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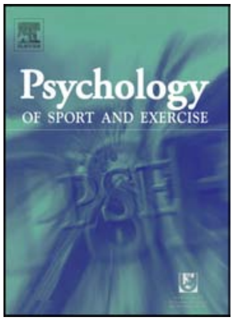

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Running head: ROLE OF LYRICS IN EXERCISE

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Abstract

Objectives. To examine the role of lyrics on a range of psychological, psychophysical, and physiological variables during submaximal cycling ergometry.

Design. Within-subject counterbalanced design.

Method. Twenty five participants performed three 6-min cycling trials at a power output corresponding to 75% of their maximum heart rate under conditions of music with lyrics, same music without lyrics, and a no-music control. Cycling cadence, heart rate, and perceived exertion were recorded at 2-min intervals during each trial. Positive and negative affect was assessed before and after each trial.

Results. Participants cycled at a higher cadence towards the end of the cycling trials under music with lyrics. Main effects were found for perceived exertion and heart rate, both of which increased from min 2 through to min 6, and for affect: positive affect increased and negative affect decreased from pre- to post-trials.

Conclusions. Participants pedalled faster in both music conditions (with and without lyrics) while perceived exertion and heart rate did not differ. The inclusion of lyrics influenced cycling cadence only at min 6 and had no effect on the remaining dependent variables throughout the duration of the cycling trials. The impact of lyrical content in the music-exercise performance relationship warrants further attention in order for us to better understand its role.

Keywords: affect, asynchronous music, cycle cadence, emotional contagion, ergogenic aid, lyrical component

On the Role of Lyrics in the Music-Exercise Performance Relationship

Music is used to accompany all types of activities (e.g., driving, cooking, cleaning, writing, relaxing, exercising), whether this is to distract, energize, or provide a rhythmic cue for the listener (Sloboda, Lamont, & Greasley, 2009). In exercise and sport settings, the use of music has become extremely widespread (see Karageorghis & Priest, 2012a, 2012b, for a review); it is used as a means to enhance performance and evoke a range of physiological and psychological responses (Brownley, McMurray, & Hackney, 1995; Laukka & Quick, 2011; Razon, Basevitch, Land, Thompson, & Tenenbaum, 2009). In particular, music has been shown to enhance positive affect, which bears strong influence on an individual's intention to exercise and adhere to an exercise programme (Ekkekakis, Parfitt, & Petruzzello, 2011). Numerous studies have supported the use of *motivational music* to induce positive feelings during exercise (e.g., Crust, 2008; Hutchinson, Sherman, Davis, Cawthon, Reeder, & Tenenbaum, 2011). Typically, motivational music has a high tempo (> 120 bpm), catchy melodies, inspiring lyrics, an association with physical endeavour, and a bright, uplifting harmonic structure (Karageorghis, Terry, & Lane, 1999).

The benefits of music use in the exercise domain have been attributed to a *rhythm response* or entrainment to music rhythm that has been associated with greater neuromuscular efficiency (e.g., Bacon, Myers, & Karageorghis, 2012), and the limited processing capacity of the central nervous system (e.g., Razon et al., 2009). Music competes with bodily cues in efferent neural pathways and thus blocks unpleasant cues replacing them with more positive ones (cf. Rejeski, 1985; Tenenbaum, 2001). Music in exercise has also been linked with a phenomenon known as *emotional contagion*, which refers to the process by which an exerciser "catches" (feels) emotion in response to music (see Juslin, 2009, for a review). The notion of emotional contagion (musically-induced/evoked emotions) has received support from research in neuroscience (e.g., Koelsch, 2010; Koelsch, Fritz, von Cramon, Müller, & Friederici, 2006), which shows that listeners can understand the intended expression (e.g., happiness or sadness) of the melody or lyrical content of music by perceiving the "motion" of the signal (Molnar-Szakacs & Overy, 2006).

Long-duration, repetitive exercise tasks such as rowing, running, and cycling, performed by recreationally active participants (not elite athletes) appear to be positively influenced by both asynchronous (background) and synchronous music (see Terry & Karageorghis, 2011, for a review). Additional benefits of music have been explained with reference to the dissociation effect (Rejeski, 1985), wherein music delays the onset of fatigue and allows individuals to increase work output/duration before internal negative sensations are perceived (Boutcher & Trenske, 1990). That is, perceptions of effort and fatigue diminish with the presence of music, thus participants are able to produce greater work output (e.g., Elliott, Carr, & Savage, 2004).

