The effects of listening to three types of music during exercise on heart rate, blood pressure, rating of perceived exertion and fatigue onset time

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Abstract: Aim: The present study aimed at investigating the effects of listening to three types of music during exercise on heart rate, blood pressure, rating of perceived exertion (RPE) and fatigue onset time. **Method**: 15 female students of physical education with the mean age of 21.93±2.43 year's height of 161.8±5.22 centimeters and weight of 54.46±7.27 kilograms were randomly selected as the participants from 45 volunteers. After warm-up, the participants started **pedaling** at 80-85% of maximum heart rate until exhaustion. The participants performed this exercise on four different days (with a one-week interval). The first exercise session was performed without listening to music, the second session was accompanied with some exciting music, the third session was held with soft, relaxing music and the last one with arbitrary music. RPE was recorded every 3 minutes during the exercise. After exhaustion, RPE, heart rate, systolic and diastolic blood pressure, and fatigue onset time were recorded. One-way ANOVA (F) was used to analyze the data and LSD test was run to compare the differences ($P \leq 0.05$). **Results:** Listening to exciting music during exercise significantly affects heart rate, RPE and fatigue onset time but not systolic and diastolic blood pressure. Listening to relaxing music during exercise significantly affects heart rate and systolic blood pressure but not diastolic blood pressure, RPE and fatigue onset time. Listening to arbitrary music, as selected by the participants themselves, during exercise significantly affects heart rate, systolic blood pressure, RPE and fatigue onset time but not diastolic blood pressure. **Discussion and conclusion**: Understanding the effects of music genre on the variables examined may help the athletes select a proper genre of music based on the type of exercise they do. For example, listening to exciting and arbitrary types of music significantly increases heart rate while relaxing music significantly decreases heart rate.
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Introduction

Art has always served human's perfectionist and charm-seeking needs. As a soothing element, it has also helped humans tolerate their pains and sufferings. Music is a type of art which conveys human emotions, feelings and perception nonverbally. Music is often regarded as an original source of provocation and inspiration in sports and athletes' exercises. There have yet been fundamental discussions about music and its relation to other arts and sports phenomena. According to some scholars, exciting music increases agitation while soft music often blocks the transmission of negative information to the nervous system [1, 2, and 3]. Based on previous studies, different genres of music may affect the athletes' performance while the results have sometimes been contradictory and sometimes confirmatory [3]. Besides, music may encourage the athletes to continue their exercise [4] and delay fatigue via reducing rate of perceived exertion on the body [5-7].

Based on the present theories, music narrows down the attention and distracts the individual from activity-induced fatigue, removes mental agitation, serves as an exciting or soothing means before or during the activity, and helps the body respond to the rhythmic components of music in sub maximal activities [8].

Copland and Franks (1991) investigated the effects of different genres of music on heart rate, RPE and fatigue time in 24 college students while they were running on the treadmill. They reported that exciting music increases heart rate to a higher extent. Moreover, fatigue time during exercise with exciting music was delayed compared to the control group [9]. Branda et al (1991) investigated the effects of exciting music and soft music types on the heart rate of athletes running on the treadmill until exhaustion. The athletes' heart rate was recorded every 30 seconds. The results showed that soft music, as compared to exciting music and control group (no music), decrease heart rate at the 1st and 6th minutes but increased the heart rate during the exercise and immediately before exhaustion. The athletes' heart rate was higher in the control group and lower than exciting music conditions comparing to soft music

[10]. Khorram (2005) studied the effects of exciting and classical music on salivary cortisol concentration and RPE during a session of training to the exhaustion stage on the treadmill at the 70% of maximum heart rate. The results showed that listening to music significantly increased the running time in the athletes but salivary cortisol concentration and RPE were significantly lower in them comparing to the control group. There was no significant relationship between salivary cortisol concentration and RPE after listening to music [5]. Fathollahi (2006) investigated the effects of two types of music on the running time, salivary cortisol and RPE in a session of training in active women. The results showed that listening to the exciting and soft music did not significantly affect the running time, cortisol concentration and RPE. As well, there was no significant relationship between salivary cortisol concentration and RPE after listening to soft music; however, this relationship was significant after listening to the exciting music [11]. Yamashita et al (2006) studied the effects of listening to music during exercise on RPE, heart rate and automatic nervous system. The purpose of their study was to investigate the effects of music on RPE and automatic nervous system both before and after sub maximal activity. The results revealed that, at 60% of VO_2 max, there was no significant difference in the RPE between the activities accompanied with music, and the activities without music. However, at the 40% of VO_2 max, RPE was lower in the activities accompanied with music compared to activities with no music. The heart rate and blood pressure at 40% and 60% of VO_2 max were significantly different between with music and without music conditions. This implies that music may cause agitation at low intensity exercise but it may not affect the automatic nervous system [12].

Due to the variety of music genres and their different effects on physiological and psychological factors and regarding the individuals' age, gender and mood as well as the time of listening, playback devices, temperament, customs, traditions, musical and cultural characteristics, personal preferences, the intensity of physical activities and different patterns of training programs, more investigations on this issue are needed. In this regard, the researchers posed the following research questions to be investigated in this study:

1. Does listening to music during exercise affect the physiological factors such as heart rate, blood pressure, RPE and fatigue onset time in the female students of physical education?

