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Psychophysiological and ergogenic effects of music in swimming

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RESEARCH ARTICLE

Abstract

We investigated the effects of listening to medium-to-fast tempo asynchronous music on performance, heart rate (HR), perceived exertion, and affect during an acute bout of swimming at a self-selected pace. Healthy college-aged recreational swimmers (n=20; M_{age}=20.3±2.0 years) were studied on two occasions in randomised order: swimming 1,200 m while listening to music (125-140 beats per minute) or during a no-music control trial. Following a period of habituation to the SwiMP3 audio player, HR, rating of perceived exertion, feeling scale responses and performance time trials were assessed for each 200 m during the 1,200 m freestyle swimming trial, each interspersed with a one min rest period. Participants swam significantly faster during the asynchronous music condition relative to control (P<0.01, η_p^2=0.32). Although music had no significant influence on perceived exertion, the music condition was associated with more favourable arousal (P<0.01, η_p^2=0.40) and affective (P<0.05, η_p^2=0.19) responses. These findings suggest that both recreational and competitive swimmers may benefit from the use of underwater MP3 players and music.

Keywords: affect, asynchronous music, attention, exercise psychology, performance

1. Introduction

The innovative technologies of the 21st century have transformed the ways in which we exercise and participate in sport – for instance, they now allow us to run, bike, lift weights, and even swim, while listening to music through portable devices. Within sport and exercise settings, researchers have examined the psychological, exertional, and ergogenic effects of music (see Karageorghis and Terry, 2009 for a review). Although early research in this area was primarily atheoretical and collectively resulted in mixed findings (see Karageorghis and Terry, 1997 for a review), more recent research has been conceptually driven and focused on mechanisms underlying the affective and performance benefits derived from listening to music while exercising (Karageorghis and Priest, 2012a). In general, this work has focused on asynchronous music (i.e. music that is not accompanied by a purposeful or conscious attempt to synchronise one's movement to the musical beat), and has shown that music serves to optimise arousal, facilitate task-relevant imagery, enhance affect, reduce the rating of perceived exertion (RPE), and improve performance (Karageorghis and Priest, 2008; Terry and Karageorghis, 2011). However, the psychological and ergogenic effects of listening to music during exercise may be influenced by a number of environmental and exercise-related characteristics, including the mode (e.g. aerobic vs anaerobic exercise) and intensity of exercise, and the motivational properties of the music itself (Karageorghis and Priest, 2008). A better understanding of these sources of influence may have significant implications within sport and exercise contexts, and warrants further research.

The extant literature focusing on music within the exercise domain has primarily focused on the traditional modes of running and cycling. Karageorghis and Priest (2008) contend that the effects of music may carry over to other aerobic-based activities that involve rhythmic and repetitive movements, such as cross-country skiing and rowing. However, swimming, an activity that relies heavily on

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repetitive motion, has remained relatively unexamined in part due to the lack of technology enabling presentation of audio stimuli in an aquatic environment. Since the advent of underwater MP3 technology, two studies have examined the psychological, psychophysical, and ergogenic effects of music in swimming (Karageorghis *et al.*, 2013; Tate *et al.*, 2012). Using a mixed-methods approach, Karageorghis *et al.* (2013) examined the effects of motivational and oudeterous (neither motivating nor demotivating) asynchronous music across a 200 m freestyle swimming time trial. They found that both music conditions resulted in significantly faster time trials relative to a control condition of swimming without music, suggesting music may serve as an ergogenic aid while swimming a short distance at high intensity. Additionally, the use of music while swimming, regardless of motivational quality, resulted in higher self-reported motivation and more dissociative thoughts compared to swimming without music. Tate *et al.* (2012) also examined the effects of music on swimming and found that self-selected music improved overall time trial performance in sprint (50 m; ~1% improvement) and long-distance (800 m; ~1% improvement) events in highly trained competitive swimmers. However, because music was self-selected in their study, participants were able to choose music that had a wide range of acoustic properties (e.g. tempo differences), which has previously been shown to influence performance and physiological responses (Karageorghis *et al.*, 2013). Moreover, participants were not familiarised with the MP3 player prior to testing and physiological measures were not assessed to evaluate workload across the different trials.

