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Acute Effects of Listening to Music and Watching Nature Videos on the Psychophysiological Responses and Time to Exhaustion During Moderate-Intensity Indoor Cycling

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ABSTRACT

The aural and visual environment in which people exercise is described as being significant to their affective responses to exercise and possibly their degree of adherence. Research investigating the use of music and video during moderate-intensity exercise is needed because they are inexpensive, simple to adopt, and can reflect activity adherence and reduce dropout rates. This study examined the acute effects on psychophysiological variables and the time for exhaustion on a cycle ergometer during a moderate-intensity workout of listening to music, watching nature videos, or doing both in the standard population. Thirty physically active young male adults (19.46 ± 0.87 years, 62.94 ± 11.86 kg; 169.23 ± 7.21 cm; 21.9 ± 3.14 kg/m2) exercised moderately to exhaustion or until 20 minutes in four different conditions: three experimental conditions (music only, video only, and music and video) and one control condition (no music and visually sterile). The results showed that the mean and standard deviation of changes in time to exhaustion and rate of perceived exertion (RPE) during the second and fourth minutes of exercise differed. Finally, the major purpose of this study was to investigate how people responded to different audiovisual stimuli while exercising on a bike ergometer. The stimuli consisted of music, video, and music-video. These findings are still being debated in the research and may be attributable to the type of exercise, intensity of the exercise, and preference for audiovisual support. As a result, understanding the customer's and/or athlete's choice for these aspects is critical for achieving better results during training sessions, particularly in the moderate-intensity domain.

Keywords: audiovisual aids; external stimuli; asynchronous music; green exercise; exercise psychology

INTRODUCTION

Music is widely used asynchronously during exercise, which means that people make no conscious effort to match their movements to the beat of the music. This application has been shown to have positive affective, psychophysical (i.e., reduced rate of perceived exertion; RPE), and motivational effects for women who execute more challenging motor tasks (e.g., circuit-type exercises) (Karageorghis, et al., 2010). This evidence and its ease of use suggest that asynchronous music while exercising may be a useful intervention. Karageorghis and Jones (2014) evaluated the effects of exercise intensity on attentional concentration across a range of music tempi (slow to extremely fast) and a no-music control condition. When exercising without music, the attentional shift from dissociative to associative thinking happened at approximately 69% of the maximum heart rate reserve. Nonetheless, Karageorghis and Jones (2014) discovered that the attentional shift occurred at 78% maxHRR during the fast-tempo condition.

There is a fast-expanding literature on the psychological, psychophysical, and ergogenic impacts of music in the exercise area (Jones, et al., 2024). In this case, numerous resources, such as listening to music, have been used to increase enjoyment while exercising (Karageorghis & Jones, 2014; Terry, et al., 2012; Karageorghis, et al., 2009; Hutchinson, et al., 2017; Dyer & Mckune, 2013). Music has become a useful and widely accepted strategy for various types of training due to its capacity to increase pleasure while decreasing RPE (Terry, et al., 2020). Furthermore, music can be considered as a distraction from unpleasant proprioceptive experiences associated with weariness, resulting in alterations in physiological responses such as heart rate (HR) (Lee & Kimmerly, 2016).

Another resource used before, during, and after exercise is watching videos with or without audio (video clips) (Loizou & Karageorghis, 2015). Because of the separation of concentration induced by both aural and visual stimulation, this technique has demonstrated efficacy in improving performance (even more so than music alone) (Barwood, et al., 2009). Loizou and Karageorghis (2015) also found that videos can increase athletes' motivation before exercise.

The aural and visual environment in which people exercise is cited as being important to their affective reactions to exercise and, maybe, their level of adherence (Karageorghis & Priest, 2012a; Karageorghis & Priest, 2012b). The stimuli in the visual environment might range from specific foci like publications and TV shows to broader foci like the countryside. Exercise in a natural setting is frequently seen as more appealing than exercise in an urban setting (Hartig & Staats, 2006; Humpel, et al., 2002), and several studies have shown that the aesthetic quality of the place increases the amount of exercise performed (Humpel, et al., 2002). The current study recommended the use of visual stimuli that were both congruent with the nature of the exercise activity (cycling) and easily standardized; consequently, a rolling grassland image was deemed appropriate. This form of "green exercise" has been linked to the concept of restoration, which necessitates psychological distance from one's usual routines and a habitual focus of attention (Hartig & Staats, 2006). And, the nature settings were more restorative than the urban ones (Neale, Lopez, & Roe, 2021).

