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Effects of Music on Performance and Perceived Exertion

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Abstract The inspirational power, mood regulation and even healing ability of music have been acknowledged for a long period. In addition, several studies have attempted to investigate the effects of music on physical activity. Research shows that music can decrease perceived exertion during exercise, enabling exercisers to engage in physical activity for longer periods of time and at higher intensity. However, individual factors like musical preference, level of fitness, and the kind of physical activity being done may affect how music affects perceived exertion. This study aims to determine whether listening to music while cycling on an exercise bike has an effect on the level of perceived exertion. Thirty undergraduate students, 12 males and 18 females, were randomly selected to participate in two cycling trials with music and without music. A 6-minute Astrand Test was used to measure VO_2 max throughout the cycling performance. VO_2 max was measured while exercising both without music and to music. Dependent t-tests were used for data analysis on the raw data in order to compute and compare mean values of the sample. The findings of this study show that, listening to music has no substantial impact on cycling performance. These go contrary to most studies that speak of a beneficial effect of music in reducing the amount of exertion perceived while engaging in strenuous activity. However, various other factors such as training protocol, type of exercise, music genre, and personal characteristics may affect the results obtained.

Keywords Music, Cycling, Perceived Exertion, VO_2 Max, Genre

1. Introduction

Music can help athletes feel better psychologically and inspire good thoughts. It supports athletes' motivation and resilience against psychological exhaustion, which in its turn enhances performance and skill acquisition. When it comes to enhancing psychological and performance-related factors, music is an effective intervention. Despite the sometimes conflicting evidence, it is generally agreed that music boosts performance in a variety of ways. Music can distract a person from their fatigue during prolonged sub-maximal activities like running [1]. Based on the long-established positive association between music and physical performance, researchers have attempted to investigate the mechanisms, through which music produces such beneficial results [2, 3].

Existing evidence suggests that listening to music while working out has significant psychological and physical advantages. It has been demonstrated that listening to music can improve exercise tolerance and aerobic endurance. Dissociation, arousal regulation, and synchronization are the mechanisms underlying the psychological-physiological effects of music [4]. Other studies aiming at reviewing the impact of music on performance indicators demonstrate contradictory findings, which highlights the need for more explanation of the motivational, psychological, and physical changes that experience athletes when they are listening to music while working out.

The subjective degree of effort, discomfort from strain, and/or fatigue felt while exercising are all examples of perceived exertion. Early research on the exertion perceived after strenuous exercise was initiated by Borg and Dahlstrom [5] in the late 1950s. According to the findings of this study, perceived exertion rises with exercise intensity.

Perceived exertion is defined by Noble and Robertson as the subjective level of effort, discomfort from strain, and/or fatigue that is felt while exercising [6]. The majority of current studies suggest that listening to music during exercise will reduce perceived exertion [6-9]. The data gathered from research in the past years, show that music is particularly good at driving away attention from perceived exertion while performing physical exercises. According to Nethery et al. [7], exercising while listening to music results in less perceived effort than doing so without any other attentional diversion. Additionally, Thornby et al. [8] tested exercisers with music, without music, and with noise. They found that, compared to the noise and no music conditions, participants perceived lower levels of exertion while exercising and listening to music at the same time.

These results seemingly speak for a connection between music and physical performance, especially in light of the growing attractiveness and sizable earnings resulting from the interrelation of music and working out. Less is known about how music listening affects performance and other physiological indicators.

Music may have a minor but significant impact during sports events, in which athletes frequently compete against others who match their skill set [10]. Additionally, music makes a great training companion. Five major ways that music can affect training and competitive performance have been identified by science: dissociation, arousal regulation, synchronization, motor skill acquisition, and flow.

Music can help focus during submaximal exercise, which in turn helps to forget about fatigue. Psychologists refer to this diversionary strategy as dissociation, which reduces perceived effort. By diverting attention from ideas about physical signs of fatigue, effective dissociation can foster a positive mood state. More specifically, aspects of mood that are favorable, like vigor and happiness, are heightened, while unfavorable aspects, like tension, depression, and anger, are lessened [11]. Only at low and moderate exercise intensities does this effect apply; at high intensities, fatigue perceptions take precedence over the effects of music as processes responsible for attention are subject to physiological reactions, such as blood lactate accumulation and respiration rate.

