Effect of listening to music with different tempo during moderate intensity pedaling exercise on the physiological responses

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Abstract

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Purpose The purpose of this study was to investigate the effect of listening to music with different tempo during moderate intensity pedaling exercise on the physiological responses. **Method** Twelve healthy participants performed moderate intensity pedaling exercise at constant exercise intensity at 7Mets for 5 minutes while three musical conditions: fast music (190 bpm), slow music (100 bpm), and no music. During the pedaling exercise, oxygen consumption (VO2), heart rate (HR), and cadence were measured. **Results** There were no significant differences in VO2, HR, and cadence among the three musical conditions (p>0.05). **Conclusion** Our data suggest that listening to music with different tempo during moderate intensity pedaling exercise, may not have different effects on the physiological response.

中強度ペダリング運動中のテンポの異なる音楽の聴取が生理学的応答に与える影響

目的　本研究の目的は、中強度のペダリング運動中に聴取する音楽のテンポの遅速が、生体にどのような影響を与えるのかを調べることである。**方法**　12 人の健康な男女が、7 メッツ相当の運動強度で自転車エルゴメーターによるペダリング運動を、早い音楽（190bpm）と遅い音楽（100bpm）、音楽なしの 3 条件で各 5 分間ずつ行った。その際の VO2、HR、回転数を計測した。**結果**　3 つの条件間の VO2、HR、回転数に、有意な差はみられなかった。（ｐ＞0.05）**結論**　本研究の結果から、運動中の音楽のみならず、テンポの異なる音楽の聴取は、生体に異なる影響を与えない可能性があることを示唆する。

中等强度蹬踏运动中听快节奏音乐对生理反应的影响

这项研究的目的是调查听快节奏音乐的效果,在中等强度的自愿蹬踏运动中对生理反应。12 名健康大学生在三种音乐条件下以相当于 7 Mets 的运动强度进行中等强度的蹬踏运动 5 分钟：快音乐 (190 bpm)、慢音乐 (100 bpm) 和无音乐。那时，测量了摄氧量、心率和踏频。摄氧量、心率和踏频节奏在三种音乐条件之间没有显着影响（p<0.05）。我们的研究结果表明，在不同的节奏下听音乐以及在运动中听音乐可能不会影响对生理反应。

Abbreviations: ECG, Electrocardiogram; HR, Heart rate; HRmax, Maximal heart rate; MWSA, Mayer wave related sinus arrhythmia; RPE, rating of perceived exertion; RSA, respiratory sinus arrhythmia; VO2, Oxygen uptake; VO2max, Maximal oxygen uptake.

Introduction

Regular physical activity is a key protective factor for the prevention and management of noncommunicable diseases (NCDs) such as cardiovascular disease, type 2 diabetes, and cancers. Physical activity also benefits mental health, including prevention of cognitive decline and symptoms of depression and anxiety and can contribute to the maintenance of healthy weight and general well-being. The WHO guidelines on physical activity and sedentary behavior (2020) provide recommendations for children, adolescents, adults, and older adults on the amount of physical activity (frequency, intensity, and duration) required to offer significant health benefits and mitigate health risks (World Health Organization. (2020). Use of WHO guidelines on physical activity and sedentary behaviour: at a glance). That is all older adults should do at least 150– 300 minutes of moderate-intensity aerobic physical activity; or at least 75–150 minutes of vigorous-intensity aerobic physical activity; or an equivalent combination of moderate- and vigorous-intensity activity throughout a week, for substantial health benefits (World Health Organization. (2020). Use of WHO guidelines on physical activity and sedentary behaviour: at a glance). In addition, ACSM recommended to promote and maintain health, all healthy adults aged 18 to 65 need moderate-intensity aerobic physical activity for a minimum of 30 min on five days each week or vigorous-intensity aerobic physical activity for a minimum of 20 min on three days each week (American College of Sports Medicine (ACSM) and American Heart Association (AHA). (2007). Use of

Physical Activity Guidelines for American). Combinations of moderate- and vigorous-intensity activity can be performed to meet this recommendation. For example, a person can meet the recommendation by walking briskly for 30 min twice during the week and then jogging for 20 min on two other days. Furthermore, according to the report of exercise standards for health promotion (2006) by Ministry of Health, Labor, and Welfare of Japan, it is recommended that to promote and maintain health, all healthy adults aged 18 to 64 need physical activity of 23 Mets / hour / week with more than 3 Mets of exercise intensity. For example, a person can meet the recommendation by walking briskly (4Mets) for 6 hours a week or jogging (7Mets) for 3 hours a week. These recommendations are provided for not only healthy person but also subpopulations, such as pregnant and postpartum women, and people living with chronic conditions or disability (Ministry of Health, Labor, and Welfare of Japan. (2006). Use of the report of exercise standards for health promotion). It follows from what has been said that undertake moderate-intensity aerobic physical activity or more is important for most humans. However, global estimates indicate that 27.5% of adults and 81% of adolescents do not meet the WHO recommendations in 2010 for physical activity with almost no improvements during the past decade. Added to this, data from ACSM in 2005 indicate that less than half (49.1%) of U.S. adults met the CDC/ACSM physical activity recommendation. In Japan, according to the National Health and Nutrition Survey (2020), it is estimated that about 70% of people do not have exercise habits and do not meet the recommendations. Using IPAQ, Shibata et al.

