# Ergogenic Effects of Pop Music on Endurance Performance in Hot Conditions among Physically Active Individuals

Eng Hoe Wee, Xiao Ying Lai and Hui Yin Ler
*Tunku Abdul Rahman University College, Jalan Genting Kelang, 53300 Kuala Lumpur, Malaysia*

Keywords: Music, Endurance Performance, Ergogenic Effects, Hot Condition.

Abstract: Music has been reported by numerous researchers to elicit psychological, psychophysical, and ergogenic effects. Some researchers found that music could improve endurance performance, others reported progressive impairment in endurance performance with increasing ambient temperature. The purpose of this study was to determine the effects of pop music on endurance performance in hot conditions (35°C) among physically active individuals. Twenty-eight physically active subjects (14 males, 14 females, age=19.57±1.7 yrs, height= 164.8±8.3 cm, weight= 58.6±8.8 kg, VO2max = 42.5±7.7 $ml.kg^{-1}.min^{-1}$) were recruited to participate in this randomized cross-over study: with music (WM) and no music (NM) trials. For each trial, subjects cycled at 60 rpm for the first 20 minutes followed by maximal cycling effort in the last 20 minutes to determine the distance achieved. The workload of 40 minutes exercise were maintained at 55% Pmax. Heart rate (HR), oxygen uptake (VO2) and rate of perceived exertion (RPE) were recorded throughout the experimental trials. Experimental trials were separated by at least 5 days apart. Results revealed that there was no significant interaction between music and cycled distance [$F(1, 26) = 1.372$, $p=0.252$, $\eta p2=0.050$]. Results also revealed that similar physiological responses (HR and VO2) and RPE were found in both WM and NM trials. In conclusion, there is no sufficient evidence to support that pop music could enhance endurance performance in the heat among physically active individuals.

## 1 INTRODUCTION

Numerous researchers studied the ergogenic aids of music on sport performance. They reported that music helps increased arousal, increased power output and heart rate, delayed fatigue, and increased exercise duration and intensity (Foster, 2010; Karageorghis et al, 2009).

Varied results had been obtained on the effects of music on sport performance. Atan (2013) found no significant differences between type of music (slow music, fast music and no music) in anaerobic power assessments, heart rate (HR) or blood lactate. Beaumont et al. (2014) studied music tempo on cycling performance and revealed that fast music and slow music had the higher average distance cycled as compared to no music. Average HR was higher in no music condition as compared to fast music condition and RPE was higher in fast music condition as compared to no music. Elisa et al. (2017) found music at high volume did not improve physical performance. While others (e.g. Waterhouse and Edwards, 2009) found faster music enabled exercise to be performed at a bigger work rate and with a greater physiological effect and more positive subjective responses, than did slower music.

Bigliassi et al. (2012) revealed that regardless of the time of application (i.e., before or during exercise), music did not affect performance and psychophysiological parameters during the 5-km time-trial cycling. Dyer and McKune (2013) in a study of the effects of fast-tempo (140 bpm), medium-tempo (120 bpm), slow-tempo (100 bpm), and no music on well-trained cyclists, results indicated no significant changes in performance, physiological, or psychophysical variables. Hagen et al. (2012) found no effect of music on 10-km cycle time-trial performance; there were no statistically significant differences in performance time or physiological or psychological markers related to music.

Another effect of listening to music is physiological (HR, systolic and diastolic blood pressure). Edworthy and Waring (2006) found a significant increase in HR while listening to fast music during exercise. Birnbaum et al. (2009)



Wee, E., Lai, X. and Ler, H.
Ergogenic Effects of Pop Music on Endurance Performance in Hot Conditions among Physically Active Individuals.
DOI: 10.5220/0006887000910097
In *Proceedings of the 6th International Congress on Sport Sciences Research and Technology Support (icSPORTS 2018)*, pages 91-97
ISBN: 978-989-758-325-4

reported that listening to fast music decreased the subjects' HR and blood pressure during steady state treadmill exercise. Conversely, Atan (2013) and Schwartz et al. (1990) examined effects of fast music tempo on HR and found no significant changes.