Although studies have revealed the potential benefits of listening to music during exercise, the mechanisms underlying the relationship remain unknown. Researchers have proposed several possible mechanisms that relate to arousal-performance, attentional strategies, synchronous movement or entrainment to the musical beat, exertional or coping effects, and emotional or affective responses that accompany music (Karageorghis and Priest, 2012a,b). For instance, Elliott *et al.* (2005) examined the ergogenic and affective benefits of motivational music on a 20 min sub-maximal cycling task. Their results indicated that regardless of motivational quality, music significantly increased the distance travelled or work output while cycling at an intensity of 60-80% of maximal heart rate (HR). In addition, higher in-task and post-task affect responses suggested that emotional or affective responses may also serve to mediate the music-performance relationship. In another study, Elliott *et al.* (2004) had participants cycle at a constant rate during a 12 min cycle ergometer trial as determined by an RPE of 13 on the 20-point Borg scale. The music condition resulted in a greater pedalling distance as well as an increase in positive feelings, which again suggested that participants were able to work harder and feel more positive at the same perceived workload. These studies demonstrate that music may result in ergogenic effects by enhancing affect and/or reducing perceived exertion.

In addition to affective and exertional responses, music may also result in ergogenic effects through its impact on physiological arousal (typically assessed through HR). Although certain forms of music (e.g. classical) have been found to lower HR along with perceptions of exertion (Szmedra and Bacharach, 1998), in general motivational and stimulative music has the effect of increasing arousal. Karageorghis *et al.* (2008, 2011) have conducted a series of studies investigating the link between exercise HR and preferred music tempo. Collectively, the results of these studies suggest that faster music is preferred at higher exercise intensities; however, based on a curvilinear relationship influenced by exercise intensity and individual differences (e.g. preference), exercisers in general prefer a narrow tempo band of 125-140 beats per minute (bpm). These conclusions are drawn from a body of evidence that has focused on exercise HR and music tempo during land-based activities. It therefore remains to be determined whether music similarly impacts arousal levels during aquatic-based activities. This is important given non-weight-bearing activity of swimming and the large number of individuals who participate in recreational swimming.

The purpose of the current study was to assess the effects of listening to medium-to-fast tempo music on performance, HR, perceived exertion, and affect in college-aged recreational swimmers during a 1,200 m freestyle swimming time trial task. Previous evidence suggests that the effects of music appear to be most potent when used to accompany self-paced exercise (Karageorghis and Priest, 2012a), thus self-selected pace was chosen for this study. The results of the current study may provide sport psychologists, exercise practitioners, and swimming coaches with more insight into the relationship between music and swimming. We hypothesised that listening to music during swimming would result in faster swimming times, lower RPE, and higher ratings of pleasurable feelings compared to the no-music condition. We also expected increases in HR for the music relative to no-music control condition, suggesting an influence of stimulative or motivational music in optimising arousal.

2. Materials and methods

Participants

Twenty healthy undergraduate students between the ages of 17-25 years were recruited from Rutgers University through the use of campus flyers and advertisements. Participants were required to meet the following inclusion criteria: (1) no presence or history of cardiovascular, neurological, or musculoskeletal problems that would impact swimming ability; (2) no use of medications that are known to influence cardiovascular responses; (3) identify as a recreational swimmer, defined as swimming at least once per week for 20 min for the previous six months; (4) regularly physically active, defined as participating in moderate-to-vigorous physical activity for at least 30 min on at least 3 days per week; and (5) reported absence of any perceived or diagnosed hearing loss. The participants were all relatively homogeneous in age (mean ± standard deviation = 20.3±2.1), body mass index (BMI) (24.2±2.0) and sociocultural background, as these variables have been determined to be important in terms of responsiveness to music (Karageorghis *et al.*, 2013; North and Hargreaves, 2008). Participants reported an average of 8.0±2.9 years of swimming experience and 2.2±1.6 days of swimming per week. This study was approved by the Institutional Review Board at Rutgers University and all participants provided written informed consent prior to participation.