(2009) estimated that 73.4% of adults do not meet the recommended standard of physical activity. All these things make it clear that there are few people who routinely carry out physical activity that exceeds the recommendations.

Various approaches have been taken to increase the amount of physical activity as much as possible. For example, extending duration, increasing intensity, increase the frequency, or changing the way are trying in order to increase total physical activity. Among various approaches, this study focused on workload for two reasons. First, there is need to exercise more efficiently in a situation there are not enough time. According to the National Health and Nutrition Survey (2020), it is clear that reason why exercise habits are hindered is that work, housework, and childcare is busy and there is no time (Ministry of Health, Labor, and Welfare of Japan. (2020). Use of the National Health and Nutrition Survey). Therefore, it can be imagined that it is practically difficult to extend the exercise time to increase the amount of physical activity. The second reason is that the importance of intensity has been gathering attention in the field of exercise physiology. High-intensity interval training (HIIT) has been attracting attention due to its effect that expected to improve cardiopulmonary function, increase muscle strength and to promote the fat burning effect in a short time (Ross et al. 2016). High-intensity exercise is also said to be effective in preventing and managing lifestyle disease such as sarcopenia and metabolic syndrome (Ross et al. 2016). As an example of an approach to increase the workload and increase the amount of physical activity, the Ministry of

Health, Labor and Welfare recommends adding to some extent workload in exercise that always do. For example, walking, if you a brisk walk you can expect 1.5 times more physical activity than normal walking, if you walk uphill, you can expect 1.7 times more physical activity, and if you slowly go up and down stairs, you can expect 1.3 times more physical activity (Ainsworth et al. 2000). Weight bearing during walking such as ankle brace could be also one of the classic ways to increase exercise intensity, have also attracted attention (Sooyong et al. 2016). However, Kutzner et al. (2010) reports that climbing stairs and hills puts a heavy burden on the knee joint, increasing the risk of injury and falls (Kutzner et al. 2010). Also, about ankle weights, Sooyong et al. (2016) may cause knee osteoarthritis disorder, increased body sway, increased risk of falls, and altered gait patterns if the ankle weights are not properly weighted (Sooyong et al. 2016). In this way, many approaches have been adopted to increase the amount of physical activity but there are always some risks in increasing the workload. These approach, which increase intensity using some tools, have been recommended and implemented in order to increase the amount of physical activity, but little attention has been given to approaches that affects the internal function of the body itself. This approach can be defined as to change the physiological responses by working on the internal parts of the body through the autonomic nerves even if the external factor does not change.

Caffeine provides an example. Effect of caffeine is many and different, for example, during exercise with caffeine, compared to not taking caffeine, research has shown that the caffeine leads to increase energy consumption by improving promotion of fat burning effect and enhance muscular force development (Shabir et al. 2018; Timmins et al. 1995; Erica et al. 2010; Chesley et al. 1998). In addition to these, previous study suggested that caffeine makes you less likely to feel tired and has an analgesic effect, so caffeine leads to lower perceive exertion measures (RPE) and improved endurance exercise performance (Adrian et al. 2013; Pasman et al. 1995; Gregory et al. 2002). The background that causes these physiological responses is that caffeine promotes central nervous system excitement and arousal, and sympathetic nerve activity is increased. The point is that, even if the external factors do not change, some internal approach such as caffeine intake is possible to stimulate the inside of the body through the autonomic nervous system and promote changes in the physiological response. Music also appears to exert direct and indirect physiologic effects through the autonomic nervous system. There is considerable evidence to show that previous study presented various types of music and measured the subject's HR, emotions, Mayer wave related sinus arrhythmia (MWSA), and respiratory sinus arrhythmia (RSA) (Umemura et al. 1998). As a result, when listening to slow music such as classical music, emotions such as calmness and relaxation were induced, and parasympathetic nerve activity increased (Umemura et al. 1998). On the other hand, intense and bright music such as rock music made positive emotional states such as excitement and activity, and HR and sympathetic nerve activity were increased (Umemura et al. 1998). Kathi et al. (2005) also showed that music to enhances patient’s well-being, reduce stress, and distract from unpleasant symptoms through the autonomic nerves. We may, therefore, reasonably conclude that the music holds the potential of causing physiological and psychological response by intervening autonomic nervous system.

In recent years, the number of people who use music during exercise has increased, and according to a previous study, it is estimated that 48% of people use that (Miyoshi.2014). One of the reasons is that music devices such as portable music players represented by the i-Pod have exploded and become widespread (Epstein 2010). It can be imagined that it has become possible to use it in all aspects of sports because these products can easily wear and with their hands and feet free. Considering the relationship between sports and music, music is widely used across sport and exercise for its reputed ergogenic and psychological properties for people of all generations regardless of a physical ability (Karageorghis. et al. 2018; Laukka & Quick 2013).

