STAYING ‘ON BEAT’ WITH INTERVAL TRAINING
STAYING ‘ON BEAT’ WITH INTERVAL TRAINING: THE EFFECTS OF MUSIC ON EXERCISE ENJOYMENT AND PERFORMANCE DURING SPRINT INTERVAL TRAINING

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H.B.Sc.Kin.

A Thesis Submitted to the School of Graduate Studies in Partial Fulfillment of the Requirements for the Degree Master of Science

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TITLE:   Staying ‘on beat’ with interval training: The effects of music on exercise enjoyment and performance during sprint interval training.

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ABSTRACT

The purpose of this study was to: (a) determine if listening to music can reduce the potential aversiveness of an acute session of sprint interval training (SIT) by improving affect, motivation and enjoyment, and examine the effects of music on performance; and (b) evaluate participants’ attitudes and intentions towards SIT and determine if they would change after experiencing SIT. Twenty moderately active adults (22±4y), unfamiliar with interval exercise, completed an acute session of SIT under two different conditions: music and no music. The exercise consisted of four, 30-second Wingate Anaerobic Test (WAnT) bouts on a cycle ergometer, separated by 4 minutes of rest. Power output, ratings of perceived exertion (RPE), affect, motivation, and enjoyment of the exercise were measured. Attitudes and intentions towards SIT were evaluated at baseline and follow-up. Mixed-effects models were used to evaluate changes in the dependent measures over time and between the two conditions. Paired sample t-tests were conducted to compare differences between attitudes and intentions from baseline to follow-up.

Peak and mean power over the course of the exercise session were higher in the music than no music condition (coefficients=49.72 [SE=13.55], 23.65 [SE=11.30], ps<0.05). A significant time X condition effect emerged for peak power (coefficients=-12.31 [SE=4.95], p<0.05). There were no between-condition differences for RPE, affect or motivation. Perceived enjoyment increased over time, and was consistently higher in the music condition (coefficient=7.00 [SE=3.05], p<0.05). Finally, attitudes and intentions towards SIT were positive at baseline and did not change upon study completion.

Overall, the results suggest music enhanced in-task performance and enjoyment of an acute bout of SIT. Listening to music during intense interval exercise may be an effective strategy to facilitate participation in, and adherence to, this form of training. Furthermore, experiencing an intense SIT protocol does not alter pre-existing positive attitudes and intentions towards SIT.
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<td>ANOVA</td>
<td>analysis of variance</td>
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<tr>
<td>FS</td>
<td>Feeling Scale</td>
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<td>IPAQ</td>
<td>International Physical Activity Questionnaire</td>
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DECLARATION OF ACADEMIC ACHIEVEMENT

This thesis is based on the following original manuscript:


M. J. Stork’s role:
• Author of ethics application at McMaster University
• Created study design and measure selection
• Responsible for participant recruitment
• Lead investigator responsible for preparation of lab settings, materials, and scripts
• Responsible for data collection, input, analysis and interpretation
• Supervised volunteers who assisted with data collection
• Primary author of manuscript

Role of co-authors:
• KMG and MJG assisted MJS with study design and measurement selection
• KMG obtained study funding
• MJG provided lab space and equipment necessary for data collection
• KMG assisted MJS with obtaining ethics approval at McMaster University
• MK ran mixed-effects models analyses with assistance from MJS
• KMG, MK and MJG assisted MJS with interpretation of the data
• KMG, MK and MJG revised the article and approved of the final version of the manuscript before submission to Medicine & Science in Sports & Exercise
INTRODUCTION

The pervasiveness of sedentary lifestyles and physical inactivity has become a widespread public health concern (Blair, 2009; Linke, Gallo, & Norman, 2011). In fact, physical inactivity has been depicted as being “the biggest public health problem of the 21st century” (Blair, 2009, p. 1). It is anticipated that the joint effects of inactivity and poor nutrition may soon overshadow smoking as the primary cause of preventable death (Mokdad, Marks, Stroup, & Gerberding, 2004). Consequently, it has become a challenge for the public health sector to find effective ways to increase physical activity (PA) and to decrease sedentary behaviour (Biddle, O’Connell, & Braithwaite, 2011). A perceived “lack of time” has consistently been cited as one of the most common reasons why people do not participate in PA on a regular basis (e.g., Stutts, 2002; Trost, Owen, Bauman, Sallis, & Brown, 2002). However, recent evidence suggests that interval exercise training is a potential strategy to combat this barrier to PA (Gibala, Little, Macdonald, & Hawley, 2012; Gibala & McGee, 2008; Linke et al., 2011; Weston, Wisløff, & Coombes, 2013).

Interval training refers to exercise that typically involves brief, repeated bursts of relatively intense exercise that are separated by periods of rest. Interval training has consistently been shown to induce similar health and performance benefits to continuous endurance exercise, but in reduced time (Gibala et al., 2012; Gibala & McGee, 2008; Weston et al., 2013). A recent systematic review and meta-analysis (Weston et al., 2013) suggested that interval training may even
be superior to moderate-intensity continuous training in improving cardiorespiratory fitness. For those who cite lack of time as a barrier, interval training makes PA participation more feasible because it is time-efficient (Gibala et al., 2012; Gibala & McGee, 2008; Weston et al., 2013) and can be incorporated into one’s daily schedule (Linke et al., 2011).

One of the most time-efficient forms of interval training is referred to as sprint interval training (SIT; Weston et al., 2013). A typical SIT protocol consists of four to six, 30-second “all-out” bouts, separated by 4 minutes of recovery (Gibala et al., 2012; Gibala & McGee, 2008). Each of these 30-second bouts is completed according to the Wingate Anaerobic Test (WAnT) protocol of Bar-Or (Bar-Or, 1987). Although the time-efficiency of SIT suggests it may be a promising option for improving PA levels, the strenuous nature of SIT may be a deterrent, as people tend to avoid exercise behaviours they find aversive (Gauvin & Brawley, 1993; Parfitt & Hughes, 2009; Tritter, Fitzgeorge, Cramp, Valiulis, & Prapavessis, 2013).

Increasing research has focused on the role of affective variables (e.g., mood states, perceived enjoyment) as key motivators for PA participation (Bartlett et al., 2011; Ekkekakis, Parfitt, & Petruzzello, 2011; Jung, Bourne, & Little, 2014; Parfitt & Hughes, 2009; Tritter et al., 2013). In particular, it has been suggested that feelings during exercise, or affective responses to exercise, may predict future exercise intentions, behaviour, and adherence (Kwan & Bryan, 2010b; Williams et al., 2008; Williams, Dunsiger, Jennings, & Marcus, 2012).
Indeed, the American College of Sports Medicine guidelines (American College of Sports Medicine, 2013) state that exercise-induced feelings of fatigue and negative affect “can act as a deterrent to continued participation” (p. 374). Further, it is believed that exercising at intensities beyond the ventilatory threshold (VT) leads to increased physiological stress and more negative affect (Ekkekakis et al., 2011). Given that SIT protocols are performed above the VT, exercisers may have more negative affective responses to SIT, which may compromise future adherence. Thus, interventions aimed at improving the affective responses to SIT are required.

A large body of research has shown that listening to music during exercise can not only enhance affect, improve enjoyment, regulate arousal, reduce perceived exertion and improve motivation, but can also enhance exercise performance (e.g., Eliakim, Meckel, Nemet, & Eliakim, 2007; Hutchinson et al., 2011; Miller, Swank, Manire, Robertson, & Wheeler, 2010; Yamamoto et al., 2003). In addition, it has been suggested that the positive impact of music on affective states can actually lead to increased adherence to exercise (Karageorghis & Priest, 2012b; Miller et al., 2010). Given that music is readily available and easy to incorporate into exercise, there may be psychological and performance benefits of incorporating music during SIT exercise. However, most research regarding music and exercise has investigated continuous aerobic exercise performed at submaximal intensities, and there has been limited and conflicting research on the influence of music during high-intensity, nearmaximal (80-100%
peak heart rate [PHR]) or supramaximal (≥100% PHR) exercise protocols (Chtourou, Jarraya, Aloui, Hammouda, & Souissi, 2012; Hutchinson et al., 2011; Karageorghis & Priest, 2012a). Although there is evidence to suggest that appropriately selected music can elicit psychological and physiological benefits during high-intensity exercise, some of these benefits may be less evident at supramaximal intensities (Hutchinson et al., 2011; Karageorghis & Priest, 2012a). For example, music does not seem to reduce ratings of perceived exertion (RPE) during exercise intensities above the VT (e.g., Chtourou et al., 2012; Hutchinson et al., 2011), but it can reduce RPE during exercise performed below the VT (e.g., Miller et al., 2010).

Some studies have shown improvements to affect, motivation, or performance by listening to music before or during a single 30-second WAnT (Chtourou et al., 2012; Eliakim et al., 2007; Hutchinson et al., 2011). However, it has been suggested that the effects of music may diminish during prolonged exercise at this intensity (Hutchinson et al., 2011), because heightened physiological states begin to dominate the processing capacity of the nervous system (Rejeski, 1985; Tenenbaum, 2001). In order to determine if this is true, the effects of music during a prolonged supramaximal exercise protocol must be evaluated.

To our knowledge, the psychological effects of music, and the ergogenic effects of music have not been evaluated using an intermittent high-intensity exercise protocol. Thus, the primary purpose of this study was to determine if
listening to self-selected music can reduce the potential aversiveness of an acute session of SIT by improving affect, motivation and enjoyment, and to examine the effects of music on performance.

**Secondary Purpose**

There is evidence that affective responses to acute exercise have the potential to influence one’s exercise attitudes and intentions towards future exercise participation (Kwan & Bryan, 2010a; Martin Ginis et al., 2006). For example, a study by Martin Ginis et al. (2006) showed that greater enjoyment from an acute bout of exercise mediated subsequent improvements in attitudes towards exercise (from pre- to post-exercise) among older adults. Another study found that young, healthy adults who reported greater improvements in positive affect during a 30-min bout of exercise reported more positive attitudes towards exercise, exercise self-efficacy, and intentions to exercise at follow-up (Kwan & Bryan, 2010a). Taking these findings into account, it appears that enjoyment and other affective experiences during acute exercise may have a positive influence on exercise-related social cognitions (i.e., attitudes and intentions).

Although there has been a growing body of literature to focus on the physiological benefits of interval training, little is known about people’s attitudes and intentions towards SIT and whether these cognitions change following experience with SIT. A study by Jung et al. (2014) found that participants had greater intentions to engage in high-intensity interval training or continuous moderate-intensity exercise in comparison to continuous vigorous-intensity
exercise. However, the researchers did not measure baseline exercise intentions, and were therefore unable to evaluate any possible changes to intentions that may have occurred after experiencing the exercise protocols. In addition, the interval exercise utilized in the study by Jung et al. (2014) was less intense and longer in duration than the SIT protocol utilized in the present study. There is value in assessing whether or not individuals’ attitudes and intentions towards SIT can be altered after exposure to such a protocol, as any changes could have implications for subsequent participation and adherence to SIT protocols. Thus, the secondary purpose of this study was to evaluate participants’ baseline attitudes and intentions towards SIT and to examine if these exercise cognitions change after experiencing SIT protocols.

**HYPOTHESES**

**Exercise Performance**

**Hypothesis 1a.** Based on previous research to show the ergogenic effects of music on a single WAnT performance (Chtourou et al., 2012; Eliakim et al., 2007; Hutchinson et al., 2011), it was hypothesized that a SIT protocol performed with music would yield greater peak and mean power output when compared to a SIT protocol performed without music.

**Hypothesis 1b.** Hutchinson et al. (2011) suggested that the ergogenic effects of music on WAnT performance may diminish as the task progresses and this is consistent with the concept that the physiological effects of exercise (e.g., acidosis) tend to predominate the psychological benefits of music as fatigue sets
in (Rejeski, 1985; Tenenbaum, 2001). Based on this research, significant time X condition effects were anticipated, such that peak and mean power output would be higher in the music condition after the first WAnT bout during the protocol, but these differences would diminish over subsequent WAnT bouts.