According to studies, the dissociation effect causes treadmill running at a moderate intensity to feel 10% less exhausting [12]. Although listening to music while exercising at high-intensity levels does not lessen the sense of effort, it does enhance the experience. By altering how the mind perceives signs of fatigue, it makes challenging exercise seem more enjoyable. Undoubtedly, running on a treadmill at 85% of aerobic capacity, VO_2 max will not feel easier. However, listening to music will contribute to the runner probably having a more enjoyable experience [13]. Thus, it can be concluded that, while music, is limited in its ability to reduce exertion during strenuous activity, it has a significant influence over how athletes perceive this amount of exertion [14].

Music can be used for its benefits of stimulating or calming up feelings of anxiety prior to competition or training because it alters emotional and physiological arousal [11]. As a result, music enables arousal control that encourages a positive state of mind. While most athletes "psych up" to loud, upbeat music, "psych down" can also be aided by quieter tunes. While the rhythmical elements of music often cause sympathetic responses in the physiological processes, lyrics or other musical associations very often, have a greater emotional impact. Faster tempi as compared to slower ones are ostensibly linked to higher arousal levels.

A few studies have also tried to look at the possible effect that the interaction of music and imagery has on participants. In their study, Lin and Lu [15] concluded that although the music-video combination and music interventions had better effects than control, these two conditions were not statistically different. Therefore, when selecting a form of external stimulation to enhance physical performance during exercise, music is a better choice than video.

The improvement of skill acquisition through music has three tenable reasons. First, music imitates many aspects of human movement and various types of bodily rhythm. As a result, through efficient movement patterns, music can transport the body, giving the sound a clear visual analogy. What is more, lyrics can help to emphasize key elements of a sporting move. Finally, music improves the educational process and motivates players to master essential skills.

The logical conclusion from research findings on the effect of music on motivational states includes the possibility that it can help people reach flow, the highest level of intrinsic motivation. In their study on the motivational uses of music in sport, Laukka and Quick [16] found out that athletes most often reported listening to music during pre-event preparations, warm-up, and training sessions and the most common motives for listening to music were to increase pre-event activation, positive affect, motivation, performance levels and to experience flow.

One of the most recent innovations that illustrates the effect of music in sport is London’s Run to the Beat half-marathon, which includes real-time motivational music performances selected using criteria developed scientifically by musicians stationed along the course. Additionally, music can be customized to fit specific training components, such as alternating between fast, loud music during work periods and slow, soft music during recovery periods.

According to existing research [17], people who exercise and play sports have a tendency to time their bursts of effort to the parts of a song that they consider particularly empowering. Such predisposition is referred to as segmentation. If the listener is very familiar with the song and can anticipate where the music will go, the segmentation effect is especially potent. It is also advantageous to adjust the pace of music to reflect how hard one is exercising. For example, when cycling at roughly 70% of the aerobic capacity, mid-tempo music (115-125 beats per minute) is more beneficial than faster music (135-145 beats per minute) [18]. Similar findings were reported by Ouergui et al. [19], in their study on the performance of male and female taekwondo athletes.

Studies have also focused on the impact of music on psychological variables because it is thought to have a significant impact on these factors. Important psychological factors in sport include perceived exertion and mood states, which are influenced by things like self-image, social and contextual factors, motivational techniques, and gender. Athletes can engage in activities for longer periods with low levels of perceived exertion [20]. Using the rating of perceived exertion (RPE) to control the level of exercise intensity while running was examined by Eston et al. in 1987. The Borg 6-20 Scale was used to measure effort estimates. The results confirmed that RPE might be an efficient tool for controlling effort intensity during demanding physical activity [21]. In a study published in 2006, Macone et al. [22] looked at how gender affected the effects of music during moderate-intensity exercise (75% of resting heart reserve) on mood, state anxiety, and time to exhaustion. The findings revealed substantial shifts in mean values of state anxiety, depression, fatigue, and tension. Yet, the results did not indicate that music had any discernible effects, with the only difference being that women, and not men, reported experiencing more exhaustion after exercising to music as opposed to exercising silently. In a moderate workout, Boutcher and Trenske discovered that subjects listening to music experienced less perceived exertion. They concluded that exercise load appeared to be dependent on the impact of music on emotional reactions when exercising [20]. According to Potteiger et al. [23], music of any genre-be it upbeat, classical, or personally chosen-reduces peripheral, central, and overall RPE and enhances performance on a cycle ergometer when the intensity is 70% of one's maximum aerobic capacity (VO_2 max). According to research, listening to music while engaging in sub-maximal exercise boosts performance and delays fatigue, especially if the athlete and the music's rhythm are in sync [1]. A deeper understanding of the psychological advantages of listening to music while exercising appears to be in need of further study, given the significant impact that music has on athletes' performance. Although previous studies have demonstrated the positive effects of music on performance, different biological, age, and gender differences, timing, mood, tradition, music style, personal preferences, exercise intensity, and training regimens can all have a different impact on how music affects a given task.