Many studies have been made on the relationship between the exercise and music of potential physiological and psychological feature, at the same time the beneficial effects of listening to music have been reported in a variety of applied settings. From an empirical point of view there are two main questions that need to be addressed. The first question is whether music has any effect on physiological and psychological measurements. The research evidence suggests that the use of music affects a range of dependent variables during exercise as below. Szmedra and Bacharach (1998) showed that exercising while listening to music differed on several measures when compared to exercising in no music (Szmedra.1998). They found that hemodynamic and lactate measures were higher in the no music than in the music condition, although there was no difference in oxygen consumption (Szmedra.1998). Perceived exertion measures were also higher in the no music condition. They interpret their results as suggesting that music might allow participants to reduce muscle tension, thus increasing blood flow and consequently having a psychobiological impact on exercise (Szmedra.1998). Thornby et al. (1995) tested the effect of music and noise on participants. They found that the time spent exercising, the amount of work and HR were all significantly higher in the presence of music than in the other two conditions. By contrast, perceived exertion was lower in the music than in the other conditions. Perceived exertion was also greater in the no music than in the noise condition. Another study, where participants performed in a variety of conditions, found that perceived exertion while exercising in music was lower than for other attention distracters and for the no distraction condition in the previous study (Nethery et al. 1991). A more recent study by Edworthy et al (2006) showed that 10minuites of exercise while listening to music had a significant increase in HR of about 3% compared to the no music (Edworthy et al. 2006). The most consistent finding seems to be that perceived exertion appears to be lower when subject exercise to music, but its effect on actual performance and other physiological measures is perhaps less clear. The second question is whether the nature of the music has any effect on physiological and psychological measurements.

In this sphere, one of the key questions is that of whether fast music has different effects than slow music on either or both objective and subjective measures.

These physiological responses caused by listening to music have been found to be influenced by the components that make up the music. According to study by Karageorghis et al. (1999), music involves complex elements such as tempo, timbre, sound pressure, volume, and melody (Karageorghis et al. 1999). Therefore, when considering the influence of music, it is necessary to clearly distinguish which components affects the living body and how, and over the past few years a considerable number of studies have been made on the nature of the music itself. For example, Bernardi et al. (2006) presented various types of music and measured the HR, respiration, and cerebral blood flow of the participants (Bernardi et al. 2006). As a result, it was suggested that the music tempo is the main factor that affects the living body rather than the type and taste of music (Bernardi et al. 2006). In addition, Edworthy et al. (2006) focused on the loudness and tempo of music, and measured HR, RPE, treadmill running speed, and emotions under five conditions: fast/loud, fast/quiet, slow/loud, slow/quiet, or absent (Edworthy et al. 2006). As a result, HR, RPE, and running speed increased significantly under fast/loud musical conditions, but the results indicate that the effect of volume is dependent on the tempo of the music (Edworthy et al. 2006). As can be seen from the above studies, tempo is an important parameter that characterizes music and has the potential to great influence on physiological responses. Therefore, many studies focusing on tempo of music. Avinash (2017) subjected their participants to three conditions, fast music, slow music and control. As a result, VO2 (5.5%), cardiac output (19%), stroke volume (17%), minute ventilation, and respiratory frequency significantly increased while listening to fast music compared to the slow music and no music. Systemic vascular resistance (SVR) significantly decreased while listening to fast music compared to slow music and no music. Brownley et al. (1995) also compared performance in fast and slow music conditions, as well as a no music condition. Their results showed an increased respiratory frequency during fast music compared to slow or no music. Becker et al. (1994) found that fast music produced a longer distance on an exercise bicycle, whereas a further study (Becker et al. 1995) found that slow music produced a decrement in walking distance. Copeland and Franks (1991) measured HR, rating of perceived exertion (RPE) and time to exhaustion on a group of exercising participants who ran on a treadmill in three different music conditions: slow easy-listening music; loud fast popular music; and no music. They found that HR, time to exhaustion and rated perceived exhaustion were all lower for the slow, soft music than for the loud, fast music. Edworthy et al. (2006) showed that fast music increases the running speed of the treadmill compared to slow music, and the heart rate increases accordingly. All these responses are possibly caused by music with different tempos. However, the effects of the nature of the music itself appear to be more ambiguous than the effects of the presence of music.

Focus on the tempo, for example, Edworthy et al. (2006) who conducted an experiment using three music conditions; fast music, slow music, absent, they adopted [Viva La Van] as fast music stimulus, on the other hand, adopted [First Born's Lullaby] as a slow music stimulus. Birnbaum et al. (2009) introduced Miley Cyrus [See You Again] and Rihanna [Don't Stop the Music] as fast music stimuli, and as slow music stimuli. Five for Fighting [Superman] and Eve 6 [Here’s to the Night] was adopted. However, these previous studies comparing slow and fast music might have issue; the tempo and harmony of the songs used in these previous studies are not constant, because it is famous songs that had already been fixed as original songs including various tempo and harmony. Therefore, we have the questions, whether the physiological response is influenced by the tempo itself, because except for elements of tempo are intricately intertwined with music.