**Perceived Exertion**

**Hypotheses 2.** Based on previous studies reporting no significant differences in RPE between music and no music conditions during performance of a WAnT bout (e.g., Chtourou et al., 2012; Hutchinson et al., 2011), it was hypothesized that RPE would be the same for both conditions, at all time points of the SIT protocol.

**Affect & Motivation**

**Hypothesis 3a.** In the study by Hutchinson et al. (2011), participants reported enhanced affect and task motivation while listening to music during a single WAnT, in comparison to participants in a no music condition. Drawing on these findings, it was predicted that a SIT protocol performed with music would lead to more positive affect and greater task motivation when compared to the same protocol performed without music.

**Hypothesis 3b.** Based on the same rationale described in Hypothesis 1b (cf., Hutchinson et al., 2011; Rejeski, 1985; Tenenbaum, 2001), significant time X condition effects were anticipated, such that affect and task motivation would be greater in the music than no music condition after the first WAnT bout during the
protocol, but these differences would diminish over subsequent WAnT bouts as physiological fatigue sets in.

**Perceived Enjoyment**

**Hypothesis 4.** Based on a previous study that found greater exercise enjoyment while listening to music during exercise in comparison to exercise performed in a control condition (Miller et al., 2010), it was hypothesized that enjoyment would be significantly greater in the music condition than no music condition.

**Attitudes & Intentions**

**Hypothesis 5.** Given the limited research evaluating change in individuals’ attitudes and intentions towards SIT, it was not possible to formulate a directional hypothesis. As such, we tested the null hypothesis that there would be no change in attitudes or intentions from baseline to follow-up.

**METHODS**

**Participants**

Twenty participants (10 men, 10 women) with a mean age of 22.5 years ($\bar{SD} = 4.3$, range = 18-30 y) were recruited from McMaster University and the surrounding community. Power calculations a priori indicated that a sample size of 20 would be required to have 80% power ($\alpha = 0.05$) to detect an effect size of 1.80 on the primary outcome measure of affect. This is consistent with the effect size for affect reported in a previous study (Hutchinson et al., 2011), where differences in affect, task motivation and performance of a single WAnT with
music versus no music were evaluated. All participants were healthy and moderately active, as assessed by the International Physical Activity Questionnaire, Short Form (IPAQ; International Physical Activity Questionnaire, 2002; median score of 2346 MET-minutes/week). Participants were excluded from the study if they had previously participated in SIT exercise, were elite athletes, participated in a specific training program within the past four months, or had contraindications to exercise based on the Physical Activity Readiness Questionnaire (PAR-Q; Physical Activity Readiness Questionnaire, 2002). The McMaster Research Ethics Board approved the study protocol. Participants were recruited through advertisements posted on campus and via email. All participants provided written informed consent.

**Study Design**

This study used a crossover design, whereby each participant completed an acute session of SIT under two different conditions: music and no music. The order of the conditions was randomized and counterbalanced to control for temporal order and carry-over effects. Participant randomization was stratified by gender.

**Measures**

**Peak & Mean Power Output.** Power output during cycling was measured using Velotron Wingate Software (Version 1.0.1, RacerMate) and was recorded in watts (W) for each WAnT bout performed.
Perceived Exertion. Borg’s CR-10 (1998) Ratings of Perceived Exertion (RPE) scale was used, which has a scale increasing from “Nothing at all” (0) to “Absolute Maximum” (10).

Affect. Hardy and Rejeski’s (1989) Feeling Scale (FS) was used to measure affective states during and following the WAnT bouts. This is an 11-point bipolar, single-item scale that ranges from “Very Good” (+5) to “Very Bad” (-5) along a pleasure-displeasure continuum. The FS has been established as a reliable and valid measure of exercise-related affective states (Hardy & Rejeski, 1989).

Task Motivation. A single-item 10-point Likert scale ranging from “Not at all motivated” (0) to “Extremely motivated” (10) was used to measure task motivation (TM; Hutchinson et al., 2011). This was the same scale used to measure task motivation following a WAnT exercise protocol in a previous study (Hutchinson et al., 2011).

Perceived Enjoyment. Perceived enjoyment of the SIT protocols was measured using an adapted version of the Physical Activity Enjoyment Scale (PACES; Bartlett et al., 2011; Kendzierski & DeCarlo, 1991). This scale has 11 negatively worded and 7 positively worded items that participants rated on a 7-point bipolar scale (ranging from 1 to 7), indicting how they felt about the exercise they had just completed. For clarity, the wording of each item was changed to the past tense (e.g., “I enjoy it” changed to “I enjoyed it”). Negative items were reverse scored and all 18 items were summed to produce a total
PACES score. The internal consistency was acceptable at each administration (Cronbach’s α’s > 0.90).

**Music.** The 6-item Brunel Music Rating Inventory-2 (BMRI-2) was used to measure the motivational components of the music tracks played during exercise (Karageorghis, Priest, Terry, Chatzisarantis, & Lane, 2006). The BMRI-2 is a tool that has been used to select and standardize music played during experimental exercise protocols (Karageorghis et al., 2006). All songs from each playlist were replayed for approximately 1 minute and participants were asked to indicate the extent to which they agreed with the 6 items for each song being played. Participants rated each item on a 7-point Likert scale ranging from “Strongly Disagree” (1) to “Strongly Agree” (7).

**Exercise Attitudes.** Participants were asked to complete a total of 7 items that were designed to measure their attitudes towards SIT (Ajzen, 1991). Refer to Appendix A, Table A for a complete list of items. Each survey item used a 7-point Likert scale (ranging from 1 to 7) and these questions were developed based on Ajzen’s recommendations for constructing a Theory of Planned Behaviour questionnaire (Ajzen, 2010). Item scores were averaged to give an overall construct score. The internal consistency was acceptable at each administration (Cronbach’s α’s ≥ 0.73).

**Exercise Intentions.** Participants were asked to complete 2 items that were designed to measure their intentions to participate in SIT in the future (Ajzen, 1991). Refer to Appendix A, Table A for a complete list of items. Both survey
items used a 7-point Likert scale (ranging from 1 to 7) and these questions were developed based on Ajzen’s recommendations for developing a Theory of Planned Behaviour questionnaire (Ajzen, 2010). Item scores were averaged to give an overall construct score. The internal consistency was acceptable at each administration (Pearson r’s ≥ 0.84).

**Procedural Overview**

Each participant made a total of five visits to the lab over the course of approximately four weeks. During the first two visits, participants were familiarized with the testing protocols and materials. All exercise sessions were performed on the same stationary cycle ergometer (Velotron Dynafit Pro, RacerMate). This cycle ergometer was set up directly facing a wall and enclosed by two temporary walls in order to reduce the potential for external distractions. On the third and fourth visits, participants completed two experimental trials (one trial for each condition). The fifth visit was used as a short follow-up assessment. To eliminate the effects of exercise fatigue and to minimize any differences between participants or the experimental trials, lab visits were spaced approximately 7 days apart and participants were instructed to maintain consistent dietary and sleep habits and to avoid any physical activity for the entire day preceding the experimental trials.

**Protocol**

**Familiarization #1 (Visit 1).** During the first visit, participants completed the written consent form, the PAR-Q, and the IPAQ. Following this, participants
completed the measures of attitudes and intentions towards SIT and completed a
music survey that would be used to create their music playlist. Participants were
instructed to select a list of 6 songs (ranked in order by preference) that they
would enjoy listening to while exercising, and were shown the RPE, FS and TM
scales. Next, each participant’s height and weight were measured using a
standardized scale (500KL Eye Level Digital Scale, Health o meter). These
measurements were used to calibrate the resistance applied by the cycle ergometer
during the exercise protocol. Participants were instructed on how to set up the seat
and bar handles on the ergometer. These settings were recorded and used for all
subsequent visits to the lab. Participants were then asked to complete a single 30-
second, “all-out” WAnT according to the protocols of Bar-Or (1987).

Participants began with a 2-minute warm-up, pedaling lightly at a set
resistance of 50 watts (W). At exactly 1 minute and 30 seconds into the warm-up,
participants verbally reported a number to represent how they felt at that moment
in time according to the RPE, FS and TM scales. After the warm-up, participants
were given a 30-second heads up for the start of their “all-out” WAnT bout and
were instructed to start increasing their pedaling rate. Participants were given a
verbal 10-second countdown until their “all-out” bout began. During the 10
seconds leading up to the sprint, the ergometer resistance was dropped to 0 W and
pedaling was unloaded for those 10 seconds. As soon at the countdown finished,
participants were verbally prompted to begin the “all-out” bout when they heard
the word “Go!” Participants were asked to perform the 30-second “all-out” bout
as fast as they possibly could against a set resistance of 7.5% of their body weight. During the bout, the experimenter provided the same verbal script to every participant. Immediately following the “all-out” bout, participants were asked to verbally indicate a number to represent how they felt during the exercise according to the RPE, FS and TM scale. This protocol was followed for each “all-out” WAnT bout performed in all subsequent exercise sessions. Once participants were finished the exercise bout, they completed the PACES scale.

**Familiarization #2 (Visit 2).** For the second familiarization visit, participants were asked to complete a total of four 30-second “all-out” WAnT bouts, with 4 minutes of rest in between each bout. The experimenter ensured that participants clearly understood the instructions and each of the scales before the exercise trial began.

Immediately following each “all-out” bout, participants were given the option to stay on the bike or to step off the bike during the 4-minute rest period. If they elected to remain on the bike, they were allowed to pedal very lightly, without physically exerting themselves any more than a 0.5 on the RPE scale. If they stepped off the bike, participants were asked to stay within the designated resting area and could walk around, stretch, or sit. At precisely 3 minutes into each rest period, participants were instructed to get back on the bike and to indicate their FS and TM score at that moment in time. Following this, participants were allowed to begin pedaling lightly and were then given a 30-second heads up for the start of the next “all-out” bout of exercise. As done
previously, participants were asked to gradually increase their pedaling rate during this time and were given a 10-second countdown leading up to their next “all-out” bout. FS and TM were also reported 3 minutes following the 4th bout of exercise.

Experimenters only interacted with participants to provide instructions, take measures, and ensure the safety of the participants during the procedure. To control for any motivational influence by the experimenter, all participants were provided with the same scripted set of instructions and feedback throughout each trial. Following the completion of the SIT session, participants completed the PACES scale.

**Experimental Protocols (Visits 3 & 4).** All participants completed one SIT session in the music condition and one SIT session in the no-music condition. The only difference between these two trials was the absence or presence of music being played. Both SIT conditions were performed according to the exact same protocols as lab visit #2, however participants were asked to rest for an additional 60 minutes following the exercise. During this time, participants were allowed to relax or read quietly, but were instructed to refrain from using electronics. Measures of FS and PACES were also taken at 30 and 60 minutes post-exercise.

**Music Condition.** Music was played from speakers at a volume of 80dB. The music was played from speakers (as opposed to headphones or ear buds) in order to allow for interactions between the participants and the experimenters when necessary. Based on the song order and the duration of each song selected
during lab visit #1, an individual music playlist was created for each participant, lasting a total of 16 minutes and 30 seconds. This playlist was designed to last the entire length of the SIT protocol, including the warm-up and rest periods. All songs were downloaded from Apple’s iTunes Store and the playlists were created using Apple’s iTunes program (Apple Inc., 2013).

**Follow-up Visit (Visit 5).** Participants were asked to complete a measure of their enjoyment of SIT overall (i.e., PACES) and to indicate their interest in listening to music during SIT in the future. Participants also rated the music they exercised to during the protocol using the BMRI-2, and completed the measures of attitudes and intentions towards SIT.