Audio device

The underwater SwiMP3 music player (Finis, Inc., Livermore, CA, USA) was used to conduct audio sound via bone-conducted transmission (Tate *et al.*, 2012). The device allows swimmers to listen to music by attaching the SwiMP3 headphones directly to the goggle straps and resting them on the cheekbones or behind the ears on the mastoids while swimming. Sound vibrates through the bones of the skull and allows the audio to vibrate directly into the inner ear, bypassing the ear canal. The quality of sound of the SwiMP3 is comparable to the quality of typical air-conducted audio headphone players. The music selected consisted of current Top 40 songs, and were all set to a medium-to-fast tempo (125-140 bpm), in line with current recommendations (Karageorghis and Terry, 2009). This tempo is similar to previous research in swimming (Karageorghis *et al.*, 2013) and is an appropriate tempo from an experimental aesthetics perspective (Karageorghis *et al.*, 2011). The music selected for this study was chosen to enhance internal validity (i.e. the music was prescribed to rather than selected by participants) and to ensure that the music had similar psychoacoustic properties. Selection was also based on previous work showing that a medium-to-fast tempo is preferred during moderate-to-high intensity exercise and improves performance (Karageorghis *et al.*, 2011). The motivational qualities of the music selections were assessed post hoc among a sample of ten volunteer undergraduate students, who were similar to the experimental participants in terms of age, gender, and sociocultural background. The average Brunel Music Rating Inventory-2 (BMRI-2) scores for the music selections was 32.5±6.4, which is similar in magnitude to previous studies incorporating motivational music (Karageorghis *et al.*, 2006, 2013).

Measures

Heart rate

HR was assessed using a Polar S810 HR monitor and transmitter (Polar Electro, Kemele, Finland). HR data were collected in 15 s intervals and averaged across each 200 m trial as an indicator of arousal and exercise intensity.

Rating of perceived exertion

RPE was assessed through Borg's (1998) 15-item scale ranging from 6 (no exertion at all) to 20 (maximal exertion). This scale is based on the perceived physical sensations experienced during exercise including changes in HR, respiration rate, sweating, and muscle fatigue. The RPE scale has well-established psychometric properties in exercise and sport settings (Borg, 1982, 1998; Karageorghis and Priest, 2012a).

Feeling scale

Affective valence was assessed immediately following each 200-m trial using the feeling scale (FS). The FS is a single-item, 11-point scale that ranges from +5 (very good) to -5 (very bad), whereby more positive responses reflect a more pleasurable experience (Hardy and Rejeski, 1989).

Music enjoyment

A single, 5-point Likert-type scale anchored by 1 (I do not like it at all) and 5 (I like it very much) was administered to each participant at the end of their final 200 m trial during the asynchronous music condition using the instruction 'Rate how much you like the music you listened to while swimming today'.

Procedure

During the initial familiarisation session, participants were given a general description of the study, provided written informed consent, and height and weight were measured. Participants completed health history and demographics questionnaires, including items about their swimming history and current physical activity status. Participants were then familiarised with the underwater SwiMP3 player, HR monitor, RPE, and FS that would be used in the subsequent experimental sessions. In preparation for these subsequent sessions, they were instructed to avoid moderate to vigorous physical activity for 24 h and limit foods and beverages containing caffeine for 3-4 h prior to each session. A within-subjects study design was used such that all participants completed two counterbalanced experimental sessions: (1) wearing the SwiMP3 while music was played, and (2) wearing the SwiMP3 without music playing. Each session occurred on a separate day at least

72 h apart at approximately the same time of day. For each experimental session, participants were asked to complete six 200 m freestyle swim trials with a 60 s rest between each trial. Each session lasted approximately 30 min.