The purpose of this study was to examine the effects of listening to music with different tempo during moderate-intensity pedaling exercise on the physiological responses. The present study used music that controlling the tempo constantly and a simple drum sound to exclude the influence of other parameters that make up the music, in order to investigate how music tempo affects the body. It was hypothesized that listening to fast music compared to listening to slow music and no music during exercise can give a greater load to the living body, such as an increase in VO2 and HR, even though the exercise intensity is the same. Because previous study reports that excitement of sympathetic nerve due to the influence of listening to fast music promotes physiological response (Birnbaum et al. 2009; Edworthy at al. 2006; Brownley et al. 1995).

Methods

1. Participants

Twelve healthy students volunteered as participants in this study (age 21.1 ± 0.5 years, height 162.4± 6.16 cm, body weight 53.4 ± 8.9 kg). No participants were taking any medication or had a smoking habit. And all subjects have not been involving vigorous exercising and drinking for 24hours before the study. They gave informed consent for the study after receiving a detailed explanation of the purposes, potential benefits, and risks associated with participation.

2. Study design

Figure 1 summarizes the design of the experiments. Subjects performed the pedaling exercise on an electrically braked cycle ergometer. Before the experiment began, subject is warm-up with 4 Mets which converted from body weight, on 5 minutes. After that subject carried out the exercise with 7Mets of exercise intensity on 5 minutes to each of the three experimental music conditions i.e., fast (190bpm), slow (100bpm), and no music. Order of three music conditions were randomized. During the pedaling exercise, VO2, HR, and pedaling cadence were measured.

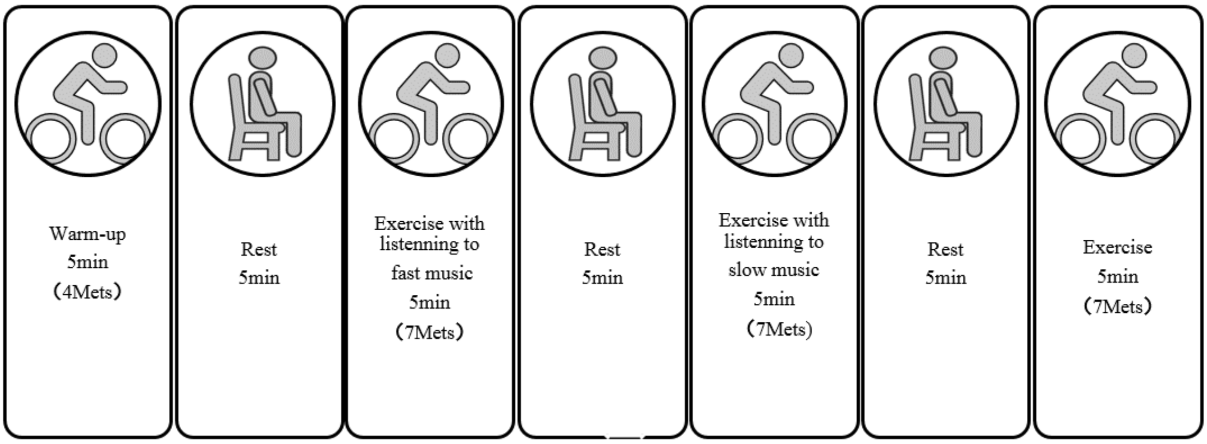

Figure1. Time schedule of the experiments.

3. Exercise

Participants performed the pedaling exercise on an electrically braked cycle ergometer (Aerobike 800; Combi Wellness, Tokyo, Japan). Saddle height was set at the trochanter height of individual. Consequently, the knee of the participants was slightly flexed (i.e., knee joint angle approximately 170 ° compared to full extension of 180 °) at the bottom of the crank cycle. Feet were fixed to the pedals by the pedal strap. The handlebar was in an upright position. The trunk of the participant was approximately vertical to horizontal line during exercise. During the pedaling exercise, participants remained seated on the saddle of the ergometer. During warm-up trial, participants were instructed to maintain pedaling cadence of 60rpm. For three music conditions, participants performed pedaling freely-chosen cadence.

Workload in the exercise was determined from the exercise intensity, which corresponds to adult medium-intensity exercise, i.e., 7Mets, with reference to the exercise standards for health promotion (2006) by Ministry of Health, Labor, and Welfare of Japan. Using ACSM’s lower limb ergometer equation, workload for the exercises with three music condition were calculated from body weight of each participant. (ACSM metabolic calculation handbook .2008).

《 Lower limb ergometer equation 》

$$V\,O2\ \text{(ml/kg/min)} = 1.8\ \frac{\text{Power}\ (kg \cdot m / \min)}{\text{Body wight}\ (kg)} + 7$$

1 Mets = 3.5ml/kg/min

《 Conversion of watts 》

$$\text{Watts} = \frac{kg \cdot m / \min}{6 \cdot 12}$$

The pedaling exercises for the three music conditions were set to 5 minutes for each, and the rest time between each exercise was set to 5 minutes.

