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ORIGINAL ARTICLE

Effect of listening to music during a warmup on anaerobic test performance

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Abstract

Purpose Many studies have investigated the effect of listening to music during exercise on performance, but the influence of music during a warmup on subsequent exercise performance is unknown. The primary purpose of this study was to determine whether or not listening to self-selected music before an intense bout of anaerobic exercise would positively affect performance. We also sought to explore the effect of music on psychological variables including rating of perceived exertion (RPE).

Methods 16 participants (8 males, 8 females; age 23.6 ± 4.8 years, BMI 18.9 ± 3.2 kg/m^2) listened to pre-selected music, self-selected music or white noise during a warmup, which consisted of cycling at 50 rpm for 10 min with a resistance of 1 kg. Once the warmup was completed, they performed a Wingate Anaerobic Test (WAnT) against a flywheel resistance of 7.5% body mass. Immediately after the WAnT, they were asked to complete the Subjective Exercise Experience Scale (SEES) and RPE was assessed. One-way repeated-measures ANOVAs were used to determine the effect of music condition on both physiological and psychological variables.

Results There were no significant differences in mean or peak power, relative power, fatigue index, or RPE (all $p > 0.05$). There were also no differences in any SEES variables (positive well-being, psychological distress, or fatigue) or in RPE (all $p > 0.05$).

Conclusion This study suggests that listening to music during a warmup has no positive effect on performance during the actual event, even when the music is self-selected.

Keywords Brunel Music Rating Inventory · Athletes · Anaerobic · Exercise

Introduction

Music has been shown to affect both emotional and psychological states [1], and has the ability to decrease fatigue, and increase arousal, motor coordination, and relaxation [2]. When an athlete needs to perform powerful movements, fast and arousing music may be most appropriate [3]. Thakur et al. [4] found that fast tempo and strong rhythmic music is stimulating and increases arousal, which would help an athlete focus on the task at hand and block out distractions. Chtourou et al. [5] noted that music has been shown to reduce the levels of perceived exertion and enhance motor coordination in short-term maximal exercises. Haluk et al. [6] showed that music helps individuals deal more effectively with exercise that elicits pain, discomfort, and fatigue. A person's psychological state can be altered through listening to music, by helping them overcome mental and emotional fatigue, thus enhancing physical and athletic performance [7]. Music has been shown to help a person push through pain and fatigue, allowing them to become self-absorbed [8]. It can also aid in arousal regulation and self-efficacy [9], and has been shown to decrease cognitive anxiety [10]. Physiological changes such as decreases in lactate and cortisol have also been shown after listening to music [11].

The use of music during exercise has been studied in depth [12] and the general consensus is that it improves performance, as shown by the fact that it is banned by many organizations (United States Track & Field Association, International Olympic Committee, etc.). However, the possible ergogenic benefits of listening to music prior to an event are unknown. Listening to music during warmups has

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been a part of sport for many years. It is now easier than ever to listen to music while warming up for a sporting event since the introduction of devices such as MP3 players, iPods, and smartphones. For athletes that participate in individual sports, listening to music with headphones before an event may help them focus on the task at hand and decrease nervousness, which may act to indirectly improve performance.

Control over the type of music that an athlete listens to before a competition and during a pre-performance warmup may have a significant impact on their performance. The primary purpose of this study was to determine whether different music conditions would affect performance on an anaerobic exercise test. We hypothesized that a music condition in which participants choose the songs would result in a significantly higher power output at the same level of perceived exertion, in addition to improved mood when compared to pre-selected and white noise conditions.

Methods

Participants

Sixteen recreationally active individuals (8 males; 8 females) participated in this study. The mean age was 23.6 ± 4.8 years and body mass index was 24.8 ± 3.2 kg/m^2. The majority of the subjects exercised 3–5 days per week, for approximately 45–60 min per session. Table 1 shows descriptive characteristics of the participants. The study was approved by the Human Subjects Institutional Review Board at the university. All participants provided informed consent and completed the AHA/ACSM Health Fitness Facility Pre-participation Screening Questionnaire [13]. Participation was limited to those classified as "low risk" for cardiovascular disease. The Lower Body Questionnaire was also administered to ensure the safety of the participants to perform a maximal effort during testing. Men and women ages 18–45 years with no lower body musculoskeletal injuries within the past 6 months or any other issue that would prevent them from riding on a bike and exerting maximal effort and no cardiovascular, respiratory, or metabolic diseases were recruited for participation. Each participant attended four sessions: an informational meeting and three exercise testing sessions.