The aforementioned benefits are load-dependent to a degree, given that music does not appear to moderate perceptions of effort at high exercise intensities (> 75% maximal heart rate reserve [HRRmax]; e.g., Karageorghis, Mouzourides, Priest, Sasso, Morrish, & Walley, 2009). Nonetheless, in direct contrast with the posits of extant theory (e.g., Rejeski, 1985; Tenenbaum, 2001), music does appear to moderate affect even at very high intensities (> 85% HRRmax; e.g., Hutchinson et al., 2011; Terry, Karageorghis, Mecozzi Saha, & D'Auria, 2012). The combination of exercise with well-selected music can have a bearing on how people feel during as well as immediately after exercise (see Karageorghis & Jones, in press; Karageorghis, Jones, & Stuart, 2008). Indeed, the mood-enhancing properties of exercise per se have been particularly well documented (see e.g., Berger & Motl, 2000). Moreover, research has shown that post-exercise mood is enhanced/more positive when compared with pre-exercise mood (e.g., Carels, Coit, Young, & Berger, 2007; Gauvin, Rejeski, & Norris, 1996).

Numerous studies in the exercise domain indicate that people routinely use music to regulate emotions and affect for activities that vary in their physical intensity demand (e.g., Brownley et al., 1995; Priest & Karageorghis, 2008). The neurophysiological concomitants of such benefits are as yet unknown; nonetheless, an important determinant of such affective qualities of music is the lyrical component, or words used in a song (Crust, 2008; Crust & Clough, 2006; Stratton & Zalanowski, 1994). While other constituents of music such as tempo (bpm) and loudness (dB) have garnered considerable attention from researchers (Brownley et al.; Edworthy & Waring, 2006; Karageorghis & Jones, in press), there is a dearth of research into the possible influence of lyrics, despite numerous qualitative and anecdotal accounts of their potential influence (e.g., Bishop, Karageorghis, & Loizou, 2007; Karageorghis et al., 2013; Priest & Karageorghis). Therefore, systematic investigation of the role of lyrics in the sport and exercise performance-relationship is warranted given both the widespread use of music in applied and research settings as well as the fact that lyrical music is often used in preference to instrumental music (Priest & Karageorghis, 2008).

The lyrical content of music is known to influence people's behaviour (see North & Hargreaves, 2008 for a review). For example, Jacob, Guéguen, and Boulbry (2010) found that listening to prosocial song lyrics during the eating (lunch and dinner) period in a restaurant increased patrons' tipping behaviours, in terms of both the proportion of customers leaving a tip and the amount of money they gave per tip. Greitemeyer (2009) showed that exposure to songs with prosocial lyrics fostered prosocial tendencies by increasing prosocial thoughts, affect, and behaviour in different situations (e.g., empathy towards others in need, donations to non-profit organizations, etc.).

Findings from the study of the effects of music with and without lyrics on mood and emotions are equivocal. Stratton and Zalanowski (1994) found that the lyrics of a song had greater capacity to alter mood than music without lyrics. More recently, Omar-Ali and Peynircioğlu (2006) asked participants to rate the intensity of four emotions (happy, sad, calm, and angry) in instrumental music or in music with lyrics. The authors found that melody had a stronger influence on emotion than lyrics. Nonetheless, in lyrical music, the lyrics "carry" the melody which adds a level of complexity in assessing the influence of lyrics and melody as singular phenomena.

Within the context of sport and exercise performance, lyrics may well relate to the task demands of repetitive activity (e.g., the potentially powerful influence of general affirmations [e.g., "Search for the hero inside yourself"]), task-specific verbal cues [e.g., "Keep on running"], and positive self-statements [e.g., "I am the one and only"]). In particular, lyrical content has been suggested to be the musical constituent that is most likely to promote a dissociation effect and thus reduce perceptions of effort (see Crust & Clough, 2006). Lyrics have also been suggested to play a role in inducing optimal mood and emotional states (Bishop et al., 2007; Crust, 2008; Laukka & Quick, 2011; Terry & Karageorghis, 2011).

The purpose of the present study was to examine the role of lyrics with reference to a range of psychological, psychophysical, and psychophysiological variables during submaximal cycle ergometry. It was hypothesized that, at the same individualized workload, cycling cadence would be significantly higher in the two music conditions (music with lyrics [ML] and music with no lyrics [NL]) when compared to a no-music control (NM), with the ML condition eliciting the largest increase in cycle cadence (H_1); as is common in the exercise science literature (e.g., Karageorghis et al., 2009) heart rate was used as a proxy for physiological stress and was expected to increase equally across the three conditions throughout the cycling task (H_2); perceived exertion (the feeling of how heavy and strenuous a physical task is; Borg, 1998, p. 8), was expected to be lower in the two music conditions when compared to NM (H_3); lastly, positive affect would increase and negative affect would decrease from pre- to post-test trials, in all three conditions (H_4), with distinct trends observed for positive affect (ML > NL > NM) and negative affect (NM > NL > ML).

