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THE EFFECTS OF MUSIC ON THE PERCEIVED EXERTION RATE AND PERFORMANCE OF TRAINED AND UNTRAINED INDIVIDUALS DURING PROGRESSIVE EXERCISE

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Hasan Mohammadzadeh[1], Bakhtiyar Tartibiyan[2], Azhdar Ahmadi[3]

Dept of Physical Education and Sport Science, Faculty of Humanities, Urmia University, Urmia, Iran
[1,2]University of Urmia, [3]Islamic Azad University Urmia Branch
E-mail: ha2004mo@yahoo.com
E-mail: babak_hady@yahoo.com
E-mail: azhdar_ahmadi@yahoo.com

Abstract. *The aim of this study was to determine the effects of listening to music during progressive exercises on perceived exertion rate and performance, as well as to evaluate the effects of fitness differences on the effectiveness of music. Twenty four healthy students (the trained group: n =12, age mean = 23.31±2.06 and untrained group: n = 12, age mean = 22.96±2.31) voluntarily participated in this study. In one session the participants were familiarized with the way the test is performed and with its evaluation instruments. The participants took part in the Bruce Test during the first session, where some of them were randomly chosen to listen to music, while others were not. During the second session, those who had been chosen to listen, took part in the Test without listening to music and vice versa. The result of the ANOVA revealed that the effects of music on the RPE and time leading to exhaustion were significant (P<0.05). In addition, monitoring the interaction between music and fitness showed that the effect of music on the RPE depended significantly on fitness, but it was not significant when it came to performance. The music had a greater effect on the RPE among untrained subjects than the trained ones. The results suggest that using music in progressive exercise would have a positive effect in terms of performance and the psychological state of the athlete, regardless of the level of fitness.*

Key words: *Music, perceived exertion rate, performance*

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1. INTRODUCTION

Music has been widely used to accompany exercise and athletic activity. It has been used to enhance the psychological state of the participants, to establish an effective mind-set, to sustain motivation and to resist mental and emotional fatigue, and it may even facilitate physical and athletic performance.

Skinner, B. F. and other behavioral analysts have developed the theory that one's behavior is influenced by external factors, such as the environment one is in (Prerce & Epling, 1999). Human drive has been thought to vary in response to the administration and deprivation of certain stimuli. One motivating stimulus that may produce an increased drive is certainly noise. Brown (1961) has theorized that in some cases noise may have a facilitative, dynamogenic effect on ones performance, as seen through significant increases in energy output and fatigue.

Perceived exertion is defined as the subjective intensity of effort, strain discomfort and/or the fatigue that is experienced during an exercise. The perception of effort, fatigue or force during exercise may be influenced by the situation in which the exercise is being performed and by the disposition of the exerciser (Noble, 1996). Situational and dispositional factors such as personality type, level of motivation, and focus of attention can influence the perception of exertion during exercise. The same factors that can affect the perception of exertion may also affect the degree to which exercise can be considered tolerable or the manner in which it is enjoyed. Using music to change the context in which physical work or exercise is performed may be a viable way of positively influencing an individual's disposition during exercise, thereby enhancing the enjoyment of the experience.

The research data suggests that the use of music affects the rating of the perceived exertion and motor performance. For example, Johnson and Siegel (1987) investigated the effects of active attentional manipulation (mental arithmetic) and passive attentional manipulation (asynchronous music) on perceived exertion. Analyses have revealed that the fatigue factor of the Physical Activity Questionnaire (PAQ) was the only component to be significantly ($p<0.01$) reduced by music. The study by Copeland and Franks (1991) included retrospective measures of the RPE for five equally spaced points during the test. The results revealed that the RPE was significantly ($p<0.01$) lower under the soft/slow music condition during moderate work. Potteiger, et al. (2000) examined the effects of different types of music on the rating of perceived exertion during 20 minutes of moderate intensity exercise. Each type of music resulted in a reduced peripheral, central, and the overall RPE when compared with exercising under no music conditions. Yamashita and Iwai (2006) investigated the relationship between the influence of music on the RPE during sub-maximal exercise at 60% and at 40% VO2max. The results showed that although the RPE did not differ during exercise at 60% VO2max, this value was lower during exercise at 40% VO2max in the presence, than in the absence of a favorite piece of music ($p<0.05$). In contrast to this finding, Schwartz, et al. (1990) found that at 75% VO 2max, the RPE values did not significantly differ for untrained participants between stimulative music and control conditions. Edworthy and Waring (2006) examined the effects of the loudness and tempo of music on running speed, heart rate, and perceived exertion. No significant differences for perceived exertion were found across conditions.

