

Effect of Music Tempo on Self-Selected Exercise Intensity in Untrained Women: A Proof of Concept Study

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Kayla Nicole Smitherman
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ABSTRACT

Purpose: To determine the impact of music tempo on self-selected exercise intensity in untrained women. **Methods:** Untrained women ($N = 13$) age ($M = 26.0$ $SD = 7.8$ years) performed a graded exercise test to determine peak oxygen consumption (VO_2) and ventilatory threshold (VT). During a separate session, participants completed three 10-minute bouts of aerobic exercise on an upright cycle ergometer under the conditions of no music (NM), medium tempo music (MT), and fast tempo music (FT). Intensity ($\%VO_{2-at-VT}$) was self-selected in all conditions. To test the primary outcome, an ANOVA was used to assess differences in intensity between conditions. **Results:** No significant differences were found between self-selected intensities between conditions (NM = 98.4 ± 15.8 $\%VO_{2-at-VT}$, MT = 99.1 ± 13.3 $\%VO_{2-at-VT}$, FT = 99.8 ± 12.0 $\%VO_{2-at-VT}$, $F(2,24) = 0.40$, $p = 0.96$). **Conclusion:** Music tempo alone may not be sufficient to impact self-selected exercise intensity in untrained women.

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CHAPTER 1

INTRODUCTION

Regarding aerobic physical activity, the United States Department of Health and Human Services recommends performing at least 150 minutes of moderate intensity physical activity, 75 minutes of vigorous intensity physical activity or a combination of the two per week for health benefits.[1] Meeting these guidelines increases the likelihood of a variety of physiological and psychological benefits such as reducing anxiety and depression on an individual level as well as reducing the prevalence and incidence of non-communicable diseases such as cardiovascular disease, Type 2 Diabetes and hypertension at the population level.[2, 3] It is estimated that only 1 in 5 adults meet the current guidelines according to the 1998-2008 National Health Interview Survey.[4] However, lower levels of achievement are believed to exist, as data from a wearable accelerometer-based device demonstrates that less than 10% of adults meet the aerobic physical activity recommendations.[5]

Low success rates among adults in the United States in meeting national physical activity guidelines can be attributed to two factors: 1) low rates of initial engagement and 2) high attrition rates.[6] Improving rates of engagement (i.e. initiation of physical activity behavior) has often been targeted through interventions applying behavioral and psychosocial theories. However, these methods have been minimally effective and account for 30% or less of the variance in physical activity behavior in intervention and cross-sectional studies.[7] This suggests that providing information on the health and wellness benefits of being physically active alone is not sufficient in creating lasting behavioral change. Of those who do initiate exercise behavior,

approximately 50% cease being physically active within the first six months.[8] A variety of perceived barriers among individuals purportedly contribute to both low engagement and attrition, such as perceived time, accessibility, and competence.[9] However, researchers have surmised that “feelings of enjoyment and well-being may be stronger motives for continued participation than the knowledge and belief in health benefits.”[10] More recently, there has been research interest in assessing the affective responses (pleasure vs. displeasure) during exercise.[11-17] In line with Hedonic Theory[18], if exercise is perceived to “feel bad”, then the physical activity is likely to be avoided in the future.[11, 12] Thus, researchers have suggested that exercise prescription should follow a tripartite model,[14] such that a given prescription is designed to 1) maximize physiological outcomes, 2) minimize risk, and 3) avoid feelings of displeasure in order to facilitate long-term and repeated behavior. To date, it is unclear how to best implement this model to yield optimal behavioral and health outcomes.

One method of preventing negative affective responses that has been explored through laboratory studies and interventions is to allow individuals to self-select exercise intensities.[6, 16, 19-22] This approach is an attractive option for several reasons. First, individuals on average tend to self-select intensities at or just below their ventilatory threshold.[23] Ventilatory threshold is an estimation of the transition aerobic and anaerobic energy processes at which ventilation begins to increase at a more rapid rate and typically occurs during moderate intensity exertion in the average untrained adult.[24, 25] This is important, as the Dual Mode Theory indicates that crossing this physiological point is associated with nearly uniform, negative affective responses.[13] Second, allowing individuals to self-select provides a degree of autonomy, which is

important for enhancing intrinsic motivation and behavioral adherence according to Self-Determination Theory.[26] This is believed to be a cognitive reframing of the task from a chore, or something they must do, to something they choose to do.[14] Further, several studies have demonstrated that imposing workloads, even at the same intensity as previously self-selected, yield less positive affective responses.[6, 22] To date, allowing sedentary individuals to self-select exercise intensity appears promising; two intervention studies have been conducted, wherein individuals were instructed to exercise at either a perceived exertion of 13 on a Borg scale[20] or allowed to exercise at a self-selected pace.[27] These studies demonstrated improvements in fitness and health such as increased fitness, decreased BMI, decreased mean arterial pressure, and decreased total cholesterol for self-paced and perceptually regulated exercise training.[20, 27] In addition, self-paced exercise yielded greater improvements in behavior such as an additional 26 minutes per week of activity with self-paced exercise than traditional interventions with prescribed intensity.[27]

While self-selection of intensity is one means of implementing the tripartite model, it is necessary to consider several important limitations. First, while individuals, on average, self-select exercise intensities just below VT, there exists a high degree of inter-individual variability in self-selected intensities.[19, 28] One concern is that people may select an intensity that feels good, but is too low to elicit perceptible improvements in health or body composition. Encouraging the participation of exercise at higher intensities will presumably allow individuals to attain more noticeable results in a time effective manner, therefore enhancing self-efficacy and promoting long term behavior change. Thus, while allowing inactive individuals to self-select their intensities appears

feasible and theoretically-supported, it may also be important to determine means of “nudging” individuals toward choosing greater intensities in order to facilitate desirable outcomes.

Playing music is one potential approach to increasing self-selected exercise intensity. Research has indicated that the addition of music appears to positively impact perceptual factors such as affect, rate of perceived exertion as well as positively impact measurable behaviors such as work output and time to exhaustion in repetitive endurance activities.[29-36] Factors that determine the motivational qualities of music include rhythm response (i.e. tempo), musicality (i.e. tune), cultural impact (i.e. societal relevance), and association (i.e. memory).[29] These factors have a hierarchical relationship with rhythm (i.e. tempo) having the strongest impact on the motivational quality of a piece of music.[29] Compared with no music conditions, studies have shown the addition of music to increase time to exhaustion during fitness testing [31-34] and a decrease in time-to-finish in competitive settings.[35, 36] However the majority of these studies have included trained individuals and men. Examining the effect of music on self-selected intensity in women is especially important, as they tend to be less active than men on a population level according to epidemiological data.[37] Further, women who are active report engaging in lower intensity exercise than men who are active.[37] Exercising at higher intensities promotes greater improvement in fitness and provides greater improvements in reducing risk factors related to cardiovascular disease.[38-40] Those participating in fitness activities often cite physical appearance as motivation.[41] Women especially cite appearance and weight control among motivators, while citing “being out of shape” as a perceived barrier.[42] Thus, it is important to determine

whether individuals, particularly women, could be guided in choosing these relatively higher intensities under their own volition to preserve autonomy, but also achieve these highly sought after outcomes that are also important for adherence. Therefore, the aim of the current study is to examine the effects of music tempo on self-selected exercise intensity in untrained women.

Research Question: Will the addition of music impact the self-selected exercise intensity of untrained women?

Hypothesis 1: Self-selected exercise intensity will be different in the music conditions compared to the no music condition.

Hypothesis 2: Self-selected exercise intensity will be different in the fast tempo music condition compared to the medium tempo music condition.

Null Hypothesis: No change in self-selected exercise intensity will occur between the conditions.

CHAPTER 2

LITERATURE REVIEW

Physical Activity Behavior and Health

Regular participation in physical activity produces numerous health and wellness benefits. Those who report higher levels of physical activity have lower risk for depression and anxiety.[2] They also demonstrate improvements in mood, self-efficacy, overall well-being, psychological well-being, and longevity.[43] Commitment to routine physical activity can reduce the risk for over 25 chronic medical conditions including coronary heart disease, Type 2 Diabetes, and some cancers along with reducing all-cause mortality rates.[3, 44] While even modest increases in physical activity can provide significant reductions in these non-communicable diseases,[44] increases in aerobic fitness provide greater reductions in risks.[45] For every 1-metabolic equivalent (MET) unit increase in cardiorespiratory fitness there is a 10-25% risk reduction in all-cause mortality in adults.[45] When considering those with low aerobic fitness levels, the reduction of risk increases to approximately 30% per 1-MET increase in cardiorespiratory fitness.[45] Participating in physical activity at higher intensities can augment improvements in fitness, provide greater improvements in reducing risk factors related to cardiovascular disease,[38, 39] and promote greater decreases in body fat.[40]

The positive impact of physical activity on health has led to public recommendations on the amount of physical activity individuals should attain. The United States Department of Health and Human Services recommends individuals attain 150 minutes of moderate or 75 minutes of vigorous intensity aerobic activity per

week for health benefits, even in small doses of 10-minutes accumulated throughout the day.[1] Other recommendations for aerobic activity include 10,000 steps per day, 450-750 MET minutes per week, or 1000-2000 kilocalories expended per week.[46, 47]

Despite the documented benefits of regular participation in aerobic physical activity the proportion of adults who meet the weekly guidelines is low. According to the 1998-2008 National Health Interview Survey, it is estimated that only 1 in 5 United States adults meet the current guidelines.[4] However, this may be an overestimation because when activity is measured by an accelerometer, less than 10% of individuals attain the recommended amount of physical activity according to NHANES 2005-2006 data.[5] The low level of physical activity participation can be attributed to two factors 1) low rates of initial involvement and 2) high attrition rates.[6] While the two are inter-related, approaches to maintenance should be unique from the adoption of physical activity behavior.[48] While intervention approaches have been successful in the adoption of physical activity, they have been unsuccessful in the maintenance of long-term behavior.[8] This is evident with the drop out or relapse into previous inactive behavior for the majority of individuals who initiate physical activity programs. Not only do the majority of individuals who begin a program drop out, but they do so at an alarming rate: 35-66% discontinue participation within the first 6 months with 50% of individuals dropping out on average.[8] While there are many determinants of continued exercise behavior across personal, environmental, behavioral and psychological domains, the most basic underlying factor is how one feels during physical activity.[10,

49, 50] A growing body of literature suggests negative affective responses during physical activity contribute to low participation and high drop-out rates.

Affective Responses and Exercise Behavior

Affective responses include multiple psychological dimensions such as mood, emotion, and core affect, which are considered distinct concepts among psychology experts. Emotions (i.e. “fear,” “anger,” “grief,”) include some form of cognitive assessment which are relatively short-lived,[51] whereas a mood (i.e. “tense,” “depressive,” “irritable”) is less specific, more global feeling that has a longer, lasting effect.[52] Core affect (i.e. experiencing pleasure or displeasure) is the most basic component of all valenced responses. [52] Measures of core affect are particularly important within the Hedonic Theory of Motivation, which states that an individual is likely to repeat behavior when it is pleasant and avoid behavior that is deemed unpleasant.[18]

While there exists a common belief that “exercise makes people feel good”, even though the majority of individuals are untrained. This belief is due mainly to early studies that only measured affective responses before and after activity, demonstrating transient positive changes from pre to post measures.[53] However, more recent studies have shown the limitation in relying solely on pre to post measures. Differences in affective response from pre-bout to in-bout responses are observed at both low-to-moderate,[15] vigorous,[54] and even strenuous[55] intensities. However, following cessation of exercise, a uniform positive response occurs.[13, 15, 54, 55] This body of literature would suggest that early studies were actually capturing a rebound effect

occurs following moderate and high intensity exercise. That is, one may feel negatively during exercise, but rate more favorable affective responses once exercise has ended and the aversive stimulus is removed.[53] Therefore, it is arguably more important to assess in-task affective responses, rather than simply assessing pre-post effects.