4. Measurements

During exercise, participants wore the mask covering their nose and mouth for detecting the expired gas. VO2 was calculated from expired gas using the breath-by-breath method with an oxygen and carbon dioxide analyzer (Nippon photoelectric aero monitor AE310S, Minato Medical Science Co., Ltd., Osaka, Japan) and a flow transducer. VO2 was averaged for every 2-4 sec. Data from the gas analyzer and flow transducer were continuously recorded after conversion through the software (AT for Windows, Minato Medical Science Co., Ltd., Osaka, Japan).

Before the experiment, wipe off the sweat and sebum from the electrode-mounted area of the participants with alcohol cotton (Sanicot EQ AS ONE Co., Ltd. Osaka Japan), and then attached an electrode (Magnerode TE-18, Fukuda Denshi Co., Ltd. Tokyo Japan) from the bipolar lead (CM5) electrocardiogram (ECG). The participants' ECG and HR were analyzed by a central monitor (DS-8600 system DS-8610) by way of ECG and respiratory transmitter (LX8100 Fukuda Denshi Co., Ltd. Tokyo Japan). The ECG signal was also collected after conversion through the software (AT for Windows, Minato Medical Science Co., Ltd., Osaka, Japan) from the gas analyzer and flow transducer. In case of failure to measure HR, subjects infrared radiation sensor at ear (ETC163 AEROBIKE 75XLⅢ, KONAMI sport & life Co., Ltd. Tokyo Japan) or finger (HPO-1601, OMRON Co., Ltd, Kyoto, Japan) were applied.

Cadences displayed on the monitor which had on an electrically braked cycle ergometer. It was recorded every 10 seconds, and the average every minute was used as the date. During exercise, participants were given discretion on the speed of the pedaling cadence.

During-the exercise trial, VO2, HR and cadences were measured at the end of the sample periods: 3-5 min.

5. Music

BPM is a unit that indicates the tempo of music and indicates how many beats are beaten in one minute. If you know the BPM value, you can grasp the approximate tempo of the song. The music was played garage band app through personal earphones (Ear Pods with Lightning Connector MMTN2JA,Apple Co.,Ltd California,America) in two of the experimental treatments, with the other treatment being a no music condition where headphones were worn but nothing was played. One fast and one slow music were made referencing a modern analog sound which only comprises dram sound. For the music with fast and slow tempo, 190 and 100 bpm were used, respectively. These tempos were set with reference to previous studies (Fraisse 1982 &Trainer 2007). As a major premise, it is said that the tempo that is easy for humans to perceive, although there are individual differences, is in the range of 67-200 bpm, which makes it impossible to keep up with pace of the song from around 200 bpm. It is speculated that 200bpm is mistaken for 100bpm. (Fraisse 1982& Trainer 2007). First, regarding the setting of a fast tempo, after trying 200 bpm in a preliminary experiment, we rejected it and decided to set it to 190 bpm, which is estimated to be the fastest within the range that humans can perceive (Fraisse 1982 & Trainer 2007). Second, regarding the setting of the slow tempo, the tempo selected as slow music in the previous research varied, so it was decided mainly through preliminary experiments. The slow criterion used in previous studies was 70bpm, 80bpm, 117bpm, etc., and was determined to be 100bpm, based on the values of the preliminary experiment and the previous study (Edworthy et al. 2006 & Birnbaum et al. 2009). Both selections were played at approximately 60±dB at the ear. Volume was held constant for each. Right before the pedaling exercise, participants attached earphones, but during rest trial, earphone were removed.

6. Statistical Analysis

All data are provided as mean and SD. Since normal distributions of data were not found by Shapilo-Wilk test, non-parametric tests were used in this study. VO2, HR and cadence were compared between three music conditions by using Friedmann test. When significant effects of music condition, post-hoc test was applied to compare the values among the conditions. The level of statistical significance was set at $p < 0.05$. All statistical analyses were performed using SPSS software (SPSS version 15.0, Tokyo, Japan).

3. Results

There were no significant effects of music conditions on VO2 (Figure 2A), HR (Figure 2B) and cadence (Figure 2C) ($p > 0.05$ for all).

Discussion

The purpose of this study was to examine the effects of listening to music with different tempo during moderate-intensity pedaling exercise on the physiological responses. This study was hypothesized that listening to fast music compared to listening to slow music and no music during exercise can give a greater load to the living body, such as an increase in VO2 and HR, even though the exercise intensity is the same. Because previous study reports that excitement of sympathetic nerve due to the influence of listening to fast music promotes physiological response (Birnbaum et al. 2009; Edworthy at al. 2006; Brownley et al. 1995). However, in this study, significant differences

