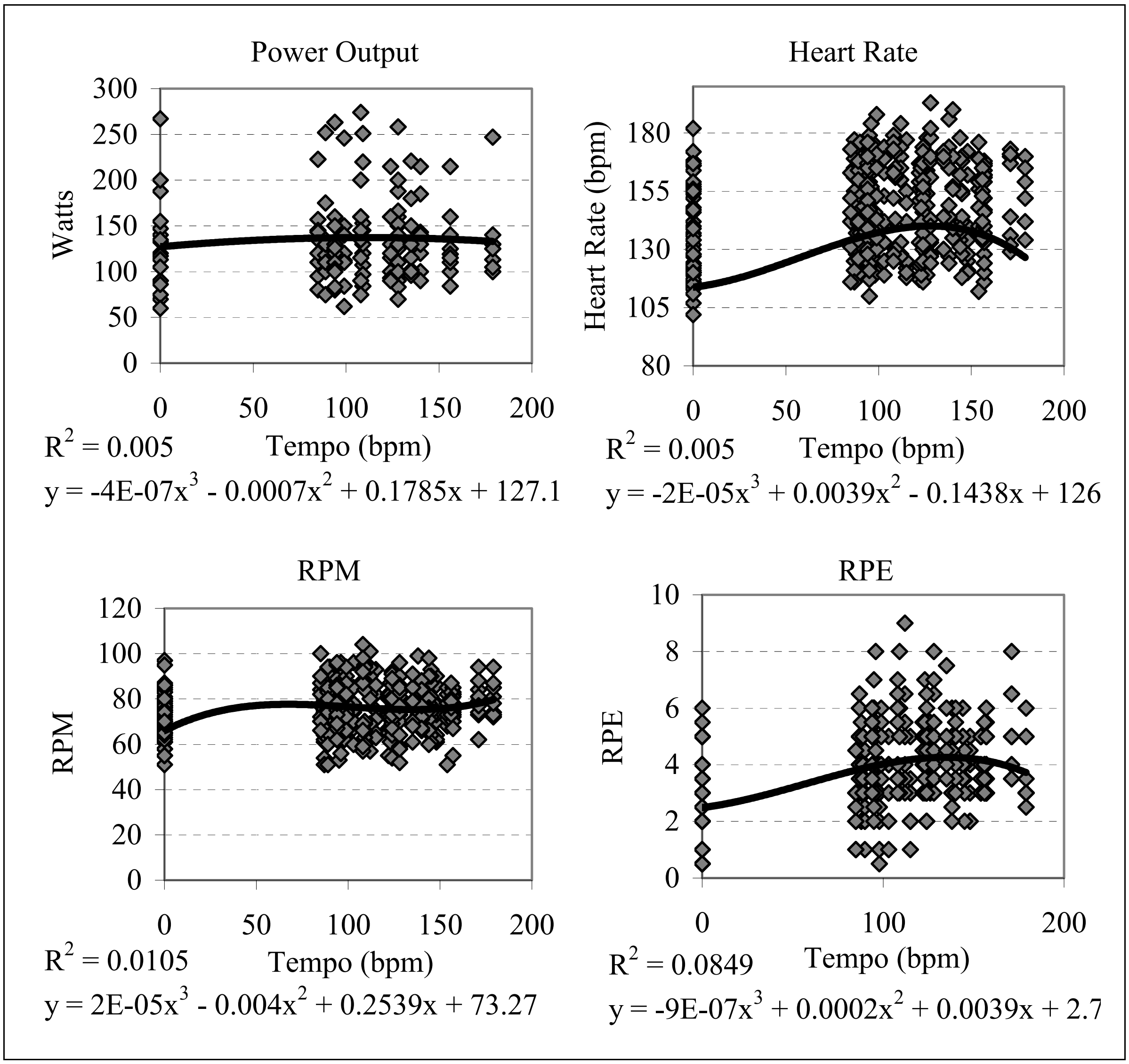

Figure 12. Individual Response to Tempo.

The only significant difference ($p < .05$) found among music genre were the PACES results. The subjects enjoyed their preferred music genre more than the Polka exercise session. Figure 13 demonstrates the PACES results.

