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Effect of Music on Rating of Perceived Exertion and Duration of Physical Activity

Mia Hines

Honors Project

Submitted to the Honors College
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Introduction

Sound and music surround us and our lives every day. Music is promoted to us as a tool to focus, reduce stress and anxiety, feel better mentally and physically, and is even shown to help people retain information when learning something with music (Akomolafe, 2020). In terms of physical activity and exercise, we see music embedded in these areas everywhere. There is warm-up music for sporting events. Marching bands often perform music selections during halftime of games. A new method of home workouts became popular on YouTube in 2020 called Song workouts or Dance Party workouts and is set to music, taking inspiration from Zumba, where the exercises and movements line up with the beats of the music. Whether for pleasure or scientific reasons, music is often connected to physical activity and exercise. I set out to explore if there was any scientific background to how music affects people in their physical activity.

Through concluding my Exercise Physiology classes through Bowling Green State University, I was introduced to the Rate of Perceived Exertion (RPE) scale as a measurement tool for assessing exertion. In our laboratory sessions, we used the RPE scale in the context of a maximal exercise test where we asked runners “How hard do you think you are working right now?” at several timestamps until they felt they needed to stop. The RPE scale was designed to define a person’s exertion in terms of physical cues where increased heart rate, breathing rate, sweating, and muscle fatigue are assessed as a whole (Martin, 2021).

Duration of physical activity and exercise is the other aspect we suspected could be impacted by music intervention. Runners can improve their running speed either by increasing their stride rate or stride length. A common point of research connecting running and music is stride and beats per minute. Motivational music and synchronization have been shown to extend a runner’s time to exhaustion compared to when there is no cadence or music (Bood et al., 2013).

Taking the concept of a metronome from the research study conducted by Bood et al. (2013), a practical application is matching a runner's pace to the beats per minute of a song. Synchronizing their steps to a song is an easy way to speed up or slow down their pace.

Connecting all of these ideas led me to an interest in looking at the relationship between music, exertion, and duration of exercise. The aim of this study is to explore if listening to music improves a person's RPE and duration of exercise. This will lead to a basis of understanding for how music intervention can improve a physical therapy patient's motivation for treatment. With regard to physical therapy, a therapist's rapport with a patient is conducive to effective treatment and music has the potential to play a factor in the safe, welcoming environment for a patient. Finding a way for each patient to adhere to their prescribed exercises is a battle for therapists and based on the existing literature, it is believed that music effectively helps the RPE during exercise.

For this research project, the goal was to retrieve additional information on the relationship between music and physical activity in order to provide clarity to the current conflicting literature. In this study, we examine the following research question: In college-aged students who listen to music while exercising, is there a difference in rate of perceived exertion and duration of exercise compared to college-aged students that do not listen to music while exercising?

Literature Review

Most studies are focused on alternate outcomes, such as fitness performance, pain, and dissociative effects of music as the main effect, but RPE and duration of physical activity are often recognized as an additional outcome. The knowledge of the topic of the effects of music on RPE and duration of physical activity are inconclusive. The existing literature on the topic has

conflicting results. Some conclusions state listening to music has no effect on exercise performance and has no change in RPE. Some studies resulted in shorter exercise duration and lower RPE when the participants were listening to music during their activity. A smaller number of studies resulted in a higher RPE when listening to music during the activity.

Atan (2013) recruited college students for their study, and they performed anaerobic fitness while listening to fast music, slow music, and no music. Atan (2013) found that the fitness performance of the participants was unaffected by the presence or tempo of the music. In a systematic review and meta-analysis composed by Castaneda-Babarro (2020), the effect of music listening was explored with the specific activity of performance of the Wingate anaerobic test. Castaneda-Babarro (2020) found that improvements in performance on the Wingate test were not significantly related to listening to music. In a study where RPE was recorded every minute of a stationary bicycle exercise, Maddigan (2019) found that there was no statistically significant change in the RPE.

The use of rehabilitation as a setting for the studies was less common but the findings remain inconclusive. Although this study will not be evaluating the rehabilitation setting, the research adds to the existing literature because it emphasizes the impact on a process of healing and could benefit physical therapists in their own clinical setting. Lim (2011) conducted a study for rehabilitation patients and researched if the presence of music during rehabilitation had any effect on their pain and RPE. Lim (2011) found that between a therapeutic instrumental music performance group and traditional occupational therapy, there was no evidence of a change in RPE due to listening to music. A study performed by Cho (2009) had patients engage in either an upper extremity exercise program where the intervention was either occupational therapy or music therapy. The patients in this study ranged from 22-86 years old which is a much wider

range than the present study, but Cho (2009) found that the average RPE was lower in patients with music therapy. A small part of the literature is focused on the type of music chosen in exercise studies.