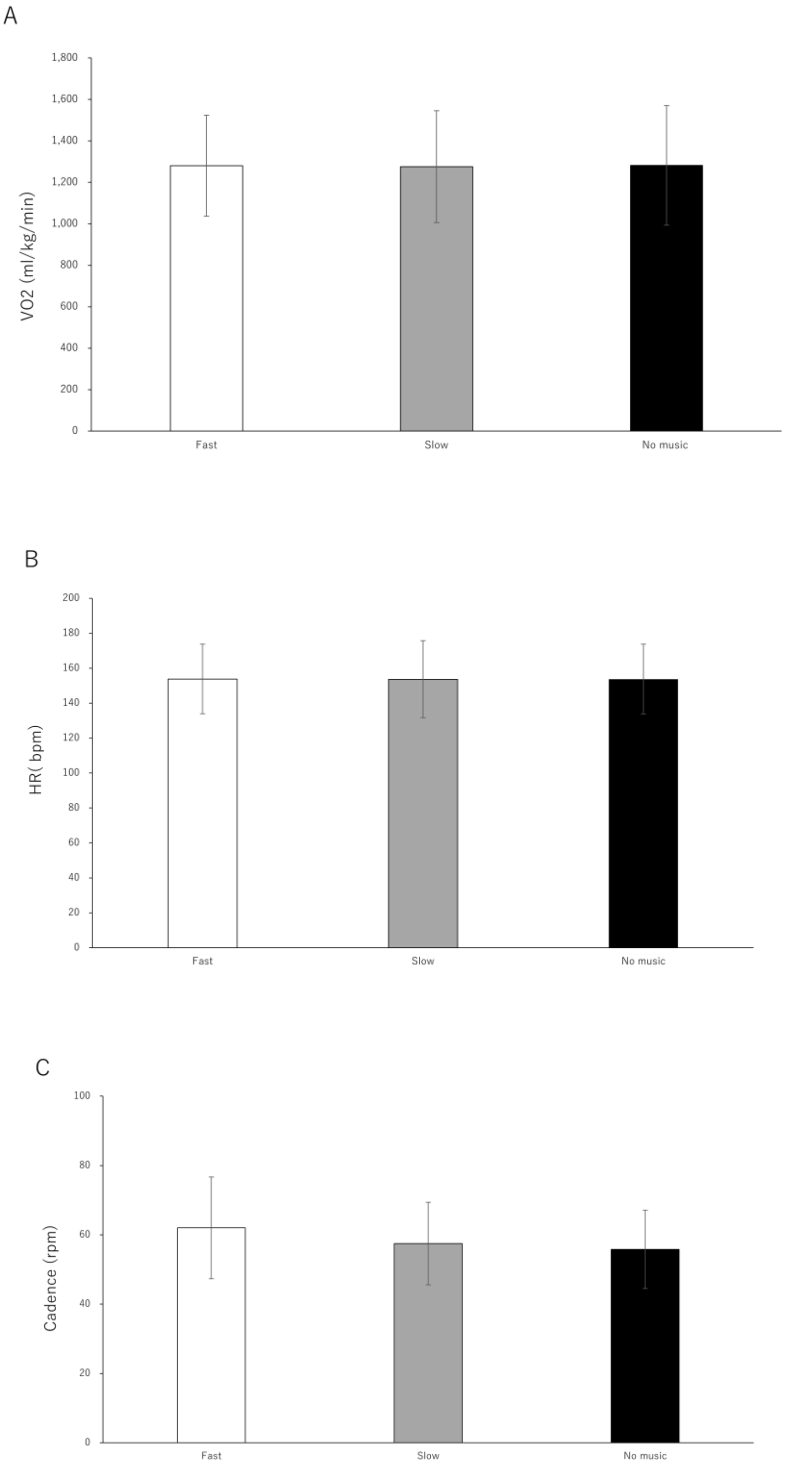

Figure 2 Mean data of oxygen consumption (VO2) (A), heart rate (HR)(B), and cadence (C) for the fast music and slow music and no music.

in Vo2, HR, and cadence under different three musical conditions could not be detected.

In this study, the workload was determined based on lower limb ergometer equation by converting the individual body weight. Its exercise intensity was 7 METs. The exercise intensity of this study based on the previous research, but incremental exercise test that used for standard way to determine the exercise intensity was not conducted, because Uchida et al. (2012) reported it is difficult to accurately obtain the data of unfamiliar non-exercise persons in the incremental exercise test (Uchida et al. 2012). Considering these reports, therefore, the load of 7 Mets was set to the wattage converted from the body weight individual. Since VO2max was not measured by performing an incremental exercise test in this study, an accurate exercise workload cannot be calculated. But %HRmax was calculated from the participant's HR based on the prospective maximal value [220-age (bpm)] (Machado et al. 2011). It can be estimated to average 76% HRmax. The load of 76%HRmax was estimated to be exercise of about 70% or less of the VO2max by referring to the report (Raven et al. 2013 & Garber et al. 2011). Both workload of 76%HRmax and 70%Vo2max seems reasonable to suppose that it is classified as medium-intensity exercise. The same observation applied to similar previous studies (Szmedra and Bacharach 1998; Edworthy et al. 2006; Birnbaum et al. 2009), it is also safe to say that compared the results of VO2, HR and cadence of our study with the previous studies (Szmedra and Bacharach 1998; Edworthy et al. 2006; Birnbaum et al. 2009). And it was predicted that the workload would not theoretically exceed anaerobic threshold (AT). However, as you can see from Figure 3, both VO2, HR tended to increase as time proceeds, so workload used in this study may reach anaerobic threshold (AT).