Copeland and Franks (1991) reported that soft/slow music increased treadmill endurance in comparison to control conditions. Brownley, et al. (1995) studied the influence of

music on physiological and affective exercise responses in trained and untrained runners under three music conditions (no, sedative, and fast) during low, moderate, and high intensity exercise. Affective measures during exercise and data collected at voluntary exhaustion revealed a significantly more positive effect among the untrained compared to trained subjects. Szabo, et al. (1999) investigated the effects of slow- and fast-rhythm classical music on progressive cycling to voluntary physical exhaustion. The results yielded a significantly higher workload and better efficiency in the slow to fast music condition. Macone, et al. (2006) examined the effects of music on mood, state of anxiety, and time to exhaustion during moderate intensity exercise. The findings suggested that women, but not men, reported greater mean fatigue after exercising in the presence of music than in its absence. There is also a body of evidence, which suggests that music does not enhance motor performance. For example, Schwartz et al. (1990) reported no significant differences in endurance time during a cycle ergometer task at 75% VO2max between stimulative music and control conditions. In one well-designed research, Pujol and Langenfeld (1999) assessed the effects of music on performance in the super-maximal Wingate Anaerobic Test. The results showed that there were no significant differences between the conditions for any of the measures.

There are several matters worth paying attention to in this area. The first one is whether music has any effect on different factors during physical exercise or not. In other words, we wonder whether a change in these factors depends on the presence of music or not. The second matter has to do with the person who is exercising. It has been shown that novice athletes employ different cognitive coping strategies to meet exercise demands (Morgan, 1973). It is also probable that training history might regulate or buffer the potential effects of music on performance. In other words, the second matter concerns the influence of the individual's level of fitness on the effectiveness of music. Most of the research carried out was on the effects of music on physiological-psychological factors during exercise of an average rate. Therefore, in this research we have tried to observe and study the effects of music on the perceived exertion rate and performance of trained and untrained individuals in a reliable physical exercise test.

2. Materials and Methods

2.1. Subjects

24 university students aged between 20 - 27 years of age, among them 18 males and 6 females from the Urmia University have participated voluntarily in this research. The trained and untrained groups were distinguished based on two criteria: their training history and the predicted VO2max. The students who did not have any regular exercise during the last 3 months made up our untrained group; and the students who had exercised regularly 3 times a week were chosen to be the trained group.

According to the of Bruce treadmill test, maximum oxygen consumption for trained males is considered to be over 42 ml / kg/ min and a little less than this for untrained males. The maximum oxygen consumption for trained females is considered to be over 32 ml / kg/ min and a little less than this amount for untrained females. Thus, the trained subjects were above average and untrained subjects were below average in terms of aerobic fitness.

2.2. Instruments

The rating of perceived exertion (RPE) (Borg, 1998), summarizes the exertion levels between rest and maximum effort (0 - 10). The Bruce treadmill test assesses maximum oxygen consumption for athletes/active and non-active people. This test starts with an incline of 40% and a rate of 2/74 km/hr, while after every 3 minutes, 2% is added to its speed. This increases until the subject is exhausted and unable of continuing the exercise. The music (some songs of the Trelinum album by Sash) used in this research is stimulative music with a fast rhythm. The music was played on an mp3 player (Sony, made in Japan).

