THESIS

EVALUATING THE IMPACT OF A NOVEL IMMERSIVE SIMULATION ON AFFECT, RATE OF PERCEIVED EXERTION, AND ATTENTION DURING A GROUP CYCLING CLASS

Submitted by

Katrina Oselinsky

Department of Psychology

In partial fulfillment of the requirements

For the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

Spring 2022

Master's Committee:

Advisor: Daniel Graham

Anne Cleary
Sara Tompkins
Matthew Hickey

ABSTRACT

EVALUATING THE IMPACT OF A NOVEL IMMERSIVE SIMULATION ON AFFECT, RATE OF PERCEIVED EXERTION, AND ATTENTION DURING A GROUP CYCLING CLASS

Background: Emerging evidence within the exercise psychology literature has highlighted the importance of positive affective responses to physical activity (PA) for both PA adoption and maintenance. A potential avenue to increase positive affective responses to PA is through attentional focus. *Purpose*: The goal of this study was to examine the impact of a novel immersive technology on participants attentional focus, ratings of perceived exertion (RPE), affect, and enjoyment during a group cycling class. *Methods*: Participants were asked to take one traditional group cycling class with audio cues only (AUD) and one video enhanced immersive cycling class (IMM). Heart rate (HR) data was gathered throughout each class. At the conclusion of each session, participants completed a brief survey asking them to report their RPE, attentional focus, and affect during the cycling class. *Results*: Participants on average reported lower RPEs and higher enjoyment in the IMM class compared to the AUD class. Although attention was not significantly different between classes, when instructor was held constant, participants reported significantly more dissociative attentional focus during the IMM class than the AUD class. Finally, HR did not differ significantly between classes. *Conclusions*: To combat the rising rates of physical inactivity researchers must strive to make the PA experience more enjoyable. This study supports the use of a novel immersive technology to lower RPE and increase enjoyment without compromising actual exertion.

TABLE OF CONTENTS

INTRODUCTION

Globally, population rates of physical activity (PA) have been declining for the past two decades (World Health Organization [WHO], 2020). Although self-reported activity data indicates three out of four adults do meet the minimum recommended amount of weekly PA (defined as a minimum of 150 minutes of moderate-to-vigorous PA per week; [WHO, 2020]), the actual number is likely much lower as data gathered via accelerometry indicate between 90.4% and 96.8% of adults are insufficiently active (Ekkekakis, 2017). Inactivity is both harmful to the individual, resulting in a 20-30% increased risk of death and presents an immense global economic burden with scholars estimating $67.5 billion dollars in health-care expenditures and lost productivity can be attributed to inactivity (Ding et al., 2016; WHO, 2020). Already deemed the biggest public health crisis of the 21st century (Blair, 2009; Ekkekakis, 2017), without substantial improvement in global rates of PA, inactivity is poised to become an unmanageable epidemic.

Although numerous campaigns aimed at reducing rates of inactivity exist (de Souto Barreto, 2013), the majority have resulted in only a small beneficial effect that fails to be sustained over time (Bird et al., 2019; Bluemke et al., 2010; Brand & Ekkekakis, 2018; Ekkekakis, 2017). The lack of interventions resulting in a meaningful population level impact on rates of PA is not indicative of a lack of effort on the part of health researchers nor is it reflective of a lack of education within the general public regarding the importance of PA for health. Rather, while past theories have proposed empirically-supported behavior change strategies and have resulted in significant improvement in exercise intentions, these models have historically been less succesful at modifying PA *behavior* (Bluemke et al., 2010). Additionally, these models only account for a small proportion of the variability in PA behavior (Bluemke et al., 2010; Zenko & Ekkekakis, 2019). The variability that remains to be explained coupled with the inability of interventions to result in lasting behavior change has forced exercise psychologists to critically re-evaulate the assumptions underlying the most common health-behavior change models.

Recent advancements within the exercise psychology literature assert that a critical flaw across many behavior change interventions is the assumption of rationality (Brand & Ekkekakis, 2018; Ekkekakis, 2017; Zenko & Ekkekakis, 2019). Models that favor rational explanations for behavior assert that people typically make well-reasoned behavioral decisions after gathering and evaluating the available evidence. These decisions are often made to serve one's own best interest. When applied to PA, theories grounded in rationality assume if people know and understand the benefits of PA they will then choose to engage in increased activity. Due to the assumption of rationality, many PA interventions have focused on promoting the benefits of activity, be they mental, physical, emotional, etc. Although perceived benefits likely represent one cognitive mechanism by which people make PA decisions, proponents of dual-process models argue this is not the only cognitive pathway that determines individuals' PA behavior.

Dual-Process Models and PA

Dual-process models assert that behavior is governed by two different types of cognitive processes. Type 1 processes are automatic and intuitive. This type of processing relies on heuristics to make quick judgements and decisions. Conversely, Type 2 processes are slow, contemplative, and deliberate. They allow time to examine all the available information before arriving at a decision (Brand & Ekkekakis, 2018; Ekkekakis, 2017; Rhodes et al., 2019; Zenko & Ekkekakis, 2019). Although these cognitive processes often work together to aid in decision making, when applied to PA, researchers hypothesize these processes can conflict with one another, forcing one type of processing to dominate over the other (Bird et al., 2019; Zenko & Ekkekakis, 2019). For example, in the following fictional, albeit common scenario, similar to that proposed by (Ekkekakis, 2017), an individual is engaged in some sort of sedentary activity such as watching television or surfing the internet. When faced with the decision to engage in PA, it is likely both types of cognitive processing are activated. The individual might be reluctant to switch activities as they are comfortable and relaxed and choosing to engage in PA will result in temporary pain and discomfort. In this case, the individual might invoke the affective heuristic (Type 1 processing) and choose to continue their sedentary but pleasurable activity instead of switching to the more effortful and uncomfortable physically active task. Alternatively, this individual knows that PA is beneficial to their health and could instead use this knowledge (Type 2 processing) coupled with self-control or motivation, to switch to a more physically demanding activity. The subsequent behavior of this individual is therefore determined by whichever type of processing dominates.

By applying the dual-process model to PA behaviors it is clear that interventions that rely only on Type 2 processing are insufficient as they fail to acknowledge that people often allow heuristics, such as the affective heuristic (a form of Type 1 processing) to govern their decision making. When Type 1 processing dominates it can result in individuals opting to engage in behaviors that act in opposition to their own best interest and therefore violates the assumption of rationality (a form of Type 2 processing). Since interventions that have targeted Type 2 decision making processes have been largely ineffective, researchers suggest that we instead shift our focus to different aspects of Type 1 processing, specifically affect.

