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Does Music Directly Affect a Person's Heart Rate?

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Summary

Music can have a profound effect on a person's body, in that it may cause people to dance and move around, but does it have a direct and significant effect on a person's heart rate if they are still? In this study, 24 high school students' heart rates were recorded while listening to 6 selections of 6 different genres of music. The effect of different types of music was tested using heart rate monitors, data collection software, and music from free music archives. We found that music has a significant impact on heart rate. Average heart rates were significantly higher after listening to rock music, despite that selection having the slowest tempo of the six genres tested. Heart rates also significantly decreased after listening to classical music and significantly increased after listening to the subjects' favorite musical selections. This indicates that someone may be able to decrease or increase their heart rate by simply listening to music. While significant patterns emerged, the study was limited, in that the order of the music was the same for every individual, the sample size was relatively small (n = 24), and heart rates were highly variable between subjects.

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Introduction

Music has an impressive impact on a person's mood, thoughts, and outlook (1). While it is known that music has a profound effect on a person's mentality, it is unknown whether or not it directly affects their physicality. Listening to music can result in the listener tapping his foot, bobbing her head, or drumming his hands to the beat. Increased physical activity is incredibly healthy and results in a multitude of benefits (2), although moderate movement while listening to music is unlikely to get heart rates to the same level as vigorous exercise. Nevertheless, any level of physical activity improves mood, helps to control weight, strengthens muscles and bones, and reduces the risk of heart disease (3). With this in mind, we wish to understand how music affects heart rate. Improvements in understanding the features of music that alter heart rate could form the basis for a new form of 'cardio' exercise consisting solely of listening to specific types of sound waves.

A 2005 study showed that heart rates and blood pressures of subjects increased while listening to music with a faster irregular tempo (4), but another study found that heart rates of subjects decreased while listening to their choice of music (5). Based on the limited knowledge behind the physical effects of listening to music, this study attempted to test whether this mental activator has any effect on the heart rate of high school students. A similar study on high school students was done in 2013, but that study only tested the difference between two songs: one with a slow tempo and one with a fast tempo (6). The present study tested six different genres of music in students and asked students to select their favorite of the musical selections they heard, in order to control for musical preferences among listeners.

We hypothesized that the subject's heart rate would correlate with the tempo of the music. This is consistent with prior research (4) and is based on the thought that music with a fast tempo may increase heart rate because of the fast beat. Interestingly, our findings were not consistent with our hypothesis; average heart rates of subjects across the different genres of music were not statistically different. However, we did find that students' heart rates were significantly lower after listening to classical music, and higher after listening to rock music and after listening to their favorite musical selection.

Results

Since it is unknown which features of music can directly and significantly increase heart rate while high school subjects are not physically active, this study attempted to determine the effect of different genres of music on a stationary subject. It was hypothesized that faster tempos would correlate to faster heart rates. To test this hypothesis, we asked high school students to hold a heart rate monitor in a quiet, dark, private conference room while remaining still and listening to 6 different musical selections. After students' heart

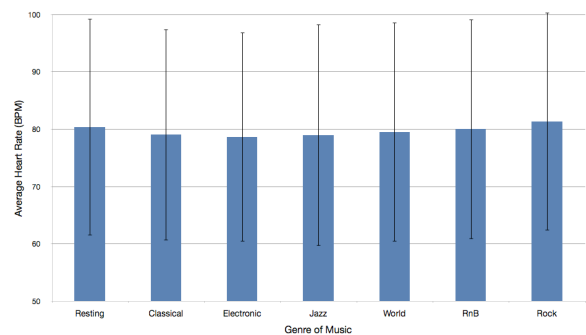


Figure 1: Average heart rate of students (in beats per minute, BPM) while listening to each musical selection. Error bars indicate standard deviation.

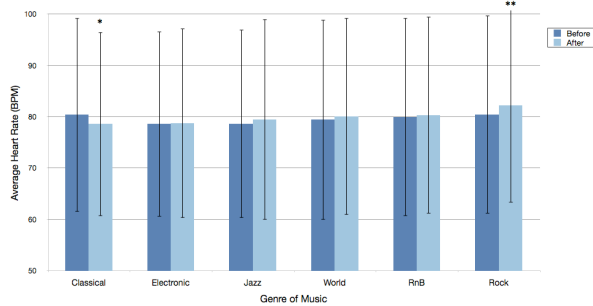


Figure 2: Average heart rate of students (in beats per minute, BPM) before (dark blue) and after (light blue) listening to each musical selection. Error bars indicate standard deviation. * significantly different pre/post (paired t-test, $p < .05$), ** significantly different pre/post (paired t-test, $p < .01$).

rates settled, the musical selections were started, each lasting 30 seconds with 2 seconds of silence between them. This experiment showed that music does not have a significant impact on average heart rate when looking across all musical selections compared to resting heart rate. Average heart rates of subjects while listening to the different genres of music were not statistically different (ANOVA, $F = 0.60$, $p = 0.999$) than their resting heart rates (Figure 1). This finding rejects the hypothesis that an increased tempo of music increases heart rate.