Methodology

Ethical approval was gained from the ethics committee of the UK university at which the research was conducted and participants provided written informed consent. The research consisted of two phases: music selection (Stage 1) and the experimental protocol (Stage 2).

Stage 1: Music Selection

Participants. Forty-nine undergraduate students (M_{age} = 19.9 years, *SD* = 1.2 years) from a sport and exercise science undergraduate course at a university in northern England, UK volunteered to participate in the selection of motivational musical tracks for use in the experimental phase of the study. In keeping with the methodological guidelines of Karageorghis and Terry (1997), these participants were of a similar socio-cultural background and age profile to participants in Stage 2.

Measures. The Brunel Music Rating Inventory-2 (BMRI-2; Karageorghis, Priest, Terry, Chatzisarantis, & Lane, 2006) was employed to select the tracks that would be used in Stage 2. This questionnaire was designed to measure the motivational qualities of music for use in an exercise environment. It is a single-factor, six-item instrument presented on a 7-point Likert-scale anchored by 1 (*strongly agree*) and 7 (*strongly disagree*). For the purposes of the study, participants were informed that the word “motivate” meant music that would “make you want to exercise harder and/or longer in a cycling performance task”. The mean Cronbach alpha coefficient for the single factor reported by the authors was .89 (Karageorghis et al., 2006). Cronbach alpha coefficients in our study were .95 for both the rating of songs with lyrics and for the rating of those without.

Procedures. Participants were randomly assigned to one of two groups that were tasked with assessing the motivational qualities of eight tracks containing lyrics (n = 27; 15 males and 12 females; M_{age} = 20.1 years, SD = 1.3 years) or the same tracks without lyrics (n = 22; 13 males and 9 females; M_{age}= 19.7, SD = 1.0 years). The decision to use two independent groups was taken to prevent any intra-individual comparison of the two versions of each track, which were identical with the exception of the presence/absence of lyrics. Testing time and room conditions were the same for both groups. Initially, all participants listened to the same piece of calming instrumental music for 2 min as a baseline (62 bpm; *Woodland Wonder* from the album Instrumental Sounds of Nature). They then listened to the given music track for 90 s and rated that track using the BMRI-2; a process that was repeated for each of the eight tracks. Music was delivered through a compact disc player (Bush Digital Portable). Volume (loudness) was standardized for all music tracks at 70 dBA, which is deemed safe from an audiological perspective (Lindgren & Axelsson, 1988).

Data Analysis. The purpose of the analyses employed in Stage 1 was to identify two tracks (i.e., a sufficiently long accompaniment for the 6-min cycling test) for use in Stage 2 with significantly (p < .05) higher BMRI-2 scores for the versions with lyrics. Data screening and diagnostic tests (normal distribution of data and homogeneity of variance) to ensure data were suitable for parametric analysis were performed (Tabachnick & Fidell, 2007, pp. 60–116). A separate mixed-model 2 (Group [lyrics/no lyrics]) x 8 (Track) ANOVA and follow-up analyses were computed to find the two pairs of tracks required for the experimental phase. Mauchly’s test was used to check the sphericity assumption and where this assumption was violated, the corresponding F ratio was subjected to Greenhouse-Geisser adjustment. Partial eta squared (η_p^2) effect sizes were computed and, in accordance with Cohen (1988, pp. 184-185), η_p^2 of .01-.03, .06-.09 and above .14 indicate a small, medium and large effect, respectively.

Results. Data screening of the BMRI-2 results revealed that there was one case that exhibited multiple univariate outliers and this was deleted prior to further analysis. Overall, the BMRI-2 data did not meet the normality assumption owing to substantial positive standard skewness (standard skew. > 3.29) and positive standard kurtosis (standard kurt. $\geq$ 3.29) in five cells of the analysis; therefore, a logarithmic transformation—suitable for this type of nonnormality— was applied to normalize these data (see Tabachnick & Fidell, pp. 86–91).

A mixed-model ANOVA on the transformed BMRI-2 scores showed a significant Group x Track interaction, $F(4.89, 224.79) = 6.62$, $p < .001$, $\eta_p^2 = .13$, and a main effect for the selected tracks, $F(4.89, 224.79) = 8.38$, $p < .001$, $\eta_p^2 = .15$. Tracks with lyrics ($M = 1.14$, $SE = .02$) were not, overall, rated as significantly ($p = .526$) more motivational than tracks without lyrics ($M = 1.12$, $SE = .02$). However, for the tracks for which the version with lyrics was rated as more motivational than the version without, follow-up analyses using standard errors indicated significant ($p < .05$) differences between the two versions of *Uninvited* (ML: $M = 1.34$, $SE = .04$ and NL: $M = 1.07$, $SE = .04$ [transformed data]) and the two versions of *Firestarter* (ML: $M = 1.20$, $SE = .05$ and NL: $M = 1.04$, $SE = .05$ [transformed data]). Accordingly, these two tracks were selected for use in Stage 2 (see Table 1 for details of all eight tracks).

