MUSIC WITH AND WITHOUT LYRICS INCREASES MOTIVATION, AFFECT, AND AROUSAL DURING MODERATE-INTENSITY CYCLING

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Thesis Prepared for the Degree of

MASTER OF SCIENCE

UNIVERSITY OF NORTH TEXAS

August 2017

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Music is used to distract, energize, and entertain during exercise by producing positive psychological and physiological responses. Specifically, listening to music during exercise enhances performance, increases motivation, improves affect, and optimizes arousal. Researchers have identified several elements of music that may moderate this relationship, including lyrics. However, few studies to date have examined the influence of motivational lyrics on psychological and physiological states during exercise. Thus, the primary purpose was to investigate the effects of lyrics in music on motivation, affect, arousal, and perceived exertion during moderate intensity cycling. Thirty (Mage = 21.0 ± 2.9 years old) college-aged individuals performed three, 8-min acute bouts of moderate-intensity exercise on a cycle ergometer during music with lyrics (ML), music without lyrics (MNL), and no music control (MC) conditions. Measures of motivation, affect, arousal, and perceived exertion were taken before and after a 6-min warm-up, every 2-min during the exercise bout, and following a 2-min cool-down. For ML and MNL conditions, participants reported higher motivation, affect, and arousal during exercise relative to the MC condition. As expected, RPE increased throughout the exercise period, with no condition differences observed. Additionally, there were no differences in responses between the ML and MNL conditions. Collectively, these results suggest that music, regardless of lyrical content, can enhance psychological responses during exercise. The current findings may help address common exercise barriers and inform exercise practitioners on music selection to improve exercise adherence.
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MUSIC WITH AND WITHOUT LYRICS INCREASES MOTIVATION, AFFECT, AND AROUSAL DURING MODERATE-INTENSITY CYCLING

Introduction

Music is often used to distract, energize, entrain, and entertain the listener during exercise by inducing favorable psychological and physiological responses (Karageorghis & Priest, 2012a, 2012b; Sloboda, Lamont, & Greasley, 2009). Specifically, listening to music during exercise enhances motivation (Hutchinson et al., 2011), increases positive affect (Elliott, Carr, & Savage, 2004), optimizes arousal (Ghaderi, Rahimi, & Azarbayjani, 2009), and decreases perceived exertion (Potteiger, Schroeder, & Goff, 2000). Although several specific elements of music (e.g., tempo, rhythm, sound, loudness, harmony) have been investigated over the past decade for their influence on these psychological variables (Karageorghis, Jones, & Stuart, 2008; Yamamoto et al., 2003), the specific element (or combination of elements) producing the greatest benefits during exercise remains unclear. One potential component of music that has received little research attention is lyrics.

Lyrics, the words included in music, often contain explicit or implicit meaning, such that the themes or statements conveyed by the lyrics may be direct and easy to comprehend or suggestive and not directly expressed. Themes and statements are not always consistent throughout a musical piece, further complicating the lyrical component of music. According to the theoretical model proposed by Karageorghis (2016), lyrics may influence psychological, physiological, and behavioral outcomes, and relative to exercise, a number of anecdotal and qualitative investigations suggest that lyrics may enhance motivation (Karageorghis et al., 2013), affect (Priest & Karageorghis, 2008), arousal (Urakawa & Yokoyama, 2005), and perceived exertion (Gfeller, 1988). However, these effects often depend upon the study design (e.g.,
synchronous vs. asynchronous exercise) and outcome variables (e.g., performance vs. psychological measures). Alternatively, the effects of lyrics in music may also be due to the perceived meaning of the lyrics by the athlete or individual exercising. As such, certain lyrics may contain more meaningful content depending on personal characteristics such as age, gender, and personality. It has also been suggested that lyrics play a role in inducing optimal emotional states, such as increasing motivation and enjoyment by instilling empathy for the artist (Bishop, Karageorghis, & Loizou, 2007), providing a source of affirmations to exercise, and conjuring inspirational imagery for the listener (Karageorghis, 2016).

In the earliest study to address lyrical influence on exercise, Sanchez and colleagues (2014) examined the effects of lyrics on performance (cycling cadence) in 25 physically active, college-aged individuals. Participants were asked to cycle for 6-min at a workload equivalent to 75% of maximum heart rate under music with lyrics, music without lyrics, and no music conditions. The authors assessed positive and negative affect before and after each 6-min session and recorded cycling cadence, ratings of perceived exertion, and heart rate at 2-min intervals throughout the session. As expected, significant differences in cadence were found between the music with and music without lyrics conditions compared to the no music condition. Furthermore, cycling cadence was higher in the lyric condition compared to the no lyric condition at the 6-min mark, suggesting small improvements in speed later in the exercise bout. Despite an increase in cadence for the music conditions, there were no differences in perceived exertion between the three conditions, providing additional support for the dissociative properties of music that limit fatigue related sensations (Hutchinson et al., 2011; Rejeski, 1985). Contrary to previous investigations (Boutcher & Trenske, 1990; Terry, Karageorghis, Saha, & D’Auria, 2012), the authors found no differences in affect between the three groups across all time points,
suggesting that while music may improve cycling performance and maintain perceived exertion levels, affective responses may not be influenced by music.