While the average heart rates over the course of each musical selection were not different from resting heart rates, the average heart rates before and after each musical selection showed some significant differences (Figure 2). Heart rates after listening to classical music were significantly lower than before listening to the classical selection (paired t-test, $p = 0.021$), and heart rates after listening to rock music were significantly higher than before listening to the rock selection (paired t-test, $p = 0.0097$). The classical selection had the second fastest tempo of the six selections while the rock selection had the slowest. Heart rates decreasing after listening to the fast tempo classical selection and increasing after listening to the slowest tempo rock selection also rejects the hypothesis that higher tempos will result in higher heart rates.

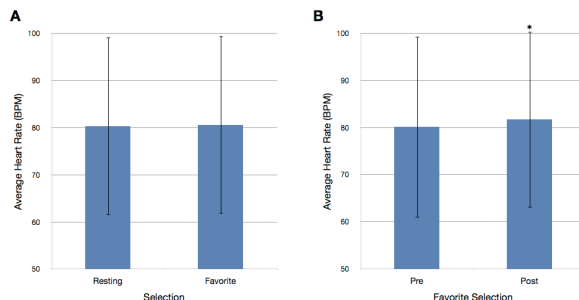


Figure 3: (A) Average heart rate (in beats per minute, BPM) at rest and during favorite selection. Error bars indicate standard deviation. (B) Average heart rate (BPM) before and after favorite selection. Error bars indicate standard deviation. * significantly different pre/post (paired t-test, $p < 0.05$).

Favorite Selection	Number of Students
Classical	3
Electronic	4
Jazz	0
World	3
RnB	4
Rock	10
Total	24

Table 1: Students' self-reported favorite musical selection of the six genres heard.

Interestingly, 41.7% of the students (10/24) indicated that the rock selection was their favorite of the six musical selections (Table 1). While the average heart rate of students over the course of their favorite musical selection was not significantly different than their resting heart rate (Figure 3A, paired t-test, $p = 0.79$), heart rates of students significantly increased after listening to their favorite musical selection (Figure 3B, paired t-test, $p = 0.045$).

Discussion

This study investigated whether music has a direct and significant effect on heart rates of high school students. The results show that subjects' average heart rates over the course of each musical selection were not significantly different from resting heart rates (Figure 1). However, heart rates after listening to the classical selection were significantly lower than before that selection and heart rates after listening to rock music were significantly higher than before that selection (Figure 2). Additionally, subjects' heart rates were significantly increased after listening to their favorite musical selection (Figure 3B). It was hypothesized that the faster the tempo of the song, the faster the subjects' heart rates would be. Our results rejected the hypothesis, finding no difference in average heart rates over the course of each musical selection, as well as a decrease in heart rate after the classical selection (the second fastest tempo) and an increase after the rock selection (the slowest tempo).

Several limitations restrict the interpretations of these findings. Despite our efforts to establish baseline heart rate conditions, other factors, such as having physical exercise prior to the administration of the test, coming from lunch, or having a stressful day may have influenced individual performance. Future studies should attempt to eliminate as many of these outlying factors as possible. Another limitation to this study is the sample size of 24 students. Though the subjects in this study were a diverse mix of genders, ethnicities, and grades (9-12), future studies should also include a larger sample size to increase statistical power. As the heart rate changes we

observed were relatively small, increasing the sample size could potentially make more findings statistically significant. Musical selections were also in the same order (classical, electronic, jazz, world, RnB, rock) for each student. To remove the possible effect of order of the music on heart rate, future studies should randomly shuffle the genres for each student, as well as include other control conditions such as silence, static, and random noises to control for music versus other auditory stimuli. Additionally, the interval between each song was only 2 seconds; other studies should increase the amount of time between songs to allow sufficient time for the heart rate to return to resting and to control for carry-over effects from the previous musical selection. Larger studies should also include multiple music samples for each genre with a variety of tempos in each genre to determine if changes in heart rate correlated with genres, tempos, or both. Although our study has several limitations, we show genre of music is an important factor to consider and we performed our experiments with 24 high school students during time-constrained classroom hours.

