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Physical activity can benefit all individuals by increasing their physical, mental, and emotional health. Therefore, finding ways to increase physical activity is a popular area of research. Researchers have found that using dissociative attentional strategies is effective in increasing physical activity. According to research, when administered individually music and video (dissociative strategies) are both effective in decreasing an individual's perceived exertion and increasing performance at low to moderate intensity activity. However, at vigorous intensities the results are less consistent. The potential effects of music and video presented simultaneously have not been compared to the effects of either in isolation.

The purpose of this study was to determine if there was a difference in attentional focus and perceived exertion during vigorous intensity exercise as a function of being exposed to music, video, both (music and video), or nothing. Results showed that at vigorous intensity, participants in the condition that received both music and video perceived significantly lower exertion (RPE) and has a significantly more dissociative focus than did participants in the other three conditions. There was no significant difference amongst the other conditions. It was concluded that even at vigorous intensity exercise, a participant could use music and video to enhance their use of dissociative strategies and to perceive less exertion. The result of perceiving less exertion could be an increase in exercise adherence, which could have important implications for public health.

THE EFFECTS OF MUSIC AND VIDEO ON PERCEIVED EXERTION AND PERFORMANCE OF A CYCLING TASK AT VIGOROUS INTENSITY

by

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Approved by

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To Dad and Mom

APPROVAL PAGE

This thesis has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro

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CHAPTER I

INTRODUCTION

Research has shown that physical activity can benefit all individuals by improving their physical, mental, and emotional health (Annesi, 2001). However, within our society today, physical inactivity is widespread and has contributed to the increase in rates of obesity and chronic diseases (Murrock & Higgins, 2009). Identifying ways to limit inactivity, motivate individuals to become physically active, or encourage exercisers to continue their positive physical activity behaviors has developed into a popular subject of research. Research for promotion of physical activity has ranged from studying behavior change (Marshall & Biddle, 2001), to environmental changes (De Cocker, Bourdeaudhuij, Brown, & Cardon, 2007), using electronic reminders (Dunton & Robertson, 2008; Fjeldsoe, Miller, & Marshall, 2010), and considering ways to control attention (Razon, Basevitch, Land, Thompson, & Tenenbaum, 2009; Lind, Welch, and Ekkekakis, 2009). Many of the aforementioned research areas target physical activity promotion by only introducing strategies to change behavior. Though these strategies may be useful in promoting physical activity, the research on attention has the potential to be even more useful because it also incorporates how an individual feels during physical activity. Research on attention shows that factors such as music and video entertainment can influence attention in a way that ultimately results in a change in behavior (Barwood, Weston, Thelwell, & Page, 2009; Razon et al., 2009). Research on entertainment not only targets change in individual's behavior but also how to improve the focus and feel of the individual while engaged in physical activity. The result then ideally is an increase in physical activity behavior.

Attention is the focus of an individual during activity (Stanley, Pargman, & Tenenbaum, 2007). When engaged in physical activity, an individual will either use an associative or dissociative strategy and the focus may change throughout the course of the activity (Hutchinson & Tenenbaum, 2007; Mohammadzadeh, Tartibiyan, & Ahmadi, 2008). When using an associative strategy, an individual concentrates on his or her internal sensations, breathing patterns, rhythm in movement, feelings in the muscles, and/or heart rate. When using a dissociative strategy, an individual focuses on external visual cues, audio cues, and the environment to provide distraction from his or her internal sensations (fatigue, breathing, exertion). The attentional focus of an individual has been shown to influence an individual's perceived exertion during physical activity (Karageorghis & Terry, 1997; Murrock & Higgins, 2009). The majority of people who engage in physical activity on a regular basis utilize a dissociative focus (Annesi, 2001). Therefore, identifying ways to increase the extent to which an individual uses a dissociative focus may result in a significant and subsequent increase in physical activity and reduction in perceived exertion. One way to encourage a dissociative focus, as research supports, is through using music and/or video entertainment. Recent research on music and video show that each form of entertainment possesses dissociative attentional qualities that may result in an individual perceiving less exertion and increasing performance (work output) during physical activity (Annesi, 2001; Barwood et al., 2009; Mohammadzadeh et al., 2008; Razon et al., 2009).

Research conducted on the effect of music during physical activity suggests that music can be utilized as an aid to reduce negative body sensations and perceived exertion (Karageorghis & Terry, 1997). However, the benefits of music (reduction in perceived exertion, increase in performance) seem to be significant only when an individual participates in low to moderate intensity physical activity (Boutcher & Trenske, 1990; Hutchinson & Tenenbaum, 2007; Karageorghis & Terry, 1997; Mohammadzadeh et al., 2008). When an individual engages in physical activity of vigorous intensity, music seems to lose its beneficial effect (Hutchinson & Tenenbaum, 2007; Schwartz, Fernhall, & Plowman, 1990). According to Hutchinson and Tenenbaum (2007), the relationship between exercise intensity and music's effect on exertion may be due to a shift in attentional focus (dissociative to associative) when an individual progresses from low/moderate to vigorous intensity physical activity. This suggests that at low to moderate intensity, individuals can effectively utilize music as a dissociative strategy to distract their focus from their bodily and internal sensations (exertion, fatigue); but if individuals begin to engage in vigorous intensity activity, it seems that an individual's focus shifts away from the distracter (music) to a more associative strategy (bodily sensations during the activity). This shift moves the individuals' focus to their fatigue, possible pain, and breathing, thus increasing their levels of perceived exertion. The result of this increase in perceived exertion is that individuals who may perceive physical activity as too difficult or uncomfortable may never begin a habit of regular physical activity. Thus, understanding specifically how music might be used to increase the use of a dissociative focus has implications for perceived exertion and performance and ultimately may be important for improving adherence to regular physical activity.

Research conducted examining the effect of video entertainment on physical activity is less prevalent than research on music effects. However, from the studies conducted with video, it also seems to have potential dissociative effects (Barwood et al., 2009; Stanley, Pargman, & Tenenbaum, 2007). Similar to music, benefits of video entertainment (reduction in perceived exertion, increased performance) during physical activity are shown at low to moderate intensity activity, but at vigorous intensity physical activity, the benefits for individuals are less consistently evident (Barwood et al., 2009; Schwartz et al, 1990; Stanley, Pargman, & Tenenbaum, 2007).

Some of the inconclusiveness may have been caused by inconsistent definitions of vigorous intensity exercise. Some studies have set intensity based upon a range of VO_2 max percentages (60%-80%), while others have set intensity using self-report scales such as ratings of perceived exertion (RPE). By using a variety of measures and a range of intensity levels, the exercise experiences for participants reportedly exercising at vigorous intensity may have been drastically different. In particular, some individuals may have exceeded their ventilatory threshold, while others may have not. This is a key point because ventilatory threshold is the point at which attentional focus may switch from dissociative to associative.

Research examining the potential benefits of video combined with music is very limited. Barwood et al. (2009) examined the effects of presenting both music and video entertainment simultaneously during vigorous physical activity. They hypothesized that together, music and video could have a potential additive (decrease exertion, increase performance) effect at all intensities of physical activity. The researchers concluded that combined music and video did have an additive effect at all intensities. Thus, the conclusions of this study countered findings of previous literature, as entertainment was shown to be beneficial even at vigorous intensity. However, there were some limitations of Barwood et al.'s study. In the study, the researchers tested a no entertainment condition, a video only condition, and a combination music and video condition. Without testing a music only condition, there is no way of knowing if the benefits observed at vigorous intensity in the combination condition was significantly influenced by an additive effect or if video was the lone contributor. Another limitation of the study was that the researchers did not measure attentional focus. Without measuring the attentional focus of participants, the researchers had no way of knowing when or if attention shifted from dissociative to associative in their conditions. Thus, these limitations must be addressed before a conclusive statement can be made detailing the effect of music and video in combination on an individual's perceived exertion and performance at vigorous intensity physical activity.

A theory that supports the research between dissociative attentional strategies and a lowering of perceived exertion/increase of performance is the dual mode theory (Ekkikakis, Parfitt, & Petruzello, 2011). This suggests that when an individual exercises below his or her ventilatory threshold or lactate threshold, cognitive strategies (such as dissociating) are useful to maintain enjoyment of an activity and help an individual perceive that he or she is feeling better. However, when an individual exercises over his or her ventilatory threshold, the dual-mode theory suggests that cognitive processes are more difficult to maintain, the focus shifts to an internal or associative focus due to body cues, and pleasure is reduced. Thus, this theory supports the previous research that suggests individuals cannot use cognitive strategies (attentional strategies) while engaged in vigorous intensity, but can when engaged in low to moderate intensity exercise. However, it is unknown if combining more than one attentional strategy, as Barwood et al. (2009) aimed to do in their study could provide, as the researchers concluded, an additive effect where an individual could continue to use cognitive/attention strategies while engaged in vigorous intensity exercise to help lower perceived exertion.

In this study, we will use ventilatory threshold as a determinant of exercise intensity. Ventilatory threshold (VT) is the point during exercise when the oxygen uptake of an individual is no longer proportionate to the amount processed in his or her body, thus the individual exhales some of the inhaled oxygen. The greater an individual works above his or her VT, the less oxygen that individual can convert within his or her body. VT has been shown to be reliable and valid as an objective determinant of exercise intensity (Amann, Subudhi, Walker, Eisenman, Shultz, & Foster (2004). Therefore, in this study, we will set exercise intensity at 125% VT, which equates to vigorous intensity exercise.

The overall focus of this study is to address the limitations of past research examining the effects on vigorous intensity physical activity that result from the presentation of video and music in combination. Specifically, in this study more objective measures of exercise intensity, such as VT, will be utilized to insure that all participants are exercising at the same relative intensity and that it is at vigorous intensity. Also, testing participants in four conditions, control (no entertainment), music only, video only, and music/video combined, will allow for a test of the cumulative and potential additive effect of music and video at vigorous intensity physical activity. Lastly, by measuring attention, data will be available to identify if and when attention shifts from a dissociative to associative focus.

Purpose/Research Question

The purpose of this study is to examine if exposure to music and/or video entertainment can influence attentional focus and lower an individual's perceived exertion while performing on a stationary cycling task (physical activity) at vigorous intensity.

Hypothesis

It is hypothesized that participants in the combined music and video treatment group will report lower perceived exertion (based on the ratings of perceived exertion scale, RPE) on the cycling task when compared to engaging in the music only, video only, or control conditions. Also, it is hypothesized that participants will report a more dissociative focus throughout the cycling task in the combined entertainment condition than when compared to the music only, video only, and control conditions.