**Statistical Analyses**

Data collected at visits #3 and #4 were analyzed using mixed-effects models in order to test hypotheses that power output, affect, task motivation and perceived enjoyment would be higher in the music than no music condition, and to evaluate patterns of change over time. Mixed-effects models were the preferred statistical method for this study as they were used to examine differences between the music and no music conditions for each of the dependent measures, estimating change within individuals over time, and accounting for correlation within and between subjects (repeated measures). Likewise, all analyses included random intercepts at the within-person level and a random slope for time, allowing for simultaneous examination of the effects of group and individual-level variables on individual-level outcomes. Mixed-effects models were used instead of statistics.
that compare means and standard deviations (i.e., analysis of variance [ANOVA]) because the latter do not take into account the unique patterns of change that occur within-subjects over time. Therefore, the estimates produced by using mixed-effects models are more representative of the true patterns emerging over time, and, in this case, are more accurate than other statistical methods for analyzing repeated-measures data (Gueorguieva & Krystal, 2004).

Each dependent variable was included in multivariate analyses with two models being specified. The first model starts by examining changes in the dependent variables over time, and tests for gender and manipulation order differences. The experimental condition (music/no music) and an interaction term for condition by time were subsequently entered into model 2. Model 2 examines the effect of the experimental condition, and the possibility that these patterns differ across time. Where appropriate, gender, affect and task motivation at warm-up, first condition order, perceived exertion, and BMRI-2 scores were included in the models as covariates. SAS version 9.3 was used for these analyses, and significance was set at $p<0.05$.

Paired sample t-tests were conducted in order to compare the differences between attitudes and intentions from baseline to follow-up. SPSS version 20.0 was used for these analyses.
RESULTS

Peak Power Output. Main effects for time (estimate = -18.51 [SE = 4.18], p<0.01), gender (estimate = -159.66 [SE = 47.24], p < 0.01) and condition (estimate = 49.72 [SE = 13.55], p < 0.01) were found for peak power across all four bouts of the SIT sessions (see Table 1). Peak power significantly decreased over the course of the exercise bouts and was greater for men than women. The significant main effects for time and condition were superseded by a significant time X condition interaction (estimate = -12.31 [SE = 4.95], p<0.05; see Table 1), indicating that, as predicted in hypothesis 1, peak power was higher during the early WAnT bouts in the music condition than the no music condition. Additionally, this interaction indicates that differences in peak power between conditions were greatest for bout 1 and became increasingly smaller until bout 4, where differences in peak power between conditions were no longer evident (see Figure 1a).

Mean Power Output. Significant main effects for time (estimate = -25.10 [SE = 3.48], p<0.01), gender (estimate = -138.77 [SE = 31.07], p<0.01), and condition (estimate = -23.65 [SE = 11.30], p<0.05) were found for mean power across all four bouts (see Table 1). Mean power significantly decreased over the course of the exercise bouts and was greater for men than women. As predicted in hypothesis 1a, mean power was consistently higher in the music than no music condition. However, contrary to hypothesis 1b, the time X condition interaction was not significant (estimate = -6.04 [SE = 4.12], p=0.145; see Table
1), suggesting that mean power decreased at a similar rate over time in both conditions. Figure 1b shows the estimates of mean power across all four bouts and for each condition.

Table 1: Mixed-effects models predicting power output

<table>
<thead>
<tr>
<th></th>
<th>Peak Power</th>
<th></th>
<th>Mean Power</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate (SE)</td>
<td>p-value</td>
<td>Estimate (SE)</td>
<td>p-value</td>
</tr>
<tr>
<td>Intercept</td>
<td>549.500 (42.64)</td>
<td>&lt;.0001</td>
<td>502.97 (29.11)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Time</td>
<td>-18.508 (4.18)</td>
<td>&lt;.0001</td>
<td>-25.097 (3.48)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Condition (music)</td>
<td>49.721 (13.55)</td>
<td>0.002</td>
<td>23.645 (11.30)</td>
<td>0.038</td>
</tr>
<tr>
<td>First Condition (no music first)</td>
<td>37.681 (47.24)</td>
<td>0.494</td>
<td>-53.783 (29.34)</td>
<td>0.069</td>
</tr>
<tr>
<td>Gender (female)</td>
<td>-159.660 (47.24)</td>
<td>&lt;.0001</td>
<td>-138.770 (31.07)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>RPE</td>
<td>3.610 (2.69)</td>
<td>0.182</td>
<td>-0.607 (2.23)</td>
<td>0.786</td>
</tr>
<tr>
<td>BMRI-2</td>
<td>37.664 (25.35)</td>
<td>0.140</td>
<td><strong>35.484 (16.33)</strong></td>
<td><strong>0.032</strong></td>
</tr>
<tr>
<td>Time*Condition</td>
<td><strong>-12.314 (4.95)</strong></td>
<td><strong>0.014</strong></td>
<td>-6.040 (4.12)</td>
<td>0.145</td>
</tr>
</tbody>
</table>

*Note:* Values are from Model 2, once all variables had been entered into the model. RPE = ratings of perceived exertion; BMRI-2 = Brunel Music Rating Inventory-2; SE = standard error.
Figure 1: Mixed-effects models for peak (a) and mean (b) power output during the music and no music conditions across the four exercise bouts. Lines represent estimate values based on the equations derived from the models.
Perceived Exertion. As predicted in hypothesis 2, RPE was not significantly different between conditions (p>0.05). RPE was included as a time-varying covariate in the mixed-effects models for peak power, mean power, FS and TM in order to account for changes in RPE over time that may have influenced exercise performance and psychological measures.

Affective Responses. Two separate equations and slopes were derived for the FS measures: one for the change in FS across all four bouts and one for the change in FS across all four rest periods. A significant main effect for time was found for both of these equations (estimates = -0.71, [SE = 0.16], -0.68 [SE = 0.17], ps<0.01; see Table 2). FS decreased across all four bouts and across all four rest periods, but, contrary to hypothesis 3, there was no significant difference in FS (during bouts or rest) between conditions. Nevertheless, participants in the music condition tended to report higher FS ratings across all time points during the bouts and rest periods, and at 30-minutes post-exercise (see Figure 2a). Although these differences are not statistically significant, the magnitude of the difference is consistent with Cohen’s (1992) definition of small- to medium-sized effects (see Appendix A, Table C for descriptive statistics and effect sizes).

Motivational Responses. Two separate equations and slopes were derived for the TM measures: one for the change in TM across all four bouts and one for the change in TM across all four rest periods. A significant main effect for time was found for both of these equations (estimates = -0.48, [SE = 0.14], -0.56
Table 2: Mixed-effects models predicting affect and task motivation scores

<table>
<thead>
<tr>
<th></th>
<th>FS bout</th>
<th>FS rest</th>
<th>TM bout</th>
<th>TM rest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate (SE)</td>
<td>p-value</td>
<td>Estimate (SE)</td>
<td>p-value</td>
</tr>
<tr>
<td>Intercept</td>
<td>4.129 (0.95)</td>
<td>0.004</td>
<td>3.745 (0.95)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Time</td>
<td>-0.710 (0.16)</td>
<td>&lt;0.001</td>
<td>-0.680 (0.17)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Condition (music)</td>
<td>0.173 (0.56)</td>
<td>0.757</td>
<td>0.322 (0.56)</td>
<td>0.568</td>
</tr>
<tr>
<td>First Condition</td>
<td>-0.743 (0.78)</td>
<td>0.341</td>
<td>-1.158 (0.78)</td>
<td>0.141</td>
</tr>
<tr>
<td>Gender (female)</td>
<td>-0.234 (0.77)</td>
<td>0.769</td>
<td>-0.351 (0.80)</td>
<td>0.662</td>
</tr>
<tr>
<td>RPE</td>
<td>-0.105 (0.11)</td>
<td>0.303</td>
<td>-0.035 (0.10)</td>
<td>0.730</td>
</tr>
<tr>
<td>BMRI-2</td>
<td>0.767 (0.43)</td>
<td>0.077</td>
<td>0.622 (0.41)</td>
<td>0.130</td>
</tr>
<tr>
<td>FS during warm-up</td>
<td>0.143 (0.18)</td>
<td>0.440</td>
<td>0.002 (0.19)</td>
<td>0.993</td>
</tr>
<tr>
<td>TM during warm-up</td>
<td>0.270 (0.15)</td>
<td>0.070</td>
<td><strong>0.525 (0.15)</strong></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Time*Condition</td>
<td>0.008 (0.19)</td>
<td>0.969</td>
<td>-0.019 (0.21)</td>
<td>0.926</td>
</tr>
</tbody>
</table>

Note: Values are from Model 2, once all variables had been entered into the model. FS = feeling scale; TM = task motivation; Bout = measurement taken during each WAnT bout; Rest = measurement taken during each rest period, following each bout; RPE = ratings of perceived exertion; BMRI-2 = Brunel Music Rating Inventory-2; SE = standard error.
Figure 2: Feeling Scale (a) and Task Motivation (b) responses ($M \pm SE$) during and following the music and no music conditions, plotted over time.
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[SE = 0.14], ps<0.01; see Table 2). TM decreased across all four bouts and across all four rest periods. Contrary to hypothesis 3, there was no significant difference in TM (during bouts or rest) between conditions. However, participants in the music condition tended to report higher TM ratings across all time points during the bouts and rest periods (see Figure 2b). Although these differences are not statistically significant, the magnitude of the difference is consistent with Cohen’s (1992) definition of small- to medium-sized effects (see Appendix A, Table C for descriptive statistics and effect sizes).

**Perceived Enjoyment.** Significant main effects for time (estimate = 2.08 [SE = 0.99], p<0.05) and condition (estimate = 7.00 [SE = 3.05], p<0.05) were found for perceived enjoyment immediately following and at 30 and 60 minutes post-exercise (see Table 3). No other effects were significant. In support of hypothesis 4, perceived enjoyment was consistently higher in the music condition, and also significantly increased over time (see Figure 3).

**Follow-up Music Preference.** After completion of all study protocols, 19 out of 20 (95%) participants reported that exercise performed in the music condition was more enjoyable than the no-music condition. Further, 20 out of 20 (100%) participants reported that if they were to participate in SIT in the future, they would listen to music while doing it.

**BMRI-2.** BMRI-2 scores ranged from a mean score of 2.43 to 6.83 out of a possible 7, indicating that not all participants had high motivational ratings of the music they selected. To account for this variability, BMRI-2 scores were
Table 3: Mixed-effects models predicting perceived enjoyment

<table>
<thead>
<tr>
<th></th>
<th>PACES</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate (SE)</td>
<td>p-value</td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>80.520 (5.88)</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>2.084 (0.99)</td>
<td>0.039</td>
<td></td>
</tr>
<tr>
<td>Condition (music)</td>
<td>6.999 (3.05)</td>
<td>0.0237</td>
<td></td>
</tr>
<tr>
<td>First Condition</td>
<td>-5.210 (6.36)</td>
<td>0.4144</td>
<td></td>
</tr>
<tr>
<td>(no music first)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender (female)</td>
<td>1.910 (6.36)</td>
<td>0.764</td>
<td></td>
</tr>
<tr>
<td>Time*Condition</td>
<td>-0.098 (1.41)</td>
<td>0.944</td>
<td></td>
</tr>
</tbody>
</table>

Note: Values are from Model 2, once all variables had been entered into the model. PACES = physical activity enjoyment scale; SE = standard error.

Figure 3: Mixed-effects models for perceived enjoyment (PACES) in the music and no music conditions at three time points post-exercise. Lines represent estimate values based on the equations derived from the models.
included as a covariate in the models for power output, FS, and TM, as reported above.

**Attitudes.** At baseline, attitudes towards SIT were relatively positive (mean of 5.04 out of 7; Table 4). In support of the null hypothesis (hypothesis 5), attitudes towards SIT did not change from baseline to follow-up (p=0.962; see Table 4).