Stage 2: Experimental Investigation

Participants. Given the dearth of studies examining the role of lyrics in the music-exercise performance relationship, we used our preliminary data to conduct a power analysis and thus establish an appropriate sample size. A power calculation (Faul, Erdfelder, Buchner, & Lang, 2009) based on a large effect size ($\eta_p^2 = .28$) indicated that 23 participants would be required. As a protection against experimental dropout and multivariate outliers, a total of 25 undergraduate students (11 women and 14 men; $M_{age} = 20.8$ years, $SD = 1.3$ years) from a sport and exercise science course at a university in northern England, UK were recruited to take part in Stage 2. These participants were different than those used in Stage 1.

Instruments and Procedures. All participants reported a liking for mainstream dance music and were physically active in accordance with the American College of Sports Medicine and the American Heart Association criteria; these entail partaking in 150 min (30 min for 5 days per week) of moderate exercise, or 60 min (20 min for 3 days per week) of vigorous-intensity exercise (Haskell et al., 2007). Participants were asked to refrain from consuming caffeine-based products and exercising for 24 hr prior to testing.

Graded exercise test (GXT). To establish the workload for each participant during the experimental and control conditions, they first performed a continuous and incremental graded exercise test on a cycle ergometer (Corival). This session also facilitated participants' familiarization with the cycling procedures and associated measurements of exercise intensity. With the ergometer in hyperbolic mode, participants performed a 5-min warm-up at 80 W after which the power output was increased by 40 W every 3 min until the point of voluntary exhaustion. Cessation of the test was determined primarily by a heart rate (HR) within ± 10 bpm of age-predicted maximum, volitional exhaustion or an inability to maintain pedal/cycling cadence above 60 revolutions per minute (RPM; Eston, Faulkner, Gibson, Noakes, & Parfitt, 2007). During the last 30 s of each increment of the GXT, we recorded HR using a heart rate monitor (FS1) and ratings of perceived exertion (RPE) using Borg's (1982) 6-20 scale. Past research has shown the appropriateness of these measures for assessing effort and perceived exertion during physical work (see e.g., Hardy & Rejeski, 1989).

Prior to commencing the test, participants were instructed in how to respond to the RPE scale (Borg, 1998, pp. 43–52). Linear regression was subsequently used to calculate the power output for each participant, which corresponded to 75% of their maximum heart rate (HR_{max}) attained during the GXT. The calculated power output was then used as the exercising workload during the experimental and control trials. This workload was selected on the basis of previous training studies that have used heart rate as a method by which to control exercise intensity (e.g., Kaikkonen, Yrjämä, Siljander, Byman, Laukkanen, 2000), and because the psychophysical effects of music are attenuated beyond this intensity (see Rejeski, 1985; Tenenbaum, 2001).

Experimental exercise trials. The experimental conditions, which were administered on different days separated by at least a day's rest and presented in counterbalanced order, comprised music with lyrics (ML), the same piece without lyrics (i.e., an instrumental piece; NL) and a no-music control (NM). Each condition consisted of a 3-min warm-up at 50 W followed by a 6-min exercise bout at the pre-established workload for each participant. The cycle ergometer was set in order that workload remained constant throughout each 6-min trial, independent of the cycling cadence selected by the participant. Measures of RPM, HR, and RPE were monitored and recorded every 2 min during each trial, with RPM obscured from the participant's view to discourage engagement in any goal-setting strategies during testing. Music was delivered through in-ear phones (iPod) connected to a compact disc player (same as above). Volume (loudness) was standardized for all testing procedures at 70 dBA. the two songs selected in Stage 1, that is *Uninvited* by Freemasons (lyrics available from http://www.metrolyrics.com/uninvited-lyrics-freemasons.html) and *Firestarter* by The Prodigy (lyrics available from http://www.metrolyrics.com/firestarter-lyrics-prodigy.html), were edited in order to be played from the beginning for 3 min each, thus matching the test duration. During the NM condition, a blank compact disc was played. All conditions were performed at the same location, at the same time of day (± 2 hr), and were completed within 10 days of the GXT. The first experimental exercise trial was separated by at least 48 hr from the end of the GXT to allow participants full recovery.