CHAPTER II

EXTENDED LITERATURE REVIEW

Attention

Attention is the underlying principle that may explain a relationship between the availability of entertainment (music and video) and a lowering of an individual's perceived exertion during physical activity. Simply described, attention is an individual's focus during activity (Stanley, Pargman, & Tenenbaum, 2007). Research focusing on an individual's attention while participating in physical activity suggests two strategies that an individual utilizes to judge his or her exertion when engaged in activity, associative or dissociative. Individuals utilize associative strategies when they focus on their internal sensations (such as breathing, heart rate, and rhythm of movement) and dissociative strategies when they focus on an external factor (audio and/or visual cues) to distract them from their internal sensations. The research suggests that most participants in physical activity tend to use a dissociative strategy when engaged in exercise. The use of these strategies seems to lower the individual's perception of exertion (Annesi, 2001; Hutchinson & Tenenbaum, 2007). Therefore, the utilization of dissociative strategies to potentially lower the perceived exertion during exercise will be the focus of the current study.

As individuals engage in physical activity at a given intensity, their perceived exertion is expected to rise. This has been demonstrated through studies that show that an individual's rating of perceived exertion (RPE) rises as he or she engages in an activity at a fixed intensity for longer periods of time. For many, the discomfort of the increased exertion, which may cause fatigue and/or pain, is a reason they choose not to engage in physical activity on a regular basis (Mohammadzadeh, Tartibiyan, & Ahmadi, 2008). Therefore, if an individual perceives less exertion at the same intensity due to the use of a dissociative strategy, he or she may engage in physical activity for longer bouts and/or more regularly, which may lead to an increase in health.

Razon et al. (2009) conducted a study on attentional focus (associative vs. dissociative) relative to the intensity of the activity. In their study, they used a handgrip-squeezing task where a participant was instructed to squeeze a handgrip dynamometer until he or she could no longer compress the dynamometer. After receiving a baseline measurement for each participant's maximum handgrip capacity, each was asked to repeat the handgrip task at 30% maximum capacity. The researchers used a 30% maximal capacity because of the results of previous studies that suggested that the use of a dissociative strategy by a participant seemed to only occur when the individual was engaged in low to moderate intensity physical activity. Before performing the handgrip tasks, participants were randomly assigned to one of four conditions. The conditions were control (no music/full vision), occluded (no music/no vision), full music (music/vision), and occluded music (music/no vision). While performing the handgrip task, participants were instructed to report their attention on a scale of 0-10 where "0" signified all external thoughts (dreaming/dissociative) and "10" signified all internal thoughts (body feelings/associative) and also their rating of perceived exertion from a scale of 0 (no exertion) to 10 (extremely high exertion). The results suggested that participants in all conditions increased their associative focus as the activity continued. The individuals within the study also demonstrated that as their perception of exertion shifted from low/moderate to vigorous, the attentional focus changed from a dissociative style to an associative style. This was observed as an individual's rating of perceived exertion increased as he or she continued to perform the handgrip task. This finding supported previous studies that showed that when an individual perceived an activity as vigorous, his or her attentional focus was predominantly associative (Boutcher & Trenske, 1990; Hutchinson & Tenenbaum, 2007). Participants in this study who received music reported lower exertion scores and experienced less of a shift from dissociative to associative attentional focus. The change of attentional focus may result in an increase in the perception of discomfort, which may be reflected in an increase in perceived exertion. As the researchers suggest, this then may potentially lead to a termination of the physical activity; therefore delaying the shift from dissociative to associative may prolong engagement in activity for individuals.

Lind et al. (2009) presented a review of the research that was conducted on the link between attention and exercise response (exertion, affect, and physiological responses). They used the words: exercise, attentional focus, association, dissociation, focal awareness, internal focus, and external focus, in their database search. They utilized the search engines 'PsycLit', 'PubMed', and 'Google Scholar' and found 88 studies that related to their search on attention and exercise response. Of the 88 studies that they reviewed, 35 examined the link between attentional strategy and exertion and 28 studies examined the relationship between attentional strategies and exercise ability/performance. An important point from the review was the definition of attentional focus. To aid in synthesizing this body of literature, the reviewers defined attention as a two-dimensional construct such that an individual's attention was measured by relevancy (focus on the task or not) and direction (internal vs. external). The reviewers pointed out that the majority of previous research had defined attention as a one-dimensional construct focusing only on direction. The reviewers used the following definitions: internal-task relevant (internal association) characterized by feel of body during exercise; internal-task not relevant (internal dissociation) characterized by daydreaming and focus on non-task related aspects; external-task relevant (external association) characterized by focus on task conditions and performance statistics (such as miles per hour, distance covered); and external-task irrelevant (external dissociation) characterized by focus on scenery and the surrounding environment. Results of the review indicated that participants who were assigned to internal-task relevant (internal association) conditions, exhibited fatigue and exhaustion earlier in the task than the other focuses. Both forms of association (internal and external) were also linked to worse feeling states than both forms of dissociation (internal and external) as individuals reported experiencing more pain during exercise. Practically, an increase in perceived pain may limit the amount of activity or desire to exercise in an individual, as exercise is then associated with pain. Another finding was that an individual's perceived exertion was influenced by his or her psychological (attentional strategies, motivation) and physiological (lactate) responses to the task, thus linking attention and physical activity output. Finally, the reviewers pointed out some limitations of previous research. A major limitation of previous research is the lack of true experiments examining the relationship between attention and individual response to exercise. Addressing this limitation will allow for better generalizability of findings to the public. Another limitation that was mentioned was the lack of and need for more rigorous control of exercise intensity in the studies. A more rigorous control, as the researchers pointed out, would clarify and help tease apart the relationship between exercise intensity, attention, and perceived exertion. In conclusion, the researchers state that there is a link between attention (association/dissociation) and exercise response. Also, dissociative attentional strategies may benefit an individual during physical activity, as they do not lead an individual to the pain he or she may feel while engaged, thus theoretically increasing his or her performance in the task. Finally, the researchers state that more experimental research studies are needed to advance and better clarify the results from previous studies on attention and exercise response.

A good example of a study that demonstrates the relationship between attention and exertion levels/exercise performance was a study conducted by Connolly and Tenenbaum. Connolly and Tenenbaum (2010) examined the relationship between attention and flow (peak performance) while an individual was exposed to different levels of exertion during physical activity. The researchers defined flow as when the individual/athlete’s state of mind is fully engaged, has goals set out, and finds full enjoyment in an activity. The individual then is able to balance and use his or her skills relevant to the task to meet demands of the activity. The researchers hypothesized that participants would utilize a dissociative attentional strategy at lower levels of exertion and utilize an associative strategy at high levels of exertion. Also, they expected that how a participant rated his or her flow in relation to perceived exertion would show a gender difference; women were expected to report higher flow at a lower perceived exertion while men were expected to report higher flow at higher perceived exertion levels. All participants completed the study on two separate days on a rowing ergometer. On the first day of the study, participants performed a maximal test on a modified ramp ergometer protocol. The ergometer only displayed power output (wattage). Participants were instructed after warm up to row at a moderate intensity, defined as an intensity at which they could converse easily, for three minutes. After three minutes participants were instructed to increase their output by 20 watts. From this point on, participants were asked to increase their output by 20 watts every minute until they could no longer continue. Upon completion of the rowing task, each participant's maximal test result was recorded as baseline. On a separate day, participants performed a rowing ergometer task for 10 minutes at 30%, 50%, and 75% of the maximal intensity identified at baseline. The order of intensities was randomized and participants were given a 15-minute break in between conditions. Participants were asked to report their RPE and attention focus every minute while rowing. The results showed that participants' attention shifted from dissociation to association as the intensity of activity increased. At lower levels of exertion dissociation was used and at higher levels of exertion association was used. An important finding in this study was that there was no gender difference between participants and how they rated their flow in relation to perceived exertion levels. Thus, this study demonstrates that there is no significant difference between males and females nor in their shift in attentional strategy as workload increases and that there is no difference between genders and flow when exposed to a low or high intensity physical activity.

Dissociative strategies can increase performance and reduce perceived exertion of an individual when he or she is engaged in physical activity. Individuals can utilize an external dissociative strategy such as audio (music) to help aid their performance on a task (Edworthy & Waring, 2006; Mohammadzadeh et al., 2008). Researchers have also begun to explore the potential of using visual cues such as video (another dissociative strategy) to provide similar benefits to an individual engaged in activity (Annesi, 2001). Finally, research has been conducted on the potential additive effect that music and video, when presented simultaneously, could have on an individual's perception of exertion and performance during physical activity (Barwood, Weston, Thelwell, & Page, 2009).

Research With Music

There has been research conducted on the effect of musical qualities (such as tempo) on an individual's perception of exertion (Schwartz, Fernhall, & Plowman, 1990). As early as the 1950s, research began on the potential effects music could have on an individual's perceived exertion. Ellis and Brighouse (1952) studied if music could influence an individual's respiration and heart rate when in a relaxed state and the potential use of music in therapy. The results of their study suggested that music increased an individual's respiration and heart rate during a relaxed state; therefore, they concluded that music could garner a physiological response in individuals.

Zimny and Weidenfeller (1962) conducted a study with children (kindergarten to 6th grade) and studied their physiological and emotional response to exciting music. Responses were assessed with galvanic skin response (GSR), which measures electrical skin conductivity through reactions such as sweat. Higher conductivity is suggestive of greater emotional arousal (excitement). They hypothesized that exciting music would elicit an increase in GSR. Results showed that music could energize a child from a resting state; thus supporting the earlier research with adults.

Building upon this research, Zimny and Weidenfeller (1963) sought to determine if the presence of exciting, calming, or neutral music had an effect on the heart rate of children. If heart rate was different between the types of music it could suggest that different types of music could affect an individual's physiological response even before they begin exercise. However, the results showed that there was no significant difference in heart rate as a function of the music conditions.

Mihevic (1981) synthesized the research that was conducted comparing physiological responses (GSR) and heart rate to an individual's perceived exertion. Her review helped demonstrate a potential link between individuals' physiological responses to changes observed in their heart rate and exertion levels. The researcher concluded that individuals determine their perceived exertion through the feelings experienced in their muscles, their breathing, and circulation in their bodies. Also, heart rate was directly related to the perceived exertion of an individual. Thus, music, because it is related to an individual's heart rate and physiological response, could have a direct influence on perceived exertion during a task. Mihevic concluded that sensory cues could have potential dissociative properties that could be utilized by an individual during physical activity to lower perceived exertion and negative feelings that may be associated with prolonged engagement in the activity.

Boutcher and Trenske (1990) examined the dissociative properties of sensory cues and the potential effect of removing a cue, such as music, on perceived exertion. Adult women cycled on a stationary bike in each of three conditions. The conditions were listening to music of choice, no music/blockage of sound by plugging of ears (sensory deprivation), and cycling with only background noise (control). The women were evaluated and exposed to these treatment conditions while cycling at low (60% max), moderate (75% max), and vigorous (85% max) workload intensities. The results of the study suggest that participants during the music condition rated their perceived exertion lower at the low and moderate intensities than when they had auditory sensory cues blocked or had only background noise (control). There was no difference in perceived exertion between conditions when participants engaged in the vigorous condition. Thus, this study suggests that in tasks of low to moderate intensity, music could have a dissociative effect and lower a participant's perceived exertion on a task.