As a result, more research into the use of music and video during moderate-intensity exercise is needed because they are low-cost, easy to use, and can reflect activity adherence and reduce dropout. The goal of this study was to investigate the acute effects of external stimuli (asynchronous music and Parkland video footage) on psychophysiological variables and time to exhaustion during a moderate-intensity exercise session in this setting.

METHOD

Stage 1: Auditory and visual stimuli selection

Music selection. Participants and Procedure. A sample of 15 university volunteer sports science students (M ± SD = 18.86 ± 0.53 years) were tasked with selecting appropriate music for the experimental technique (Stage 2). Given the personal factors that influence music choices, participants in the current study were comparable in terms of age (18-22 years), race (Asian), and cultural and socioeconomic level. When asked if they had any type of hearing loss, none of the subjects responded.

The participants were instructed to record their top five tracks for a stationary cycling session. Following that, the selections were sorted by tempo, and 20 tracks with tempos comparable to those required for experimental testing (120-130 bpm) were further analyzed. A panel of fifteen sports science students (age, M ± SD = 18.86 ± 0.53 years) utilized the Brunel Music Rating Inventory-3 to rate the motivating characteristics of the 20 tracks (Karageorghis, et al., 2008). This procedure ensured that the music used in the trials was consistent in terms of motivational features (lyrical affirmations, extramusical connotations, etc.), as an absence of similarity can undermine internal validity. To optimize the music selection technique, the final music selection adhered to qualitative characteristics defined by Karageorghis et al. (Karageorghis, et al., 2006). When a track's pace did not meet the proper tempo, it was digitally modified. In Stage 2 of the experiment, four songs (total duration: 10 minutes) with equal motivational quotients from each pace were chosen.

Video Selection. Participants and procedures. Sixteen university sports science students (M ± SD = 20.06 ± 1.20 years) rated three pieces of video material on a 5-point scale for how well they resembled a pleasant rural landscape (not at all, somewhat, moderately, strongly, or very strongly representative) (Pretty, et al., 2005). A standard of 90% of the panel finding the footage to be at least "strongly representative" was established; this criterion was met by a single video. A video taken from the point of view (POV) of a biker in a parkland area was selected.

Stage 2: Experimental Study

Participants. This randomized crossover trial study aimed to investigate the performance and perceptual effects on physically active young male adults (only male subjects because doesn't want the distinctions between the sexes) under three experimental conditions (music only, video only, and music + video) and one control condition (no music and visually sterile). Each session comprised moderate-intensity exercise on a bike ergometer. Human-use research follows all applicable national and institutional policies. Participants met at a designated site and were asked to sign a written informed consent about the study's risks and benefits before beginning the study activities, following the ethical requirements of the Declaration of Helsinki. The Udon Thani Rajabhat University's ethical committee supported this work. The inclusion criteria included being between the ages of 18 and 22, engaging in physical activity, not having a known disease or any bone, joint, or muscle impairment, not smoking, not being hypertensive, and not taking any drugs that could affect the autonomic nervous system, and thus the variables studied. Exclusion criteria included failing to finish all experimental sessions and refusing to adhere to the test rules and procedures.

To find the optimal sample size, a power analysis was performed using G*Power3 (Faul, et al., 2007). Based on moderate estimated effect size (f = 0.25 (Karageorghis & Hutchinson, 2013)), an alpha level of 0.05, and a power of 0.8, the study predicted that 20 volunteers would be needed to protect beta at four times the level of alpha (Cohen, 1988). An additional ten people were recruited to account for participant attrition and exclusions due to outliers.

Measures. To complete the research procedures, participants were requested to visit the lab six times. During the initial visit, the participant completed the Physical Activity Readiness Questionnaire (PAR-Q) [Liguori, 2020), had their anthropometric measures taken, and became comfortable with the cycle ergometer. Participants determined their VO2 max (maximal aerobic capacity) in a submaximal incremental test during the second visit. The participants in the third, fourth, fifth, and sixth sessions used a cycle ergometer to execute three experimental conditions (music only, video only, and music + video) and one control condition (no music and visually sterile) in random order. There was at least a seven-day break between sessions. Every session was held at the same time and in the same setting.

During the experiments, a heart rate monitor (PolarH10, Polar®, Electro Oy, Kempele, Finland) was used to measure HR every two minutes (HR2, HR4, HR6, HR8, HR10, HR12, HR14, HR16, HR18, HR20). RPE was measured every 2 minutes using a rate of perceived exertion scale (ranging from 6 to 20 points), with 7 indicating the lowest intensity and 19 indicating the highest (Kaercher, et al., 2019).

