THE EFFECTS OF MUSIC ON TIME TRIAL PERFORMANCE

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

Jana Hagen

College of Science and Health

December, 2011
THE EFFECTS OF MUSIC ON TIME TRIAL PERFORMANCE

By Jana Hagen

We recommend acceptance of this thesis in partial fulfillment of the candidate's requirements for the degree of Master of Science in Clinical Exercise Physiology.

The candidate has completed the oral defense of the thesis.

Carl Foster, Ph.D.
Thesis Committee Chairperson

Richard Mikat, Ph.D.
Thesis Committee Member

Charles Hendrix M.S.Ed.
Thesis Committee Member

Thesis accepted

Vijendra K. Agarwal, Ph.D.
Associate Vice Chancellor for Academic Affairs

Date
Hagen, J. The effects of music on time trial performance. MS in Clinical Exercise Physiology, December 2011. 33p. (C.Foster)

Purpose: Exercise, particularly higher intensity or competitive exercise, depends on the interaction of a template or plan. This plan determines how to go about the exercise and feedback from the body determines how the exercise bout is affecting the body. In well-trained people the interaction between template and feedback is very sophisticated, and allows exercise performance to be optimized. The ‘language’, which the brain apparently speaks in terms of this template and feedback, can be understood in terms of Rating of Perceived Exertion (RPE). Motivational music has generally been shown to augment exercise performance. The purpose of this study is to determine if motivation music, used as a strategy to manipulate the template-feedback system, during a cycle time trial, will change performance. Methods: (N=18) mean age= 27.6±8.7 well-trained cyclists performed two randomly assigned 10km cycle time trials, either listening to self-selected motivational music or control trial. A variety of performance markers (power output, HR, blood lactate, RPE) were monitored. Results: Self-selected motivation music had no effect on HR 174.1±11.3 and 171.8±10.4, power output 222±66 and 220±65, RPE 8.4±1.5 and 8.5±1.6, blood lactate 8.2±3.6 and 8.2±3.5 or time 17.75±2.1 and 17.81±2.06 (p>.05). Conclusion: The results show no significant difference in time trial responses relative to the presence of music.
TABLE OF CONTENTS

LIST OF FIGURES.............................................................................................................v
INTRODUCTION.....................................................................................................................1
METHODS..............................................................................................................................6
   Table 1: Descriptive Statistics of the Subjects (N=18).........................................................6
PROCEDURES.......................................................................................................................7
RESULTS.................................................................................................................................8
   Table 2: Subject's (n=18) Performance Statistics as mean ± SD.........................................8
DISCUSSION..........................................................................................................................13
REFERENCES.........................................................................................................................15
APPENDICES........................................................................................................................17
   Appendix A: Informed Consent............................................................................................17
   Appendix B: Review of Literature......................................................................................20
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURES</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Comparison of mean power output</td>
<td>9</td>
</tr>
<tr>
<td>2. Comparison of mean RPE</td>
<td>10</td>
</tr>
<tr>
<td>3. Comparison of mean heart rate</td>
<td>11</td>
</tr>
<tr>
<td>4. Comparison of mean blood lactate</td>
<td>12</td>
</tr>
</tbody>
</table>
INTRODUCTION

From the Middle Ages to the Renaissance, the Baroque Age, the Classical Period, and the Romantic Era all the way to the Twenty First Century; music has been an important part of the lives of human beings. Whether through religion, culture, dancing, opera, or just simple appreciation, music has been shown to elicit a wide range of emotional and physiological responses.

In the twenty first century, technology has influenced the way people experience music. People are constantly striving for new ways to express themselves through music; moreover, music has been used for healing purposes, augmenting physical performance, body movement and coordination, productivity, relaxation, and altering mood.

Physical activity is an important part of leading a healthy lifestyle. The American College of Sports Medicine recommends exercising three to five times per week for at least 20-60 minutes at a moderate intensity to maintain cardiovascular fitness (1). However, many people find exercising on a regular basis to be very difficult. However, music may make exercise more enjoyable.