How one feels during a single bout of exercise is linked to activity patterns and future behavior. Additionally, decision making processes or cognitive beliefs about activity behavior are mediated through the individual's affective associations with that behavior.[56] Cross-sectional and longitudinal studies have found a significant relationship between core affect and physical activity behavior.[11, 12, 56-58] In one such study, Williams et al.,[12] reported both a cross-sectional relationship between affective response during moderate intensity exercise with current level of physical activity ($\beta = 28.6$, $p = 0.008$). These same authors also reported a longitudinal relationship between affective response and level of physical activity 6 months later ($\beta = 14.8$, $p = 0.030$). Other studies have also concluded similar findings in children, young adults, low active adults and sedentary adults.[11, 12, 56-58] Overall, those who displayed more positive affect during exercise had greater participation in physical activity. Williams et al.[11] found that a 1-unit increase on the FS during a moderate intensity of exercise was associated with 38 and 41 additional minutes of at least moderate-to-vigorous intensity physical activity (MVPA) at the 6-month and 12-month follow-up respectively. These studies are consistent with the conceptual framework of Hedonic Theory in suggesting physical activity when deemed pleasurable will be

repeated and suggests a relationship between the intensity of physical activity and affect.

Affect is impacted by exercise intensity as explained by the Dual Mode Theory.[13] This theory recognizes the interplay between cognitive and physiological factors on affect during exercise in relation to exercise intensity.[13] At lower intensities cognitive cues (i.e. “self-efficacy,” “distractions”, “enjoyment”) have a greater impact on affective response but as intensity increases, physiological cues (i.e. “muscular discomfort,” “labored breathing”) become the stronger determinants.[13] In general, an inverse relationship exists that is greatly dependent on metabolic landmarks, such as the ventilator threshold (VT), the lactate threshold (LT), or the onset of blood lactate accumulation (OBLA).[14] When examining the affect-intensity relationship at group level, affect seems to improve or remain unchanged below these anaerobic markers, decline above these anaerobic markers and produce a homogenous decline in negative affect when approaching maximal exertion.[14] This occurs because physiological cues such as muscular discomfort or labored breathing become stronger than cognitive cues such as self-efficacy, mood or enjoyment.[13]

While these trends exist, there is a great deal of variability in inter-individual affective responses, especially at intensities below and leading up to these anaerobic markers which is affected by many factors including but not limited to gender, fitness level and age.[13] A landmark study by Van Landuyt et al.,[15] reported differences in affective responses within their sample in that 44.4% of participants increased affective response, 41.3% decreased affective response, and 14.3% demonstrated no change in affective response while exercising at a moderate intensity (60%VO₂max). Another

study by Parfitt et al.,[16] also reported variability in affective response in sedentary men exercising at intensities below VT with 58% of participants demonstrating an increase in affective response, 25% demonstrating a decrease, and 17% demonstrating no change in affective response. Similar results were also reported in a study of sedentary women with variability in affective responses below VT with 42% increasing in affective response, 32% decreasing in affective response, and 26% demonstrating no change in affective response as well as variability in affective responses at VT with 21% in affective response, 42% decreasing in affective response, and 37% demonstrating no change 37% in in affective response.[17]

Currently, exercise prescription only considers effectiveness and safety.[59] While these components are essential foundations to exercise prescription, they are limited in reinforcing long-term physical activity behavior. It has been suggested that exercise prescription should consider not only effectiveness and safety, as in current guidelines, but they should also consider pleasure or enjoyment. This tripartite model has been recommended as a solution to promote long-term adherence.[14] This is believed to be a promising approach in which the practitioner not only prescribes the classic activity prescription but also incorporates concessions to activity in order to prevent negative affective responses. However, because of the unique psychological and physiological responses to exercise that demonstrate great inter-individual variability, it would be impossible and problematic to advise a one size fits all

prescription. One solution to prevent negative affective responses during an exercise is to allow the individual to self-select the intensity of exercise.

Self-Selected Intensity

One method for promoting and preserving positive affective response during physical activity is to allow individuals to self-select the intensity of the bout. According to Ryan et al.[26] persistence and performance in a task can be enhanced through motivation. When motivation is controlled from self-supported or autonomous means, the value of an activity is promoted by positive factors such as greater interest, excitement, and confidence compared to when motivation is controlled by external factors which can include negative consequences or negative reinforcement.[26] Approaching a task with autonomy and intrinsic motivation allows for a cognitive reframing of the task from a chore, or something that must be done, to an interest as something chosen to be done.[14] Therefore, the promotion of intrinsic motivation should be of paramount importance in physical activity interventions. Fostering intrinsic motivation through the recognition of factors within the self-determination theory such as competence and autonomy will be necessary to promote practical changes in interventions. Research with the cognitive evaluation theory, which aims to identify and explain variability within the SDT, has shown that competence cannot effect intrinsic motivation without the complement of a sense of autonomy.[26] To this end, it is important to examine the effects of autonomy on physical activity behavior.

Allowing individuals to self-select their intensity has been shown to preserve positive affective response to exercise. In a study by Lind et al.[6] a significant decrease

in pleasure was found during an imposed condition that was only 10% greater in speed than that of a self-selected bout. Twenty-five middle-aged, overweight, sedentary females performed a 20 minute walking bout on a treadmill at a self-selected pace. Upon returning to the lab, the participants completed an imposed bout of exercise on the treadmill at a speed that was 10% higher than the previous bout and pleasure significantly decreased. However, due to the nature of the study it was unclear whether or not the increase in intensity or the loss of autonomy contributed to the decrease in pleasure. In a follow-up study conducted by Vazou-Ekkekakakis et al.,[22] participants completed an imposed condition that was identical to a prior self-selected bout. The loss of autonomy alone independently lowered affective responses. In a study by Parfitt et al.,[16] twelve sedentary men completed a self-selected bout along with imposed intensity conditions below and above the lactate threshold. When allowed to self-select, the participants worked close to but not above their lactate threshold, on average.[16] Selected intensity was examined in another study with middle aged formerly sedentary women as participants in which the participants were asked to self-select intensity during a twenty minute exercise bout on the treadmill. On average, the women selected an intensity that corresponded to but did not exceed their ventilatory threshold.[19] It was also reported that the intensity did not feel hard or unpleasant and affective valence remained positive and stable throughout the bout.[19]

Allowing individuals to self-select intensity seems to be a viable option as a few intervention studies have demonstrated the practicality of incorporating self-selection of intensity when prescribing training programs.[21, 27] Parfitt et al.[20] conducted an 8-week supervised intervention study in which sedentary participants exercised 3 times a

week for 30 minutes at a RPE of 13 (give the verbal description) on the Borg scale.[20] Participants increased their cardiorespiratory fitness by 17% while maintaining a positive affective response of “good” on the feeling scale during exercise.[20] In an unsupervised intervention study by Williams et al.,[27] participants were either assigned to a moderate intensity or self-paced walking program for a 6-month period. At the end of the study those in the self-paced group reported performing almost 26 more minutes than the moderate intensity group along with a slight increase in total energy expenditure per week.[27]

While self-selection is an option that warrants further exploration, it is not without limitations. Despite the fact most individuals will select an intensity that is near an anaerobic threshold such as VT or LT on average, a wide range of inter-individual variability exists in what intensity individuals select when individuals are left up to their own devices.[14] This range indicates that some people select intensities that are above the recommended range of safe exercise intensity. This could produce negative affective response and increase risk for injury. Other people could select intensities that are too low to be physiologically and behaviorally relevant. When prompted to “get a good workout,” or only given the options of jogging and running individuals exceeded the ACSM recommended range of intensities.[59] Conversely, some individuals self-select intensities that are too low. While small increases in the volume of physical activity can produce significant improvements in health,[44] they may not be salient to the individual therefore contributing to the attrition in physical activity. This can lead to lack of maintenance if the activity is not perceived as aiding in health, wellness, or fitness outcomes. Working at higher intensities provides greater increases in

cardiorespiratory fitness,[38] provides greater cardioprotective benefits,[38, 39] and aids in the achievement weight-loss goals.[60] This could be particularly beneficial, especially among women, who cite appearance and weight control among motivators for women and cite being out of shape as a perceived barrier.[42] Weight loss is a frequent rationale for engagement in exercise among women. Among college women weight maintenance or weight loss is a stronger motivator than other behavioral factors such as health, fitness, mood, or social interaction.[61] Taking this into account, suggesting higher levels of physical activity have been shown to better promote long-term weight loss.[60] To this end, it is important to examine possible strategies for increasing self-selected exercise intensity in order to strike a balance between feeling good and eliciting physiological outcomes that are salient to the individual (i.e. desired weight loss).

Music

Listening to music is a potential choice for promoting greater self-selected intensities in untrained adults. The combination of music with exercise is common in fitness settings. It is common to see individual exercisers often exercise with the accompaniment of personal hand-held listening devices. In 2012, Kargeorghis et al.[29, 30] provided a two-part comprehensive review of studies that have examined the effects of music on exercise and created some conceptual framework in which to structure studies involving music and performance. In this review, Karageorghis et al.,[29] suggested the existence of a hierarchy to musical components and their motivational impact on exercise performance: 1) rhythm response, 2) musicality, 3) cultural impact,

and 4) association.[29, 30] While the last two factors are highly variable and dependent on the individual listening to the music, the first two factors are objectively descriptive of the music itself with rhythm response referring to beat or tempo of the music and musicality referring to the pitch or harmony of the musical piece. Music impacts both psychological and physiological components during the exercise session. The motivational qualities of music are believed to enhance mood, decrease RPE and control arousal, all of which can enhance not only a single bout of exercise but may lead to the promotion of exercise.[29, 30]

Listening to music during exercise tends to lower ratings of perceived exertion. When comparing exercise sessions with and without musical stimuli, sessions with music tend to have lower reported values of perceived exertion during both cycling and treadmill exercise.[33, 62-64] Listening to music causes reduced RPE at low-to-moderate intensity exercise but not during vigorous intensity exercise.[63] Some studies have shown no differences in RPE even while exercise intensities increase with the addition of music.[65-67] No difference in RPE between conditions suggests that music can dampen the psychological response to exercise intensity, in that participants work harder with no noticeable changes in exertion in the presence of music.