Table 1 Descriptive statistics

Variables	Total (N = 16)	Males (n = 8)	Females (n = 8)
Age (year)	23.6 ± 4.8	23.4 ± 6.6	23.8 ± 2.4
Body mass (kg)	72.3 ± 12.2	75.4 ± 14.5	69.2 ± 9.4
Height (cm)	170.4 ± 7.9	173.5 ± 8.8	167.3 ± 5.9
BMI (kg/m$^{2)}$	24.8 ± 3.2	24.8 ± 3.3	24.8 ± 3.3

Data presented as mean ± SD

Informational meeting

This meeting was arranged to allow the potential participants an opportunity to understand the purpose and details of the study. The participants were made aware of the time commitment and reminded that participation was voluntary. Participants were given the opportunity to ask questions. The study was verbally explained; the informed consent document was provided for them to read. If they agreed to participate, the informed consent document was signed and the health screening form and the Lower Leg Injury Questionnaire were then completed.

The participants were then asked to list their five favorite songs and each were rated using the Brunel Music Rating Inventory [14]. The top three rated songs were chosen for the self-selected trial; these songs were located on Spotify™, which is an online music application that is used to create different stations and playlists. Table 2 shows the tempo for each participant's chosen songs. The following songs were selected for the pre-selected music condition: Lose Yourself, by Eminem (171 bpm), Eye of The Tiger, by Survivor (109 bpm), and Thunderstruck, by AC/DC (134 bpm). These songs were selected from Get Pumped! Your Top 25 Workout Songs (2015), and were chosen to represent a mixture of popular genres (rap, rock, and heavy metal).

Exercise testing sessions

The participants warmed up on a Monark™ 818E cycle ergometer for 10 min while listening to either self-selected

Table 2 Self-selected music tempos for each participant

Participant	Song 1 bpm	Song 2 bpm	Song 3 bpm	Average bpm
1	120	115	96	110.3
2	127	128	145	133.3
3	93	80	75	82.7
4	102	134	200	145.3
5	167	140	75	127.3
6	92	91	82	88.3
7	110	75	130	105.0
8	171	91	140	134.0
9	129	138	152	139.7
10	157	98	145	133.3
11	96	126	90	104.0
12	128	75	90	97.7
13	99	122	125	115.3
14	132	135	130	132.3
15	93	130	110	111.0
16	145	150	171	155.3

BPM (beats per minute) BPM was taken from http://songbpm.com

music, pre-selected music, or white noise. The participants had an opportunity to practice on the equipment and ask any questions. Once they were comfortable with the equipment, the researcher adjusted the seat both vertically and horizontally, so when one pedal of the bike was at the top of the pedal crank, their knee would be flexed at approximately 90°, while the other leg was almost fully extended. Participants were supplied with Logitech™ G430 headphones by the researcher. The participants were able to fully control the volume of the music. The order of conditions was randomly assigned.

The 6–20 rating of perceived exertion scale (RPE; [15]) and the Subjective Exercise Experience Scale (SEES) were fully described. RPE is a single number chosen by the participant, and includes verbal descriptors such as "hard" and "very hard". The SEES includes 12 adjectives describing feelings (great, awful, drained, positive, crummy, exhausted, strong, discouraged, fatigued, terrific, miserable, and tired); each adjective is rated 1–7, with 1 being low and 7 being high [16]. After scoring, the results are provided within three subscales: positive well-being, psychological distress, and fatigue.

The participants began the warmup by pedaling at 50 rpm for 10 min with a resistance of 1 kg on a Monark 818E cycle ergometer. Once 10 min had elapsed, the headphones were removed. Participants were asked to move to the WAnT ergometer (Monark 894E Peak). They were asked to pedal as fast and as hard as possible against a resistance of 7.5% of their body mass in kilograms. Once the participants had reached 120 rpm, the weight was released onto the flywheel. The participants were verbally encouraged to keep pedaling as fast as they could for 30 s. The weight was lifted from the flywheel and the participants were asked to continue pedaling at a comfortable slow pace for a cool down. Immediately following the WAnT, participants were asked their RPE and to complete the SEES questionnaire.