Measures and apparatus. To standardize music intensity at 75 decibels, an electrically braked cycle ergometer, a wall-mounted audio system, and a decibel meter were employed for testing (it did not surpass 85 decibels). If the noise level is less than this, individuals should use ear protection. A desktop computer connected to a projector was used to play back video footage. The video images were projected onto a 195 × 280 cm projection screen (KD-50X80J, Sony 4K UHD Google TV) 3 m in front of the participant.

PROCEDURES

Aerobic tests and experimental sessions.

The incremental test was carried out using a MONARK cycle ergometer (Model 828E). Before the test, a 2-minute warm-up (without load) at 50 rpm was carried out. The load was increased by 25 watts per minute after the test began, while the speed remained at 50 rpm. The test was ended when the individual reached 19 on the RPE scale or was unable to keep the cycle ergometer spinning at 50 rpm.

Participants in the experimental sessions sat in silence for 10 minutes before starting to use the cycle ergometer. The heart rate was recorded at the end of this session. The subjects were then placed on the cycle ergometer for a 2-minute warm-up (without load). The subjects then began to exercise by gradually increasing the load by 25 watts per minute while maintaining a rotation speed of 50 rpm until they reached voluntary exhaustion or were unable to sustain the rotation speed. To assess performance (time to exhaustion), each session's duration was recorded in minutes. HR and RPE were measured every two minutes throughout the sessions.

An experimental trial. Three experimental conditions (music only, video only, and music + video) and one control condition (no music and visually sterile) were employed for moderate-intensity exercise on a cycle ergometer. Participants in the music-only condition listened to a 20-minute playlist while immersed in a visually sterile environment. Participants in the video-only condition were shown a 20-minute film of point-of-view (POV) footage shot in a parkland setting from a cycling route with no audio accompaniment (i.e., no parkland background noises). In the music-and-video condition, each participant listened to 20 minutes of music while watching point-of-view video footage. Participants in the control condition were not shown any music or video footage; nevertheless, for ecological validity, their eyes and ears were not closed.

Analysis

Data was obtained and stored in a Microsoft Excel 2010® file. Following that, the data was exported to SPSS 17.0 for Windows®. The data was analyzed descriptively, with results presented as means and standard deviations. The Shapiro-Wilk test confirmed normalcy. A one-way ANOVA with Bonferroni's post-hoc analysis was used to compare sessions and moments. Mauchly's test was used to validate the sphericity hypothesis, and when it was not met, Greenhouse-Geisser estimations were used to correct degrees of freedom. The p-0.05 level of significance was used.

RESULTS

A total of 30 physically active young male adults participated in the study. The participants had an average age of 19.46 ± 0.87 years, a BMI of 21.9 ± 3.14 kg/m2, a height of 169.23 ± 7.21 cm, and a body mass of 62.94 ± 11.86 kg.

Table 1. Basic statistical characteristics of HR, RPE, and time to exhaustion for moderate-intensity exercise sessions in music, video, music and video, and no music and visually sterile conditions.

	Music only		**Video only**		**Music and video**		**No music and visually sterile**	
Variables and every two minute	M	SD	M	SD	M	SD	M	SD
HR2	103.43	11.547	103.31	11.643	97.06	7.019	104	7.248
HR4	113.44	10.696	112.75	11.204	110.31	9.911	111.5	8.764
HR6	118.69	10.531	118.75	10.567	116.31	10.281	119.19	9.649
HR8	126.44	6.976	125.94	7.646	124.44	9.612	126.25	9.448
HR10	131.31	5.701	131.25	5.756	129.88	14.687	131.44	9.373
HR12	137.19	6.002	137.13	6.087	136.19	16.441	137.31	10.163
HR14	140.44	6.261	146.19	6.358	140.75	17.849	139.67	8.364
HR16	145.38	5.795	145.06	5.949	146.19	17.52	145.73	9.445
HR18	150.25	6.382	149.81	6.635	150.94	17.168	148.46	7.423
HR20	153.89	6.459	153.4	6.39	154.06	14.04	151.83	7.082