Exercise in hot conditions causes heat stress which can be detrimental to sporting performance. However numerous studies had reported the mediating effects of music on sport performance in hot conditions. In a Malaysian study (Nikol et al., 2018) of running time-to-exhaustion for 12 runners during the synchronous music and no music conditions, it was reported that participants ran significantly run longer before reaching exhaustion while listening to synchronous music compared to the no music condition with a main gain of 151s. On the contrary, Tatterson et al. (2000) found in a study comparing the performance of trained cyclist in a 30-min time-trial, with (32°C) and without (23°C) heat stress, reported 6.5% reduced power output.

Due to inconclusive and controversial results from previous research, this study proposed to investigate the effects of pop music on cycling performance in hot conditions.

# 2 METHOD

## 2.1 Participants

Twenty-eight physically active individuals (14 males, 14 females, age = 19.57±1.7 yrs, height = 164.8±8.3 cm, weight= 58.6±8.8 kg, VO2max = 42.5±7.7 $ml.kg^{-1}.min^{-1}$) volunteered for this study (Table 1). All subjects were of good health and free of any chronic health conditions through the scrutiny of Medical Health History. They were chosen based on ACSM's (2014) criteria that they performed at least 30 minutes of moderate-intensity physical activity five days per week or 20 minutes of more vigorous activity three days per week.

Table 1: Participants characteristics and $VO_{2max}$ parameters (mean ± SD).

| Variable | Male (µ ± SD)(n=14) | Female (µ ± SD)(n=14) | Total (µ ± SD) |
|---|---|---|---|
| Age (Years) | 19.14 ±1.5 | 20.0 ±1.8 | 19.57 ±1.7 |
| Height (cm) | 170.9 ±5.5 | 158.8 ±5.7 | 164.8 ±8.3 |
| Weight (kg) | 64.5 ±7.15 | 52.8 ±5.9 | 58.6 ±8.8 |
| $VO_{2max}$ (ml/min/kg) | 48.10 ±5.1 | 36.8 ±5.3 | 42.5 ±7.7 |

Prior to the participation, the participants completed the Physical Activity Readiness Questionnaire (PAR-Q), to rule out contraindications to participation. The approval to conduct this research was approved by the University College Ethics Committee. In conforming to the principles of the declaration of Helsinki of the World Medical Association, participants were briefed on the methods, procedures, benefits and potential risk before signing the written consent.

## 2.2 Research Design

This study applied a crossover randomized experimental design which consisted of two experimental conditions, to test the effects of 'With Music' (WM) and 'No Music' (NM) on endurance cycling performance in hot conditions. After the preliminary testing, each subject was required to undergo two randomized-separate experimental trials. The two experimental trials were NM in the Hot Condition (35°C) and WM in Hot Condition (35°C).

## 2.3 Music Selection

Based on the recommendation of Lopes-Silva et al (2015) and Karageorghis et al. (1999), pop and rock music tracks were selected for the music condition. Fifteen pieces of pop and rock music tracks were selected and in their original form, the tracks were played in the tempo range of 78-144 bpm. However, in order to control music tempo, the tempo of the music tracks was standardized at 150 bpm. using a computer software package (Virtual DJ v. 8; Atomic Productions, Paris, France) as suggested by Karageorghis et al. (2010). The subjects with music condition listened to the music at 150 bpm through headphones connected to a portable MP3 player set at approximately 80 decibels as proposed by Edworthy and Waring (2006). Each track lasted approximately 4 minutes and the track sequence was applied during all the music conditions.

## 2.4 Procedure

Procedure consisted of two phases (a) Familiarization and Preliminary Testing, (b) Experimental Trials. The research design consisted of experimental conditions. Each subject was tested two times under the same laboratory conditions in a randomized manner. Condition 1 (NM) consisted of performing warm-up and cycling exercise without music. For condition 2 (WM) the athletes listened to music during warm-up and while performing cycling exercise.

### 2.4.1 Familiarization and Preliminary Testing

The first phase of the research involved the Maximal Oxygen Uptake ($VO_{2max}$) Test. Upon the arrival of each subject, subject's height and weight were measured. After which the subject was fitted onto the cycle ergometer (Corival, Lode) and the saddle height and reach length were measured and recorded for subsequent experimental trials and profiling purposes. Once the subject settled in, heart rate (HR) and resting blood pressure (BP) were measured using a heart rate monitor (FT4M, POLAR, Australia) and a blood pressure monitor (Omron 1 A2, OMRON, Japan). When the subject was sufficiently rested and ready, the Portable Metabolic System (K4 b2, Cosmed, Italy) was fitted. The Modified Astrand Maximal Cycle Protocol was used in this $VO_{2max}$ test.