Music has aided in the increased duration of maximal exercise testing. Time to exhaustion during exercise has been increased in maximal graded exercise tests with the addition of music.[31-34] While music increased time-to-exhaustion with slow or fast tempo music[34] in both trained and untrained participants,[33] music seemed to have greater effects with fast-paced music and untrained participants during maximal

fitness testing. Self-selected music also significantly increased time-to-exhaustion during Bruce protocol test.[31]

Quite a few studies examined the effects of music on aerobic performance in cycling, running, and walking in recreational endurance and team-sport athletes. In a study by Atkinson et al.[35] the addition of music produced an average two percent decrease in time 10-km cycle trial. Auditory stimuli (synchronous music and metronome) also significantly increased running distance in recreational runners.[32] Not only can pace be increased with the use of music, but time to exhaustion is increased as well. Time to exhaustion in elite triathletes increased significantly with the use of self-selected music during a treadmill running task.[68] A similar phenomenon occurred in participants collected from team sport groups walking at 75% of their maximal heart rate reserve while listening to motivational, outdeterous (neither motivating nor demotivating) music and no music. Time to exhaustion was improved in both music conditions compared to the no music.[69]

Music has positively impacted cycling performance in university students compared to conditions without music.[70, 71] In a study by Cohen et al.,[70] music had a significant effect on cycling rate but not duration of exercise. While participants were allowed to pedal freely, resistance was pre-set by the researchers to elicit a heart-rate response of 60% age predicted HRmax. In other studies, distance traveled was significantly impacted by music during both a 12-minute cycling task[71] and a 20-minute cycling task.[72] During the 12-minute cycling task participants were asked to

work at an RPE of “13” on the Borg scale[71] whereas the 20-minute cycling task participants were given a range of intensity (60-80 % HRmax).[72]

Music tempo and volume both impact work performed during self-paced exercise. Increasing music tempo has been shown to increase distance traveled, work and cadence in undergraduate students. In a study by Elliott et al.,[66] 18 undergraduate students were asked to cycle for 20 minutes under no music, slow music (100bpm), moderately-fast music (140 bpm), and fast music (180 bpm) conditions. Distance traveled was significantly further in the fast and moderately fast music conditions compared to the no music and slow music conditions with no significant difference between distance traveled and the fast and moderately-fast music conditions. In another study, twelve healthy male participants cycled at a self-selected work rate for about 25 minutes, under three conditions: normal, 10% tempo increase and 10% tempo decrease condition.[67] Overall distance, power and cadence increased when the participants listened to fast music and decreased when the participants listened to slow music. Music volume also impacts self-paced exercise when coupled with a faster tempo. In a study by Edworthy et al.,[65] significant differences in treadmill speed and heart rate were found between the fast/loud and slow/quiet conditions. Overall tempo was determined to have a main effect on performance with increased aid from volume. A study by Wilson et al.[73] determined 85-89 decibels (d(B)) to be preferred by most exercisers in an aerobic setting.

Some limitations within the existing literature include the lack of variation in population studied (i.e. untrained, women) and the addition of instructions that might have skewed the natural response to musical stimuli. Some of the studies impacted the

self-selection of intensity by either suggesting participants “get a good workout,” push themselves, selecting resistance, suggesting intensity by perceived exertion, or by providing an intensity range [70-72]. It is unclear if music would have a positive effect on performance in a fully autonomous environment in which participants have full control over both resistance and cycle rate. The majority of studies have examined the effects of music on performance in active individuals and in male populations while fewer studies have suggested that music may impact performance in untrained individuals and women.[33, 34] Studying the effects of music in untrained women is necessary due to the gender discrepancies in physical activity intensities. Females are not only consistently less active than males, but they also consistently engage in lower intensity activities.[37, 46, 74] When participating in activity other than walking, men are more likely to perform moderate-to-vigorous intensity activity than women.[37] Given the aforementioned findings, we hypothesize that the addition of music will impact the exercise intensity selected by untrained women.

CHAPTER 3

MANUSCRIPT

ABSTRACT

Purpose: To determine the impact of music tempo on self-selected exercise intensity in untrained women. **Methods:** Untrained women (N= 13) age ($M= 26.0$ $SD= 7.8$ years) performed a graded exercise test to determine peak oxygen consumption (VO_2) and ventilatory threshold (VT). During a separate session, participants completed three 10-minute bouts of aerobic exercise on an upright cycle ergometer under the conditions of no music (NM), medium tempo music (MT), and fast tempo music (FT). Intensity ($\%VO_{2-at-VT}$) was self-selected in all conditions. To test the primary outcome, an ANOVA was used to assess differences in intensity between conditions. **Results:** No significant differences were found between self-selected intensities between conditions (NM= 98.4 ± 15.8 $\%VO_{2-at-VT}$, MT= 99.1 ± 13.3 $\%VO_{2-at-VT}$, FT= 99.8 ± 12.0 $\%VO_{2-at-VT}$, $F(2,24)= 0.40$, $p=0.96$). **Conclusion:** Music tempo alone may not be sufficient to impact self-selected exercise intensity in untrained women.

Introduction

Accumulating 150 minutes of at least moderate-intensity aerobic physical activity (or the metabolic equivalent), as recommended in the 2008 Physical Activity Guidelines, yields a variety of psychological and physiological benefits such as reducing the likelihood of anxiety and depression on an individual level, as well as reducing the likelihood of the prevalence and incidence of non-communicable diseases at the population level.[1-3] Yet despite the known benefits, only about 1 in 5 adults in the United States report meeting these guidelines for aerobic activity according to the 1998-2008 National Health Interview Survey.[4] The low success rates are often attributed to two behavioral factors: 1) low rates of initial engagement and 2) high attrition rates.[6] In regard to the latter, of those who do initiate exercise behavior, approximately 50% drop out of activity involvement within the first six months.[75] While a variety of barriers purportedly contribute to both low engagement and attrition (i.e. perceived time, accessibility, competence), Dishman et al,[10] previously suggested that one's enjoyment of exercise has a greater influence on continued behavior.

More recently, there has been a growing interest among researchers in the assessment of affective responses (pleasure vs. displeasure) *during* exercise.[11-17] In line with Hedonic Theory,[18] if exercise is perceived to “feel bad”, then the activity is likely to be avoided in the future.[11, 12] Thus, researchers have suggested that exercise prescription should follow a *tripartite model*,[14] such that a given prescription should be designed to 1) maximize physiological outcomes, 2) minimize risk, and 3) prevent feelings of displeasure in order to facilitate long-term and repeated behavior.

To date, it is unclear how to best implement this model to promote physical activity and yield optimal behavioral and health outcomes.

One suggested method of preventing negative affective responses associated with physical activity that has been explored through laboratory studies and interventions is to allow individuals to self-select exercise intensities.[6, 16, 19-22] This approach is a viable option for several reasons. First, individuals on average tend to self-select intensities proximal to their ventilatory threshold (VT).[13] This is important, as the Dual Mode Theory indicates that crossing this physiological point is associated with nearly uniform, negative affective responses.[14] Second, according to Self-Determination Theory, allowing individuals to self-select exercise intensity provides the individual a degree of autonomy, which is important for enhancing intrinsic motivation and behavioral adherence.[26] Further, several studies have demonstrated that imposing exercise workloads, even at the same intensity as previously self-selected, yield less positive affective responses.[6, 22] Taken together, allowing sedentary individuals to self-select intensity has proved promising in intervention studies in improving both health and fitness, as well as behavior.[20, 21]

While self-selection of intensity may prove useful for generalized exercise prescription, it is important to consider potential limitations. At present those who engage in exercise prefer to do so autonomously, yet the majority of individuals do not participate in regular physical activity.[4, 76, 77] When participating in self-paced exercise, few use either HR or RPE for a measure of intensity, as ACSM suggests, with 86% of adult women reporting using neither.[59, 78]. Thus, explicitly instructing self-selection may be redundant if it is the sole approach to changing behavior. Additionally,

while individuals, on average, self-select proximal to their VT, there exists a high degree of inter-individual variability in self-selected intensities similar to a study by Lind et al.,[19] which suggests individuals on average selected 100% $\text{VO}_2\text{-at-VT}$ with a range of 60-160% $\text{VO}_2\text{-at-VT}$. One concern is that people may select an intensity that feels good, but is not sufficient at yielding perceivable improvements in health or body composition. Exercising at higher intensities promotes greater improvement in fitness and provides greater improvements in reducing risk factors related to cardiovascular disease.[38-40], which aligns with common exercise goals in that those participating in fitness activities often cite physical appearance as motivation.[41] Women especially cite appearance and weight control among motivators, while citing “being out of shape” as a perceived barrier.[42] Thus, it is important to determine whether individuals can be guided in choosing these relatively higher intensities under their own volition to preserve autonomy, but also achieve these highly sought after outcomes that are also important for adherence.

Playing music is one potential approach of increasing self-selected exercise intensity. Research has indicated that the addition of music appears to positively impact perceived factors [34]such as positive affect, rate of perceived exertion, as well as positively impact work output and time to exhaustion in repetitive endurance activities.[29, 30] Compared with no music conditions, studies have shown the addition of music increases time to exhaustion during fitness testing,[31-33] as well as decreasing in time to finish in competitive settings.[35, 36] Within the multiple properties of music itself, tempo or rhythm response appears to be the strongest determinant of increased performance.[29, 65-67] However the majority of these

studies have mainly included trained individuals and/or a sample consisting only of men. Considering that women engage in less exercise and less intense exercise relative to men[37, 46, 74] and that weight maintenance/weight loss is a stronger motivator than other behavioral factors such as health, fitness, mood, or social interaction,[61] research is needed to determine whether or not music can serve to increase self-selected exercise intensity specifically within untrained women. Therefore, the current proof-of-concept study was designed to examine the effects of music tempo (moderate and fast) on self-selected exercise intensity in untrained women.

Methods

Experimental Overview

All procedures were approved by the University of Tennessee Institutional Review Board (UTK IRB-15-02508-FB). In order to elicit natural, self-selected responses to each condition, participants were blinded to the true purpose of the study. Using targeted language in the informed consent and implementing sham cognitive tasks, participants were led to believe that the purpose was to determine the impact of exercise, with and without music, on cognitive performance. Upon study completion, participants were debriefed and provided additional informed consent revealing the true nature of the study. Those eligible for the study completed two visits to the lab. Upon their first visit to the laboratory, participants provided informed, written consent, demographic and psychological questionnaires, measures of height and weight, and participated in a peak aerobic fitness test on a cycle ergometer to establish ventilatory threshold (VT) and peak oxygen consumption ($\text{VO}_{2\text{peak}}$). The second visit consisted of

three bouts of exercise (separated by approximately 10 minutes), surveys, and computer tasks. At the conclusion of the second lab visit, a time of debriefing was provided to complete another informed consent which disclosed the true purpose of the study.

Study Participants

Eligible female participants between the ages of 18-55 years of age were recruited from the Knoxville, Tennessee area. Participants were considered eligible if they had a body mass index (BMI) between 18.5 – 34.9 kg/m² and reported less than 150 minutes of recreational moderate intensity exercise per week or metabolic equivalent as determined from the Global Physical Activity Questionnaire (GPAC).[79] Individuals were excluded from the study if they answered “yes” to any of the Physical Activity Readiness Questionnaire (PAR-Q) items, or reported being pregnant or planning to become pregnant.[80] Thirteen participants completed both sessions and were included for statistical analyses.

