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The Relationship Between Exercise Intensity and Preferred Music Intensity

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Self-selected music intensity (i.e., volume) and perceived music usefulness were examined across a range of exercise intensities that were standardized around ventilatory threshold (VT). The influence of gender and athletic status (i.e., athletes vs. recreational exercisers) was also explored. Participants were male (n = 23) and female (n = 19) volunteers; 18 were recreational exercisers, and 24 were collegiate athletes. Participants completed a maximal treadmill graded exercise test (GXT) while listening to motivational music. Participants controlled the music volume, and could adjust it at any time during the GXT. Ratings of music usefulness were collected at 1-min intervals throughout the test. It was expected that both music intensity and perceived music usefulness would be highest at or immediately after VT, and lowest at the extreme beginning and end of the test. This quadratic trend was confirmed by our results. Recreational exercisers preferred louder music than athletes, and made more volume adjustments at points beyond VT. No gender differences were observed for music intensity. Music was perceived as increasingly useful up until the point of VT, after which ratings plateaued and then declined during cool-down; however, a gender × task intensity interaction revealed that whereas males followed a clear quadratic trend, females rated music as increasingly useful until the end point of the GXT. The results of this study are supportive of the information processing framework. Individual differences in preferred music intensity and use of music should be considered in future investigations.

Keywords: arousal potential, ventilatory threshold, gender, athletic status

Research into the relationship between music and exercise has revealed that music has a beneficial effect on the psychophysiological state of the participant (see Karageorghis & Priest, 2012a, 2012b for review). Karageorghis, Terry, and Lane (1999) identified three key mechanisms by which music engenders these positive effects: (1) alterations in psychomotor arousal levels, (2) enhanced affective states at both medium and high levels of work intensity, and (3) narrowed attention focus, resulting in decreased awareness of bodily sensations of fatigue and thus lower ratings of perceived exertion (RPE) during low- and moderate-intensity exercise. Research attention has been directed toward several aspects of the musical accompaniment to exercise, such as tempo (Karageorghis, Jones, & Low, 2006; Karageorghis, Jones, & Stuart, 2008) and synchronicity (Karageorghis et al., 2010; Simpson & Karageorghis, 2006), but scant research attention has been paid to the intensity (i.e., volume) of the musical selection. The present study aims to shed light on this area by examining the relationship between exercise intensity and preferred music intensity.

The psychophysical properties of a given external stimulus contribute to its *arousal potential* (i.e., its capability of producing psychobio-

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logical arousal). These properties depend on spatial and temporal distributions of energy, thus stimuli of greater intensity (brighter lights, louder sounds, etc.) hold greater arousal potential (Berlyne, 1971). Several studies have attempted to tease out which aspects of music result in increased states of arousal in listeners and the most important factors appear to be tempo (speed) and intensity (loudness); an increase in either of them results in higher activation (Gabrielsson & Lindström, 2001).

Copeland and Franks (1991) varied both the intensity and tempo of music during a treadmill run to exhaustion, and found that heart rate (HR), time to exhaustion, and RPE were all lower for a slow and soft music condition than for a loud and fast music condition. While demonstrating a negative relationship between music intensity (volume and tempo) and exercise endurance, these findings cannot be considered conclusive, as volume was not separated from tempo in this design.

Edworthy and Waring (2006) exposed participants to four experimental music conditions (fast/loud, fast/quiet, slow/loud, and slow/quiet) and a no-music control condition during a repeated 10-min treadmill run. Participants produced higher treadmill speeds when the music was fast, with the "fast/loud" condition producing the fastest pace of all. There was no significant difference reported for RPE across conditions; however, it is assumed that music did influence perceived exertion, otherwise RPE would have reflected the greater metabolic strain present in the aforementioned music conditions. An interaction between treadmill speed, music volume, and music tempo indicated that fast and loud music was particularly effective in increasing speed of running *during* the test period. That is, participants in this condition showed a tendency to speed up as the task progressed. These results suggest that fast and loud music might enhance running performance, and indicate ways in which loudness and tempo interact. A criticism of both the aforementioned studies is that they examined intensity extremes (i.e., fast or slow, loud or quiet) and neglected the intermediate levels. Participant preferences were also not taken into account.