Consequently, the primary objective of the current study was to compare the effects of listening to preferred music to no music on young adults' cycling performance. Based on prior research demonstrating that preferred music has a beneficial influence on perceived exertion, we expected that exercising on an exercise bike while listening to music would result in better physical performance compared with no music condition.

2. Materials and Methods

This correlational study set out to find out how college students perform and perceive exertion while cycling on an exercise bike and listening to music. To ascertain if music had an effect on cycling performance and perceived exertion levels, 30 undergraduate students majoring in Movement Studies (12 males, 18 females; age = 19.9 ± 0.9 years) were recruited to participate in our study. The sample was randomly chosen out of 153 first-year students. For the purpose of the study, 38 students were invited to take part. Eventually, 30 students volunteered to participate. All the subjects selected for the trials were physically active, based on self-reported levels of physical activity and none of them reported neuromuscular disorders or specific musculoskeletal injuries based on medical records submitted at enrolment.

The week before the experiment, test procedures and instruments were explained to the participants, and they were offered the possibility to practice on the exercise bike. Whereas the main experiment involved two trials that happened within a 5-day distance from each other. In the first trial, participants were made to cycle without listening to music, while in the second, they were subjected to cycling while listening to music. Participants engaged in a typical 10-minute warm-up that included light jogging, dynamic stretching, and jumping before the testing began. Subjects were able to choose their own songs, which were played on a personal audio player. For the Cycling Performance (CP), a Monark bicycle ergometer, model 839E was used. A 6-minute Astrand Test was used to measure VO_2 max throughout the CP. Both peak heart rate (HR_{peak}) and mean heart rate (HR_{mean}) were measured and recorded by a Polar Heart Rate Monitor. VO_2 max was measured while exercising without music and exercising to music. During the trials, no verbal encouragement was given. In order to prevent outside influences on pace, participants were also not told of the amount of time elapsed or the amount of time remaining.

Immediately after the test, Borg's 6-20 RPE scale was used to measure perceived exertion. The scale is designed to increase linearly with the level of exercise; a score of 6 denotes "light exertion," and a score of 20 denotes "extreme exertion". Dependent t-tests were used for data analysis on the raw data in order to compute and compare the mean values of the sample.

3. Results

Astrand Test results for the two trials of the cycling performance (CP) are shown in figure 1.

The first trial involved cycling without listening to music (CPWOML = 12.94 ± 3.35 min), and the second trial involved cycling with music playing (CPWML = 12.50 ± 2.48 min). VO_2 max was measured while exercising without music (30.87 ±7.83) and exercising to music (28.2 ±4.92). The results are shown in figure 2.

Dependent t-tests were used for data analysis on the raw data to compute and compare the mean values of the sample. The results of statistical analyses did not reveal a significant difference (p < .05) between the performance of runners and cyclists while listening to music. Cardiac frequency values of the participants are presented in table 1.