Clark et al. (2016), performed a study where older participants were involved in a walking program following cardiac rehabilitation and the authors monitored their music preferences and analyzed the music. The preferred music for their walking exercises had a moderate to fast tempo, was in a major key, and had predictable harmonies with a consistent pulse (Clark, Baker, & Taylor, 2016). Participants were asked how the music influenced them while walking and if it impacted how they felt. While there was no numerical data, several of the comments from participants support the theory that music helped to increase their heart rate and their effort while walking. In addition, some participants stated that music helped to motivate them to walk when they were feeling more stressed or anxious about the exercise (Clark, Baker, & Taylor, 2016). Another study looked at the effect of music in cardiac rehabilitation with patients previously having undergone a coronary artery bypass graft. Murrock (2002) analyzed RPE for these cardiac rehabilitation patients and found that there was no significant change with music compared to not listening to music. The other outcome monitored by Murrock was mood changes and the participants in the music group reported improved general mood (Murrock, 2002).

As mentioned before, the overall results determined from the literature are inconclusive if listening to music during exercise improves RPE. There are several studies where the authors found an increase in RPE when listening to music. Bonnette, Smith, Spaniol, Ocker, & Melrose (2011), performed a study with undergraduate students and the participants ran a mile and a half under a music condition and a control. The participants were running at a high intensity and

when they listened to music, their running times improved and their RPE was higher (Bonnette et al., 2011). The concept of running intensity was further explored with listening to music. It is suggested that once a person is running or exercising at a certain intensity, the effect of music is lowered and the exerciser perceives that they are working hard regardless of the possible dissociative effect of music. Atkinson, Wilson, & Eubank (2004), also explored the concept of the dissociative effect of music in a study with cyclists on a 10KM ride. In a setting where the participants need to ride a specific number of kilometers, the authors concluded that the duration of exercise was lower since the average pace of the participants was faster when listening to music (Atkinson et al., 2004). Although the pace of the riders was higher with music, the average RPE was higher compared to when they did not listen to music. Chtourou, Chaouachi, Hammouda, Chamari, & Souissi (2012), explored the effect of music listening in the warm up before an exercise. The subjects performed four experimental test session in a random order: Two session in the morning and two sessions in the evening with either a ten minute warm up with music or a ten minute warm up without music. The majority of the literature involves the intervention of music during the activity but these authors wanted to explore if listening to music before the activity had an effect on muscle power output and RPE. Each participant recorded their RPE after a warm up, and after the Wingate test (Chtourou et al., 2012). The results showed there was an increase in power output for those in the study that used music in their warm up, compared to those who did not use music. In addition, the increase was more significant during the morning warm up.

The authors found that the average RPE was higher during their warm up. The authors had the participants perform the warm up and activity at seven in the morning and five in the afternoon. They found that the muscle power output was higher and improved in the afternoon

(Chtourou et al., 2012). In addition to RPE, an alternate outcome researched in rehabilitation patients was adherence to exercise. Chair, Zou, & Cao (2021), performed a study involving patients with coronary heart disease participating in various treadmill exercises. The findings show that the music group had a higher attendance and adherence to the exercise along with lower recorded RPE (Chair et al., 2021).

Instead of solely measuring exercise performance, some researchers monitored emotion, affective valence, and pleasure as additional outcomes. Benham (2014) conducted a study on junior high students and wanted to research their level of physical activity and mood when listening to music. The research showed that music increased the participants' enjoyment. Throughout the range of music played during their physical activity, the level of physical activity was highest when the music selection had a fast tempo (Benham, 2014). Bird, Hall, Arnold, Karageorghis, & Hussein (2016) researched music and music with video as interventions with participants on a cycle ergometer. Their main outcome measured was affective valence and they found that both music and music with video had higher positive affective valence compared to no music during their exercise (Bird et al., 2016). In another study of traditional treadmill running, exercise intensity was monitored when listening to music and the participants reported having much higher remembered pleasure of the exercise (Hutchinson et al., 2018). Psychological effects in general have also been explored as an outcome for music tempo during exercise. Karageorghis, Jones, & Stuart (2008) conducted a study with participants with an average age of 20 years old and the music for the intervention was either medium tempo, or fast tempo. The participants exercised on a treadmill at 70% of their max heart rate reserve under multiple conditions of music and the authors found that the medium tempo music produced the highest levels of intrinsic motivation (Karageorghis et al., 2008).

In a couple of the sources I discovered, there was an improvement in RPE and variant results for exercise performance. In a study performed by Bigliassi, Karageorghis, Hoy, & Layne (2019) task performance and RPE was monitored after a 400 meter run completed in silence, with music, and with a podcast. Task performance was unaffected by any audio stimulus and the average RPE was highest in the control, lowest with the music and the podcast had ratings in between those two conditions (Bigliassi et al., 2019). Different types of music were researched as an intervention for riding a stationary bike in a study (Connon, 2011). In terms of exercise performance and RPE, Connon (2011) found that performance was increased with all conditions of music and the average RPE was higher in the group that exercised in silence.

Overall, there was no one overwhelming conclusion from the literature and the studies seem to prove how the outcomes of the participants are more dependent on the individual and less dependent on the presence of music or the type of music.

My interest in the topic of the effect of music on RPE and duration of exercise developed from my interest in music therapy. Since my first year Introduction to Psychology course, I had a peaked interest in how music affected the brain. There were cases of people with impaired memory who would listen to music and be able to remember and sing the lyrics to the song. From then on, I was inspired by the power of music. Adjusting focus from the brain to exercise performance, I wanted to research if listening to music altered a person's focus and in turn affected their RPE and how long they exercised. I want to use this literature and original research and apply it in my future career as a physical therapist and hopefully help increase their adherence to the exercises and improve health in patients.

