The Effects of Music on Heart Rate and Perceived Exertion During 20 Minutes of Treadmill Running

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The Effects of Music on Heart Rate and Perceived Exertion During 20 Minutes of Treadmill Running

Tara Litz

Senior Honors Project

Submitted in partial fulfillment of the graduation requirements of the Westover Honors Program

Westover Honors Program

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Dr. Nancy Cowden, Biology, Westover Advisor

Dr. Deb Bradney, Athletic Training
Abstract

This study examined the effects of music on heart rate (HR) as well as ratings of perceived exertion (RPE-B) while running on a treadmill for 20 minutes. Research subjects included men and women, ages 18 to 25. All subjects completed a 20-minute treadmill run set at 5.0 mph with 0% grade. Omron heart monitors were used to measure and record subjects’ HR every 2 minutes after the start of the test. Subjects reported ratings of perceived exertion -using the Borg Scale- which was also recorded every two minutes throughout the test period. One treadmill session included music; the other session did not. The hypothesis tested whether subjects would report a lower RPE-B value while running with music and whether there would be a significant difference in HR between the two sessions. The data was analyzed using a one-way ANOVA. Results indicated no significant difference in HR or RPE-B between the two sessions. An additional statistical analysis, a sign test, was used to analyze the RPE-B data. Results of that test indicated a significant difference in RPE-B values between the music and non-music sessions for women. These results suggest that women may respond differently than men to auditory stimuli while exercising.
The Effects of Music on HR and RPE in 20 Minutes of Treadmill Running

**Introduction**

Many college students exercise with music believing that it helps to lower attentional focus to physical stress while increasing the ability to maintain a constant intensity for a longer period of time. Previous research has both supported and opposed this concept (1,2,7, 8-14,16-18). Matesic and Comartie suggested that music stimulates the body into reaching target heart rate sooner, allowing the body to warm quicker, enabling the participant “to get into the flow of the exercise and/or competition they are partaking in more quickly (10)”.

In order to measure physical stress and monitor intensity during exercise, the Borg Scale for Ratings of Perceived Exertion (RPE-B) has been suggested by researchers to be a simple and convenient tool for measuring intensity in healthy adults (3). This scale has numeric values representing corresponding exercise intensities. It is a 15-point scale ranging in numbers from 6 to 20. The lowest number corresponds to “very, very light” intensity, and the highest number to “very, very hard” intensity. Many researchers have examined the validity and reliability of this laboratory model (2-4,7). Ceci and Hassmen concluded that the RPE-B functioned well as a method of monitoring exercise intensity in an outdoor setting as well as on a treadmill (2). Glass and colleagues further acknowledged that RPE-B served well as a means to prescribe exercise intensity during level treadmill running (4). Smutok, Skrinar, and Pandolf investigated the reliability of the RPE-B by exercising subjects on a treadmill at various speeds. The conclusion of this investigation was that the RPE-B values were accurate when HR was above 150 beats per minute (bpm)(17).
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The studies that found a significant difference in perceived exertion during exercise with the use of music included other variables such as visual stimulation, different music genres, and manipulated tempos. General results supported evidence that music does lower RPE during exercise (18). White and Potteiger reasoned that the visual images showed a significantly higher RPE because they may evoke strong, emotional responses that may heighten awareness of physical sensations. They then concluded that auditory, rather than visual, stimulation resulted in a lower RPE reading (18). Potteiger et al. investigated the effects of fast upbeat music, classical music, self-selected music, and no music during sub-maximal running. They discovered that all three instances where music was played were associated with lower ratings of perceived exertion (14).

Brenda and colleagues investigated the effects that fast music and slow music had on both RPE and HR. The RPE values for both musical groups when compared to the control group (which involved no music) were slightly lower, indicating no support for the researchers’ original hypothesis that fast music increases physiological or psychological arousal. Conflicting with this finding, Kibler and Rider concluded that sedative music reduces anxiety, while fast, upbeat music produces higher physiological arousal and state-anxiety (9).