2.3. Procedure

At first, the subjects were familiarized with the way the test is carried out and the instruments necessary for completing the Bruce treadmill test and the rating perceived exertion (RPE) scale. During the first testing session, half of the subjects, who were randomly selected, performed the Bruce test without music and the other half performed it to music, while during the second testing session the opposite took place. Voice intensity was the same for all of the subjects during the exercise. The subjective scales, rating the perceived exertion (RPE) (Borg, 1982), were showed throughout each trial and the subjects' verbal ratings were recorded at specific intervals. Time was measured by a digital watch from the start of the exercise till the subjects' exhaustion. The subjects did warm up activities for 3 minutes before the main exercise and did some activities after it to relax. In order to be sure that tiredness has no effect on the subjects' performance, the second session was conducted two days after the first session.

3. THE RESULTS

The results are divided into two sections: the rate of perceived exertion, and the performance. The results of a 2 (music condition: music/no music) × 2 (fitness: trained/ untrained) ANOVA is given for each of the two measures. This shows the contrast and interaction of the effects of the fitness levels on the effectiveness of music.

The mean and standard deviation values for these two measures, according to the experimental conditions, are summarized in Table (1).

Table 1. Effects of music on the RPE and performance. (Mean and standard deviations).

	RPE				performance			
Conditions	no music		music		no music		music	
Groups	M	SD	M	SD	M	SD	M	SD
Trained	3.98	1.51	3.64	1.43	13.25	0.89	13.40	0.75
Untrained	4.79	1.02	3.82	0.97	10.94	0.36	11.23	0.25

3.1. Rating of perceived exertion

A 2×2 (music/no music condition; trained/untrained fitness level) ANOVA was carried out on the sample of subjects. The analysis revealed a significant main effect of music on the RPE ($F = 24.59$, $p < 0.05$). The participants' RPE was lower in the music condition than in no music condition (Table 1). The means for the two conditions were 3.98 for the trained

and 4.79 for the untrained subjects for the no music condition and 3.64 for the trained and 3.82 for the untrained subjects for the music condition. A significant fitness and music interaction emerged ($F = 7.03$, $p < 0.05$), as shown in Figure 1. The results indicated that the effect of music on the RPE depends on the fitness of the subjects. There is a large effect of music on the RPE among the untrained subjects in relation to the trained ones.

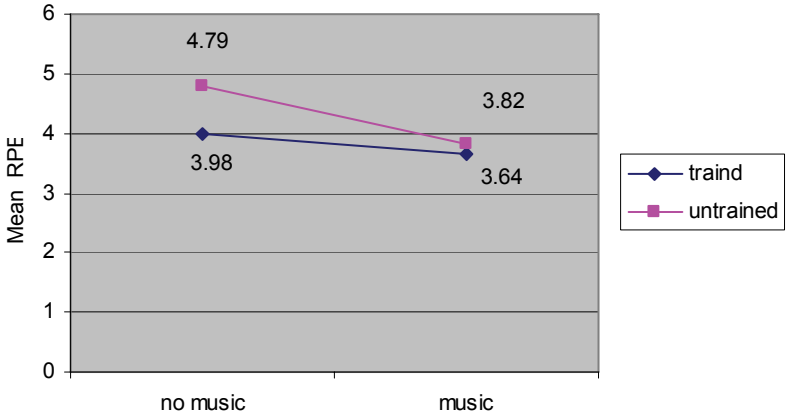

Fig. 1. Music and fitness interaction, RPE data

3.2. Performance (time to exhaustion)

A 2×2 (music/no music condition; trained/untrained fitness level) ANOVA carried out on the sample of subjects revealed a significant main effect of music on the time leading to exhaustion ($F = 17.68$, $p < 0.05$). The participants' time to exhaustion was longer in the music condition than in the no music condition (Table 1). The means for the two conditions were 13.25 min for the trained and 10.94 min for the untrained group under the no music condition and 13.40 min for the trained and 11.23 for the untrained subjects under the music condition. A significant relationship between fitness and music interaction was not determined ($F = 1.57$, $p > 0.05$), as shown in Figure 2.