Physical Activity and Affect

Although previously disregarded by researchers who favored Type 2 (cognitive) theories to explain PA behavior, affect has been shown to be a strong predictor of PA (Ekkekakis et al., 2013; Hutchinson et al., 2015; Jones et al., 2014). While there is consensus that people who exercise regularly report greater levels of general well-being, recent research indicates that the emotional valance people experience during exercise is an important predictor of future PA and that post-task affective valance can be influenced by one's in-task affective experiences (Bird et al., 2019, 2021; Ekkekakis et al., 2013; Hutchinson et al., 2015).

The hypothesized relationship between affective valance and future PA behavior is multifaceted and complex; however, several meta-analyses confirm that affective response, which is how one feels while performing or immediately after completing PA, is predictive of future PA behavior (Rhodes & Kates, 2015; Stevens et al., 2020). While in-task affective responses to PA are the most valid representation of PA experiences, research indicates that recalled affective evaluations can impact future exercise intentions and affective forecasts (i.e., the prediction of one's future emotional or mood state; Graupensperger et al., 2019). Taken together, there exists strong empirical support that affect (comprised of both in-task and post-task affective responses to PA) is an important predictor of PA adoption and adherence.

As the burgeoning literature has begun to converge on the importance of positively valanced affective experiences of PA, educational bodies such as the American College of Sports Medicine have started to incorporate affect as an important element of exercise prescription stating for example, "…feelings of fatigue and negative affect ...can act as a deterrent to continued participation" (American College of Sports Medicine, p. 374, 2013; Hutchinson et al., 2015; Jones et al., 2014). Affective experiences of exercise are closely tied to exercise intensity and, for the majority of people, exercising at intensities that result in significant health benefits is often uncomfortable and fatiguing (Hutchinson et al., 2015). As a result of the negatively-valanced affective responses to exercise at moderate-to-vigorous intensities, and the negative impact these responses are likely to have on exercise adoption and adherence, it is essential that researchers identify interventions that can increase positive affect even at vigorous intensities.

Integrative Model

A recent framework proposed by Alvarez-Alvarado et al. (2019) sought to unpack the relationships between exercise intensity, perceived exertion, attentional focus, and the resulting affective responses to PA. The authors found that at low to moderate intensities, cognitive mechanisms dominate as internal sensory cues are weak and are processed below consciousness. When exercising at low to moderate intensities, affect is generally positive, attention is dissociative (i.e., focused on external cues that are irrelevant to task performance such as auditory or visual stimuli), and ratings of perceived exertion (RPEs) are low/ "easy" (Ekkekakis et al., 2013; Hutchinson et al., 2015, 2017; Jones & Ekkekakis, 2019; Terry et al., 2012). As exercise intensity approaches and exceeds the ventilatory threshold (VT; defined as the point in exercise training at which breathing becomes difficult and the exerciser is no longer able to speak comfortably; Thompson, 2017), physiological signals move into conscious awareness and sensory cues dominate. At this higher intensity, attention is associative (i.e., focused on internal bodily sensations such as breathing or heart rate [HR]) and is focused on adverse sensory cues, affect becomes increasingly negative and there are sustained increases in RPE (Alvarez-Alvarado et al., 2019). Although the VT seems to be the point at which the exercise experience shifts from positive to negative, Alvarez-Alvarado et al. (2019) concluded that it is likely attentional focus mediates the relationship between exercise intensity and affect. They propose that even at exercise intensities at or above the VT, when individuals are able to maintain dissociative attentional focus they continue to experience positive affect (Alvarez-Alvarado et al., 2019).

Association/Dissociation (A/D)

Although the literature is mixed regarding the efficacy of dissociation as a means to increase positive affect during exercise (Brick et al., 2014; Lind et al., 2009), research suggests that in general, exercisers who engage in dissociative thinking (e.g., focus their attention on external stimuli) tend to experience lower RPEs and higher levels of positive affect than those who utilize associative thinking (e.g., focus on bodily sensations such as breathing or HR) (Bird et al., 2021; Gillman & Bryan, 2020; Glen et al., 2017; Hutchinson et al., 2017; Pottratz et al., 2021). In line with the Integrative Model outlined above (Alvarez-Alvarado et al., 2019), while dissociative thinking is easily accessible at low intensities, it becomes harder to divert attention away from bodily sensations as the intensity increases and internal sensory cues come to conscious awareness. Due to the increased salience of adverse physiological cues as exercise intensity increases, researchers have attempted to identify external stimuli that can evoke dissociation even when exercise intensity becomes vigorous.

Dissociative Stimuli

One of the most commonly used methods to elicit dissociative thinking is listening to music during PA. Several studies have confirmed that listening to music can enhance affective responses to exercise, presumably through attentional dissociation (Ekkekakis et al., 2013; Hutchinson et al., 2015, 2017; Jones & Ekkekakis, 2019; Terry et al., 2012). Research indicates that even at high intensities music can be successfully used to maintain a positive affective response to PA (Chow & Etnier, 2017; Jones et al., 2014). In a recent study, researchers Karageorghis and Jones (2014) found that when exercisers listened to music they were able to delay the shift from positive to negative affect during high-intensity exercise by ~10% of maximal heart rate reserve. Research by Hutchinson and Karageorghis (2013) arrived at a similar conclusion lending support to the notion that listening to music can delay the affective shift. Although the results of these studies were important as they demonstrated that positive affect can be maintained at or above the VT, the resulting increase in the duration of positive affect from listening to music was short-lived, lasting only an additional 4-6 minutes (Hutchinson & Karageorghis, 2013). Based on the concept of perceptual load, which asserts that different stimuli occupy varying amounts of attentional resources, further work has attempted to identify if stronger stimuli (i.e., those that occupy more cognitive resources and therefore leave little to no capacity for the processing of competing stimuli such as adverse physiological cues) or a combination of stimuli (i.e., video and music) can be more effective at increasing positive affect (Hutchinson et al., 2017). In a follow up study, Hutchinson et al. (2015) sought to determine the impact of music plus video on participants' state attention, RPE, and affective valance at exercise intensities 10% above and 10% below their VT. The researchers concluded that the combination of music and video enhanced dissociative thinking resulting in lower RPE and increased positive affect regardless of exercise intensity. In a similar study, Chow and Etnier (2017) concluded that the use of music and video together elicited higher levels of dissociation, and lower RPE during high-intensity PA than did music or video alone. Given the beneficial impact of combined music and video on participants' experience of PA coupled with recent advancements in video technology, researchers have begun to explore the use of increasingly immersive technologies on participants' experiences of PA. Based on previous findings, researchers have hypothesized that the more immersive the stimulus the more beneficial the effect on participants' experience of PA.