Submaximal oxygen uptake test was performed before the $VO_{2max}$ test. The initial workload was 25 watts for female and 30 watts for male (Pollock et al., 1987). Subjects were instructed to maintain 60 rpm in every load. After 4 minutes at this initial workload, the workload was increased in increments of 25 watts for female and 30 watts for male. The submaximal test ended after 4 stages of increments. Subjects were instructed to sit and rest until they recovered to resting heart rate. After that, subjects started on the $VO_{2max}$ test by a load that was achieved by the subject's when his/her HR was at 130+/-bpm in the previous submaximal test. Subjects' load was added 25 watts for female and 30watts for male every 2 minutes. The test continued until the participant was exhausted or was no longer maintaining the pedalling frequency of 55 rpm. The data from the submaximal and $VO_{2max}$ test were used to determine the 55% $P_{max}$ for the experimental trials.

### 2.4.2 Experimental Trials

Subjects were required to complete 2 experimental trials that were conducted each week in the sports and exercise science laboratory. All subjects were involved in both conditions of WM in Hot Condition ($35^0$ C) and NM in Hot Condition ($35^0$ C). Humidity for both conditions were maintained at 55-65%.

After arriving at the laboratory for the experimental trials, subjects rested for 10 minutes, after which RHR was measured using a HR monitor. Before the experimental trial started, the subject was fitted with the portable metabolic system and all the required ancillary instruments as mentioned in the preliminary testing. In the music conditions, a portable MP3 player was turned on after warm-up. In the non-music conditions, headphones were connected, but the portable MP3 player remained off during the entire test.

Each experimental trial consisted of 40 minutes 55% of $P_{max}$ cycling which the subjects maintained 60 rpm for the first 20 minutes and followed by cycling as fast as possible in the last 20 minutes to determine the distance completion. Prior to each experimental trial, subjects warmed up for 5 minutes on the cycle ergometer at 60 rpm without resistance. HR, $VO_{2max}$, RPE were measured at intervals of 5 minutes during the experimental trials and distance of completion for the last 20 minutes were recorded. The experimental trials were separated by at least 5 days to ensure full recovery from previous experimental trial.

## 2.5 Statistical Analysis

The statistical software package "SPSS Statistics 23.0" (IBM) was used for statistical analysis. Mean value and standard deviation for the research parameters were calculated. T-tests were used for comparative analyses. Two way Repeated Measures ANOVA was used to examine the differences across the $VO_2$, HR, distance and RPE for both trials. When significant interaction was obtained, pair-sampled t-test was used to identify differences between mean scores. The level of significance was set at $p < 0.05$.

# 3 RESULTS

The Two-way repeated-measures ANOVA (minutes 20 through 40) showed there was a significant interaction between music and HR [$F(1,26) = 76.698$, $p<0.001$, $\eta p^2=0.754$]. HR responses were higher in NW trial as compared to WM trial but statistically not significant ($p>0.05$). The HR values from 0 to 40 minute values are displayed in Figure 1.

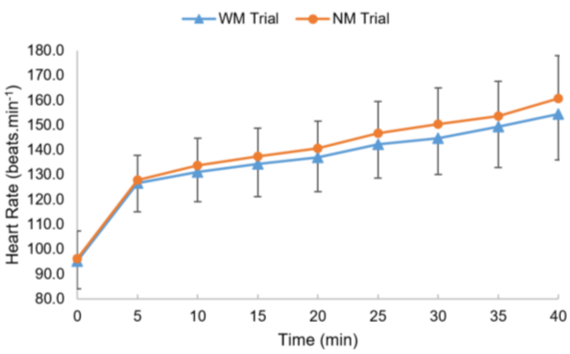


Figure 1: HR Responses during WM and NM Trials.