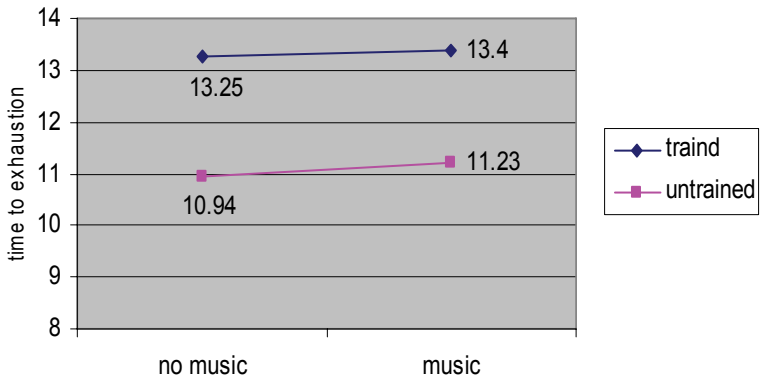

Fig. 2. Music and fitness interaction, performance data

4. DISCUSSION

The effects of music on the perceived exertion rate and performance during progressive exercise in the case of trained and untrained individuals were investigated. Like the findings of previous studies, the results of this research have also shown a relationship between music and the perceived exertion rate. In fact these results have proved one of the hypotheses of this research, one which was based on the assumption that the subjects' exercising to music will lead to less exertion than among those subjects who exercised without music. The findings of most previous research just reported the effectiveness of music on the subjects' perceived exertion rate, Copeland and Franks (1991) and Szmedra and Bacharach (1998), Potteiger, et al. (2000). But the findings of some other researchers do not agree with this idea (Schwartz, et al., 1990). Of course the kind of music used in most research up to date was that of an average extensive kind, where, like in our research, the exercised progressively led to the subjects' total exhaustion. As the progressive rate of the perceived exertion is directly related to the working mass of the organs of the body and the related metabolic requirements of the type of exercise (Pandlof, 1978), the results of this research cannot be compared with the results of other research and cannot be generalized to cover other types of activities.

By comparing the recorded exertion time of the two situations, it became clear that the subjects who exercised to music performed a lot better than those who did not. The findings of some researchers have indicated the effectiveness of music on the performance of the subjects when the exercise was performed below maximum (Anil, Bharani, et al., 2004). The research of Schwartz, Fernall, & Plowman (1990), Copeland and Franks (1991) Pujol, & Langenfeld (1999), which investigated the effect of music on the performance of Wingate's three tests (super maximal exercise), showed no meaningful effect of music on the subjects' performance. Lee (1989) also, using motivating and calm music, could not find a meaningful difference in the perseverance of the subjects in a below maximum running exercise.

By analyzing the effects of the level of fitness on the effectiveness of music and the perceived exertion rate and performance in this progressive exercise, it became clear that music has a greater effect on the perceived exertion rate of the untrained subjects. No significant difference in the fitness level could be seen for performance. In other words, regardless of their fitness level, music had an effect on the time leading to exhaustion for both of the groups. The assumption is that the trained subjects concentrated on the internal stimulus of the exercise while exercising, so they responded very little to the musical stimulus. In contrast, the untrained subjects, in order to overcome the tiredness caused by the exercise, focused their attention on the external stimulus and, therefore, were greatly affected by the music. However, the trained subjects of this research were affected by the music as well.

By describing the results of this research, it can be claimed that when doing an exercise without any motive subjects mostly concentrate on their struggling; and the exertion rate that they perceive is high. In other words, in a no music situation the subjects do not do any excessive exercise but they perceive that they are exercising heavily. Music as a powerful external motive causes distraction and excitement (Dorney, 1992), so the amount of concentration on the exercise decreases, and the perceived exertion rate decreases as well.