To test this theory, Jones et al. (2014) utilized low-immersion footage of rural parklands filmed from a cyclist's point of view. Participants were seated on a stationary bike in front of a projector screen that displayed the footage. The researchers found that participants exhibited more positive affective responses in the music-only and music + video conditions even at exercise intensities 5% above the VT than they did in the video-only or no stimuli condition. Although the results of this study support the use of dissociative attentional focus at or above the VT to maintain positive affect, this study failed to support the hypothesis that more immersive stimuli would produce more-positive affective responses to PA than less immersive. The researchers hypothesized that it is possible the video failed to offer the same motivational qualities as the selected music and therefore, did not impact participants' affective responses. (Jones et al., 2014). In a follow up study, Jones and Ekkekakis (2019) increased the level of immersion through the use of a virtual reality (VR) headset during a recumbent cycling task with overweight, inactive adults. They found that the use of VR did increase the level of dissociation experienced by the participants and that the use of VR increased participants' affective responses to exercise even at the VT. Although the researchers did not test for mediation, the results of this study lend support to the idea that A/D might act as a mediator of the relationship between exercise intensity and affective response. Finally, research by Glen et al. (2017) found that participants using exergaming technology exercised at a higher intensity (on average above their VT), experienced greater levels of dissociation, and more positive affect when compared to a control condition that included no audio or visual distraction.

Taken together, the literature supports the use of immersive technologies to enhance participants' affective responses to PA. Although a seemingly fruitful avenue for inquiry, there has been little research utilizing immersive technologies conducted in ecologically valid settings. Much of the past work has been delivered in laboratory settings under extremely controlled conditions. Research has yet to evaluate the utility of video immersion in real-world settings such as at non-experimental fitness facilities (i.e., health clubs) or during group fitness classes. To date, one research team has tested the effects of an immersive video simulation delivered in a group fitness setting on enjoyment and RPE among novice and experienced exercisers (Gottschall & Hastings, 2017). The researchers found that in the immersive condition, novice participants experienced greater levels of enjoyment and lower RPEs compared to a non-immersive control condition; however, actual HR did not differ between conditions. The similar HRs experienced in both classes indicates that although exertion was similar in both classes, the novice participants did not perceive that they were working as hard in the immersive condition. Conversely, experienced exercisers spent significantly more time in their max HR zone (90-100%) and reported significantly higher RPEs in the non-immersive control condition than they did in the immersive condition indicating that they worked harder and were aware of their increased exertion in the control condition. Although this study used a novel and highly immersive technology, proposed explanatory pathways such as lower RPE via attentional focus, were not evaluated. Given the differential effect of the immersive stimuli for experienced vs. novice exercisers and lack of explanatory variables, further investigation into the impact of video immersion on participants' experiences of PA is warranted.

Due to the lack of ecologically valid studies and the differing results of Gottschall and Hastings (2017), the aim of the present study is to evaluate the impact of a novel immersive technology on participants' experiences of exercise. To that end, the goal of this study is to compare participants' affective, cognitive, and physiological responses to exercise in an audio only (AUD; music only) vs. an immersive (IMM; music + video) group fitness setting. We hypothesize that:

1. *Participants will experience more dissociative attentional focus during the IMM class than the AUD class*
2. *Participants will experience greater enjoyment in the IMM class than the AUD class*
3. *RPE will be lower in the IMM class than the AUD class*
4. *A/D will mediate the relationships between class type and affect/RPE, respectively*

METHOD

Participants

Study volunteers (n=31) were recruited through convenience sampling from a group fitness studio located in central Pennsylvania. In order to participate, individuals had to be members of the studio and agree to participate in one AUD class and one IMM class between June 8, 2019 and June 23, 2019. Participants' average age was 43 years (SD=14.90), and the sample was predominately female (77%). Average BMI of the sample was 24.20 (SD=2.70; Range=18.28-29.33).

Power analysis

A-priori power analysis was conducted using G*Power software (Faul et al., 2007) to identify the necessary sample size. Based on a moderate-to-large predicted effect size for A/D (d=0.65; Chow & Etnier, 2017; Glen et al., 2017; Hutchinson et al., 2015), an alpha of 0.05, and power at 0.8, the analysis indicated that a minimum of 21 participants would be required for two-tailed t-tests comparing differences between two dependent means. An additional 10 participants were recruited to protect against attrition and deletions due to outliers.

Apparatus/Measures

Apparatus

Exercise sessions were completed indoors using the Body Bike Supreme stationary bike. All adjustable parts of the bike were adjusted for participant comfort (i.e., seat height, handle bar height, and seat distance to handle bars). Participants had the option of wearing clip-in cycling shoes. In the IMM condition, videos were projected onto a cinema-scale, floor to ceiling screen

(~10 feet [diagonal width] with a ratio of 16:9; Les Mills The TRIP, see Appendix B for images and sample video). Blackout curtains were used to cover windows and mirrors on three sides of the room to enhance immersion (See Appendix B for images of the exercise environment).

Class Type

Participants were instructed to complete one AUD class and one IMM class in the order of their choosing. Both classes were approximately 40 minutes in length and included both warmup and cooldown phases. Both classes used similar music in which the tempo of the music was synchronized to the instructor-recommended speed of one's pedal strokes operationally defined as revolutions per minute (RPMs). Although an instructor was present and provided cadence and resistance recommendations, in both class formats, participants were able to self-select their desired intensity via cadence and resistance modifications. In the IMM class only, resistance and cadence were coordinated with the simulation (i.e., when you are cycling up a hill in the simulation the instructor prompts you to add more resistance to mimic what one would experience if cycling on a real-world course).

Heart Rate

Heart rate (HR) was recorded at 60-second intervals using short-range radio telemetry via the Polar H10 HR transmitter chest strap (Polar Electro Inc, Bethpage, NY). Heart rate data are expressed as maximal heart rate (as calculated by subtracting the participant's age from 220) and as percent of time spent in HR zones (70-80% Max HR; 80-90% Max HR; 90-100% Max HR).

Survey

RPE: Participants were asked to rate their subjective level of recalled exertion via a modified version of the Borg's RPE Scale (Appendix A; Borg, 1982; Graupensperger et al., 2019). The measure's single item asked participants to "Rate how hard you had to exert yourself during the class you just completed. Focus on your total feeling of exertion. Do not focus on just one factor (shortness of breath or leg pain). Circle the number that best describes your exertion." Response options ranged from 6 (no exertion) to 20 (maximal exertion). Although it is preferable to ask participants to rate their exertion *during* the exercise session, the modified scale which asked participants to recall their experienced exertion was utilized due to class constraints (not everyone in the class consented to participate in the study) and in consideration of participant safety. This modified version of the Borg RPE scale has been found to be moderately correlated with physiological exertion (e.g., HR) and is considered both a reliable and valid measure of perceived intensity (Graupensperger et al., 2019; Haddad et al., 2017).

Day/Time: Participants were asked to report the day of the week and time of day that the class took place by circling the appropriate value on the survey.

Affective Responses: To measure affective responses, participants were instructed to answer a series of questions including "I like the amount of physical activity I got from this class" and "Rate your enjoyment with the class" (see Appendix A for full survey) using a 7-point Likert scale ranging from 1-not at all to 7-extreme. Participants were instructed to circle the response that they felt best described themselves. Participants were also asked to rate how they felt during the exercise session using the 11-point Feeling Scale, a valid and reliable assessment of affective valance, with responses ranging from -5 (Very Bad) to +5 (Very Good) (Gillman & Bryan, 2020; Hardy & Rejeski, 1989; Karageorghis & Jones, 2014; Maher et al., 2015).

Association/Dissociation: A/D was measured via a one-item survey question developed by (Tammen, 1996). Participants were asked to self-report their state of attention during the exercise session on an 11-point Likert scale, ranging from 0=dissociative to 10=associative. In the original research, Tammen (1996) concluded that this one-item scale is an efficient and valid measure of attentional focus (Alvarez-Alvarado et al., 2019; Tammen, 1996). Although originally designed to measure in-task A/D, research by Masters and Ogles (1998) found this single-item measure to be effective at capturing participants' in-task attentional focus immediately following exercise cessation (Masters & Ogles, 1998)

Procedure

Participants were recruited via verbal announcements at the gym in which data collection took place and brief email notifications. In order to participate, individuals had to be members of the gym at which data collection took place. Participants were eligible to participate if they were healthy and did not have any conditions that would prevent them from safely engaging in two 40-minute exercise sessions. Additionally, individuals could only participate if they were able to attend one IMM class and one AUD class between June 8th, 2019- and June 23rd, 2019. Informed consent was obtained from all participants prior to study enrollment. Once consent was obtained, the research team outfitted participants with a HR monitor to wear for the duration of the class. The monitor was worn at the chest and tracked HR for the duration of the class session. Instructions were provided regarding proper monitor placement. Participants could not see their HR via the study monitors. Following proper calibration of the HR monitors participants were asked to complete the exercise classes (IMM and AUD) as they would when not under observation. Lastly, participants were instructed to complete the exercise sessions on different days in order to allow for complete recovery and to prevent fatigue derived during one class from impacting performance in the other. After completing their first class, participants were reminded to complete the remaining class within the specified time frame. Immediately following the conclusion of each class, participants completed the survey. At the end of the study period, participants were thanked for their participation.

ANALYSES

Analyses were conducted in 2021 using RStudio Statistical Software version 1.4.1717 (RStudio Team, 2020). Paired samples t-tests were used to determine the impact of class type (traditional audio only [AUD] vs immersive video enhanced [IMM]) on participants' RPE, enjoyment and attentional focus. To control for possible confounding variables, a series of linear mixed effects models (LMM) were estimated controlling for both time of day, as energy and physiological performance capacity fluctuate throughout the day (Racinais, 2010), and class instructor, to control for individual preferences as well as varying levels of instructor difficulty. Class type, instructor, class time and the outcome variables were fixed effects and subject was random. Alpha was set at $p < 0.05$ for all analyses. A Shapiro Test for normality indicated that the outcome variables (RPE, enjoyment, and attentional focus) did not conform to a normal distribution ($p < 0.05$ for all variables). Although the aforementioned analyses are robust against deviations from normality for large sample sizes (n>30), the researchers opted to also conduct the non-parametric Wilcoxon test and used bootstrap confidence intervals to confirm the accuracy of the t-tests and LMM results, respectively. Finally, a mediation model was estimated using the path analysis framework proposed by Judd et al. (2001) and modified by Montoya and Hayes (2017) to determine if the impact of class type on RPE and affect respectively, is mediated by attentional focus.

RESULTS

Participants on average enjoyed their cycling sessions (6.45=IMM; 6.03=AUD on a 7-point scale), perceived that they were working hard (15.87=RPE IMM; 17.13=RPE AUD where 20 = maximal exertion), and generally reported an internal, associative attentional focus (8.29=IMM; 8.96=AUD where 0=dissociative and 10=associative). While enjoyment and RPE did not vary significantly depending on the instructor, RPE did vary depending on the class time with the 8:30am and 5:30pm classes showing the lowest RPEs and the 10:30am and 6:30pm resulting in the highest (Figure 1).

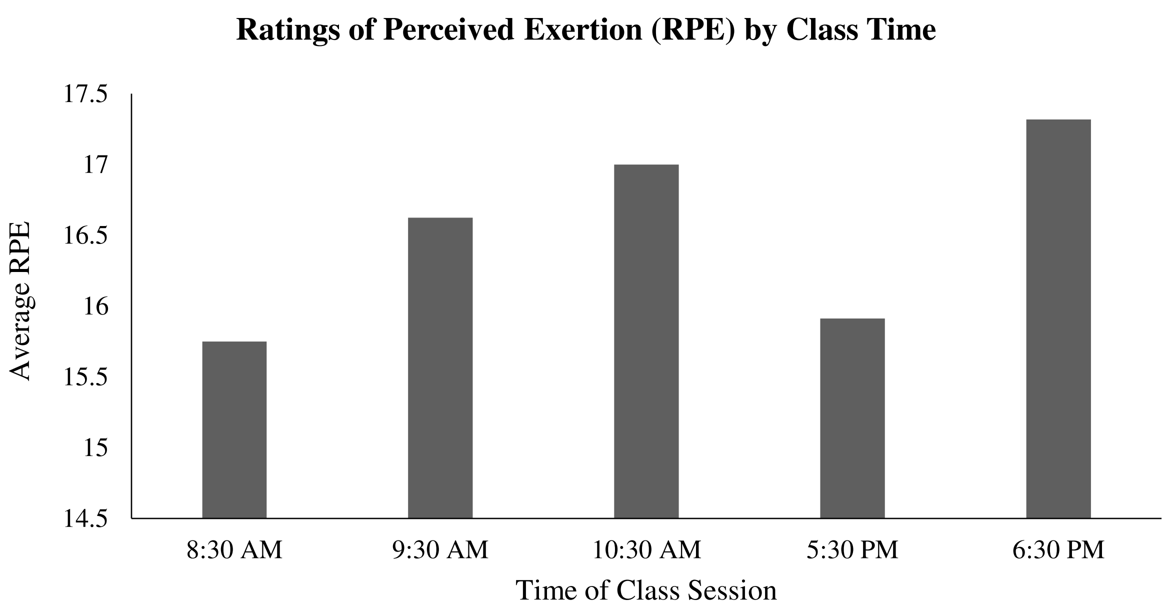

Figure 1. Participants' average ratings of perceived exertion (RPE) by class time

The results of the t-tests indicated that class type did have a significant impact on RPE and enjoyment with RPE being significantly lower (t= -4.462, p<.001) and enjoyment being significantly higher (t = 3.2433, p<.01) in the IMM class. Although the sample size in this study was relatively large, the data failed to conform to a normal distribution (S1 p<0.05 for all outcome variables). Due to this nonnormality, in order to confirm the accuracy of the independent samples t-test, the non-parametric Wilcoxon test was also conducted. In line with the results of the t-test, both enjoyment and RPE were significantly different between classes indicating participants perceived they did not work as hard and had greater enjoyment in the IMM class than the AUD (*ps*<0.01, RPE 95% CI [-2.00, -1.00], Enjoyment 95% CI [1.00, 1.500]). Although attention was not significantly different between the classes (*p*=0.053), on average, participants reported a more dissociative attentional focus during the IMM class than the AUD class. Finally, max HR and time spent in 70% or greater of one's max HR zone did not differ significantly between classes (*ps*=0.051); however, participants on average had higher max HRs and spent more time in 70% or greater of their max HR zone during the AUD class than the IMM class.

A series of LMMs were evaluated to control for the impact of instructor and class time on participant ratings of perceived exertion, affect and attention. Each outcome variable (RPE, enjoyment, and attention) was regressed on the categorical indicator of condition, a dummy coded indictor of instructor and a centered version of time (time was converted to minutes with midnight corresponding to a time of 0 minutes) to ensure meaningful interpretation. After adjusting for instructor, class type was found to exert a significant influence on attention in that during the IMM class participants self-reported focus was 0.70 units lower than in the AUD class (*p*=0.048; Table 1). This indicates that the IMM class did result in more dissociative attentional focus when instructor was held constant.

Table 1. Regression estimates and 95% confidence interval for the model in which attention and instructor were regressed on class type

	Attention		
Predictors	*Estimates*	*CI*	*p*
(Intercept)	9.13	8.17 – 10.09	**<0.001**
Class Type	-0.70	-1.39 – -0.01	**0.048**
Instructor	-0.07	-0.43 – 0.28	0.673
Random Effects			
σ^2	1.74		
$\tau_{00\ ID}$	0.76		
ICC	0.30		
N_{ID}	31		
Observations	62		
Marginal R^2 / Conditional R^2	0.047 / 0.337		

Note: The non-immersive, audio only cycling class (AUD) was used as the reference group

In order to determine if attentional focus mediates the relationship between class type and RPE/affect, a mediation model using the path analysis framework proposed by Judd et al. (2001) and modified by Montoya and Hayes (2017) was estimated (Figure 2). To account for the within-subjects design of the study, difference scores were used to assess each of the path components. Although the results of the a-path indicated there was a 0.68 unit decrease in attentional focus in the IMM class compared to the AUD, the results failed to achieve statistical significance (*p*

=0.053). In order for mediation to exist both the a and b-paths must be statistically significant; therefore, mediation was not supported.

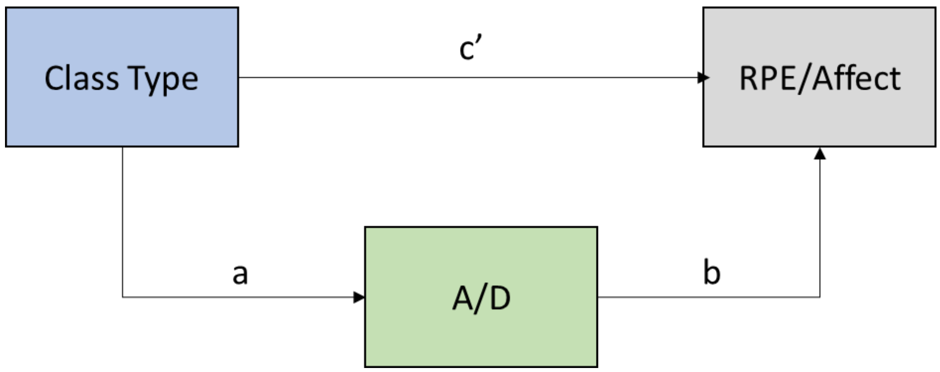

Figure 2. Proposed mediation model

DISCUSSION

This study sought to determine the impact of a novel, immersive technology on participants' ratings of perceived exertion (RPE), affect, and attentional focus during a group cycling class. In line with our hypotheses, in the immersive audio + video condition (IMM) participants reported significantly lower RPEs than in the traditional audio-only class (AUD). Additionally, participants reported higher levels of enjoyment during the IMM class than the AUD. Contrary to our hypotheses, attention did not differ significantly between classes and therefore failed to mediate the relationship between class type and RPE/affect respectively. Although attentional focus was not significantly different between classes, when instructor was held constant this relationship became significant indicating that the IMM class led to more dissociative thinking than the AUD class.

In thinking about why class instructor exerted a significant influence on attentional focus, it is likely that the different instructors utilized slightly different coaching cues. Although all instructors are provided guidelines and a semi-structured script detailing what coaching cues to use and when, the class format does allow for flexibility. It is likely some instructors, especially those trained in multiple fitness modalities (i.e., cycling, yoga, boxing, etc.) naturally gravitated towards more associative cues such as those related to leg speed or breathing as cues like these are common across most types of group fitness instruction. If this was the case, it is possible these cues counteracted the dissociative impacts of the immersive simulation as they are intended to draw attention inward towards a more associative, bodily focus. Conversely, seasoned instructors who have spent more time coaching the immersive class were likely more comfortable utilizing the simulation cues (i.e., cues about elements of the simulation such as animals or hills) as they have had more time to adjust and learn effective cueing techniques specific to this type of video-enhanced class. Although it would have been ideal to have the same instructors across both class types, only one instructor in this study taught both classes.

The results of this study align with the previous literature supporting the use of various distracting stimuli to lower RPE and increase enjoyment (Bird et al., 2016; Chow & Etnier, 2017; Glen et al., 2017). Although attention was not significantly different between classes, participants did report more dissociative thinking during the IMM class than the AUD, lending support to our original hypotheses and in line with the current literature (Bird et al., 2019; Glen et al., 2017). Importantly, this study demonstrated that while RPE was lower in the IMM class, actual exertion (as measured via HR) did not significantly differ between the classes. Although past studies indicate that there is a near universal affective shift as exercise intensity approaches or exceeds the ventilatory threshold (VT), several studies have been able to delay that shift by using various distractions, resulting in a longer duration of positively-valanced affect (Hutchinson & Karageorghis, 2013; Karageorghis & Jones, 2014). This study lends support to and expands upon the existing literature indicating that distracting stimuli can be successfully utilized to impact participants' overall affective response to the exercise session without compromising the essential health benefits derived from exercising at traditionally uncomfortable intensities. Based on the dual-process model, it is hypothesized that if we can increase rates of positively-valanced affect experienced during and immediately following the cessation of exercise it is likely exercise will cease to be remembered as a negative experience that one should avoid. Rather, if PA becomes something enjoyable, then Type 1 automatic evaluations and Type 2 deliberative evaluations will align and it is more likely that individuals will adhere to a consistent exercise routine (Ekkekakis, 2017).

Strengths

This study has several strengths. First, this study is one of only a handful of studies examining the impact of immersive technology on participants' experiences of PA to be conducted in an ecologically valid setting. Although conducting this study in a group fitness studio does not allow for the same level of control as can be produced in traditional laboratory research settings, the findings are more likely to generalize beyond the lab to a diversity of real world situations. Additionally, this study recruited participants both diverse in age and body mass index (Age range: 20-64; BMI Range: 18.24-29.27) enabling the results of this study to generalize to a wide range of individuals. Finally, all the measures used in this study have been shown to be valid and reliable measures of the constructs they are intended to assess, therefore increasing confidence in the study's findings (Gillman & Bryan, 2020; Graupensperger et al., 2019; Haddad et al., 2017; Hardy & Rejeski, 1989; Karageorghis & Jones, 2014; Maher et al., 2015; Masters & Ogles, 1998).

Limitations

Although the results of this study are promising, there were several limitations that must be addressed. First, while it would have been preferable to obtain multiple, in-task measurements of RPE, affect, and attention, due to safety concerns the research team was only able to gather data immediately following the exercise session. While less than ideal, the research team was careful to pick measures that would mitigate the negative impact of suboptimal measurement timing on the outcome variables. For example, when determining the most appropriate way to measure affect given the situational limitations, the research team relied on the concept of affective rebound to obtain an accurate measurement. While all participants likely experienced affective rebounding (Box et al., 2020), past research indicates that post-task affective evaluations do reflect in-task affective experiences and a more negative in-task affective response corresponds to lower post-task affective ratings and likewise for positive affect. Since between-class differences were observed for affect, it can therefore be understood that in-task affect was lower during the AUD class than the IMM class. Although steps were taken to maximize the accuracy of the data, affect, attentional focus, and RPE were likely highly variable throughout the exercise session, but due to the limited number of measurement instances, within-session variability in these constructs was not captured. Future studies should seek to implement multiple measurement occasions to garner a better understanding of how these variables operate throughout the exercise session.

This study also failed to account for exerciser status (experienced vs. novice). Research indicates that attentional focus operates differently depending on one's familiarity with the PA task (Gottschall & Hastings, 2017; Gillman & Bryan, 2020). Novice exercisers (those less familiar with the exercise task or new to PA), do seem to benefit from the use of dissociative thinking, typically reporting higher levels of positively-valanced affect when their attention is focused on external stimuli instead of on uncomfortable bodily sensations. Conversely, experienced exercisers (those familiar with the exercise task) tend to show improved performance when their attention is associative and do not seem to respond to distracting stimuli intended to invoke dissociative thinking (Gillman & Bryan, 2020).

Future Directions

Future research should seek to identify potential causal mechanisms to explain the diverging use of attentional focus strategies in experienced vs. novice exercisers to better understand how attention operates across different types of individuals. Additionally, future research should seek to isolate the impact of this immersive technology on participants attentional focus in which instructor is held constant and attention is measured throughout the exercise session. Multiple measurements across multiple exercise sessions would allow for the use of additional statistical techniques that can lead to more definitive conclusions regarding the proposed causal pathway by which attentional focus mediates the relationship between class type and RPE/affect. Research should also seek to identify if utilizing immersive exercise technology results in increased adherence over time, as the ultimate goal of PA interventions is to produce enduring PA behavior change. Lastly, in light of the current covid-19 pandemic, researchers should seek to identify the impact of adding or removing stimuli that have traditionally been present in certain PA situations. For example, during this pandemic the Tour de France and the Olympics, events that traditionally attract thousands of spectators from across the globe, were conducted for the first time ever without fans. This presents a unique opportunity to better understand the affect, RPE, and attentional focus relationship by evaluating a historically unique situation in which an ever-present stimulus (fans cheering in the crowd) was removed from an intense competition.

Conclusions

The use of a novel, immersive cycling simulation increased positive affect and lowered RPE without impacting actual exertion in a diverse group of exercisers. This study both supports and expands on the current literature by introducing a new technology tested in an ecologically valid setting and demonstrates that this immersive technology can be used to lower RPE and combat the negative affective shift that occurs when exercising at uncomfortable but optimal intensities without compromising actual exertion.

REFERENCES

Alvarez-Alvarado, S., Chow, G. M., Gabana, N. T., Hickner, R. C., & Tenenbaum, G. (2019). Interplay Between Workload and Functional Perceptual–Cognitive–Affective Responses: An Inclusive Model. *Journal of Sport and Exercise Psychology*, *41*(2), 107–118. https://doi.org/10.1123/jsep.2018-0336

American College of Sports Medicine. (2013). *ACSM's Guidelines for Exercise Testing and Prescription* (9th ed.). Lippincott Williams & Wilkins.

Bird, J. M., Hall, J., Arnold, R., Karageorghis, C. I., & Hussein, A. (2016). Effects of music and music-video on core affect during exercise at the lactate threshold. *Psychology of Music*, *44*(6), 1471–1487. https://doi.org/10.1177/0305735616637909

Bird, J. M., Karageorghis, C. I., Baker, S. J., & Brookes, D. A. (2019). Effects of music, video, and 360-degree video on cycle ergometer exercise at the ventilatory threshold. *Scandinavian Journal of Medicine & Science in Sports*, *29*(8), 1161–1173. https://doi.org/10.1111/sms.13453

Bird, J. M., Karageorghis, C. I., Baker, S. J., Brookes, D. A., & Nowicky, A. V. (2021). Ready Exerciser One: Effects of music and virtual reality on cycle ergometer exercise. *British Journal of Health Psychology*, *26*(1), 15–32. https://doi.org/10.1111/bjhp.12445

Blair, S. N. (2009). Physical inactivity: The biggest public health problem of the 21st century. *British Journal of Sports Medicine*, *43*(1), 1–2.

Bluemke, M., Brand, R., Schweizer, G., & Kahlert, D. (2010). Exercise Might Be Good for Me, But I Don't Feel Good About It: Do Automatic Associations Predict Exercise Behavior?

Journal of Sport and Exercise Psychology, *32*(2), 137–153. https://doi.org/10.1123/jsep.32.2.137

Borg, G. A. (1982). Psychophysical bases of perceived exertion. *Medicine and Science in Sports and Exercise*, *14*(5), 377–381.

Box, A. G., Feito, Y., Zenko, Z., & Petruzzello, S. J. (2020). The affective interval: An investigation of the peaks and valleys during high- and moderate-intensity interval exercise in regular exercisers. *Psychology of Sport and Exercise*, *49*, 101686. https://doi.org/10.1016/j.psychsport.2020.101686

Brand, R., & Ekkekakis, P. (2018). Affective–Reflective Theory of physical inactivity and exercise: Foundations and preliminary evidence. *German Journal of Exercise and Sport Research*, *48*(1), 48–58. https://doi.org/10.1007/s12662-017-0477-9

Brick, N., Macintyre, T., & Campbell, M. (2014). Attentional focus in endurance activity: New paradigms and future directions. *International Review of Sport and Exercise Psychology*, *7*, 106-134. https://doi.org/10.1080/1750984X.2014.885554

Chow, E. C., & Etnier, J. L. (2017). Effects of music and video on perceived exertion during high-intensity exercise. *Journal of Sport and Health Science*, *6*(1), 81–88. https://doi.org/10.1016/j.jshs.2015.12.007

de Souto Barreto, P. (2013). *WHO | Why are we failing to promote physical activity globally?* WHO; World Health Organization. https://www.who.int/bulletin/volumes/91/6/13-120790/en/

Ding, D., Lawson, K. D., Kolbe-Alexander, T. L., Finkelstein, E. A., Katzmarzyk, P. T., van Mechelen, W., Pratt, M., & Lancet Physical Activity Series 2 Executive Committee. (2016). The economic burden of physical inactivity: A global analysis of major noncommunicable diseases. *Lancet (London, England)*, *388*(10051), 1311–1324. https://doi.org/10.1016/S0140-6736(16)30383-X

Ekkekakis, P. (2017). People have feelings! Exercise psychology in paradigmatic transition. *Current Opinion in Psychology*, *16*, 84–88. https://doi.org/10.1016/j.copsyc.2017.03.018

Ekkekakis, P., Hargreaves, E. A., & Parfitt, G. (2013). Invited Guest Editorial: Envisioning the next fifty years of research on the exercise–affect relationship. *Psychology of Sport and Exercise*, *14*(5), 751–758. https://doi.org/10.1016/j.psychsport.2013.04.007

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191. https://doi.org/10.3758/BF03193146

Gillman, A. S., & Bryan, A. D. (2020). Mindfulness Versus Distraction to Improve Affective Response and Promote Cardiovascular Exercise Behavior. *Annals of Behavioral Medicine*, *54*(6), 423–435. https://doi.org/10.1093/abm/kaz059

Glen, K., Eston, R., Loetscher, T., & Parfitt, G. (2017). Exergaming: Feels good despite working harder. *PLOS ONE*, *12*(10), e0186526. https://doi.org/10.1371/journal.pone.0186526

Gottschall, J. S., & Hastings, B. (2017). Immersive Cycling Environment Yields High Intensity Heart Rate Without High Perceived Effort In Novice Exercisers: 864 Board #43 May 31 3: 30 PM - 5: 00 PM. *Medicine & Science in Sports & Exercise*, *49*(5S), 223. https://doi.org/10.1249/01.mss.0000517458.24189.cc

Graupensperger, S., Gottschall, J., Benson, A., Eys, M., Hastings, B., & Evans, M. B. (2019). Perceptions of Groupness During Fitness Classes Positively Predict Recalled Perceptions of Exertion, Enjoyment, and Affective Valence: An Intensive Longitudinal Investigation. *Sport, Exercise, and Performance Psychology*, *8*. https://doi.org/10.1037/spy0000157

Haddad, M., Stylianides, G., Djaoui, L., Dellal, A., & Chamari, K. (2017). Session-RPE Method for Training Load Monitoring: Validity, Ecological Usefulness, and Influencing Factors. *Frontiers in Neuroscience*, *11*. https://doi.org/10.3389/fnins.2017.00612

Hardy, C. J., & Rejeski, W. J. (1989). Not What, but How One Feels: The Measurement of Affect during Exercise. *Journal of Sport and Exercise Psychology*, *11*(3), 304–317. https://doi.org/10.1123/jsep.11.3.304

Hutchinson, J. C., & Karageorghis, C. I. (2013). Moderating influence of dominant attentional style and exercise intensity on responses to asynchronous music. *Journal of Sport & Exercise Psychology*, *35*(6), 625–643. https://doi.org/10.1123/jsep.35.6.625

Hutchinson, J. C., Karageorghis, C. I., & Black, J. D. (2017). The Diabeates Project: Perceptual, Affective and Psychophysiological Effects of Music and Music-Video in a Clinical Exercise Setting. *Canadian Journal of Diabetes*, *41*(1), 90–96. https://doi.org/10.1016/j.jcjd.2016.07.009

Hutchinson, J. C., Karageorghis, C. I., & Jones, L. (2015). See Hear: Psychological Effects of Music and Music-Video During Treadmill Running. *Annals of Behavioral Medicine*, *49*(2), 199–211. https://doi.org/10.1007/s12160-014-9647-2

Jones, L., & Ekkekakis, P. (2019). Affect and prefrontal hemodynamics during exercise under immersive audiovisual stimulation: Improving the experience of exercise for overweight adults. *Journal of Sport and Health Science*, *8*(4), 325–338. https://doi.org/10.1016/j.jshs.2019.03.003

Jones, L., Karageorghis, C. I., & Ekkekakis, P. (2014). Can high-intensity exercise be more pleasant?: Attentional dissociation using music and video. *Journal of Sport & Exercise Psychology*, *36*(5), 528–541. https://doi.org/10.1123/jsep.2013-0251

Judd, C. M., Kenny, D. A., & McClelland, G. H. (2001). Estimating and testing mediation and moderation in within-subject designs. *Psychological Methods*, *6*(2), 115–134. https://doi.org/10.1037/1082-989X.6.2.115

Karageorghis, C. I., & Jones, L. (2014). On the stability and relevance of the exercise heart rate–music-tempo preference relationship. *Psychology of Sport and Exercise*, *15*(3), 299–310. https://doi.org/10.1016/j.psychsport.2013.08.004

Lind, E., Welch, A., & Ekkekakis, P. (2009). Do "Mind over Muscle" Strategies Work? Examining the Effects of Attentional Association and Dissociation on Exertional, Affective and Physiological Responses to Exercise. *Sports Medicine (Auckland, N.Z.)*, *39*, 743–764. https://doi.org/10.2165/11315120-000000000-00000

Maher, J., Gottschall, J., & Conroy, D. (2015). Perceptions of the activity, the social climate, and the self during group exercise classes regulate intrinsic satisfaction. *Frontiers in Psychology*, *6*, 1236. https://doi.org/10.3389/fpsyg.2015.01236

Masters, K. S., & Ogles, B. M. (1998). Associative and dissociative cognitive strategies in exercise and running: 20 years later, what do we know? *The Sport Psychologist*, *12*(3), 253–270. https://doi.org/10.1123/tsp.12.3.253

Montoya, A. K., & Hayes, A. F. (2017). Two-condition within-participant statistical mediation analysis: A path-analytic framework. *Psychological Methods*, *22*(1), 6–27. https://doi.org/10.1037/met0000086

Pottratz, S. T., Hutchinson, J. C., Karageorghis, C. I., Mullin, E. M., & Zenko, Z. (2021). Prime Movers: Effects of Subliminal Primes, Music, and Music Video on Psychological Responses to Exercise. *Annals of Behavioral Medicine*, *55*(2), 112–122. https://doi.org/10.1093/abm/kaaa036

Racinais, S. (2010). Different effects of heat exposure upon exercise performance in the morning and afternoon. *Scandinavian Journal of Medicine & Science in Sports*, *20 Suppl 3*, 80–89. https://doi.org/10.1111/j.1600-0838.2010.01212.x

Rhodes, R. E., & Kates, A. (2015). Can the Affective Response to Exercise Predict Future Motives and Physical Activity Behavior? A Systematic Review of Published Evidence. *Annals of Behavioral Medicine*, *49*(5), 715–731. https://doi.org/10.1007/s12160-015-9704-5

Rhodes, R. E., McEwan, D., & Rebar, A. L. (2019). Theories of physical activity behaviour change: A history and synthesis of approaches. *Psychology of Sport and Exercise*, *42*, 100–109. https://doi.org/10.1016/j.psychsport.2018.11.010

RStudio | Open source & professional software for data science teams. (n.d.). Retrieved October 18, 2021, from https://rstudio.com/

Stevens, C. J., Baldwin, A. S., Bryan, A. D., Conner, M., Rhodes, R. E., & Williams, D. M. (2020). Affective Determinants of Physical Activity: A Conceptual Framework and Narrative Review. *Frontiers in Psychology*, *11*. https://doi.org/10.3389/fpsyg.2020.568331

Tammen, V. V. (1996). Elite middle and long distance runners associative/dissociative coping. *Journal of Applied Sport Psychology*, *8*(1), 1–8. https://doi.org/10.1080/10413209608406304

Terry, P. C., Karageorghis, C. I., Saha, A. M., & D'Auria, S. (2012). Effects of synchronous music on treadmill running among elite triathletes. *Journal of Science and Medicine in Sport*, *15*(1), 52–57. https://doi.org/10.1016/j.jsams.2011.06.003

Thompson, N. (2017). *What is the Difference Between VT1, VT2 and VO2 max?* /fitness-certifications/ace-answers/exam-preparation-blog/3139/what-is-the-difference-between-vt1-vt2-and-vo2-max/

World Health Organization. (2020). *Physical activity*. https://www.who.int/news-room/fact-sheets/detail/physical-activity

Zenko, Z., & Ekkekakis, P. (2019). Internal consistency and validity of measures of automatic exercise associations. *Psychology of Sport and Exercise*, *43*, 4–15. https://doi.org/10.1016/j.psychsport.2018.12.005

APPENDIX A

Participant Number: ____________ Date:_____________ 1. Class: RPM or TRIP 2. Instructor: ____________

Please circle the day and time for the class you just completed. Rate how hard you had to exert yourself during the **class you just completed**. Focus on your **total feeling** of exertion. Do **not** focus on just one factor (shortness of breath or leg pain). Circle the number that best describes your exertion.

3. Day						
Mon	Tues	Wed	Thur	Fri	Sat	Sun

4. Time				
5:30am	8:30am	9:30am	5:30pm	6:30pm

5. Exertion														
6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
no exertion		extremely light	very light		light		somewhat hard		hard		very hard		extremely hard	max

For the following questions about the **exercise class you just completed**, please answer using the scales provided. Circle **one response** that describes you.

	not at all			**somewhat**			**extreme**
6. Rate your satisfaction with the class.	1	2	3	4	5	6	7
7. Rate your enjoyment with the class.	1	2	3	4	5	6	7
	not at all	**true of me**		**somewhat**		**extremely**	**true of me**
8. I believe I improved today compared to my past performances in this class.	1	2	3	4	5	6	7
	strongly	**disagree**		**neither**		**strongly**	**agree**
9. I liked the amount of physical activity I got in this class.	1	2	3	4	5	6	7
10. I am satisfied with my life right now.	1	2	3	4	5	6	7
11. My physical health was good today.	1	2	3	4	5	6	7
12. My mental health was good today.	1	2	3	4	5	6	7
13. The instructor encouraged me.	1	2	3	4	5	6	7
14. The instructor provided helpful technique and intensity guidelines.	1	2	3	4	5	6	7
15. The instructor provided me with feedback on my efforts during the class.	1	2	3	4	5	6	7
16. I enjoyed my social interactions within the class.	1	2	3	4	5	6	7
17. We, as participants of the class, enjoyed each others company.	1	2	3	4	5	6	7
Comments:							

1. Estimate your state of attention during the exercise session. (**Associative** = focused on the present moment, bodily sensations such as heart rate, breathing, technique; **Dissociative** = unfocused,in past or future, daydreaming, thinking about your to-do list etc.)

0	1	2	3	4	5	6	7	8	9	10
Dissociative										Associative

2. Rate your motivation during the exercise session. By '**serious'** we mean that you were pursuing, or at least thinking about, some essential goal. For example, the goal might be reaching a certain RPM, or it may be something related to greater physical fitness. By '**playful'**, we mean the feeling that you are in the moment and doing what you are doing for its own sake. In this case, your activity is felt to be enjoyable in itself and not to require any further justification.

0	1	2	3	4	5
Serious					Playful

3. Rate how you felt during the exercise session.

-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Very bad					Neutral					Very good

4. Did you feel the interval lengths were attainable during the class? Did you feel you could maintain the intended speed, resistance, or power for the full interval?

1	2	3	4	5
Never	Sometimes	Half the time	Most of the time	Always

5. Rate how pleasant your experience was today.

1	2	3	4	5	6	7
Not at all pleasant						Extremely pleasant

6. What attracted you to this class? Circle all that apply.

The Time The Instructor The Format The Class Length The Video ElementsThe Music Friends/Family Workout Intensity

Other: ________________

7. Why do you choose to come to **Fitology 542**? Circle all that apply.

Proximity to home/work Instructors Group based format Music/ChoreographyFacility Class Times Other Members Research based exercise Class Variability Instructor knowledge/training Results Social interactionOther (Please explain): ________

APPENDIX B

Figure 3. Body Bike Supreme. This image illustrates the type of exercise bike used in this study.

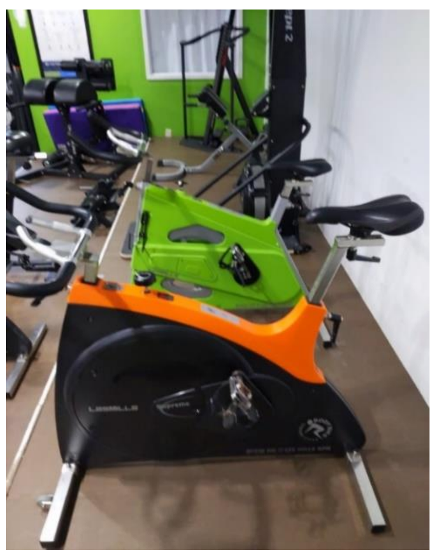

Figure 4. Body Bike Supreme. This image illustrates the type of exercise bike used in this study.

Figure 5. Immersive Screen. This image displays the simulation enviroment used during the immersive cycling class.