For each testing session, participants were fitted with a Polar S810 HR monitor (chest strap and watch) after arriving at the swimming pool, and the FINIS SwiMP3 player was fixed to their goggle straps. Depending on condition designation, participants were either assigned to wear the audio device and listen to medium-to-fast tempo (125-140 bpm) current Top 40 songs or wear the audio device while it remained off (no-music control condition). The music was asynchronous, in that no conscious effort was required on the part of participants to synchronise their movements to the beat of the music. Swim caps, earplugs, and goggles were required for all participants taking part in the study.

Participants wore the SwiMP3 device during a 5 min standardised warm-up and 200 m freestyle swim trial (with or without music depending on the condition) to serve as a brief habituation. None of the participants reported having used an underwater audio player prior to participating in this study. Thereafter, participants were instructed to complete six 200 m freestyle swim trials as fast as they could comfortably. Self-paced exercise was chosen because it boasts enhanced external validity (Karageorghis and Priest, 2012a). After each 200 m trial, there was a 60 s rest period where the experimenter immediately recorded HR, RPE, and FS responses. Trained researchers recorded each 200 m lap with a stopwatch. No time trial or physiological data (i.e. HR values) were provided to participants during experimental sessions. Participants completed these trials individually and no one else was swimming in the pool at the time. Following completion of the final testing session, participants were briefed on the purpose of the experiment and compensated $20 for their participation.

Data analysis

Descriptive statistics were performed on participant demographic, swim history and music preference data. Swimming performance, HR, RPE, and FS responses were submitted to a 2 (condition: music, no-music) × 6 (time: trials 1-6) repeated measures ANOVA. The time trials refer to the individual 200 m trials within each 1,200 m swimming condition.

3. Results

Preliminary analyses revealed no significant gender differences in BMI, age, years of swimming experience, swimming frequency, and music enjoyment. Similarly, there were no significant gender differences in swimming performance, HR, RPE, and FS responses (P>0.05) in either music or no-music conditions. Subsequent analyses were therefore collapsed across gender.

The 2-way repeated measures ANOVA for swimming performance revealed a significant main effect of condition ($F(1,19)=9.0$, $P<0.01$, $\eta_p^2=0.32$) and time ($F(5,15)=5.5$, $P<0.01$, $\eta_p^2=0.65$). Shorter average time trial performances were found for the music (mean (M)=228.5, standard error (SE)=12.2) relative to no-music (M=233.7, SE=12.2) conditions. Decomposition of the time main effect revealed that participants swam progressively slower for each successive 200 m trial, but all trials were only significantly slower than the initial 200 m swim trial, regardless of condition (Figure 1). No significant condition × time interaction was observed for swimming performance

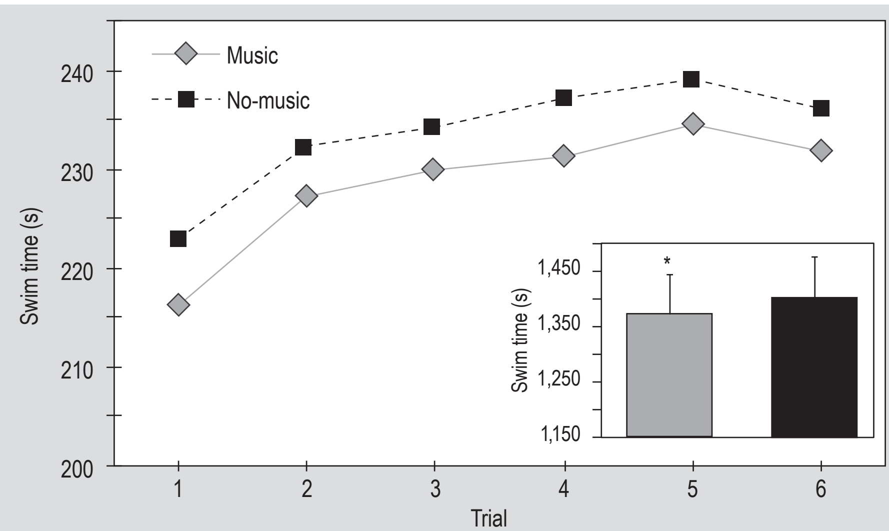

Figure 1. Average trial times for each 200 m trial across a 1,200 m swimming trial performed with and without music. Inset includes overall 1,200 m swim time by condition. ****P*<0.05.