Procedures

Initial Session

Following consent and eligibility, participants completed questionnaires assessing demographic information, self-determination toward physical activity, and preference for and tolerance of exercise intensity to determine if individual characteristics impact what individuals self-select.[81, 82] Height and weight were measured using standard procedures to calculate body mass index (BMI). Participants

were outfitted with a Polar heart rate monitor (Polar Electro, Lake Success, NY) via chest strap and a mouthpiece that connects to a metabolic cart (ParvoMedics, TrueOne 2400, Salt Lake, UT) and cycled on the Lode Excalibur Sport ergometer (Lode Excalibur Sport, Groningen, Netherlands) during the peak cycle ergometer test. Participants then performed a graded exercise test using a ramp protocol starting with a warm-up at 25 Watts (W) for three minutes. After the warm-up the initial load was set to 40W followed by an increase of 10W every minute until termination of test.[83] Participants' peak oxygen uptake ($\text{VO}_{2\text{peak}}$) and ventilatory threshold (VT) were measured with the use of the metabolic cart.

Supervised Exercise Session

During the second session the participants completed a pre-exercise packet which included the Positive and Negative Affective Schedule (PANAS)[84] and the Feeling Scale (FS)[85, 86] in order to determine baseline affect that day. Participants then completed three separate 10-minute bouts of self-selected exercise under three conditions of no music, medium tempo music (MT; 120bpm), and fast tempo music (FT; 160 bpm) on an upright stationary cycle bike (Matrix U5X, Cottage Grove, WI) with a custom made blinder to block the display screen. The Matrix U5X was selected because it is a commercially available device that allows participants to readily control resistance. Resting heart rate was recorded via a Polar heart rate monitor (Polar Electro, Lake Success, NY) during seated rest for 5 minutes prior to the no music condition. Each exercise bout was preceded by a 3 minute warm-up at a light load of 35W. The first bout consisted of the no music condition followed the medium tempo

music (MT) and fast tempo music (FT) conditions in counter-balanced order. Participants were allowed to freely adjust resistance and cadence during the bouts and were given the prompt “you are free to change the resistance during the next ten minutes”. Heart rate and watts were recorded during the last 15 seconds of every minute during the 10-minute exercise bout. Average watts were used to calculate intensity as a measure of $\text{VO}_2\text{-at-VT}$ for each bout at a later time using the ACSM metabolic equations.[87] Cadence was recorded continuously via the use of a commercially available magnetic device (GARMIN, Edge 25, Chicago, IL), attached to the pedal of the stationary bike.

Each exercise bout was preceded by two cognitive tasks (Stroop and Flanker)[88] via a computer program downloaded from the Psychology Experiment Building Language (PEBL) website. These tasks were implemented to allow adequate time for the heart rate to return to within 10 bpm of the resting rate before the start of each subsequent exercise bout to ensure the participant had fully recovered between bouts. The addition of these tasks also aided in distracting the participants to the true purpose of the study. The FS was administered before and after the cognitive tasks. The Brunel Music Rating Inventory-2 (BMRI-2) and VAS questionnaires were administered immediately following the music conditions to determine the motivational qualities of the music as well as to determine the participants’ level of focus on exercise and music. At the conclusion of the second session a debriefing consultation was

given to inform the participants of the true purpose of the study and educate the participants on why the deception was important to the research.

Music Selection

Within the multiple properties of music itself, tempo or rhythm response is the strongest determinant of increased performance.[29] Therefore, tempo was selected as the primary difference between musical conditions. In an attempt to standardize musicality between the MT and FT conditions, songs were chosen by the researchers for both the medium tempo and fast tempo playlists from Power Music's website with a selection of "Top 40 Hits".[89] This website is available for the creation of music for group fitness classes which ensures a steady tempo and motivational qualities in the musicality of the selected music. Music volume was placed at a loud but safe level of 85 dB(A) via a stereo device (Harman, JBL Flip, Stamford CT) .[73]

Survey Instruments

Behavioral Regulation in Exercise Questionnaire (BREQ-2): The BREQ-2 survey includes 19 items which are scored on a 5-point Likert scale (0 = not true for me, 2 = sometimes true for me, 4 = very true for me). These items are computed into a Relative Autonomy Index (RAI) score which indicates the degree to which respondents feel self-determined in exercise. Scores can range from 0-20 with higher, positive scores indicating greater relative autonomy; lower, negative scores indicating more controlled

regulation. The BREQ-2 was administered during the first session and has been shown to be both valid and reliable.[82]

The Preference for and Tolerance of the Intensity of Exercise Questionnaire (PRETIE-Q): The PRETIE-Q assessed individual differences regarding the intensity of exercise preferred and the intensity that can be tolerated. The questionnaire includes 16 items which are scored on a 5-point Likert Scale (1 = totally disagree, 3 = neutral, 5 = totally agree). The PRETIE-Q is separated into two subscales, preference and tolerance, with 8-items relating to each subscale. The subscale items are averaged and can range from 1-5 with higher scores indicating more preference or tolerance for higher intensities respectively. The PRETIE-Q was administered during the initial session and has been shown to be internally consistent, structurally valid and related to the frequency of participation in vigorous physical activity and total leisure time.[90]

Positive and Negative Affect Schedule (PANAS): The PANAS is a 20-item scale that has been previously validated for use in determining acute affective valence.[91] The PANAS is separated into two subscales, positive affect and negative affect, with 10-items relating to each subscale. The subscale scores can range from 10-50 with higher scores indicating more positive or negative affect respectively. The PANAS was administered at the start of the supervised exercise session.

Feelings Scale (FS): This 11-point scale assesses immediate affective feelings of pleasure and displeasure.[85, 86] The FS ranges from -5 (very bad) to 5 (very good)

with 0 (neutral) as the midpoint. The FS has been used as a measure of affective valence in response to acute exercise.[11, 92] FS responses have been related to other measures of affective valence[55] as well as past and future physical activity participation.[11, 85, 86] The FS was administered at the start of the supervised exercise session.

Brunel Music Rating Inventory -2 (BMRI-2): is a 6-item scale that examines the motivational qualities of music toward exercise. This scale examines individual factors of music such as rhythm, tempo, instrumentation and melody. Each response ranges from 1 (strongly disagree) to 7 (strongly agree).[93] BMRI-2 scores can range from 6-42 with scores divided into categories of highly motivational (36-42), moderately motivational (24-36), or outdeterous(≤ 24). The BMRI-2 was administered during of the supervised exercise session following each of the music conditions.

Dissociation Visual Analogue Scale (VAS): Each question will be ranked on a 100mm line from “Not at All” to “Extremely” regarding how focused the individual was toward 1) exercise and 2) music. Each VAS was administered during the supervised exercise session immediately following each of the music condition bouts.

Statistical Analysis

All analyses were conducted using the Statistical Package for the Social Sciences (SPSS, version 23; SPSS Inc., Chicago IL). Repeated measures ANOVAs were completed using Bonferroni adjustments for post hoc analyses in order to

determine differences in self-selected exercise intensities and pre-bout HR between conditions. A paired-samples t-test was used to determine differences between the motivational qualities of the music conditions, as determined by the BMRI-2 score following the MT and FT conditions. All results are presented as Mean $\pm$ Standard Deviation. Significance was set at $p < 0.05$. Power estimates were conducted using the online Glimmpse software.[94]

Results

Manipulation Checks

No significant differences were detected between pre-condition HR ($F(2,20) = 2.80$ $p = 0.11$) at the start of each exercise bout, which suggests each bout can be considered to be independent of the others. No significant differences were found between the motivational qualities of the music of the MT (BMRI-2 = 34.54 ± 6.12) and FT conditions (BMRI-2 = 32.54 ± 7.71 ; $t = 0.941$, $p = 0.37$).

Primary Outcome

Thirteen untrained women completed the study. On average the women were young adults (age = 26.00 ± 7.78 years) of normal weight (BMI = 24.48 ± 4.00 kg/m²) with relatively low aerobic fitness ($VO_{2peak} = 27.45 \pm 4.94$ ml*kg*min⁻¹). Table 1 provides additional demographic information. The repeated measures ANOVA indicated no statistical significance ($F(2, 24) = 0.40$, $p = 0.96$) regarding self-selected intensity between experimental conditions (Figure 1, Panel A; NM = 98.39 ± 15.81 , MT = 99.06 ± 13.34 , FT = 99.84 ± 12.03 % $VO_{2-at-VT}$). Variability in inter-individual responses to each condition are also highlighted (Figure 1, Panel B). Table 3 displays the range of

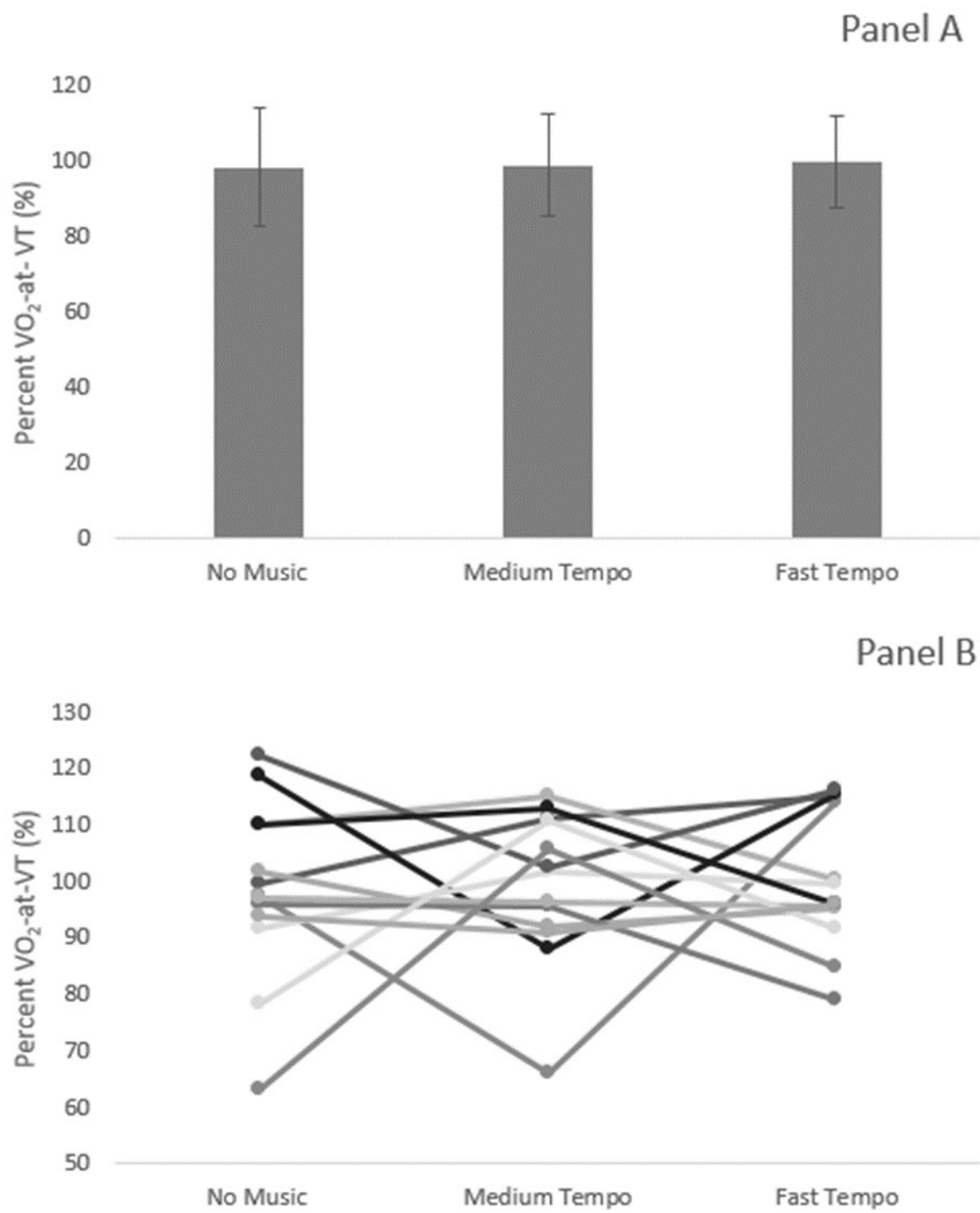


Figure 1: Mean (Panel A) and Inter-Individual (Panel B) Self-Selected Exercise Intensity per Condition