Schwartz et al. (1990) sought to determine if music enhanced an individual's performance on a cycling task. Their study was conducted with participants who were physically inactive (2 days or less of activity a week). Each participant was administered both conditions, a fast-tempo music condition and a no music condition, on separate days. The order of conditions was randomly assigned. Results indicated that music did not affect a participant's perceived exertion. Though these results contradict previous research on music's relationship to perceived exertion, in this study the non-significance may have been attributable to the fact that these participants were inactive prior to the study. Thus, the participants may have perceived the cycling as vigorous activity. If the cycling were perceived as vigorous, as the research on attention suggests previously, music would not have a dissociative effect for the individuals (as they would have used an associative style) in this study; therefore, music would not be expected to influence perceived exertion.

Karageorghis and Terry (1997) reviewed the research conducted on music and its effect on enhancing performance. The purposes of the review were to present studies that demonstrate the effects that music has on individuals and to clarify the contradicting results of studies on the potential enhancing effects on perceived exertion and performance that music could have on an individual engaged in exercise. The researchers sought to use previous studies to test three hypotheses about music and physical activity. They wanted to examine how music affects an individual's attention, the bodily arousal of the individual, and if individuals were naturally inclined to react to music qualities, such as tempo and beat, while engaged in physical activity. The researchers also reviewed studies that found potential beneficial psychological effects that music could have on an individual. Based upon the results of 35 studies, the researchers concluded that listening to music while engaged in activity could benefit an individual's psychological state, affect, and motor performance. Thus, they hypothesized that these effects could ultimately benefit a participant engaged in physical activity. The results of the review also suggest that at low to moderate intensity physical activity, music may reduce an individual's perceived exertion (RPE) and increase performance on a task. The researchers also pointed out limitations of previous studies such as musical selections and uncontrolled factors such as volume and tempo of music. They suggested that these limitations needed to be addressed in future research. Finally, due to implications that music could influence an individual's performance, this review also helped guide future studies that examined whether or not video, another form of entertainment, could influence an individual's performance and perceived exertion on a physical activity task.

Elliot, Carr, and Savage (2004) conducted a study to determine if performance could be enhanced by different styles of music. The researchers asked participants to listen to a blank tape, motivational music, or calming music. They measured their resulting physical activity output at fixed perceived exertion intensity on a cycling task. Participants received all three conditions over the course of three weeks (one condition a week) and cycled at an RPE of '13' during each of the sessions. The researchers recorded distance covered and the condition. The results of this study suggested that the presence of music (motivational, calming) positively enhanced performance (rode longer distances) even though RPE was consistent at '13' throughout the entire task. This suggests that with the presence of music, the participant works harder at an RPE of "13". The results of the study also suggested that participants who were given motivational music exhibited the most improvement in performance.

Edworthy and Waring (2006) focused on how music, volume, and tempo (pace) influenced the perception of exertion in a running (treadmill) task. Participants were assigned to one of five conditions: loud/fast, loud/slow, soft/fast, soft/slow, and no music.

Participants were instructed to run/walk at their own comfortable pace for 10 minutes on a treadmill while assigned to one of the conditions. Encouragement was not provided, but participants were told they could alter the speed of the treadmill to maintain comfort. The researchers recorded speed, RPE, and heart rate during the task. The results suggested that music volume and tempo had an effect on perceived exertion. The participants who were assigned the condition where music was loud and fast and those in the no music control group rated their perceived exertion levels the highest. Also, those who were assigned to the loud and fast condition ran the fastest and had the highest heart rates, thus contributing to their higher reports of exertion. The results of the other conditions did not show significant differences. Thus, this study suggests that music tempo and volume can influence the pace at which an individual runs, which then affects the individual's perceived exertion and heart rate.

Mohammadzadeh et al. (2008) also studied the effect of fitness level (trained/untrained) and music on performance and perceived exertion. An individual was considered trained if he or she had engaged in regular exercise the previous three months, whereas they were considered untrained if they had not done this much exercise. The study was conducted on two separate days and each participant received both conditions. On the first day, the researchers randomly assigned participants, eighteen males and six females, to either a music condition, where participants received music with a fast rhythm or to a no music condition. The alternate condition was assigned to the participant the second day. Participants on both days were assessed using a Bruce treadmill maximum oxygen consumption test, where the treadmill began at a 40% incline and at a speed of

2/74 km/hr. The participants' rating of perceived exertion was also evaluated while they engaged in the treadmill task. Every three minutes, the treadmill was sped up by 2% and exertion was measured. This process continued for each participant until he or she was exhausted and could no longer continue the activity. The results showed that all the participants had an increase in performance (endurance) and overall their perceived exertion was lower throughout the task in the music condition. Untrained participants received greater enhancement (difference in RPE when examining no music/music conditions) from having music while engaged on the treadmill task than the trained participants; however, both benefited in the music condition. Thus, these results also support the notion that music can lower an individual's perception of exertion during physical activity and increase his or her performance.

Research conducted on the effect of music on perceived exertion has shown that music can lower an individual's perceived exertion during physical activity when the activity is low to moderate in intensity but at high intensities results are mixed. At all intensities the participants seem to utilize music as a dissociative attentional strategy to "distract" them from the feelings of fatigue, pain, and heart rate that are associated with physical activities, thus resulting in an increase in performance. Similar to music, studies have shown that watching video entertainment can also influence an individual's perceived exertion during physical activity.

Research With Video

Although only a few studies have examined the effects of video entertainment on exercise performance and perceived exertion during exercise, the results of this research suggest that video can influence an individual's perceived exertion during physical activity (Annesi, 2001).

Stanley et al. (2007) examined the effect of attentional strategies on perceived exertion. In one of their experimental conditions, they also sought to determine if video entertainment had dissociative effects on female participants that could potentially lower the perception of exertion during physical activity. Where an individual directed her attention (internally or externally) in relation to her body was also evaluated in this study. The study lasted five weeks for each participant. The first week was a control condition during which each female's sub-maximal VO_2 was measured and heart rates were recorded. Over the next four weeks, participants were randomly assigned to one of four conditions each week. The four conditions were focusing attention on internal association (breathing patterns, body feelings), internal dissociation (only video condition, daydreaming), external association (keeping track of calories burned, distance run), or external dissociation (paying attention to their surroundings and scenery) while the participant exercised on a stationary bicycle for 20 minutes (5 minute warm up, 10 minute task, 5 minute cool down). During the 10-minute task, the participant's bicycle was adjusted for a moderate level resistance (75-80 Watts). Also, each participant had to maintain her pre-assigned heart rate (75% VO_2 max) throughout the cycling. Every minute for the 10 minutes, participants were asked to report perceived exertion and the researcher recorded their heart rate. The results of this study showed that for both conditions of dissociation (internal and external), the participants' rating of perceived exertion was lower while engaged in physical activity than participants who were assigned to either associative conditions. However, the researchers did not report a significant difference between internal and external dissociation conditions. Heart rate for each of the four conditions was not significantly different within participants. Thus, this study demonstrates that using a dissociative strategy can significantly lower an individual's perceived exertion when compared to an associative strategy. Video entertainment was shown to have dissociative properties that may be used to help a participant perceive a lower exertion when engaged in physical activity at a predetermined heart rate.

Barwood et al. (2009) studied if a participant's perceived exertion was affected when he or she was presented motivational music and video entertainment simultaneously, while engaged in physical activity. The researchers hypothesized that since music and video separately had positive effects on lowering perceived exertion, combined they might have an additive effect. An additive effect may allow individuals engaged in vigorous physical activity to be able to utilize a dissociative attentional strategy. They referenced previous studies that concluded that as an individual listened to music or watched a video, his or her attention drifted away from internal sensations to the external surroundings, such as to music or video. Male participants were assigned to participate in each condition on different days; the conditions were a motivational video and music condition, a non-motivational video and no music condition, or a no music and video condition (control). Motivation was determined using the Brunel Music Rating Inventory, which enables researchers to determine if music selections are motivational. In regards to video, the researchers used video of sport triumphs or accomplishments as motivational and a political trial and public speaking segment as non-motivational. Blood lactate levels for each participant were also measured before and after each study day as a means to determine the participant's aerobic and anaerobic metabolism while they ran. Each participant, after warm-up, ran for 15 minutes at maximal capacity trying to cover the most distance he could on a treadmill. RPE was recorded every two minutes. Results showed that when participants were in the motivational video and music condition and the non-motivational video condition they outperformed (covered more distance) and reported lower perceived exertion during the task than when they received the control condition. There was no difference in performance or exertion between the motivational and non-motivational video conditions. The results of blood lactate taken after the activity showed an increase in lactate levels from pre-activity to post-activity. The blood lactate levels in the motivational music and video condition were significantly greater than the blood lactate levels in the non-motivational video condition. There were no other significant differences between treatment conditions and blood lactate levels. Therefore, the results affirm previous literature that music and video entertainment can significantly lower an individual's perception of exertion and increase performance during physical activity. The results of the study suggest that music and video can act as a dissociative strategy for an individual engaged in physical activity. Also, when an individual was exposed to the combination of music and video, he continued to perceive exertion as lower and experienced an increase in performance even when engaged in high intensity activity. The researchers concluded that combining music and video might have an additive effect on perceived exertion of individuals when engaged in physical activity.

However, by not having a “music only” condition, where only music was presented in a condition, and because the differences between the two non-control conditions (non-motivational video and motivational music/video condition) were not significant, there is no way of knowing what contributed to the lower perception of exertion and increase in performance. This was a limitation of the study and needs to be addressed. If there is an additive effect, an individual may utilize the potential dissociative benefits of music and video entertainment when engaged in all intensities of physical activity.

The research that has been presented suggests that a participant when exposed to music and/or video entertainment may perceive lower exertion during activity. Also, as Barwood et al. (2009) suggest, combining music and video entertainment may have the potential to reduce the perceived exertion of an individual during physical activity of all intensities. This quality is something that music and video separately has not consistently shown. Barwood et al.’s study, to date, was the first to study the effects of combining music and video entertainment and presenting them simultaneously to a participant during activity. Thus far, no study has compared the effects of music and video by itself, and then a combination of the two to determine which form of entertainment may provide the most benefit to an individual while engaged in physical activity. Studying each form of entertainment by itself and then in combination will allow the researcher to test for additive effects. This would address the limitation that Barwood et al.’s study presented, by not having a music only condition, and allow a researcher to decisively state if there is an additive effect. Therefore, the current study is designed to measure the effects of music, video, and a combination of both forms of entertainment on perceived exertion during activity. Also, the study will include measures of the participant's attentional focus, which was a limitation of past studies because it was not assessed in the research on music and video. Music and video has each been shown to lower an individual's perceived exertion during low to moderate intensity exercise. However, most research supports the notion that alone, neither form of entertainment has a significant effect at vigorous intensities. Should music and video combined have an additive effect, a participant may be able to also experience a decrease in perceived exertion at vigorous intensity physical activity when both forms of entertainment are presented in unison. Thus, vigorous intensity exercise will be utilized in the current study. Attentional strategy will also be measured for each participant to test the effects of dissociative strategies that music and/or video has on perceived exertion at vigorous intensity physical activity.