The second known study on lyrical influences during exercise investigated the effects of lyrics on perceived exertion in 23 non-athletic individuals (Baranie, Pooraghei, and Zarein (2015). Participants were asked to run on a treadmill for 5-min at vigorous intensity (~80% age-predicted maximum heart rate) and report perceived exertion following music with lyrics, music without lyrics, and no music conditions. A significant difference in perceived exertion was observed between both music conditions relative to the no lyrics condition; however, no significant differences between the music conditions were observed. Unfortunately, no further information on heart rate or psychological variables was reported, and the authors only assessed perceived exertion at one time point following the 5-min exercise bout, which occurred after 20-30 minutes of warm-up exercises. Thus, baseline differences in perceived exertion and changes in perceived exertion during each condition were not considered. Taken together, both studies reported significant reductions in perceived exertion in the music conditions compared to the no-music condition, suggesting that music in general may reduce perceptions of effort and exertion.

The lack of support for music with lyrics may be due to several methodological limitations. For instance, Sanchez et al. initially standardized resistance to 75% of heart rate maximum but allowed subjects to pedal at a self-selected cadence. Changes in exercise intensity during the exercise bout may be one potential reason subjects reported no significant differences in affect during the music conditions relative to the control condition. Previous work indicates that as heart rate passes ventilatory threshold, affective responses decline (Ekkekakis, Parfitt, & Petruzzello, 2011), thus increases in cadence may have masked changes in positive and negative feelings. Additionally, affect was only measured before and after exercise, which prevents us
from understanding the influence of lyrics on in-task feelings. Next, the music selection in both studies was conducted at rest by a sample similar in age and athletic ability to the test subjects. The questions were framed with exercise in mind, yet rating the motivational content of the lyrics may be more accurate if done during exercise at a similar intensity and duration. Lastly, to our knowledge, no one has examined the effects of lyrics on motivation despite its undoubtedly important role in the music-performance relationship. Motivation and emotions are psychological variants that are viewed as an integral part of the experience of exertion (Borg, 1998); however, research adopting a multidimensional approach to perceived effort has shown that motivation is experienced distinctly from other dimensions of perceived exertion (Hutchinson & Tenenbaum, 2006; Tenenbaum & Hutchinson, 2007). Further supporting this idea, researchers have found improved motivation during exercise, with no change in perceived exertion, while listening to music (Hutchinson et al., 2011; Karageorghis et al., 2008).

Currently, empirical support for the effect of lyrics on psychological and physiological outcomes is lacking and warrants further research. Therefore, the primary purpose of this study was to examine the effects of lyrics on motivation during moderate-intensity cycling. Based on the limited research that is available, we hypothesized that both music conditions (with and without lyrics), relative to a no music control, would produce increases in self-reported motivation during exercise. We further hypothesized that the music with lyrics condition would produce a larger effect on motivation during exercise compared to the music without lyrics condition. A secondary purpose was to examine the effects of music on affect, arousal, and perceived exertion. In line with previous research, we hypothesized that both music conditions would increase affect and arousal and have little effect on perceived exertion compared to the no
music control condition. We further hypothesized that greater effects would be displayed in the music with lyrics condition compared to the music without lyrics condition.

Methods

Part 1: Music Selection

One song was selected for use during the experimental conditions. First, researchers selected five tracks from a pre-determined list of songs recommended to accompany cycling tasks. The five selected tracks were selected specifically for the higher reported levels of motivational lyric content (Karageorghis, 2016). Next, 28 students between the ages of 18 and 27 (22.11 ± 1.89) volunteered to rate each track on its motivational properties. Based on Borg’s ratings of perceived exertion (RPE; Borg, 1982), participants cycled at moderate-intensity (RPE = 13) while listening to each track in a randomized order. After listening to each track for 2-min, participants rated the motivational quality using the Brunel Music Rating Inventory-2 (BMRI-2; Karageorghis, Priest, Terry, Chatzisarantis, & Lane, 2006). The BMRI-2, a 6-item instrument presented on a 7-point Likert-scale anchored by 1 (strongly agree) and 7 (strongly disagree), was designed to measure the motivational qualities of music for use in an exercise setting. In addition to the original 6-items on the BMRI-2, two additional items assessing vocals and lyrics were included to ensure that the lyrical content of the tracks were perceived as motivational. In the present study, participants were informed that the term “motivate” meant music that would “make you want to continue to exercise during a cycling task”. Finally, the mean score for each track was calculated for each item and the track with the highest total score (5.45 ± 1.59) and highest lyric score (4.89 ± 1.93) was selected for the experimental trials (Boom Boom Pow by the Black Eyed Peas). The full list of songs and BMRI-2 scores can be found in Table 1.
Part 2: Experimental Trials

Participants

Thirty (19 females) college-aged individuals ($M_{age} = 21.03 \pm 2.94$) were recruited from the local university via recruitment emails and flyers. Inclusion criteria included: (1) men and women aged 18-35 years; (2) no physical limitations or contraindications to exercise; and (3) reported regularly listening to music during exercise. Exclusion criteria included: (1) current or present history of cardiovascular disease; (2) past or present history of psychiatric or neurological disorder; (3) currently taking medications that would prevent them from completing moderate-to-vigorous intensity exercise; and/or (4) pregnancy or considering becoming pregnant in women. Prior to each session, enrolled participants were screened for regular sleep patterns, stimulant use (e.g., caffeine and tobacco), meal consumption, exercise participation, stress levels, and current mood. Any subjects that provided irregular responses relative to their normal daily activities were re-scheduled. The Institutional Review Board at the University of North Texas approved research procedures and all participants provided written informed consent prior to data collection.