For athletes as well, whether competing against others or against themselves, beating personal records or other competitors is always the ultimate goal. If athletes reach a performance plateau, they may look at ergogenic aids to help them improve. Ergogenic aids are substances that enhance an athlete’s performance by reducing fatigue symptoms or by augmenting the training response.
Numerous physiological variables and mental factors are associated with exercising and fatigue. Tucker (2009) has proposed that exercise is regulated by the effects of the physiological feedback system, which is superimposed on a pre-exercise template. This feedback system seeks to maintain homeostasis within narrow limits and appears to be designed to prevent exertional levels from causing harm to the body. At the beginning of an exercise bout, afferent feedback to the brain is based on external stimulus and exercise intensity (8). An acceptable rate of growth in RPE is established and monitored based on afferent feedback compared to an anticipatory component to determine how hard the athlete is working (8). Once RPE increases to near maximal levels the athlete is forced to stop exercising based on the feedback from a variety of internal receptors. This feedback system’s purpose is to stop exercise before a potentially harmful homeostatic disturbance happens (8).

There have been numerous studies done on the effects of music during exercise. Music may initially distract the feedback system with external stimulation (e.g. increased arousal) potentially overpowering the experience-based template. Subsequently, music may mask information from the feedback mechanism. Thus, either enhanced arousal or reduction of feedback relative to fatigue may enhance exercise performance.

Music has the potential to increase the level of arousal in individuals. Priest et. al. (2004), had subjects complete a survey that focused on the importance of listening to music while they exercised. Some quotes from subjects included, “Music tempo has a significant impact on how hard I push myself. Upbeat music is best.” Another subject stated, “I find music improves my motivation to carry on with my workout when the music is lively.”
Increases in the level of arousal through music can also exert positive effects on exercise. It has been shown that younger subjects, aged 16-34, reported that music motivated them more than it did older subjects, aged 35+ (6). However, older subjects enjoyed music while exercising, but at a slower tempo (6). It appears that music has an effect on exercise intensity and it has been shown that there is a preference for fast tempo music during low (40% HRR) and moderate (60% HRR) intensity exercise, and a very strong preference for fast tempo music during high (75%HRR) intensity exercise (3).

These findings support the concept that music can act as a positive external stimulus and can interrupt the feedback system reporting homeostatic disturbances. By interrupting afferent feedback, music has the potential to create an ergogenic effect (7). This was illustrated when subjects sprinted 400m faster while listening to motivational music (72.95sec. ± 1.24 in the control group vs. 72.27sec. ± 1.39sec. in the music group) (7).

Additionally, motivational music has been shown to increase power output. This can be associated with the rate of change in RPE. It has been shown that as exercise intensity increases, RPE increases linearly. Up-beat music that is considered "motivational" has been shown to make exercising on either the treadmill or cycle ergometer feel easier (6). This is especially true in patients doing cardiovascular exercise (6). Music significantly lowered the subject’s rating of perceived exertion when exercising on a treadmill until exhaustion, particularly in untrained individuals. However, trained athletes also had a lower RPE with music (5). Thus, exercising for a longer time or at a higher intensity may be possible with music. While listening to music by both
trained and untrained athletes, time to exhaustion was longer than without listening to music (5).

Music has also been shown to improve mood by increasing endorphins within the body while exercising. A 10-point bipolar scale developed by Rejeski (1985) has been used to measure exercise induced feeling states. On this scale a +5 means the subject is feeling very good, 0 is neutral, and a -5 is feeling very bad. Exercising at a high intensity elicited a higher number on the 10-point bipolar scale when the subjects were listening to music than with no music (2). This was also true with moderate intensity exercise (2). Improving mood through motivational music could potentially increase adherence to an exercise program. In addition, music may elicit more frequent exercise sessions, particularly in males, who are more likely to exercise more than five times per week than females (6). This increases the likelihood of making exercise part of the lifestyle, thus decreasing the risk for health problems and leading to a greater energy expenditure, as well as improved cardiovascular fitness (4).

Numerous studies have used music in open-loop exercise sessions where subjects exercise until exhaustion. These studies suggest music is an effective external stimulus, acting to decrease RPE and increase exercise session duration. However, there is a lack of information during closed-loop exercise sessions (e.g. time trial performance). A study done at the University of Wisconsin La Crosse looked at the effects of auditory input on RPE during cycling. Subjects completed four forty-minute cycling trials, listening to self-selected motivational music; yoga music; Larry the Cable Guy (e.g. distracting comedy); and no music. It was concluded that RPE was significantly lower in the last twenty minutes while listening to self-selected motivational music (9). Accordingly, it appears
that music has the potential to distract the relationship between exercise intensity and RPE. During closed-loop exercise RPE increases linearly no matter the distance of the time trial, and with or without hypoxia (10). During time trials, athletes appear to compare how they currently feel to how they expect to feel based on past experience. Power output decreases or increases based on RPE in a way designed to minimize disturbance in homeostasis. Johnson et. al. (2009) concluded that with hypoxia, power output decreased until conditions were normalized and then power output increased when normoxia was restored. This further supports the Tucker (2009) model of homeostatic regulation. Using an external stimulus (e.g. music) to reduce RPE might act to prevent a slow down in a time trial performance.