CHAPTER III

METHODS

Participants

Healthy male participants who can safely participate in physical activity according to the American College of Sports Medicine (ACSM) guidelines were the participants in this study. The participants were ages 18 to 45. Prior to the study, participants were screened using ACSM's Pre-participation Questionnaire for medical problems. If a participant had a prior history of health problems (heart disease, pulmonary disease, stroke), was physically unable to perform the cycling task, was taking medication (e.g., asthma medication) that could impact exertion or coordination during physical activity, or had a condition that limited maximal output during physical activity, he was not permitted to participate in this study without consent from a medical doctor. All participants had to meet ACSM guidelines (30min/week at least 3 times) for physical activity for the six months prior to beginning the study (See Table 1). All participants signed a consent form (approved by the institutional review board) and confirmed that they were healthy enough to participate in physical activity. The participants were recruited from a local university in Greensboro, North Carolina. There were 15 participants recruited for this study.

Materials and Measures

Ratings of perceived exertion. During all sessions, a participant's ratings of perceived exertion was measured using the Borg Rating of Perceived Exertion (RPE) scale (Borg, 1982). This scale ranges from 6 (very, very light) to 20 (very, very hard) perceived exertion. Karavatas and Tavakol (2005) examined the correlation and concurrent validity between heart rate and RPE and concluded that RPE could be utilized as an accurate tool to measure an individual's exercise intensity; RPE and heart rate are moderately correlated (r=0.58). Therefore, Borg's RPE scale was utilized in the current study as a measure of a participant's perception of exertion while engaged in the cycling task. RPE was also evaluated during each exercise session.

Attention. During all study sessions, participants' attentional focus was measured using a scale ranging from "0", pure dissociation (entertainment, environment, external), to "10", pure association (body feel, breathing, internal). Attention was measured in millimeters (mm), thus a 100 mm vertical line separated the numeric anchors. Participants were asked to draw a line perpendicular to the line reflecting their attentional focus. The location of this perpendicular line was measured starting from the zero (0) millimeter mark. Fifty (50) millimeters was considered a neutral focus where a participant was equally dissociating and associating while cycling. Any measurement less than 50mm were considered a dissociative focus, while a measurement more than 50mm was considered an associative focus. Tammen (1996) and Razon et al. (2009) stated the scale could not be assessed for internal reliability because it was a one-item measure. However, the authors found that the validity of the scale was sound. Thus, this scale was used while the participants engaged in all experimental cycling sessions.

Heart rate. Participants were provided with a Polar heart rate monitor prior to beginning the exercise. Participants were asked to wear the heart rate monitor and sit quietly for five minutes. Upon completion of the sitting period, resting heart rate was assessed. The researcher ensured that heart rate could be measured before the study began to ensure that the Polar Heart Rate Monitor would work properly during the study. On the maximal fitness day (session 1), participants' heart rate was measured every three minutes until conclusion of the maximal test. On every experimental day, the participants' heart rate was recorded every four minutes until the conclusion of the session.

Feeling scale. During all study sessions, participants were asked to rate their feelings on a scale from "+5", very good to "-5", very bad. Pham (1992), reported that the feeling scale had high internal consistency (α=0.88) and validity. On the maximal fitness day (session 1), participants rated how they felt every three minutes until conclusion of the maximal test. During the experimental sessions, participants were asked to rate their feelings every four minutes until the conclusion of the session.

Felt Arousal scale. During each session, participants were also asked to rate their arousal levels on a scale of "1" low arousal to "6" high arousal. Pham (1992) reported that the felt arousal scale had high internal consistency (α=0.86) and validity. Also, the felt arousal scale was found to be theoretically orthogonal and positively correlated (r=0.264) to the feeling scale. Thus, we used the felt arousal scale in conjunction with the feeling scale in our study. Similar to the other measures, arousal was measured every three minutes until conclusion during the maximal test session. During the experimental sessions, participants were asked to rate their arousal levels every four minutes until the conclusion of the session.

Work rate. Work rate is defined as total distance covered (in kilometers). Work rate was recorded every three minutes during the maximal test session. During the experimental sessions, work rate was recorded every four minutes until conclusion of the session. Participants were also asked to maintain a constant workload of 80-95 revolutions per minute (rpm) during all sessions to ensure that work rate was consistent and not influencing the experimental measures. If a participant did not maintain a workload within this rpm range, he was asked to increase or decrease his speed. If a participant could not maintain the rpm range at a given speed, the speed was reduced by 10 watts until the participant was able to maintain a workload within the range.

Lactate levels. Lactate levels and threshold were analyzed using a lactate reader (Lactate Plus Analyzer: Sports Resource Group, Minneapolis, MN). Lactate readers have been shown to accurately reflect (r=0.999) an individual's lactate levels from a small blood sample (25 micro-liters) from a finger prick (White, Yaeger, & Stavrianeas, 2009). However, in our study, even when we followed the manufacturer's instructions, called representatives of the company, purchased and used quality control solutions, and reviewed our procedures with exercise physiologists, the measurements reported by the lactate reader were consistently unreliable. Therefore, after multiple trials we terminated this measurement. Lactate was measured during the maximal fitness test day for four participants and during all the experimental conditions for four different participants (See Table 2 and 3).

Ventilatory threshold. Ventilatory threshold (VT) was calculated upon completion of the VO_2 maximal test. Due to the interest in examining the effects of entertainment during vigorous physical activity, after a participant's VO_2 max and VT were calculated, the participant's work rate for vigorous intensity (125% VT) was calculated. If the participant's 125% VT fell in between two workloads, the researcher determined the work rate that corresponded to the workload at the participant's 70% VO_2 max (another measure of vigorous intensity) and used that workload on the exercise days. In every instance, the participant's workload at 70% VO_2 max was at one of the two workloads identified as potentially representing 125% VT. Thus, this calculated workload served as every participant's work rate for the remainder of the study.

Stationary bicycle. During all study sessions, participants cycled on a recumbent stationary bicycle. Participants were only able to see the amount of time cycled, total distance covered, and rpms.

Treatment conditions. The four treatment conditions were a control condition during which participants did not listen to or watch anything while cycling, a music condition during which participants listened to music while exercising, a video condition during which participants watched a video while exercising, and a music and video condition during which participants listened to music and watched video while exercising. In the control condition, participants were fitted with soundproof headphones but neither music nor noise was not projected through them.

In all entertainment conditions, the final 20 minutes (before credits) of Cirque du Soleil: *La Nouba* was selected and presented to the participants. All participants were assigned the same music and/or video selection every session. The researchers chose this selection because it incorporated acrobatic/active movements, constant music/noise that makes “sense” when paired with the video, and a relatively equal proportion of male and female performers.

In the music condition, participants were provided a music-playing device. The device was connected to soundproof headphones and music was projected through the headphones. Participants only heard the music and were not able to view the video.

In the video condition, participants watched the segment of video on a video projector. While viewing the video segment, participants wore soundproof headphones even though no music or noise was projected through them.

In the music and video combined condition, participants listened to the same selection of music and viewed the same video segment simultaneously. Participants wore soundproof headphones that played music for the duration of the cycling task.

Procedures

The study consisted of five sessions for each participant. Every session was separated by at least 48 hours. Participants were asked not to engage in any physical activity two hours prior to testing, not to engage in vigorous intensity physical activity at all, and not to eat or consume caffeine three hours before the test. Every participant in this study was male.

On the first day of the study, all participants signed the informed consent prior to study commencement. Participants were also asked to quantify on the Godin Leisure Time Exercise Questionnaire the number of times per week that they exercised at strenuous, moderate, and mild intensities. Strenuous intensity was described as “heart beats rapidly”, and activities listed as examples were running, soccer, basketball, and judo. Moderate intensity was defined as “not exhausting”, and sample activities included fast walking, tennis, easy biking, and volleyball. Mild intensity was described as “minimal effort”, and the examples were yoga, archery, bowling, fishing, golf, and easy walking. Upon consent and completion of the Godin questionnaire (See Table 1), all participants were equipped with a heart rate monitor and their resting heart rate was measured. After this measure was taken, participants began a graded exercise test on a cycle ergometer to determine VO_2 maximal test. Participants were asked to cycle on a stationary bicycle, the work rate on the bicycle was set for each participant at 100 Watts for all participants. Every three minutes the work rate was increased by 25 Watts until the participant reached his maximal output. During the last minute of every three-minute interval, an individual’s ratings of perceived exertion, attentional focus, feelings, felt arousal, heart rate, work rate, and lactate levels were measured. The maximal fitness test concluded when the participant could no longer increase in work rate or could not complete a set work rate (cycling more than 70 rpm) and volitionally terminated the test; the researcher never terminated the test for a participant. Participants in this study were deemed to have reached a “true” maximum value if they met at least 2 of 3 criteria for the maximal test (RPE over 17, Heart Rate over 170, Respiratory Quotient over 1.10). All participants in this study met this requirement (See Table 4). At the conclusion of the maximal test, VT, VO_2 max, lactate levels and total work (distance covered) were recorded. These measures were used to identify the exercise intensity (work rate) on the bicycle that corresponded to 125% VT and 70% VO_2 max, which are considered vigorous intensity (See Table 5). This was the target exercise intensity for each of the subsequent sessions. Upon completion of the VO_2 max test, participants were randomly assigned to one of four conditions each day they returned to the study until every participant had engaged in all the experimental conditions.

During the four experimental sessions, all participants performed the same cycling task; only the treatment differed. All participants were given a heart rate monitor and proceeded to the stationary bicycle, which was positioned in the exact same location (marked by tape) for every session. The cart holding the television was also positioned in the exact same location (marked by tape) for every session regardless of if a participant was receiving entertainment. After a five-minute warm up, exercise intensity was raised to the calculated work rate reflecting 125% VT. All the participants maintained cycling at this work rate and between 80 to 95 rpm for 20 additional minutes. Once the constant load work rate was achieved, RPE, heart rate, attentional focus, work rate, feelings, and felt arousal were evaluated during the last 40 seconds of every four minute segment until conclusion of the 20 minutes. Lactate was measured at midpoint (10 minutes) using a finger stick to ensure that the participant was engaged in vigorous intensity exercise. If a participant was not maintaining their work rate at 80-95 rpms the participant was encouraged to increase or decrease his cycling speed in order to return to the work range.

In all cases, workload was reduced if necessary so that subjects could complete 20 minutes of activity, this occurred for two participants. Verbal cues were not otherwise given to a participant during a session. During the last minute of the 20-minute cycling task, RPE, heart rate, attentional focus, work rate (distance covered), feelings, felt arousal, and lactate were measured and recorded for each participant in every condition. When participants completed all experimental conditions they were debriefed and given compensation for completing the study.

Compensation

Participants in this study received institutional credit and/or payment. If participants completed the study, they received $50. If they did not complete the study, they were only given the option for institutional credit at the discretion of the course instructor.