Supporting the hypothesis that external cues act as distracters, Nethery found that exercising with music resulted in a significantly lower RPE when compared to using video, an environment completely void of external stimuli, and a control group, (with no stimuli). Earlier research agrees with Nethery’s conclusion that the increase in RPE could be attributed to a lack of external stimuli. (15).
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Previous research examining the effects of music on HR has found evidence to support the hypothesis that HR changes with music (1). However, some research has suggested otherwise (11,14). In a recent study both fast and slow music were used, along with a control group that received no music. Despite the fact that the researchers found no significant difference between the fast music and no music with respect to HR values, slow music resulted in a lower HR than either (1).

Ratings of perceived exertion have been determined to be valid measures of perceived intensity during exercise, in addition to heart rate (2,4). The relationship between music and RPE has indicated that music in general will produce a lower RPE (13). Conflicting research supports the presumption that HR may be manipulated by external cues such as music. However, the specific effects are subject to the type and tempo of the music (1,5,6,8,16). In this study music was hypothesized to help decrease RPE-B by causing decreased attentional focus on the physical discomfort of running. It was also hypothesized that there would be a significant difference in HR between the music- and non-music conditions.

The effects music has on physiological factors such as heart rate and ratings of perceived exertion as well as the psychological aspects affecting these factors have been studied (1,2,7,8-14,16-18). If it is possible to determine that music does enhance physical performance, then athletes, coaches, and even individuals could benefit from such information by enabling them to supplement exercise routines with music. This study attempted to touch upon these matters and answer some of the questions that have been raised.
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Methodology

Subject Selection

Subjects for this study included 11 men and 6 women, ages 18 to 25. Median age for females was 20.5 and median age for males was 21. All subjects signed an Informed Consent Form before any tests were administered (Appendix A). In addition, each subject filled out an information sheet that included height, weight, age, sex, athletic involvement, their daily exercise routine, academic society affiliations, musical interests, and if they could complete 20 minutes of running (Appendix B).

Testing Procedures

Subjects completed a 20-min sub-maximal (less than subject’s VO2max,) run on treadmill paced at 5.0 mph and set at a 0% grade in the exercise physiology lab at Lynchburg College. The pace of the run remained the same for both test scenarios: with music and without music. Omron heart rate monitors were worn by the subjects throughout the run. Heart rate (HR) was recorded immediately before the run and every 2 minutes throughout the duration of the run. The Borg Scale for Ratings of Perceived Exertion was used to assess RPE for each subject (Appendix C). This was also recorded prior to the run and every 2 minutes throughout. With the exception of the tester, no other persons were present during the testing. This further removed possible sources of distraction to the subject.

Subjects completed two sessions, each occurring on a different day. One session did not include music. The other session, the subjects were asked to bring music that they felt comfortable listening to while running. The order of the testing conditions was
random to ensure reliable results. The music was played in the same portable CD player with the volume constant for all tests.

Statistical Analysis

A one-way analysis of variance (ANOVA) was used to determine if HR and RPE-B are dependent on the presence of music. The ANOVA was run following similar procedures used by researchers Brenda, Copeland, and Franks. The level of significance was set at 0.05 prior to the study, contrary to that of the study conducted by Brenda et al, which tested with a significance of 0.10. A sign test was used to analyze the RPE-B data. Although not part of the original hypothesis, differences in HR and RPE were tested between genders using a one-way ANOVA. The subjects that did not complete both sessions of the experiment were dropped from the data analysis.

Results

Results of the ANOVA do not support the hypothesis that HR and RPE-B are dependent on music (Table 1 and Table 2). There was also no evidence to indicate significant differences in HR and RPE-B between genders. Graphical representations of mean HR values for males and females appear in Fig. 1 and Fig. 2 respectively. Graphical representations of mean RPE-B values for males and females appear in Fig. 3 and Fig. 4 respectively.