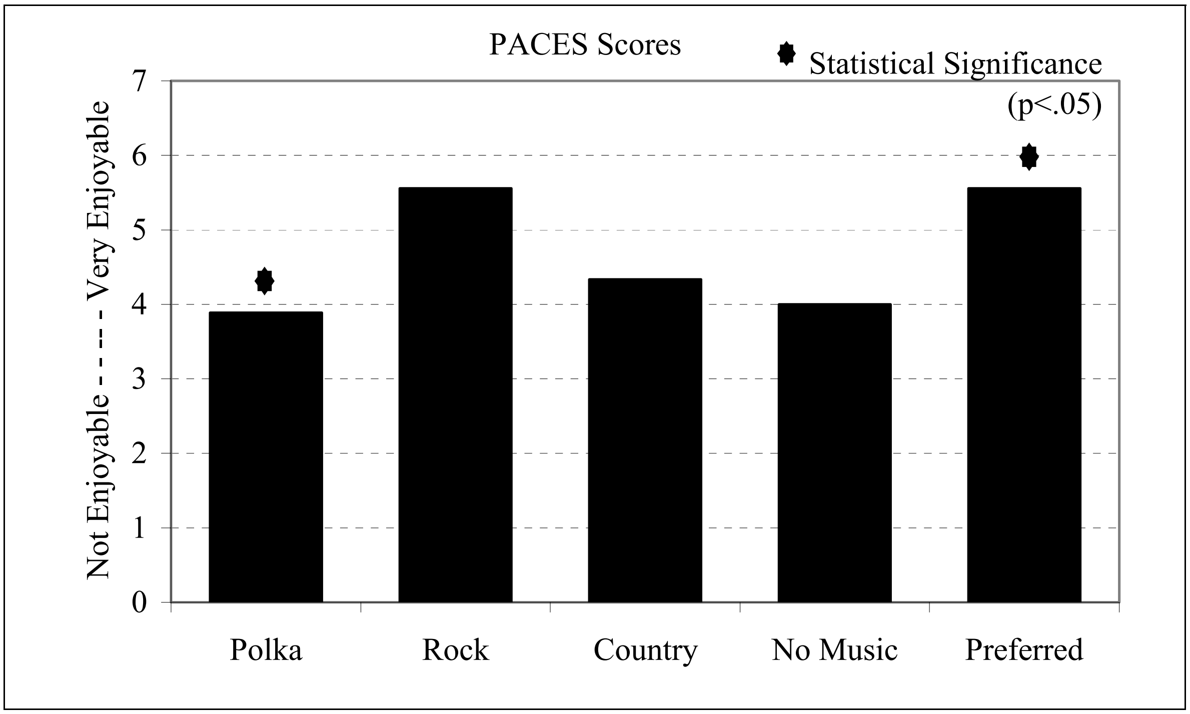

Figure 13. Results of PACES.

DISCUSSION

The purpose of this study was to determine if music genre, as well as musical tempo (5), affected spontaneous exercise and enjoyment. The analysis suggests that music genre does not have an effect on exercise, but musical tempo has a small, but significant, effect.

According to the data, exercising to any type of music elicits a more intense workout than not having any music at all (3). Although there were no significant differences between the music genres and the control condition, there were many differences between the tempos of music (ST, MT, FT) and that of the nonmusical tempo (WN). Perhaps the anticipation of the music that would eventually be played magnified the intensity of the nonmusical tempo. During the exercise bout, power output during song 10 (WN) decreased. This would suggest that a particular song track signified a break in the music and signaled the subject it was time to reduce power output. The subject anticipated the return of the music and reacted accordingly. During the control (No Music) exercise bout, the subject had no music and knew there would be no music, resulting in an exercise bout with little deviation in power output. The preferred music genre, although not significantly different, stimulated the subjects to work harder, thus increasing their power output (1, 2).

Sensations, memories, or habits, known as extramusical associations, can be developed using certain types of music. Two of the subjects in this study were aerobic cycling instructors and commented many times on the ease or difficulty of trying to “spin” with the music. It is as a result of these associations that musical preference was thought to have an effect on exercise (6). Extramusical associations could be the reason why one type of music is preferred over another type of music. These associations could also lead to a like or dislike of an activity. The Physical Activity Enjoyment Scale (PACES) was developed to quantify the enjoyment of exercise and activity (12). PACES scores were the highest for the preferred music genre, which is to be expected. This higher score could reflect the attitude of the subject during the exercise and, therefore, explain why power output was higher during the preferred music exercise bout than any of the other bouts on an individual basis (although not statistically significant).

The use of music during exercise is to distract the exerciser from the effects of exercise (fatigue, sweating, etc.). If the music were doing its job, a lower RPE would be the result (the person exercising would pay more attention to the music than to the effects of exercise) (7). The data suggests that the more preferred the music genre, the higher the RPE. This could be due to the higher power output obtained during the preferred music bout or to the familiarity of the RPE scale to the subject. It could also be due to an increase in the general arousal level by the presence of music. The Polka bout had the lowest average RPE rating among the exercise bouts along with the lowest power output and lowest PACES results. Significant differences were found between tempos of music, when considering RPE, due to the progression of song tempos (5) and the associated increase in power output.