In this study, we examine the following research question: In college-aged students who listen to music while exercising, is there a difference in rate of perceived exertion and duration of exercise compared to college-aged students that do not listen to music while exercising?

Methods

The present research was conducted at Bowling Green State University (BGSU), a mid-size university campus in Bowling Green, Ohio. Participants consisted of 120 students. After the opening statement detailing informed consent, one participant gave their informed consent and then did not continue the survey. The inclusion criteria included participants between the ages of 18 and 25 and participants that were physically active at least one day a week. Seven participants were outside of the parameters for the acceptable age range of 18-25 and were not eligible as part of the data and one participant did not continue the survey, reducing the number of participants to 111.

As part of the recruitment plan, a list of BGSU e-mails was provided from the Office of Institutional Research Data Request Form. No BGSU e-mails were received from the request, so our method of delivery was changed. The survey and survey script were sent to two BGSU student organizations. The BGSU Honors College runs a weekly newsletter and an invitation to participate in our survey was included in the newsletter for one week. The invitation to participate in our survey was also included on the BGSU Campus Update which is a daily update of events and activities on campus. The survey was posted on Campus Update two separate times. The final method of survey distribution was by Dr. Morgan on behalf of Mia Hines. Dr. Morgan emailed the students from both of her Exercise Science classes and invited them to participate in the survey.

In an effort to determine the effect of music on exercise, a six-question survey (see Appendix I) was to be distributed via email to students at Bowling Green State University. The study design is a cross-sectional study. The present research study was approved by the Institutional Review Board on October 27th, 2021.

The flow of the survey was conditional to the responses declared by the participants. After eliminating the participants who did not meet the inclusion criteria or did not continue the survey, the number of viable participants was 102. Once determining a participant was physically active, they were asked to explain their average activity according to its duration and declare their RPE based on the RPE scale (see Appendix II). Participants then addressed if they preferred to listen to music or not during their physical activity and if they did listen to music, they had the ability to declare any specific musical genres.

Results

The ages of the participants ranged from 18 years old to 25 years old and the majority of them are within 18 years old and 22 years old with a very small portion of participants aged 23-25 years old (see Figure 1).

What is your age?

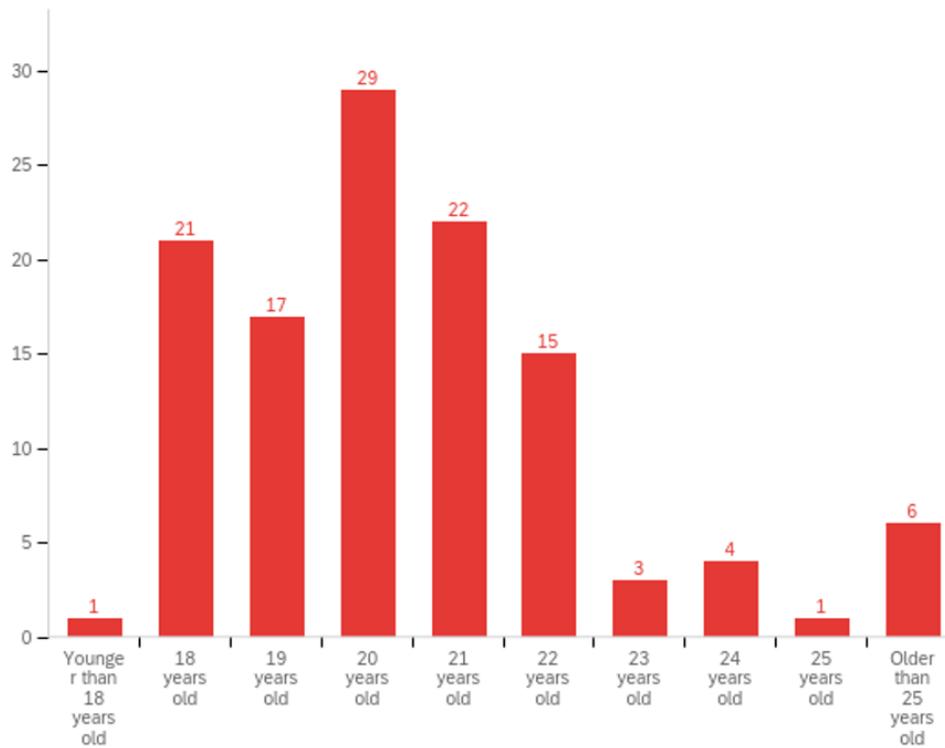


Figure 1

While the majority of participants stated that they are physically active three to four days a week, participants were similar in their overall number of days they are active as shown in Figure 2. The duration of exercise for the participants had mostly an even spread over all of the time intervals. Most participants were active between 15 minutes and up to 60 minutes. A slightly lower number of participants were active less than 15 minutes or longer than an hour (see Figure 3).

How many days a week are you physically active?