Adopting a qualitative approach, Priest, Karageorghis, and Sharp (2004) surveyed health club participants to investigate the motivational qualities of music in exercise settings. They discovered that participants preferred music delivered at a high volume than music delivered at a low volume. A statement from one of the research participants, "the louder it [the music] is the more motivated you are to do more" indicated that the stimulation provided by louder music contributes to its motivational qualities (Priest et al., p. 80). Because the commonly accepted definition of motivational music draws its lineage from the terms used to describe stimulative music (Karageorghis et al., 1999), it appears that by contributing to the stimulative qualities of music, increased volume can also enhance its motivational qualities (Priest et al., 2004).

In addition to enhancing state motivation and arousal, music of a louder volume may also increase distraction in exercise participants. It is theorized that one of the ways music enhances performance is by occupying attentional bandwidth, thereby distracting the subject from unpleasant stimuli (Karageorghis et al., 2013). According to Rejeski's (1985) parallel information processing model, the amount of information one can process at a given time is limited, so it is assumed that focusing attention on a distracting stimulus (such as music) will alter effort perceptions. Stimulus strength is an important consideration within an information processing approach; when there is competition between sensory signals for limited channel capacity, the strength of each stimulus becomes paramount. A stronger stimulus of louder music should facilitate greater dissociation from the internal sensations of fatigue than softer music. However, there seems to be a point during exercise at which this distraction effect wanes. Tenenbaum (2001) suggested that during high-intensity exercise, physiological cues predominate as the most salient influence on psychophysical responses, rendering external cues such as music less influential. Thus, as exercise intensity increases, attention typically shifts from external stimuli to internal sensations of fatigue (Hutchinson & Tenenbaum, 2007; Razon, Basevitch, Land, Thompson, & Tenenbaum, 2009). Research has pointed to the ventilatory threshold (VT) as best representing this critical transition point (Karageorghis & Terry, 1997).

If music is functioning as a distractor during exercise, then one would expect to see attempts on the part of the exerciser to amplify the level of distraction as the critical transition point is approached. One way in which this can be achieved is to increase the intensity (i.e., volume) of the musical accompaniment to exercise. The present study sought to test this hypothesis by examining preferred music intensity at various time points during a graded exercise test (GXT) to fatigue. As a supplement to this data, perceived usefulness was assessed throughout the GXT to see if the music was perceived as more or less useful at specific exercise intensities.

Reactions to music are not determined solely by the objective properties of sound; listener characteristics influence the subjective perception of music (Kellaris & Altsech, 1992). There is evidence to suggest that men and women differ in terms of hearing sensitivity (Sax, 2010), which may impact preferred music intensity. Moreover, music appears to be more beneficial for the untrained or recreational participant than it is for the well-trained or competitive athlete (Karageorghis & Priest, 2012a). Accordingly, this study included both athletic status and gender as between-subject variables.

Gender Differences

Psychophysical investigations wherein participants' sensitivity to sound has been directly measured have consistently found that females are more sensitive to sound than males, with the average maximum comfort level for females approximately 6 to 8 decibels (dB) lower than that of men (Sax, 2010). Consistent with these findings, females have been shown to self-select lower volume levels than males when listening to different types of music (Kageyama, 1999). There is also evidence to suggest that females are more sensitive to particular aspects of music than males. Corso (1963) was among the first to note that females have more acute hearing in the higher frequency range (≥4,000 Hz) than male counterparts. This finding has since been replicated in a number of different cultural groups (Dunckley & Dreisbach, 2004; Dreisbach, Kramer, Cobos, & Cowart, 2007; Shahnaz, 2008). High-frequency overtones determine the timbre or "color" of a musical note (Dowling & Harwood, 1986), and are responsible for adding "life and brightness" to music tracks (Rose, 2008, p. 245). Such frequencies are more prevalent within the pop music genre, which tends to be preferred by females (Colley, 2008). However, it is undetermined whether this is due to gender differences in processing of music or to the influence of gender-specific cultures of musical taste.