Measures

Heart rate (HR) and intensity. HR was assessed continuously throughout the test sessions with a Polar S810 HR monitor and transmitter (Polar Electro, Kemele, Finland). HR data were collected after each 2-min block and used as an indicator of arousal and exercise intensity. In order to standardize workload intensity between conditions, an individualized heart rate range between 64-76% (moderate-intensity) of age-predicted maximum heart rate ($HR_{max}$) was calculated for each participant. $HR_{max}$ was calculated based on ACSM guidelines (i.e., $220 - \text{age} = HR_{max}$) for establishing exercise intensity zones (Garber et al., 2011).
**Ratings of perceived exertion (RPE).** The in-task perception of physical exertion was measured using Borg’s 15-point scale (Borg, 1970), which ranges from 6 to 20 with verbal anchors at 7 (very, very light), 9 (very light), 11 (fairly light), 13 (somewhat hard), 15 (hard), 17 (very hard), and 19 (very, very hard). Meta-analytic findings on RPE validity data indicate that this scale displays strong validity with common physiological measures of exertion and intensity (Chen, Fan, & Moe, 2002). The validity of the RPE scale in terms of its correlation with standard physiological indices (e.g., blood lactate, oxygen uptake, respiratory exchange ratio) has been previously demonstrated ($r = .80$ to 0.95; Borg). The scale also displays both high intratest ($r = .93$) and retest ($r = .83$ to .94) reliability (Borg, 1998). Within the current sample, alpha coefficient values for the RPE scale ranged between .71 and .87.

**Motivation.** The 11-point Motivation Scale (MS; Tenenbaum, Kamata, & Hayashi, 2007), which assesses the direction and intensity of effort, was used to measure state motivation. Participants were specifically asked, “How motivated are you to keep going?” at the end of each 2-min block. The scale is anchored at 0 (not at all motivated), 5 (moderately motivated), and 10 (extremely motivated). In exercise settings, motivation can also be viewed as the action of some external influence on behavior (Priest, Karageorghis, & Sharp, 2004). Using effort tolerance as a criterion, Tenenbaum et al. (2007) report higher predictive validity of such scales ($rs > .50$) when compared to reliable dispositional measures. The MS scale showed high reliability with a Cronbach alpha between .85 and .95.

**Affect.** In-task affect was assessed using the 11-point Feeling Scale (FS; Hardy & Rejeski, 1989). The FS is a single-item, bipolar scale of pleasure and displeasure with anchors at -5 (very bad), -3 (bad), -1 (fairly bad), 0 (neutral), +1 (fairly good), +3 (good), and +5 (very good). Numerous physical activity studies have utilized the FS as a measure of affective valence.
(Ekkekakis, 2003). The single affect dimension (positive vs. negative) was validated using a discriminant function analysis. The positive affect subscale of the Multiple Affective Adjective Checklist (Zuckerman & Lubin, 1985) was used to discriminate with 95.2% accuracy between two matched groups of participants who were instructed to check adjectives associated with either “good” or “bad” feeling states. The FS also demonstrates negative correlations with HR \( (r = -.70; p < .05) \), respiratory rate \( (r = -.62; p < .05) \), and oxygen uptake \( (r = -.69; p < .05) \) at various exercise intensities. Cronbach alpha coefficients within the current study ranged from .72 to .90.

Arousal. The 6-point Felt Arousal Scale (FAS; Svebak & Murgatroyd, 1985) originally a component of the Telic State Measure within the reversal theory, was used to measure in-task arousal levels. The FAS is a single-item scale with anchors at 1 (low arousal) and 6 (high arousal). Similar to the FS, the FAS has been used as a reliable measure of perceived arousal in a number of previous investigations (Astorino, Cottrell, Lozano, Aburto-Pratt, & Duhon, 2012; Ekkekakis, Hall, & Petruzzello, 2008) The FAS is correlated with the arousal scale of the Self-Assessment Manikin \( (r = .45-.70) \) and the arousal scale of the Affect Grid \( (r = .47-.65); \) Ekkekakis et al., 2008), and displayed high reliability with a Cronbach alpha values ranging between .77 and .92.

Procedures

Participants visited the laboratory on three separate occasions at approximately the same time of day separated by at least 48 hours. During the first session, participants meeting all inclusion criteria provided written informed consent and completed a health history survey to ensure that it was safe to engage in exercise. Once questionnaires were complete, participants were escorted to the cycle ergometer where adjustments were made to achieve optimal comfort.
(e.g., seat height and pedal settings) for the remaining sessions. Participants then completed their first session once adjustments were recorded. For the three experimental sessions, participants completed a ML, MNL, and MC condition in counterbalanced order. All three conditions were 16-min in duration and consisted of a 6-min warm-up, 8-min of continuous exercise at moderate-intensity, and a 2-min cool-down. For each condition, the metronome was played at 65 bpm during the 6-min warm-up period. Participants were instructed to pedal to the beat of the metronome while experimenters gradually increased the resistance of the cycle ergometer until the participant’s individualized heart rate range was achieved. During the 8-min exercise period, the music was synced and overlaid to the metronome during the ML and MNL conditions whereas the metronome continued to play throughout the MC condition. Following the 8-min exercise period, the music faded out and participants again pedaled to the beat of the metronome during the 2-min cool-down. The experimenter continued to adjust the resistance throughout the experimental condition to maintain the specified heart rate range. The metronome and music volume were standardized for all testing procedures and were delivered through a Logitech speaker system setup behind the cycle ergometer. Due to the length of the pre-selected song (4-min), each version of the song was repeated once during the 8-min test period. MS, FS, FAS, RPE, and HR were measured at the beginning and end of the warm-up, as well as at each 2-min interval during the exercise condition and at the end of the cool-down. Following completion of the final testing session, participants were briefed on the purpose of the study.