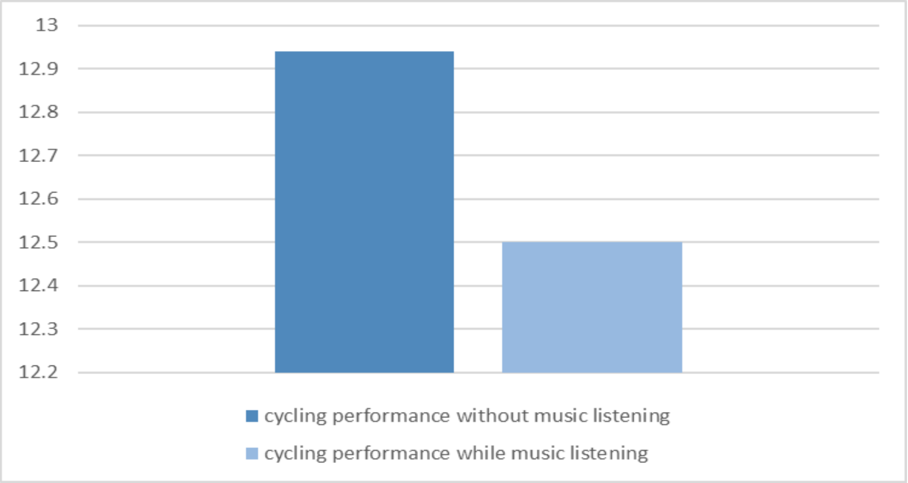

Figure 1. Cycling performance

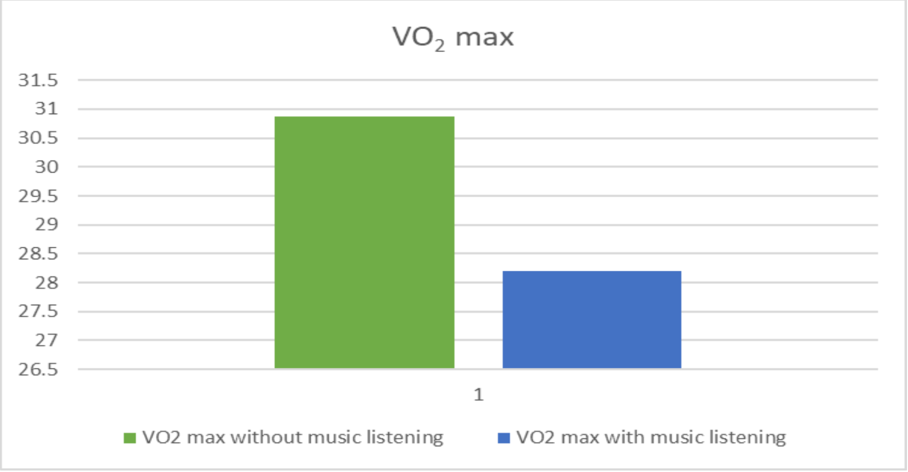

Figure 2. VO_2 max while listening to music and without it

Table 1. Mean Cardiac frequency while exercising with music and without music

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
cardiac frequency (without	30	125.17	185.17	155.6489	12.53207
cardiac frequency (with music)	30	128.00	180.83	151.2889	12.93240
Valid N (listwise)	30				