The purpose of this study was to determine if self-selected motivational music improves an athlete’s performance in a time trial. It was hypothesized that either (1) music will have a positive effect on performance of an athlete in a 10km time trial by decreasing RPE and increasing power output, or (2) music will have a positive effect on performance during the first part of the time trial and then the RPE will increase drastically. Power output will decrease as an increased homeostatic disturbance overwhelms the effect of music.
METHODS

The subjects were healthy well-trained volunteers between the ages of 19 and 41. Descriptive characteristics are provided in Table 1. Each subject provided written informed consent before the start of the study and the University of Wisconsin-LaCrosse Institution Review Board approved the protocol for the Protection of Human Subjects.

Table 1. Descriptive statistics of the subjects (N=18)

<table>
<thead>
<tr>
<th></th>
<th>Men (9)</th>
<th>Women (9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>30.6±8.6</td>
<td>24.7±8.2</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>182.7±7.7</td>
<td>167.1±4.2</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>85.68±13.78</td>
<td>60.18±6.77</td>
</tr>
<tr>
<td>Peak PO (watts)</td>
<td>354±41</td>
<td>232±27</td>
</tr>
<tr>
<td>Peak PO (watts/kg)</td>
<td>4.19±0.69</td>
<td>3.91±0.67</td>
</tr>
<tr>
<td>VO2 Max (L/min)</td>
<td>4.61±3.8</td>
<td>2.79±3.5</td>
</tr>
<tr>
<td>VO2Max (ml/kg/min)</td>
<td>54.8±8.2</td>
<td>46.7±7.5</td>
</tr>
</tbody>
</table>
PROCEDURES

The subjects first performed a maximal incremental exercise test on a cycle ergometer to document their basic fitness level. Subsequently, each subject completed four 10km time trials. The first two time trials were for habituation, to get a good baseline performance level, and to develop a performance template (8,12). Subsequently two experimental trials were performed in random order. In one the subject listened to self-selected music, designed to increase motivation. In the other they were blocked from auditory input. During these trials, the subjects were given a small monetary incentive if they improved their time over their second habituation trial. Subjects were asked to bring in their own headphones to listen to the music that they selected. During all trials, heart rate, power output and time were constantly recorded through the Velotron Coaching Software, Version 1.5.272, Racermate, Inc. RPE was measured at the end of each 500m. Blood lactate concentrations was measured before the start of the time trial, at 2km, 4km, 6km, 8km and at the finish of the time trial using dry chemistry (Lactate Plus, Nova Biomedical). Results are presented in Table 2 and Figures 1-4. There were at least 48 hours of rest between each time trial to allow for recovery. Subjects were asked to eat a normal diet and exercise as they normally would before competition.
RESULTS

Table 2. Subject's (n=18) Performance Statistics as mean ± SD

<table>
<thead>
<tr>
<th></th>
<th>Music</th>
<th>No Music</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>17.75±2.1</td>
<td>17.81±2.06</td>
</tr>
<tr>
<td>Power Output</td>
<td>222±66</td>
<td>220±65</td>
</tr>
<tr>
<td>Heart Rate</td>
<td>174.1±11.3</td>
<td>171.8±10.4</td>
</tr>
<tr>
<td>Lactate</td>
<td>8.2±3.6</td>
<td>8.2±3.5</td>
</tr>
<tr>
<td>RPE</td>
<td>8.4±1.5</td>
<td>8.5±1.6</td>
</tr>
</tbody>
</table>
The results show no significant difference ($p > .05$) in time trial responses relative to the presence of music. Power output responses show no significant differences with either condition. There is the normally expected end spurt effect, but no evidence of either an overall music effect or a tendency for music to influence power output early during the time trial. The mean power output was $221 \pm 64.5$, which was 75% of the maximal power output observed during the incremental exercise test.
Figure 2. Comparison of the mean RPE.

The results show no significant difference (p > .05) in the response of RPE in relation to music. The terminal values for RPE were consistent with expected values during closed-loop time trials.
The results show no significant difference (p > .05) in the HR response in relation to music. The terminal value of HR during the time trial was $183.8 \pm 8.7$, 102% of the HR observed during the incremental exercise test.