Overall, the high variability in heart rates (see standard deviations in Figures 1-3) and heart rate increases and decreases during the course of each musical selection (see Figure 4) made data interpretation and finding significant results challenging. Not surprisingly, the three students who came directly from physical fitness class had the three highest resting heart rates and increased the standard deviations a great deal. Because of this high variability, it was impossible to find any significant differences in the average heart rate of students over the course of each musical selection compared to resting heart rates (Figures 1, 3A).

Prior research has shown that heart rates and blood pressures increased with a faster irregular tempo (4), and another study has shown subjects' heart rates decrease while listening to music of their choice (5), indicating that song tempo and musical preference both play a role in heart rate while listening to music. However, the findings of the present study are not consistent with either of these previous findings. The rock music selection was the favorite of 41.7% of students and had the slowest tempo, yet the high school students tested had significantly higher heart rates after listening to this selection. Conversely, the classical music selection was a favorite of only 12.5% of the students and had the second fastest tempo of the six selections, but the high school students tested had lower heart rates after listening to this selection.

It has long been known that classical music is "relaxing" and has been used in recent years as a therapy to relax a diverse array of subjects, including but not limited to: students before exams, Alzheimer's patients, and patients undergoing surgery (7-9). Considering the past research on the relaxation potential of classical music and the results of this study, our results suggest that the genre of music should be considered along with the tempo and musical preference of subjects when determining the effect of music. Our finding that

subjects' heart rates significantly decreased after listening to classical music but increased after listening to rock music may indicate that high school students find certain genres of music more "relaxing" and others more "stimulating", regardless of preference or tempo. This information should be useful to anyone wanting to create a "relaxed" (i.e. prior to surgery) or "energetic" (i.e. during a physical workout) atmosphere.

In conclusion, the results show that music can significantly impact a person's heart rate. Although this study is not able to determine how each genre of music directly alters heart rate, we find that students' heart rates significantly increase after listening to rock music and significantly decrease after listening to classical music. Additionally, students' heart rates significantly increase after listening to their favorite musical selection.

Methods

Twenty-four high-school students, six from each grade 9-12, twelve male and twelve female, were given consent forms to sign prior to the experiment. The first three males and first three females from each grade who returned the forms were chosen for the experiment. Subjects were tested in a quiet, private, dark conference room. They were instructed to hold the heart rate monitor but to remain still. Students were allowed to adjust to the room and holding the heart rate monitor prior to testing. Testing began when their heart rates steadied.

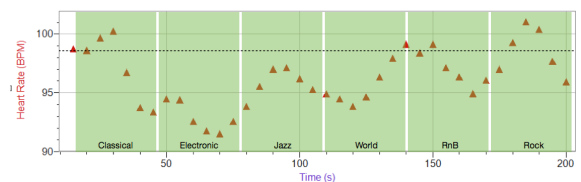


Figure 4: Sample of a subject's heart rate (in beats per minute, BPM) during the course of listening to the six genres of music. Green blocks indicate time in which student was listening to specific musical selection, white spaces indicate silence. Dashed line indicates resting heart rate.

Selections of six pieces of music, each of a different genre (classical, electronic, jazz, world, RnB, and rock) were retrieved from various free music websites and compiled into one single sound file. Each musical selection was thirty seconds long, and two seconds of space were left between each selection. Every selection was unfamiliar to all of the subjects. Tempos for each musical selection were found in beats per minute (BPM) using Shockwave-Sound (<http://www.shockwave-sound.com/tools/tap-BPM-tempo.html>) and were as follows: classical, 125 BPM; electronic, 119 BPM; jazz, 154 BPM; world, 124 BPM; RnB, 99 BPM; rock, 79 BPM. After listening to the musical selections, each student was asked his or her favorite genre and favorite selection of the six he or she had just heard.

The heart rates were recorded while listening to an audio file containing selections of six different genres

of music (Figure 4). The students remained stationary throughout the testing in a private, darkened conference room. A hand-held heart rate monitor was used (Vernier) along with Vernier LoggerPro software to measure and record the heart rate of each student. Each student's heart rate was tested, recorded, and saved. Each line graph from LoggerPro was adjusted to have roughly equal intervals, cropped using Microsoft Snipping Tool, and saved as an image on the computer. An example student heart rate graph is shown in Figure 4. Then, the line graphs and accompanying data table were examined to calculate the average heart rate for each thirty-second selection, as well as the change in heart rate during the selections. This data was inserted into a Microsoft Excel Spreadsheet and each student's average heart rate for each thirty-second selection was calculated, as well as the change in heart rate during the selection. The average heart rates and changes in heart rate for each selection were compared.

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