Experimental Design and Counterbalancing

A within-subjects experimental design was utilized to examine the effects of music with and without lyrics on the primary outcome, motivation (MS). Secondary outcomes included affect (FS), arousal (FAS), and perceived exertion (RPE) responses. All outcome measures were
assessed throughout each condition at seven time points (0, 6, 8, 10, 12, 14, and 16 minutes). The three experimental conditions consisted of a music with lyrics (ML), music without lyrics (MNL), and a no music control (MC) day (see Figure 1 for study diagram). The ML condition consisted of the experimental song in its original form, the MNL condition consisted of the same song with the lyrics removed, and the MC condition consisted of a metronome set at 65 beats per minute (bpm). The metronome tempo corresponded to one half of the tempo of the selected song (i.e., music tempo equal to 130 bpm) and was synced to the music and played in the background during the ML and MNL conditions.

Data Analysis

Data were analyzed using SPSS Statistical Software version 24 (SPSS Inc., Chicago, IL). Descriptive statistics were performed on participant demographic, cycling history, and music preference data. MS, FS, FAS, RPE, and HR responses were submitted to a 3 (Condition: ML, MNL, MC) x 7 (Time: 0, 6, 8, 10, 12, 14, 16) repeated measures analysis of variance (RM-ANOVA) with a family-wise alpha level set at 0.05. All planned comparisons and post-hoc analyses were conducted using Bonferroni corrected t tests. Effect sizes (ESs) are presented as partial eta squared ($\eta^2_p$) for ANOVA results.

Power analysis. The study was specifically powered to detect changes in motivation rather than secondary outcomes. Using G*Power version 3.1.9.2 (Faul, Erdfelder, Buchner, & Lang, 2009), a priori power estimates suggested that at least 27 participants completing each condition was sufficient to provide 80% power to detect an effect size of 0.24 with alpha set at .05. The number of participants was increased to 30 to ensure that an equal number underwent each permutation of the counterbalanced experimental conditions.
Results

Preliminary analyses revealed no significant gender differences in BMI, age, prior music listening frequency, song enjoyment, or cycling history. Similarly, there were no significant gender differences in MS, FS, FAS, RPE, or HR responses. Thus, subsequent analyses were collapsed across gender.

Heart Rate (HR)

As expected, average HR during exercise fell within the calculated 64-76% $\text{HR}_{\text{max}}$ range ($140.2 \pm 3.27$) for all conditions. Additionally, the two-factor RM-ANOVA did not reveal a Condition main effect for HR, $F(2,28) = .53, p = .60, \eta^2_p = .04$, suggesting that HR was similar between all three experimental condition. Additionally, a Time main effect, $F(6,24) = 116.74, p < .001, \eta^2_p = .967$, showed an increase in HR during the warm-up, a relatively stable HR throughout exercise, and a reduction in HR during the cool-down. No Condition x Time interaction was found, $F(12,18) = 1.09, p = .42, \eta^2_p = .42$.

Perceived Exertion (RPE)

A significant time main effect, $F(6,24) = 42.24, p < .001, \eta^2_p = .91$, was found for perceived exertion, such that RPE increased during the warm-up, remained relatively stable throughout exercise, and decreased during the cool-down. No significant Condition main effect, $F(2,28) = .60, p = .56, \eta^2_p = .04$, or Condition x Time interaction was observed, $F(12,18) = .568, p = .84, \eta^2_p = .28$ (Figure 2).

Motivation (MS)

The two-factor RM-ANOVA for the MS revealed a significant Condition main effect $F(2,28) = 11.75, p < .001, \eta^2_p = .46$, such that motivation was reported highest in the ML (5.11 ± 0.35) and MNL (5.14 ± 0.36) conditions relative to the MC (4.10 ± 0.43) condition, $p < .001$ as
shown in Figure 2. There was no difference found between the two music conditions. Additionally, a significant time main effect, $F(6,24) = 7.614, p < .001, \eta^2_p = .66$, showed that participants felt significantly less motivated at 0- (pre warm-up) and 16- (post cool-down) min. These main effects were superseded by a significant Condition x Time interaction, $F(12,18) = 3.26, p = .01, \eta^2_p = .69$. Decomposition of this interaction revealed that motivation was significantly higher in ML and MNL conditions at 8-, 10-, 12-, 14-, and 16-min relative to the MC condition. There were no differences between groups found at the 0- and 6-min time points (Figure 3).

Affect (FS)

The RM-ANOVA for the FS revealed condition, $F(2,28) = 4.58, p = .019, \eta^2_p = .25$, and time, $F(6,24) = 5.13, p = .002, \eta^2_p = .56$, main effects. Follow-up Bonferroni corrected $t$ tests indicated significantly higher affect during ML (2.51 ± 0.23) and MNL (2.47 ± 0.23) conditions relative to MC (1.94 ± 0.27) condition. No differences were found between the two music conditions, $p > .05$. Collapsed across condition, the time main effect indicated that affect was higher during 8-, 10-, 12-, 14-, and 16-min time points relative to the 0- and 6-min time points, which was primarily due to the reduction in affect found during the MC condition. No significant Condition x Time interaction was found, $F(12,18) = 1.71, p = .15, \eta^2_p = .53$.