RPE2	8.29	1.816	11	2.184	6.43	0.514	9.07	1.817
RPE4	10.93	3.362	13.57	2.533	9.71	2.494	11.57	2.901
RPE6	12.93	3.668	15.62	3.28	12.14	3.718	13.21	3.423
RPE8	14	3.488	15	3.024	13.08	3.303	14.46	3.357
RPE10	14	3.423	15	3.162	14.55	3.751	14.89	2.088
RPE12	13.4	2.302	16	2.944	12.8	1.924	15.71	2.87
RPE14	14.8	3.033	16.67	2.887	14	2.345	15	1.871
RPE16	14.5	0.577	16	0	14	0.816	16	1.871
RPE18	15.5	0.577	17	1.414	15.25	0.5	16.5	2.517
RPE20	16.75	0.957	17.5	2.121	15.75	0.5	17.5	3.109
Time to exhaustion	20	0	19.88	0.5	20	0	18.88	2.306

Note: HR = heart rate; RPE = rate of perceived exertion; M = mean, SD = standard deviations

Table 1 shows the basic statistical characteristics of HR, RPE, and time to exhaustion for moderate-intensity exercise sessions in all conditions.

Figure 1 shows the HR values for several settings (music only, video only, music and video, and no music and visually sterile) during moderate-intensity workout sessions. There was no statistically significant difference between the groups ($p>0.05$).

Figure 2 shows RPE responses during exercise for music, video, music and video, and no music and visually sterile conditions. The second (music-only and video-only, music-only and music-and-video, video-only and music-and-video, video-only and no music and visually sterile, music-and-video and no music and visually sterile), and fourth (music-only and music-and-video) minutes of moderate-intensity exercise, RPE increased significantly less between groups ($p<0.05$).

Figure 3 shows the time for exhaustion (in minutes) for moderate-intensity exercise sessions in all conditions. There were significant differences ($p>0.05$) between music-only and visually sterile, as well as music-and-video and visually sterile.

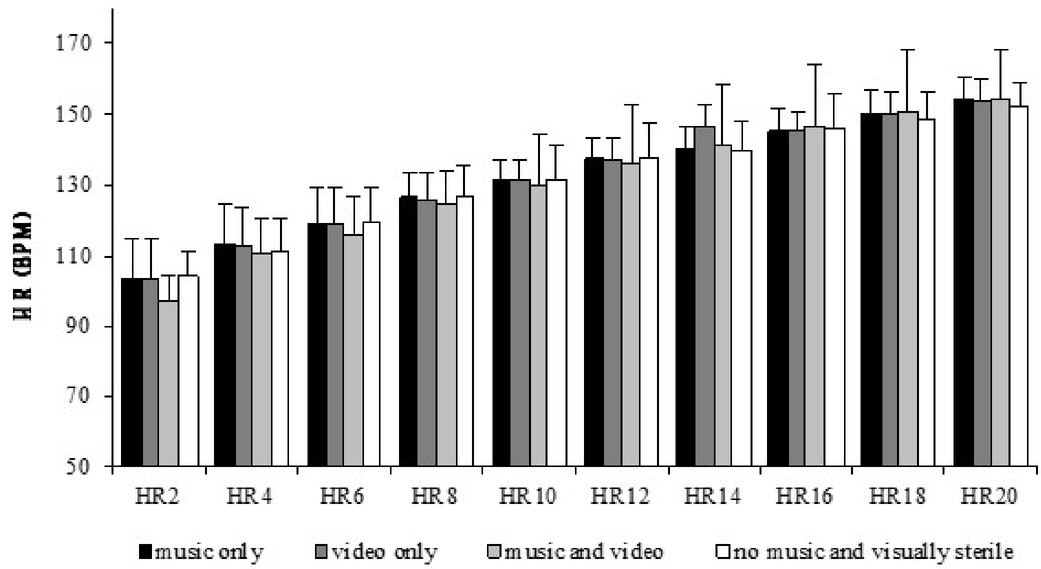

Figure 1. Means and standard deviations of HR during exercise in the music only, video only, music and video, and no music and visually sterile (n=30).