The participants were asked to stay in the lab for at least 15 min from the completion of the cool down, so that the researcher could monitor their recovery. Once the first session was completed, the researcher scheduled the participant for the other two trials. The remaining two trials were conducted in the same manner as previously described. The order of conditions was randomized to reduce any order effect.

Statistical analysis

All statistical analyses were calculated using IBM SPSS v. 20. (SPSS Inc., Chicago, IL, USA). The significance level was set a priori at $p < 0.05$. One-way repeated-measures ANOVAs were used to determine the effect of music condition on the dependent variables. Shapiro–Wilk tests were used to confirm that the data were normally distributed; in cases of non-normal distribution, Friedman tests were used to examine the differences. If there was a significant main effect, then *t* tests with Bonferroni adjustment were used for post hoc analyses. Effect sizes are given as partial eta squared (η_p^2).

Results

There was no significant effect of music condition on peak power (PP), relative peak power (RPP), mean power (MP), relative mean power (RMP), or fatigue index (FI): PP [$F(2,30) = 0.593$, $p = 0.559$, $\eta_p^2 = 0.038$], RPP [$F(2, 30) = 0.884$, $p = 0.424$, $\eta_p^2 = 0.056$], MP [$F(2, 30) = 0.119$, $p = 0.888$, $\eta_p^2 = 0.008$], RMP [$F(2, 30) = 0.224$, $p = 0.801$, $\eta_p^2 = 0.015$], and FI [$F(2, 30) = 1.321$, $p = 0.282$, $\eta_p^2 = 0.081$]. See Table 3 for all WAnT variables.

There were also no differences between music conditions on positive well-being (PWB), psychological distress (PD), or fatigue (FAT): PWB [$F(2, 30) = 1.477$, $p = 0.244$, $\eta_p^2 = 0.090$], PD [$F(2, 30) = 0.660$, $p = 0.524$, $\eta_p^2 = 0.042$], and FAT [$F(2, 30) = 0.545$, $p = 0.586$, $\eta_p^2 = 0.035$]. See Table 4 for all SEES variables.

Finally, there were no differences between any of the conditions in RPE [$F(2, 30) = 0.582$, $p = 0.565$, $\eta_p^2 = 0.037$]. Self-selected music: 14.6 ± 2.6, pre-selected music: 14.6 ± 2.7, and white noise: 15.0 ± 2.8.

Table 3 WAnT variables

Variable	Self-selected music	Pre-selected music	White noise	*p* value	Effect size
Peak power (W)	679.4 ± 227.6	652.4 ± 174.6	667.2 ± 220.4	0.559	0.038
Relative peak power (W/kg)	9.5 ± 2.7	9.0 ± 1.9	9.3 ± 2.8	0.424	0.056
Mean power (W)	455.3 ± 123.2	458.4 ± 100.0	462.6 ± 124.5	0.888	0.008
Relative mean power (W/kg)	6.4 ± 1.5	6.4 ± 1.1	6.5 ± 1.6	0.801	0.015
Fatigue index (%)	54.9 ± 7.9	54.7 ± 16.5	59.9 ± 18.4	0.282	0.081

Data presented as mean ± SD. *W* Watts, *kg* kilograms. Effect size given as partial eta squared (η_p^2)

Table 4 SEES variables

Variable	Self-selected music	Pre-selected music	White noise	*p* value	Effect size
Positive well-being	20.4 ± 3.5	20.7 ± 4.2	19.1 ± 3.6	0.244	0.090
Psychological distress	7.9 ± 3.7	7.3 ± 2.9	8.6 ± 6.0	0.524	0.042
Fatigue	15.3 ± 4.8	15.6 ± 5.5	16.5 ± 5.3	0.586	0.035

Data presented as mean ± SD. Effect size given as partial eta squared (η_p^2)

Discussion

The primary purpose of this study was to determine whether different music conditions or white noise during a warmup would affect physiological or psychological variables during and immediately after the Wingate anaerobic test. We showed that there was no effect of listening to music or white noise on any of the variables; specifically, in a condition, where the music was self-selected, there was no significant improvement in performance.