2. Do different types of music exert the same influence on the above-mentioned physiological factors?

Method

This is a practical study which was conducted with three experimental (exciting, relaxing and arbitrary music) and one control mode. The population of the study consisted of **150** female students of physical education in Bojnord Islamic Azad University.

Participants: From the population, **15** female students with the mean age of 21.93±2.43 years, mean height of 161.8±5.22 centimeters and mean weight of 54.46±7.27 kilograms were randomly selected as the participants. They were all living in the university dorm and took regular exercises 3 days a week on average. No one had a history of mental, ontological and hormonal disorders.

Training program: The training protocol consisted of pedaling the exercise bike at the intensity of 80-85% of maximum heart rate till exhaustion. In this regard, the participants exercised on the exercise bike on four different days (with a one-week interval) The first exercise session was performed without listening to music, the second session was accompanied with some exciting music, the third session was held with soft, relaxing music, and the last session with arbitrary music. All the participants listened to music over headphones. The main exercise protocol started at 20 Watts and the pressure was increased by 20 Watts every 3 minutes. The participants' pedaling rhythm was 80 rpm (Table 1).

Data collection and procedure: The participants were informed about the research process in a meeting. Then they were asked to fill out a form requiring their personal information. Next, their blood pressure and pulse were measured at rest. Then, having done a 10-minute warm-up (1 minute of fast walk, 1 minute of jogging, 8 minutes of static and dynamic stretching exercises), they did the pedaling test. A digital wrist barometer was used to measure heart rate and blood pressure. Systolic and diastolic blood pressure and heart rate were recorded at rest and-immediately after the test; the participants' RPE was measured using the Borg 20-ponit scale. To this end, after the warm-up and at the earlier stages of the test while they were pedaling, the participants were asked to announce a point on the Borg 20-point scale which best described their perceived exertion. Their perceived exertion was recorded every 3 minutes from the start of the test to the exhaustion. Fatigue onset time was determined based on the disruption of the pedaling rhythm. The initial pedaling rhythm was 80 rpm. Once this rhythm was disrupted and the participant could not restore it, it was regarded as the fatigue onset time for the participant. At the end of every 3 minutes, before the increase of exertion, RPE was recorded on the Borg

scale. At the time of exhaustion, RPE, heart rate, systolic and diastolic blood pressure and fatigue onset time were recorded again.

Instrument: The instruments of the study included an informed consent to be filled with personal information, JEMIS digital chronometer made in Taiwan, UNIVERSAL full automatic exercise bike made in Taiwan, OMRON digital wrist barometer and pulse meter Model RX-3 made in China, MP3 player and headphones and some pieces of exciting and relaxing music.

Data analysis: Descriptive statistics including mean and standard deviation was used to categorize the data and to draw diagrams. One-way ANOVA (F) was run to analyze the data and LSD test was run to examine the differences. The level of significance was set at $P \leq 0.05$ for all the tests.

Results

As it is shown in Table 2, there are significant differences between variables of heart rate (p=0.001), systolic blood pressure (p=0.003), rating of perceived exertion (p=0.001) and fatigue onset time (p=0.001) in different conditions (listening to music and without music).

The results of Post hoc test (LSD) are delineated as follows:

1. LSD for the heart rate showed that the differences in the heart rate mean in all the three conditions with music were significant except for the difference between exciting and arbitrary music ($P \leq 0.05$).

2. LSD for the Systolic Pressure showed that differences in the mean Systolic Pressure in all the three conditions with music were significant except for the difference between the control group and the exciting and arbitrary music and between the arbitrary music and the control group ($P \leq 0.05$).

3. Also LSD for the rating of perceived exertion showed that the differences in the mean rating of perceived exertion in the three conditions accompanied with music were significant except for the difference between arbitrary music and the control group ($P \leq 0.05$).

4. And LSD for fatigue onset time showed that the differences in the mean fatigue onset time in all the conditions accompanied with music were significant, except for the difference between the exciting and arbitrary music, and between relaxing music and the control group ($P \leq 0.05$).

Discussion and conclusion

The results showed that music affects the heart rate of female students of physical education during exercise. Exciting and arbitrary music significantly increase heart rate while relaxing music significantly decreases heart rate. This finding is consistent with the findings of Mohammed Zadeh and Ahmedi [13], Torabi [14], Liptalk [15], Davis [16], Branda et al [10], Copland and Franks [9], Brownley et al [17], Knight and Richard [18], Nethery [7] and Yamashita et al [12]. However, it is inconsistent with the findings of Nikbakhsh [9], Szabo et al [20], Lee Crust [21] and Yamamutu et al [22].