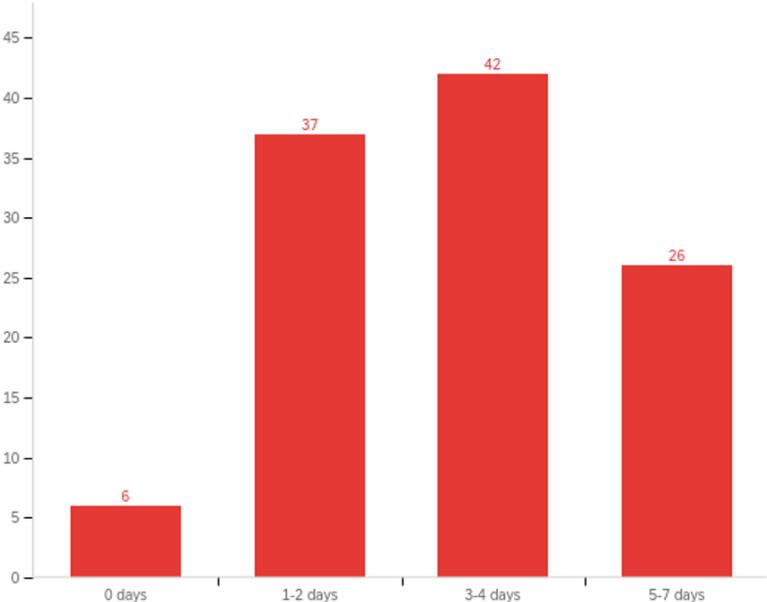


Figure 2

On average, how long do your workouts last?

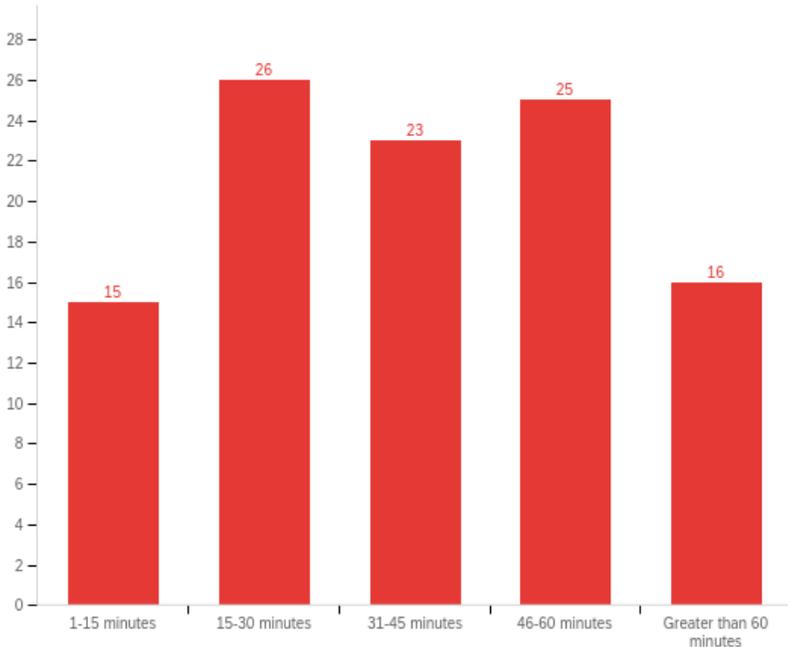


Figure 3

The mean RPE overall was approximately 12.6. As shown in Figure 4, the majority of participants claimed that their RPE was 13, meaning they were exerting themselves somewhat hard. No participants said their RPE was 18-20, so we collected no information for the effect of music at an extremely hard or maximal exertion. The mean RPE for the group who listened to music at an extremely hard or maximal exertion. The mean RPE for the group who listened to music was approximately 12.9. The mean RPE for the group who did not listen to music was approximately 11.7 (see Figure 5). There was not a statistically significant difference in mean RPE between groups (12.9 ± 2.2 versus 11.7 ± 2.4 , $p=0.583$). The mean RPE for those who were active longer than 30 minutes had a statistically significant difference between groups (13.8 ± 1.6 versus 13.4 ± 0.9 , $p=0.036$). There was not a statistically significant difference for those who were active for less than 30 minutes between groups (10.9 ± 2.0 versus 10.2 ± 2.4 , $p=0.438$).

On average, what is your perceived exertion when you are working out?