Research pertaining to gender and music reactivity in the sport and exercise domain is relatively limited. There appears to be a trend for females to experience more enhanced affective states as a result of listening to music during exercise (Karageorghis et al., 2010). This is supplemented by qualitative evidence that suggests females report feeling "motivated" by music more frequently than males (Priest et al., 2004). In the context of exercise enjoyment, females rate melody to be of greater importance than males, who are more influenced by sporting associations with music (Crust, 2008). However, there appears to be no difference in the importance that men and women ascribe to rhythmic factors in an exercise context (Crust, 2008; Priest et al., 2004), and no mediating influence of gender when it comes to the effects of music on task performance (Karageorghis et al., 2013). Despite the prevalence of empirical evidence indicating that females may be more sensitive to music, and in particular to effects stemming from sound intensity, there has been no research to date that has empirically examined gender differences in preferred music intensity in an exercise context.

Athletic Status

Two studies have compared the effects of music on trained and untrained participants during exercise, and both have supported the notion that music is more beneficial for the untrained (Karageorghis & Priest, 2012a). In the first study, untrained participants reported more positive affect while listening to fast-tempo music during both low- and high-intensity exercise compared with trained participants (Brownley, McMurray, & Hackney, 1995). Trained participants actually reported lower affect in both music conditions compared with control. This led the authors to conclude that listening to stimulative music may benefit untrained runners yet proves counterproductive for trained runners. In the second study, music was associated with lowered RPE among untrained, but not trained, participants during a maximal GXT

(Mohammadzadeh, Tartibiyan, & Ahmadi, 2008). In both studies, the group difference was attributed to assumed differences in the state attentional focus of the participants. That is, untrained participants directed their attention toward the external stimulus to cope with sensations of fatigue, whereas trained subjects were thought to be more focused on the exercise task, so they were not as influenced by the musical stimulus (Mohammadzadeh et al., 2008). Thus, it appears that less-trained exercisers depend to a greater extent on the positive-feeling states engendered by music, whereas the focus of trained exercisers rests on the tasks and specifics of their training. Indeed, the presence of music has been suggested to be disruptive to the associative focus of trained athletes (Brownley et al., 1995). Another consideration is that highly trained individuals tend to work at high intensities, so are more accustomed to tolerating sensations of fatigue. The present study sought to further explore training status differences by comparing the preferred intensity and perceived usefulness of music in recreational exercisers and trained athletes across a range of exercise intensities during a GXT.

Hypotheses

It was expected that as exercise intensity increased over the duration of a GXT, a corresponding increase in preferred music intensity would be observed, up to a given point (i.e., VT). Once participants reached this threshold it was anticipated that, due to the overwhelming physiological sensations experienced and corresponding decline of the positive dissociative effect of the music, preferred music intensity would plateau. On cessation of the GXT, during the cool-down phase, the preferred volume of the music was expected to dramatically decrease, as the physiological conditions driving the desire to amplify the level of distraction would have passed. Perceived usefulness of the music was expected to mirror this quadratic trend (i.e., music would be perceived as increasingly useful up until the point of the VT, after which it would plateau and then decline).

An effect of gender was expected, wherein males were expected to demonstrate a preference for louder music than females throughout the exercise task. However, females were expected to rate the music as more useful throughout the GXT than males. Owing to a greater reliance on external stimuli during sustained effort, recreational exercisers were expected to demonstrate a preference for louder music than athletes, and to rate the music as more useful throughout the GXT.

Method

Participants

Forty-two college-aged, predominantly Caucasian (78%), male (n = 23) and female (n = 19) participants volunteered to participate in this study. Eighteen participants were habitually active recreational exercisers, per ACSM (2010) guidelines, and 24 were trained collegiate athletes from endurance-type sports (rowing, soccer, and cross-country). Participant data are presented in Table 1. The University's institutional review board for the protection of human subjects approved this study.

Instrumentation

The Brunel Music Rating Inventory-2 (BMRI-2: Karageorghis, Priest, Terry, Chatzisarantis, & Lane, 2006) was used to select musical tracks that best represented the preferences of the study sample. The BMRI-2 was developed to assess the motivational qualities of a particular musical piece and to facilitate the selection of music for exercise settings.