Analysis (Repeated Measures Two-Way ANOVA)

The current study used a randomized-groups experimental design. Every participant was evaluated for RPE, heart rate, attentional focus, feelings, felt arousal, work rate, and lactate in each of the four conditions (control, music only, video only, and music and video). Results for RPE, attentional focus, feeling, and felt arousal were statistically evaluated using a two-way repeated measures analysis of variance (ANOVA) to test the effects of type of entertainment (control, music, video, music/video) and time (4min, 8min, 12min, 16min, 20min). Results for heart rate and work rate were statistically evaluated using a two-way repeated measures analysis of variance to test the effects of type of entertainment (control, music, video, music/video) and time (0min, 4min, 8min, 12min, 16min, 20min). Results for lactate were statistically evaluated using a two-way repeated measures analysis of variance to test the effects of type of entertainment (control, music, video, music/video) and time (0min, 10min, 20min). The results determined if type of entertainment in a vigorous task could lower an individual's perceived exertion during physical activity.

CHAPTER IV

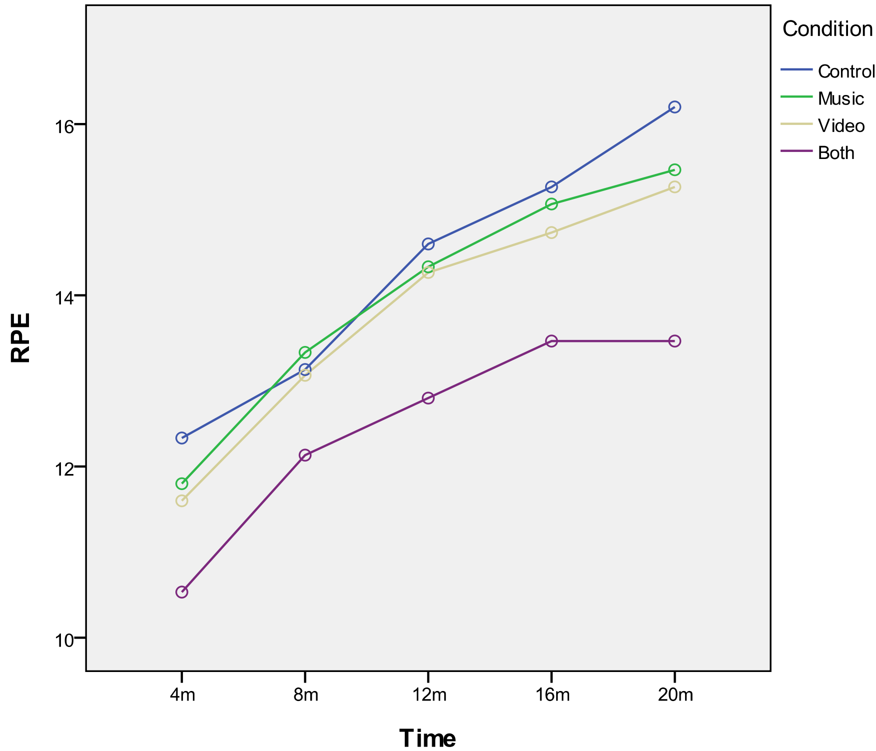
RESULTS

Descriptive statistics for all dependent variables as a function of time and type of entertainment is presented in Table 6 and Table 7.

Ratings of Perceived Exertion

There was a significant difference in RPE as a function of type of entertainment, $F(2.73, 38.24)=7.86$ $p<.001$, partial $\eta^2=0.36$. RPE was significantly lower ($p<.01$) in the combined entertainment (music and video) condition ($M=12.48$, $SE=0.19$) when compared to the music only ($M=14.00$, $SE=0.42$), video only ($M=13.79$, $SE=0.38$), and control ($M=14.31$, $SE=0.49$) conditions. There was no significant difference in RPE between the music only, video only, and control conditions. There was a significant difference in RPE as a function of time, $F(1.19, 16.67)=52.75$, $p<.001$, partial $\eta^2=0.79$. The nature of this effect was that RPE significantly increased as time engaged in the cycling task increased. There was also a significant interaction between entertainment and time, $F(7.67, 107.42)=2.34$, $p=.03$, partial $\eta^2=0.14$, such that as time increased on the cycling task, there was a significant difference between type of entertainment conditions (see Figure 1). In particular, when participants were given the control, music, or video condition, there was no significant difference between the conditions in RPE the longer the participant engaged in the cycling task. However, when participants were given the combined condition (music and video simultaneously), the participants perceived a significantly lower exertion when compared to the other conditions in RPE the longer they engaged in the cycling task.

Figure 1. Estimated Marginal Means of RPE

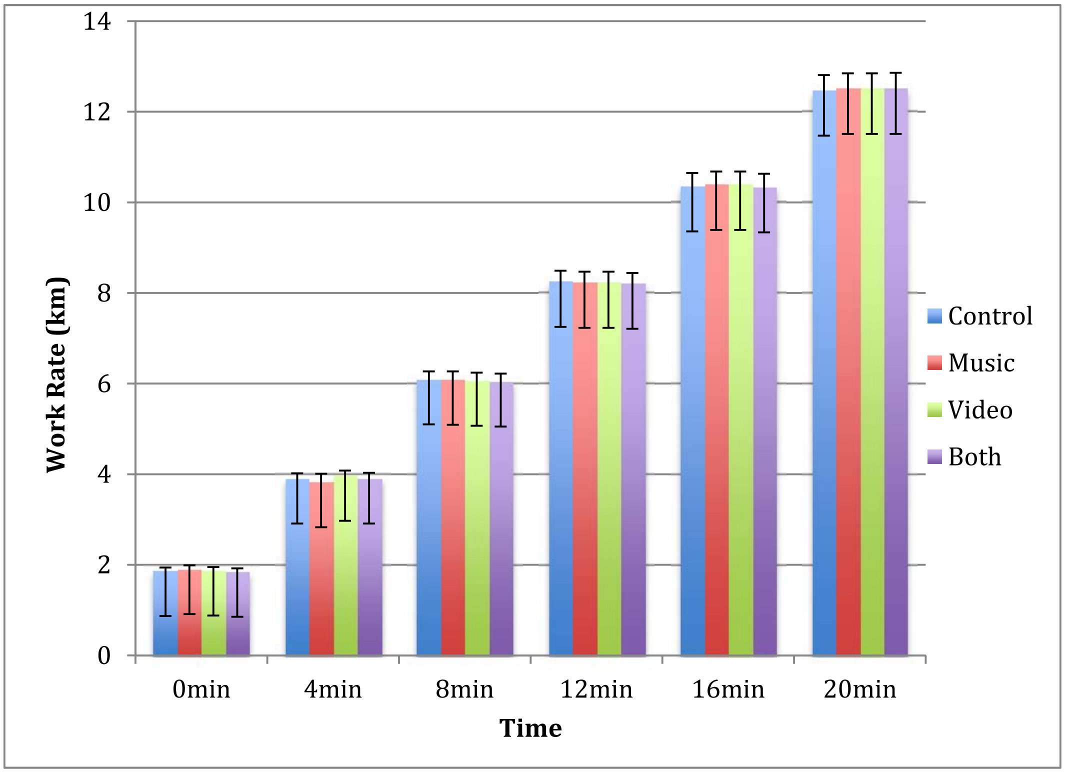


Work Rate

During our study, we decreased the work rate for two participants to insure that they could complete the full 20 minutes of exercise. However, there was no significant difference in work rate (distance covered) as a function of type of entertainment, $F(2.22, 31.01)=0.19$, $p=.85$, partial $\eta^2=0.01$. There was a significant difference in work rate as a function of time, $F(1.04, 14.62)=1305.28$, $p<.001$, partial $\eta^2=0.99$. The nature of this effect was that work rate significantly increased as time increased on the cycling task.

There was not a significant interaction between type of entertainment and time, $F(2.63, 36.87)=0.51$, $p=.51$, partial $\eta^2=0.05$ (see Figure 2).

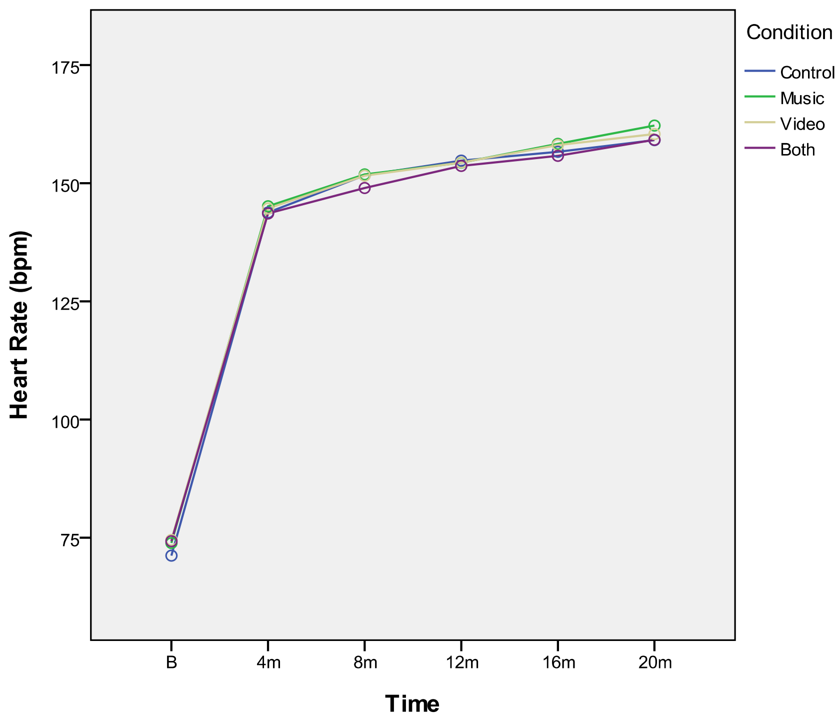
Figure 2. Estimated Marginal Means of Work Rate



Heart Rate

There was no significant difference in heart rate as a function of type of entertainment, $F(3, 42)=0.38$, $p>.77$, partial $\eta^2=0.03$. There was a significant difference in heart rate as a function of time, $F(1.29, 18.01)=442.73$, $p<.001$, partial $\eta^2=0.97$. In particular, heart rate increased significantly as time engaged on the cycling task increased. There was not a significant interaction between type of entertainment and time, $F(8.873, 124.22)=1.18$, $p>.32$, partial $\eta^2=0.08$ (see Figure 3).