The Two-way repeated-measures ANOVA (minutes 20 through 40) showed there was a significant interaction between trials and $VO_2$ [$F(1,26) = 104.836$, $p < 0.001$, $\eta p^2=0.801$] as NM trial displayed an increase in $VO_{2max}$ values over time greater than WM trial. $VO_2$ in NM trial was significantly higher than WM trial at 20 min and at 40 min ($p=0.041$, $p=0.016$) respectively (Figure 2).

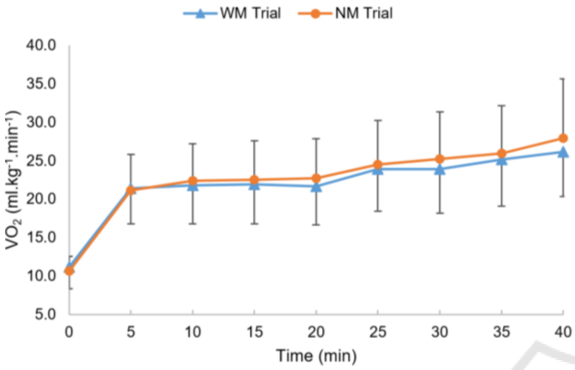


Figure 2: $VO_2$ responses during WM and NM Trials.

The Two-way repeated-measures ANOVA showed that there was no significant interaction between music and cycled distance [$F(1,26) = 1.372$, $p = 0.252$, $\eta p^2=0.05$]. Subjects cycled the similar distance during both experimental trials. Maximum effort cycled distance in 20 to 40 minute values are displayed in Figure 3.

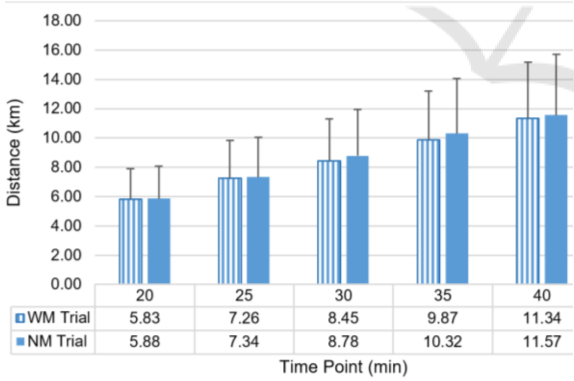


Figure 3: Cycled distance during WM and NM Trials.

Similarly result was obtained in examining interaction between music and RPE. The Two-way repeated-measures ANOVA revealed no significant interaction between music and RPE [$F(1,26) = 20.406$, $p>0.05$, $\eta p^2=0.440$]. Subjects of NM trials perceived exercise to be harder as compared to the perception of WM trials. However, the difference in perceptions in the two trials was not statistically significant ($p<0.05$). RPE values of 0 through 40 minutes are displayed in Figure 4.

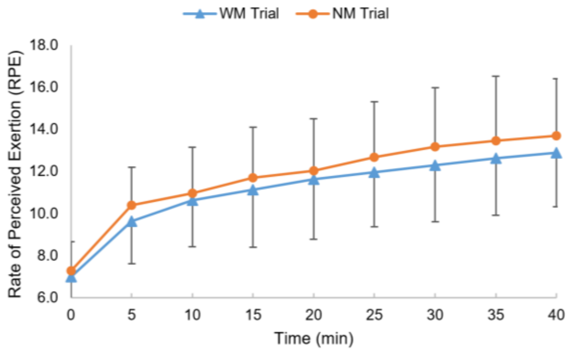


Figure 4: RPE measures during WM and NM Trials.

# 4 DISCUSSIONS

The purpose of this study was to determine the effects of music on endurance performance in physically active individuals in hot condition (35°).

## 4.1 Effects of Music on Endurance Performance

The Two-way repeated-measures ANOVA showed there was no significant interaction between music and cycled distance [$F(1, 26) = 1.372$, $p=0.252$, $\eta p2=0.050$]. Subjects cycled the similar distance during both experimental trials.

Similar performance in the NM condition can be explained by Lima-Silva et al. (2012) and Tenenbaum et al. (2004). They reported that listening to music did not delay fatigue on exercise performance. Similarly, the result of this research is supported by Nakamura et al., (2010) who found that total distance covered during constant-load exercise performed at critical power (207 ± 53 W) was not increased compared to the control group, irrespective of listening to preferred or non-preferred music. In contrast, there was a study done by Atkinson et al. (2004), when athletes listened to music, there was an improvement in performance during a 10km cycling time trial compared to no music.

