Effects of music tempos on blood pressure, heart rate, and skin conductance after physical exertion

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Abstract

Past research reveals that types of music varying in tempo, or beats per minute, can have physiological effects on the body. It is shown that fast tempo music of 120-130 beats per minute increases anxiety observed through an increase in blood pressure and heart rate, while slow tempo music of 50-60 beats per minute has the opposite effect on the body (Edworthy and Waring 2010). The present study measures heart rate, blood pressure, and Galvanic skin response (GSR) after two minutes of physical exertion while listening to rock, classical, and no music. Consistent with previous research, it was hypothesized that classical music will have a greater significance on lowering heart rate than rock or no music. Fourteen participants rode stationary bikes three times at two minutes apiece, followed by listening to different music tempos. Rock music produced a higher heart rate than any music tempo, $p < .01$. Classical music produced a higher systolic blood pressure than any other music tempo, $p < .01$. GSR, diastolic blood pressure and time were unaffected by music tempo, $p = .77$, $p = .99$, and .07 respectively. Future research should better control for individual differences and should include a larger sample size. Continued research on this topic could provide support for music therapy for patients who experience anxiety or tension.

Keywords*: heart rate, blood pressure, music tempo, GSR and tension.*

Introduction

Today, it is common to find people listening to music during many daily activities. The reasons for which they are listening to music and to what type of music they listen to varies with personal preference. The effect of music on an individual is an increasingly researched topic, especially in regards to emotional response, relaxation, and anxiety. One study found that while listening to a Mozart sonata, participants' tension increased as tempo increased and decreased with moderate tempos (Krumhansl 2002). It is also suggested that music increases learning ability and memory through different interconnected processes in the brain (Trappe 2010). The increasing number of studies on the effects of music on emotion and memory have led to further research at the cellular level.

Several recent studies suggest that music has a number of effects on participants at the physiological level. These studies provide evidence that leads some researchers to recommend music as a form of therapy. Trappe (2010) found that patients with anxiety, pain, stress, depressive syndromes, and sleeplessness will benefit the most from listening to classical music as it caused both heart rate and blood pressure to decrease. This same study suggested that hip hop and rap music, associated with fast tempos, cause negative influences on patients by increasing their blood pressure and heart rate. A similar study by Iwanaga and Youko (1999) showed that listening to music reduces patients' anxiety pre-surgery as measured by their systolic blood pressure and heart rate. It was also found that certain types of music, like fast and slow tempos, have different effects on physiological measurements during exercise. In one study, participants preferred higher tempo music while exercising, shown by an increase in physiological arousal (Karageorghis, Jones, and Low 2006). Edworthy and Waring (2010) observed the effect of slow versus fast tempo music and found a significant difference between the heart rate of participants who exercised while listening to fast-loud music versus slow-quiet music. In the same study, researchers compared the effects of slow versus fast music and found significantly higher heart rates in patients who exercised while listening to fast-loud music versus slow-quiet music.

According to all of these studies, music can have an effect on the physiological measurements of a person who is experiencing an increase in blood pressure or heart rate due to anxiety or physical exertion. Following these studies, the current study expects that slow tempo music will return participants' heart rates to baseline faster than fast tempo music. This is based on findings that fast tempo music is shown to increase physiological arousal and slow tempo music is shown to relax a patient. The physiological arousal of participants will be measured through heart rate, blood pressure, and Galvanic skin response (GSR). GSR is used to measure the physiological arousal of participants through skin conductance. If the blood pressure and heart rate both increase with physiological arousal, the GSR measurement should also increase. Monitoring the heart rate will show the amount of time needed for participants' heart rates to return to baseline while listening to different types of music. In agreement with the literature, it is expected that classical music will relax participants faster than fast tempo music. The purpose of this experiment is to test whether music tempo has a direct effect on returning heart rate to baseline. More specifically it could provide evidence that slow tempo music can effectively reduce the heart rate after physical exertion.