(F(5,15)=0.63, P=0.18, η_p^2=0.37). A follow-up paired sample student's t-test on total swim time (sum of all 200 m trial times; Figure 1) revealed significantly faster total swim times in the music (M=1,370.9, SE=72.9) compared to the no-music (M=1,402.1, SE=73.4) condition (t=3.0, P=0.01).

The 2-way repeated measures ANOVA for HR similarly revealed a main effect for condition (F(1,19)=12.4, P<0.01, η_p^2=0.40) and time (F(5,15)=7.6, P<0.01, η_p^2=0.72). Significantly elevated HR was observed during music (M=165.6, SE=3.4) compared to no-music (M=160.9, SE=3.7) conditions. As expected, HR increased gradually for each successive 200 m trial, despite the one min rest period between trials (Figure 2). No significant condition × time interaction was found for HR (F(5,15)=1.24, P=0.34, η_p^2=0.29).

Figure 3 shows RPE values between music and control conditions across time trials. Analysis of the RPE data showed a significant main effect for time (F(5,15)=6.6, P<0.01, η_p^2=0.69) with perceived exertion increasing across each subsequent 200 m trial. This elevation in RPE parallels the increase in HR across the 1,200 m distance. The condition main effect and two-way interaction of condition × time were non-significant.

The two-way repeated measures ANOVA for FS responses revealed significant condition (F(1,19)=4.4, P<0.05, η_p^2=0.19) and time (F(5,15)=4.6, P<0.01, η_p^2=0.61) main effects. Participants reported feeling significantly more pleasant during the music condition (M=1.2, SE=0.4) when compared to control (M=0.6, SE=0.4). Collapsed across condition, participants reported feeling more positive immediately following trials 2 and 3 (400 and 600 m)

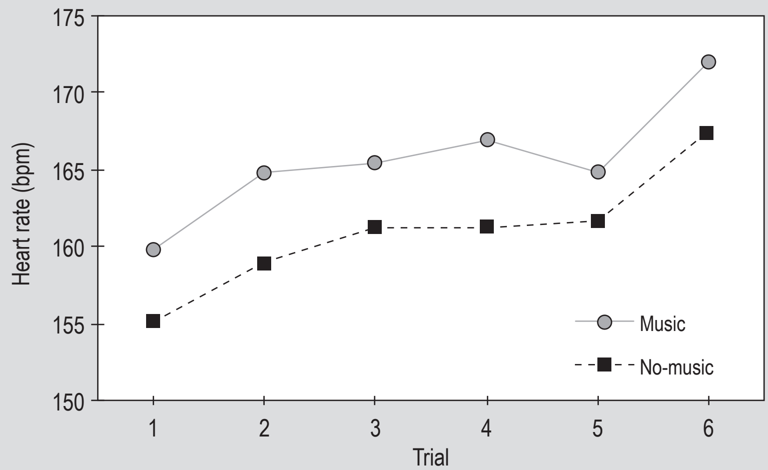

Figure 2. Average heart rate (HR) values for each 200 m trial across a 1,200 m swimming trial performed with and without music.