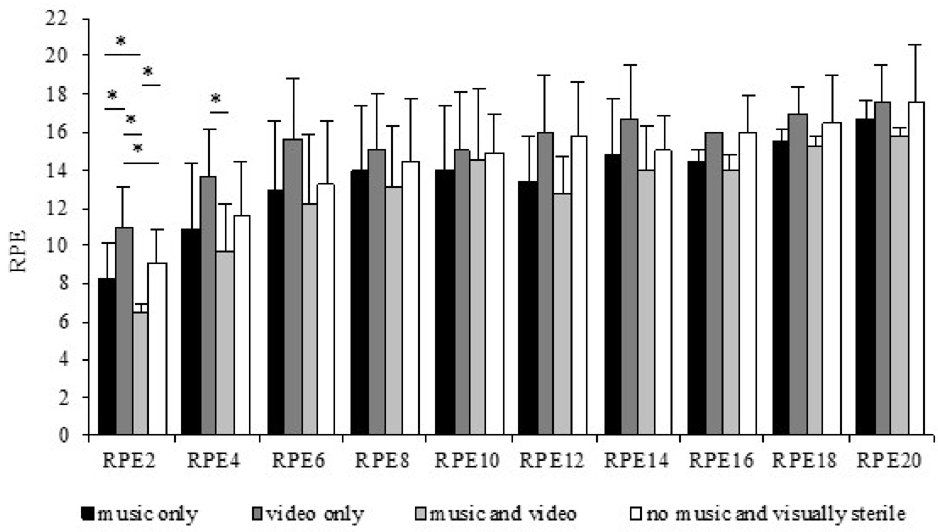

Figure 2. Means and standard deviations of RPE during exercise in the music only, video only, music and video, and no music and visually sterile (n=30).

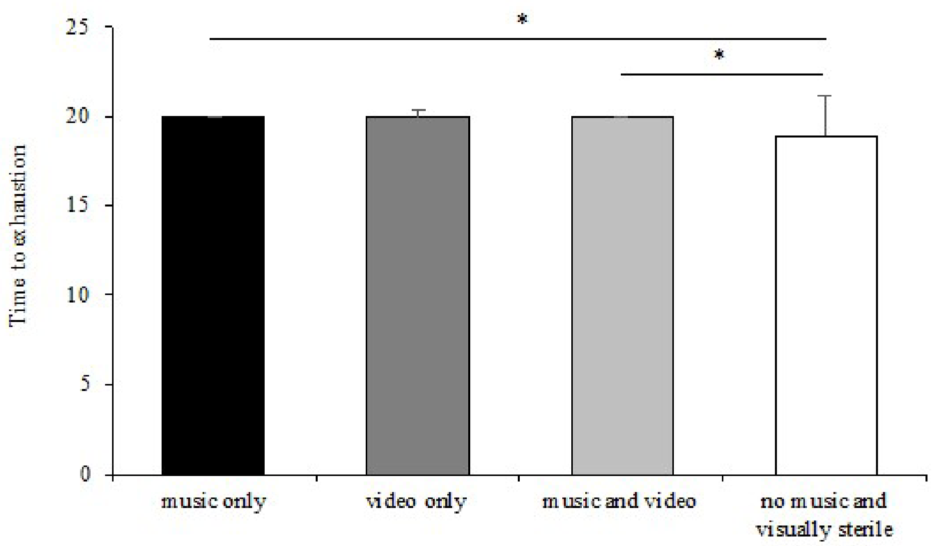

Figure 3. Means and standard deviations of time to exhaustion during exercise in the music only, video only, music and video, and no music and visually sterile (n=30).

DISCUSSION

The major purpose of this study was to evaluate how people responded to various audiovisual stimuli while exercising on a bike ergometer. Music, video, and music-video stimuli were among the available options. We also evaluated the effects of the aforementioned audiovisual stimuli on moderate-intensity exercise. Heart rate (HR), perception (RPE), and time to exhaustion were used as dependent variables.

The main outcome of this study was that listening to music and watching videos reduces perceived exertion and increases positive affect during a moderate-intensity exercise session in the second and fourth minutes, and the time to exhaustion differed between groups. Furthermore, there were no differences in HR or other RPE minutes during exercise among experimental circumstances. This finding lends credence to the notion that including audiovisual stimuli in a workout environment appears to improve perceived activation when compared to control conditions in the initial period of study (Bigliassi, et al., 2019; Jones, et al., 2014), and previous research has shown that audiovisual stimulation can elicit more dissociative ideas than a single stimulus (for example, music or video). Music may impair the ability to filter out unnecessary information and prioritize the most important, altering individual experiences throughout the activity. As a result, the lower RPE could be attributed to music diverting attention away from the exercise and towards the music, which has been demonstrated to affect brain dynamics during stationary cycling (di Fronso, et al., 2018). This intervention could be utilized to increase cardiovascular exercise demand, which could be useful for persons with low exercise tolerance (Carlier & Delevoye-Turrell, 2017). Adding music to indoor cycling can help to raise internal load without increasing exercise length or external load. Music can also help to improve workout adherence (Stork, et al., 2015).