Table 1: Demographics and Baseline Information

	<u>Mean±SD</u>
Age (years)	26.00±7.78
BMI (kg/m ²)	24.48±4.00
VO ₂ peak (ml*kg*min ⁻¹)	27.45±4.94
VO ₂ -at-VT (ml*kg*min ⁻¹)	16.00±3.47
Recreational Physical Activity (MET-min/week)*	234.85±307.61
White (%)	76.92
Preference for Exercise Intensity	2.60±0.79
Tolerance for Exercise Intensity	2.43±0.57
BREQ-2 RAI	7.29±3.83

*Derived from GPAQ Recreation Domain

BMI = Body Mass Index, RAI = Relative Autonomy Index derived from the Behavioral Regulation in Exercise Questionnaire

Table 2: Self-Selected Intensities during No Music, Medium Tempo, and Fast Tempo Conditions

	<u>No Music</u> <u>(M±SD)</u>	<u>Medium Tempo</u> <u>(M±SD)</u>	<u>Fast Tempo</u> <u>(M±SD)</u>	<u>F</u>	<u>p</u>
%VO ₂ peak	57.11±9.59	57.84±10.88	58.27±10.22	1.93	0.17
%HRmax	67.37±10.19	69.83±12.38	71.65±10.90	0.07	0.89

Table 3: Range and Mean Self-Selected Exercise Intensity

	<u>Mean±SD</u>	<u>Minimum Value</u>	<u>Maximum Value</u>
No Music (%VO ₂ -at-VT)	98.39±15.81	63	122
Medium Tempo (%VO ₂ -at-VT)	99.06±13.34	66	113
Fast Tempo (%VO ₂ -at-VT)	99.84±12.03	79	116

self-selected exercise intensity per condition. Table 2 summarizes self-selected intensities of each condition expressed as percent of age-predicted maximal heart rate (%HRmax) and percent of peak oxygen consumption (%VO2peak). Additionally, no significant differences in cadence were found between conditions in either the warm-up ($F(2,22) = 1.03$ $p=0.37$) or 10-minute self-selected bout (NM = 65.64 ± 13.09 , MT = 65.64 ± 11.39 , FT = 69.36 ± 11.93 rpm; $F(2,24) = 0.89$ $p=0.42$).

Effect Size and Power Analyses

Results of the primary repeated measures ANOVA indicated a very small effect size (eta squared = 0.003 ; Cohen's D = 0.11). A *post hoc* power analyses was conducted to determine the power of the current study and to estimate the minimum sample size needed to examine main condition effects with at least 80% power and a Type I error rate of 5%. The effect of repeated observations over time was considered with a base correlation of 0.5 between adjacent measurement time points. Results indicated that a substantially larger sample (N=1392) would be required to adequately detect such small departures from the null hypothesized value.

Discussion

The purpose of this pilot study sought to determine the impact of medium and fast music tempi on self-selected cycling intensity relative to a no music condition in a sample of untrained women. Contrary to the main hypothesis, no significant differences in self-selected exercise intensity were observed between the no music and music tempo conditions and the main effect size was found to be relatively trivial. To date,

nine previously published studies have tested the impact of music on self-paced exercise and all demonstrated statistically significant, favorable effects.[65-67, 70, 72, 95-98] The discussion herein aims to elucidate potential reasons why such results were not replicated in the current study.

As this was a gap in the previous literature, a primary difference was that the present study is the only study to date assessing a population consisting entirely of untrained women. Previous studies assessing the impact of music on volitional exertion have either used solely men[67, 97, 98] or a mixed sample of men and women.[65, 66, 70, 72, 95, 96] These studies used sample sizes ranging from 6 to 60 participants (mean = 22). Prior studies have also included individuals who were active or had some level of training such as rugby and football team members,[98] varied in training from little to no weekly participation in physical activity to three or more sessions of aerobic activity per week,[66, 67, 72, 95, 97] or did not include a measure to assess fitness or activity level.[65, 70, 96]. Epidemiological data has demonstrated that physical activity patterns do differ between the sexes, such that women not only tend to be less active than men, but also report engaging in lower intensity exercise than men when participating in physical activity.[37] However, rather than simply reducing the current findings to inherent sex-based differences, our results suggest that music tempo *alone* may not be sufficient enough to increase self-selected exercise intensity in untrained women. While music has been used asynchronously and synchronously when accompanying exercise,[29, 30] when used synchronously, the effects on performance are amplified.[30] The present study monitored cadence to assess whether participants would naturally synchronize their movements to the tempo, however, no such

phenomenon was witnessed. Similar to the majority of prior work, the present study was limited in regard to cultural impact and association due to the researchers selecting music, therefore, future studies should examine such qualities of music in conjunction with rhythm response and musicality to more completely understand the impact of music on self-selected exercise intensity in men and women.

The present study also differed from prior research, in that the experimental protocol was designed (via deception and neutral prompting) to elicit self-selection of exercise intensity with the least amount of bias. In previous studies that purportedly examined the effects of music on self-paced exercise, researchers imposed some level of control over resistance and/or cadence.[66, 70, 72] For example, studies have encouraged participants to stay above a certain cadence (i.e. 50 rpm)[70, 72] or pre-set the resistance.[66, 70, 72] One study by Elliott et al.[72] instructed participants to stay within an intensity range of 60-80%HRmax. Therefore, it is reasonable to argue that true self-selection was not possible with such restrictions and results of those studies are not directly comparable to those of the current study. The current study was specifically designed to elicit more natural self-selection by avoiding language that could indicate comfort or effort and avoided providing any guidance or suggestions for exercise intensity. Additionally, in order to reduce potential bias, participants were blinded to the true purpose of the study and researchers explicitly avoided telling them to cycle at an intensity that “feels good” or used words/phrases that indicated the bout should be used for “exercise” or a “workout”. This was an important aspect to the current study because research has demonstrated prompts alone can impact self-selected intensity.[22, 99-101] That is, participants select below the ACSM

recommended exercise intensity range (64-94% HRmax) without the use of prompts,[99], but within the range with the use of prompts,[22, 100] when given prompts that indicate “brisk” or “fast” pace, intensity can exceed ACSM recommended range[101]. Therefore, it is possible that if participants were encouraged to “get a workout in,” greater intensity differences may have been observed across conditions. Taking the findings of this pilot study and prior research into consideration, subsequent studies may benefit from assessing the independent and combined effects of music and prompts to determine the most promising approach for increasing volitional exertion in women.

Perhaps most importantly, the current study assessed intensity relative to ventilatory threshold, which is behaviorally meaningful. The majority of previous studies have used performance-based indices of effort (distance traveled, cadence, or lap pace), while the current study identified %VO₂-at-VT as the intensity expression of interest. Numerous studies have indicated that exercise that surpasses VT is likely to elicit negative affective responses in untrained individuals[14], which is concerning because lower ratings of in-task affect are predictive of lower rates of exercise behavior in the future.[11, 12] While routinely advising inactive individuals to exercise well below this physiological point is likely to elicit more positive affective responses, it is important to recognize that without a degree of progressive overload (i.e. training at or above VT), improvements in aerobic capacity will be limited. Given that the average untrained adult will surpass VT during moderate-intensities,[92] one can only increase exercise volume through increasing exercise duration if selecting an intensity that “feels good”. This is a problematic proposition, considering that perceived lack of time is a commonly reported

barrier to physical activity.[102] Thus, paying attention to intensity relative to VT is particularly important for future studies aiming to strike a balance between what is physiologically relevant for desirable outcomes and what is behaviorally manageable.

While this expression of intensity is relevant, the high degree of inter-individual variability may have contributed to the small effect size observed. Intensities selected in each bout were consistent with other self-selection literature, in that the average intensity selected was proximal to VT (and within moderate-intensity ranges based on heart rate responses) with a relatively wide range of inter-individual variability for each condition,[16, 19] In assessing inter-individual responses, the mean intensity values may not be particularly representative of individual behavior. That is, while the mean values would suggest that self-selected intensity was relatively stable near VT across all conditions, few participants demonstrated this pattern. This observation is similar to results from the landmark study by Van Landuyt et al., which highlighted the importance of examining both mean and individual patterns in psycho-behavioral research[15]. This study elegantly demonstrated that mean FS values suggested stable affective responses during moderate intensity exercise, however, this pattern was representative of only 14.3% of the participants. In reality, most individual responses indicated increases or decreases in FS throughout the bout. In the current study, the highest degree of variability was observed in the NM condition, the first condition all participants completed. Thus, there exists the possibility that the inter-individual behavior observed in the current study may be more influenced by the “law of initial values,”[103-105] in that higher initial intensities are associated with decreases over time and lower initial intensities are associated with increases over time. In this case, additional

familiarization sessions may be warranted prior to hypothesis testing in further studies. When assessing human exercise behavior, researchers likely need to progress beyond the common assumption that a graded exercise test is sufficient in this regard.

It is important to note the strengths and limitations of the current study. This study was theoretically sound in a number of ways including choice of music, measure of intensity used, the use of incomplete disclosure and the implementation of neutral prompting. While the music was selected by the researchers, the music was rated as motivational by the participants using the BMRI-2. The measure of intensity used was behaviorally significant and the participants were blinded to the true purpose of the study allowing for a natural response with the addition of music. The results of the current study are limited in that they are likely not generalizable across different populations (untrained men, older adults, high-risk adults) or other modes of exercise (walking, running). Additionally, results may not be generalizable across other measures of effort (time trials, time to exhaustion, duration). Although 10-min bouts were used for proof of concept, comparing longer duration bouts is worthwhile to pursue.

CHAPTER 4

CONCLUSION

While the use of music and the self-selection of exercise intensity are plausible approaches in theory, music tempo alone did not positively impact self-selected exercise intensity in the entire group of untrained women. Future studies and interventions may benefit from adding an initial period of familiarization training or more specific prompting if music is employed to improve behavior.

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APPENDICES

Appendix A: Informed Consent

Informed Consent to Take Part in a Research Study

Effect of Music and Exercise on Cognition

Investigator: Kayla Smitherman, B.S.

You are being asked to take part in a research study. This informed consent form will tell you about the study. Please read this form carefully. You will be given a chance to ask questions. If you decide to be in the study, you will be given a copy of this consent form.