The differences found in heart rates among the tempos of music can also be explained by the increase in power output. Since there were no significant differences between the genres in power output, it would be difficult to find any differences in heart rate considering the physiologic effects of exercise. Many other studies have found no significant differences in heart rate response to music (1, 2, 3, 7, 8, 9, 10, 11). Perhaps the heart rate response to music could be better identified by analyzing the effect of entrainment on subjects as they exercise (5).

The entrainment theory attempts to explain why RPMs during an exercise bout increase with an increasing tempo of music. Perhaps people will modify their cadence so as to always be in the same position, or variation thereof, on the down beat of the music. If this were to occur, there would be good correlation between RPM and musical tempo (bpm) (5). There does not appear to be any clear manner of entrainment when considering the tempo of the music and RPM in this study. Polka music was selected to test for this entrainment pattern. Polka has a definite dance beat which the subjects could easily identify and was the only exercise bout that followed the pattern of the entrainment theory. Figure 1 illustrates that as the tempo of the music increases or decreases, so does the RPM (with the exception of song 8) during the Polka music exercise bout. Rock and Country music do not follow this entrainment pattern (see Figures 2-3). Perhaps the familiarity of the music to the listener contains the necessary extramusical associations that elicit the pattern of entrainment (5).

When analyzing the results of the exercise bout during the preferred music genre, no differences in any of the monitored effects of exercise were evident. If, however, the subjects were given the option of exercising as long as they would like, there may be a different result in exercise duration when compared to the other genres (13).

If the subjects were allowed to supply their own music, a higher power output with some sort of entrainment could be expected (5). Considering most audio distracters available at fitness and health clubs do not allow for such personal customizing of music, the subjects were not allowed to bring in their own music for this study. This study was to examine the effects of musical preference if the subject did not have a choice. Further investigation is needed to determine if customizable music has an effect on exercise when compared to prepackaged music (8).

Familiarity of the songs selected for each genre could have had an effect on the results of this study. Subjects not from the United States could be hearing some or most of the music for the first time and not have developed any associations with the music. Research into the training of extramusical associations and the impact on exercise could reveal interesting results. Another deleterious effect the song selection may have had on this study was the variability of length of each song. The longest song for the Polka music exercise bout was just longer than 3-minutes; the shortest was just under 2-minutes. Perhaps this is not long enough to elicit a physiologic response in contrast to Rock music (5:31 and 3:07).

In summary, music genre does not seem to have an effect on the intensity of a spontaneous exercise bout. Tempo seems to be the dominant force behind an increase or decrease in intensity (5). The deciding factor, however, could be the extramusical associations that people have with differing styles of music or the anticipation of the onset of music during an exercise bout.

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APPENDIX A

INFORMED CONSENT

INFORMED CONSENT FORM FOR
THE EFFECTS OF MUSIC GENRE ON SPONTANEOUS
EXERCISE AND ENJOYMENT

I, ____________________________________, volunteer to participate in a research study conducted at the University of Wisconsin-La Crosse. I have been informed that the purpose of the study is to compare the effect of different styles of music on exercise performance. I have been informed I will perform an exercise test on an exercise bicycle that is progressively harder until I become tired. During this test, I will wear a scuba-type mouthpiece with my nose plugged to analyze my breathing. I will also wear a chest strap to measure my heart rate. I have been informed my participation in this research study will require me to exercise for about an hour on a stationary bicycle on 4 different occasions. During each of these sessions I will be listening either to music of 'white noise' through a set of headphones. I have been informed my heart rate, rating of perceived exertion, pedaling rate, power, and enjoyment of the exercise bout will be recorded during the test. I have been informed the testing and exercise bouts will take place at the Human Performance Lab on the campus of the University of Wisconsin-La Crosse. I have been informed the results of the research study are intended to be published, but my personal information shall remain confidential. I have been informed the approximate total amount of time I will be partaking in this research study is 6 hours. I have also been informed that I may withdraw from the study at any time for any reason without penalty and participation in this research study is completely voluntary.

I have been informed of the potential risks of participating in the research study, which include muscle soreness and general fatigue. There are no likely side effects from participating in this study. The test(s) will be terminated if any complications should arise or I wish to voluntarily terminate the test(s) at any time for any reason. I have been informed personnel trained in CPR will be on site during testing and that there is an emergency protocol in place in the Human Performance Lab.