**Intentions.** Intentions to participate in SIT were relatively positive at baseline (mean of 4.55 out of 7; Table 4). Also in support of the null hypothesis (hypothesis 5), intentions towards SIT did not change from baseline to follow-up (p=0.534; see Table 4).

**Table 4: Raw means, SDs, possible scoring ranges, and p-values for exercise attitudes and intentions (N = 20).**

<table>
<thead>
<tr>
<th>Scale</th>
<th>Possible Scoring Range</th>
<th>Baseline (Visit #1)</th>
<th>Follow-up (Visit #5)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise Attitudes</td>
<td>1 to 7</td>
<td>5.04 (0.75)</td>
<td>5.03 (0.77)</td>
<td>0.962</td>
</tr>
<tr>
<td>7 items</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exercise Intentions</td>
<td>1 to 7</td>
<td>4.55 (1.48)</td>
<td>4.80 (1.43)</td>
<td>0.534</td>
</tr>
<tr>
<td>2 items</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note:* Higher scores denote more positive response. Values are reported in Mean (SD).
DISCUSSION

The primary finding of the present study was that music improved the enjoyment of SIT, while enhancing acute exercise performance. To our knowledge, this is the first study to demonstrate both the psychological and physiological benefits of listening to self-selected music during a SIT protocol. In addition, a secondary finding was that participants expressed positive attitudes and intentions towards SIT at baseline, which did not change after experience with SIT. This was the first study to empirically evaluate individuals’ attitudes and intentions towards SIT.

Exercise Performance

Consistent with our hypotheses, peak and mean power output were higher in the music versus no music condition (Table 1, Figure 1). These findings are supported by previous research, which has found listening to music prior to or during a single 30-second WAnT can significantly increase power output (Chtourou et al., 2012; Eliakim et al., 2007; Hutchinson et al., 2011). However, these studies did not evaluate the effects of music prior to or during the performance of multiple WAnT bouts, which are characteristic of interval type training. In fact, Hutchinson et al. (2011) suggested that in order to determine if this “initial burst of power” (p. 144) diminishes over time, the evaluation of a progressive or interval exercise task is needed. Our data are the first to illustrate that the ergogenic effects of music can persist over the course of repeated
intervals. It should be noted, however, that this relative effect appears to diminish over the course of the SIT session (see Figure 1).

The performance response observed in the present study is unlike that typically seen after several weeks of interval exercise training. For example, researchers (MacDougall et al., 1998) reported increased peak and mean power during a repeated WAnT task after 7 weeks of SIT, but this was mainly related to performance improvements for the latter bouts of exercise. In contrast, we found performance differences for the earlier bouts, indicating music has the potential to elicit an immediate performance benefit during acute SIT exercise. An explanation for this effect is not immediately clear. We did not include invasive measurements in this study (e.g., needle blood samples of various catecholamines such as norepinephrine) to examine potential physiological mechanisms, but it is possible that elevated arousal or motivation from the music may have facilitated these effects.

Pre-task music has been shown to promote optimal arousal levels (Yamamoto et al., 2003) and can assist in physiological preparation for a short bout of high-intensity cycling exercise (Chtourou et al., 2012; Eliakim et al., 2007). Specifically, studies have found increased circulating levels of epinephrine and heart rate when stimulating music was played prior to an all-out WAnT protocol, in comparison to slow music or a no music control (Eliakim et al., 2007; Yamamoto et al., 2003). It has also been suggested that leading up to exercise, participants may experience “segmentation,” where particular segments of the
musical pieces that are yet to be played are anticipated by the participant, resulting in a heightened state of arousal and a conscious trigger for increased work output (Karageorghis & Priest, 2012a, 2012b; Priest & Karageorghis, 2008). In the context of the present study, it is possible that the music being played during the 2-minute and 30-second warm-up elicited a heightened (and optimal) state of physiological arousal leading into the first WAnT bout. In addition, given that participants self-selected their songs, the “segmentation” effect may have been in play. That is, participants may have anticipated the upcoming motivational segments of the music they selected and this may have ‘psyched up’ or energized participants, causing them to increase their work output. To support these notions, TM and FS were both significantly higher in the music condition during the warm-up (when music began to play), suggesting that participants experienced heightened motivation and affect leading up to the first WAnT bout in the music condition (see Appendix A, Table C). Furthermore, given the intermittent nature of the SIT protocol and the continuous play of music during rest periods, the music would have had both pre- and in-task effects for each of the WAnT bouts. This may have created additive effects for each of the four bouts, and may partially explain why the ergogenic effects of music persisted for multiple WAnT bouts.

**Perceived Exertion**

As hypothesized, there was no significant difference in RPE between conditions. Yet, although participants reported physically exerting themselves
equally as hard in both conditions, they still achieved greater power output in the music condition. Interestingly, other studies have reported similar findings where individuals showed higher work outputs when music was played before or during a WAnT (in comparison to a no music control), despite p-values reporting no significant differences in RPE between music and no music conditions (Chtourou et al., 2012; Hutchinson et al., 2011). This is consistent with the notion that music may be less influential at altering psychophysical states (e.g., RPE) at exercise intensities exceeding the VT due to the dominance of physiological cues in attentional processing (Rejeski, 1985; Tenenbaum, 2001).

Although RPE was high in both conditions of this study, these ratings did not deter participants from reporting positive levels of enjoyment during SIT (see Appendix A, Table C). This finding is consistent with a study by Bartlett et al. (2011), where participants reported that high-intensity interval running was actually more enjoyable than moderate-intensity continuous running, despite producing a higher RPE. Together, these results suggest that even though individuals experience high levels of RPE during interval exercise, it does not necessarily make the exercise less enjoyable.

**Affect & Motivation**

Differences in affect and task motivation between the two conditions were not statistically significant across the four bouts. These findings are inconsistent with the hypotheses and are at odds with the study by Hutchinson et al. (2011) that found significantly higher ratings of FS and TM when a 30-second WAnT
bout was performed with music versus without music. Although disparities between studies is not uncommon in the music literature – especially when it comes to supramaximal exercise (Karageorghis & Priest, 2012a) – it is possible that the conflicting findings may be due to differences in the implementation of the music intervention. Hutchinson et al. (2011) utilized researcher-selected music and playing of the music was specifically timed so that the increasing momentum of the song would accompany an increase in participant pedaling rate. In contrast, the current study administered self-selected music that was played during the warm-up and continued, without manipulation, over the duration of the exercise task. Thus, it is possible that matching the timing of a build-up in momentum of the song to participants’ increased pedaling cadence led to a more powerful acute music intervention in the study by Hutchinson et al. (2011).

Although differences in FS and TM between the two conditions were not statistically significant across all time points, trends towards more positive FS scores and higher TM in the music condition were still evident (see Figure 2). This trend suggests that our study was underpowered to detect significant differences on these variables. Our a priori sample size calculations were based on the expectation of a very large effect size; however, we only detected small- to medium-sized effects. Additional studies, powered to detect modest effects, are needed to further evaluate the influence of music during SIT.

Interestingly, the objective increase in workload in the music condition occurred at no cost to in-task affect (i.e., affect was not rated more negatively in
the music condition, even though the workload was greater). This finding is consistent with previous research to evaluate such changes during a WAnT bout (Elliott, Carr, & Savage, 2004; Hutchinson et al., 2011). Collectively, these findings are encouraging as research suggests that future exercise intentions and behaviour seem to be higher for individuals who experience less of a decline in affect during an exercise bout (Ekkekakis, 2009; Kwan & Bryan, 2010a, 2010b; Parfitt & Hughes, 2009; Williams et al., 2008). Likewise, these findings also suggest that the enhancement of affective states from music may be independent from interval exercise workload.

It is important to note that although FS significantly dropped over the course of the four bouts of exercise, a large rebound towards more positive FS was observed post-exercise in both conditions. This “rebound effect” is consistent with previous research showing changes in affect during and following exercise performed at an intensity above the VT (Ekkekakis, Hall, & Petruzzello, 2008; Parfitt & Hughes, 2009). After the progressive decline in affect over the course of the SIT protocol, it appears that affect returned or “rebounced” back towards baseline levels by 30- and 60-minutes post-exercise (see Figure 2a). Although most research suggests that affect during exercise is a strong predictor of future exercise behaviour, there is some evidence that post-exercise affect also plays a role in determining whether people follow through on their exercise intentions (e.g., Kwan & Bryan, 2010b). Thus, even though participants experienced a decline in affective states during SIT, their rebound to more positive affective
states post-exercise could also influence their future SIT participation. Further measures are needed to test this notion.

**Perceived Enjoyment**

In line with the hypotheses, perceived enjoyment of the SIT exercise was found to be significantly higher in the music than no music condition across all three time points post-exercise (see Figure 3). This is consistent with a previous study that found greater exercise enjoyment while listening to music in comparison to exercising in a verbal dialogue control condition (Miller et al., 2010). The current findings are promising given that exercise enjoyment has been advocated as an important predictor of exercise adherence (Bartlett et al., 2011; Johnson & Heller, 1998; Tritter et al., 2013; Wankel, 1993). More specifically, it has been suggested that increasing the enjoyment of exercise has the potential to improve adherence to exercise in the long term (Bartlett et al., 2011). Thus, individuals may be more likely to participate in and adhere to SIT exercise if they listen to music while doing it. In support of this reasoning, all participants reported that they would listen to music during SIT if they were to participate in SIT in the future.

The perceived enjoyment of SIT improved over time in both conditions and was relatively positive overall (mean scores of >80 out of a possible 126). Follow-up reports of general enjoyment of SIT were also relatively positive (mean of 92.3 out of 126). This suggests that SIT may be more enjoyable than people are led to believe. Previous research has shown that intermittent exercise is perceived
as being more enjoyable and less boring than traditional endurance exercise
(Bartlett et al., 2011; Tjønna et al., 2008; Wisløff et al., 2007). Jung et al. (2014)
also found that participants reported greater enjoyment of, and preference for,
high-intensity interval exercise in comparison to continuous moderate- or
vigorous-intensity exercise. A potential explanation for this is that interval
exercise is different from, and more challenging than, other forms of exercise, and
variety and challenge have been previously identified as factors that may
influence exercise enjoyment (Biddle, 1995; Motl et al., 2001). In addition, it is
possible that the brevity of the intervals, the periods of rest between each interval,
and the reduced total time commitment, make interval exercise a less monotonous,
and more appealing and enjoyable form of high-intensity exercise (Jung et al.,
2014). Some researchers have even suggested that “individuals may find short
bouts of exercise less overwhelming and physically demanding than sustained
exercise” (Linke et al., 2011, p. 198). However, future research should investigate
whether the levels of enjoyment observed in this study can be sustained over
continued participation in SIT. Nonetheless, this study is the first to document
exercise enjoyment following this specific SIT protocol.

**Attitudes**

At baseline, attitudes towards SIT were relatively positive (mean of 5.04
out of 7), and this did not change upon study completion (see Table 4). This
suggests that moderately active individuals (with no prior experience with SIT)
have generally positive attitudes towards SIT, and these attitudes are unaffected after being exposed to multiple SIT protocols.

It has been suggested that an enjoyable exercise experience can contribute to the formation of positive exercise attitudes (Martin Ginis et al., 2006) and that enjoyment of fitness training may be an important determinant of attitudes towards fitness training (Palmer, Burwitz, & Smith, 1999). Based on this, it is not surprising that follow-up measures of attitude in this study remained positive after participants experienced acute sessions of SIT that they enjoyed. Thus, it is reasonable to speculate that participants maintained their positive attitudes towards SIT partially because they found the exercise enjoyable.

It should be noted that participants reported higher levels of enjoyment in the music condition than no music, and this may have had a differential impact on participants’ attitudes towards SIT. Future research is encouraged to determine if experiencing acute SIT exercise with music versus no music has a different influence on one’s attitudes towards SIT due to increased levels of SIT enjoyment. Nevertheless, after experiencing a combination of SIT trials with and without music, participants in this study maintained positive attitudes towards SIT.