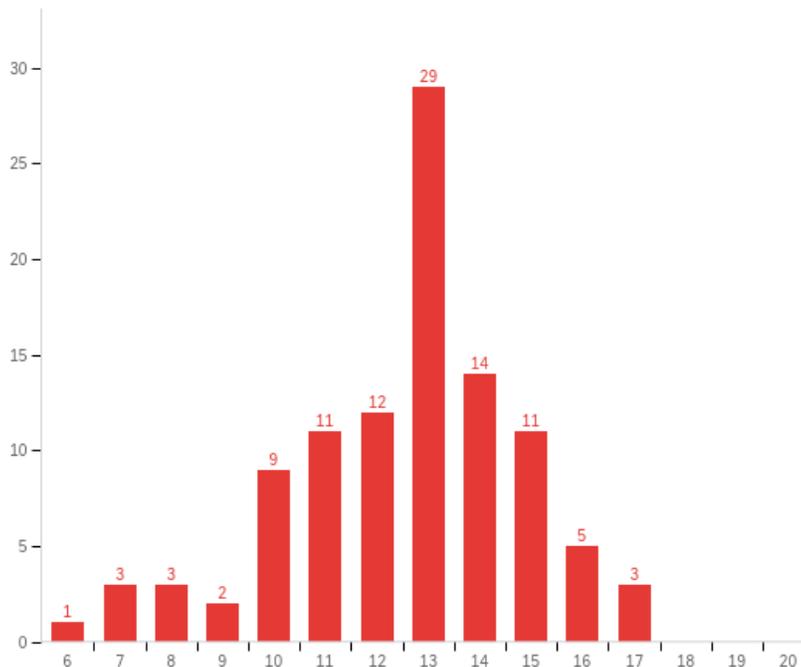


Figure 4

RPE Compared to Music Listening

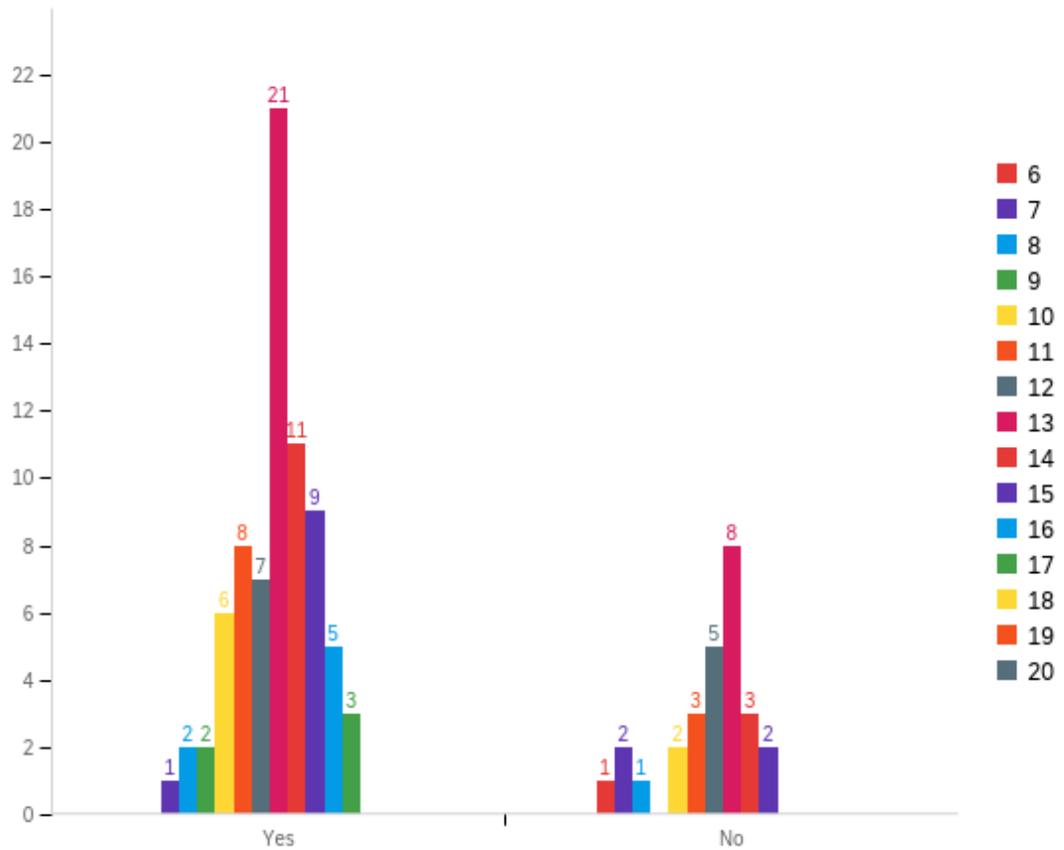


Figure 5

There was a significant discrepancy between the number of participants in the music group versus the non-music group. A total of 75 participants listened to music while active compared to 27 who did not listen to music (see Figure 6). The music-listening group listed any specific genres they listen to during their activity. The range of the preferred genres are shown in Figure 7.

Do you listen to music at least 75% of the time, during physical activity?

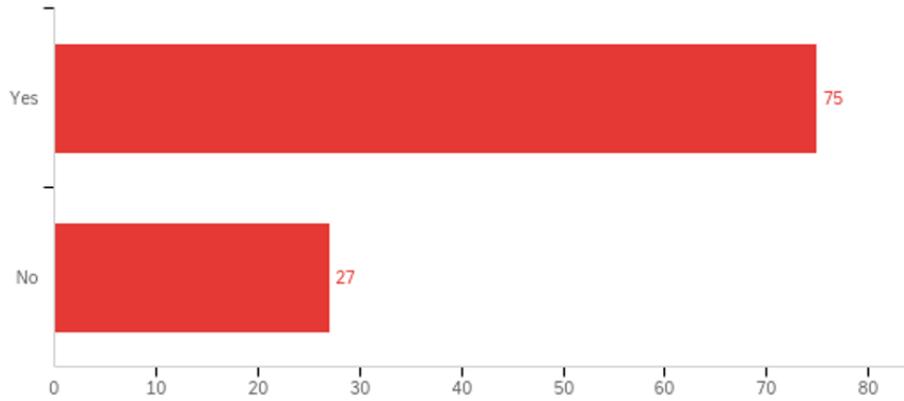


Figure 6

What genre(s) you listen to? Select all that apply.