Arousal (FAS)

Condition, $F(2,28) = 5.49, p = .01, \eta^2_p = .28$, and time, $F(6,24) = 8.79, p < .01$, main effects were found for the FAS. Follow-up tests indicated that the highest arousal responses were recorded in the ML (3.32 ± 0.19) and MNL (3.23 ± 0.18) conditions relative to the MC (2.84 ± 0.23) condition, with no significant difference between the two music conditions. For the Time main effect, the lowest arousal score occurred at min 0, increased from min 6 to 14, and
decreased dropped back to near-baseline values at min 16. A significant Condition x Time interaction, $F(12,18) = 4.72$, $p = .002$, $\eta^2_p = .76$, superseded these main effects. Decomposition of the interaction revealed that arousal was significantly higher in ML and MNL conditions at 10-, 12-, and 14-minutes relative to the MC condition. Additional comparisons indicated that arousal was significantly higher in the ML condition at 8-minutes relative to MC condition and significantly higher in the MNL condition at 16-minutes relative to the MC condition.

Discussion

The primary aim of this study was to examine the effects of lyrics in music on motivation during moderate-intensity cycling. A secondary purpose was to examine the effects of music on affect, arousal, and perceived exertion. We hypothesized that participants would report higher levels of motivation, improved affect, increased arousal, and no change in perceived exertion during both music conditions relative to a no music control condition and that these effects would be largest in the music with lyrics condition. In line with previous research (Elliott et al., 2004; Hutchinson et al., 2011; Karageorghis et al., 2013), a positive effect of music was observed during both music conditions such that participants reported higher levels of motivation, affect, and arousal during exercise relative to the no music control condition. These results support a growing body of literature suggesting that music can be used during exercise to facilitate positive psychological and affective states (Karageorghis & Priest, 2012a, 2012b). While the data generally supports the beneficial effects of music during exercise, no significant difference in the psychological and physiological variables was observed between the music with lyrics and music without lyrics conditions. Thus, our hypothesis that music with lyrics would produce a larger effect on the outcome variables compared to the other conditions was not supported.
Relative to the potential mechanisms, three proposed hypotheses include the dissociative properties of music, improved affective responses through the promotion of pleasure, and synchronization of the body and bodily sensations (e.g., respiration, heart rate) to the music (Karageorghis & Priest, 2012a). The dissociative concept suggests that music may serve to distract attention from the unpleasant sensations often experienced during exercise (Rejeski, 1985). The term unpleasant doesn’t necessarily refer to pain, but may also be related to other negative components of exercise including boredom and monotony. Related to our findings, participants reported increased positive feelings of affect and higher levels of motivation during both music conditions, suggesting that music may have reduced negative feelings by serving as a distraction from exercise. Contrary to previous investigations (Karageorghis & Priest, 2012a; Potteiger et al., 2000), there were no reported differences in perceived exertion between conditions. However, findings are consistent with previous studies assessing RPE across exercise conditions at a similar intensity. Tenenbaum et al. (2004) found similar RPE responses during music and no-music conditions while participants performed treadmill running despite reporting higher levels of motivation to continue the exercise bout. Similarly, Yamashita, Iwai, Akimoto, Sugawara, and Kono (2006) found no significant differences in RPE during music and no-music conditions while performing an acute bout of cycling at 60% VO_{2peak}. Together, these results suggest that even if listening to music during exercise has no effect on RPE, it may still improve motivation and affective responses.

Similar to previous investigations (Boutcher & Trenske, 1990; Terry et al., 2012), we found improvements in affect for both music conditions compared to the no music control condition. This may be explained by several key factors that have been suggested in the music and exercise performance literature. For instance, the current study utilized synchronous activity
at a cadence of 65 rpm, which was half the song tempo (i.e., 130 bpm). Despite increases in resistance to achieve moderate-intensity exercise, this entrainment (i.e., synchronization) to music rhythm may have led to more efficient movement patterns (Bacon, Myers, & Karageorghis, 2012; Terry et al., 2012), potentially optimizing arousal and leading to enhanced affective responses. In a similar study, Elliott and colleagues (2004) had participants perform 12-min of cycling at a constant rate (RPE of 13) while listening to motivational music. Participants in the music condition displayed increased pedaling distance compared to the no-music control condition at the same RPE. Further supporting this idea, researchers have previously found improved motivation during exercise, with no change in perceived exertion, while listening to music (Hutchinson et al., 2011; Karageorghis et al., 2008). Taken together, these results suggest that participants may work harder without a perceived increase in exertion. Importantly, this suggests that even if listening to music results in no changes in RPE compared to no music, it still may improve in-task or post-exercise affective or emotional responses.