According to Nakamura (2010), differences in the findings may be due to the methodological issues such as the differences in exercise protocols and other aspects of age, music tempo, musical preference and socio-cultural influences.

## 4.2 Effects of Music on HR

The Two-way repeated-measures ANOVA (minutes 20 through 40) showed there is a significant interaction between music and HR [$F(1,26) = 76.698$, $p=0.<0.001$, $\eta p2=0.754$] as NM condition displayed an increase in HR values over time greater than WM condition. HR responses were higher in NW trial as compared to WM trial but statistically not significant ($p>0.05$).

The result of this study differed from the findings of Hagen et al. (2013). In conducting a 10-km cycle time trial with music as ergogenic aids, Hagen et al. found that HR were not significant different between the music and no-music trials. The result of this study was also in contrast to the study by Nethery (2002) and Lopes-Silva et al. (2015) where no significant difference in HR was found between the session with music and without music.

Similarly Potteiger et al. (2000) reported during 20 min. of moderate intensity exercise the under varied conditions of fast upbeat music, classical music, self-selected music, and no music that decrement in HR occurred in all conditions except the NM condition.

The HR responses of WM condition were slightly lower over time than NM trials but not significant. This is a common notion that music serves as a distraction from the exercise itself, and other investigators have reported an increase in HR and blood pressure due to stimulation of the sympathetic nervous system when listening to music while exercising (Birnbaum et al., 2009; Mitchell and Wolffe, 1990; William and Michael, 1989; Yamashita et al., 2006).

In supporting the findings of this study, Edworthy and Waring (2006) and Thornby, Haas & Axen (1995) revealed a significant increase in HR when their subjects listened to fast music while exercising. However, their studies used different exercise protocols and different music selection processes, which may account for the contradictory findings. The discrepancy between our findings and previous studies could be differences in exercise type (circuit type resistance exercise versus treadmill or cycle), duration, training status of the subjects, and the music selection process (fast versus medium or low tempo).

## 4.3 Effects of Music on $VO_{2max}$

The Two-way repeated-measures ANOVA (minutes 20 through 40) showed there was a significant interaction between trials and VO2 [$F(1,26) = 104.836$, $p<0.001$, $\eta p2=0.801$] as NM trial displayed greater VO2 values over time than WM condition. VO2 in NM trial were significantly higher than WM trial at 20 min and at 40 min ($p=0.041$, $p=0.016$, respectively).

There was a 2.97% of decrement in $VO_{2max}$ mean scores during WM Trial compared to the $VO_{2max}$ mean scores during NM Trial. The reduction of $VO_{2max}$ is supported by Bacon, Myers & Karageorghis (2012) who stated that $VO_{2max}$ was lower in synchronous music compared to the slow tempo asynchronous condition. According to Nomura et al. (2006), a reduced of $VO_{2max}$ was because of the cycling pedal revolution rate was synchronized with music. Cycling pedal revolution rate synchronized with music could enhanced coupling between the regular muscular contractions of cycling and HR which would improve the metabolic efficiency.

The HR response in WM trial (Figure 1) showed the HR mean score was between 137-154 bpm after 20 minutes. This showed that music enhanced coupling between the regular muscular contractions of cycling and HR. Besides, Szabo, Small & Leigh (2012) was also stated that there was an improvement in metabolic efficiency when fast tempo music was used during incremental exercise.

The increasing $VO_{2max}$ over time of 20 to 40 minutes in WM group of this study did not paralleled the findings of Szmedra and Bacharach (1998). Szmedra and Bacharach found $VO_{2max}$ lower in WM trial because of a relaxing effect that music had on the participants and it led to reducing muscle tension and lessening the narrowing of blood vessels. This condition had improved blood flow to the working muscle and helped in cleaning up plasma lactate and decreasing the production of plasma lactate which may involve in muscle fatigue (Thomas et al., 2004).