**Intentions**

Intentions to participate in SIT were relatively positive at baseline (mean of 4.55 out of 7) and did not change upon study completion (see Table 4). This finding suggests that individuals with no prior experience with SIT have generally positive intentions to participate in SIT, and these intentions are unaffected after
experiencing multiple SIT protocols. From a theoretical standpoint, it is not surprising that our results for the intentions measure parallel our results for the attitudes measure, as exercise attitudes are an important predictor of one’s exercise intentions (Ajzen, 1991).

**Study Strengths**

As highlighted previously, this study provides original contributions to the literature in several different ways: to our knowledge, the psychophysiological impact of music on intermittent exercise of this nature has never been evaluated. Further, psychological measures before, during, and following SIT have never been taken in the same time-sensitive manner as in this study. In addition, this is the first time that music has been shown to elicit higher ratings of perceived enjoyment during SIT, while simultaneously producing greater work outputs. Finally, individuals’ attitudes and intentions towards SIT exercise have never been empirically evaluated.

The current study followed rigorous methodology in order to minimize potential confounds and to isolate the effects of the music intervention. Some studies that evaluated the effects of music on WAnT protocols have not included a familiarization trial or have failed to provide adequate recovery between experimental trials (e.g., Brohmer & Becker, 2006; Pujol & Langenfeld, 1999). In this study, two familiarization protocols were completed prior to the experimental trials in order to mitigate any learning effects and to ensure participants fully understood the experimental procedures. Lab visits were spaced 7 days apart and
participants were instructed to maintain consistent dietary and sleep habits and to avoid any physical activity for the entire day preceding the experimental trials. This was done in order to eliminate the effects of exercise fatigue and to minimize any differences between participants or the experimental trials. In addition, experimenter interactions with participants during trials were fully scripted in order to control for extraneous motivational influence.

This study utilized a within-subject crossover design and the order of the conditions was randomized and counterbalanced to control for temporal order and carry-over effects. In addition, participant randomization was stratified by gender and, as mentioned previously, familiarization trials were used to limit any learning effects. However, we acknowledge that it is possible that differential patterns may have emerged among participants who experienced the music condition first versus experiencing the no music condition first. Thus, several steps were taken in order to ensure that this did not have a significant impact on the study findings. First, we included first condition order (no music first) as a covariate in each of the models, and no significance was detected (refer to Tables 1-3). Second, we split the data based on first condition order and plotted all raw data for each of the dependent variables against each other to determine if any visible patterns were emerging. Third, we conducted repeated measure analysis of variances (RM ANOVAs) using SPSS, with first condition order as a between-subject factor. Based on this series of analyses, it was determined that first condition order effects were not confounding the overall findings from the mixed-effects analyses. It
should be noted that these were additional analyses; therefore, they were not reported in the study results.

For this study, mixed-effects models were used to examine differences between the music and no music conditions for each of the dependent variables. This advanced statistical method accounted for between and within subject error, allowing for the examination of the effects of group and individual-level variables on individual-level outcomes. Thus, the estimates produced by using mixed-effects models provided a better representation of the patterns occurring within subjects over time, and more accurate estimates, than other statistical methods that compare means and standard deviations (e.g., RM ANOVAs).

**Study Limitations**

Despite these strengths, there are some limitations to the current study. First, this study was underpowered to detect significant differences for FS or TM scores between the two conditions, despite the apparent trends towards higher scores in the music condition. Although our power calculations were based on a very large effect size, as found in the study by Hutchinson et al. (2011), our study yielded only small- to medium-sized effects for FS and TM. Given the lack of research in this area, there were limited studies on which to base our power calculations. While our power calculations were statistically appropriate, very large effect sizes may be unrealistic for all studies comparing the effects of music versus no music during exercise. Indeed, we also had limited information on the key methodological elements that may be necessary for insuring larger effects.
Future studies that are powered to detect smaller effect sizes are required for investigating the influence of music on affect and motivation during SIT.

Given that the participants self-selected the music they listened to during the SIT protocol, there was large variability in the music characteristics (e.g., genre, tempo, beat etc.). Thus, each participant was exposed to a different musical stimulus during the SIT protocol. We acknowledge that this is a study limitation. However, the purpose of this study was not to determine what type of music could elicit benefits for SIT, but was to determine if music could be used to elicit such benefits. In addition, it has been suggested that self-selected music is particularly efficacious in an applied context (Karageorghis & Priest, 2012b) and may be more indicative of a real-life situation than researcher-selected music (Hutchinson et al., 2011). Although there is a large array of research to evaluate the moderating effects of different types of music (e.g., high vs. low tempo, lyrical vs. non-lyrical, self-selected vs. researcher-selected, etc.) on continuous exercise (Karageorghis & Priest, 2012a, 2012b), future research is encouraged to investigate the influence of these factors during interval-based exercise protocols such as SIT.

Due to the supramaximal nature of the SIT exercise performed in this study, it is difficult to identify the true intensity at which participants were exerting themselves. Measures of heart rate were not included to corroborate that participants were actually exercising at an “all-out” intensity for each of the WAnT bouts performed. The use of heart rate monitors (in addition to RPE scales), are encouraged for future research in this area.
As mentioned previously, BMRI-2 scores had high variability in this study, indicating that some participants did not have unanimously high motivational ratings of the music they selected, and some participants may have been better at selecting music than others. Thus, it is possible that the music intervention may not have been motivational or stimulating enough to elicit a maximal response for all participants, and this may have, in part, contributed to the non-significant findings with FS and TM measures. Nevertheless, the positive effects of the music were still evident in this study, as reflected in improved exercise performance and greater enjoyment in the music condition. These findings are encouraging, as it is possible that the music intervention used in this study could be improved upon to elicit even greater effects in future research.

**IMPLICATIONS & FUTURE DIRECTIONS**

**Exercise Intensity & Affect Literature**

Previous literature has cautioned against the prescription of exercise performed at intensities above the VT because it is associated with a decline in affect, and this is believed to deter future exercise behaviour (e.g., Ekkekakis et al., 2008, 2011). However, until very recently, studies that have examined the relationship between exercise intensity and affect have only investigated traditional continuous aerobic exercise. Considering that there are other forms of vigorous exercise – such as interval exercise – that have not yet been extensively evaluated, the avoidance of vigorous-intensity exercise may be preemptive. In fact, the study by Jung et al. (2014) has shown that participants reported more
favourable affective responses to vigourous-intensity exercise performed in 1-min *intervals* (with 1-min recovery periods in between), as they did to vigourous-intensity *continuous* exercise. Nonetheless, it should be reiterated that the interval exercise protocol described in their study was performed at a lower intensity and longer duration than the SIT protocol used in the current study. In any case, these findings suggest that there are clear differences in affective responses between continuous vigorous-intensity exercise and intermittent vigorous exercise (Jung et al., 2014). Consequently, the discretion towards prescribing exercise at an intensity that is above VT may not apply to interval exercise.

The present study has shown that music has the potential to increase physical workload during a SIT protocol, without any further cost to in-task affect. In addition, consistent trends towards higher affect in the music condition did emerge. In light of the findings by Jung et al. (2014), it is possible that the use of music during interval exercise may actually produce a form of vigorous exercise that elicits even more favourable affective responses than interval exercise performed without music. Thus, individuals can still exercise at a high intensity without being deterred from future exercise participation, because they are more likely to have a positive affective experience during the exercise. However, in order to determine if this is true, further research needs to evaluate the influence of music on affective responses to different interval exercise protocols performed at varying intensities.
Music & Exercise Literature

Although there is strong evidence to show the range of physiological and psychological benefits that listening to music can have on exercise, none of this research has evaluated interval exercise, and very few studies have investigated exercise performed at a supramaximal intensity. Thus, the current study gives us a new understanding of the effects of music on interval exercise performed at a supramaximal intensity.

Previous studies have illustrated the ergogenic effects of music on performance of a single 30-second WAnT exercise bout (Chtourou et al., 2012; Eliakim et al., 2007; Hutchinson et al., 2011). However, as suggested by Hutchinson et al. (2011), “future studies using an interval protocol, or involving anaerobic tests of differing durations are warranted” (p. 144). As proposed, our study showed that the ergogenic effects of music can persist for multiple bouts of an interval exercise protocol. This is an important discovery, as it not only supports the notion that music can still have an effect on supramaximal exercise, but it also lays the path for future research to investigate interval exercise protocols.

According to Karageorghis & Priest (2012a), *the congruence of music introduction with the task* is one of the five main classifiers of music in the literature. Typically, this classifier is broken down based on whether a study is investigating the effects of pre-task, in-task, or post-task music. Pre-task music is mostly used to stimulate or sedate people prior to exercise, in-task music is often
designed to accompany an exercise task, while post-task music is typically used as a recuperative agent that aids in recovery from injury, competition, or training (Karageorghis & Priest, 2012a, 2012b). Since the present study was the first to evaluate the influence of music being played over the duration of an entire interval exercise protocol, it offers an entirely new perspective for evaluating this classifier. Considering the intermittent nature of SIT, and the continual play of music during the warm-up, exercise bouts, and rest periods, it is apparent that music was being played pre-task (*before* a bout began), in-task (*during* a bout), and post-task (*following* a bout) – for each of the four bouts. Further, participants would have experienced both pre- and post-task music effects *simultaneously* during the rest periods between bouts 1 to 2, 2 to 3, and 3 to 4. This is highly unique to interval exercise, as music played during continuous exercise could not elicit both pre- and post-task effects concurrently. As a result, it is unclear what psychological and physiological effects this may have. Thus, future research to investigate the effects of music on interval exercise may need to alter the way the congruence of music introduction with the task is evaluated.

**Practical Applications**

This study provides several practical applications for researchers, exercise practitioners (e.g., fitness instructors, personal trainers, coaches, etc.), and the general public. First, the detailed methodological framework outlined in this paper can easily be replicated by other researchers for future studies. The use of familiarization trials, spacing of lab visits, timing of measures, lab set-up, etc.
from this study can be used as a template for future studies that investigate the
effects of music on SIT or other interval exercise protocols. In addition, many of
the future considerations outlined in this paper can be readily incorporated into
the current design. For example, a future study to investigate the differential
impact of self-selected versus researcher-selected music on SIT could use the
same overall study design and simply alter the characteristics of the music
intervention.

Based on the findings from the current study, the use of self-selected
music may be recommended for use during SIT. Although other forms of interval
exercise have not been empirically evaluated this way, it can be speculated that
less-intense versions of SIT would also elicit similar benefits from music for two
reasons: (1) SIT is one of the most intense versions of interval exercise, and
higher exercise intensities are associated with greater decreases in affect
(Ekkekakis et al., 2011; Parfitt & Hughes, 2009); and (2) the psychophysical
benefits of music on exercise appear to be less evident at supramaximal intensities
(Hutchinson et al., 2011; Karageorghis & Priest, 2012a). Thus, individuals who
participate in interval exercise protocols performed at near-maximal intensities
(80-100% PHR) as apposed to supramaximal intensities (≥100% PHR), may
actually be more likely to elicit benefits from music due to the fact that they will
experience less of a decline in affect during exercise, and are more likely to reap
the benefits of music. Nonetheless, future research is required to determine
whether or not this is true.
The present study was conducted in a controlled lab-based setting, where any extraneous influences were limited (e.g., cycle ergometer was set up facing a wall and enclosed by temporary walls, only the experimenters were allowed in the lab during testing, experimenter responses were scripted in order to avoid motivational influence, etc.). Thus, the social interactions and motivational influences that could arise in naturalistic settings may actually produce additive psychological and physiological effects, above and beyond what was found in a lab-based setting. In other words, a self-selected music intervention, like that utilized in this study, may be even more effective when applied in real-world settings. Likewise, although participants performed the SIT protocol in this study in isolation and using a stationary cycle ergometer (Velotron Dynafit Pro, RacerMate), individuals can certainly perform SIT-type exercise protocols with others or in a group-based setting, and they can use different exercise modalities (e.g., running on a track or a treadmill).