Participants were also instructed to complete the International Positive and Negative Affect Schedule Short Form (I-PANAS-SF; Thompson, 2007) prior to and immediately after each trial. This questionnaire has 10 items presented on a 5-point Likert scale anchored by 1 (*never*) and 5 (*always*). Sample items include “inspired” (positive affect; PA) and “upset” (negative affect; NA). Participants were instructed to answer each item using a “how do you feel right now?” response set. The Cronbach alpha coefficients reported by the author are .78 for the PA subscale and .76 for the NA subscale. Cronbach alpha coefficients in the present study ranged from .71 to .92 for PA and NA pre- and post-trial in each condition.

Data Analysis. Similar data screening and diagnostic tests were used to those detailed in Stage 1. A two-factor 3 (Music Condition) x 2 (Time) repeated measures (RM) ANOVA was computed for RPM and MANOVAs using the same model were computed for PA and NA, and RPE and HR. One-way RM MANOVA was computed to assess mean RPE and HR data. Pairwise comparisons with Bonferroni adjustments were used where necessary.

Results. One univariate outlier was identified and reduced by modifying the raw score towards the mean, to a unit below the next less extreme raw score (Tabachnick & Fidell, 2007, p. 77). The data were normally distributed (standard skew./kurt. $\leq$ 2.58) with the exception of the negative and positive affect data which showed moderate positive skewness in four cells of the analysis. Given the moderate nature of this violation, a square root transformation was sufficient to normalize the affect data (see Tabachnick & Fidell, pp. 86–91).

Interaction Effects

The two-factor RM ANOVA for RPM revealed a significant Condition x Time interaction, $F(4, 96) = 3.89$, $p = .006$, $\eta_p^2 = .14$, with a large effect size. Follow-up tests indicated that at min 6, RPM was significantly ($p = .010$) higher in the ML ($M = 100.60$, $SE = 4.63$) condition when compared to NL ($M = 96.20$, $SE = 4.70$), but that there were no such differences at min 2 and 4 (see Figure 1). The same interaction in a RM MANOVA was nonsignificant for PA and NA, Hotteling's Trace = .13, $F(4, 92) = 1.51$, $p = .194$, $\eta_p^2 = .06$. In a separate RM MANOVA, the same interaction was nonsignificant for RPE and HR, Pillai's Trace = .119, $F(8, 192) = 1.52$, $p = .152$, $\eta_p^2 = .06$.

Main Effects

There was a condition main effect for RPM, $F(2, 48) = 18.49$, $p < .001$, $\eta_p^2 = .43$, associated with a large effect size, with pairwise comparisons indicating that the highest RPM was recorded in the two music conditions ($p < .001$). There was also a time main effect for RPM, $F(1.15, 27.70) = 31.66$, $p < .001$, $\eta_p^2 = .57$, again associated with a large effect size, with pairwise comparisons indicating that RPM increased in a linear manner throughout the duration of the 6-min exercise bout ($p < .01$; see Figure 1).

There was no condition main effect for PA and NA, Hotteling's Trace = .01, $F(4, 92) = .14$, $p = .966$, $\eta_p^2 = .01$, although there was a main effect for time, Hotteling's Trace = 4.03, $F(2, 23) = 46.32$, $p < .001$, $\eta_p^2 = .80$, associated with a large effect size. Stepdown *F* tests indicated differences for PA, $F(1, 24) = 68.53$, $p < .001$, $\eta_p^2 = .74$, and NA, $F(1, 24) = 28.93$, $p < .001$, $\eta_p^2 = .55$, with pairwise comparisons revealing that PA increased from pre- to post-task while NA decreased ($p < .001$; see Table 2).

There was no condition main effect for RPE and HR, Pillai's Trace = .15, $F(4, 96) = 1.98$, $p = .104$, $\eta_p^2 = .08$, although there was a main effect for time, Pillai's Trace = .74, $F(4, 96) = 14.11$, $p < .001$, $\eta_p^2 = .37$, associated with a large effect size. Stepdown *F* tests indicated differences for RPE, $F(1.13, 27.12) = 39.41$, $p < .001$, $\eta_p^2 = .62$, and HR, $F(1.15, 27.62) = 56.78$, $p < .001$, $\eta_p^2 = .70$, with pairwise comparisons revealing that both RPE and HR increased in a linear manner throughout the duration of the task ($p < .001$; see Table 3).

Discussion

The present study examined the role of the musical constituent of lyrics with reference to a range of psychological, psychophysical, and physiological variables during submaximal cycle ergometry. Two main findings emerged: First, musical accompaniment per se resulted in a higher cycling cadence and this was manifest without any corresponding increase in perceived effort or heart rate. The condition with lyrics elicited a higher cadence (RPM) than the condition without *only* at min 6, therefore H_1, stating that RPM would be significantly higher in the two music conditions, is partially supported. Second, the inclusion of lyrics had no bearing on the remaining psychological (affect), psychophysical (RPE), and physiological (HR) variables. Therefore H_2, stating that HR was expected to increase equally across the three conditions throughout the task, is accepted, while H_3, stating that RPE would be lower in the two music conditions, and H_4, stating that positive affect would increase and negative affect decrease from pre- to post-test in all three conditions (with distinct trends to be observed for positive affect [ML > NL > NM] and negative affect [NM > NL > ML]), are not supported by the present data. Main effects for time were found for RPE and HR, both of which increased from min 2 through to min 6 of the task, and for affect: positive affect increased and negative affect decreased from pre- to post-trial.