Borg's (1998) 10-point RPE scale was used as a measure of perceived effort during exercise. A single-item music-usefulness scale (see Tenenbaum, Kamata, & Hayashi, 2007), an-

Table 1
Participant Characteristics (N = 42)

Age	21.60 (5.81)
VO_2 max (ml.kg.min^{-1})	52.36 (11.74)
Male	59.85 (9.35)
Female	42.80 (6.23)
Athlete	59.98 (11.13)
Recreational	46.44 (8.21)
Training frequency (hr.wk^{-1})	
Athlete	11.66 (1.12)
Recreational	5.48 (1.30)
Training intensity (0–10)	
Athlete	8.11 (1.32)
Recreational	7.66 (1.42)

Note. Values are mean ± *SD*.

chored by 0 (*not useful at all*), 5 (*moderately useful*), and 10 (*extremely useful*), was administered to assess perceived usefulness of the music during the GXT using the instruction: "Please indicate how *useful* you find the music *right now, at this moment*."

Music Selection Procedure

A sample of 40 volunteer undergraduate students (26 male, 13 female; M_{age} = 19.1 year, SD = 2.4) from the same university were asked to nominate musical selections for use in the experimental phase. These volunteers shared a similar demographic profile to the experimental participants (cf. Karageorghis & Terry, 1997). The 10 most frequently recommended tracks that met published guidelines for selecting music for exercise and sport (Karageorghis et al., 2006) were rated according to their motivational qualities for treadmill exercise by a panel of 12 students (five females, four males; M_{age} = 21.5 years, SD = 2.4 years) using the BMRI-2. The panel members were representative of the intended experimental participants in terms of age, gender breakdown, ethnicity, and sociocultural background, but were not involved in the experimental phase. The four highest-rated tracks for each gender were used for experimental phase. A full list of tracks can be requested from the first author.

Testing Procedure

On arrival at the laboratory, each participant completed an informed consent form and a physical activity readiness questionnaire, which was checked to determine their health status and eligibility for participation in the study. Next, demographic information and the participant's height and weight were collected. This was followed by the fitting of a HR monitor (Polar E600). Once the integrity of the signal from the monitor was established, the participants were oriented to the treadmill and were presented with a description of the testing protocol. Safety information pertinent to the exercise test such as hand signals and test termination criteria were reviewed with the participant at this time. Participants were then fitted with a face mask equipped with a low-resistance one-way valve for the collection of expired gases.

The treadmill exercise protocol used for the GXT was the multistage Bruce protocol (Bruce & Hornstein, 1969). Participants exercised for 3 min at each stage, and were encouraged to exercise to their maximum capacity until volitional exhaustion. Oxygen consumption (VO_2) and minute ventilation (VE) were measured continually using a Fitmate Pro metabolic system and Fitmate PC software. Maximal oxygen consumption (VO_2 max) was considered the greatest VO_2 in ml·kg·min^{-1} achieved during any 30-s period. All participants demonstrated two of the following three criteria for the attainment of VO_2 max: (a) terminal respiratory exchange ratio greater than 1.10, (b) 95% or greater of the age-predicted maximal HR (HR = 220 − age), and (c) a plateau in VO_2 with increasing workload.

During the GXT, participants listened to the preselected music, which was started simultaneously with the onset of the test. Throughout the test, the CD player (Sony CFD-G700CP Xplod) was situated on a table approximately 2 m from the participant, and was oriented toward the participant. Music volume was measured using an Extech 407730 Digital Sound Level Meter. The music was started at an initial volume of 60 dB, which was just audible. Sixty decibels is typical of soft background music such as that heard in stores and restaurants (Kellaris & Rice, 1993). Participants held a small remote control during the test, which enabled them to adjust the volume of the music to their preference at any time during the test. They were instructed that they were in full control of the music volume and could make it as loud or as quiet as they wished, and were free to change the volume at any time during the test. HR (bpm) was measured continually during the test via telemetry and recorded at 15-s intervals. Music volume (dB), RPE, and perceived music usefulness were measured and recorded at 1-min intervals. Because a mouthpiece prohibited a verbal rating, RPE and perceived music usefulness were measured by having participants point out their selections on A3-size versions of the scales, which were held directly in front of them whenever responses were required. After each response, a research assistant repeated the participant's selection out loud to ensure that the information would be recorded correctly. On completion of the test, participants cooled down by walking at 2.5 mph, 0% grade, for 3 min, followed by a period of seated rest.