Taking part in this research study is voluntary. You may choose not to take part in the study. You are also free to withdraw from the study at any time. Choosing not to participate or choosing to withdraw from participation will involve no penalty or loss of benefits to which you would otherwise be entitled.

Why is this study being done?

The purpose of this study is to determine the effects of music and exercise on cognition.

How long will the study last?

In addition to this orientation session, you will visit the Applied Physiology Laboratory in the Health, Physical Education, and Recreation Building (HPER) one more time to complete three 10-minute exercise bouts and questionnaire packets. The first visit will may take up to 45 minutes and the second visit may take up to 1.5 hours.

How many people will be in the study?

Up to 100 adult women will participate in this study.

What will happen to me during the study?

During today's visit, the orientation to the study, you will complete the Physical Activity Readiness Questionnaire to determine if you meet the study requirements. We will also measure your height and weight, and you will fill out questionnaires regarding your exercise attitudes and preferences. Next, you will perform a maximal fitness test on a cycle bike. The maximal fitness test is important in determining your level of aerobic fitness. That is, how fit your heart and lungs are during exercise. Your fitness will be measured by cycling on a stationary bike starting with a three minute warm-up with light resistance followed by a slight increase in resistance for the first minute and small increases in resistance for every minute after, such that it feels like you are riding up a hill. During this test you will be asked to perform the exercise for as long as you can. Heart rate and your ratings of effort will be recorded every minute. For the exercise test, you will be required to wear a mouthpiece held in place by fitted head gear. A plastic hose will connect your mouthpiece with the metabolic cart. This will allow the researchers to determine your energy expenditure, in terms of how much oxygen you are using and how much carbon dioxide you are producing. You will also be asked to wear a Polar heart rate monitor with a chest strap placed underneath the clothes so that the monitor can maintain contact with you skin in order to accurately measure your heart rate during the test. The exercise test will continue until you ask to stop or until you show any other signs, symptoms, or responses that indicate we should stop the exercise test.

_____ (Place initials here)

IRB NUMBER: UTK IRB-15-02806-FB
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IRB EXPIRATION DATE: 11/16/2018

What will happen to me during the study? (Continued...)

After completing your orientation visit, you will be asked to come to HPER Building room 315 for an additional supervised exercise session to be completed at least 48 hours after today's visit. For three 10-minute bouts, you will be allowed to pedal at your own pace. The last two bouts will be accompanied with music. You will also be asked to fill out questionnaires and perform cognitive tasks before, after, and in-between exercise bouts. You will wear a Polar heart rate monitor for the supervised exercise session so that we can measure your heart rate.

What risks can I expect from being in the study?

The risks associated with this study are minimal. The maximal fitness test introduces more risk than the following exercise session as you will exercise in progressively increasing intensities until you decide that you can't work any harder. Although we plan to exclude individuals who have a history of heart disease, there is still a possibility that a cardiac event could occur during exercise. The possibility of experiencing a sudden cardiac event has been estimated to be one per year during vigorous intensity exercise for every 1 in 15,000-18,000 adults. Specific to maximal exercise testing, the risk of a cardiac event occurring is low in this population (6 events/10,000 tests). Pre-existing cardiovascular, metabolic, pulmonary or orthopedic conditions could also be exacerbated by exercise. American College of Sports Medicine guidelines will be followed during the exercise sessions to further reduce this risk. However, in the event that you experience a serious medical condition during your exercise session, the session will be stopped and appropriate emergency care will be provided and 9-1-1 will be called. An individual who is certified in CPR/AED/First Aid will be present during all exercise testing sessions. A minor risk of any exercise session in this study is that you may experience general fatigue and in some cases, muscle soreness.

Loss of confidentiality is also a risk. However, to minimize this risk, all data will be collected under an identification number and kept in a locked file cabinet separate from this consent document (i.e. the only document linking your name to this study). Further, all electronic files will be stored on a password-protected computer that is accessible only by Kayla Smitherman and Dr. Kelley Strohecker.

Are there benefits to taking part in the study?

Your participation will benefit research as results from this study may help guide further exercise prescription for adults.

Compensation

As an incentive, you will receive \$20 in the form of Kroger gift cards upon completion of the study.

What if I am injured in this study?

The University of Tennessee does not automatically reimburse subjects for medical claims or other compensation. If physical injury is suffered in the course of research, or for more information, please notify the investigator in charge Kayla Smitherman at ksmithel@vols.utk.edu.

_____ (Place initials here)

IRB NUMBER: UTK IRB-15-02806-FB
IRB APPROVAL DATE: 12/07/2016
IRB EXPIRATION DATE: 11/16/2018

Who do I contact if I have questions about the study?

Questions about the study (or if you experience adverse effects as a result of participating in this study) should be addressed to: Kayla Smitherman, B.S., ksmithel@vols.utk.edu or Dr. Kelley Strohacker, Ph.D., kstrohac@utk.edu.

Questions about your rights as a research subject: the University of Tennessee, Knoxville, Office of Research IRB Compliance Officer at 865-974-7697. The IRB is a group of people that reviews studies for safety and to protect the rights of study subjects.

Can I stop being in the study?

You may withdraw from the study at any time. Your confidential information will be destroyed upon request. Choosing not to participate or choosing to withdraw from participation will involve no penalty or loss of benefits to which you would otherwise be entitled.

Could I be removed from the study?

You may be withdrawn from the study without penalty for any of the following reasons:

- You fail to show up for your appointments.
- You show signs of being incapable of moderate intensity exercise during the fitness test.
- During the screening procedures, we find that you do not meet the entry criteria.

CONSENT OF SUBJECT:

I have read or have had read to me the description of the research study. The investigator or her representative has explained the study to me and has answered all of the questions I have at this time. I have been told of the potential risks, discomforts and side effects as well as the possible benefits (if any) of the study. I freely volunteer to take part in this study.

_____	_____	_____
Printed Name of Subject	Signature of Subject	Date

_____	_____	_____
Printed Name of Person Obtaining Consent	Signature of Person Obtaining Consent	Date

_____	_____	_____
Printed Name of Investigator	Signature of Investigator	Date

IRB NUMBER: UTK IRB-15-02806-FB
IRB APPROVAL DATE: 12/07/2016
IRB EXPIRATION DATE: 11/16/2018

Appendix B: Debriefing Informed Consent

Debriefing Informed Consent Form

Investigator: Kayla Smitherman, B.S.

Thank you for taking the time to be a part of this research study. This form will tell you about the purpose of the study. Please read this form carefully. You will be given a chance to ask questions. If you decide to remain in the study, you will be given a copy of this form.

Taking part in this research study is voluntary. You are also free to withdraw from the study at any time.

Why is this study being done?

The purpose of this study is to determine the effects of music tempo on self-selected exercise intensity in insufficiently active young adult females.

We expect to see a changes in percent of maximal heart rate (or intensity) between the three exercise conditions of no music, medium tempo music, and fast tempo music.

Why describe a different purpose at the start of the study?

In this study, we believed it would be easy for participants to realize the true purpose of the study. In order to minimize this effect on the data gathered we misled you by providing an alternate purpose for the study and added the cognitive tasks to the rest period between exercise bouts. This was added to distract participants from trying to figure out the hypothesis or feel compelled to exercise more or less intensely when listening to the different music tracks. While there were some misleading aspects to this study, our purpose was not to "trick" you but to allow you to respond naturally to the various music tracks. This was an important aspect to the study used to facilitate a natural response by the participants.

How will your results from the follow-up questionnaire be used?

Results from the questionnaire will be used to determine the successfulness of our attempt to ensure natural response to the musical stimuli.

Who do I contact if I have questions about the study?

Questions about the study (or if you experience adverse effects as a result of participating in this study) should be addressed to: Kayla Smitherman, B.S., ksmithel@vols.utk.edu, Dr. Kelley Strohacker, Ph.D., kstrohac@utk.edu.

Questions about your rights as a research subject: the University of Tennessee, Knoxville, Office of Research IRB Compliance Officer at 865-974-7697. The IRB is a group of people that reviews studies for safety and to protect the rights of study subjects.

_____ (Place initials here)

**IRB NUMBER: UTK IRB-15-02806-FB
IRB APPROVAL DATE: 12/07/2016
IRB EXPIRATION DATE: 11/16/2018**

Can I withdraw my data from the study?

You may withdraw from the study at any time. Your confidential information will be destroyed upon request. Choosing not to participate or choosing to withdraw from participation will involve no penalty or loss of benefits to which you would otherwise be entitled.

INFORMED CONSENT OF SUBJECT:

I have read or have had read to me the description of the research study. The investigator or her representative has explained the study to me and has answered all of the questions I have at this time. I have been told of the potential risks, discomforts and side effects as well as the possible benefits (if any) of the study. I freely volunteer to take part in this study.

Printed Name of Subject	Signature of Subject	Date	_____
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Printed Name of Person Obtaining Consent	Signature of Person Obtaining Consent	Date	_____
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Printed Name of Investigator	Signature of Investigator	Date	_____
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IRB NUMBER: UTK IRB-15-02806-FB
IRB APPROVAL DATE: 12/07/2016
IRB EXPIRATION DATE: 11/16/2018

Appendix C: Recruitment and Communication Materials

Email

Hello,

The purpose of this letter is to invite you to participate in a research study to test the cognitive response to music and exercise at self-selected intensities in inactive young adult females.

This study will be open to individuals between the ages 18-55 years. Participants must meet additional eligibility criteria that will be assessed through subsequent emails and in person. Briefly, participants must be healthy (no signs of heart disease, no bone or joint problems, not taking medication for blood pressure or heart conditions, no diagnosed metabolic disease, such as diabetes) and be low-active (exercising less than 150 minutes per week). This study is being conducted by Kayla Smitherman B.S., an exercise physiology Masters student, and Dr. Kelley Strohacker, an Assistant Professor, from the Department of Kinesiology, Recreation, and Sport Studies at the University of Tennessee.

This study will include up to 100 individuals and will involve measuring height, weight and aerobic fitness level, as well as collecting questionnaire information. Participants will be required to attend one orientation/fitness testing meeting and then complete one cycle-based exercise session (45 minutes for the first session and 1.5 hours for the second session). **Kroger gift cards equaling \$20.00 will be provided upon completion of study requirements.**

Please contact Kayla Smitherman (ksmithe1@vols.utk.edu) if you are interested in participating in the study.

Sincerely,

Kayla Smitherman, B.S.
ksmithe1@vols.utk.edu

PARTICIPANTS NEEDED FOR RESEARCH STUDY

Study Description:

- Participants will complete two visits during this research study which examines the effects of music and exercise on cognition. The first will be a maximal fitness test. The second will have three, 10-minute exercise bouts performed at a self-selected intensity. All exercise will be completed on a cycle ergometer. Participants will also complete questionnaire packets and cognitive tasks before, during and after exercise.

Female Young Adults (18-55 years old) Wanted:

- Currently engaging in less than 150 minutes of exercise per week
- No cardiovascular, pulmonary, metabolic or orthopedic limitations

Time Commitment:

- The first visit will take up to 45 minutes and the second visit will take up to 1.5 hours in the Health, Physical Education, and Recreation (HPER) building.