The present findings reveal that both music with lyrics and music without elicited significantly (p = .006) greater mean cycling cadence (RPM) throughout the cycling test than the no-music control condition. This adds to an emerging literature that supports the potential of music to aid physical performance (e.g., Crust & Clough, 2006; Karageorghis et al., 2013; Terry et al., 2012). In addition, the findings support those of previous studies that used similar protocols, and reported no changes in physiological indices (e.g., blood lactate concentration) with a concomitant increase in RPM (e.g., Lim, Atkinson, Karageorghis, & Eubank, 2009). An increase in cycling cadence without a corresponding increase in heart rate could be attributed to participants' entrainment to the rhythmical qualities of music, which is likely to engender more efficient movement patterns (Terry et al., 2012). Recent research by Bacon et al. (2012) has found that participants required 7% less oxygen when cycling in time to the beat of the music when compared to an asynchronous music condition at a slightly slower tempo. Similarly, in the first study to examine the effects of synchronous music with elite athletes (triathletes), Terry et al. (2012) found that oxygen consumption during treadmill running was 1.0-2.7% lower with music (whether motivational or neutral), when compared against a no-music control.

The matching of a music playlist to the requirements of a given activity has been identified as an important factor when investigating the effects of music on performance (Atkinson, Wilson, & Eubank, 2004; Karageorghis et al., 1999). In line with past research (e.g., Elliott, Carr & Savage, 2004), participants in our study may have derived benefit from the rhythmical qualities of the music (tempo ≥ 128 bpm) in terms of maintaining a regular movement pattern. Nonetheless, contrary to expectations, exercising with music with lyrics did not result in higher cycling cadence when compared to exercising with music that had no lyrics. This study is the first to experimentally examine the impact of lyrics in the music-physical performance relationship; hence, a direct comparison with previous findings is somewhat challenging. Previous research does indicate, however, that music differing in its motivational qualities elicits significant differences during exercise (Elliott et al.; Karageorghis et al., 2006, 2009). Also, fatigue may inhibit participants from processing lyrical content in a similar way to that at rest (cf. Tenenbaum, 2001). Despite the fact that past empirical research has not addressed this issue directly, it seems entirely plausible that such syntactical content would be challenging to process at high exercise intensities owing to the automatic attentional switching that apparently takes place beyond the anaerobic threshold (Rejeski, 1985).

In the present study, the higher cycling cadence reported in the two music conditions was not accompanied by concomitant increases in perceived exertion; this supports the findings of similar studies (e.g., Lim et al., 2009). The primary reason for a lower perceived exertion despite the higher work-rate relates to the dissociation promoted by music listening, which limits the fatigue-related sensations transmitted via the efferent nervous system (Hutchinson et al., 2011; Rejeski, 1985). Given that most research in this area has focused on protocols of longer durations than our 6-min submaximal test (e.g., Boutcher & Trenske, 1990; Karageorghis et al., 2009), further research examining a longer bout of exercise accompanied by an entire music programme with and without lyrics is recommended.

As expected, the present findings showed an increase in positive affect and a decrease in negative affect post-exercise, for all conditions. This is in line with past research that supports the beneficial role of exercise with reference to a range of psychological state variables (e.g., Carels et al., 2007). However, contrary to expectations, neither the presence of instrumental music nor the presence of music with lyrics influenced participants' affective states when compared to a no-music control. This does not concur with past findings, which have shown an enhancement in affect associated with music conditions when compared to no-music controls (e.g., Boutcher & Trenske, 1990; Karageorghis et al., 2009; Terry et al., 2012). It has also been suggested that individuals can be emotionally aroused by the lyrical content of music and the manner of its vocal delivery (see North & Hargreaves, 2008; Priest & Karageorghis, 2008). Such emotional responses to music could implicate a mirror neuron mechanism (Molnar-Szakacs & Overy, 2006), which is so called because it is activated both when the individual acts and observes the same action performed by another. Mirror neurons have been proposed as a mechanism that allows "...an individual to understand the meaning and intention of a communicative signal by evoking a representation of that signal in the perceiver's own brain." (Molnar-Szakacs & Overy, p. 235). This mechanism may also relate to the earlier described notion of emotional contagion wherein the listener "catches" the emotion that a composer or artist seeks to convey through music (Juslin, 2009). Accordingly, there is a necessity for neurophysiological investigation of the influence of lyrics and vocal delivery within exercise and sport settings. Such research might cast light on the mechanisms and neural circuits that underlie how these aspects of music influence affective and performance-related outcomes (e.g., exercise endurance).