A sign test was used to analyze the RPE-B values a second time. Results showed a significant difference in values between the music and non-music sessions for women (p=8.7e-6), but not for men (p=1.00) (19). Comparing the entire co-ed group resulted in a significant different also, with the entirety of that attributable to the results for women.
Scatter plots were constructed to illustrate differences between HR and RPE-B values for males and females for the music and non-music sessions (Fig. 5 and Fig. 6). One noticeable difference is that there is a larger range in HR values for the music session compared to the non-music session. Also, during the music session, women have a visibly high RPE-B than men, whereas in the non-music session, it is less distinct.
Figure 1: Mean Heart Rate Values for Males
The Effects of Music on HR and RPE in 20 Minutes of Treadmill Running

Figure 2: Mean Heart Rate Values for Females

![Graph showing mean heart rate values for females with and without music during 20 minutes of treadmill running.](image)
Figure 3: Mean RPE-B Values for Males

Mean RPE-B for Males

- Music
- No Music

Time (mins)
Figure 4: Mean RPE-B Values for Females

Mean RPE-B For Females

RPE-B

Music
No Music

Time (mins)

0 2 4 6 8 10 12 14 16 18 20
Figure 4: Mean RPE-B Values for Females

Mean RPE-B For Females

Time (mins)

RPE-B

Music
No Music
Figure 6: HR vs. RPE-B for Males and Females with Music
The Effects of Music on HR and RPE in 20 Minutes of Treadmill Running

Table 1: Descriptive Statistics For Variables Measured

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<th>Non-Music</th>
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<td>St. Dev</td>
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<tr>
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<td>1.47</td>
</tr>
<tr>
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## Table 2: ANOVA Results for Music vs. Non-music

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<td>HR at 14</td>
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<td>HR at 16</td>
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The Effects of Music on HR and RPE in 20 Minutes of Treadmill Running

Discussion

The hypotheses of this study were that subjects would report a lower RPE-B while running with music and that there would be a significant difference in HR between the music and non-music sessions. Based on the results of the one-way ANOVA, RPE-B and HR are not dependent on music, thus giving no support for the two original hypotheses.

The ANOVA was used to analyze significant differences in both HR and RPE-B values because previous research similar to this study considered it a statistically appropriate test (1). However, because RPE-B values are non-parametric data, a more appropriate statistical test, the sign test, was used to analyze this data a second time in the current study. The sign test results did indicate that there was a significant difference in RPE-B between the music and non-music session for the entire co-ed group. When gender was considered, only the results for the women were shown to be significant. These results suggest that women respond differently than men to auditory stimulation during sub-maximal running.

The experimental design for the two tests was intended to be a sub-maximal effort. Because all subjects reported prior to the experiment that they could run for 20 minutes, it was assumed that all subjects were fit and able to complete both sessions. However, out of the original 19 subjects, three dropped out of the non-music session before the end of the 20 minutes. It is possible that these individuals began to experience maximal effort, but that should have been indicated by the subjects through an RPE-B value of 20. The last reported RPE-B values of the three individuals’ were below 20: 15, 17, and 19. Possible explanations for these reported values is that the Borg Scale may
not be as valid a measure of exercise intensity as researchers previously reported (2-4,7), or the subjects were unable to appropriately determine perceived exertion levels.

The numbers on the Borg Scale were supposed to correspond to a heart rate at approximately ten times the RPE-B value. For example, an RPE-B value of 12 would correspond to a HR of 120. This observation occurred only four times in this study. Therefore, either the Borg Scale failed to be a valid measure of exercise intensity, or the subjects did not have a full understanding of the scale and its purpose. Further research in this area may focus attention on the Borg Scale validity as it relates to sub-maximal exercise intensities.

Aside from potential invalidity of the Borg Scale, there were some problems with the original experimental procedures. Ideally, it would have been beneficial for all subjects to complete the two sessions within one or two days of each other, and at the same time of day, with no bout of exercise in between. However, because of scheduling conflicts between subjects, the researcher, and the availability of the room, this was not always a guarantee. Another factor that could have influenced the outcome of the experiment is population size. Differences in HR and RPE-B between the music and non-music session might have showed more significance if the population was larger. All of these factors could have affected the results of the experimental sessions.

One important fact to be aware of in this study is that of the three subjects who dropped out of the non-music session, all were able to complete the session that included music. Not only that, but the RPE-B values were lower in the music session, despite the same HR. This indicates that the subjects were still experiencing the same intensity in both sessions, but their perception of intensity was lower during the session with music.
Although this is not statistically significant data, it is still relevant to the study and an important finding to consider.