Contact:

If interested in participating in the study contact Kayla Smitherman by email
(ksmithe1@vols.utk.edu)

The project has been reviewed by the University of Tennessee Office of Research (865) 974-7697.

All participants will receive a Kroger gift cards valued at \$20.00 upon completion of the study.

Cycle Exercise Study - Kayla Smitherman (ksmithe1@vols.utk.edu)	Cycle Exercise Study - Kayla Smitherman (ksmithe1@vols.utk.edu)	Cycle Exercise Study - Kayla Smitherman (ksmithe1@vols.utk.edu)	Cycle Exercise Study - Kayla Smitherman (ksmithe1@vols.utk.edu)	Cycle Exercise Study - Kayla Smitherman (ksmithe1@vols.utk.edu)	Cycle Exercise Study - Kayla Smitherman (ksmithe1@vols.utk.edu)	Cycle Exercise Study - Kayla Smitherman (ksmithe1@vols.utk.edu)	Cycle Exercise Study - Kayla Smitherman (ksmithe1@vols.utk.edu)	Cycle Exercise Study - Kayla Smitherman (ksmithe1@vols.utk.edu)	Cycle Exercise Study - Kayla Smitherman (ksmithe1@vols.utk.edu)
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Appendix D: Eligibility Screening Materials

Pre-Screen Email

Hello,

Thank you so much for your interest in the research study "Exercise and Music on Cognition." Below you'll find a brief description of the study, its requirements and initial eligibility criteria.

The goal of this project is to measure the effects of exercise and music on cognitive tasks. If you are eligible and consent to join, this study requires the following:

1. That you complete a maximal fitness test (cycling on a stationary bike for up to 25 minutes at continually increasing resistance)
2. That you attend a supervised exercise session in which you cycle on a stationary bike and complete cognitive tasks at the Health, Physical Education, and Recreation (HPER) Building located at 1914 Andy Holt Avenue.

If you want to continue with the research study, please take a few minutes to do the following:

1. Determine your eligibility:
 - a. Your BMI
 - i. Please find your height and weight and the associated BMI on the included chart
 - ii. If your BMI is below 18.5 or at/above 35 you will not be eligible for the study
 - iii. If you cannot find your BMI on the chart, use the following link to calculate your BMI:
http://www.nhlbi.nih.gov/health/educational/lose_wt/BMI/bmicalc.htm
 - b. The Physical Activity Readiness Questionnaire (PAR-Q)
 - i. If you answer yes to any of the questions asked on the PAR-Q, you will not be eligible for the research study
 - c. If you currently engage in regular physical activity (more than 150 minutes per week) you will not be eligible for the research study.
 - d. If you have any condition(s) that would limit their participation in physical activity or health concerns that could be exasperated by physical activity such as but not limited to: cardiovascular, metabolic, pulmonary or orthopedic conditions you will not be eligible for the research study.
 - e. If you are pregnant, planning to become pregnant, or feel that it is possible that you may be pregnant and not know it, you will not be eligible for the research study.
2. If you think that you do qualify for the study and wish to participate, please respond by email and I will get back to you to schedule an in-person appointment.
 - a. Height, weight and exercise habits will be assessed objectively at the first in-person appointment
 - b. Individuals who consent to be in the study will be asked to complete a maximal fitness test using stationary cycle bike at the orientation session.

DISCLAIMER: PLEASE DO NOT RESPOND BY EMAIL WITH ANY CONFIDENTIAL INFORMATION (i.e. your BMI, PAR-Q responses or activity level).

For any questions or concerns, please contact Kayla Smitherman.

Email: ksmithe1@vols.utk.edu

BMI Chart

	NORMAL						OVERWEIGHT					OBESE										EXTREME OBESITY		
BMI	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Height (feet-inches)	Weight (Pounds)																							
4' 10"	91	96	100	105	110	115	119	124	129	134	138	143	148	153	158	162	167	172	177	181	186	191	196	201
4' 11"	94	99	104	109	114	119	124	128	133	138	143	148	153	158	163	168	173	178	183	188	193	198	203	208
5' 00"	97	102	107	112	118	123	128	133	138	143	148	153	158	163	168	174	179	184	189	194	199	204	209	215
5' 01"	100	106	111	116	122	127	132	137	143	148	153	158	164	169	174	180	185	190	195	201	206	211	217	222
5' 02"	104	109	115	120	126	131	136	142	147	153	158	164	169	175	180	186	191	196	202	207	213	218	224	229
5' 03"	107	112	118	124	130	135	141	146	152	158	163	169	174	180	186	191	197	203	208	214	220	225	231	237
5' 04"	110	116	122	128	134	140	145	151	157	163	169	175	180	186	191	197	204	209	215	221	227	232	238	244
5' 05"	114	120	126	132	138	144	150	156	162	168	174	180	186	192	198	204	210	216	222	228	234	240	246	252
5' 06"	118	124	130	136	142	148	155	161	167	173	179	186	192	198	204	210	216	223	229	235	241	247	253	260
5' 07"	121	127	134	140	146	153	159	166	172	178	185	191	198	204	211	217	223	230	236	242	249	255	261	268
5' 08"	125	131	138	144	151	158	164	171	177	184	190	197	204	210	216	223	230	236	243	249	256	262	269	276
5' 09"	128	135	142	149	155	162	169	176	182	189	196	203	210	216	223	230	236	243	250	257	263	270	277	284
5' 10"	132	139	146	153	160	167	174	181	188	195	202	209	216	222	229	236	243	250	257	264	271	278	285	292
5' 11"	136	143	150	157	165	172	179	186	193	200	208	215	222	229	236	243	250	257	265	272	279	286	293	301
6' 00"	140	147	154	162	169	177	184	191	199	206	213	221	228	235	242	250	258	265	272	279	287	294	302	309
6' 01"	144	151	159	166	174	182	189	197	204	212	219	227	235	242	250	257	265	275	280	288	295	302	310	318
6' 02"	148	155	163	171	179	186	194	202	210	218	225	233	241	249	256	264	272	280	287	295	303	311	319	326
6' 03"	152	160	168	176	184	192	200	208	216	224	232	240	248	256	264	272	279	287	295	303	311	319	327	335
6' 04"	156	164	172	180	189	197	205	213	221	230	238	246	254	263	271	279	287	295	304	312	320	328	336	344

Physical Activity Readiness Questionnaire (PAR-Q) and You

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:

YES	NO	
☐	☐	1. Has your doctor ever said that you have a heart condition <u>and</u> that you should only do physical activity recommended by a doctor?
☐	☐	2. Do you feel pain in your chest when you do physical activity?
☐	☐	3. In the past month, have you had chest pain when you were not doing physical activity?
☐	☐	4. Do you lose your balance because of dizziness or do you ever lose consciousness?
☐	☐	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?
☐	☐	6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
☐	☐	7. Do you know of <u>any other reason</u> why you should not do physical activity?

**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.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- 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 actively. 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.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever — wait until you feel better; or
- if you are or may be pregnant — talk to your doctor before you start becoming more 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.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

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

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME _____

SIGNATURE _____

DATE _____

SIGNATURE OF PARENT
or GUARDIAN (for participants under the age of majority) _____

WITNESS _____

Note: This 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.

Global Physical Activity Questionnaire GPAQ

GPAQ

Physical Activity			
Next I am going to ask you about the time you spend doing different types of physical activity in a typical week. Please answer these questions even if you do not consider yourself to be a physically active person. Think first about the time you spend doing work. Think of work as the things that you have to do such as paid or unpaid work, study/training, household chores, harvesting food/crops, fishing or hunting for food, seeking employment. <i>[Insert other examples if needed]</i>. In answering the following questions 'vigorous-intensity activities' are activities that require hard physical effort and cause large increases in breathing or heart rate, 'moderate-intensity activities' are activities that require moderate physical effort and cause small increases in breathing or heart rate.			
Questions	Response		Code
Activity at work			
1	Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like <i>[carrying or lifting heavy loads, digging or construction work]</i> for at least 10 minutes continuously? <i>[INSERT EXAMPLES] (USE SHOWCARD)</i>	Yes 1 No 2 <i>If No, go to P 4</i>	P1
2	In a typical week, on how many days do you do vigorous-intensity activities as part of your work?	Number of days	P2
3	How much time do you spend doing vigorous-intensity activities at work on a typical day?	Hours : minutes : hrs mins	P3 (a-b)
4	Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking <i>[or carrying light loads]</i> for at least 10 minutes continuously? <i>[INSERT EXAMPLES] (USE SHOWCARD)</i>	Yes 1 No 2 <i>If No, go to P 7</i>	P4
5	In a typical week, on how many days do you do moderate-intensity activities as part of your work?	Number of days	P5
6	How much time do you spend doing moderate-intensity activities at work on a typical day?	Hours : minutes : hrs mins	P6 (a-b)
Travel to and from places			
The next questions exclude the physical activities at work that you have already mentioned. Now I would like to ask you about the usual way you travel to and from places. For example to work, for shopping, to market, to place of worship. <i>[insert other examples if needed]</i>			
7	Do you walk or use a bicycle (pedal cycle) for at least 10 minutes continuously to get to and from places?	Yes 1 No 2 <i>If No, go to P 10</i>	P7
8	In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places?	Number of days	P8
9	How much time do you spend walking or bicycling for travel on a typical day?	Hours : minutes : hrs mins	P9 (a-b)
Recreational activities			
The next questions exclude the work and transport activities that you have already mentioned. Now I would like to ask you about sports, fitness and recreational activities (leisure). <i>[insert relevant terms]</i>.			
10	Do you do any vigorous-intensity sports, fitness or recreational (leisure) activities that cause large increases in breathing or heart rate like <i>[running or football]</i> for at least 10 minutes continuously? <i>[INSERT EXAMPLES] (USE SHOWCARD)</i>	Yes 1 No 2 <i>If No, go to P 13</i>	P10
11	In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational (leisure) activities?	Number of days	P11
12	How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?	Hours : minutes : hrs mins	P12 (a-b)

Continued on next page

GPAQ, Continued

Physical Activity (recreational activities) contd.			
Questions		Response	Code
13	Do you do any moderate-intensity sports, fitness or recreational (leisure) activities that causes a small increase in breathing or heart rate such as brisk walking, cycling, swimming, volleyball/for at least 10 minutes continuously? <i>[INSERT EXAMPLES] (USE SHOWCARD)</i>	Yes 1 No 2 <i>If No, go to P16</i>	P13
14	In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational (leisure) activities?	Number of days <u> </u>	P14
15	How much time do you spend doing moderate-intensity sports, fitness or recreational (leisure) activities on a typical day?	Hours : minutes <u> </u> : <u> </u> hrs mins	P15 (a-b)
Sedentary behaviour			
The following question is about sitting or reclining at work, at home, getting to and from places, or with friends including time spent [sitting at a desk, sitting with friends, travelling in car, bus, train, reading, playing cards or watching television], but do not include time spent sleeping. <i>[INSERT EXAMPLES] (USE SHOWCARD)</i>			
16	How much time do you usually spend sitting or reclining on a typical day?	Hours : minutes <u> </u> : <u> </u> hrs mins	P16 (a-b)

Appendix E: Orientation Session Surveys

Behavioral Regulations in Exercise Questionnaire (BREQ-2)

Participant ID _____

Session _____

Date _____

Exercise Regulations

WHY DO YOU ENGAGE IN EXERCISE?