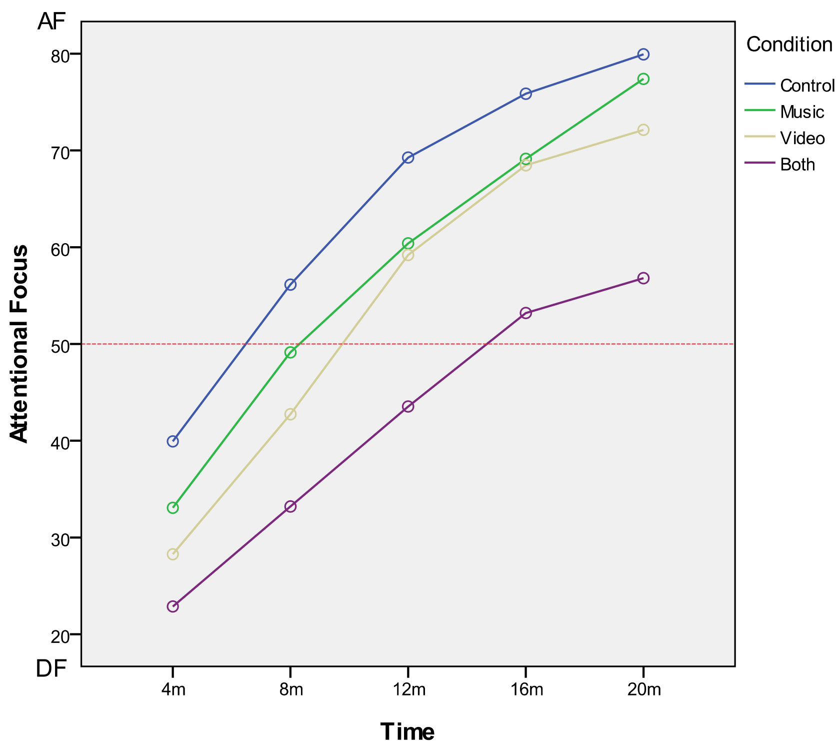
Figure 3. Estimated Marginal Means of Heart Rate



Attentional Focus

There was a significant difference in attentional focus as a function of type of entertainment, $F(3, 42)=5.68$, $p=.002$, partial $\eta^2=0.29$. A participant's attentional focus was significantly ($p<.05$) more dissociative in the combined entertainment condition (M=41.92, SE=4.21) when compared to the music only (M=57.83, SE=4.66), video only (M=54.16, SE=4.68), and control (M=64.23, SE=5.34) conditions. There was no significant difference in attentional focus between the music only, video only, and control conditions. There was a significant difference in attentional focus as a function of time, $F(1.38, 19.30)=81.08$, $p<.001$, partial $\eta^2=0.85$. This effect was such that an individual's attentional focus shifted towards a significantly more associative focus as time engaged in the cycling task increased. There was not a significant interaction between type of entertainment and time, $F(12, 168)=1.25$, $p=.26$, partial $\eta^2=0.08$ (see Figure 4).

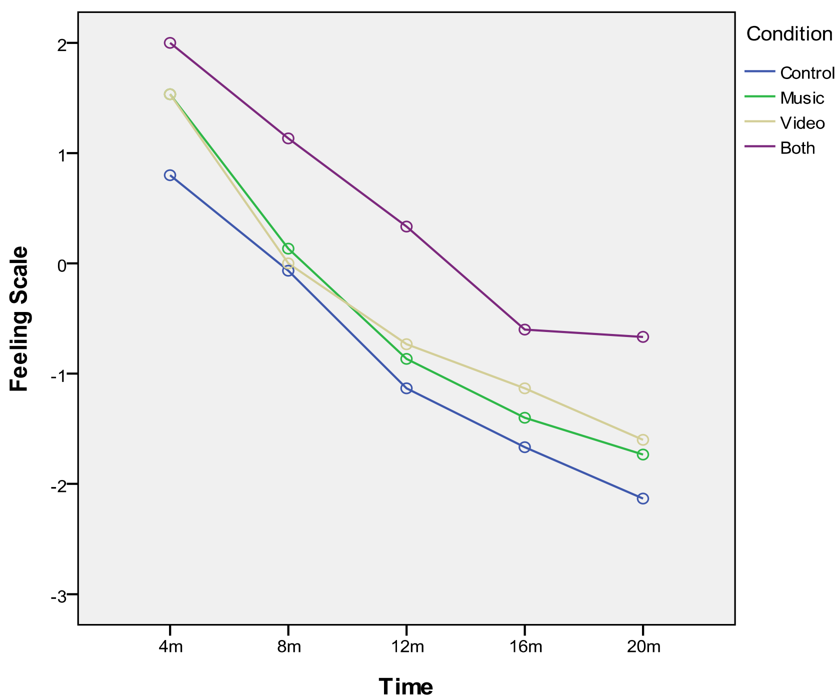
Figure 4. Estimated Marginal Means of Attentional Focus



Feeling Scale

There was a significant difference in feelings as a function of type of entertainment $F(3, 42)=3.76$, $p=.02$, partial $\eta^2=0.21$. Feelings were significantly ($p<.05$) more positive in the combined entertainment condition ($M=0.44$, $SE=0.37$) when compared to the music only (M=-0.47, SE=0.47), video only (M=-0.39, SE=0.55), and control (M=-0.84, SE=0.46) conditions. There was no significant difference in feeling between the music only, video only, and control conditions. There was a significant difference in feeling as a function of time, $F(1.52, 21.34)=49.76$, $p<.001$, partial $\eta^2=0.78$. The nature of this effect was feelings became significantly more negative as time on the cycling task increased. There was not a significant interaction between type of entertainment and time, $F(6.46, 90.39)=0.81$, $p=.58$, partial $\eta^2=0.05$ (see Figure 5).

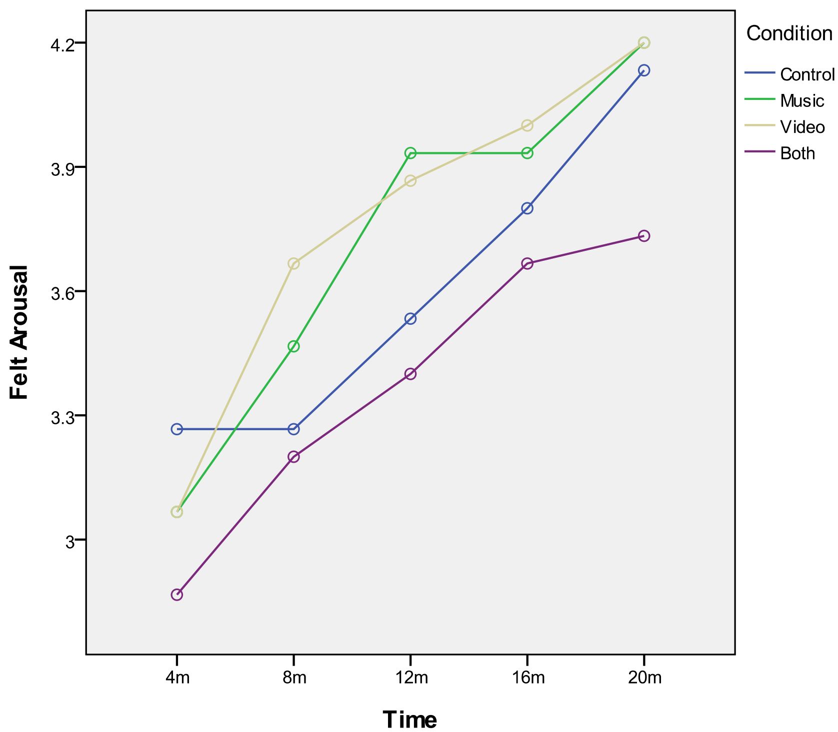
Figure 5. Estimated Marginal Means of Feeling Scale



Felt Arousal Scale

There was no significant difference in felt arousal as a function of type of entertainment, $F(3, 42)=1.72$, $p=.18$, partial $\eta^2=0.11$. There was a significant difference in felt arousal as a function of time, $F(1.73, 24.15)=10.57$, $p=.001$, partial $\eta^2=0.43$. The effect was such that an individual's felt arousal significantly increased as time engaged in the cycling task increased. There was not a significant interaction between type of entertainment and time, $F(12, 168)=0.84$, $p=.62$, partial $\eta^2=0.06$ (see Figure 6).

Figure 6. Estimated Marginal Means of Felt Arousal



Lactate

Because of the challenges with using the lactate analyzer, lactate concentration during the experimental sessions was measured for only four participants. Of those participants, there was no significant difference in lactate as a function of type of entertainment, $F(1.08, 3.25)=0.74$, $p=.46$, partial $\eta^2=0.20$. There was a significant difference in lactate as a function of time, $F(2, 6)=24.91$, $p=.001$, partial $\eta^2=0.89$. In particular, lactate levels significantly increased as time increased on the cycling task. There was not a significant interaction between type of entertainment and time, $F(6, 18)=0.88$, $p=.53$, partial $\eta^2=0.23$ (see Figure 7).

Figure 7. Estimated Marginal Means of Lactate

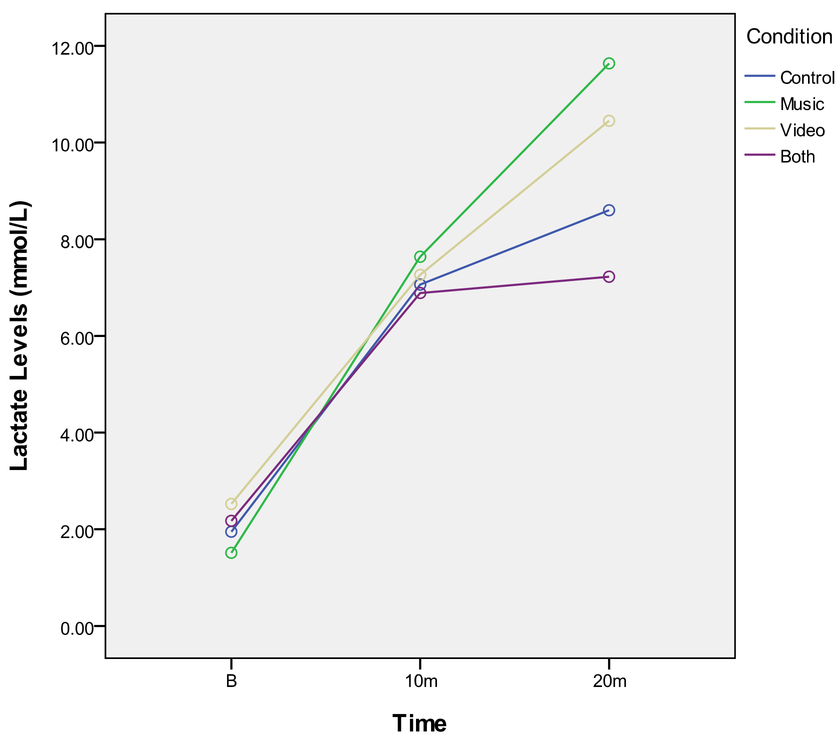


Table 1. Descriptive Information for all Participants

ID	Age (yrs)	Height (in)	Weight (lb)	Preference during Exercise (Music, Video, Both, Neither)	*Godin Strenuous	*Godin Moderate	*Godin Mild
1001	24	67	176	Neither	2	3	7
1002	21	70	192	Music	4	7	2
1003	21	73	210	Both	3	3	2
1004	22	74	195	Neither	3	0	1
1005	23	72	195	Music	5	5	3
1006	21	69	155	Neither	4	1	7
1007	23	72	210	Music	2	2	4
1008	22	72	180	Music	3	4	7
1009	22	73	161	Music	0	6	7
1010	22	68	155	Music	5	0	3
1011	24	73	200	Music	3	5	1
1012	23	70	157	Neither	5	1	1
1013	19	71	175	Music	0	5	5
1014	20	73	195	Music	4	5	5
1015	21	68	137	Neither	6	0	1

* These are the number of times per week a participant reported participating in exercise at strenuous, moderate, and mild intensities.