I have been informed I will benefit from the results of the maximal exercise test and will have a better understanding of my own fitness level. I have also been informed I may receive appropriate guidance relative to improving my fitness level should I inquire.

I have read all of the information on this consent. I have been informed of the procedures, expectations, and risks associated with this research study. Any questions I have regarding this research study will be directed to the principle investigator, Victor Johnson, (507) 313-1840, or his research advisor, Dr. Carl Foster, Department of Exercise and Sport Science, UW-La Crosse, La Crosse, WI (608) 785-8687. Questions regarding the protection of human subjects may be addressed to Dr. Garth Tymeson, the

Chair of the UW-La Crosse Institutional Review Board for the Protection of Human Subjects, (608) 785-8124.

Subject: ____ Date: __________________

Investigator: ____ Date: __________________

APPENDIX B

PHYSICAL ACTIVITY ENJOYMENT SCALE

PHYSICAL ACTIVITY ENJOYMENT SCALE*

Please rate how you feel at the moment about the physical activity you have been doing.

	1	2	3	4	5	6	7	
I enjoy it								I hate it
	1	2	3	4	5	6	7	
I feel bored								I feel interested
	1	2	3	4	5	6	7	
I do not like it								I like it
	1	2	3	4	5	6	7	
I find it pleasurable								I find it unpleasurable
	1	2	3	4	5	6	7	
I am very absorbed in this activity								I am not at all absorbed in this activity
	1	2	3	4	5	6	7	
It’s no fun at all								It’s a lot of fun
	1	2	3	4	5	6	7	
It makes me depressed								It makes me happy
	1	2	3	4	5	6	7	
It’s very pleasant								It’s very unpleasant
	1	2	3	4	5	6	7	
I feel good physically while doing it								I feel bad physically while doing it
	1	2	3	4	5	6	7	
It’s very invigorating								It’s not at all invigorating
	1	2	3	4	5	6	7	
It’s very gratifying								It’s not at all gratifying
	1	2	3	4	5	6	7	
It’s very exhilarating								It’s not at all exhilarating
	1	2	3	4	5	6	7	
It’s not at all stimulating								It’s very stimulating
	1	2	3	4	5	6	7	
It gives me a strong sense of accomplishment								It does not give me a strong sense of accomplishment
	1	2	3	4	5	6	7	
It’s very refreshing								It’s not at all refreshing
	1	2	3	4	5	6	7	
I felt as though I would rather be doing something else								I felt a though there was nothing else I would rather be doing

*adapted from Kendzierski, D., and DeCarlo, K.J. Physical Activity Enjoyment Scale: Two validation studies. *Journal of Sport and Exercise Psychology* 13(1):50-64, 1991.

APPENDIX C

THE MUSIC SURVEY

The Music Survey

From the list below, check the artists you would typically listen to if given the choice.

	Lawrence Welk		Madonna		Six Fat Dutchmen		Nickel Creek
	DJ Sammy		Frankie Yankovic		Toby Keith		Pat Green
	Garth Brooks		Emmy Lou Harris		Stas Krell		LinkinPark
	Eminem		Nickleback		Dick Rodgers		Alabama
	John Mayer		Rascal Flatts		Alan Jackson		Jolly Brothers
	Johnny Cash		Dave Mathews		Counting Crows		Myren Floren
	The Magic Organ		Jimmy Sturr		Matchbox 20		Dixie Chicks

APPENDIX D

REVIEW OF LITERATURE

Introduction

Distracters are a staple in the modern-day exercise industry. Nearly every health and fitness club has televisions or a sound system available for their members to take away some of the "pains" of exercising. Researchers have long been intrigued by the effects distracters may have on people while they exercise. Since the early 1950's, music has taken center stage as the primary distracter of choice for exercisers. Researchers have tried to find a relationship between the use of music with exercise in three various realms: psychological (1-4), physiological (5-8), and performance (9-11).

Music and the Brain

Music has been thought to provoke an emotional response that is commonly known as "arousal." Fast-tempo, loud music would bring someone to a higher state of arousal than would slow-tempo, soft music. One particular study examined the effects these two styles of music had on physical strength by trying to influence the subjects' state of arousal (1).