The possible mechanisms for a lower RPE during exercise to music include decreasing sensitization of the endocrine stress response systems, especially in regards to the hypothalamic-pituitary-adrenal axis. Khalfa et al. (2003) reported that the concentration of salivary cortisol decreased rapidly in the subjects who were exposed to music after acute stress, while the corisol levels continued to rise in those who were not. Research carried out by Szmedra et al. (1998) showed higher values for the hemodynamic variables (heart rate, systolic blood pressure) and lactate with no music during exercise at work-loads relative to each subject's ability (percentage of VO_{2max}). The researcher concluded that all kinds of exercise to music allowed the subjects to reduce muscle tension, thereby increasing blood flow and lactate clearance. This increased clearance affected the heart rate and breathing frequency, causing a 10% decrease in the RPE among the subjects exercising to music. The levels of norephinephrine were also lower, indicating a decrease in the sympathetic division of the automatic stress response.

It should be mentioned that despite the researcher's effort to hide the aims of this research from the subjects, because of the use of the MP3 player with headphones for listening to the music, there is the probability that the subjects tried to exercise harder to music. However, the use of a standard and reliable exercise in research would certainly decrease this probability. For decreasing the effect of practice on the dependent variables, half of the subjects exercised to music and the other half did not exercise to music in the first section; and in the second section the subjects did the exact opposite.

CONCLUSION

In general, the results of the research indicate that exercising to music makes that exercise more exciting and pleasant, which causes, in effect, a great increase in performance - a characteristic essential for preserving the continuity of a physical exercise. According to the findings of this rsearch, music can be used to increase the motivation of those who do not have enough motivation to exercise because of the repetitiveness or dullness of the physical activities of the exercise. The findings of this research can also be useful for trainers and athletes alike. Regardless of their level of fitness, athletes can use music as a psychological motive to increase their performance even in progressive exercise.

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EFEKTI MUZIKE NA PRIMETAN STEPEN NAPORA (NAPREZANJA) I IZVOĐENJE TRENIRANIH I NETRENIRANIH INDIVIDUA TOKOM PROGRESIVNOG VEŽBANJA

Mohammadzadeh Hasan, Tartibiyan Bakhtiyar, Ahmadi Azhdar

Cilj ove studije je bio da se utvrde efekti slušanja muzike tokom progresivnog vežbanja na primetan stepen napora i izvođenje, kao i da se proceni efekat razlika u fitnesu na efektivnost muzike. Dvadeset četiri zdravih studenata (grupa koja trenira: n=12, prosek godina = 23,31±2,06 i grupa koja ne trenira: n=12, prosek godina = 22,96±2,31) su dobrovoljno učestvovali u ovoj studiji. Tokom prve sesije učesnici su se upoznali sa načinom izvođenja testa i sa instrumentima za procenu. U prvoj sesiji učesnici su uzeli učešće u Bruce Test-u, gde su neki slučajno izabrani da slušaju muziku, a ostali da ne slušaju muziku. Tokom druge sesije oni koji su izabrani da slušaju, uradili su test bez slušanja muzike, dok je za drugu grupu važilo obrnuto pravilo. Rezultati ANOVE su pokazali da je efekat muzike na RPE i vreme iscrpljenosti značajno (P<0,05). U dodatku, pregled interakcije između muzike i fitnesa, pokazao je da efekat muzike na RPE značajno zavisi od fitnesa, ali nije značajan za izvođenje. Postoji veći efekat muzike na RPE grupe koja ne trenira nego na onu koja trenira. Rezultati pokazuju da bi korišćenje muzike kod progresivnog vežbanja imalo pozitivan efekat na izvođenje i psihološki pogled, bez obzira na nivo fitnesa.

Ključne reči*: Muzika, primetan stepen napora, izvođenje*