Limitations and Recommendations

Music selection in the present study was conducted at rest whereas experimental testing required participants to perform a submaximal exercise task. In the field of sport and exercise sciences, it is common for music selected to be conducted while participants are at rest. The approach in our domain mirrors that in mainstream psychology wherein studies of the influence of lyrics have generally been conducted with participants in a restful state (e.g., in a restaurant setting; see Jacob et al., 2010). Nevertheless, given the specifics of the sport and exercise domain, researchers in this field might consider conducting music selection under conditions that mirror the modalities and intensities of the activity that will be used in subsequent experimental trials (e.g., cycling at a high intensity or running at a moderate intensity). Currently, the BMRI and its derivatives require respondents to rate a given piece of music with an exercise task in mind, rather than while actually performing that task.

The tracks used in Stage 2 of the study were preselected in Stage 1 according to their motivational properties for exercise by participants of a similar socio-cultural background and age profile to participants who took part in Stage 2 (cf. Karageorghis & Terry, 1997). Past research has shown that it may be beneficial to include self-selected pieces in the study of the music-performance relationship (e.g., Razon et al., 2009; Terry et al., 2012). Although a wide range of music has been used in past research to examine its effect on performance, such music has generally not been selected with explicit reference to its lyrical content. From an applied practitioner perspective, the lyrical content of music can enhance affect as well as provide positive affirmations or task-related verbal cues (e.g., Crust, 2008; Laukka & Quick, 2011; Priest & Karageorghis, 2008). Moreover, had the present protocol been of a longer duration, symptoms of fatigue may have been more likely to impinge on attentional processes, rendering the exercise to be more pleasurable in the presence of music (e.g., Elliott et al., 2004; Karageorghis et al., 2009).

In the present study, the experimental manipulation that we employed entailed using instrumental versions of tracks that were commonly heard with lyrics. Given that the composers of these tracks had conceived them with the presence of lyrics, we do not know how participants would respond to music that had been composed to be purely instrumental in nature; such music uses the meshing of instrumental sounds to elicit an emotional response in the listener. Past research that has examined music, emotions, and lyrics has shown that interpretation of the lyrics (e.g., the truthfulness of the words, the message of the lyrics) influences the overall emotional experience of music (see e.g., Juslin, 2009 for a review).

In addition, neither the meaning of the lyrics nor how participants interpreted them was considered in the present study. The songwriters' intended meaning compared against the typically diverse interpretation of listeners indicates that future researchers might consider both the lyrical content of tracks and individual interpretations (Priest & Karageorghis, 2008). Researchers should also account for the possibility of lyrics being heard via auditory imagery during a no-lyrics condition; the selected songs in the present study were top 10 hits in the UK charts and thus generally well known. Both of the aforementioned limitations could be assuaged through the use of music that was previously unfamiliar to participants.

Conclusions

The present study supported the notion that carefully selected music can engender an ergogenic effect in an exercise task. Participants' cycling cadence increased in a short-duration, individually fixed-load cycling bout when compared to performance in a no-music control condition. The presence of lyrics bolstered the ergogenic effect of the music only in the closing stages of the trial (min 6), although the tracks with lyrics were delineated as being more motivating for exercise than the same tracks without lyrics. Sport and exercise psychology researchers suggest that lyrics can play an important role in sport and exercise settings through the affirmations or task-relevant cues they provide (e.g., Bishop et al., 2007; Terry & Karageorghis, 2011). Thus, the lyrical content of music warrants further investigation in order that we might better understand its role and harness its motivational and affective properties.

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Table 1

BMRI-2 Scores (Mean and Standard Deviation) for Tracks with Lyrics (ML; n = 26) and Tracks without Lyrics (NL; n = 22)

Track No.	Song Title	Artist	Music Condition	BMRI-2
1	Now You're Gone	Basshunter	ML NL	12.31 (6.12) 11.41 (4.64)
2	It's Over Now	Big Ang ft. Siobham	ML NL	14.19 (7.83) 15.60 (5.95)
3	Yeah Yeah	Bodyrox	ML NL	15.42 (7.59) 19.09 (7.98)
4	Perfect (Exceeder)	Mason vs. Princess Superstar	ML NL	14.27 (6.60) 15.32 (5.75)
5	Uninvited	Freemasons	ML NL	23.15 (7.34) 13.45 (6.99)
6	I Like To Move It	Real 2 Real ft. The Mad Stuntman	ML NL	11.88 (5.44) 12.45 (7.76)
7	Crazy In Love	Beyoncé	ML NL	17.73 (7.60) 18.41 (7.29)
8	Firestarter	The Prodigy	ML NL	18.42 (10.53) 12.27 (6.09)

Note. The descriptive statistics recorded here are pre-transformation (see text for further details).