Data Reduction and Analysis

Given that the duration of the GXT varied among individuals, exercise intensity was standardized around the VT to reflect metabolically comparable conditions across all participants. Based on a method previously described by Hall, Ekkekakis and Petruzzello (2002), exercise intensity was standardized using the following time points: (a) the beginning of exercise, (b) the VT, and (c) the end of exercise. After the identification of the VT, using the ventilatory equivalent for VO_2 method (Luks, Glenny, & Robertson, 2013; Reinhard, Muller & Schmulling, 1979), the ratings made at the following eight time points during exercise were retained: the first min, the fourth min, 1 min before the VT (VT − 1), the minute of the VT, 1 min post-VT (VT + 1), 2 min post-VT (VT + 2), the last min completed, and the first and third (final) min of the cool-down period. These particular ratings were retained to examine music intensity and usefulness differences across a broad range of comparative exercise intensities.

After checks to ensure that the data were suitable for parametric analysis, mixed-model 2 × 2 × 8 (athletic status × gender × intensity) repeated-measures (RM) analyses of variance (ANOVA) were used to test the equality of the volume means and ratings of perceived usefulness. In cases in which the sphericity assumption was violated in the ANOVA, Greenhouse–Geisser adjustments were made to the relevant *F* test. All data were analyzed using SPSS Statistical Software version 18.0 (SPSS Inc., Chicago, IL), and the level of statistical significance was set at $p \leq .05$. Effect sizes for the univariate *F* tests are reported as partial eta squared (η_p^2). Additional effect sizes were calculated [$d = (M_1 - M_2)/SD_{pooled}$] to assess the magnitude of the differences between means (Cohen, 1992).

Results

The average duration of exercise until the point of volitional exhaustion was 11.3 min (SD = 2.29 min). The average terminal RPE was 8.65 (SD = 1.17; between "Very hard" and "Extremely hard"), and the average terminal HR was 193 bpm (SD = 7.20). The average RPE at VT was 5.9 (SD = 1.57; between "Hard" and "Very hard"), and the average HR at VT was 177.12 bpm (SD = 12.10).

Preferred Music Intensity

RM ANOVA with Greenhouse–Geisser correction indicated that self-selected music intensity differed significantly across the time course of the GXT, $F(2.11, 82.54) = 6.39$, $p = .002$, $\eta_p^2 = 0.14$. Planned contrasts revealed a significant quadratic trend, $F(1, 38) = 18.51$, $p < .001$, $\eta_p^2 = 0.32$, indicating that the preferred volume was lowest at the extreme ends of the test. As anticipated, there was a sharp rise in preferred music volume just before VT, followed by a plateau (Figure 1). The estimated effect size of volume changes from Min 1 to VT

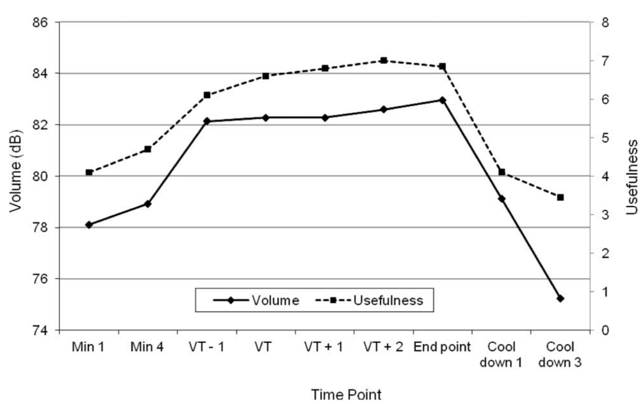

Figure 1. Relationship between task intensity, preferred music intensity, and perceived music usefulness during a graded exercise test (GXT).

in the present study was $d = .49$ (i.e., "medium" according to Cohen, 1992), whereas the volume change from VT to the end of the test was very small ($d = .08$), confirming the plateau.