Figure 3. Comparison of the mean heart rate.
Figure 4. Comparison of the mean blood lactate.

The results show no significant difference (p > .05) in the response of blood lactate in relation to music. The peak blood lactate concentration is within the expected value for closed-loop cycle time trials.
DISCUSSION

The purpose of this study was to determine if self-selected motivational music improves the performance of a 10km time trial. It was concluded that music does not benefit performance. The results showed that at high intensity exercise there was no change in RPE, power output, heart rate, or blood lactate with either condition; no music or while listening to motivational music. Thus, the primary experimental hypothesis of an ergogenic effect of music was not supported. Second, there was no evidence of an early up regulation of power output secondary to increased arousal from music. Accordingly, the secondary hypothesis was not supported.

These findings do not concur with previous research on the effects of music during exercise. However, previous studies used open-loop exercise sessions where subjects exercise either until exhaustion or for a pre-defined period of time. In these studies music was shown to have a positive effect. During self-selected exercise at an intensity characteristic of exercise training, music tempo had a significant impact on power output, RPM, and heart rate (13). It was also found that music tempo acted to increase arousal allowing cardiac rehabilitation patients to work at a higher intensity, with inappropriate increases in both heart rate and RPE (14). When listening to slower music and then changing to faster music, subjects performed at a significantly higher power output without drastic changes in heart rate (15). Self-selected music was also shown to significantly reduce RPE and increase arousal during the second half of the
exercise bout (9). Thus, research findings have consistently supported the idea that music acts as an external stimulus and can distract the exerciser from the feedback system allowing for a higher intensity exercise (8). Music also potentially influences the intensity of the workout because of synchronization with the tempo of the music, allowing an increase in power output (9, 11, 13, 14, 17).

Post ride discussions with the subjects suggested that the self-selected music was more enjoyable versus the no music condition. Subjects stated that music was more enjoyable and distracted them from having to focus on their power output and distance during the time trial. They reported that the overall time trial felt easier even though subjects' average time did not improve significantly and momentary RPE was the same. Similar findings were shown in a previous study using the Rejeski (1985) 10pt Bipolar Scale (2). Most studies have found that subjects enjoy music while exercising. However, it appears that at maximal intensity the introduction of music will not significantly impact overall performance. When exercising at maximal intensity the subject is already disturbing homeostasis and music may not be enough to overpower the feedback system.

In summary, contrary to the experimental hypothesis, music did not improve performance during a heavy, closed-loop task. There was no evidence that increased arousal from the music increased the power output early during the simulated race. There was no evidence that music disrupted the tight coupling between the magnitude of homeostatic disturbance and monetary RPE.
REFERENCES


9.) Prieboy, M. The effects of auditory input on perceived exertion during cycling. College of Science and Allied Health- University of Wisconsin-La Crosse. April, 2009. (C. Foster)

15


APPENDIX A
INFORMED CONSENT
Protocol Title: Effects of music on time trial performance

Principal Investigator: Jana Hagen
E4112 CTY RD KK
Chaseburg, WI 54621

Emergency Contact: Dr. Carl Foster
133 Mitchell Hall
University of Wisconsin-La Crosse
608-785-8687

Purpose and Procedure
- The purpose of this study is to determine the effects of music tempo on cycle time trial performance.
- Agreement to take part in this study will involve a maximal test and four 10K time trials all on a stationary bike with competitive simulations.
- Total time commitment consists of five 90-minute visits over a two-month period.
- Testing will take place in room 225 Mitchell Hall, UW-L.
- During all trials, I will wear a heart rate monitor to record my heart rate throughout the test.
- Blood will be taken from my fingertip before the trial, mid-point, and at the end of the trial to measure blood lactate.

Potential Risks
- I may experience finger and muscle soreness after the test. However, soreness will only be temporary. There is low risk of serious injury for healthy individuals.
- Individuals trained in CPR, Advanced Cardiac Life Support and First Aid will be present during all tests.
- If any complications occur during the test, the test will immediately be terminated.

Rights & Confidentiality
- My participation is voluntary.
- I can withdraw from the study at any time for any reason without penalty.
- The results of this study may be published in scientific literature or presented at professional meetings using group data only.
- All information will be kept confidential through the use of number codes. My data will not be linked with personally identifiable information.