Methods

Three female and one male experimenter from the University of Wisconsin-Madison voluntarily recruited participants. There were 14 participants (7 females) ages 20 – 22 years old

(*M* = 21.14, *SD* = 0.86). Participants first signed a consent form (Appendix A) and filled out the background survey (Appendix B) regarding health and lifestyle. The researchers then connected the participants to the GSR, heart rate, and blood pressure apparatuses to get baseline measurements for each (Figure 1). Participants then went into the hallway and sat on an exercise bike. Researchers told participants to ride the bike until their heart reached and remained above 130 bpm. After reaching 130 bpm they rode at a consistent pace, while maintaining above 130 bpm for two minutes (Figure 1). After two minutes, the participant stopped pedaling and the experimenter immediately placed the headphones on the participant and played the music according to the randomized counterbalancing. Participants sat in the classroom in a chair next to the computer while listening to the music. When listening to rock music with a fast tempo of 120-130 beats per minute on average, participants heard *Thunderstruck* first, followed by *TNT, Highway to Hell,* and *Dirty Deeds.* When listening to classical music with a slow tempo of 50-60 beats per minute on average, *The Redeemer* played on repeat. In all trials for every participant, music volume was kept constant. However, loudness variation within each song was not considered. The music played until the participant's heart rate returned to their original resting heart rate or for 600 seconds. If heart rate returned to normal prior to 600 seconds, experimenters recorded the time and then measured GSR and blood pressure (Appendix C). If, after 600 seconds, heart rate was not back to resting, the heart rate, blood pressure and GSR were all measured at 600 seconds. After this set of measurements participants went back onto the bicycle and repeated the entire process with a music variable change. After the second exercise and data collection round, participants went on the bike for a third and final time. Following the last set of measurements, researchers thanked participants. Sessions lasted approximately 25 minutes.

Figure 1 Left: A subject being observed as her heart rate returns to baseline while listening to classical music. Her right hand is attached to the GSR and her right hand is attached to a heart rate monitor. Right: A subject is increasing her heart rate by aerobic exercise.

Results

To determine the effects of music type on heart rate, blood pressure, and GSR, after exercise, three 1 x 4 factor ANOVAs were conducted with Bonferroni post hoc tests as a follow up. Also, to examine the effects of music type on time it took heart rate to return to baseline a 1 x 3 factor ANOVA was conducted with Bonferroni post hoc tests. It was expected that listening to rock music after exercise would maintain a higher heart rate longer, where as classical music would lower heart rate to baseline faster. A statistically significant difference is considered a p-value of < .05. A highly significant difference is considered a p-value of < .01.

There was a high significant difference of music tempo on heart rate, $F(3, 39) = 7.67$, $p < .01$ (Figure 2). While listening to rock music, participants had a higher ending heart rate ($M = 80.64$, $SD = 15.17$) than their baseline ($M = 69.07$, $SD = 11.87$), $p < .01$. While listening to classical music, participants' heart rate was not higher ($M = 73.36$, $SD = 11.86$), than their baseline, $p = .48$, or lower than rock music, $p = .11$. While not listening to music participants' heart rate was not higher ($M = 75.57$, $SD = 12.42$), than baseline, $p = .14$, classical, $p = 1.00$, or rock, $p = .24$ (Appendix D).

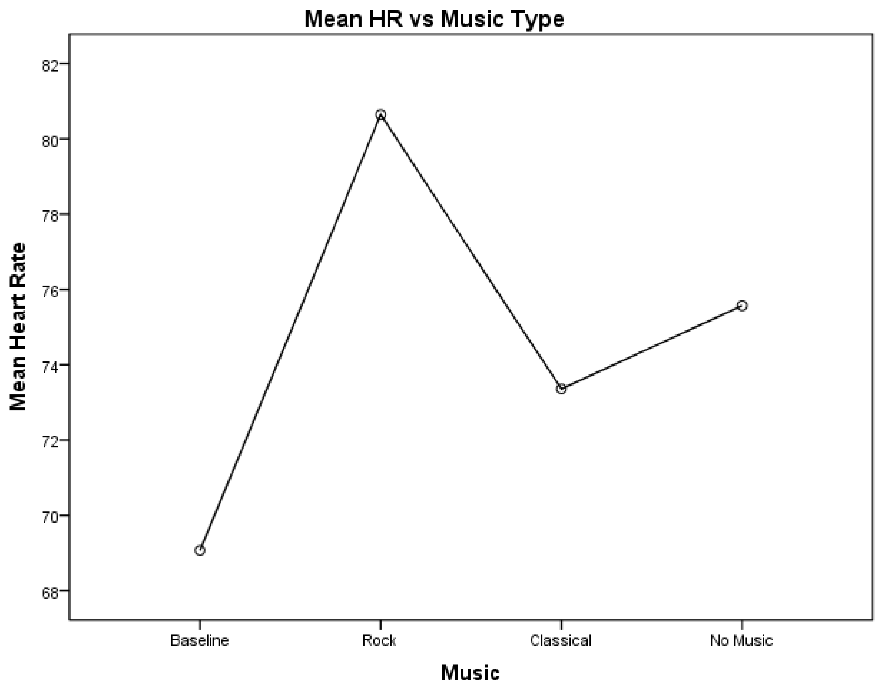

Figure 2 Displays the significant difference of heart rate between music types.