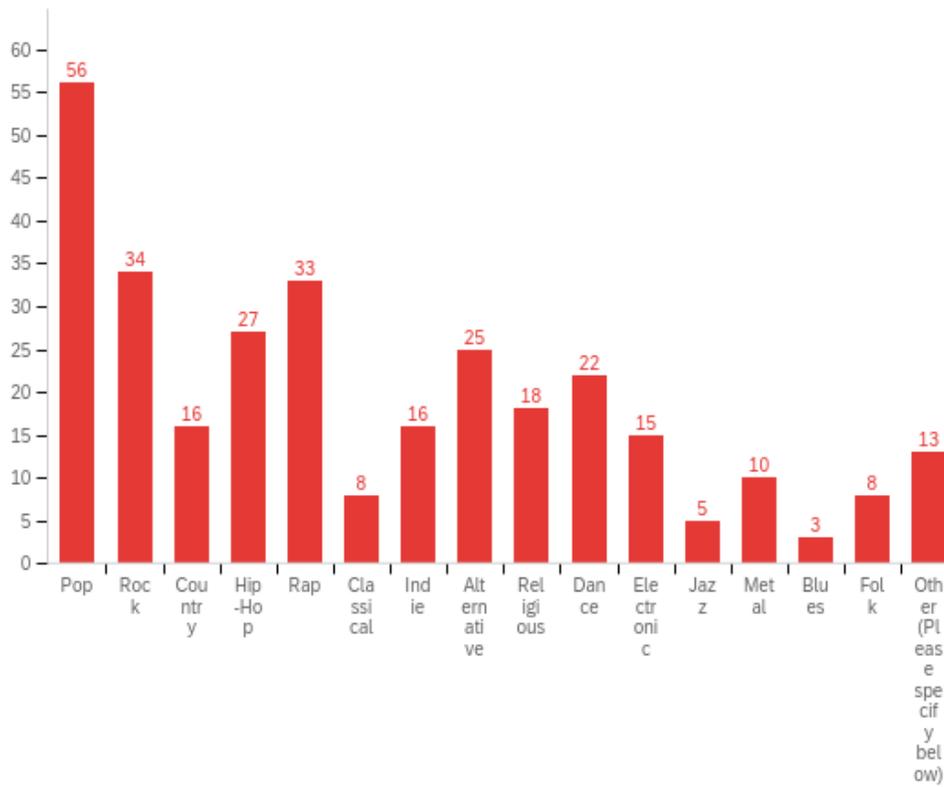


Figure 7

To find answers for the guiding research question, the data from question 4 and question 5, and question 3 and question 5 were comparatively analyzed and displayed in Figure 8 and Figure 9, respectively. Figure 8 demonstrates the spread of selections for RPE for both conditions of listening and not listening to music. The findings show that the participants who do not listen to music at least 75% of the time during their physical activity, tend to have a lower RPE compared to the music-listening group. The highest occurring RPE for each group was 13. At the RPE's of 14 and higher, the number of people listening to music (n = 28) far outweighs the people not listening to music (n = 5).