## 4.4 Effects of Music on RPE

The Two-way repeated-measures ANOVA revealed no significant interaction between music and RPE [$F(1,26) = 20.406$, $p>0.05$, $\eta p^2=0.440$]. Subjects of NM trials perceived exercise to be harder as compared to the perception of WM trials.

The increase in RPE in WM condition of this study is inconsistent with those of previous studies that reported reduced RPE while listening to music. Nethery et al. (1991), Potteiger et al. (2000), Nethery (2002), Yamashita et al. (2006), and Dyer and McKune (2013) reported a decrease in RPE when listening to music while exercising. Similarly, many other researchers (Birnbaum et al., 2009; Caria et al., 2007, Schwartz et al., 1990) found that listening to music had no affected any changes in RPE.

However, since this study involved WM subjects cycling at 55% of $VO_{2max,}$ the increase in RPE in WM condition seemed to be supported by Lopes-Silva et al. (2014) that music could influence the RPE only at low-to-moderate exercise intensity (<80% $VO_{2max}$). This was due to the fact that external stimuli such as music would be able to compete against weaker internal cues for attentional focus. Similarly, Bigliassi et al. (2012) emphasised that low intensity exercise would enhance the brain's capability to shift its attention from the exercise from load to external stimuli, leading to a reduction in the rate of RPE. In addition, in a study on the effects of known and unknown exercise duration on RPE by Coquart et al. (2008), it was reported that RPE was lower when the total duration was unknown beforehand. The subjects of WM in this study had knowledge of exercise duration, thus external stimuli (music) could not help subjects overcame attentional focus. This has helped increase RPE in WM subjects. This increments in RPE in this study is supported by Bwonley et al., (1995), that trained participants had higher post-exhaustive RPE compared to untrained participants. Pires et al. (2011) explained that the long exercise duration (<80% $VO_{2max)}$ such as exercise duration in this study, could affect the peripheral signals to contribute substantially to generate RPE.

## 5 CONCLUSION

The results of this study revealed that pop music has no effect on cycling performance in the heat among physically active individuals. One possible reason had to be the choice of music. Preferred music could motivate and improve physical performance (Karageorghis et al., 2011, Karageorghis et al., 2006), influenced perceived exertion (Nakamura et al., 2010). Thus it is suggested that more investigation on the effects of type of music and music preference on endurance performance in the hot conditions would be investigated.

## REFERENCES


ACSM (2014) ACSM's Guidelines of Exercise testing and Prescription. 9th ed. Philadelphia, PA, USA: Lippincott Williams & Wilkins.

Arazi, H., Asadi, A. and Purabed, M. (2015) Physiological and psychophysical response to listening to music during warm-up and circuit-type resistance exercise in strength trained men, *Journal of Sports Medicine*, pp.1-6.

Atan, T. (2013) Effect of music on anaerobic exercise performance, *Biology of Sport*, pp.30(1), 35-39.

Atkinson, G., Wilson, D., Eubank, M. (2004) Effects of music on work-rate distribution during a cycling time trial, Int J Sports Med, 25, pp.611–615.

Bacon, C.J., Myers, T.R. and Karageorghis, C.I. (2012) Effect of music-movement synchrony on exercise oxygen consumption, *Journal of Sports Medicine and Physical Fitness*, 52(4), pp.359-365.

Bigliassi, M., Dantas, J.G., Smirmaul, B.P.C. and Altimari, L.R. (2012) Influence of Music and Its Momnts of Application on Performance and Psychophysiologyogical Parameters during a 5km Time Trial, *Rev Andal Medicine Deporte*, 5(3), pp.83-90.

Beaumont, J., Deaton, M., Schowalter, M. and Van Dyk, V. (2014) "The Effect of Music Tempo on Cycling Performance in Female College Students". 13th Annual Celebration of Undergraduate Research and Creative Performance. Paper 116. Available at: https://digitalcommons.hope.edu/curcp_13/116 [Accessed 10 Apr. 2018].

Birnbaum, L., Boone, T. and Huschle, B. (2009) Cardiovascular responses to music tempo during steady-state exercise. *Journal of Exercise Physiology*, 12(1), pp.50–57.

Brownley, K.A., McMurray, R.G. and Hackney, A.C. (1995) Effects of music on physiological and affective responses to graded treadmill exercise in trained and untrained runners. *International Journal of Psychophysiology* 19, pp.193-201.