Limitations

While the findings indicate that music generally improves motivation, affect, and arousal, there are potential limitations worth mentioning. First, the exercise intensity was standardized but the resistance of the cycle ergometer was not. Resistance was manually adjusted throughout the session to maintain an individualized heart rate range. Thus, it is possible that the adjustment served as a distraction from the music. Moreover, the number of resistance adjustments likely varied between participants and session, with some participants or conditions requiring more adjustments than others. These resistance inconsistencies should be noted as a potential limitation for future replication. For this reason, it is suggested that a graded exercise test be administered before the music trials to determine relative workload for each participant,
assuming a similar experimental design is adopted. It may also be beneficial to use a cycle ergometer with a digital readout to ensure resistance values can be recorded and analyzed. Additionally, participants could have pedaled at a similar rate but with higher resistance during each exercise session, despite using RPE and HR to verify maintenance of exercise intensity. This may be an especially important point considering work output likely varied between participants due to several individual differences, including training status. This potential variation in resistance may have also led to increased muscular fatigue in lower fit participants. However, standardizing intensity in this way should have allowed us to better isolate the psychological variables in question without dealing with physiological artifact (e.g., elevated HR responses). Nevertheless, research comparing standardized versus unstandardized intensity and music influence in trained versus untrained individuals is warranted considering that untrained individuals may benefit more from music than trained individuals (Karageorghis & Priest, 2012a).

Second, participants were directed to cycle at a cadence that matched the tempo of a pre-selected song. The use of a standardized cadence did not allow us to examine the effects of music with lyrics on cycling performance or work output since all participants should have pedaled a similar distance. Additionally, the standardized cadence reduces the generalizability of the findings outside of a research setting. That is, some participants may prefer to listen to music with a faster tempo and pedal at a faster cadence with lower resistance, or vice versa, which may influence their psychological, physiological, and affective responses during exercise. Along these lines, past research suggests that it may be more beneficial to include self-selected music versus prescribed music to increase positive responses (Razon, Basevitch, Land, Thompson, & Tenenbaum, 2009; Terry et al., 2012). However, such music has generally not been selected with
explicit reference to its lyrical content nor has it been selected while performing a similar exercise bout, whereas in the current study, the track was determined in Part 1 according to its motivational properties by participants of a similar socio-cultural background and age profile to participants who completed Part 2 (Karageorghis & Terry, 1997) and during a similar bout of exercise.

Finally, neither the meaning of the lyrics or how the participants interpreted them was considered in this study. Past research that has examined music, emotion, and lyrics has shown that the interpretation of the lyrics influences the overall emotional experience of music (Juslin, 2009). The interpretation of the lyrics may provide further insight into the potential mechanisms behind the relationship between lyrics and psychological states during exercise. Furthermore, participants reported high familiarity with the selected song. Due to its popularity and reported level of familiarity, it is possible that participants were singing the lyrics in their head during the music without lyrics condition, potentially negating the effects of removing the lyrics from the song. This could partially explain why we observed no clear differences between the two music conditions. For future studies, we suggest that researchers select less familiar songs with high motivational qualities or have participants select songs from a list that they view as having high motivational content.

Conclusion

In sum, our findings suggest that music, with or without lyrics, can play an important role during exercise. Specifically, results showed that both music conditions produced an increase in motivation, affect, and arousal during acute moderate-intensity aerobic exercise, with no difference in ratings of perceived exertion between groups. However, there were no differences between the music with and without lyrics conditions, suggesting that within the context of the
selected exercise intensity, mode, population, and song, lyrics *per se* do not improve motivation, affect, and arousal levels greater than music without lyrics during an acute bout of aerobic exercise. Considering lack of motivation, negative feelings, and exercise difficulty are considered barriers to physical activity (Bethancourt, Rosenberg, Beatty, & Arterburn, 2014; Mazzola, Moore, & Alexander, 2016), understanding these benefits may be especially useful to an increasingly sedentary population. More importantly, reducing these barriers may influence future intentions to exercise and in the long-term, improve exercise adherence (Ekkekakis et al., 2011). The results of our study add to the limited literature focused on the effects of lyrics in music on psychological and physiological responses during exercise. Future studies should focus on study design issues (e.g., music selection, exercise duration) and take into consideration the limitations of the current study in order to better understand the role lyrics play in facilitating positive psychological states during exercise.
Table 1

**BMRI-2 Scores (M ± SD) for Music Section**

<table>
<thead>
<tr>
<th>Track No.</th>
<th>Song Title</th>
<th>Artist</th>
<th>BMRI-2 ± SD</th>
<th>BPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wake Me Up</td>
<td>Avicii</td>
<td>4.27 ± 1.44</td>
<td>125</td>
</tr>
<tr>
<td>2</td>
<td>Boom Boom Pow</td>
<td>Black Eyed Peas</td>
<td>5.44 ± 1.47</td>
<td>130</td>
</tr>
<tr>
<td>3</td>
<td>Work Hard Play Hard</td>
<td>Tiesto</td>
<td>3.51 ± 1.32</td>
<td>128</td>
</tr>
<tr>
<td>4</td>
<td>Instant Replay</td>
<td>Dan Hartman</td>
<td>4.51 ± 1.72</td>
<td>129</td>
</tr>
<tr>
<td>5</td>
<td>Reflections</td>
<td>Jacob Plant feat. Example</td>
<td>4.34 ± 1.84</td>
<td>126</td>
</tr>
</tbody>
</table>