The intent of this study was to replicate an anaerobic sporting event in a laboratory setting; this was done using two different cycle ergometers and two areas of the laboratory. The participants first warmed up on the Monark 818E for 10 min listening to either pre-selected music, self-selected music, or white noise through headphones. Once the warmup period was over, they moved across the lab to the Monark 894E peak bike, where the testing was conducted. The current study is highly comparable to three recent studies, all of which used music during a warmup before a WAnT. Eliakim et al. [3] used an isolated room for warmups in which the participants pedaled for 10 min at 60 rpm against a resistance of 1 kg. There were two conditions: music and no music. The music condition was played only during the warmup, through speakers in the room, and the music tempo was 140 bpm. Jarraya et al. [17] and Chtourou et al. [18] used the same warmup resistance and music with a tempo between 120 and 140 bpm. In the current study, the pre-selected average music tempo was 138 bpm. Contrary to our findings, these studies showed that peak power was significantly higher after listening to music ($p < 0.05$) compared to a no music condition. A possible reason for the differences between studies could be due to the participants that were used. In our study, recreationally active individuals were used, whereas in the Eliakim et al. study, all the participants were elite volleyball players, in the Jarraya et al. study, they used highly trained athletes, and in the Chtourou et al. study, elite sprinters were used. This suggests that there may be a training specificity effect, although this is in opposition to some previous studies, showing that untrained participants may be more influenced by music than trained individuals. For example, Brownley et al. [19] showed greater positive affect in untrained compared to trained individuals when listening to music during a graded exercise test to exhaustion. However, the notion of training status influencing the results is further corroborated by another study using music during warmups. Chtourou et al. [20] showed that peak power on a WAnT improved after warmup music only in a group of sprinters, and not in a group of long-distance runners. In addition, Aloui et al. [10] showed that listening to self-selected music during a warmup was not able to increase distance covered in a maximal 30 s running test in untrained male subjects. Aloui and colleagues also had their subjects perform the same running tests during Ramadan, which involves intermittent fasting. Interestingly, they showed that music was able to retain maximal running performance during the fasted state.

We also did not find any differences in RPE between the three conditions. The reported RPE values from our participants were somewhat lower than other studies have found (self-selected music: 14.6 ± 2.6, pre-selected music: 14.6 ± 2.7, and white noise 15.0 ± 2.8), but had larger variability. Chtourou et al. [5] reported RPE values post-WAnT with music at 7:00 am (17.42 ± 1.56), and at 5:00 pm (17.58 ± 1.38), and without music at 7:00 am (16.25 ± 1.76), at 5:00 pm (16.33 ± 1.67). Eliakim et al. [3] had post-WAnT RPE values for females of 18.1 ± 0.5 with music and 18.2 ± 0.5 without music, and for males 18.5 ± 0.4 with music, 18.5 ± 0.3 without music. Jarraya et al. [17] reported RPE values of 17.4 ± 1.4 and 16.2 ± 2.0 with and without music, respectively. These findings are in line with the previous studies, and suggest that RPE is not significantly influenced during maximal bouts of exercise. This is also likely due to the consistent finding that self-pacing allows an individual to maintain a desired RPE during exercise.

SEES is one way to assess the participants' mood state post-test. We did not find any significant differences in the three SEES variables between conditions [PWB ($p = 0.204$), PD ($p = 0.509$), and FAT ($p = 0.671$)]. However, the two music conditions did show slightly higher PWB values compared to the white noise condition. In addition, PD and FAT were slightly lower in the music conditions compared to the white noise. As these were taken after the WAnT, and there were no physiological differences between conditions, these findings are not surprising. If the SEES were administered between the warmup and the WAnT, there may have been differences between the three conditions.

A limitation to this study is that a full all-out familiarization to the WAnT was not performed. Some studies have shown that this is able to provide improved test–retest

correlations [21]. Future studies should implement this familiarization to achieve the highest level of accuracy and reliability.

Conclusion

Our findings suggest that listening to music prior to an anaerobic exercise test is not beneficial to performance. In addition, there was no difference in any of the psychological variables. Control over the type of music did not positively improve performance. The findings also suggest that training specificity and level may influence the relationship between music during a warmup and subsequent anaerobic exercise performance.

Compliance with ethical standards

Conflict of interest None of the authors have any conflicts of interest to declare.

Ethical approval The study was approved by the Human Subjects Institutional Review Board at the university.

Informed consent Informed consent was obtained from all individual participants included in the study.

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