There was also a high significant difference of music tempo on systolic blood pressure, $F(3, 36) = 4.47$, $p < .01$ (Figure 3). While listening to rock music, participants did not have a higher ending systolic blood pressure (M =122.21, SD = 18.57) than their baseline (M =127.00, SD = 15.96), p = 1.00. While listening to classical music, participants' systolic pressure was not higher (M =139.00, SD = 17.69), than their baseline, p = .06. However, listening to classical music created a higher systolic blood pressure than rock, $p < .01$. While not listening to music, participants' systolic blood pressure was not higher (M =130.29, SD = 21.17), than baseline, p = 1.00, classical, p = .77, or rock, p = .16 (Appendix E).

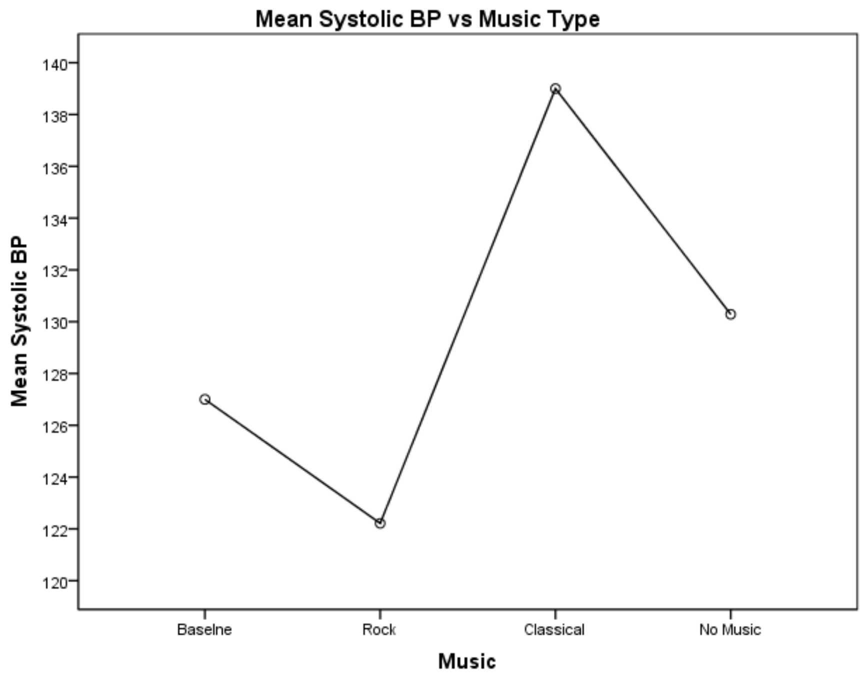

Figure 3 Displays the significant difference of systolic blood pressure between music types.

There was no significant difference of music tempo on diastolic blood pressure, $F(3, 36) = .043$, $p = .99$. While listening to rock music, participants did not have a higher diastolic blood pressure ($M = 77.07$, $SD = 12.92$) than their baseline ($M = 76.57$, $SD = 10.74$), $p = 1.00$. While listening to classical music, participants' diastolic blood pressure was not higher ($M =77.86$, $SD = 10.47$), than their baseline, $p = 1.00$ or rock, $p = 1.00$. While not listening to music participants' diastolic blood pressure was not higher ($M =77.21$, $SD = 10.03$), than baseline, $p = 1.00$, classical, $p = 1.00$, or rock, $p = 1.00$ (Appendix F).