The time-to-exhaustion approach was employed to analyze performance in this study, and statistically significant variations were found across the various scenarios. Similar research using audiovisual resources (Barwood, et al., 2009; Lin & Lu, 2013) supports this. Other studies, unlike ours, found a decrease in RPE and an increase in performance when simple music was employed (Waterhouse, et al., 2010; Coelho Silva, 2016). These differences, however, could be explained by the type and intensity of the exercise. Furthermore, bike speeds changed during the study.

The current study contributes fascinating findings to the literature; nonetheless, some limitations must be addressed. Participants were unable to choose their preferred tunes because all volunteers had to maintain a consistent tempo. Nonetheless, the pre-established playlist provided a variety of selections for the participants to choose from. Furthermore, limiting the cycle pace to 50 rpm may be a limitation. Nonetheless, this was essential to assess performance using time to fatigue.

Other studies (Potteiger, et al., 2000; Nethery, 2002) have indicated that listening to music during moderate-intensity exercise without tiredness lowers RPE. Potteiger et al. (2000) showed, for example, that listening to fast, intense music, classical music, or self-selected music while exercising at 70% VO2max enhanced peripheral, central, and overall RPE compared to the non-music group. Similarly, Nethery (2002) discovered that listening to music when exercising at 50% VO2max decreased RPE relative to control or sensory-deprived settings, but not when exercising at 80% VO2max. Although there is no obvious cause for the variations between our study and others (Potteiger, et al., 2000; Nethery, 2002), the different exercise protocols (until exhaustion versus 20 minutes) could explain these variances. In a study conducted by Coquart and Garcin (2008), participants performed constant-load running tests at 90% of maximal aerobic velocity for known and unknown durations, and RPE was lower when the total duration was unknown beforehand, indicating that knowing the end point influences the RPE response during exercise. As a result, some studies that found a lower RPE during constant-load exercises while listening to music informed participants about the length of the test ahead of time (Potteiger, et al., 2000; Nethery, 2002). Instead, in the current study, participants were told to cycle until they were fatigued, which could have affected the effect of music on RPE response.

This finding supports the hypothesis that a dissociative strategy's effectiveness is determined by its perceptual burden. Lower RPE scores were expected to imply increased detachment from internal fatigue cues. RPE scores were lower in the music-and-video condition compared to the control settings, but there was no significant difference between the two experimental conditions or between music-only and control. This finding suggests that the music-only condition's dissociative effect was insufficient to have a significant impact on RPE. This lends support to the notion that the efficacy of several external stimuli during exercise should outweigh that of a single stimulus (Chapados & Levitin, 2008; Annesi, 2001). Discomfort has been highlighted as a major barrier to regular exercise participation in the general population (Poulton, et al., 2002). Given that the combined stimulation of music and video can lower perceived exertion at moderate-to-high exercise intensities, such therapies may help improve exercise adherence.

The relative ineffectiveness of the video-only condition is somewhat surprising. Compared to the control condition, this condition did not influence participant responses. This study may imply that visual pictures of the type used here (pleasant parks) do not engage sensory pathways as much as when paired with music. Another factor is the unfamiliarity of watching park footage without music. If comparable studies were conducted in an outdoor setting with hearing deprivation, it would be fascinating to explore how the availability of identical visual stimuli might alter participants' answers. Furthermore, the music was picked for its motivational properties in an exercise setting, however, the movie was not selected with such qualities in mind because there is no comparable guiding framework to draw on. The parks video material was chosen with the expectation that it would bring psychological benefits (Pretty, et al., 2005), albeit there may have been some disagreement between the motivational components of the music and the video.

CONCLUSION

During moderate-intensity aerobic activity, listening to music and watching video clips can help reduce frustration and increase mood. In this case, sports and health practitioners could use music and video clips as effective tools to increase workout adherence and make it more fun. In addition, gyms should use audiovisual aids during customer workouts to increase happiness while performing an activity.

Our data also showed that HR, RPE, and time to exhaustion did not differ between the experimental sessions. These findings are still being contested in the research, and they could be attributed to exercise type (cycling), intensity (moderate), and audiovisual assistance preference (songs and/or video clips). As a result, understanding the customer's and/or athlete's preferences for these factors is crucial for improving exercise results, especially in moderate-intensity domains.

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