Mostly the effects of music on exercise performance have been studied, previous study showed that music affects to reduce rating of perceived exertion, increase exercise enjoyment, and enhance exercise performance, mainly in low-moderate intensity exercises (Bucket et al. 2002; Crust et al. 2004; Potteiger et al. 2000; Schwartz et al. 1990). However surprisingly few studies have so far been made at supramaximal exercise, the effect of music on supramaximal exercise is not clear yet. Atan (2013) and Pujol et al. (1999) investigated the music effect on Wingate Anaerobic Power performance, and they found no significant differences between music and no music conditions (Atan 2013; Pujol et al. 1999). Schwartz et al. (1990) reported that in the case of anaerobic exercise, music and its rhythm cannot change physiological responses such as HR, blood lactate, and performance during exercise (Schwartz et al.1990). Some of the previous studies have shown that during anaerobic exercise listening to music with different tempo improves physical performance (Brownley et al. 1995; Copeland et al. 1991), but some studies have shown no improvement in performance (Coutts et al. 1961; Koç et al. 2009; Nelson et al. 1963; Schwartz 1990; Yamamoto et al. 2003). Like this, it has been reported that the influence of music is remarkable in the case of aerobic exercise, but the influence of music may be reduced in the case of anaerobic exercise. This study may support the results of these previous studies that investigated the effects of listening to

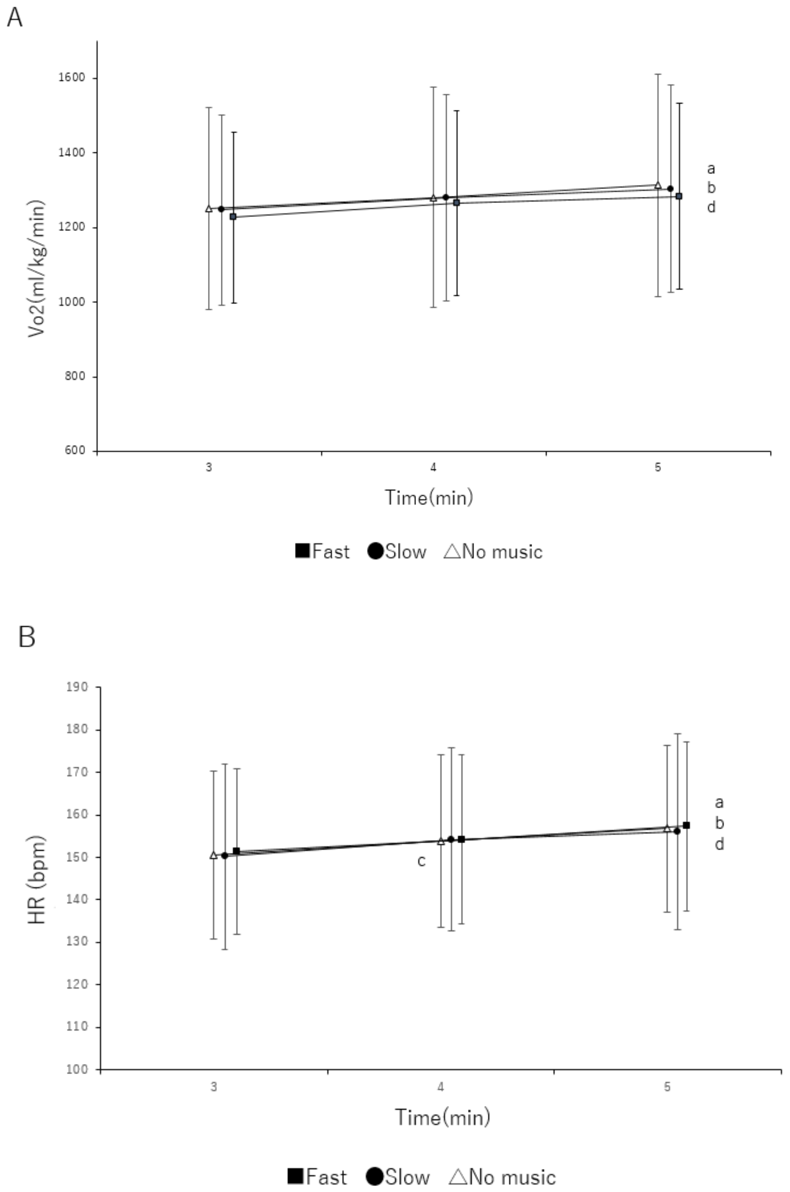

Figure 3 Time courses of oxygen consumption (VO2) (A) and heart rate (HR)(B)during exercises for the fast music and slow music and no music. a p<0.05 vs 3min for absent music; b p<0.05 vs 3min for 100bpm; c p<0.05 vs 3min for 100bpm; d p<0.05 vs 3min for 190bpm.