Table 2

Positive Affect (PA) and Negative Affect (NA) Values (Mean and Standard Deviation) before (pre-trial) and after (post-trial) Cycling under Conditions of Lyrics, No Lyrics and a No-music Control

	Music condition	Pre-trial	Post-trial
PA	Lyrics	15.48 (4.11)	19.24 (4.07)
	No lyrics	15.44 (3.97)	19.56 (3.56)
	No music	15.52 (3.08)	18.40 (4.01)
NA	Lyrics	7.44 (2.96)	6.40 (2.10)
	No lyrics	7.56 (2.77)	6.16 (1.62)
	No music	7.72 (3.33)	6.28 (2.21)

Table 3

Heart rate and RPE Responses (Means and Standard Deviations) at 2, 4, and 6 min while Cycling under Conditions of Lyrics, No Lyrics, and a No-music Control

Heart Rate (bpm)	2 min	4 min	6 min	Overall
Lyrics	136.84 (14.37)	141.64 (23.09)	154.52 (19.24)	140.20 (13.56)
No lyrics	139.00 (13.35)	148.84 (17.43)	154.40 (21.13)	145.40 (15.26)
No music	136.77 (12.49)	142.80 (14.63)	144.52 (32.49)	140.49 (14.03)
RPE	2 min	4 min	6 min	Overall
Lyrics	10.76 (1.98)	12.08 (1.89)	13.68 (2.11)	11.83 (1.66)
No lyrics	10.72 (1.70)	12.36 (1.68)	13.68 (2.10)	11.84 (1.49)
No music	11.16 (1.89)	12.52 (1.56)	13.96 (2.26)	12.16 (1.54)

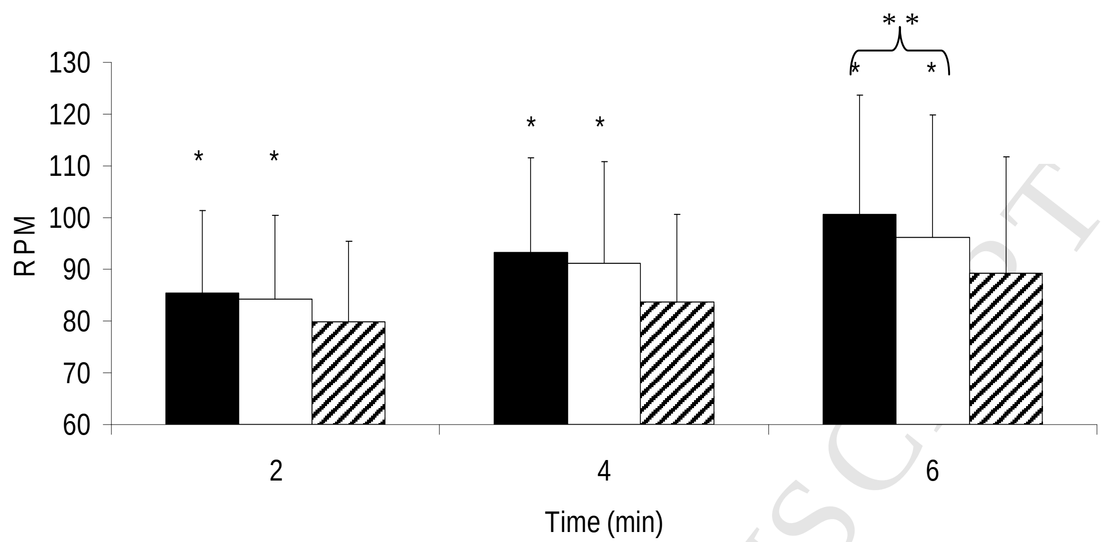

Figure 1. Mean revolutions per minute (RPM) responses at each 2 min interval during the 6-min cycling trial for ML (black bar), NL (white bar) and NM (striped bar) conditions. T-bars represent standard deviation. *Differs significantly (p = .006) from NM condition. * *ML differs significantly (p = .010) from NL.

Highlights

- Experimental assessment on the role of lyrics in exercise.
- Psychological, psychophysical, and physiological variables included.
- Musical accompaniment enhanced cycling cadence during submaximal cycle ergometry.
- The inclusion of lyrics enhanced cycling cadence towards the end of the task.
- Inclusion of lyrics had no effect on affect, perceived exertion, or heart rate.