Table1. Participants` training program in each exercise session

music type	Pedal Load (Watt)	Velocity (Round / min)	Increase Work load until Exhaustion (watt)
Exciting	20	80	20
Relaxing	20	80	20
Arbitrary	20	80	20
Control	20	80	20

The effects of relaxing music on heart rate reduction may be attributed to the increase in plasma norepinephrine [9], decrease in muscular tension [23], decrease in cardiac pressure [24], decrease in factors associated with pain and discomfort [9] and/or the nervous effects of relaxing music which are not yet fully known. On the other hand, the effects of exciting music on heart rate increase may relate to the increase in blood norepinephrine [9], increase in cortisol concentration [25], decrease of muscular tension [23] and the nervous effects of exciting music. Besides, short movements of different limbs coordinating with music rhythm may increase these factors as well [2].

The results showed that listening to music during exercise affects the systolic but not diastolic blood pressure in the female students of physical education. Although exciting music increased the mean systolic blood pressure, the increase was not significant. However, relaxing and arbitrary music significantly affected systolic blood pressure. This is consistent with the findings of MohammedZadeh and Ahmedi [13], Davis [16], Knight and Richard [18] and Yamashita et al [12].

Listening to music during exercise affects RPE in the female students of physical education. Accordingly, exciting and arbitrary music decreased RPE, but exercising with relaxing music or without music increased the RPE in the students. This is consistent with the findings of Khoram [5], Fathollahi [11], Ghaderi [26], Ahmedi [27], Szmedra et al [3], Knight and Richard [18], Meeks et al [28], Nethery [7], Maraki et al [29] and Yamashita et al [12], but it is inconsistent with findings of Nikbakhsh [19] and Lee Crust [21].

Table 2: Mean, comparative F and LSD test among listening to three types of music during exercise

variables	conditions	Mean ± SD	F	P-Value	Post hoc test (LSD)
Heart rate (b/ min)	Exciting music	155.53±7.47	9.028	0.001	Significant in all conditions except between exciting with arbitrary music
	Relaxing music	148.13±8.39			
	Arbitrary music	154.93±8.69			
	control	152.33±6.98			
Systolic Pressure (mmHg)	Exciting music	13.86±.875	6.410	0.003	Sig. in all conditions except between exciting with music arbitrary and both with control group
	Relaxing music	12.96±.676			
	Arbitrary music	13.57±.537			
	control	13.363±.486			
Diastolic Pressure (mmHg	Exciting music	8.080±1.068	0.312	0.869	Not sig.
	Relaxing music	8.226±0.658			
	Arbitrary music	8.240±.572			
	control	8.273±0.756			
perceived exertion rate (score)	Exciting music	13.53±1.302	10.098	0.001	Sig. in all conditions except between arbitrary music with control group
	Relaxing music	14.80±1.264			
	Arbitrary music	13.86±1.187			
	control	14.66±1.170			
fatigue onset time (min)	Exciting music	8.18±2.050	8.164	0.001	Sig. in all conditions except between exciting with arbitrary and relaxing music with control group
	Relaxing music	7.21±1.400			
	Arbitrary music	7.59±1.590			
	control	7.19±1.190			

According to Rejeski a combination of psychological and physiological factors affect RPE during parallel processing of information. In this regard, sensory information and stimuli are subconsciously processed in parallel [30]. Thus, sensory information like exertion or stimuli like encouragement and workload-induced worries affect the RPE in the individual. Rejeski suggested that physiological factors are significantly more effective than psychological responses in heavy exercises. Besides, external stimuli like music may be very effective in low intensity exercise [30]. According to Boutcher and Trenske, listening to music during exercise may block the unfavorable feedback from peripheral and central factors to the central nervous system allowing the individual to feel more comfortable during the exercise [6].

The present findings revealed that listening to music during exercise affects fatigue onset time in the female students of physical education. Both exciting and arbitrary music delayed the fatigue onset time, that is, these types of music increased the pedaling time. However, listening to either relaxing or no music decreased the fatigue onset time and consequently reduced the pedaling time. This is consistent with the findings of Khoram [5], Ghaderi [26], Torabi [14], Liptalk [15], Davis [16], Meeks et al [28], Copland and Franks [9] and Szabo et al [20], but is inconsistent with the findings of Fathollahi [11] and Yamamutu et al [22].

Research has shown that the music-induced increase in aerobic performance time may be mainly attributed to the energizing and encouraging effects of music. It is said that listening to music during exercise may narrow down the attention and distract the individual from the exercise-induced feeling of fatigue, because the data processing capacities are limited and this changes the individual's RPE [29, 31].

Combining exercise with music may increase cognitive provocations via generating motivation [32]. Also, music may replace the sensory data pertaining to physical activities transmitted to the central nervous system, increase the efficiency of performance and improve the activity-induced agitation [33]. Research has shown that muscular tension changes as the type of music changes: exciting music increases but relaxing music decreases the muscular tension [34]. Relaxing music may reduce muscular activity during exercise, but exciting music increases the pedaling and running time and delays fatigue; therefore, it encourages the individual to do the exercise and allows him/her to lengthen the exercise time [9].

In conclusion, the results of the present study showed that the mean fatigue onset time and mean heart rate were significantly higher in the participants while they were listening to exciting and arbitrary music compared to relaxing and no music. RPE was significantly lower in the participants while they were listening to exciting and arbitrary music, compared with relaxing and no music. However, listening to different types of music did not significantly affect systolic and diastolic blood pressure.

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