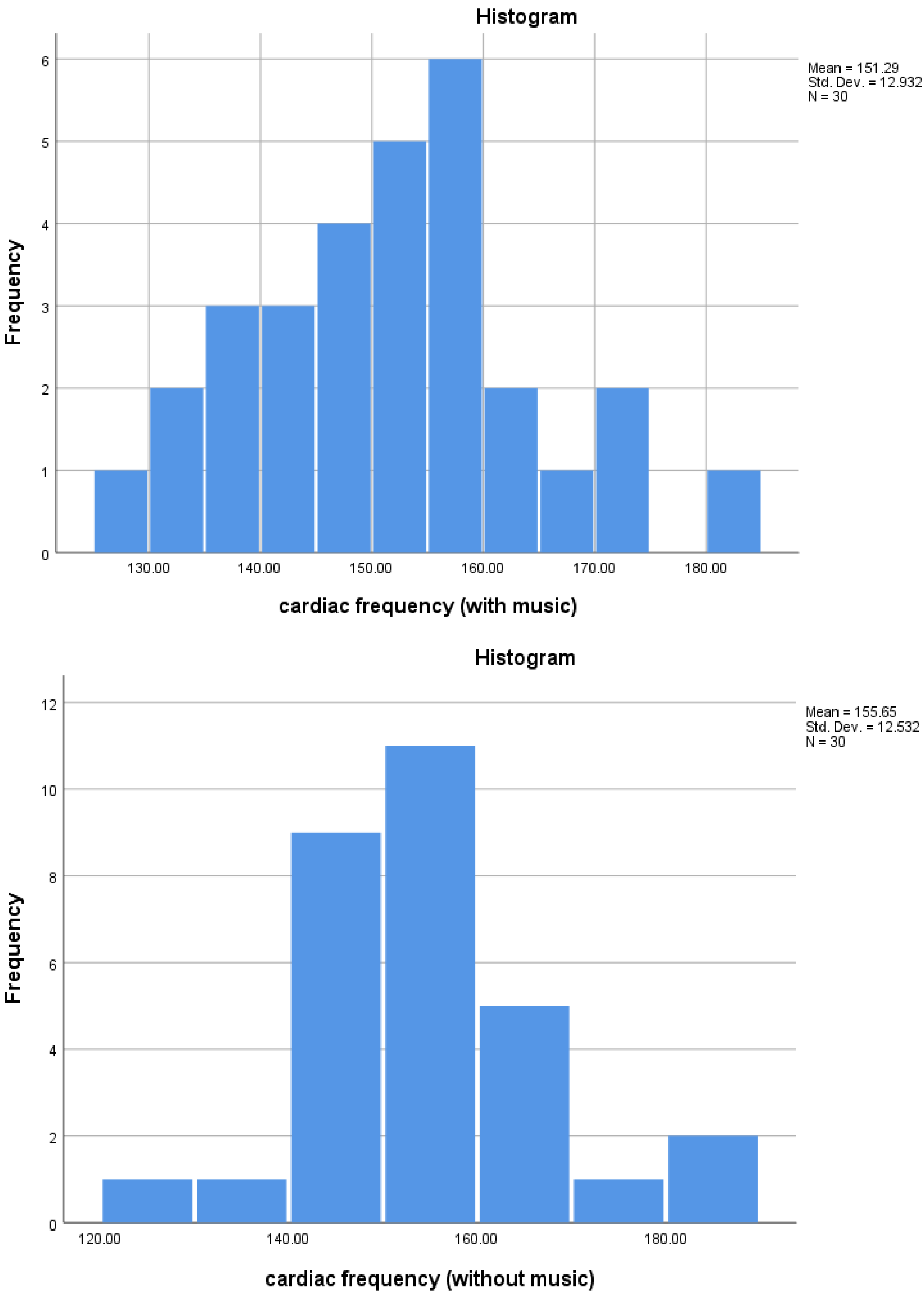

Figure 3. Histograms of cardiac frequency while exercising with music and without music

Cardiac frequency (without music) scores ranged from 125.17 to 185.1 with a mean and standard deviation (155.65 ±12.53). Cardiac frequency (with music) scores ranged from 128.00 to 180.83 with a mean and standard deviation (151.29 ±12.93).

Histograms for cardiac frequency with music and without music are presented in figure 3.

Box plots of cardiac frequency while exercising both to music and without music are presented in figure 4.

Borg 6 to 20 RPE scale was used to measure perceived exertion, and there was no discernible difference between perceived exertion without music listening (PEWOML = 14.7 ± 1.3) and perceived exertion while listening to music (PEWML = 15.2 ± 2.4), as shown in figure 5.