There was no significant difference of music tempo on GSR, $F(3, 36) = .38$, $p =.77$. While listening to rock music, participants did not have a higher GSR ($M =13.03$, $SD = 5.00$) than their baseline ($M =12.76$, $SD = 4.56$), $p = 1.00$. While listening to classical music, participants' GSR was not lower ($M =12.51$, $SD = 5.92$), than their baseline, $p = 1.00$ or rock, p

= 1.00. While not listening to music participants' GSR was not higher (*M* =13.14, *SD* = 4.90), than baseline, $p = 1.00$, or classical, $p = 1.00$, or rock, $p = 1.00$ (Appendix G).

There was no significant difference of music tempo on time to baseline heart rate, $F(2, 24) = 2.91$, $p = .07$. While listening to rock music, participants' heart rate did not take longer to return to baseline (*M* =498.86, *SD* = 158.80) than classical music (*M* =348.36, *SD* = 207.21), $p = .18$. Also rock music did not prolong heart rate more than not listening to music (*M* =420.93, *SD* = 169.12), $p = .23$. While listening to classical music, participants' heart rate did not take longer to return to baseline than when not listening to music $p = .95$ (Appendix H).

Discussion

As expected, while listening to rock music, participants maintained a higher heart rate than their baseline, more so than when listening to classical or no music. Participants also had higher systolic blood pressures while listening to classical music than rock, which could be attributed to the participants' physiological differences and procedural problems. Although not significant, classical music tended to lower heart rate faster than rock or no music. Unexpectedly, GSR was not affected by music tempo.

Throughout the duration of this experiment, many strengths and weaknesses surfaced. First, the data was effectively measured as stated in the original methods. Also, the group dynamic fostered a productive and efficient atmosphere that was fun yet educational to work in. The experiment yielded data with trends that further research could develop into significant findings. For example, a highly significant effect of rock music on heart rate was observed, which is important considering there were only 14 participants. Future research could use this effect as a starting point and could further develop it. A final strength to be considered is that the age range of the participants was small, which is important in cardiovascular and hearing studies, as both systems change continuously over time.

The experiment also had several unexpected problems that caused slight alterations in the original procedure and data interpretation. First, the equipment used during the procedure was not consistent. For example, in one trial, the batteries in the heart rate monitor died and had to be replaced in the middle of the participant's physical exertion. This could have negatively affected the data because the monitor may not have been working properly. Additionally, prior to the start of the experiment, all group members agreed upon the methods. Unfortunately, there could have been slight variation when each member took measurements, leading to a slight discrepancy in the results. Also, it took more time for the participants' heart rate to drop to their baseline than originally expected. Therefore, on each trial, participants were given a maximum of ten minutes to drop to their baseline. If after 600 seconds the baseline was not reached, the heart rate was recorded at that time.

It is also important to consider the "practice effect" when interpreting the data. It was possible that the participant knew what to expect after completing the first trial and then could mentally alter their heart rate knowing what was being measured and expected of them. Also with that, it is possible that participants tired after the first or second trial and therefore by the final trial were more exhausted. The practice effect is also sometimes known as "testing effects" (Ray 2009). To compensate for practice effects, each subject was randomly assigned an order in which they would receive each treatment.

The original procedure stated that each trial was not over until heart rate, blood pressure, and GSR returned to the individual's baseline. It became difficult to simultaneously record all of these measurements, so the procedure was altered. Once the participant's heart rate reached baseline, blood pressure and GSR were recorded at this time.

In addition, due to a time constraint, a limited number of participants were tested. Even after taking advantage of class time and utilizing the open lab after hours, only seven participants of each gender were able to be tested. Ideally, more participants would be tested in order to receive more data from which more accurate conclusions could be drawn.

Also while background surveys were used to collect music preferences, more information could be gathered on athletic ability. It seems unreasonable to assume that participants who exercise regularly experience the same effects from working out on the stationary bike as someone with less athletic training. It would be beneficial for future research to control for athletic ability.

For future groups attempting to follow this procedure, there are some changes that could be made to ensure more accurate results. First of all, it is speculated that participants might have been able to lower their heart rate faster when tested in lab after hours because there were no other students in the room. During scheduled class time, there were thirty other students moving around in the room making a lot of noise, which does not produce a relaxing environment and could have been a confounding variable in preventing heart rate from returning to baseline. Also, during lab time, some of the tested partipants were participating in other experiments, meaning that participants might have received caffeinated soda or other energy drinks. Again, these beverages may have affected participants' heart rates. Lastly, future groups could extend the artificial 600 second time constraint for reaching heart rate baseline that was placed in this study with an unlimited experimental time.

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