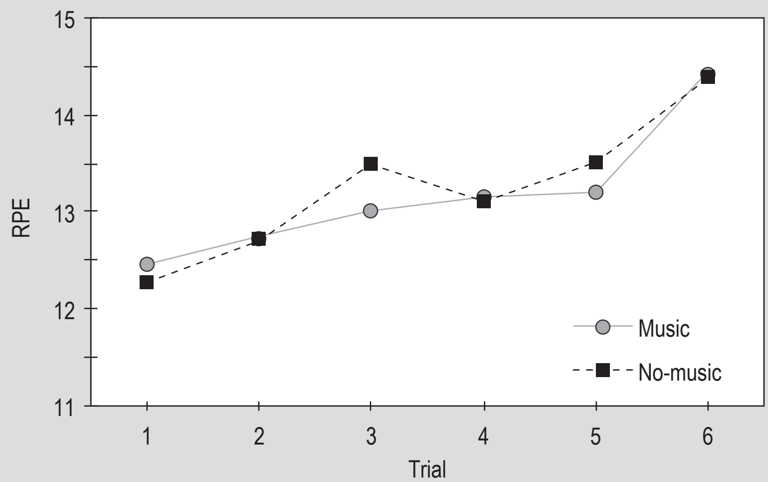

Figure 3. Average perceived exertion (RPE) scores for each 200 m trial across a 1,200 m swimming trial performed with and without music.

compared to the initial 200 m trial (Figure 4). Following this observed increase, FS responses were progressively lower following trials 4 and 5 (i.e. after 800 and 1000 m trials). FS responses were significantly elevated after the final time trial compared to trials 4 and 5. The two-way interaction of condition × time on FS responses was non-significant ($F(5,15)=0.74$, $P=0.42$, $\eta_p^2=0.26$).

4. Discussion

The aim of this study was to assess the effects of listening to medium-to-fast tempo music on affect, perceived exertion, HR, and performance in college-aged recreational swimmers during a 1,200 m freestyle swimming time trial task. In line with a large body of research centred on traditional land-based exercise contexts (Karageorghis and Terry, 2009), an ergogenic effect was observed such that participants swam faster in the asynchronous music condition relative to control. This finding is also consistent with previous research indicating that listening to music can improve performance in swimming (Karageorghis *et al.*, 2013; Tate *et al.*, 2012). Tate *et al.* (2012) found similar improvements in 24 highly trained competitive swimmers equipped with a SwiMP3 audio device in both 50 and 800 m swim trials. Karageorghis *et al.* (2013) reported that regardless of motivational quality, asynchronous music enhances performance among collegiate swim club members. When comparing overall 1,200 m swim times in our study, participants swam 2.2% faster while listening to music. This finding corroborates the results from the Karageorghis *et al.* (2013) study, and is slightly larger in magnitude to the findings from the Tate *et al.* (2012) study. The participants in the latter study were highly trained and thus performance would not be expected to be as variable as in recreational swimmers from the current study. Moreover, highly trained athletes are more likely to employ associative rather than dissociative attentional strategies (Masters and Ogles, 1998; Morgan and Pollock, 1977) and would therefore be expected to be less influenced by music. Regardless, early findings in this area suggest that music has an ergogenic benefit for recreational and competitive-level swimmers.

Recent research has focused on plausible mechanisms that may help to explain the performance benefits derived from music (Bishop *et al.*, 2013). Mechanisms have focused on psychophysiological, psychophysical, and affective states while performing the exercise, as well as rhythmic entrainment that occurs when participants synchronise their movements with the beat of the music. Karageorghis *et al.* (2013) found that motivational and oudeterous (non-motivational) music were associated with significantly higher levels of state motivation and attentional dissociation than a no-music control condition. In the current study, it was hypothesised that listening to music during swimming would result in lower RPE, higher ratings of pleasurable feelings, and increases in arousal assessed via HR. These hypotheses were partially supported. Specifically, the improvements seen in swimming performance were accompanied by increases in HR during the music condition compared to the no-music condition. There were no differences in perceived exertion by condition, which suggests that participants were able to increase work output, indicated by faster time trials and elevated HR, without the perception of greater effort. Elliott and colleagues (2004) similarly exposed participants to motivational music during a 12 min cycle ergometer trial where they were required to cycle at a constant rate as determined by an RPE of 13 on the 20-point Borg scale. The music condition in their study resulted in an increased pedalling distance compared to the control condition at the same RPE. Collectively, these