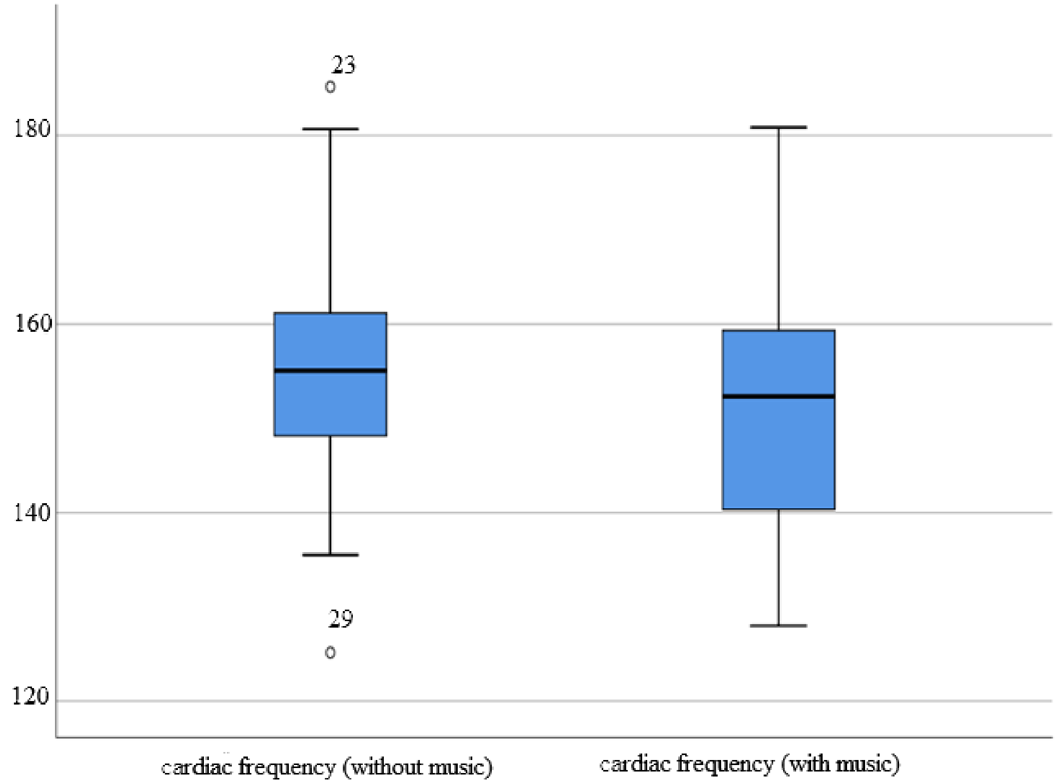

Figure 4. Boxplots of while exercising with music and without music

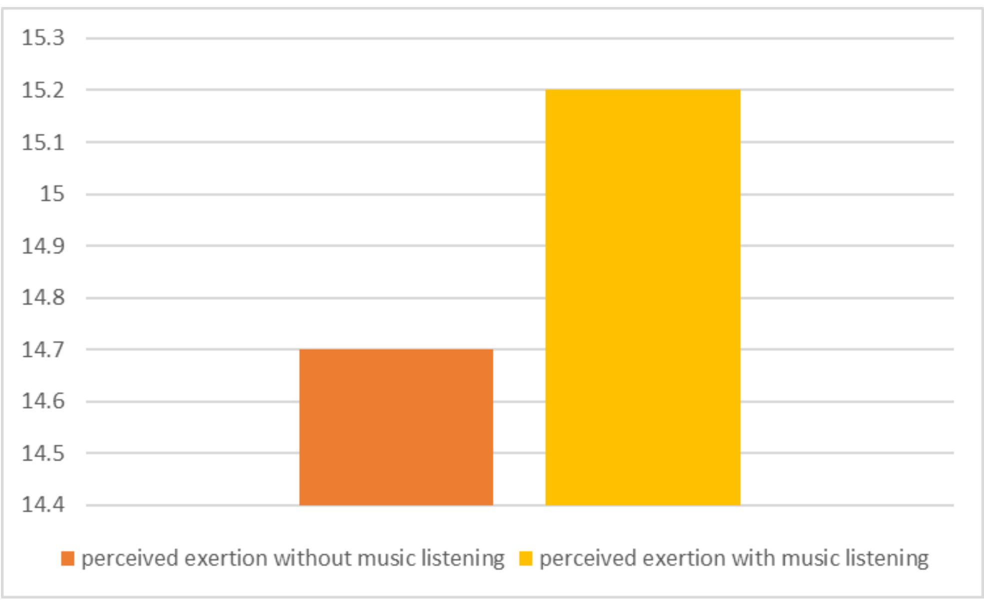

Figure 5. Perceived exertion while exercising with music and without music

4. Discussion

The relationship between exercise-induced psychological effects and attention during exercise is mediated by exercise intensity. External stimulants, like music, can divert attention from fatigue during high-intensity exercise. It has been demonstrated that selecting the appropriate style of music and adapting to the participants' music tastes can boost performance. For example, the unpleasant feedback from strenuous exercise can be replaced by soothing music, which will enhance performance. The present study's findings, however, suggested otherwise, and the cause of the discrepancy may have been the music chosen for the study, as participant musical preferences are a significant issue in such studies. Different participant responses may result from the music depending on whether it is engaging, effective for some, boring, and ineffective for others. This runs counter to Pujol and Langenfeld's findings [24]. Variations in exercise intensity, music style, and exercise type are to blame for this inconsistency. The current study used upbeat music, and little research has been done on the impact of this particular genre. According to the study's findings, there was no discernible difference in perceived exertion between the experimental and control groups. This is in line with what Copeland and Franks discovered. They looked at how ratings of perceived exertion were affected by fast and slow music. The outcomes revealed negligible differences between the experimental and control groups [4]. Hutchinson et al., Boutcher and Trenske, Wales, Schwartz et al., and Thomas [10,20,25-27] are some other studies that have reported similar results. Any of these studies does not speak for a correlation between music and perceived exertion. According to Boutcher and Trenske [20], exercise intensity increased perceived exertion in music-playing and music-free environments alike. Additionally, Thomas [27] hypothesized that the impact of music might be muted by the physiological effects of the Wingate test. According to Nethery's findings [28], perceived exertion increases as intensity of exercise increases. Due to the intense nature of the exercise, Schwartz [26] concluded that perceived exertion is not affected by the presence or absence of music. Findings from studies by Copeland and Franks, Szmedra and Bacharach, Boutcher and Trenske, Eston et al., Potteiger et al., Anshel and Marisi, and Matesic and Cromartie [4,14,20,21,23,29,30], are in disagreement with the findings of the present study. Results are inconsistent for a variety of reasons, including gender, age, exercise intensity, music type, and type of exercise. For instance, 30 young men were studied by Eston et al. [21]. Perceived effort, on the other hand, is a crucial addition to physiological evaluations. It incorporates a significant