A great example of a potential application of the findings from this study would be in traditional spin (or cycle) classes offered at most general membership gyms. These classes are often intermittent in nature as they consist of high-intensity periods of heavy pedaling (with an increased resistance manually applied), followed by low-intensity periods of light pedaling (usually with a lower or unloaded resistance) or rest. In addition, the instructor typically selects his/her own music to be played out loud on speakers, for the entire duration of the class (including warm-up). Thus, the findings from this study would support the
continued use of music during spin classes, as this may elicit performance and
enjoyment benefits. However, this example also highlights the importance of self-
selected versus pre-selected music, as a spin class instructor must select music for
the entire class. In this example, there would be value for class instructors to be
educated on which music characteristics (e.g., tempo, rhythm, beat, etc.) would be
most appealing to an entire spin class, and which characteristics would be ideal
for performance of interval-based exercise.

CONCLUSION

Sprint interval training is a time-efficient alternative to traditional
endurance exercise. However, the intensive nature of SIT has the potential to
evoke negative feelings during exercise that can deter people from future
participation. The present findings suggest that although listening to self-selected
music during SIT exercise did not significantly reduce such negative feelings
during exercise, it did make the exercise more enjoyable overall, and lead to
improved performance. Our results also indicate that the ergogenic effects of
music present during a single WAnT can persist for multiple WAnT bouts
performed during SIT. Additionally, moderately active individuals expressed
positive attitudes and intentions towards SIT, which did not change after
experiencing intense SIT exercise protocols. Together, these findings suggest that
the use of music during SIT can be used to enhance exercise performance and
enjoyment, and that people may actually have positive attitudes and intentions
towards participation in SIT exercise. Thus, listening to music during SIT exercise
may be an effective strategy to encourage people to participate in, and adhere to, SIT exercise.
REFERENCES


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APPENDIX A: SUPPLEMENTARY TABLES

Table A
Table B
Table C
Table A: Questionnaire items used to assess participants’ attitudes and intentions towards sprint interval training.

<table>
<thead>
<tr>
<th>Construct (# items)</th>
<th>Items included in scale</th>
<th>Response Scale</th>
<th>Internal consistency reliability score (α) or correlation (r)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attitudes (7 items)</strong></td>
<td></td>
<td></td>
<td>α’s ≥ 0.73</td>
</tr>
<tr>
<td>1. To what extent do you think that participating in high-intensity interval exercise (4x30s “all-out” bouts), at least 3 days per week, over the next month would be:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. extremely unenjoyable/extremely enjoyable</td>
<td>Anchors represent extremes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. extremely harmful/extremely beneficial</td>
<td>(1/7) on 7-point Likert scale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. extremely unpleasant/extremely pleasant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. extremely painful/extremely painless</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. extremely fatiguing/extremely refreshing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. extremely worthless/valuable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. To what extent is the following statement likely?: I would recommend high-intensity interval exercise (4x30s “all-out” bouts) to my friends.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 = Extremely unlikely, 7 = Extremely likely</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Intentions (2 items)</strong></td>
<td></td>
<td></td>
<td>r’s ≥ 0.84</td>
</tr>
<tr>
<td>1. To what extent is the following statement true for you?: I will try to do 14 minutes of high-intensity interval exercise (4x30s “all-out” bouts), at least 3 days per week over the next month.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 = Definitely false, 7 = Definitely true</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. To what extent is the following statement likely?: I intend to do 14 minutes of high-intensity interval exercise (4x30s “all-out” bouts), at least 3 days per week over the next month.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 = Extremely unlikely, 7 = Extremely likely</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: The column indicating scale internal reliability (Cronbach’s alpha) scores for the items on the scale and Pearson correlations between the items on the scale represent the lowest values across the two time points (baseline and follow-up). All internal consistency reliability scores were acceptable.*
Table B: Raw means, SDs, and effect sizes for peak and mean power output ($N = 20$).

<table>
<thead>
<tr>
<th>Scale</th>
<th>No Music</th>
<th>With Music</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peak Power</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bout 1</td>
<td>495.24 (165.57)</td>
<td>532.47 (164.39)***</td>
<td>0.22</td>
</tr>
<tr>
<td>Bout 2</td>
<td>478.47 (160.89)</td>
<td>504.90 (164.50)***</td>
<td>0.16</td>
</tr>
<tr>
<td>Bout 3</td>
<td>459.83 (145.25)</td>
<td>467.59 (138.68)</td>
<td>0.05</td>
</tr>
<tr>
<td>Bout 4</td>
<td>450.05 (140.99)</td>
<td>452.76 (132.83)</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Mean Power</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bout 1</td>
<td>437.61 (142.22)</td>
<td>455.62 (136.60)***</td>
<td>0.13</td>
</tr>
<tr>
<td>Bout 2</td>
<td>403.13 (126.51)</td>
<td>412.21 (119.89)*</td>
<td>0.07</td>
</tr>
<tr>
<td>Bout 3</td>
<td>375.50 (107.71)</td>
<td>376.27 (100.68)</td>
<td>0.01</td>
</tr>
<tr>
<td>Bout 4</td>
<td>359.93 (100.45)</td>
<td>362.03 (96.60)</td>
<td>0.02</td>
</tr>
</tbody>
</table>

*Note*: All power outputs are reported watts (W). Values are reported in Mean (SD). *p<0.05. **p≤0.01. ***p≤0.001.
Table C: Raw means, SDs, possible scale ranges and effect sizes for perceived exertion, affect, task motivation and perceived enjoyment measures (N = 20).

<table>
<thead>
<tr>
<th>Scale</th>
<th>Possible Scoring Range</th>
<th>No Music</th>
<th>With Music</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPE</td>
<td>0 to 10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warm-up</td>
<td></td>
<td>1.68 (0.96)</td>
<td>1.70 (0.83)</td>
<td>0.02</td>
</tr>
<tr>
<td>Bout 1</td>
<td></td>
<td>6.45 (2.31)</td>
<td>6.30 (2.23)</td>
<td>0.06</td>
</tr>
<tr>
<td>Bout 2</td>
<td></td>
<td>7.75 (1.71)</td>
<td>7.55 (2.31)</td>
<td>0.12</td>
</tr>
<tr>
<td>Bout 3</td>
<td></td>
<td>8.50 (1.57)</td>
<td>8.55 (1.23)</td>
<td>0.03</td>
</tr>
<tr>
<td>Bout 4</td>
<td></td>
<td>9.05 (1.15)</td>
<td>8.90 (1.59)</td>
<td>0.13</td>
</tr>
<tr>
<td>FS (Affect)</td>
<td>-5 to +5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-exercise</td>
<td></td>
<td>+2.75 (1.71)</td>
<td>+3.50 (1.24)*</td>
<td>0.44</td>
</tr>
<tr>
<td>Warm-up</td>
<td></td>
<td>+2.55 (1.70)</td>
<td>+3.55 (0.94)*</td>
<td>0.59</td>
</tr>
<tr>
<td>Bout 1</td>
<td></td>
<td>+2.10 (1.68)</td>
<td>+2.60 (0.99)</td>
<td>0.30</td>
</tr>
<tr>
<td>Rest 1</td>
<td></td>
<td>+2.20 (1.91)</td>
<td>+3.05 (1.19)*</td>
<td>0.45</td>
</tr>
<tr>
<td>Bout 2</td>
<td></td>
<td>+1.20 (1.94)</td>
<td>+1.85 (0.41)</td>
<td>0.34</td>
</tr>
<tr>
<td>Rest 2</td>
<td></td>
<td>+1.70 (1.92)</td>
<td>+2.05 (0.43)</td>
<td>0.18</td>
</tr>
<tr>
<td>Bout 3</td>
<td></td>
<td>+0.40 (2.54)</td>
<td>+0.95 (2.61)</td>
<td>0.22</td>
</tr>
<tr>
<td>Rest 3</td>
<td></td>
<td>+0.45 (2.46)</td>
<td>+1.50 (2.78)</td>
<td>0.43</td>
</tr>
<tr>
<td>Bout 4</td>
<td></td>
<td>-0.30 (2.94)</td>
<td>+0.25 (2.95)</td>
<td>0.19</td>
</tr>
<tr>
<td>Rest 4</td>
<td></td>
<td>+0.25 (2.69)</td>
<td>+0.80 (2.71)</td>
<td>0.20</td>
</tr>
<tr>
<td>30-mins Post</td>
<td></td>
<td>+2.45 (1.54)</td>
<td>+3.15 (1.42)*</td>
<td>0.45</td>
</tr>
<tr>
<td>60-mins Post</td>
<td></td>
<td>+3.50 (0.69)</td>
<td>+3.50 (1.24)</td>
<td>0.00</td>
</tr>
<tr>
<td>TM (Motivation)</td>
<td>0 to 10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warm-up</td>
<td></td>
<td>7.00 (1.69)</td>
<td>7.80 (1.54)*</td>
<td>0.47</td>
</tr>
<tr>
<td>Bout 1</td>
<td></td>
<td>6.80 (1.77)</td>
<td>7.35 (1.22)</td>
<td>0.31</td>
</tr>
<tr>
<td>Rest 1</td>
<td></td>
<td>6.60 (1.57)</td>
<td>7.35 (1.57)</td>
<td>0.48</td>
</tr>
<tr>
<td>Bout 2</td>
<td></td>
<td>6.30 (1.42)</td>
<td>6.85 (1.60)</td>
<td>0.39</td>
</tr>
<tr>
<td>Rest 2</td>
<td></td>
<td>6.15 (1.60)</td>
<td>6.85 (1.84)</td>
<td>0.44</td>
</tr>
<tr>
<td>Bout 3</td>
<td></td>
<td>5.45 (1.88)</td>
<td>6.25 (2.10)</td>
<td>0.43</td>
</tr>
<tr>
<td>Rest 3</td>
<td></td>
<td>5.60 (2.23)</td>
<td>6.40 (2.35)</td>
<td>0.36</td>
</tr>
<tr>
<td>Bout 4</td>
<td></td>
<td>5.05 (2.48)</td>
<td>5.75 (2.47)</td>
<td>0.28</td>
</tr>
<tr>
<td>Rest 4</td>
<td></td>
<td>4.80 (2.09)</td>
<td>5.50 (0.46)</td>
<td>0.33</td>
</tr>
<tr>
<td>PACES</td>
<td>0 to 126</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Enjoyment)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediately Post</td>
<td></td>
<td>81.15 (4.14)</td>
<td>87.81 (3.59)**</td>
<td>0.36</td>
</tr>
<tr>
<td>30-mins Post</td>
<td></td>
<td>82.65 (3.39)</td>
<td>89.94 (3.32)**</td>
<td>0.48</td>
</tr>
<tr>
<td>60-mins Post</td>
<td></td>
<td>85.32 (3.56)</td>
<td>91.78 (3.38)**</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Note: Higher scores denote more positive response. RPE = ratings of perceived exertion; FS = feeling scale; TM = task motivation; PACES = physical activity enjoyment scale. Values are reported in Mean (SD). *p<0.05. **p≤0.01. ***p≤0.001.
APPENDIX B: STUDY MATERIALS

Consent Form
Baseline Checklist
Physical Activity Readiness Questionnaire
International Physical Activity Questionnaire
Exercise Attitudes & Intentions Questionnaire (Visit 1)
Music Survey
Ratings of Perceived Exertion Scale
Feeling Scale
Task Motivation Scale
Physical Activity Enjoyment Scale
Exercise Attitudes & Intentions Questionnaire (Visit 5)
Brunel Music Rating Inventory-2
Measurement Chart
Verbal Script for Experimental Trials
PARTICIPANT LETTER OF INFORMATION / CONSENT FORM

Title of Study: Staying on beat with high-intensity interval exercise.