Caria, M.A., Tangianu, F., Concu, A., Crisafulli, A. and Mameli, O. (2007) Quantification of Spinning bike performance during a standard 50-minute class, *Journal of Sports Sciences*, 25(4), pp.421–429.

Coquart, J.B.J., Legrand, R., Robin, S., Duhamel, A., Matran, R. and Garcin, M. (2008) Influence of successive bouts of fatiguing exercise on perceptual and physiological markers during an incremental exercise test. *Psychophysiology*, 46(1), pp.209-216.

Dyer, B. J. and McKune, A. J. (2013) Effects of music tempo on performance, psychological, and physiological variables during 20 km cycling in well-trained cyclists, Perceptual and Motor Skills, 117, pp.484–497.

Edworthy, J. and Waring, H. (2006). The Effects of Music Tempo and Loudness Level on Treadmill Exercise, *Ergonomics*, 49(15), pp.1597–1610.

Elisa, A.G., Gennifer, A.F. and Jorge Alberto, A.C. (2017) Exploring music intensity on heart rate, perceived exertion and physical performance during sub-maximal exercise, *Revista Kronos*, 16(2), pp.1-7.

Foster, C., Porcari, J.P. and Anders, M. (2010) Exploring the effects of music on exercise intensity, *ACE Certified News*, pp.1-3.

Hagen, J., Foster, C., Rodriguez-Marroyo, J., de Koning, J. J., Mikat, R. P., Hendrix, C. R. and Porcari, J. P. (2013) The Effect of Music on Time Trial Performance, International Journal of Sports Physiology and Performance, 8(1), pp.104-106.

Karageorghis, C.I. and Priest, D.L. (2012) Music in the exercise domain: a review and synthesis (Part I), International Review of Sport and Exercise Psychology, 5(1), pp.44-66.

Karageorghis, C.I., Jones, L., Priest, D.L., Akers, R.I., Clarke, A., Perry, J.M and Lim, H.B.T. (2011) Revisiting the Relationship Between Exercise Heart Rate and Music Tempo Preference, *Research Quarterly for Exercise & Sport*, 82(2), pp.274-284.

Karageorghis, C.I., Priest, D.L., Williams, L.S., Hirani, R.M., Lannon, K.M. and Bates, B.J. (2010) Ergogenic and psychological effects of synchronous music during circuit-type exercise, Psychology of Sport and Exercise, 11, 551-559.

Karageorghis, C.I., Mouzourides, D., Priest, D.L., Sasso, T., Morrish, D. and Walley, C. (2009). Psychophysical and Ergogenic Effects of Synchronous Music during Treadmill Walking, *Journal of Sport & Exercise Psychology*, 31, pp.18-36.

Karageorghis, C. I., Jones, L. and Low, D. C. (2006) Relationship Between Exercise Heart Rate and Music Tempo Preference, *Research Quarterly for Exercise and Sport*, 77 (2), pp.240-250.

Karageorghis, C.I., Terry, P.C. and Lane, A. M. (1999) Development and validation of an instrument to assess the motivational qualities of music in exercise and sport: The Brunel Music Rating Inventory, Journal of Sports Sciences, 17, 713-724.

Lima-Silva, A. E., Silva-Cavalcante, M. D., Pires, F. O., Bertuzzi, R., Oliveira, R.S. F. and Bishop, D. (2012) Listening to Music in the First, but not the Last 1.5 km of a 5-km Running Trial Alters Pacing Strategy and Improves Performance, *Int J Sports Med*, 33(10), pp.813-818.

Lopes-Silva, J.P., Lima-Silva, A.E., Bertuzzi, R. and Silva-Cavalcante, M.D. (2015) Influence of Music on Performance and Psychophysical Responses during Moderate-Intensity Exercise Preceded by Fatigue, *Physiology & Behavior*, pp.274-280.

Mitchell, J. H. and Wolffe, J. B. (1990) Neural control of the circulation during exercise, *Medicine & Science in Sports & Exercise*, 22, pp.141–154.

Nakamura, P.M., Pereira, G., Nakamura, F.Y. and Kokubun E. (2010) Effects of Preferred and Non preferred Music on Continuous Cycling Exercise Performance, Perceptual and motor skills, 110, pp.257-264.