*Note. BMRI-2 = Brunel Music Rating Inventory-2; BPM = beats per minute.*

Table 2

**Participant Characteristics (M ± SD) Overall and by Gender**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>11</td>
<td>19</td>
<td>30</td>
</tr>
<tr>
<td>Age (years)</td>
<td>21.7 ± 2.3</td>
<td>20.6 ± 3.3</td>
<td>21.03 ± 2.9</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>24.7 ± 4.2</td>
<td>22.7 ± 3.9</td>
<td>23.4 ± 4.1</td>
</tr>
<tr>
<td>Height (cm)*</td>
<td>180.6 ± 9.4</td>
<td>164.6 ± 7.6</td>
<td>170.4 ± 11.3</td>
</tr>
<tr>
<td>Weight (kg)*</td>
<td>80.5 ± 14.4</td>
<td>61.5 ± 12.3</td>
<td>68.4 ± 15.9</td>
</tr>
<tr>
<td>Song Familiarity (1-5 scale)*</td>
<td>4.4 ± 0.8</td>
<td>4.95 ± 0.2</td>
<td>4.7 ± 0.6</td>
</tr>
<tr>
<td>Song Enjoyment (1-5 scale)</td>
<td>3.3 ± 1.1</td>
<td>4.0 ± 1.0</td>
<td>3.7 ± 1.1</td>
</tr>
</tbody>
</table>

*Note. kg = kilogram; m = meter; cm = centimeter.* Significant difference, unpaired Student’s t test between male and female participants, $p < .05$.

**Figure 1.** Experimental study design.
Figure 2. Average heart rate (BPM) and perceived exertion (RPE) across a 16-minute cycling trial performed during music with lyrics, music without lyrics, and no music control conditions.

Figure 3. Average motivation (MS), affect (FS), and arousal (FAS) responses across a 16-minute cycling trial performed during music with lyrics, music without lyrics, and no music control conditions.
APPENDIX A

INFORMED CONSENT
University of North Texas Institutional Review Board

Informed Consent Form

Before agreeing to participate in this research study, it is important that you read and understand the following explanation of the purpose, benefits and risks of the study and how it will be conducted. Please read this document carefully, initial the bottom of each page, and sign the final page if you understand it and agree to participate.

If at any time you have questions regarding any of the information on this form, please ask a member for the research team. When all of your questions have been answered, you will be asked to sign this consent form if you agree to be in the study. Upon request, a copy of the form will be given to you to keep for your records.

*Participation is this study is voluntary and you may withdraw at any time without penalty.*

**Title of Study:** The Effect of Music on Motivation and Affect during Moderate Intensity Cycling.

**Investigator:** Ryan L. Olson, PhD; University of North Texas (UNT) Department of Kinesiology, Health Promotion, and Recreation

**Purpose of the Study:** To investigate the potential effects of music on motivation and affect during moderate-intensity exercise on a cycle ergometer.

**Study Procedures:** The total anticipated time commitment for this study is approximately 2 hours. The study will take place over 3 testing sessions occurring at the same approximate time of day, separated by at least 48 hours. During each 40-minute session you will be asked to cycle at moderate-intensity for approximately 16 minutes while music is played.

Screening, Health History, and Triathlon Experience (Day 1): You will be asked to complete a brief medical history form and physical activity readiness questionnaire (PAR-Q) prior to participating in the study to assess any pre-existing medical conditions that may preclude you from study participation and ensure your safety during the exercise sessions. Once approved, we ask that you provide a schedule of your availability that we can use to schedule you for the remaining sessions. Next, you will be asked to complete a general triathlon survey that provides us with information related to your previous event experience and current activity levels.

Pre-Post Questionnaires (Days 1-3): Prior to exercising, you will be asked to fill out a short questionnaire related to your sleep, nutrition, and exercise patterns. You will then be asked to complete a series of questionnaires regarding attention, motivation and arousal levels, mood, affect, and stress and anxiety levels.

In-Task Questionnaires (Day 1-3): During each exercise session we will ask you to provide information relative to your current motivation and arousal levels, affect, and perceived exertion. These questions will be asked every 2 minutes during exercise. When prompted, you will be asked to point to a value on the chart and provide auditory confirmation of your selection.

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APPROVED BY THE UNT IRB
FROM ___/___/2016 TO ___/___/2017

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Exercise Protocol (Days 1-3): Once you have completed your pre-test questionnaires we will escort you to the cycle ergometer where you will perform 16 minutes of continuous exercise at a moderate-intensity. At this time, you will be asked to wear a heart rate monitor so we can assess cardiovascular responses, which we will use to maintain a moderate-intensity throughout the session. After you are seated on the bike you will be given 6 minutes to warm-up. We will use this warm-up period to get your cycling cadence on pace with a metronome while maintaining heart rate within a moderate-intensity range. You will then perform an 8-minute exercise trial followed by a 2-minute cool-down. Resistance may be adjusted throughout the testing session to ensure you remain within a moderate-intensity heart rate range.

Foreseeable Risks: Trained personnel with appropriate supervision will perform all test procedures, and all attempts will be made to minimize any risks associated with your participation in this study.

Screening and Questionnaires: The health history screening and/or questionnaires may be stressful for some people. A small portion of individuals may experience increased emotional discomfort as they discuss or think about past or present problems during these assessments. A trained professional will be available for consultation should discomfort become too difficult (see resources below).