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Sponsors
Arts Research Board (ARB)

Overview
You are being invited to participate in this research study because you are a healthy, regularly active male or female between the ages of 18 and 45. In order to decide whether or not you want to be part of this research study, you should understand what is involved and the potential risks and benefits. This form gives you detailed information about the research study, which will be discussed with you. Once you understand the study, you will be asked to sign this form if you
wish to participate. Please take your time to make your decision. Feel free to discuss it with your friends, family or your family physician.

**Purpose of the Study**
The main purpose of this study is to examine the psychosocial factors involved with participating in high-intensity interval exercise while listening to music.

**Study Procedures**
You will first be asked to complete two questionnaires that are designed to identify potential reasons (i.e., medical or other) that might preclude your participation in the study. These forms will be administered by one of the investigators listed above. Following successful completion of the forms and entry into the study, you will make 5 visits to the Kinesiology laboratory in the Ivor Wynne Centre at McMaster University over the course of approximately 4 weeks. During the first two visits, we will allow you to become familiar with exercise testing devices and protocols. The third and fourth visits will be the actual experimental trial days. The final visit will be used as a short follow-up assessment, where questionnaires will be handed out for completion. Total time spent in the lab will be approximately 45 minutes for the first two visits, approximately 1 hour and 20 minutes for each of the experimental trials, and approximately 20 minutes for the final visit. Thus, the total time commitment for the entire study is approximately 3 hours and 45 minutes.

**Visit #1: Sprint Exercise Familiarization Trial**
On the first visit to the lab, participants will be asked to fill out three different surveys, including one that is based on music preferences. We will then measure your body weight and height using a standard scale. Following this, you will complete an exercise test to help you get accustomed to doing a 30-second sprint on a cycle ergometer. After a short warm-up, you will perform one 30-second sprint as fast as you can, against a set resistance (based on your body weight). The goal is to produce as much power and work as possible during the 30 seconds. Before and after the exercise bout, you will be asked to indicate how you are feeling at the moment according to three different physical activity scales. Once you are finished the exercise bout, we will ask you to fill out a simple questionnaire regarding your enjoyment of the exercise.

**Visit #2: High-Intensity Interval Exercise Familiarization Trial**
This exercise test will consist of performing four 30-second sprints as hard as you can on a cycle ergometer. You will have 4 minutes of rest between these sprints, during which you can recover. At different time points before, during, and after the exercise protocol you will be asked to indicate how you are feeling at the moment according to three different physical activity scales. Once you are finished the exercise protocol, we will ask you to fill out a simple questionnaire regarding your enjoyment of the exercise.
Visits #3 and #4: Experimental Trials
The experimental trials will be very similar to interval exercise familiarization trial, however one of the two sessions will be completed while listening to music. Once again, you will be instructed to respond to several short scales at time points before, during, and after the exercise protocols. Following the experimental protocol, you will fill out a simple questionnaire regarding your enjoyment of the exercise and then you will rest for 1 hour in the lab. You will be prompted to fill out some short questionnaires at 30 minutes and 60 minutes post-exercise and will be given time to relax or read quietly to pass the time. Each of these trials will take a total of about 1 hour and 20 minutes, or less. The two trial visits (one with music and one without) will be separated by 1 week. We ask that you maintain consistent dietary and sleep habits, and refrain from exercise for 24 hours prior to each exercise trial.

Visit #5: Follow-Up Assessment
Participants will be asked to complete one questionnaire and a simple music inventory survey. The information gathered from this will be used to learn more about your experiences from the experimental trials.

Potential Risks and Discomforts
The potential risks and discomforts associated with the exercise testing procedures are similar to those associated with any form of strenuous physical activity. These include fatigue, nausea, vomiting, fainting, abnormal blood pressure, irregular heart rhythm, and in very rare instances, heart attack, stroke or death. Every effort will be made to minimize these potential risks by evaluation of preliminary information relating to your health and fitness and by careful observations during testing.

Injury Protection/Coverage
Financial compensation for such things as lost wages, disability or discomfort due to this type of injury is not routinely available. However, if you sign this consent form it does not mean that you waive any legal rights you may have under the law, nor does it mean that you are releasing the investigator(s), institution(s) and/or sponsor(s) from their legal and professional responsibilities. If the researchers learn of anything that may endanger your health or well-being by participating, or continuing to participate in the study, you will be notified immediately.

Potential Benefits
We cannot guarantee any personal benefits from your participation in this study. However, during your participation you may gain insight into your exercise preferences and will learn a new exercise strategy to improve performance. The general public will potentially benefit by learning that exercising for just a few minutes per day may improve psychological and physical health, and exercise performance.
Confidentiality
Any information that is obtained from this study will remain confidential. Appropriate measures, consistent with Research Ethics Board guidelines, will be taken to ensure privacy. The results from this study will be used for educational purposes and shared with the scientific community. However, all personal information will be removed from the data and your name will not be recorded on any of the study documents. The questionnaires are completely private and will be kept in a locked filing cabinet in The Health and Exercise Laboratory for a period of five years. If the results of the study are published, your name will not be used and information that discloses your identity will never be revealed. Upon completion of the study, you will have access to your own data and the group data for your own interest.

Participation and Withdrawal
You can decide whether to take part in this study or not. If you volunteer for this study, you may withdraw at any time over the course of the data collection period (from January 2013 to April 2013). You can choose to remove your data from the study any time before June 2013, when all data will be finished being analyzed. You may also refuse to answer any questions you don’t want to answer while remaining in the study. The investigators may also withdraw you from the study if circumstances arise which warrant doing so.

Payment/Reimbursement
If you agree to take part, you will receive an honorarium of $50.00 in order to compensate you for your time and effort. In the event that you do not complete the study, you will receive a pro-rated amount based on the proportion of the study completed. You will receive $5 if you withdraw after lab visit #1, $12 if you withdraw after lab visit #2, $27 if you withdraw after lab visit #3, and $42 if you withdraw after lab visit #4.

Information About the Study Results
I expect to have the study results completed by approximately by August, 2013. If you would like a brief summary of the results, please let us know and leave your email contact ________________.

Questions About the Study
If you have questions or require more information about the study now or later, please feel free to contact us.

If you have questions regarding your rights as a research participant, you may contact the Office of the Chair of the HHS/FHS REB at 905-521-2100, ext. 42013.
This study has been reviewed by the McMaster University Research Ethics Board and received ethics clearance. If you have concerns or questions about your rights as a participant or about the way the study is conducted, please contact:
McMaster Research Ethics Secretariat
Telephone: (905) 525-9140 ext. 23142
c/o Office of Research Services
E-mail: ethicsoffice@mcmaster.ca

CONSENT

I have read the information presented in the information letter thoroughly. I have had the opportunity to ask questions about my involvement in this study, and all of my questions have been answered to my satisfaction. I understand that if I agree to participate in this study, I may withdraw from the study at any time. I have been given a copy of this form. I agree to participate in the study.

_____________________________________
Name of Participant

___________________
Signature of Participant ___________________  Date

Consent form administered and explained in person by:

_____________________________________
Name and title ________________________________________________________________________

___________________
Signature ___________________  Date

SIGNATURE OF INVESTIGATOR

In my judgment, the participant is voluntarily and knowingly giving informed consent and possesses the legal capacity to give informed consent to participate in this study.

_____________________________________
Signature of Investigator ___________________  Date

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BASELINE CHECKLIST

Age: _____           Sex: MALE or FEMALE

Please circle YES or NO for each of the following questions:

Do you consider yourself to be healthy?         YES       NO

Are you highly trained and/or an elite athlete? YES       NO

Have you ever participated in this intermittent exercise protocol: 4 x 30s of “all out” sprints, with 4 minutes of rest in between? YES       NO
# PAR-Q & YOU

## (A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?</td>
<td></td>
</tr>
<tr>
<td>2. Do you feel pain in your chest when you do physical activity?</td>
<td></td>
</tr>
<tr>
<td>3. In the past month, have you had chest pain when you were not doing physical activity?</td>
<td></td>
</tr>
<tr>
<td>4. Do you lose your balance because of dizziness or do you ever lose consciousness?</td>
<td></td>
</tr>
<tr>
<td>5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?</td>
<td></td>
</tr>
<tr>
<td>6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?</td>
<td></td>
</tr>
<tr>
<td>7. Do you know of any other reason why you should not do physical activity?</td>
<td></td>
</tr>
</tbody>
</table>

**If you answered YES to one or more questions**

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

**If you answered NO to all questions**

- Start becoming much more physically active — begin slowly and build up gradually. This is the safest and easiest way to go.
- Take part in a fitness appraisal — this is an excellent way to determine your basic fitness so that you can plan the best way for you to live active. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

**PLEASE NOTE:** If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

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**No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.**

**No physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.**

© Canadian Society for Exercise Physiology www.cspe.ca/forms
INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?
   
   _____ days per week
   
   [ ] No vigorous physical activities  ➡️ Skip to question 3

2. How much time did you usually spend doing vigorous physical activities on one of those days?
   
   _____ hours per day
   _____ minutes per day
   
   [ ] Don’t know/Not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.
3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

   _____ days per week

   [ ] No moderate physical activities  →  Skip to question 5

4. How much time did you usually spend doing moderate physical activities on one of those days?

   _____ hours per day
   _____ minutes per day

   [ ] Don’t know/Not sure

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

   _____ days per week

   [ ] No walking  →  Skip to question 7

6. How much time did you usually spend walking on one of those days?

   _____ hours per day
   _____ minutes per day

   [ ] Don’t know/Not sure
The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the last 7 days, how much time did you spend sitting on a week day?

   _____ hours per day
   _____ minutes per day

☐ Don't know/Not sure

This is the end of the questionnaire, thank you for participating.
EXERCISE ATTITUDES & INTENTIONS QUESTIONNAIRE (VISIT 1)

Please answer the following questions by checking off one box for each item listed. Try to answer as honestly as possible.

1. To what extent do you think that participating in high-intensity interval exercise (4 x 30s “all-out” bouts), at least 3 days per week, over the next month would be:

<table>
<thead>
<tr>
<th>Extremely Unenjoyable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Extremely Enjoyable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely Harmful</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>Extremely Beneficial</td>
</tr>
<tr>
<td>Extremely Unpleasant</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>Extremely Pleasant</td>
</tr>
<tr>
<td>Extremely Painful</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>Extremely Painless</td>
</tr>
<tr>
<td>Extremely Fatiguing</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>Extremely Refreshing</td>
</tr>
<tr>
<td>Extremely Worthless</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>Extremely Valuable</td>
</tr>
</tbody>
</table>

2. To what extent is the following statement likely?: I would recommend high-intensity interval exercise (4 x 30s “all-out” bouts) to my friends.

<table>
<thead>
<tr>
<th>Extremely Unlikely</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Extremely Likely</th>
</tr>
</thead>
</table>

3. To what extent is the following statement true for you?: I will try to do 14 minutes of high-intensity interval exercise (4 x 30s “all-out” bouts), at least 3 days per week over the next month.

<table>
<thead>
<tr>
<th>Definitely False</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Definitely True</th>
</tr>
</thead>
</table>

4. To what extent is the following statement likely?: I intend to do 14 minutes of high-intensity interval exercise (4 x 30s “all-out” bouts), at least 3 days per week over the next month.

<table>
<thead>
<tr>
<th>Extremely Unlikely</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Extremely Likely</th>
</tr>
</thead>
</table>
MUSIC SURVEY

Please answer the following questions:

1) Do you typically listen to music while you exercise?