RPE and Music Groups

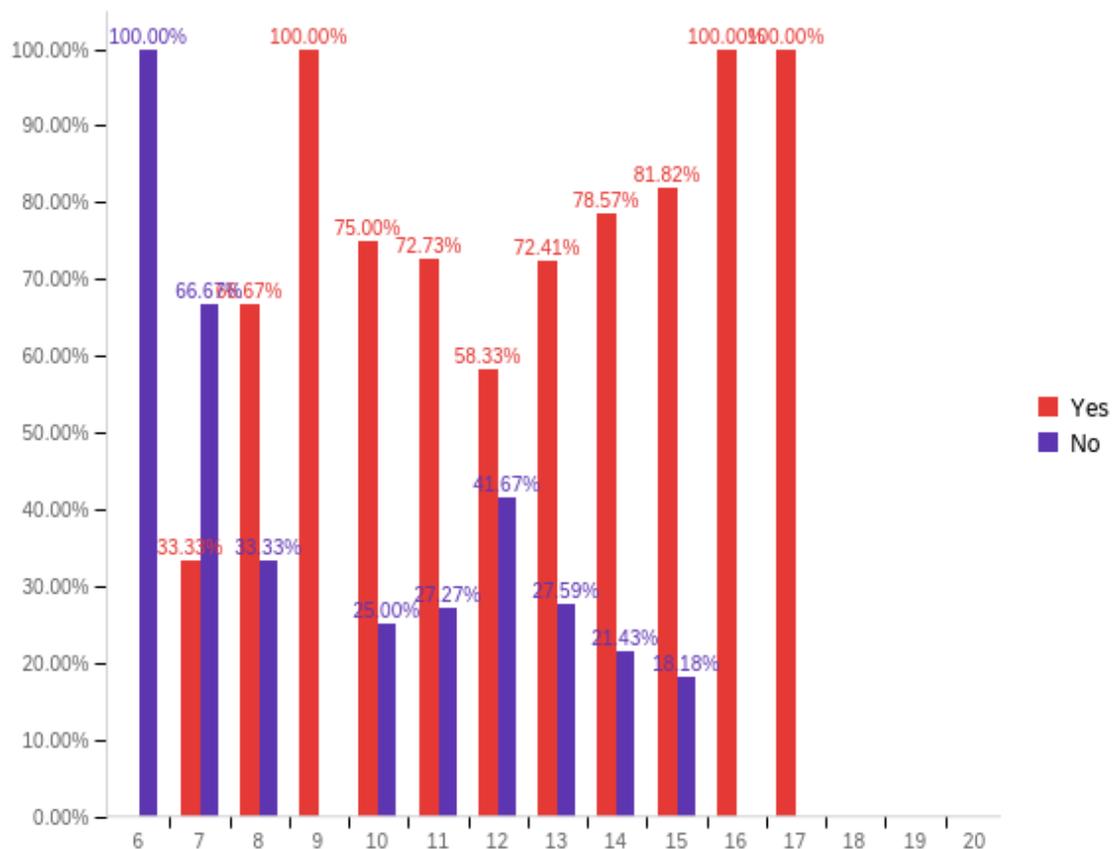


Figure 8. *Rate of Perceived Exertion When Listening to Music or Not*

Figure 9 demonstrates the breakdown of the average length of workouts by the conditions of listening and not listening to music. The findings suggest that those who do not listen to music at least 75% of the time during physical activity tend to work out for a shorter amount of time. There is a statistically significant difference in RPE between the music group and the non-music group for those who were active for more than 30 minutes (13.8 ± 1.6 versus 13.4 ± 0.9 , $p=0.036$). As shown in Figure 9, from 1 minute to 45 minutes of physical activity, the marginal differences between the music group and the non-music group are relatively similar. From 46 minutes to above 60 minutes of activity, the margin between groups is significantly increased in favor of the music group.

Exercise Duration and Music Groups

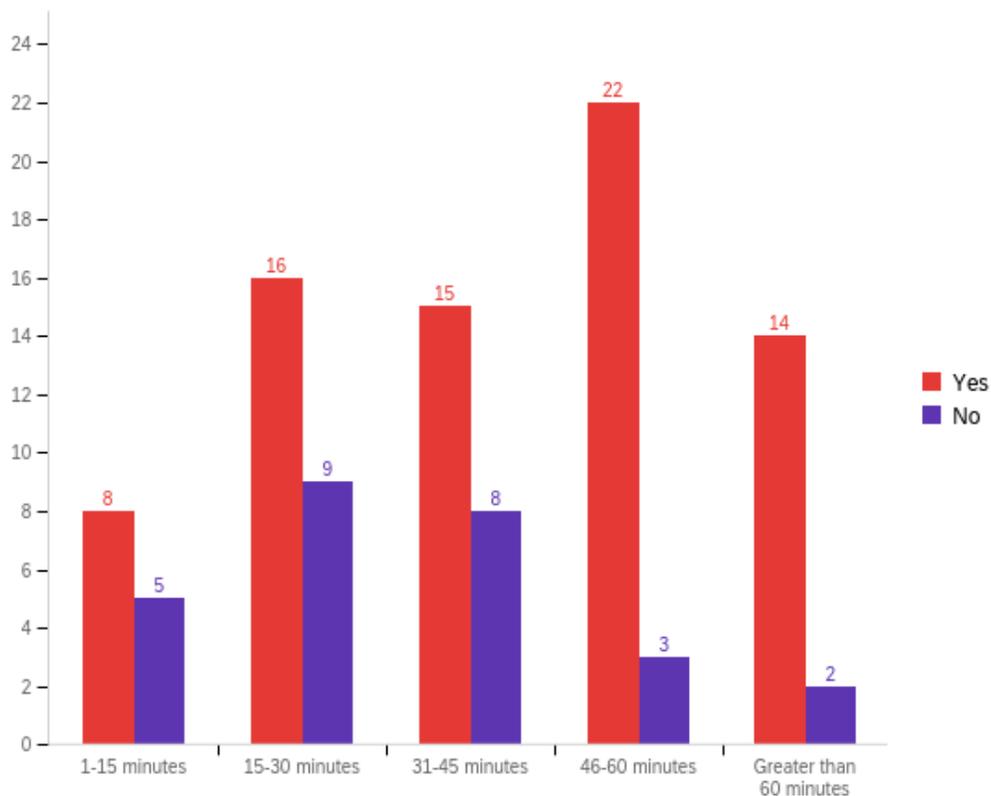


Figure 9. *Duration of Exercise When Listening to Music or Not*

The music genres with the highest percentages of participants who declared their RPE as 16 and 17 (very hard) are Rock, Hip-Hop, Rap, Alternative, and Folk. The findings suggest that a preferred genre of music for very hard physical activity is one with a high rate of beats per minute. Classical and Indie music had a more prominent presence for lower RPE which may be due to the nature of the traditional instruments and production of those genres which typically do not result in high energy like Rock.