**Suggestions for further research**

Previous research investigating RPE-B response to musical stimuli reported that music did have a significant impact on RPE-B (1). The researchers focused on psychological aspects of music types and not simply the presence or absence of music as a passive distracter (1). This may have contributed to the conflicting results between that study and this one. Future researchers could examine the psychological and physiological effects further by comparing different genres of music on RPE-B and HR values during exercise. Another possible suggestion is to investigate the effects of different tempos on RPE-B and HR. Within the current study, subjects’ paces noticeably changed, despite the constant treadmill speed, when a new song with a different tempo was introduced. Whether subconscious or not, this could indicate a psychological response to tempo change and might promote future researchers to investigate this implication.

After the completion of the music and non-music sessions, some subjects voluntarily self-reported that the music session seemed shorter and easier than the non-music session. Considering this response, it would have been beneficial to incorporate a post-test interview to ask the subjects which test seemed easier and why. Further research in this area might produce different results.

Because the validity of the Borg Scale was in question following the results of this study, researchers in the future may want to change the intensity of the experimental design to one that is of maximal effort. Another option is to use a different perceived exertion scale to estimate intensity during sub-maximal running and compare the results.
to those of this study. The effects of music on RPE-B could also be examined on an outdoor track where the subjects could be self-paced, which is more sport-specific than treadmill running. This test could be designed for sub-maximal or maximal effort.

Despite the fact that the results of the ANOVA did not support the hypothesis that RPE-B and HR would change significantly with music, the sign test did indicate that differences in RPE-B values between the music and non-music sessions were significant for women. Although the purpose of this study was not to determine different responses to exercise between genders, the results of the sign test provide evidence to suggest that females respond differently than males to auditory stimulation during sub-maximal exercise. There are still many unanswered questions about the psychological and physiological responses to exercising with music. Perhaps this study will allow future researchers to investigate new avenues of exploration in this area of research.
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References


APPENDIX A

**Informed Consent Agreement**

Please read this consent agreement carefully before you decide to participate in the study

**Project Title:** The effects of music on heart rate and RPE during 20 minutes of running.

**Purpose of the research study:** The purpose of this study was to investigate the effects that music may have on heart rate and ratings of perceived exertion while running.

**What you will do in the study:** You will be asked to wear a heart rate monitor and understand and apply the Borg Ratings of Perceived Exertion scale while running for 20 minutes. You will perform this test two times on two separate occasions. One session will include music that is self-selected and the other session will include no music.

**Time required:** Including the time required to put on the heart rate monitor and explain the Borg Ratings of Perceived Exertion scale, each test session should only take 30 minutes.

**Risks:** There are no risks.

**Benefits:** There are no direct benefits to you for participating in this study.

**Confidentiality:** All information that you give in this study will be handled confidentially. Your information will be coded with a number. The results of the study will include this number but will not include any of your information. Your name will not appear in the final report.

**Voluntary participation:** Your participation in this study is completely voluntary.

**Right to withdraw from the study:** You have the right to withdraw from the study at any time without penalty.

**How to withdraw from the study:** If you want to withdraw from the study, tell the experimenter. There is no penalty from withdrawing.

**Payment:** You will receive no payment for participation in this study.

**Who to contact if you have questions about the study:** Tara Litz, Telephone: (434) 544-5867, Email: litz_t@students.lynchburg.edu

**Who to contact about your rights in the study:** Dr. Peter Magyari, Institutional Review Board, Lynchburg College, Lynchburg, VA 24501. Telephone: (434) 544-8683. Email: Magyari@lynchburg.edu

**Agreement:**

I agree to participate in this study described above.

**Signature:**

___________________________________________________ Date __________________

We will receive a copy of this form for your records
APPENDIX B

Information

Name: ___________________________ Age: ________ Gender: ________
Weight: ________ Height: ________

How much do you exercise per day?: ________________________________
Per week?: ________________________________

Do you participate in athletics?: Yes/No (circle one)
If yes, which sport?: ___________________________ Varsity/Intramural? (circle one)
Are you in any academic societies?: ___________________________
What type of music do you primarily listen to?: ___________________________
Can you run for 20 minutes?: Yes/No (circle one)
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APPENDIX C

**Test Information**

Name: __________________________

Date: __________

Music used?: yes/no Genre: __________________________ Speed: _______

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