We are interested in the reasons underlying peoples' decisions to engage, or not engage in physical exercise. Using the scale below, please indicate to what extent each of the following items is true for you. Please note that there are no right or wrong answers and no trick questions. We simply want to know how you personally feel about exercise. Your responses will be held in confidence and only used for our research purposes.

	Not true for me me	Sometimes true for me			Very true for
1. I exercise because other people say I should	0	1	2	3	4
2. I feel guilty when I don't exercise	0	1	2	3	4
3. I value the benefits of exercise	0	1	2	3	4
4. I exercise because it's fun	0	1	2	3	4
5. I don't see why I should have to exercise	0	1	2	3	4
6. I take part in exercise because my friends/family/partner say I should	0	1	2	3	4
7. I feel ashamed when I miss an exercise session	0	1	2	3	4
8. It's important for me to exercise regularly	0	1	2	3	4
9. I can't see why I should bother exercising	0	1	2	3	4
10. I enjoy my exercise sessions	0	1	2	3	4
11. I exercise because others will not be pleased with me if I don't	0	1	2	3	4

12. I don't see the point in exercising	0	1	2	3	4
13. I feel like a failure when I haven't exercised in a while	0	1	2	3	4
14. I think it is important to make the effort to exercise regularly	0	1	2	3	4
15. I find exercise a pleasurable activity	0	1	2	3	4
16. I feel under pressure from my friends/family to exercise	0	1	2	3	4
17. I get restless if I don't exercise	0	1	2	3	4
18. I get pleasure and satisfaction from participating in exercise	0	1	2	3	4
19. I think exercise is a waste of time	0	1	2	3	4

Participant ID _____

Session _____

Date _____

Preference and Tolerance for Intensity of Exercise

Instructions: Please, read each of the following statements and then use the response scale below to indicate whether you agree or disagree with it. There are no right or wrong answers. Work quickly and mark the answer that best describes what you believe and how you feel. Make sure that you respond to all the questions.

	Totally Disagree	Disagree	Neutral	Agree	Totally Agree
1. Feeling tired during exercise is my signal to slow down or stop	1	2	3	4	5
2. I would rather work out at low intensity levels for a long duration than at high-intensity levels for a short duration	1	2	3	4	5
3. During exercise, if my muscles begin to burn excessively or if I find myself breathing very hard, it is time for me to ease off	1	2	3	4	5
4. I'd rather go slow during my workout, even if that means taking more time	1	2	3	4	5
5. While exercising, I try to keep going even after I feel exhausted.	1	2	3	4	5
6. I would rather have a short, intense work out than a long, low –intensity workout	1	2	3	4	5
7. I block out the feeling of fatigue when exercising	1	2	3	4	5
8. When I exercise, I usually prefer a slow steady pace	1	2	3	4	5
9. I'd rather slow down or stop when a workout starts to get too tough	1	2	3	4	5
10. Exercising at low intensity does not appeal to me at all	1	2	3	4	5
11. Fatigue is the last thing that affects when I a workout; I have a goal and stop only when I reach it	1	2	3	4	5
12. While exercising, I prefer activities that are slow-paced and do not require much exertion	1	2	3	4	5
13. When my muscles start burning during exercise, I usually ease off some	1	2	3	4	5
14. The faster and harder the workout, the more pleasant I feel	1	2	3	4	5
15. I always push through muscle soreness and fatigue when working out	1	2	3	4	5
16. Low-intensity exercise is boring	1	2	3	4	5

Participant ID _____

Session _____

Date _____

Demographic Information

Please answer the following questions.

1) What is your age? _____

2) What is the highest grade you have completed in school?

(1) less than high school graduate (write in year 7-12) _____

(2) high school graduate

(3) some college

(4) college graduate

(5) post-graduate work

3) Which of the following do you consider to be your racial group?

(1) American Indian/Alaskan Native

(2) Asian

(3) Native Hawaiian or Other Pacific Islander

(4) Black or African American

(5) White

(6) Other (describe)_____

(7) Combination (describe) : .

(8) Don't know/refuse

4) Which of the following do you consider to be your ethnic group?

(1) Hispanic or Latino

(2) Not Hispanic or Latino

5) Are you employed?

(1) No (If no, please skip to item 10.)

(2) Yes

6) Which of the following best describes your job?

(1) Professional, administrator, or executive (i.e., Government official, manager,

purchasing agent, marketing rep., doctor, nurse, lawyer, teacher)

(2) Clerical work, administrative support, sales, or technician (i.e., Office worker,

data processing occupation, sales clerk or supervisor, lab tech, LPN, legal

asst.)

(3) Crafts, trade, factory work, service, or labor (i.e., carpenter, electrician,

machine operator, machinist, foreman, police officer, restaurant worker,

barber)

(4) Other (Please describe): _____

8) How many hours per week (on average) do you spend at your job?

(1) 1-15 hours

(2) 16-30 hours

(3) 31-40 hours

(4) 41-50 hours

(5) 51 or more hours

9) How stressful do you consider your job to be?

(1) Not at all stressful

(2) Somewhat stressful

(3) Stressful

(4) Very Stressful

(5) Extremely Stressful

Appendix F: Supervised Exercise Session Surveys

Acute Exercise Readiness Questionnaire (AERQ)

Pre-Exercise State

Directions: Think about how you feel, RIGHT NOW, in this moment, in response to each of the questions below. There are no right or wrong answers, so please be honest in your self-assessment.

In the spaces following each sentence, please indicate your self-assessment by circling a number ranging from 0 (not at all) to 6 (extremely).

	Not at all			Moderately			Extremely
Happy	0	1	2	3	4	5	6
Pain	0	1	2	3	4	5	6
Strong	0	1	2	3	4	5	6
Lively	0	1	2	3	4	5	6
Worn Out	0	1	2	3	4	5	6
Achy	0	1	2	3	4	5	6
Energetic	0	1	2	3	4	5	6
Drained	0	1	2	3	4	5	6
Fit	0	1	2	3	4	5	6
Exhausted	0	1	2	3	4	5	6
Healthy	0	1	2	3	4	5	6
Stiff	0	1	2	3	4	5	6

The Positive and Negative Affect Schedule (PANAS)

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you feel this way right now, that is, at the present moment. Use the following scale to record your answers.

1
very slightly
or not at all

2
a little

3
moderately

4
quite a bit

5
extremely

_____ interested
_____ distressed
_____ excited
_____ upset
_____ strong
_____ guilty
_____ scared
_____ hostile
_____ enthusiastic
_____ proud

_____ irritable
_____ alert
_____ ashamed
_____ inspired
_____ nervous
_____ determined
_____ attentive
_____ jittery
_____ active
_____ afraid

Feelings Scale (FS) and Felt Arousal Scale (FAS)

The Feelings Scale and Felt Arousal Scale will be posted near the treadmill. At points throughout the exercise session, subjects will be asked to indicate the number that corresponds to their immediate state. Instructions for each scale are provided below.

FEELINGS SCALE

FELT AROUSAL SCALE

+5	Very Good	XXXXX	1	Low Arousal
+4		XXXXX		
+3	Good	XXXXX	2	
+2		XXXXX		
+1	Fairly Good	XXXXX	3	
0	Neutral	XXXXX		
-1	Fairly Bad	XXXXX	4	
-2		XXXXX		
-3	Bad	XXXXX	5	
-4		XXXXX		
-5	Very Bad	XXXXX	6	High Arousal

Verbal instructions given to participants for FS and FAS

FS

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 develop this scale to measure such responses.

FAS

Estimate here how aroused you actually feel. Do this by circling the appropriate number. By “arousal” we meant how “worked-up” you feel. You might experience high arousal in one of a variety of ways, for example as excitement or anxiety or anger. Low arousal might also be experienced by you in one of a number of different ways, for example as relaxation or boredom or calmness.

Dissociation Visual Analogue Scale

1. How focused on exercise you were during the last bout of exercise

Not at All

Extremely

2. How focused on music you were during the last bout of exercise

Not at All

Extremely

The Brunel Music Rating Inventory -2 (BMRI-2)

The purpose of this questionnaire is to assess the extent to which the piece of music you just listened to would motivate you during exercise. For our purposes, the word “motivate” means music that would make you want to exercise harder and/or longer. 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.

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

Appendix G: Debriefing Materials

Incomplete Disclosure Script

When discussing the purpose of the study with study participants those on the research team will adhere to the following description.

“The purpose of this study is to determine the effects of music and exercise on cognitive processes such as attention, inhibition and reaction.”

Debrief

Thank you for your participation in the study. I would like to take a few minutes to tell you about the purpose of this study. The goal of this study is to examine the effects of music tempo on selected exercise intensity. As it turns out the cognitive tasks you were asked to perform between exercise bouts was just an approach used so that participants (you) would not be distracted with trying to figure out the hypothesis or feel compelled to exercise more or less intensely when listening to the different music tracks. Furthermore, our purpose was not to “trick” you, but to allow you to respond naturally to the various music tracks. So, as you may see there are some misleading aspects to this study, but we hope that you understand that they were included for an important reason. Are you ok with this and do you have any further questions about these aspects of the study?

We believe this study is important because it allows us to better understand how music affects exercise performance. We are not interested in any one participant’s response by themselves. Rather, we are interested in the general responses of all participants when they are combined together. If you are uncomfortable in any way as a result of answering any of the questionnaire items, then please speak with me before you leave. Your participation today was greatly appreciated and will help in furthering our understanding of music in exercise performance. We ask that you do not discuss this research with anyone else, at least until the end of the semester, because it could ruin the study for other participants. Would that be ok with you? If you have any questions or concerns regarding your participation in this study please contact Kayla Smitherman whose contact information is listed on your copy of the consent form.

Debriefing Questions

Music and Media Use

When engaging in physical activity or exercise,

1. How often do you use the aid of media such as music, television, or movies?
2. How often do you use the aid of a personal electronic device that plays music?
3. Do you have a preference for use music, video, no media, or other stimulant during exercise?

Modality and Cycle Experience

When engaging in physical activity or exercise,

1. Do you have a preference for type of activity when exercising or being active such as: walking, cycling, swimming, group fitness, or other?
2. Have you had experience riding a bicycle outdoors?
3. Have you had experience using an indoor cycle bike?
4. Do you enjoy cycling both outdoors and indoors?

VITA

Kayla Nicole Smitherman was born in Winston-Salem, NC to Kevin and Sandra Smitherman. She lived in East Bend, NC with her parents and sister, Whitney Smitherman. During her early years she attended East Bend Elementary and continued to Forbush High School in East Bend, NC. While pursuing her undergraduate degree she was introduced to a career in health and wellness through her work at the campus recreation center where she attained numerous group fitness and personal trainer certifications and licensures. She graduated from the University of North Carolina at Greensboro with a Bachelors of Science degree in Kinesiology with a concentration in Sports Medicine in 2011. Following her undergraduate studies she accepted positions as a graduate teaching assistant and a graduate research assistant in the Kinesiology, Recreation, and Sport Studies Department at the University of Tennessee in Knoxville. In August 2016, she graduated with a Masters of Science degree in Kinesiology with a concentration in Exercise Physiology from the University of Tennessee in Knoxville.