There was a significant main effect for athletic status, $F(1, 38) = 9.97$, $p = .003$, $\eta_p^2 = 0.21$, with recreational exercisers self-selecting a higher music intensity than athletes (Mdiff = 6.53 dB, $SE = 2.01$, $d = .65$). A significant athletic status × task intensity interaction, $F(2.11, 82.54) = 5.83$, $p = .004$, $\eta_p^2 = 0.11$, revealed that recreational exercisers preferred louder music throughout the duration of the GXT, but quieter music at the final cool-down point. Athletes preferred a lower volume and made fewer adjustments to the music volume during the GXT (Figure 2). Means and effect sizes are presented in Table 2. There was no significant main or interactive effect of gender for music intensity ($p > .05$).

Perceived Usefulness

RM ANOVA, with Greenhouse–Geisser correction, indicated that perceived usefulness differed significantly across the time course of the GXT, $F(3.56,132.72) = 31.50$, $p < .001$, $\eta_p^2 = 0.46$. Planned contrasts revealed a significant quadratic trend, $F(1, 38) = 107.10$, $p < .001$, $\eta_p^2 = 0.74$, indicating that the perceived usefulness was lowest at the extreme ends of the GXT and highest at 2 min post-VT (Figure 1). The estimated effect size for the difference in perceived music usefulness from Min 1 to VT was large ($d = 1.10$), whereas from VT to the end of the test the difference was small ($d = .19$).

A significant gender × task intensity interaction, $F(3.57,135.72) = 4.45$, $p = .004$, $\eta_p^2 = 0.11$, revealed that whereas males followed the predicted quadratic trend, females showed less of a plateau in perceived usefulness; they rated music as increasingly useful until the end point of the GXT (Figure 3). Specifically, at the three time points after the VT, females rated the music as more useful than males ($d = .43$, .57, and .54 for VT + 1, VT + 2, and end point, respectively).

Discussion

The purpose of the present study was to investigate the proposed quadratic relationship between exercise intensity and preferred music intensity by examining self-selected music volume at various time points during a maximal GXT. A secondary aim was to explore whether this relationship was moderated by gender or athletic status. It was hypothesized that preferred music intensity would increase in correspondence with workload up to a given threshold. Once participants reached their VT, it was anticipated that preferred music intensity would plateau, with a decrease during the cool-down phase. This hypothesis was supported and the associated effect size was large ($\eta_p^2 = 0.32$).

Music is considered to be a source of situational motivation and psychomotor arousal (Karageorghis & Priest, 2012a), and previous research has suggested that increasing the volume of music can enhance its arousing and motivational effects (Edworthy & Waring,

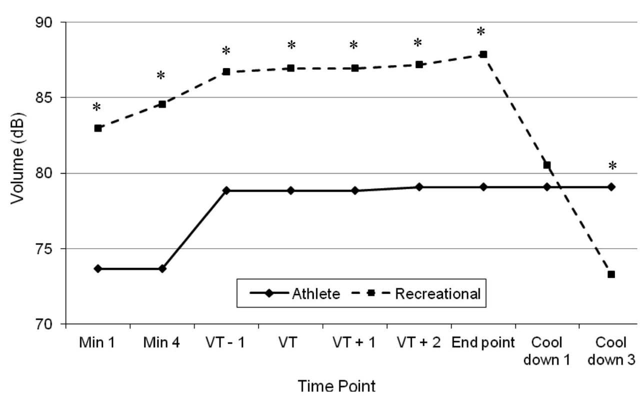

Figure 2. Task intensity × athletic status interaction for preferred music intensity ($p = .004$) during a GXT. * $p < .01$. *Note*. Initial music intensity was 60 dB for both groups.

Table 2
Descriptive Statistics (Means ± SD) and Effect Sizes (Cohen's d) for Athletes and Recreational Exercisers' Self-Selected Music Intensity During a GXT

	Mean (dB) ± *SD*		
	Athlete	Recreational	Cohen's *d*
Min 1	73.65 ± 10.15	83.01 ± 7.81	−1.03
Min 4	73.65 ± 10.62	84.57 ± 8.17	−1.15
VT − 1	78.83 ± 12.70	86.72 ± 9.78	−0.69
VT	78.83 ± 13.17	86.95 ± 10.14	−0.69
VT + 1	78.83 ± 13.17	86.95 ± 10.14	−0.69
VT + 2	79.08 ± 13.72	87.19 ± 10.56	−0.66
End	79.08 ± 13.02	87.88 ± 10.02	−0.76
Cool down 1	79.08 ± 21.42	80.52 ± 16.48	−0.07
Cool down 3	79.08 ± 30.22	73.28 ± 23.26	0.21