Pearce examined the grip strength of 33 male and 16 female undergraduate students (1). Music dubbed stimulative ("Rock and Roll" by Led Zeppelin) and sedative ("Emanuel" by Michael Columbier) was used in addition to a no-music trial to discover the effects the different selections had on grip strength. The subjects were seated in a chair and instructed on how to use a hand dynamometer. When the subjects understood how to use the device, they were handed headphones. The examiner sat behind the subjects so as to not distract them from the musical selection that was randomly played over the headphones. The examiner played music through the headphones while the subject sat still in the chair. After two minutes, the subject was asked to squeeze the dynamometer for 10 seconds. The results were recorded and 30 seconds after the squeeze the second trial with one of the other two stimuli began.

Pearce observed there was lower grip strength while listening to the sedative music and the silent trials. These results suggest that the sedative music and silence actually decrease physical strength by bringing the subject to a lower state of arousal.

Music has also been used to influence the thoughts and emotions of people before performing a highly complex skill such as a movement in karate (2). Four female and 10 male subjects (M = 31.7, SD = 12.6) of varying karate abilities (M = 6.6, SD = 4.9 years experience) from two Shotokan classes were used by Ferguson, Carbonneau, and Chambliss to test the "music and performance" hypothesis.

The music used in the study was designated as "positive," "negative," or white-noise. The music was played for the subjects using headphones. A kata, a combination of movements in karate, was selected in which the subjects would be rated by two judges using a Kata Evaluation Scale (seven item, five point scale). The subjects performed the same kata a total of three times. Prior to each performance, the subjects listened to one of the musical selections for one minute.

The results support the hypothesis that music affects performance. The trial performed after the positive and negative music received higher scores than the trial performed after the white-noise. Later, 11 subjects mentioned that the music allowed them to feel more comfortable and 10 subjects mentioned the music had a relaxing affect upon them.

If it weren't for the fact the trials were completely random in order, one could assume the subjects performed the kata better on the third trial due to practice of the skill. The investigators did not mention the duration between kata performance and music listening. This could have played a role in the excitation, or arousal, of the subjects during the performances. This study raised the question of whether any type of music is better than no music at all considering both music interventions returned higher kata scores.

Music has been used as a tool to change certain psychological aspects in regards to exercise or athletic performance. In these situations, music does not play that large of an influence on the outcome. There are some modern-day exercises in which music is the most important part of the exercise. In fact, without music, many aerobics classes would not be around today.

By means of a survey, Gfeller discovered the importance of musical style and preference during aerobic exercise (3). Thirty-five males (M = 21.85 years) and 35 females (M = 19.75 years) randomly selected from 182 students participating in an aerobic activity physical education class took part in a written survey regarding the type and style of music played during an aerobic exercise class.

Gfeller's data support the hypothesis that musical components are the most effective in aiding aerobic activity. Ninety-seven percent of the respondents reported that music made a difference in class performance. This difference was not clarified as a positive or negative effect in the class performance. Style, tempo, rhythm, and "extramusical associations" were listed as the most important features when considering music for aerobic exercise. Rock, Popular, and New Wave Music were the three most frequently preferred musical styles, or genres, for an aerobic workout as reported by the subjects. Music was also stated as an aid in pacing, strength, and endurance during the aerobic exercise class and also improved attitude toward the exercise itself.

Gfeller's data suggests that preferred music can be used as a motivational factor in relation to exercise. "Musical taste should be a primary consideration when selecting music for aerobic activities" (p. 42, 3). The idea of nonpreferred music was not discussed by Gfeller.

Via the use of music, researchers have been able to influence arousal (1), create a level of comfort (2), and use music as a means to help people exercise (3). According to the research, music has a definite effect on the brain, but what about the body?

Zimney and Weidenfeller observed the effects music had upon heart rate (HR) and the galvanic skin response (GSR) (4). GSR measures the electrical conductivity of the skin. Certain psychological reactions (such as an emotional stimulus; fright) can affect GSR. The investigation related psychological effects of listening to music with a physiological response (in this study, HR was the related measure).

Ten male and eight female college students were randomly selected from 78 summer school students. Each subject underwent three trials of music listening. The investigators selected three classical music pieces to use in the study: Dvorak's "New World Symphony," Chopin's "Les Sylphides," and Bach's "Air for the G-String." Each of the selections was associated with a different emotional state: exciting, neutral, and calming respectively. Each selection was six minutes in duration.

The subjects were exposed to all three selections randomly with counterbalancing. They were seated alone in an easy-chair in a sound-proof room. GSR and HR measurements were recorded before the music started to play from a stereo system into the sound-proof room. After the six minute selection was played, GSR and HR were again recorded. The subjects were asked to rest outside of the lab for five minutes. When the resting period was concluded, the subjects entered the sound-proof room for the subsequent trial.