Possible Benefits
- Others and I may benefit by understanding the effect of music on time trial performance.
Questions regarding study procedures may be directed to Jana Hagen, (608-852-6967), or her advisor (Dr. Carl Foster, 608-785-8687). Questions regarding the protection of human subjects may be addressed to the UW-LaCrosse Institutional Review Board for the Protection of Human Subjects, (608-785-8124 or irb@uwjx.edu).

Participant

Date

Researcher

Date
APPENDIX B
REVIEW OF LITERATURE
REVIEW OF LITERATURE

This literature review is designed to discuss topics related to the effects of exercise and music tempo. This review looks at physiological changes that occur within the body and how rating of perceived exertion and power output change in relationship to music tempo.

Many people find music a very enjoyable part of life and music can make working out less of a "have to" and more of a "want to." Music has the potential to help people start exercising and stick to a fitness program.

For an athlete, whether it is competing against others or against oneself, beating personal records or succeeding competitively, improving is always the ultimate goal. If an athlete seems to be at a plateau with their performance, they may try ergogenic aids (legal or illegal) to help them improve. Ergogenic aids are substances that enhance an athlete's performance by reducing fatigue symptoms. Music qualifies as a legal ergogenic aid.

Numerous physiological variables and mental components are associated with exercising and fatigue. Tucker (2009) examined the effects on the physiological feedback system in our body and exercise. During exercise there is a feedback system that happens in the brain in correlation with the activity at hand (1,2). This feedback system maintains homeostasis and makes sure that one does not do too much work to cause harm to the body (1, 3). In the beginning of exercise, afferent feedback to the brain is based on
external stimulus and exercise intensity (1). To keep homeostasis regulated, an anticipatory component comes in play to make sure the athlete can finish the exercise duration at that given intensity (1, 2).

RPE is established based on afferent feedback and this anticipatory component to determine how hard the athlete is working (1). As RPE increases physiological changes happening within the body give afferent feedback and travel to the brain. Once RPE approaches maximal levels, the athlete is forced to either slow down or stop exercising based on the physiological changes and feedback occurring at that time. This feedback system’s purpose is to stop exercise before potentially harmful homeostatic disturbance happens (1, 3).

There have been numerous studies done on the effects of music on different populations in an exercise setting. The use of music initially distracts the feedback system with external stimulation, overpowering the internal stimulus of physiological changes and afferent feedback. It was shown that switching from slow music to fast music, work output was significantly higher (Control: 193.75, Slow to fast music: 203.13, p<0.05) (4). Music was suggested to be a temporary distraction therefore decreasing conscious level of fatigue (4).

Various studies have concluded that music decreases sensation of fatigue, increases level of arousal, encourages motor coordination and/or synchronization and increases mood (5-10).

Boutcher & Trenske (1990), looked at the effects of sensory deprivation and music on perceived exertion. Twenty-four untrained females exercised on a cycle ergometer with a pedaling rate of 60rpm. Three, forty-minute sessions were conducted:
control group, sensory deprivation, and music group. Workloads corresponded with 60, 75 and 85 percent of maximal heart rate, correlating with light, moderate and heavy intensity. Results indicated that RPE was affected at light and moderate intensity and subjects reported feeling better during moderate and heavy exercise when accompanied by music than when exercising in the sensory deprivation group (5). Untrained athletes have been shown to have a greater effect when listening to music with a lower RPE than trained athletes (8). While using the 1-10 Borg Scale (1998), RPE in the no music condition; untrained 4.79, trained 3.89, compared to the music condition; untrained 3.82, trained 3.64, p<0.05 (8).

Music has the tendency to get people to move to the beat (synchronization). Different cultures listen to different music and accustom themselves to the beat of the music. Music also can influence performance during aerobic activity by synchronizing movement to the beat of the music. It is important that music is chosen on an individual basis because level of arousal is different for everyone (11, 12).

Simpson and Karageorghis (2006), looked at whether or not motivational music would enable faster 400m times than ouderterous (neutral) music or no music at all. The hypothesis was that both music conditions would enable faster times than without music. Thirty-six male subjects were tested while running, 400m-time trials. They concluded that running times in the motivational and ouderterous music conditions were faster than those with no music (72.27 ± 1.39, 72.64 ± 1.20, 72.95 ± 1.24) (7). Aerobic performance was also shown to be enhanced by music and decrease in RPE than no music condition (13). A stress hormone, cortisol has also been shown to be at a lower concentration five minutes post exercise when listening to motivational music vs. no music (13).
Synchronized motor coordination to music was shown to have an ergogenic effect and a strong influence on performance.