2006). Preferred levels of aesthetically evoked arousal are context-dependent; that is, in a given situation, individuals will select stimuli that optimize their responses to that situation (North & Hargreaves, 2000). Examination of music tempo has demonstrated that exercise participants prefer music of a faster tempo when exercise intensity is high, or when high arousal is likely to facilitate performance (Rendi, Szabo, & Szabo, 2008). Our findings indicate the same may be true of music intensity. Karageorghis et al. (2011) described a cubic relationship between task intensity and preferred music tempo, in which tempo and HR are linearly related at low to moderate exercise intensities (40%–60% heart rate reserve [HRR]), followed by a leveling of the trend line at moderate to high exercise intensities (60%–80% HRR), and then a "ceiling effect" or slight attenuation at very high intensity (above 80% HRR). In the present study, exercise intensity was standardized around VT, so no direct comparison can be made, but clear parallels exist between this body of work and our present findings, which are worthy of future consideration. Also worthy of note is the fact that Karageorghis et al. reported a fairly narrow band of preferred music tempi (125–140 bpm) across a wide range of exercise intensities. Our research also indicates a narrow range of preferred music intensity, with an average difference of <5 dB between the beginning of the GXT (*Mean* HR = 113 bpm, *Mean* RPE = 1.41) and the end point (*Mean* HR = 193 bpm, *Mean* RPE = 8.65). These findings may be explained by Berlyne's (1971) interpretation of the classic Wundt curve, in which positive hedonic value comes from a moderate rise in arousal (p. 86). According to Berlyne, as arousal potential rises above the absolute (noticeable) threshold, "the stimulus becomes more and more pleasant and rewarding, with positive hedonic value reaching a peak at a moderately high level of arousal. Further increases cause a decline in positive hedonic tone . . . toward indifference, and the stimulus becomes increasingly unpleasant . . ." (p. 90).

A two-way athletic status × task intensity interaction effect revealed that both athletes and recreational exercisers elected to increase the intensity of the music between Min 4 and 1 min before VT. Beyond this point, athletes made no

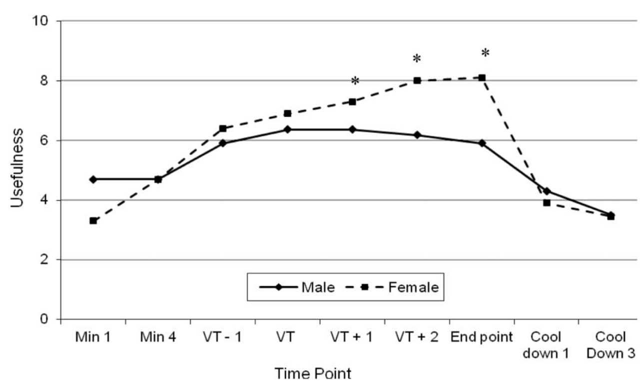

Figure 3. Task intensity × gender interaction for perceived music usefulness (p = .004) during a GXT. * $p < .05$.

further volume adjustments, including during the cool-down period, whereas recreational exercisers made a slight increase at the very end of the test, and a dramatic decrease during cool down. Previous research has reported that athletes have a tendency toward an associative focus of attention (Morgan & Pollock, 1977), thus it may be the case that these participants had greater cognitive engagement in the task beyond VT and paid little attention to the music. Clearly, this is a matter of some speculation and would benefit from further study incorporating a state measure of attention focus (Tammen, 1996). Nevertheless, our research lends indirect support to the notion that athletes may gain some benefit from music at low to moderate task intensity when the task is not particularly challenging, and music can provide a useful distraction from the monotony of the training experience (Masters & Lambert, 1989). However, at high training intensities (i.e., those that exceed VT), athletes appear to derive little benefit from music, as their attention focus is directed toward performance.