Zimney and Weidenfeller found no significant differences in HR during the trials. GSR, however, decreased significantly during the exciting music trial. This suggests that music definitely has an effect on emotions but may not have an effect on HR. Does the type of music play a role in this situation? Perhaps, if the HR and GSR were recorded during the playing of the music, differences in HR may have appeared. Also, if a different type of music were used, instead of classical music, differences in both HR and GSR may have appeared.

Can Music Control the Human Body?

Zimney and Weidenfeller (4) were not the first researchers to use music in order to elicit a physiological response. The concept of biofeedback, using an external source such as music to affect physiological functions, is not a new concept. According to biofeedback, the heart may, or may not, change its pace to beat in time with music. According to research, however, heart rate is not affected by music of any type or volume

(4, 6). Heart rate is not the only physiological measure that has been put to the test in regard to using music with exercise.

Ellis and Brighouse observed the relationship between heart rate (HR), respiratory rate (RR), and music in a study done in the early 50's (5). These are two of the physiological processes believed to be most affected by music on the grounds of biofeedback.

Volunteer undergraduate college students (18 male, 18 female) enrolled in an undergraduate psychology class were used as subjects. This sample was probably chosen as a sample of convenience to the investigators. The music that Ellis and Brighouse selected for use in this study was primarily instrumental, such as jazz and classical: Hall's "Blue Interval", DeBusey's "Prelude to the Afternoon of a Farm", and Liszto's "Hungarian Rhapsody #2." There was no mention as to the tempo of the musical selections or as to whether or not the subjects particularly enjoyed the respective genres.

HR was measured using electrodes placed on the left wrist and the right leg of the subjects and registered changes in the electrical activity of the heart on an EKG monitor. A pnuemograph adjusted to the diaphragm region of the subjects measured the RR.

The subjects were told to lay down on a mattress in a comfortable position. It was assumed the subjects were to be as still as possible as to not influence the HR or RR by moving. The counterbalanced experiment contained three trials, one for each musical selection, for a total time per trial of 30 minutes. The trials were no less than 24 hours apart. The trials began with nine minutes of silence as the baseline levels for HR and RR were recorded. Music was played from speakers for 30 minutes while the subject lay on the mattress. HR and RR were constantly recorded while the music played. After 30 minutes of musical stimulation, the music was shut off and a five minute period of silence followed while HR and RR were still being recorded.

Ellis and Brighouse discovered that RR increased during the onset of all musical selections by 5 – 10% while there were no significant differences in HR between any of the trials. RR returned to normal rates after cessation of the music.

Music has changed since the 1950's when Ellis and Brighouse did their study (5). Rock music became prevalent over the radio airways in the 60's and 70's. Up until this point, most of the studies testing the physiological relationship music had with exercise involved instrumental or classical music (4, 5). Wilson and Aiken decided to do a study with rock music to determine if the new, harder beats and catchy rhythms had an affect on biofeedback.

Heart rate and RR were used as measures of biofeedback as they were in other studies (4, 5), but Wilson and Aiken decided to make the musical selections reflect the musical preferences of their subjects (6). Fifty-two undergraduates and 4 graduate students were used for the study. The sample was limited to subjects who had a preference for rock music. The majority of the subjects were born after 1945 and had normal hearing. This reflected the age-specific design for the selection of the music (see Table 1).

The music selections were cut to the first 30 seconds of the songs. The subject was set in a chair with a speaker five feet away. All of the recording instruments were located behind the subject so they could not see the instruments. This allowed the music

Table 1. Rock Music Selections for the Wilson Study.

Title of Selection	Artist
“Sergeant Pepper’s Lonely Hearts Club Band”	The Beatles
“21st Century Schizoid Man”	King Crimson
“All Right Now”	Free
“Purple Haze”	Jimmy Hendricks
“Mississippi Queen”	Mountain
“Honky Tonk Woman”	The Rolling Stones
“Heartbreaker”	Led Zeppelin
white-noise	Unoccupied television channel

to be the primary distracter without the added commotion of the investigator during testing. The cardiac cycles and inhalation peaks were recorded during the testing and enjoyment was recorded after the testing using the Gough Adjective Check List. The 30-second segments were played at varying volumes: Loud Music (LM) at 95 db, Soft Music (SM) at 79 db, Loud Noise (LN) at 92 db, and Soft Noise (SN) at 76 db.

Wilson and Aiken recorded differences in both HR and RR during the testing, although these differences were not significant (6). The subjects’ HRs were faster during the loud inputs (LM and LN), slower for music (LM and SM) than for noise (LN and SN), and rose at a slower rate during music than for noise. The RRs were faster during music than during noise, faster during SM than during LM, and rose during SM input. This is contrary to Pearce (1) who found HR actually decreased with softer music.