music under anaerobic exercise (Atan 2013; Pujol et al. 1999; Schwartz et al. 1990; Coutts et al. 1961; Koç et al. 2009; Nelson et al. 1963; Schwartz 1990; Yamamoto et al. 2003). Stuckey et al. (2012) reported that modulate autonomic nervous system inhibition and activation can depend on intensity and duration of exercise. First, regarding relationship between intensity and autonomic nervous system, studies by Daniela et al. (2014) and Shobo et al. (2010) have reported that high intensity exercise tends to suppress parasympathetic nerve activity and excite sympathetic nerve activity (Daniela et al. 2014; Shobo et al. 2010). These studies suggest that the higher the intensity, the higher the sympathetic nerve activity, while the lower the intensity, the higher the parasympathetic nerve activity. Previous studies using exercise intensity at 70％HR max has advocate these studies (Szmedra and Bacharach.1998; Birnbaum et al. 2009). However, in our study, despite the moderate or higher intensity exercise, we supported results different from those in previous studies using exercise intensity at 70％HR max. Regarding the relationship between duration of exercise and the autonomic nerve, according to the report by Shobo et al. (2010), among the exercise at 80%VO2max, the parasympathetic nerve showed a significant decrease after 2 minutes, and the sympathetic nerve showed a significant increase after 5 minutes. Because the exercise was performed for 5 minutes in this study, it is possible that the exchange nerve did not work predominantly within the experimental time. It can be considered that this may not have enhanced the effect of the music that should be supposed to obtained.

Effect of listening to music with different tempo on the physiological response in each study may be due to differences in music tempo. Music tempo used in this study was 190 bpm for fast music and 100 bpm for slow music. Regarding the fast tempo, considering the possibility that it will not be able to keep up with the beat and miscounted beat, the tempo is set to 5 % lower to maximum of perceptible tempo which was reported 200bpm (Fraisse, 1982; Trainer, 2007). Compared to similar previous studies (Atan.2013; Edworthy.2006), 190bpm is somewhat consistent with Atan (2013) and Edworthy (2006) with 200 bpm. Regarding the slow tempo, we also referred to previous studies (Atan.2013; Edworthy.2006). However, in this study, there was no difference in the physiological response under the three musical conditions, it is probable that setting the tempo in this study had some problems. Compared with Brohmer and Becker (2006) and Pujol (1999) studies which used 85-120 bpm as fast music, fast music in the present study was much faster (Brohmer and Becker 2006; Pujol 1999). On the other hand, compared with the studies of Atan (2013) and Edworthy et al. (2006) which used 70-80 bpm as slow music, slow music in the present study was much slower (Atan 2013; Edworthy et al. 2006). According to Umemura et al. (1998), the faster the music, the more significant the sympathetic nerve activity, on the other hands, the slower the music, the greater the parasympathetic nerve activity. In that case, the larger the difference between fast music and slow music, the larger the difference in stimulation to the autonomic nerves, which may have led to a large difference in physiological responses. In fact, in previous studies (Edworthy

2006), there were significant differences in HR, RPE, running speed, and emotions between 200bpm and 70bpm (difference of 130bpm). In this study, the contrast was 100bpm-190bpm (difference of 90), which was lesser than that of the Edworthy et al.'s study that supported the influence of music tempo, so it was possible that the results would be difficult to obtain (Edworthy et al. 2006). It may need to consider that individuals may feel differently because of their different responsiveness to music. The responsiveness of music may change depending on the feelings of the day, and the sensitivity and may differ depending on the habit of listening to music such as volume, frequency, and type of song (Kliuchko et al. 2015). Since the sensitivities differ from person to person, it is possible that the effects of music obtained between individuals were not maximized (Kliuchko et al. 2015; Hernandez et al. 2015; Ridder et al. 2013; Funahashi 2012).

The physiological responses evoked by listening to music have been found to be influenced by the components of the music (Edworthy et al. 2006). We used the music adopted a drum sound, and the tempo and volume were controlled to be constant in the three exercise tasks, aimed to consider how the influence of tempo on physiological responses. However, one issue that was not considered in this study was that of preference. As the music selection was made by the music speed, it is quite possible that some of the participants did not like the music. It is important as individual and preference factors are also known to affect in exercise performance (Dwyer et al. 1995; Karageorghis et al. 1999; North and Hargreaves. 2000), which in turn may have led to some of the participants exercising less optimally than others. In addition, it has been reported that listening to subjectively preferred music and rhythms may affect changes in autonomic nervous function during exercise and promote psychological changes (Kornysheva 2010: Umemura et al. 1998). The data collected in this study do not allow any detailed investigation of the potential effects of preference on performance, but it is quite possible that preference would have had some effect, particularly if the findings presented here are to any extent aesthetically mediated, which they appear to be.

In conclusion, the purpose of this study was to examine the effects of listening to music with different tempo during moderate-intensity pedaling exercise on the physiological responses. However, there were no significant effects of music conditions on in VO2, HR, and cadence ($p>0.05$). Our data suggest that listening to fast or slow music during moderate-intensity voluntary pedaling exercise may not have different effects on the physiological responses.

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