An area that may warrant further investigation is the observed difference in preferred music intensity between athletes and recreational exercisers during the cool-down phase. There is tentative evidence to suggest that listening to music postexercise is associated with reduced RPE and restored physiological function (Jing & Xudong, 2008). In their recent review article, Karageorghis and Priest (2012b) identified posttask music as a fruitful area for future research. Such explorations may have implications for exercise adherence, particularly in reference to the "remembering-self" concept (Kahneman & Riis, 2005), wherein exercise bouts that end with positive emotions are more likely to be repeated.

As an adjunct to the dependent variable of music intensity, this study also sought to examine perceived usefulness of music at various points during a GXT. A quadratic trend was expected for perceived music usefulness; this hypothesis was supported and the effect size was large ($\eta_p^2 = 0.46$). In line with the music intensity results, music was perceived as increasingly useful up until the point of VT, after which the perceived usefulness plateaued and then declined during cool down. However, examination of the interaction results indicated that this pattern was strong among males, but less so for females. Among female participants, the perceived usefulness of music mirrored that of the male participants up until VT; however, a point of inflection at 1 min post-VT (Figure 3) showed that females rated the music as more useful from this time point until the end of the task. Previous research has demonstrated that females derive more affective benefit from music during circuit-type exercises (Karageorghis et al., 2010), and qualitative evidence indicates that females experience a higher incidence of feeling "motivated" by music than males (Priest et al., 2004). It has also been reported that females have a greater tendency toward dissociative attentional strategies than men (Philippe & Seiler, 2005). Based on the current study, it appears that females find music more useful than males during exercise, particularly at high exercise intensities. Future research might investigate whether targeted music interventions for females engaged in high-intensity activity would lead them to experience greater enjoyment and adherence (Karageorghis et al., 2013).

It was hypothesized that males would prefer louder music than females throughout the task, this hypothesis was refuted. Preferred music intensity did not differ significantly between males and females. This finding is contrary to existing research (Kageyama, 1999); however, this study was unique in that it examined preferred music intensity *during* an exercise task. There is evidence to suggest that females experience more enhanced affective and motivational states as a result of listening to music during exercise (Karageorghis et al., 2010; Priest et al., 2004), which may explain why females prefer louder music in this particular context than they do in other settings. Future research should seek to replicate this novel finding.

It was hypothesized that recreational exercisers would prefer louder music than athletes throughout the task. This hypothesis was supported; recreational exercisers selected a music intensity that was an average of 6.5 dB louder than athletes during the GXT. This finding is consistent with the theory that recreational participants use music to distract themselves from sensations of exertion, more so than athletes who are relatively accustomed to such sensations and would likely have developed the appropriate strategies to deal with them (Tenenbaum et al., 2001). Previous studies that have tested the effects of music on trained and untrained participants during treadmill running both supported the notion that music is more beneficial for the untrained (Brownley et al., 1995; Mohammadzadeh et al., 2008).

Limitations

Although a rigorous music selection protocol was followed, it is possible that female and/or recreational participants preferred the music used in this study more than their counterparts. A limitation of the current research design is that no post-task measure of music-liking was used, so this is purely conjecture. Future research ought to include this post-task measure. The data collected in this study do not allow any detailed investigation of the potential effects of tempi or familiarity on preferred music intensity, but it is quite possible they may have had some effect, particularly as the effects appear to be aesthetically mediated. Research that replicates the current design using self-selected music, or music of varying tempi, may be of value, as would research efforts that incorporate the use of different exercise modalities.

Perceived music usefulness was assessed at 1-min intervals during the GXT. Use of an in-task measure was critical to testing the load-dependent hypothesis of music usefulness; however, it is acknowledged that taking such a measure during task engagement may have distracted participants from the music (and usefulness thereof) by imposing an additional attentional demand.

As a final word of caution, it should be noted that prolonged exposure to loud sound (>85 dB) produces permanent damage to the hair cells in the inner ear (NIOSH, 1998). Although louder music might be functional during exercise, purportedly raising the listener's psychomotor arousal and distracting the listener from noxious afferent stimuli, it is clear that damaging music volumes are contraindicated. In his commentary on the seductive, yet destructive, allure of loud music, Barry Blesser concludes "Like every stimulant, moderation rather than excess is often the best compromise" (Blesser, 2007, p. 6). It may also be the case that there are less potentially damaging aspects of music intensity that produce equivalent effects, and these should be explored.

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