Cohen et. al. (2007), tested twenty-five subjects on the effects of music and reinforcement on a cycle ergometer exercise session to exhaustion or 45 minutes. It was concluded that music has a synchronous effect since cycling rate was significantly higher than in the no music condition (two no-music conditions: 80 revolutions/min compared to the two music conditions at 83 revolutions/min) (10). Therefore, music was shown to increase subjects' workout effort.

In relationship to looking at synchronization and music, Karageorghis et. al. (2006), examined the relationship between exercise heart rate and music tempo preference. Twenty-nine undergraduates reported their preference for slow, medium, and fast tempo selections for three treadmill trials at 40%, 60% and 75% maximal heart rate reserve. Slow was defined as 80bpm, medium as 120 bpm, and fast as 140 bpm. Subjects used a ten-point scale to rate their preference for a particular music tract at specific exercise intensity with 1 stating, “I do not like it at all” and 10 stating, “I like it very much.” Participants reported a preference for medium and fast tempo music for low and moderate intensity exercise and fast tempo music for high intensity exercise (40%- slow: 4.52, medium & Fast: 6.93, 60%- slow: 4.59, medium: 7.24, fast: 7.10, 75%- slow: 4.41, medium: 6.45 and fast: 7.38) (9). There was a significant preference for fast tempo music (4, 11) for high intensity exercise (9). This suggests that external stimulus helps diminish conscious feelings allowing increased intensity to be more enjoyable and doable.

To further this conclusion, Karageorghis et. al. (2009), looked at the effects of motivational music compared to oudeterous music and no music. Thirty subjects
participated in this study and were all selected from aerobic based sports. Subjects were asked to walk on a treadmill beginning at 75% maximal heart rate reserve and then gradually increase the incline until voluntary exhaustion. Four dependent variables were studied: time to exhaustion, rating of perceived exertion, in-task affect and exercise-induced feeling states. It was concluded that motivational music allowed for a longer exercise duration when compared to no-music control by 15%, with a 6% increase compared to the oulteriorous music ($p < .01$). Furthermore, in-task affect utilized an 11-point, Bipolar Feeling Scale designed exclusively for exercise, by Hardy and Rejeski in 1989, (+5 for feeling good, 0 for neutral and -5 for feeling very bad). It was concluded that motivational music can temper how one feels during high intensity exercise sessions, and that music causing arousal can help create a more positive attitude (no music: 1.38, motivational music: 2.42, two minutes after target HR was met and two minutes before voluntary exhaustion; no music: -3.42, motivational music: -3.04 using the Bipolar Feeling Scale) (6).

In contrast, Lim (2009), looked at the effects of music being introduced and taken away during a 10km cycling time trial. Eleven males participated in three conditions consisting of: no music, start with music and then removed between 5-10km, start with no music and then added between 5-10km. It was concluded that music is a beneficial aid during the later part of a exercise bout, but there was no significant findings in relationship to RPE, Positive Affect, Power Output, Race Time, Cadence and Speed (14).

A study done at the University of La Crosse examined the effects of a forty minute, high intensity exercise bout on a cycle ergometer under four conditions: no music, sedative music, self-selected motivating music, and verbal conversation without
music. There was a significant decrease in RPE when subject listened to self-selected music compared to the no music group. This did not show to be true until halfway through the exercise bout (12). This further concludes that music used as an external stimulus can change RPE and increase arousal; therefore improving the performance of the individual exercising.

**SUMMARY**

Numerous studies have used open-looped exercise sessions where subjects exercise until exhaustion. These studies suggest that music can be used as an external stimulus, therefore decreasing RPE and increasing exercise session duration.

However, closed-loop exercise sessions on time trial performance is a better indicator of how people carry out an intense exercise session. RPE has been shown to be a reliable indicator of homeostasis disturbances contrary for what is expected for that particular closed-loop exercise and what is physically acceptable (15).

The purpose of this study is to determine if music tempo increases an athlete’s performance in a time trial. It is hypothesized that one, either music will have a positive effect on the performance of an athlete in a 10km time trial by decreasing RPE and increasing power output. Or two, music will have a positive effect on performance during the first part of a time trial and then the athlete’s RPE increase drastically and power output will decrease as an increased homeostatic disturbance overwhelms the effect of music.
REFERENCES


12.) Prieboy, M. The effects of auditory input on perceived exertion during cycling. College of Science and Allied Health- University of Wisconsin-La Crosse. April, 2009. (C. Foster)