Table 2. Lactate of Participants (mmol/L) (VO_2 Max Session)*

ID	Rest	3 min	6 min	9 min	12 min	15 min
1003	1.5	2.6	Err	3.5	2.9	3.0
1004	1.7/4.8	2.5	5.3	4.6	4.9	9.2
1005	2.5/2.2	3.1/2.7	3.9/3.9	5.9/5.7	6.0/7.4	8.2/Err
1008	5.7/3.9	6.2/6.6	8.0/9.7	9.9/12.0	16.2/Err	N/A

* If two readings were taken from each finger (2^{nd} and 3^{rd} drops of blood), the lactate concentration was reported as 2^{nd} drop concentration/3^{rd} drop concentration

- Err = Lactate concentration was unable to be analyzed by the reader
- N/A = Participant did not reach stage

Table 3. Lactate of Participants (Experimental Sessions)

ID	C R	C Mid	C End	M R	M Mid	M End	V R	V Mid	V End	B R	B Mid	B End
1001	1.2/ 1.7	8.5/ 9.2	Err/ 13.9	0.8/ 1.7	9.2/ 10.4	Err/ 13.6	1.9/ Err	9.7/ 10.3	13.5/ 16.1	1.7/ Err	Err/ 10.5	10.2/ Err
1002	1.3/ 1.7	8.6/ 6.8	6.6/ 3.6	2.1/ 2.0	8.0/ 6.6	22.6/ 14.6	4.2/ 3.4	4.6/ 4.5	3.4/ 3.8	1.4/ 1.9	4.2/ 3.7	3.2/ 3.5
1006	2.6/ 1.9	5.1	6.5	1.6/ 1.5	8.1/ 6.8	7.5/ 7.5	2.5/ 1.5	Err/ 7.5	9.1/ 9.5	2.5/ 2.4	6.6/ 6.2	6.7/ 6.4
1007	2.2/ 3.0	7.3/ 5.9	8.1/ 9.7	1.2/ Err	5.8/ 6.2	6.8/ 6.9	2.7/ 2.1	7.0	14.1	2.7/ 3.1	6.7	8.8

* C=Control, M=Music, V=Video, B=Both (Music and Video)
- R=Value at rest before the session and warm-up began
- Mid=10 minute (middle) of cycling task
- End=20 minute (conclusion) of cycling task
- If two readings were taken from each finger (2^{nd} and 3^{rd} drops of blood), the lactate concentration was reported as 2^{nd} drop concentration/3^{rd} drop concentration
- Err = Lactate concentration was unable to be analyzed by the reader
- For participants 1006 (Control Mid/End) and 1007 (Video Mid/End and Both Mid/End) after being administered the finger stick and collecting the 2^{nd} drop of blood, the incision site closed and a 3^{rd} drop could not be obtained

Table 4. Participant VO_2 Max Session Data (Maximum Values Observed)

ID	RPE	Heart Rate	Respiratory Quotient	Workload (Stage)	Attention Focus (mm)	Feeling Scale	Felt Arousal
1001	17	183	1.23	225W (6)	86	-3	4
1002	19	160	1.10	250W (7)	100	-5	5
1003	19	143	1.26	225W (6)	88	-3	5
1004	17	167	1.17	225W (6)	100	-3	6
1005	17	178	1.18	225W (6)	84	-3	4
1006	17	170	1.22	225W (6)	79	-3	5
1007	16	184	1.14	200W (5)	81	0	4
1008	16	178	1.17	200W (5)	87	1	5
1009	17	179	1.21	225W (6)	55	-2	4
1010	15	180	1.11	200W (5)	75	-1	4
1011	19	181	1.07	225W (6)	97	0	5
1012	17	181	1.28	200W (5)	90	-3	5

1013	19	178	1.25	175W (4)	100	-3	1
1014	19	199	1.18	200W (5)	84	-3	5
1015	20	176	1.15	250W (7)	100	-3	5

Table 5. Ventilatory Threshold and VO_2 Max Data

ID	VO_2 Max	70% VO_2	VT	125% VT
1001	38.8	26.7	1.96	2.45
1002	41.8	29.3	1.74	2.17
1003	34.5	24.2	1.80	2.25
1004	31.7	22.2	1.04	1.30
1005	37.0	25.9	2.05	2.56
1006	45.7	32.0	2.65	3.32
1007	30.4	21.3	1.80	2.25
1008	34.5	24.2	1.80	2.25
1009	39.8	27.9	1.90	2.37
1010	40.3	28.2	1.80	2.25
1011	41.4	29.0	2.37	2.96
1012	42.1	29.5	1.65	2.07
1013	13.4	9.4	1.00	1.25
1014	37.0	25.9	2.00	2.50
1015	57.4	40.2	2.00	2.50

Table 6. Descriptive Data Collapsed Across Time for each Experimental Condition (Mean, M, and Standard Error, SE).

	RPE	Work Rate (km)	Heart Rate (BPM)	Attention Focus	Feeling Scale	Felt Arousal	Lactate Levels (mmol/L)
Control	M: 14.31 SE: 0.49	M: 7.16 SE: 0.21	M: 140 SE: 3.42	M: 64.23 SE: 5.34	M: -0.84 SE: 0.46	M: 3.60 SE: 0.21	M: 5.87 SE: 0.80
Music	M: 14.00 SE: 0.42	M: 7.16 SE: 0.21	M: 141 SE: 3.55	M: 57.83 SE: 4.66	M: -0.47 SE: 0.47	M: 3.72 SE: 0.23	M: 6.93 SE: 1.10
Video	M: 13.79 SE: 0.38	M: 7.18 SE: 0.20	M: 141 SE: 3.56	M: 54.16 SE: 4.68	M: -0.39 SE: 0.55	M: 3.76 SE: 0.16	M: 6.75 SE: 1.07
Both	M: 12.48 SE: 0.19	M: 7.14 SE: 0.20	M: 139 SE: 3.07	M: 41.92 SE: 4.21	M: 0.44 SE: 0.37	M: 3.37 SE: 0.16	M: 5.43 SE: 0.95

Table 7. Descriptive Data for the Condition x Time Interaction (Mean, M, and Standard Error, SE).

	0 minute	4 minute	8 minute	12 minute	16 minute	20 minute
RPE Control	N/A	M: 12.33 SE: 0.55	M: 13.13 SE: 0.59	M: 14.60 SE: 0.47	M: 15.27 SE: 0.52	M: 16.20 SE: 0.55
RPE Music	N/A	M: 11.80 SE: 0.45	M: 13.33 SE: 0.40	M: 14.33 SE: 0.47	M: 15.07 SE: 0.49	M: 15.47 SE: 0.56
RPE Video	N/A	M: 11.60 SE: 0.45	M: 13.07 SE: 0.38	M: 14.27 SE: 0.44	M: 14.73 SE: 0.44	M: 15.27 SE: 0.54
RPE Both	N/A	M: 10.53 SE: 0.27	M: 12.13 SE: 0.22	M: 12.80 SE: 0.28	M: 13.47 SE: 0.26	M: 13.47 SE: 0.29
Work Rate Control	M: 1.87 SE: 0.07	M: 3.91 SE: 0.11	M: 6.10 SE: 0.17	M: 8.25 SE: 0.24	M: 10.36 SE: 0.29	M: 12.47 SE: 0.34
Work Rate Music	M: 1.91 SE: 0.08	M: 3.83 SE: 0.18	M: 6.09 SE: 0.18	M: 8.23 SE: 0.24	M: 10.37 SE: 0.29	M: 12.51 SE: 0.34
Work Rate Video	M: 1.88 SE: 0.07	M: 3.97 SE: 0.11	M: 6.07 SE: 0.17	M: 8.23 SE: 0.24	M: 10.39 SE: 0.29	M: 12.51 SE: 0.35
Work Rate Both	M: 1.85 SE: 0.07	M: 3.91 SE: 0.12	M: 6.05 SE: 0.17	M: 8.21 SE: 0.23	M: 10.34 SE: 0.29	M: 12.51 SE: 0.35
Heart Rate Control	M: 71 SE: 1.98	M: 144 SE: 3.77	M: 152 SE: 4.09	M: 155 SE: 4.10	M: 157 SE: 4.14	M: 159 SE: 4.06
Heart Rate Music	M: 74 SE: 2.04	M: 145 SE: 3.82	M: 152 SE: 4.17	M: 154 SE: 4.25	M: 158 SE: 4.30	M: 162 SE: 4.49
Heart Rate Video	M: 75 SE: 2.15	M: 145 SE: 3.56	M: 152 SE: 4.12	M: 154 SE: 4.34	M: 158 SE: 4.25	M: 160 SE: 4.37
Heart Rate Both	M: 74 SE: 2.17	M: 144 SE: 3.39	M: 149 SE: 3.59	M: 154 SE: 3.75	M: 156 SE: 3.83	M: 159 SE: 3.57
Attention Control	N/A	M: 39.93 SE: 6.95	M: 56.13 SE: 5.79	M: 69.27 SE: 5.17	M: 75.87 SE: 5.71	M: 79.93 SE: 5.06
Attention Music	N/A	M: 33.07 SE: 5.40	M: 49.13 SE: 5.54	M: 60.40 SE: 5.57	M: 69.13 SE: 5.35	M: 77.40 SE: 4.19
Attention Video	N/A	M: 28.27 SE: 5.06	M: 42.73 SE: 5.83	M: 59.20 SE: 4.80	M: 68.47 SE: 5.02	M: 72.13 SE: 5.21
Attention Both	N/A	M: 22.87 SE: 3.81	M: 33.20 SE: 4.41	M: 43.53 SE: 4.90	M: 53.20 SE: 4.84	M: 56.80 SE: 5.80
Feeling Control	N/A	M: 0.80 SE: 0.50	M: -0.07 SE: 0.44	M: -1.13 SE: 0.49	M: -1.67 SE: 0.49	M: -2.13 SE: 0.60
Feeling Music	N/A	M: 1.53 SE: 0.49	M: 0.13 SE: 0.45	M: -0.87 SE: 0.47	M: -1.40 SE: 0.55	M: -1.73 SE: 0.60