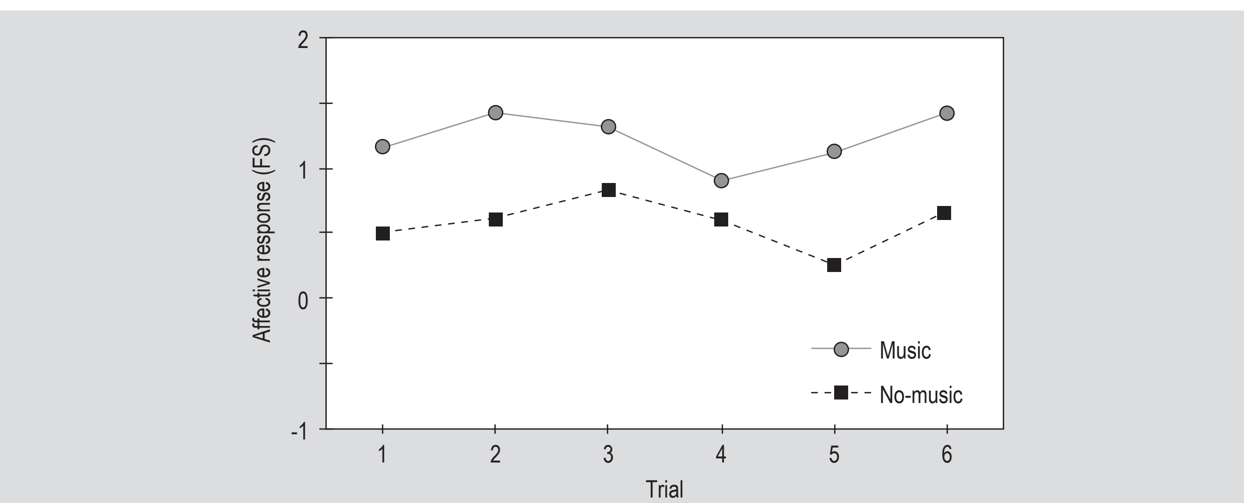

Figure 4. Average feeling scale (FS) responses for each 200 m trial across a 1,200 m swimming trial performed with and without music.

results suggest that participants are effectively working harder without a perceived increase in exertion.

FS responses in our study were also significantly more favourable for the music relative to no-music conditions. The performance benefits observed in our study may therefore be due to an optimisation of arousal and favourable affective or emotional responses. Although we did not measure attentional focus strategies in this study, it is plausible that our participants experienced a more dissociative attentional focus during the music condition in a similar fashion to the Karageorghis *et al.* (2013) study. Within the attentional focus literature, measuring absolute or relative HR as well as blood pressure has been common practice (Lind *et al.*, 2009). Previous studies have shown that associative and dissociative attentional strategies result in lower as well as higher HR, thus leading to equivocal findings. Future research should therefore be aimed to carefully examine the interconnection between attentional strategies and physiological arousal to determine their unique or combined effects in the music-performance relationship.