Nethery, V.M., Harmer, P.A. and Taaffe, D. R. (1991) Sensory mediation of perveived exertion during submaximal exercise. *Journal of Human Movement Studies*, 20, pp.201–211.

Nethery, V.M. (2002) Competition between Internal and External Sources of Information during Exercise: Influence on RPE and the Impact of the xercise Load, *Journal Sports Medicine Phys Fitness*, 42, pp.172-178.

Nikol, L., Kuan, G., Ong, M., Chang, Y-K and Terry, P.C. (2018) The Heat Is on: Effects of Synchronous Music on Psychophysiological Parameters and Running Performance in Hot and Humid Conditions. Front, Psychol (9), 1114.

Nomura, K., Takei, Y., Yoshida, M. and Yanagida, Y. (2006) Phase – dependent chronotropic response of the heart during running in humans, *European Jrl. of Applied Physiology*, 97, pp.240-247.

Pires, F.O., Lima-Silva, A.E., Bertuzzi, R., Casarini, DH, Kiss, M.A.P.D.M., Lambert, M.I. and Noakes, T.D. (2011) The influence of peripheral afferent signals on the rating of perceived exertion and time to exhaustion during exercise at different intensities, *Psychophysiology*, 48(9), pp.1284-1290.

Pollock, M.L., Foster, C., Knapp, D., Rod, J.L. and Schmidt, D.H. (1987) Effect of age and training on aerobic capacity and body composition of master athletes, *Journal of Applied Physiology*, 62(2), pp. 725-731.

Potteiger, J.A., Schroeder, J.M. and Goff, K.L. (2000) Influence of Music on Ratings of Perceived Exertion during 20 minutes of Moderate Intensity Exercise, *Perceptual and Motor Skills*, 91, pp.848-854.

Schwartz, S. E., Fernhall, B. and Plowman, S. A. (1990) Effects of music on exercise performance, *Journal of Cardiopulmonary Rehabilitation*, 10(9), pp.312–316.

Szabo, A., Small, A. and Leigh, M. (1999) The effects of slow-and fast – rhythm classical music on progressive cycling to voluntary physical exhaustion, *J Sports Med Phys Fitness*, 39, pp.220-225.

Szmedra, L. and Bacharach, D.W. (1998) Effect of music on perceived exertion, plasma lactate, norepinephrine and cardiovascular hemodynamics during treadmill running, *Int J Sports Med* 19(1), pp.32-37.

Tatterson, A.J., Hahn, A.G., Martin, D.T. and Febbraio, M.A. (2000) Effects of heat stress on physiological responses and exercise performance in elite cyclists, J Sci Med Sport. 3(2), 186-93.

Tenenbaum, G., Lidor, R., Lavyan, N., Morrow, K., Tonnel, S., Gershgoren A, Meis, J. and Johnson, M. (2004) The effect of music type on running perseverance and coping with effort sensations, *Psychology of Sport & Exercise*, 5(2), pp.89–109.

Thomas, C., Sirvent, P., Perrey, S., Raynaud, E. and Mercier, J. (2004) Relationships between maximal muscle oxidative capacity and blood lactate removal after supramaximal exercise and fatigue indexes in humans, *J Appl Physiol*, 97(6), pp.2132-2138.

Thornby, M. A., Haas, F. and Axen, K. (1995) Effect of distractive auditory stimuli on exercise tolerance in patients with COPD, *Chest*, 107(5), pp.1213–1217.

Yamashita, S., Iwai, K., Akimoto, T., Sugawara, J. and Kono, I. (2006) Effects of music during exercise on RPE, heart rate and the autonomic nervous system, *Journal of Sports Medicine and Physical Fitness*, 46(3), pp.425-430.

Waterhouse, J. and Edwards, B.J. (2009) Effects of Music Tempo upon Submaximal Cycling Performance, *Scandinavian Journal Medicine & Science in Sports*, 20, pp.662-669.

William, B. D. and Michael, H. T. (1989) The influence of preferred relaxing music on measures of state anxiety, relaxation and physiological responses, *Journal of Music Therapy*, 26, pp.168–187.