One reason for the discrepancies between this study and a previous study (1) could be the fact that Wilson and Aiken cut their musical selections to play only the first 30 seconds of the song. Thirty seconds may not be long enough to elicit the proper response when considering the biofeedback factors. Today, the music selections in this study would definitely not be considered Rock. Wilson and Aiken made it a point to use age-appropriate and preferred music when conducting this study.

Schwartz, Fernhall, and Plowman observed the effects of music and exercise by using nearly every physiological test they could find (7). Among these tests were values from RPE, HR, VO2, VE, RER, blood lactate levels, and the amount of time spent exercising. They chose to use so many measurements so they could hide the true purpose of the study (the effects of music on exercise performance) from the 10 untrained men (M = 20.2 years old) and 10 untrained women (M = 21.4 years old) who participated in their study.

Testing consisted of riding the cycle-ergometer a total of three times with a minimum of two days in between bouts. The subject first performed an exercise test to measure VO2 and blood lactate levels on a cycle-ergometer. The second and third trials were randomized and included exercising with or without music playing while riding the cycle-ergometer. The music was started as soon as the subject began to exercise. The subject, however, was not told the music was part of the study. The instructions were to ride at a cadence of 50 rpm with the workload set at 70% of the VO2 max. The testing was terminated when the cadence fell below 50 rpm. HR and RPE values were recorded every three minutes. VO2, VE, and RER were continuously recorded with the final numbers being averaged every minute. Blood lactate levels were taken via finger prick nine minutes into the exercise, termination of exercise, three minutes post-exercise, and six minutes post-exercise. The duration of the exercise was also recorded.

The results of the testing returned no definite conclusions. None of the tested values had significant differences. However, Schwartz, Fernhall, and Plowman did notice the subjects spent more time exercising while the music was playing although the results were not significant.

This study misled the subjects into believing they were being tested physiologically, not psychologically. They were told later the true intent of the study was to observe the effect music had on exercise. The question of music preference was addressed in this study as well. The music selected by the investigators was "age-specific." The selected music was an up-beat popular/rock music that reflected the preference of the majority of the age-group tested but it was not individualized. Some people may not prefer to listen to the "age-specific" music and could react differently during exercise.

Listening to music during exercise is supposed to divert one's focus away from the effects of exercise, giving a lower rating of perceived exertion (RPE). If this were the case, total sensory deprivation should put the focus completely on the effects of exercise, giving a higher RPE. Boutcher and Trenske tested this hypothesis using 24 untrained undergraduate women (M = 19.20 years old, SD = 1.53) (8).

The subjects rode a cycle ergometer during a submaximal exercise test to obtain base levels of exercise. After the base levels were collected, they participated in three more training bouts on the cycle ergometer over four weeks with a minimum of two days between bouts. The three trials (control, deprivation, and music) were randomized and started with a 3-minute warm-up period at 50 w. The intensity of the exercise was increased from 60, 75, and 85% of the subject's predicted maximum heart rate at an interval of six minutes. A three-minute cool-down followed the exercise. During the deprived trial, the subject wore opaque goggles and earplugs. Headphones playing the subject's favorite music were used for the music trial. The control trial consisted of ambient noise. The investigator sat behind the subjects during testing and recorded RPE every one, two-and-a-half, four, and five-and-a-half minute marks of every exercise interval. Heart rate was recorded continuously during the testing.

RPE scores were lower in the music trial compared to the deprived trial and the control trial. This supports the initial hypothesis that music would distract the exerciser from the effects of exercise. However, RPE scores were also lower in the deprived trial than the control trial. This suggests that the subjects may have been trying to find something outside of them to focus on instead of the effects of exercise. In trying to find something else to focus on, they were distracting themselves from the effects of exercise and lower RPE scores resulted.

This study shows that both music and sensory deprivation result in lower RPE scores. This means people think they are not working as hard while exercising under these two conditions. What this study fails to explore is whether or not the subjects enjoyed the exercise under the sensory deprivation.

Music: The Performance Enhancer?

Physical performance requires a combination of both psychological and physical prowess. Music has been shown to influence both of these vital components (1-8). Researchers have decided that since music can influence both components, it must, in turn, be able to influence the outcome of physical performance.

Arousal is an important factor when considering physical performance. Some activities require a large amount of arousal, such as football, whereas others require very little arousal, such as golf. Music is thought to affect a person's level of arousal. For example, a football player may listen to music that has a hard, definite bass line such as Rock while a golfer may select a slower, calming piece such as Classical for a preperformance listen. Dorney, Goh, and Lee decided they would test this hypothesis using dart throwers (9).