database, including cues from the central nervous system, peripheral muscles and joints, and cardiovascular and respiratory systems [5]. In the current study, it was not possible to examine or regulate the physiological conditions of every participant. However, when comparing perceived exertion levels scored by male and female students, there is a difference between the two groups, with females rating exertion as being lower. Taking into account gender differences, the findings of our study are in line with those in the study of Macone et al. [22] who found no evidence of a significant impact of music, with the exception of the women reporting greater mean exhaustion after exercising to music as opposed to exercising without it. These results support Rejeski's theory [31], according to which physiological cues predominate attentional processes when subjects work at maximum intensities beyond the anaerobic threshold, decreasing the effectiveness of external cues like music on RPE. Astrand Bicycle test ratings of perceived exertion were not significantly impacted by music listening (p .05), according to the results. The research null hypothesis regarding the impact of music on the assessment of perceived exertion has thus been accepted. Additionally, it was discovered that listening to music made female subjects rate RPE as being more difficult. This provides more evidence that the dissociative effects of music do not transfer to exercise that exceeds 75% of one's VO_2 max.

5. Conclusions

The findings of this study, unlike findings from previous research [11–17, 32], show that listening to music seems to have no substantial impact on cycling performance during the 6-minute Astrand Test, as there was no discernible difference in how much effort was felt at this distance. A limitation of the current study is the small sample and that participants were not guided on how to select appropriate music for the task under consideration. However, the fact that even though participants could play their preferred playlist does not seem to have a mediating effect, might prove helpful from an applied perspective, especially in those sports contexts where the choice of music is not dependent on the musical preference of individual participants. In order to be able to objectively assess the potential benefits of music in the realm of physical activity, a range of other factors such as type of exercise, music genre, and personal characteristics must be taken into consideration. What is more, future research is needed in order to establish whether a combination of music with visual cues, is superior to exercising in the presence of music only. Another point deserving due consideration is the medium of music delivery, for example comparing the effect of listening to music played on a sound system rather than on a personal music player. Such research will benefit coaches, athletes, and regular exercisers in order to make appropriate additions to the training regimen, as a means of improving performance.

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