Please circle one:  YES  NO

2) Please provide a list of 6 songs that you find uplifting and/or enjoyable to listen to while exercising. A playlist (lasting 16.5 mins) will be created using this song list, and the playlist will be played during one of the exercise trials in this study. Keep in mind that due to the time limit, not all songs listed will necessarily be included in the playlist. Thus, try to list songs in a ranked order by preference. Please include both the song and artist names.

1. Song:____________________________________________________
   Artist:____________________________________________________

2. Song:____________________________________________________
   Artist:____________________________________________________

3. Song:____________________________________________________
   Artist:____________________________________________________

4. Song:____________________________________________________
   Artist:____________________________________________________

5. Song:____________________________________________________
   Artist:____________________________________________________

6. Song:____________________________________________________
   Artist:____________________________________________________
RATINGS OF PERCEIVED PHYSICAL EXERTION (RPE)

0   Nothing at all

0.3

0.5   Extremely weak

1   Very weak

1.5

2   Weak

2.5

3   Moderate

4

5   Strong

6

7   Very Strong

8

9

10  Absolute Maximum
Feeling Scale (FS)  
(Hardy & Rejeski, 1989)

While participating in exercise, it is common to experience changes in mood. Some individuals find exercise pleasurable, whereas others find it to be unpleasant. Additionally, feeling may fluctuate across time. That is, one might feel good and bad a number of times during exercise. Scientists have developed this scale to measure such responses.

+5 Very good  
+4  
+3 Good  
+2  
+1 Fairly good  
0 Neutral  
-1 Fairly bad  
-2  
-3 Bad  
-4  
-5 Very bad
**TASK MOTIVATION SCALE**
Hutchinson et al., 2011

**Motivation**

<p>| | | | | | | | | | | |</p>
<table>
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<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Not at all motivated</td>
<td>Weak motivation</td>
<td>Moderate motivation</td>
<td>Strong motivation</td>
<td>Extremely motivated</td>
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</tbody>
</table>

**Instructions**

Motivation refers to the how much you want to keep going (persistence) and the extent to which you want to push yourself to work harder (effort).

Look at the rating scale; we want you to use this scale from 0 to 10, where 0 means “not motivated at all” (i.e. you are not at all motivated to keep going or to work hard) and 10 means “extremely motivated” (i.e. you are extremely motivated to keep going or to work hard).

Try to appraise your feelings of motivation as honestly as possible. Don’t underestimate it, but don’t overestimate it either. It is your own feeling of motivation that is important, not how it compares to other peoples. What other people think is not important either. Look at the scale and the expressions and then give a number.
PHYSICAL ACTIVITY ENJOYMENT SCALE (PACES)

Now that you have completed this physical activity protocol, we want to know how you enjoyed it. Think about how you are currently feeling about the workout you just completed as you respond to each of the following items. Please circle only one number for each item and try to respond as honestly as possible.

<table>
<thead>
<tr>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>I enjoy it</td>
<td></td>
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<td></td>
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<tr>
<td>I feel bored</td>
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<tr>
<td>I dislike it</td>
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<tr>
<td>I find it pleasurable</td>
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<tr>
<td>I am very absorbed in this activity</td>
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<tr>
<td>It’s no fun at all</td>
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<td>I find it energizing</td>
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<td>It makes me depressed</td>
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<td>It’s very pleasant</td>
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<tr>
<td>I feel good physically while doing it</td>
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<tr>
<td>It’s very invigorating</td>
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<td>I am very frustrated by it</td>
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<td>It’s very gratifying</td>
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<tr>
<td>It’s very exhilarating</td>
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<tr>
<td>It’s not at all stimulating</td>
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<tr>
<td>It gives me a strong sense of accomplishment</td>
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<tr>
<td>It’s very refreshing</td>
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<tr>
<td>I felt as though I would rather be doing something else</td>
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</tbody>
</table>
EXERCISE ATTITUDES & INTENTIONS QUESTIONNAIRE (VISIT 5)

Please answer the following questions by checking off one box for each item listed. Try to answer as honestly as possible.

1. To what extent do you think that participating in high-intensity interval exercise (4 x 30s “all-out” bouts), at least 3 days per week, over the next month would be:

   - Extremely Unenjoyable
   - Extremely Harmful
   - Extremely Unpleasant
   - Extremely Painful
   - Extremely Fatiguing
   - Extremely Worthless

   Extremely Enjoyable
   Extremely Beneficial
   Extremely Pleasant
   Extremely Painless
   Extremely Refreshing
   Extremely Valuable

2. To what extent is the following statement likely?: I would recommend high-intensity interval exercise (4 x 30s “all-out” bouts) to my friends.

   - Extremely Unlikely
   - Extremely Likely

3. To what extent is the following statement true for you?: I will try to do 14 minutes of high-intensity interval exercise (4 x 30s “all-out” bouts), at least 3 days per week over the next month.

   - Definitely False
   - Definitely True

4. To what extent is the following statement likely?: I intend to do 14 minutes of high-intensity interval exercise (4 x 30s “all-out” bouts), at least 3 days per week over the next month.

   - Extremely Unlikely
   - Extremely Likely

5. After participating in both exercise trials, which exercise condition did you find more enjoyable overall?  □ With Music  OR  □ No Music

6. If you were to participate in HIE in the future, would you listen to music while doing it?    □ YES  OR  □ NO
BRUNEL MUSIC RATING INVENTORY-2

The purpose of this questionnaire is to assess the extent to which the music you selected motivated you during exercise. We will replay each of the songs in your playlist. As you listen to the piece of music, indicate the extent of your agreement with the statements listed below by circling one of the numbers to the right of each statement. We would like you to provide an honest response to each statement. Give the response that best represents your opinion and avoid dwelling for too long on any single statement. For our purposes, the word “motivate” means music that makes you want to exercise harder and/or longer.

1. Song:____________________________________________________
   Artist:____________________________________________________

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>In-between</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The rhythm of this music would motivate me during exercise</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>The style of this music (i.e. rock, dance, jazz, hip-hop, etc.) would motivate me during exercise</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>The melody (tune) of this music would motivate me during exercise</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>The tempo (speed) of this music would motivate me during exercise</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>The sound of the instruments used (i.e. guitar, synthesizer, saxophone, etc.) would motivate me during exercise</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>The beat of this music would motivate me during exercise</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
</tbody>
</table>

2. Song:____________________________________________________
   Artist:____________________________________________________

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>In-between</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
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<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>The style of this music (i.e. rock, dance, jazz, hip-hop, etc.) would motivate me during exercise</td>
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<td></td>
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<td>The beat of this music would motivate me during exercise</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
</tbody>
</table>

(Continued for a total of 6 possible songs)
## Measurement Chart

<table>
<thead>
<tr>
<th>Time</th>
<th>Measure</th>
<th>Score</th>
<th>Seat Height</th>
<th>Handle Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEFORE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0:00</td>
<td>Warm-up Starts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1:30</td>
<td>RPE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>FS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2:30</td>
<td>Wingate #1 begins</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:00</td>
<td>RPE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>FS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7:00</td>
<td>Wingate #2 begins</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7:30</td>
<td>RPE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>FS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:30</td>
<td>Wingate #3 begins</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:00</td>
<td>RPE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>FS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16:00</td>
<td>Wingate #4 begins</td>
<td></td>
<td></td>
<td>(Stop Music)</td>
</tr>
<tr>
<td>16:30</td>
<td>RPE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>FS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19:30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resting Room</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>46:30:00</td>
<td>FS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PACES</td>
<td>Fill Out</td>
<td></td>
<td></td>
</tr>
<tr>
<td>76:30:00</td>
<td>FS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PACES</td>
<td>Fill Out</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
VERBAL SCRIPT FOR EXPERIMENTAL TRIALS

NOTE: highlighted sections indicate notes added in for the music trial only.

Welcome back to the lab. If you need a couple minutes to get changed, please go ahead and use one of our lab change rooms (direct them).

Today we will be participating in the exact same bike exercise protocol as your last visit to the lab. The only difference is that we will ask you to stay around in the lab for an additional 60 minutes in order to fill out some simple questionnaires and surveys. We will prompt you to do this at exactly 30 minutes and 60 minutes after you finish the exercise protocol. During the 60 minutes we will ask that you do some quiet reading and do not use your cell phone or computer. In addition, the music playlist you have selected will be played over the duration of today’s exercise protocol.

Like last time, you will be asked to begin pedaling lightly and we will give you about 2 minutes to warm up. At 1 minute and 30 seconds into your warm-up, we will ask you to indicate a number to represent how you’re feeling at that moment according to these 3 scales: RPE, FS, and TM (quickly show them).

Towards the end of your warm-up, we will give you a 30-second heads-up for you to start the exercise bout. We will ask you to start to ramp-up your pedaling until you are prompted to start your bout. You will then pedal as hard and as fast as you possibly can for a total of 30 seconds. We will give you an indication of how much time you have remaining at 15s, 10s, and 5s. At the end of the 30 seconds, we will then ask you to indicate a number representing how you felt during the exercise bout, according to the same 3 scales (that we will hold in front of you). We will ask you to do this after each 30-second bout.

After this, you will be given the option to step off the bike or stay on, and will be given 4 minutes of rest. During the rest, we request that you please remain within the designated area that is outlined by the tape placed on the ground (point). You will have the option to walk around, sit in the chair provided, stretch, or sit.

3 minutes into each rest period you will be asked to indicate a number to represent how you’re feeling at that moment for the FS scale and the TM scale again. After this, you will get back on your bike for the next bout and we will give you another 30-second heads-up before you to start.

Finally, we will request that you complete one last scale only after your final 30-second bout (PACES).
**(Review scales/measures with instructions)**

Please take a moment to indicate a number for this scale before we begin (FS).

Do you have any questions before we start?

Okay, let’s begin. You can now get yourself set up on the bike. Please start your warm-up for the next 2 minutes. We will give you a 30s heads up for when you are to begin your exercise bout.

(START STOPWATCH TIME) (START MUSIC)

(1:30 into warm-up): Please indicate a number for each of these scales (RPE, FS, TM).

**BOUT 1**
(at 2:00) Okay, in 30 seconds we will ask you to start your all-out bout.

(Count down from 10 seconds).

“Go!”
At 15 seconds: “Great job, only 15 seconds left”
At 10 seconds: “10 seconds”
At 5 seconds: “5, 4, 3, 2, 1”
At zero: “Well done”

Please indicate a number on this scale (RPE), this scale (FS) and this scale (TM).

Your rest has started. You are welcome to stay on the bike or step off of the bike when you’re ready.

Please get yourself set up on the bike.
(At 3:00 after bout): Please indicate a number on each of these scales (FS and TM)

…………**Repeated for bouts 2-4**…………

**BOUT 4**

(STOP MUSIC AFTER BOUT)

Please indicate a number on this scale (RPE), this scale (FS) and this scale (TM).
Give yourself a few seconds and please step off of the bike when you’re ready.
(At 3:00 after bout #4): Please point to a number on each of these scales (FS and TM). Please read the instructions carefully and circle a response to each of the items (PACES).

For the next 60 minutes you are free to rest and recover in this room. You are welcome to do some quiet reading, but we ask that you please refrain from using your cell phone or computer. In about 30 minutes we will ask you to respond to 2 surveys. In about 60 minutes, we will ask you to respond to 3 surveys. If you have any questions or concerns, please ask us at any time.

(After 30 minutes) Please take a moment to fill out these 2 surveys (FS, PACES).

(After 60 minutes) Please take a moment to fill out these 3 surveys (FS, PACES).

Thank you for your time, you are done for today.

***Schedule next visit***

**NOTE:**
The next lab visit will be scheduled approximately one week from now. We request that you maintain your typical dietary and sleep habits, and avoid any strenuous physical activity for the entire day preceding your next visit to the lab.

*Reminder: we would recommend that you bring a textbook or novel to the next lab visit, as we will be giving you 60 minutes to rest and relax after your workout. During this time we will ask that you casually read and do not use your cell phone or computer.*