Although there was a significant increase in HR and affective ratings for the music condition, perceived exertion was not significantly influenced by music. In general, music has been shown to reduce perceptions of effort at low-to-moderate intensities of exercise by approximately 10%, but does not appear to impact RPE beyond the anaerobic or lactate threshold due to the dominating influence of physiological cues on attentional processes (Karageorghis and Priest, 2012a; Rejeski, 1985; Tenenbaum, 2001). Given the self-selected pace chosen for this study, it was initially hypothesised that exertional responses would be lower for the music condition. Indeed, multiple studies found that listening to music while running on a treadmill at moderate intensities resulted in reduced RPE compared to running without music (Karageorghis and Terry, 1999; Potteiger *et al.*, 2000; Yamashita *et al.*, 2006). Our hypothesis was refuted. However, our findings coincide with previous studies indicating that music does not moderate RPE during higher-intensity exercise (Boutcher and Trenske, 1990; Hutchinson *et al.*, 2011; Karageorghis *et al.*, 2013). Swim trial times, HR, and RPE scores all increased across trials throughout the 1,200 m trial in both sessions, indicating that participants were exercising at a moderate-to-high intensity. In accordance with the theoretical assertions of Rejeski (1985) and Tenenbaum (2001), the peripheral physiological sensations accompanying exercise and fatigue during higher intensity exercise would likely dominate attentional focus and reduce the ergogenic effect of music. The present findings are concordant with previous findings suggesting that the ergogenic effects of music may not be accompanied by changes in psychophysical (exertional) responses. It remains unknown whether music might have even greater benefits at lower intensities, and this issue warrants future study. Notably, however, participants in this study were encouraged to swim at a self-selected pace in order to facilitate the beneficial effects of music (Karageorghis *et al.*, 2011). Despite the inability to influence RPE at higher exercise intensities, in prior studies, participants generally report that exercising with music is more enjoyable than exercising without it, even if there were no differences detected by physiological or psychophysiological variables. For example, participants in the Tenenbaum *et al.* (2004) study reported that listening to music directed their attention to the music and motivated them to continue. Schie *et al.* (2008) reported that among cyclists pedalling for 20 min at 80% of VO_2 peak, 67% later perceived cycling to music to be 'easier' compared to cycling without music. Importantly, this suggests that even if listening to music may result in no changes in RPE compared to no music, it still may improve in-task or post-exercise affective or emotional responses.

While the data support beneficial psychophysiological and ergogenic effects of music, several limitations should be considered. First, we did not attempt to standardise the tempo of the music to swimming movement. We did, however, choose music within a tempo of 125-140 bpm, a tempo that has been recommended for moderate-to-high intensity exercise. It is possible that some participants attempted to synchronise their movements to the music (i.e. entrainment), but this was not assessed in the current study. Karageorghis *et al.* (2013) outlined the possibility of using music with a 3/4 (i.e. three quarter beats to the bar) rather than a 4/4 time signature to meet the mechanical and rhythmic movements in swimming. Detecting whether rhythmical entrainment is beneficial in swimming and how this context might differ from more traditional exercise contexts warrants future investigation. Second, intensity was not controlled for or standardised across conditions, which may confound our interpretation of music effects on arousal. It is possible that faster swim trials with music resulted in higher HRs due to the physiological demands of the increased workload, rather than the stimulative effects of music per se. However, participants in our study swam faster and had elevated HRs even at a same relative exertional level. Therefore, music may have ergogenic benefits by increasing arousal either through enhanced output and/or through its stimulative properties. This issue warrants future research. Finally, participants in the current studies were able to swim at a self-directed pace, and the swimming conditions could have been completed at different intensities based on various demand characteristics (expectancy or Hawthorne effects). Various studies have shown that listening to music during self-guided exercise improves performance and enhances work output (Cohen *et al.*, 2007; Matesic and Cromartie, 2002) and this type of exercise has been recommended to enhance the beneficial effects of music (Karageorghis and Terry, 2009). Self-paced exercise also generalises to exercise behaviour that occurs outside a research setting. More research needs to assess the difference between using music during self-paced exercise and directed intensities.

5. Conclusions and recommendations

The present findings further support the ergogenic effects of music and add to the emerging study of music in aquatic exercise and sport contexts. Asynchronous music resulted in greater arousal and affective/emotional responses but did not have a meaningful effect on perceived exertion. Music may therefore increase work output during exercise through arousal and affective mechanisms, even when performed at the same relative perceived intensity without music. Our findings add to the previous two studies suggesting that both recreational and competitive swimmers may benefit from the use of underwater MP3 players and music.

Future directions in the area of music and exercise should address using different types of music, such as synchronous music, while swimming. Swimming is an activity requiring repetitive movements and using music that synchronises with swimming strokes may result in optimal performance. In addition, in the present study, we used a music and no-music condition. To determine the overall effects of music on performance, studies should include an oudeterous music condition in addition to motivational music and control conditions, similar to what has been attempted in traditional exercise settings. In conclusion, the results of our study add to the growing body of literature focusing on using music during exercise in that swimming performance is positively influenced by the use of moderate-fast tempo asynchronous music.

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