Feeling Video	N/A	M: 1.53 SE: 0.52	M: 0.00 SE: 0.59	M: -0.73 SE: 0.59	M: -1.13 SE: 0.62	M: -1.60 SE: 0.61
Feeling Both	N/A	M: 2.00 SE: 0.39	M: 1.13 SE: 0.41	M: 0.33 SE: 0.40	M: -0.60 SE: 0.35	M: -0.67 SE: 0.56
FAS Control	N/A	M: 3.27 SE: 0.25	M: 3.27 SE: 0.18	M: 3.53 SE: 0.27	M: 3.80 SE: 0.33	M: 4.13 SE: 0.34
Felt Arousal Music	N/A	M: 3.07 SE: 0.23	M: 3.47 SE: 0.24	M: 3.93 SE: 0.25	M: 3.93 SE: 0.28	M: 4.20 SE: 0.31
Felt Arousal Video	N/A	M: 3.07 SE: 0.21	M: 3.67 SE: 0.19	M: 3.87 SE: 0.19	M: 4.00 SE: 0.22	M: 4.20 SE: 0.24
Felt Arousal Both	N/A	M: 2.87 SE: 0.26	M: 3.20 SE: 0.18	M: 3.40 SE: 0.19	M: 3.67 SE: 0.19	M: 3.73 SE: 0.21
	0 minute		10 minute		20 minute	
Lactate Control	M: 1.95 SE: 0.28		M: 7.06 SE: 0.80		M: 8.60 SE: 1.93	
Lactate Music	M: 1.51 SE: 0.20		M: 7.64 SE: 0.79		M: 11.64 SE: 2.77	
Lactate Video	M: 2.53 SE: 0.44		M: 7.26 SE: 1.12		M: 10.45 SE: 2.59	
Lactate Both	M: 2.18 SE: 0.30		M: 6.89 SE: 1.35		M: 7.23 SE: 1.50	

CHAPTER V

DISCUSSION

Research conducted on attention demonstrates that entertainment, such as that provided by music and video, can be effective in changing an individual's exercise behavior (Barwood et al., 2009; Razon et al., 2009). Individuals engaged in physical activity can use the entertainment as a distraction technique to turn their focus away from the internal sensations/body feel (association) experienced during exercise and towards the external entertainment (dissociation). The result is that exercisers perceive a lower exertion while exercising (Annesi, 2001; Karageorghis & Terry, 1997; Razon et al., 2009). This could result in an increase in physical activity behavior. However, researchers found that the beneficial effects of music and video were only present at low to moderate intensity exercise (Boutcher & Trenske, 1990; Hutchinson & Tenenbaum, 2007; Stanley, Pargman, & Tenenbaum, 2007; Mohammadzadeh et al., 2008). At vigorous intensity exercise, the beneficial effects of music and video entertainment were less evident (Schwartz et al., 1990; Stanley, Pargman, & Tenenbaum, 2007; Barwood et al., 2009).

Research examining the potential benefits of presenting music and video in combination is very limited and there is no past research in which definitive statements could be drawn regarding the potential additive effects of music and video combined.

Thus, the purpose of this study was to examine if the presentation of entertainment while cycling would influence an individual's perceived exertion at vigorous intensity.

Results of the study indicated that when participants were presented with music and video simultaneously, they perceived a significantly lower perceived exertion (RPE) when compared to the other treatment conditions (music only, video only, and control), despite working at the same intensity. This finding supported our hypothesis that participants would report a lower RPE when presented with music and video simultaneously compared to the other conditions. Thus, these results support the notion that music and video combined provide an additive effect, as Barwood et al. (2009) suggested, because participants did not perceive lower exertion when presented with music or video in isolation, but did when presented simultaneously. We also hypothesized that participants would report a more dissociative focus throughout the cycling task in the combined entertainment condition than when given music only, video only, or the control condition. The results of the study supported our hypothesis as participants rated their attentional focus as significantly more dissociative in the combined entertainment condition than when compared to the music only, video only, and control conditions.

The results of this study partially support Ekkekakis's dual-mode theory. As the participants cycled above VT, when presented with music only, video only, or nothing (control) they were unable to maintain a dissociative attention style due to the intensity. In fact, in these conditions, the attentional focus became associative after 10 minutes and became increasingly associative over time. By contrast, in the combined condition, attention remained dissociative through 14 minutes and was only slightly associative by the end of the exercise session. Thus, the vigorous intensity exercise limited the ability of the individual to use music or video in isolation as a distracter from the body cues and/or fatigue they felt while cycling; therefore participants perceived higher exertion in these conditions. Participants also reported greater negative feeling the longer they engaged in the vigorous cycling task.

However, when music and video were presented simultaneously, counter to what is suggested by the dual-mode theory, a participant was able to continue to dissociate (cognitive strategy) even when exercising above VT. Participants also reported significantly better feeling in this condition than the other three. An explanation for this disparity is that the additive effect of receiving both forms of entertainment enabled participants to maintain their cognitive strategies longer despite cycling at a vigorous intensity/above (125%) VT. The result then was better feeling, as the participants were not cued as quickly into how their bodies felt while cycling at the vigorous intensity.

Though the results of our study are promising, there was a limitation to the study. We originally sought to measure lactate threshold and lactate levels of participants while cycling. However, we quickly realized that using a finger stick of blood on a lactate reader was unreliable. After multiple trials, we terminated the measuring of lactate during the cycling task. Lactate would have provided another objective measure of exercise intensity during the cycling task to confirm that each participant indeed was cycling at vigorous intensity and at the work rate corresponding to 125% VT. However, in this study, because there were no significant differences in total work output (distance cycled) and heart rate between each session, we can assert that exercise intensity was maintained throughout all conditions. Since the researchers set the work rate based upon the objective measure of VT based on the results of a VO_2 max test, we can confirm that all participants were cycling at a vigorous intensity.

Future research in this area should seek to utilize lactate threshold and lactate levels to set and confirm exercise intensities. Using a catheter or venous puncture to draw blood would be a more valid and reliable method to measure lactate levels than using a finger stick/lactate reader method. Also, because only males were recruited for this study, including female participants in the future will help the generalizability of results. Utilizing female participants will also determine if the simultaneous presentation of music and video significantly lowers a female's perceived exertion and delays her shit in attention from a dissociative focus to an associative focus when engaging in vigorous intensity exercise.

CHAPTER VI

CONCLUSION

In this study, we demonstrated that an individual could utilize music and video in combination as a method to perceive significantly less exertion when engaged in vigorous intensity exercise. The implication of this finding is that due to the lower perceived exertion, an individual could engage longer in vigorous intensity exercise. This is accompanied by a delay in the shift to an attentional focus and more positive feelings states while engaged in the exercise. The result of this increase theoretically is an increase in activity, motivation, and the overall health of that individual. Therefore, our findings have implications for all individuals and especially for populations who need to increase their exercise output, such as the hypertensive and the obese.

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APPENDIX A

AHA/ACSM HEALTH/FITNESS FACILITY PRE-PARTICIPATION SCREENING QUESTIONNAIRE

Assess your health status by marking all *true* statements

History

You have had:

___ a heart attack

___ heart surgery

___ cardiac catheterization

___ coronary angioplasty (PTCA)

___ pacemaker/implantable cardiac

___ defibrillator/rhythm disturbance

___ heart valve disease

___ heart failure

___ heart transplantation

___ congenital heart disease

Symptoms

___ You experience chest discomfort with exertion.

___ You experience unreasonable breathlessness.

___ You experience dizziness, fainting, or blackouts

___ You take heart medication.

If you marked any of these statements in this section, consult your physician or other appropriate health care provider before engaging in exercise. You may need to use a facility with a **medically qualified staff.**

Other Health Issues

___ You have diabetes.

___ You have asthma or other lung disease.

___ You have burning or cramping sensation in your lower legs when walking short distances.

___ You have musculoskeletal problems that limit your physical activity.

___ You have concerns about the safety of exercise.

___ You take prescription medication(s)

___ You are pregnant

Cardiovascular Risk Factors

___ You are a man older than 45 years.

___ You are a woman older than 55 years, have had a hysterectomy, or are postmenopausal.

___ You smoke, or quit smoking within the previous 6 months.

___ Your blood pressure is > 140/90 mm Hg

___ You do not know your blood pressure.

___ You take blood pressure medication.

___ Your blood cholesterol level is > 200 mg/dL

___ You do not know your cholesterol level.

___ You have a close blood relative who had a heart attack or heart surgery before age 55 (father or brother) or age 65 (mother or sister).

___ You are physically inactive (i.e., you get < 30 minutes of physical activity on at least 3 days per week).

___ You are > 20 pounds overweight.

If you marked two or more of the statements in this section you should consult your physician or other appropriate health care provider before engaging in exercise. You might benefit from using a facility with a **professionally qualified exercise staff†** to guide your exercise program.

___ None of the above

You should be able to exercise safely without consulting your physician or other appropriate health care provider in a self-guided program or almost any facility that meets your exercise program needs.

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*Modified from American College of Sports Medicine and American Heart Association. ACSM/AHA Joint Position Statement: Recommendations for cardiovascular screening, staffing, and emergency policies at health/fitness facilities. Med Sci Sports Exerc 1998: 1018.

† Professionally qualified exercise staff refers to appropriately trained individuals who possess academic training, practical and clinical knowledge, skills, and abilities commensurate with the credentials defined in Appendix F.

APPENDIX B

DEMOGRAPHICS

Age: _______ Date of Birth: _____________

Ethnic Background: African American/Black Asian/Pacific Islander

Caucasian/White Hispanic

Native American Other: _____________________

Education Completed: College/Secondary School: 1 2 3 4

Degree program: __________________________________

Graduate School: Yes/No

If "Yes", then degree and year: ________________________

Height: ____________________

Weight: _____________

Exercise Behavior Tendencies

When you exercise, do you typically:

_______ Listen to music

_______ Watch a video or television

_______ Both (Listen to music and watch video/television)

_______ Neither

Godin Leisure Time Exercise Questionnaire

Considering a **7-Day period** (a week), how many times on the average do you do the following kinds of exercise for **more than 15 minutes** during your **free time** (write on each line the appropriate number.

Times Per Week:

a) STRENUOUS EXERCISE (HEART BEATS RAPIDLY) ______________
(e.g., running, soccer, basketball, judo, racquetball)

Times Per Week:

b) MODERATE EXERCISE (NOT EXHAUSTING) ______________
(e.g., fast walking, tennis, easy biking, volleyball, badminton, easy swimming, dancing)

Times Per Week:

c) MILD EXERCISE (MINIMAL EFFORT) ______________
(MINIMAL EFFORT)
(e.g., yoga, archery, fishing, bowling, golf, easy walk)

APPENDIX C

BORG RPE SCALE

6	
7	**Very, very light**
8	
9	**Very light**
10	
11	**Fairly light**
12	
13	**Somewhat hard**
14	
15	**Hard**
16	
17	**Very hard**
18	
19	**Very, very hard**
20	

APPENDIX D

ATTENTION SCALE

*Not to scale

0 Pure Dissociation

10 Pure Association

APPENDIX E

FEELING SCALE

+5 Very Good

+4

+3 Good

+2

+1 Fairly Good

0 Neutral

-1 Fairly Bad

-2

-3 Bad

-4

-5 Very Bad

APPENDIX F

FELT AROUSAL SCALE

1 Low arousal

2

3

4

5

6 High arousal