Along with the outcomes of the actual performance (dart throwing scores), heart rates (HR) were recorded to measure the effect the music had upon the subjects. A higher HR would indicate a higher arousal level.

Thirteen male and 17 female college students (19-32 years old, M = 22) participated in this study. The musical stimulations included: No Music (NM), Classical (CM), and Rock (RM). Tchaikovsky's "Romeo and Juliet" was selected as the CM, and Mental as Anything's "Rock and Roll Music" was selected as the RM. Both pieces were played for only 90 seconds during the testing. The subjects performed the dart-throwing task three times with the three different musical stimulations in a random order. During each trial, the subject was told to focus on the musical stimulation for 90 seconds and then immediately throw 10 darts with the goal of scoring the largest amount of points. HR was recorded before and after the three trials and before and after the listening to the musical stimulations.

No significant differences were found in the scores of the dart-throwing tasks. Also, no significant differences were found in HR during any point of testing. The researchers had noted, however, that HR decreased slightly after the CM and RM trials. The conclusion was there is no relationship between music and performance when trying to create a certain level of arousal.

Possibly, dart throwing is not the type of activity in which arousal plays a deciding factor. This could be one of the reasons this study did not support the hypothesis that music affects arousal and, in turn, affects performance. Ninety seconds may not be long enough to elicit any biofeedback related changes such as a rise in HR.

Cycling has been highly regarded as a sport of pace or tempo. With the emphasis of performance in cycling being placed heavily on the cadence of the pedaling, music was thought to have a direct effect on the outcomes of cycling while listening to music. Schwartzmiller et al., observed the effects music tempo had on spontaneous cycling performance (10).

Twenty male and female apparently healthy college students (M = 24.4 years old, SD = 2.1 years) participated in the study. The subjects exercised regularly on most days of the week. The subjects had control as to what type of music they were to listen to while riding a stationary bike. Tempo was the variable that the investigators controlled. Using computer software, the songs selected by the subjects were organized into three categories: slow (< 100 bpm), medium (100-129 bpm), and fast (> 130 bpm). One track with no discernable pulse (waves crashing) was added to a defined playlist and transferred to a personal MP3 player.

Each subject performed a maximal exercise test on an electrically braked cycle-ergometer to establish peak VO2 and maximum heart rate. Testing consisted of approximately 60 minutes of exercising while riding a stationary cycle and listening to the defined playlist with their preferred music. The defined playlist consisted of 13 songs of varying tempos (1 no tempo, 5 slow, 4 medium, and 4 fast). Ten seconds of silence were inserted between the songs.

The outcomes of the spontaneous cycling performance were directly affected by the tempo of the music. As the tempo of the music increased, so did the cadence of the pedaling and power. Significant differences were found in cadence, power, and HR. The differences in HR were attributed to a relatively short warm-up period.

Swartzmiller et al., noticed a definite effect in spontaneous cycling performance when using music the subjects selected. It is assumed the subjects selected music they preferred. What were to happen to power and cadence if the music was less-than pleasing to the subject's ears? Tempo may not have been the only factor in the differences found in this study.

Music has had an affect on aerobic exercise (3, 8, 10). Kozhaspirov, Zaitsev, and Kosarev decided they would observe the effects of using music during resistance training in 65 weightlifters (17-28 years old) (11).

The first musical session began during the warm-up with a duration of 15-20 minutes. The music varied in tempo from the slow moderato to the very fast tempo of presto. This was used to lift the mood and "perk up" the athletes. The athletes were instructed to perform their normal workout routine. Music was not played again until the most fatiguing bouts of training. Then, music was played with the same varying tempos for 10-12 minutes.

The data collected by use of a survey showed the music had a positive effect on attitude during the resistance training. Greater efforts were achieved during the more fatiguing exercises when the subjects' favorite music was played.

This study supports the findings of Gfeller (3) in that musical preference may have a direct effect on the attitudes and outcomes of exercise participants. This study does not go into detail about what genre of music was used and whether or not the favorite music of the subjects was known before or after the observations took place.

Summary

Research conducted regarding the possible effects music may have on the body during exercise has failed to explore one vital area: music preference. When someone exercises with music, they are more than likely going to choose music they prefer. This allows them to divert some of their attention to the music and distract themselves from the effects of exercise. This is the purpose of a distracter. What would happen if the distracter was somewhat less than desirable to the exerciser? More research analyzing music genre with respect to tempo can help answer this question.

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