UNT Student Health and Wellness Center: 940-565-2333
UNT Counseling Center: 940-565-2741
Denton County MHMR Crisis Line: 1-800-762-0157 (open 24 hours a day)
National Suicide Prevention Hotline: 1-800-273-8255 (open 24 hours a day)

Exercise Protocol: Risks associated with exercise or fitness testing may include increased heart and breathing rate, elevated blood pressure, muscle fatigue, dizziness, musculoskeletal injuries, and possible muscle soreness lasting 24-48 hours post exercise. Trained investigators will take all precautions necessary to minimize any adverse side effects, including additional training and oversight by the study principal investigator. If at any time during the testing procedure abnormal heart rate or blood pressure is monitored, testing will be terminated immediately. In the event of an emergency, trained personnel will use CPR or AED and 911 will be contacted.

Benefits to the Subjects or Others: This study is not expected to be of any direct benefit to you; however, indirect benefits will include: 1) information regarding your physical and mental health based on questionnaire responses and 2) your data may improve our current understanding of the relationship between music and sport performance.

Compensation for Participants: You will be entered into a raffle for a chance to win a $50 gift card upon successful completion of the study. Your name will not be entered into the raffle if you choose to withdraw before study completion.

Procedures for Maintaining Confidentiality of Research Records: This research is confidential. The research records will include some information about you, which will be stored in such a manner that some linkage between your identity and the response in the research exists. Some of the information collected about you includes psychological and physiological data. Please note that we will keep this information confidential by assigning you an ID code, limiting individual’s access to the research data, and keeping all data in a secure location.

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FROM 1/1/06 TO 11/30/17

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The research team and the Institutional Review Board at UNT (a committee that reviews research studies in order to protect research participants) are the only parties that will be allowed to see your data, except as may be required by law. If a report of this study is published, or the results are presented at a professional conference, only group results will be stated. All study data will be kept for at least five years, at which point any files that link your ID code to your name will be destroyed.

Additionally, we may ask you to provide names or contact information of other potential research subjects. You may decline to provide this information; however, confidentiality will be maintained if you choose to provide research staff with this information.

Injury and Compensation: UNT, the principal investigator, and the research team are not liable for any injury you might sustain while participating in this study. UNT, the principal investigator, and the research team are not able to offer financial compensation or absorb the costs of medical treatment should you become injured as a result of participating in this study.

Questions about the Study: If you have any questions about the study, you may contact Dr. Ryan L. Olson at Ryan.Olson@unt.edu or (840) 565-3417.

Review for the Protection of Participants: This research study has been reviewed and approved by the UNT Institutional Review Board (IRB). The UNT IRB can be contacted at (940) 565-4843 with any questions regarding the rights of research subjects.

Research Participants' Rights: Your signature below indicates that you have read or have had read to you all of the above and that you confirm all of the following:

- Ryan L. Olson, PhD or another trained member of the research team has explained the study to you and answered all of your questions.
- You have been informed of the possible benefits and the potential risks and/or discomforts of the study.
- You understand that participation is voluntary, and your refusal to participate or your decision to withdraw will involve no penalty or loss of rights or benefits.
- The study personnel may choose to stop your participation at any time.
- You understand why the study is being conducted and how it will be performed.
- You understand your rights as a research participant and you voluntarily consent to participate in this study.
- You have been told you will receive a copy of this form.

Printed Name of Participant __________________________ Signature of Participant __________________________ Date ____________

For the Investigator or Designee: I certify that I have reviewed the contents of this form with the subject signing above. I have explained the possible benefits and the potential risks and/or discomforts of the study. It is my opinion that the participant understood the explanation.

Signature of Investigator or Designee __________________________ Date ____________

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APPENDIX B

RECRUITMENT EMAIL AND FLYER
Hello,
My name is Dan Marshall and I am a graduate student working under Dr. Ryan Olson in the Department of Kinesiology, Health Promotion, and Recreation at UNT. Thank you for your interest in our research study examining motivation and performance during exercise! We are currently in a recruitment period for fall 2016 and spring 2017. As long as you are between the ages of 18-35 you are eligible to participate. Please find details regarding study participation below.

**Time commitment:**
The total anticipated time commitment for this study is approximately 2 hours. The study will take place over 3 testing sessions occurring at the same approximate time of day, separated by at least 48 hours. During each 40-minute session you will be asked to cycle at moderate-intensity for approximately 16 minutes while music is played.

**Benefits:**
- Receive important information regarding your physical and mental health
- Access to free exercise prescription and nutritional guidance
- You will be entered into a raffle for a chance to win a $50 cash gift card

We are looking to schedule participants as soon as possible. If you could please provide me with days and times that would work best for you, we will do our best to try and schedule you for your first visit.

**Note:** We will not schedule your appointment until we confirm the posted time and date that works best for you. Thanks again for your interest and please feel free to e-mail me with any questions or concerns you may have.

Best regards,

Dan

Daniel Marshall
Kinesiology M.S. Student
UNT Psychophysiology Lab
The Exercise Psychophysiology Lab at the University of North Texas is conducting a research study to investigate motivation during exercise.

Wanted: Experienced male and female cyclists or triathletes between the ages of 18-35 years old.

Description: Subjects will fill out questionnaires before, during, and after cycling at moderate-intensity.

Time commitment: Requires 120 minutes of time over 3 sessions lasting 40 minutes each. You will be asked to cycle for 16 minutes during each testing session.

Location: All testing sessions will take place in the Physical Education Building (PEB), room 125-A

$50 Gift Card Raffle Entry!

For more information about becoming a subject, please contact:
John Doe
Phone: (555) 867-5309
John.Doe@unt.edu

This project has been reviewed and approved by the UNT Committee for the Protection of Human Subjects
REFERENCES