Discussion

The expected result of this survey was that the music-listening group would show a lower RPE and higher duration of exercise. The actual results suggest that since the music group has a longer duration of exercise, the effect of working out longer gives the perspective that they are working out harder. This connection may explain why the music-listening participants had higher trending RPE. For each interval of exercise duration, the margin of how many people listened to music during the activity increased which can demonstrate a correlation between music and longer bouts of exercise.

This study aligns with current research that claims that fitness performance of participants are unaffected by the presence or tempo of the music (Atan, 2013). While this data associates higher RPE and high tempo music, the correlation is not statistically significant. The present study did not support the current literature for RPE and listening to music. Most literature found a higher RPE associated with the non-music group while this study found lower RPE for the non-music group. It is presumed that because the group who did not listen to music worked out for less time, they did not feel as exerted and thus had a lower RPE.

Overall, the findings of the survey supports one hypothesis of music-listening during physical activity is connected to a longer duration of activity. The findings did not support the hypothesis associating a low RPE with listening to music during activity.

Limitations and Implications for Future Research and Practice

It would be worthwhile to conduct a randomized control trial along this field of study. It would have a long lasting impact on physical activity in general. This survey data is solely based on subjective past information. Because of the lack of control in this study, we are unable to declare causation as to if listening to music causes someone to be able to work out longer and therefore associate that with working harder. Future research can focus on the psychological aspect of this research, including addressing if music serves as a dissociative factor in the outcomes. The psychological research into the scientific effect of music is outside my scope of practice and understanding.

There are several limitations of this study that range from the survey methods to the small sample size and formatting. The main limitation is how the design of the survey questions contains no controls of the different types of exercises that the participants are doing or on how much effort is actually taking place. The final question which asked about music genre preference was difficult to find conclusive data due to the format being select-all-that-apply instead of multiple choice. Some genres that had very few responses were ranked higher for each RPE category than Pop or Rock that had a lot more responses total. I believe this is due to 75 participants recording a total of 309 responses for the question. In future research, the participants should be limited to one response for genre preference.

Another possible adjustment for future research entails testing this on other populations outside of college-aged individuals. For future practice, I can take the data and implement it in a

physical therapy setting. Music may not help an individual feel like they aren't working as hard, but it may be able to lengthen the amount of time a patient will adhere to their prescribed exercises. Whether music is a motivator, a distractor, or a way to connect, it is correlated to a longer duration of exercise. This information will be useful and applicable in a clinic because it poses no risk to the individual and shows a significant difference in preference for music when individuals are active for longer periods of time.

Reflection

As my time at BGSU comes to a close and I pursue my Doctorate in Physical Therapy I began my honors project with a combination of everything that I have learned and hope to learn going forward. This honors project began when I was inspired by a video where I witnessed an Alzheimer's patient who was almost non-responsive come to life with verbal and nonverbal expression when they played music that was familiar. I was so inspired by the effects of music therapy that I began leaning into a way to research how music may play a role in exercise and physical therapy. I quickly found the questions I was seeking answers to through research were above my abilities. I had only taken a General Psychology class and a Lifespan Development Psychology class. In addition to those classes, I was, however, very familiar with the equipment and techniques of exercise physiology where I was exposed to the RPE scale. This is where I landed on my honors project.

What I have learned about myself from this project is that I thrive in environments where I have a clear plan of action or a road map. I also save some of my hardest work to be completed at the end of my task lists. Although I always give my best, I learned going forward I may need to modify these methods so they better serve my skill sets. Because of my love of consistency, I actually got annoyed when I received results that did not line up with my assumptions. I now appreciate even more the value of ethics in research. The result of the research should be published even if they don't show the results you wanted. You have to be ok being wrong. You can't hide the truth of research just to shape a preferred narrative or hide a narrative you disagree with. I and my patients in the future will benefit from these life lessons

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Appendices

I. Survey Questions

	Question	Answer Choices
Q 1	What is your age?	Younger than 18 years old, 18, 19, 20, 21, 22, 23, 24, 25, Older than 25 years old
Q 2	How many days a week are you physically active? (“Physical Activity is defined as any bodily movement produced by the contraction of skeletal muscles that results in a substantial increase in caloric requirements over resting energy expenditure” – American College of Sports Medicine)	0 days, 1-2 days, 3-4 days, 5-7 days
Q 3	On average, how long do your workouts last?	1-15 min, 15-30 min, 31-45 min, 46-60 min, greater than 60 min
Q 4	On average, what is your perceived exertion when you are working out? (Table 2 was shown)	6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20
Q 5	Do you listen to music at least 75% of the time, during physical activity?	Yes, No
Q 6	Identify the genre(s) you listen to? Select all that apply.	Pop, Rock, Country, Hip-Hop, Rap, Classical, Indie, Alternative, Religious, Dance, Electronic, Jazz, Metal, Blues, Folk, Other (please specify)

II. RPE Scale

Rating	Descriptor
6	No exertion at all
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard (heavy)
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion