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Effects of Virtual Interactive Cycling on Perceived Duration and Exercise Enjoyment in Sedentary Adults

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Abstract BACKGROUND/OBJECTIVE: The purpose of this study was to examine the effects of a virtually led Spin class on perceived duration and exercise enjoyment. METHODS: Twenty-four sedentary adults (27.6 ± 9.9 $ml \times kg^{-1} \times min^{-1}$) completed a VO_2 peak test, a 30-min virtual Spin class via a fitness application (PA), and a matched workload cycling class without visual or audio interaction (NA). Heart rate (bpm) and VO_2 ($ml \times kg^{-1} \times min^{-1}$) were recorded each min while blood lactate ($mmol \times dL^{-1}$), and acute differential RPE overall (RPE-O), legs (RPE-L), and breathing (RPE-B) were recorded every 5-min. Additionally, exercise enjoyment via the PACES questionnaire, session RPE (SRPE) and perceived duration (min) were assessed 15-min post exercise. RESULTS: Intensity differences between trials were negligible. No significant differences in perceived duration were observed between trials (PA 30.6 ± 15.0; NA 33.0 ± 9.6; $p = 0.153$) despite significantly higher levels of enjoyment (PA 2.48 ± 1.33; NA 3.42 ± 1.42; $p = 0.02$) and lower SRPE (PA 5.8 ± 1.5; NA 6.5 ± 18; $p = 0.008$) for the PA trial. CONCLUSION**:** It is possible that the inclusion of a virtual Spin class may elicit increases in exercise adherence for sedentary individuals due to the higher levels of enjoyment observed with the visual and audio interaction.

Keywords: *Peloton, Spin, Time perception, Velotron, Scalar Expectancy Theory*

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1. Introduction

Habitual physical activity (PA) is strongly associated with a decreased disease risk [1,2,3], a reduced risk of all-cause mortality [4], and ultimately improved quality of life. Despite well-established benefits, only 50.9% of American adults meet professional recommendations for aerobic activity [5]. With the epidemic of physical inactivity in the United States, it is critical to identify methods which effectively aid individuals in increasing their PA levels to achieve health benefits. A possible explanation of low PA stems from common barriers such as: perceived lack of time, insufficient knowledge, minimal social support, inadequate access to resources [6,7], or aversion to (i.e. lack of enjoyment) PA. Specifically, enjoyment has been considered one of the most important factors for sustaining PA among adults [8] with higher levels of enjoyment linked to increased adherence [9,10].

A potential approach to increase PA in sedentary individuals would be to utilize a personal trainer [11]. Personal trainers have been suggested to improve attitudes towards PA with previous literature reporting 73% of participants advancing a minimum of one stage of the Transtheoretical Model following a 10-week, one-on-one personal training program [12]. In addition to enhancing attitude toward PA, the use of a personal trainer has elicited a 10.6% increase in energy expenditure and a 7% increase in heart rate during a live personal training session compared to an identical prerecorded DVD session [11]. Not only were participants' exercise intensity selections higher in a personal training workout, but 89% of participants actually preferred the personal training session over the DVD session. While personal training may increase exercise adherence [11,12,13], barriers such as perceived time availability, lack of facilities, and funds remain present.

An alternative to personal training at a fitness facility is virtual exercise which allows individuals more flexibility in scheduling and exercise options than traditional one-on-one training sessions frequently occurring at a designated facility. Additionally, previous research suggests home-based exercise can lead to increased adherence vs. group exercise sessions at fitness facilities [14]. This model of exercise participation would not only allow individuals to receive instruction similar to a personal training session but also the ability to exercise in one's home. The integration of smart devices in home fitness equipment has contributed to the popularity of this market, valued at 10.18 billion in 2020 and projected to reach 14.74 billion by 2028 [15]. This modality may be beneficial for individuals desiring optimal convenience, without conceding instruction given in a personal training session or group exercise class.

One of the most popular group exercise classes is Spin [16], which is choreographed indoor cycling led by a fitness instructor. Spin is appropriate for a variety of fitness levels due to the personalized nature of the intensity selection with changes in cycling cadence, resistance, and music rhythm [17] based on subjective feelings of exertion. Spin may be linked with health benefits including improved VO_{2max}, lean body mass, HDL, LDL, triglycerides, and systolic and diastolic blood pressures [17]. With Spin classes often including periods of high intensity, individuals participating have reported higher acute VO_2 values vs. a clamped 30-min cycling trial [18]. While the physiological benefits of Spin have previously been investigated [17], perceptual responses for Spin type classes are still unclear.

When comparing perceptual measures between 20-min high intensity (70% VO_2 peak) cycling sessions with music vs. no music, ratings of perceived exertion (RPE) were significantly higher ($p \leq 0.05$) by an average of 0.9 at each five-minute timepoint for the session without music [19]. Furthermore, Reason et al. [20] found that when completing a 40-min virtual trail ride, RPE was significantly lower vs. an intensity and time matched cycling session without visual interaction. In contrast, Shaulov and Lufi [21] reported no significant effect of music (vs. none) on RPE when participating in a Spin class. However, the authors postulate that the lack of significance could be due to the participants' high level of experience with Spin classes (average of 15 months) which may have diminished the impacts of a distractive mechanism such as audio or visual input on their perceived effort [21]. It is plausible that an instructor led Spin class would influence RPE in sedentary populations due to the presence of distractive mechanisms. Such mechanisms may allow individuals to enter a "flow state" where they lose sense of self as they are immersed in an audio or visual environment [22] which may divert attention from feelings of fatigue. As a consequence, perceptual markers and estimated time spent exercising could be impacted.

In addition to RPE, exercise enjoyment has the potential to be higher as the music and instructor could be a distraction for the participant. Specifically, with time perceptions decreasing (passing quicker) in the presence of positive feelings associated with a task [23], these distractive mechanisms have the potential to increase positive feelings toward a specific activity [20], therefore decreasing perception of PA duration compared to modalities without interaction. While enjoyment of a Spin class (vs. traditional constant load cycling) is not well-understood, prior research has reported significantly greater feelings of enjoyment with a gaming bike exercise session vs. traditional constant load cycling despite similar acute and session RPE estimations [24]. Therefore, it is plausible that distraction resulting from music and engagement/instruction of a fitness leader in a Spin class could enhance enjoyment and alter perception in exercise duration. While there is a paucity of direct research on traditional Spin classes, simulated Spin classes that are completed with a smart device are even less well-understood. This study examined the effects of a simulated Spin class using the Peloton app vs. a matched workload cycling session. It was hypothesized that individuals would perceive the virtually integrated exercise session as shorter and more enjoyable compared to the matched workload session.

2. Methods

2.1. Participants

Twenty-four sedentary individuals between the ages of 18 and 45 volunteered to participate . G-Power software (v3.1, Düsseldorf, Germany) determined *a priori* that 24 participants would be sufficient to achieve a desired power of 0.8, using a moderate-high effect size, and an alpha level set at 0.05 when using perceived duration as the primary dependent variable. All procedures were approved by the institutional review board for protection of human subjects and followed research ethics guidelines. Each participant signed a written informed consent prior to data collection. Additionally, all participants were screened for safety using the PAR-Q+ [25]. Those who were deemed greater than minimal risk based on known risk factors were excluded from participating. To qualify for the study, individuals had to be considered sedentary based on American College of Sports Medicine Guidelines [5] by reporting less than 150 min of moderate intensity, 75 min of vigorous intensity, or a combination of the two activity intensities per week. Participants reported to the lab well-rested (no strenuous exercise within 24 hrs prior), well-hydrated, and instructed to avoid caffeine for a minimum of 24 hrs prior to each trial. Anthropometric data were collected using a stadiometer for participants height (cm) (Detecto, Webb City, MO, USA) and a digital scale (kg) (BWB-800, Tanita co., Alinton Heights, IL, US) for body mass. Body fat percentage was estimated [26] with skin fold calipers (Lange, Cambridge, MD, USA) using the three-site skinfold measurement equation (Males: chest, abdomen and thigh; Females: triceps, suprailiac and thigh).

2.2. VO_2 Peak Trial

Following anthropometric measurements, participants were familiarized with the Velotron bike (Velotron, Racer Mate, Seattle, WA, US), while seat and handlebars were adjusted to appropriate heights prior to the VO_2 peak test. The protocol consisted of a three min warm-up cycling at a resistance of 60 watts (W) followed by an increase of 50 W for males and 30 W for females every two min until volitional exhaustion was achieved. Volitional exhaustion was defined as the inability to maintain an appropriate wattage even when provided verbal encouragement. Metabolic data (VO_2, VCO_2, V_E and RER) were analyzed and recorded every min using a Parvo Medics system (Parvo Medics TrueOne 2400, Sandy, UT, USA) with integrated software. The metabolic system was calibrated prior to each trial using a gas of known concentration (16% O_2 and 4% CO_2) with the flowmeter calibrated using a Hans Rudolph (Series 4900) 3.0 L calibration syringe (Hans Rudolph, Kansas City, MO, US). Heart Rate (HR) response was assessed every min using a Polar chest monitor (T31 Transmitter, Polar Electro, Kempele, Finland). An Omni cycling pictorial RPE scale was in full view of participants throughout the trial [27]. Participants estimated overall RPE during the last 10 sec of each min.

2.3. Interactive vs. Traditional Cycling Trials

Following VO_2 peak assessment, participants reported to the lab on two separate occasions. During the first trial they completed an interactive cycling trial on the Velotron with the Peloton app (PAA) (Peloton app, Peloton Interactive Inc, New York, NY, US) and on the second they completed an intensity matched cycling trial (NAA) on the Velotron. The PAA trial consisted of participants completing a preselected advanced beginner 30-min Spin class using the Peloton app with a virtual instructor displayed via television mounted on the wall in full view throughout the trial. In conjunction with the virtual instructor, participants were allowed to adjust their workload (wattage & cadence) as they deemed necessary based on the instructor cues given during the virtual cycling class. Wattage was recorded every 30 sec of the trial and used to create an intensity matched cycling class for the NAA trial. The matched trial intensity, using Velotron Coaching Software (Velotron Coaching Software, Racer Mate, Seattle, WA, US), was identical to the interactive cycling trial but omitted virtual cycling instruction. Throughout each cycling trial wattage data were recorded every 30 sec and averaged every 5 min for analyses purposes. In addition, metabolic data (VO_2), along with HR, were recorded at baseline and every min and averaged every 5 min for analysis. Lactate (mmol×dL^{-1}) (Analox GL5, Analox Instruments, Boston, MA, US), acute RPE measures for overall (RPE-O), legs (RPE-L), and breathing (RPE-B) were estimated at baseline and every five min of the exercise session using the OMNI cycle RPE scale [27]. Throughout each cycling trial, participants were blinded to elapsed time to assure estimations of perceived duration (min) were based solely on subjective feelings. Furthermore, participants were unaware that the NAA trial was intensity matched based off PAA trial data.

Following each trial, participants remained in the lab for 15-min seated recovery after which they estimated session RPE (SRPE) using the same RPE pictorial scale [27]. Additionally, participants estimated how long they perceived the duration of the trial and completed a Physical Activity Enjoyment Scale (PACES) that assessed enjoyment associated with the exercise trial [28]. Following the final trial, participants reported which trial (app or no app) they preferred.

2.4. Statistical Analysis

Means and standard deviations for descriptive characteristics of participants were calculated. Separate 2 (condition) x 7 (timepoint) factorial ANOVAs were used to compare HR, VO_2, RPE-O, RPE-L, RPE-B, and wattage measures between PAA and NAA. Because HR, VO_2, and wattage were recoded every 30 sec to one min, an average of every 5 min was used for analyses. When necessary, paired samples t-tests were used for follow-up comparisons. Furthermore, paired samples t-tests were used to compare responses of the PACES questionnaire, SRPE, and perceived duration between trials. Results were considered significant at $p \leq 0.05$. For statistical analyses, IBM Statistical Package for the Social Sciences (v 28) software was used.

3. Results

Descriptive data for participants are represented in Table 1. Regarding HR, there was no main effect of condition nor interaction, however, there was an observed main effect of time ($p < 0.001$). Follow up analyses suggested no significant differences in HR between trials at any time point. There was also a main effect of both time ($p < 0.001$) and condition ($p = 0.016$) for lactate but no main interaction. Follow up analyses suggested significant differences between PAA and NAA trials at time points 10, 15, and 30 ($p \leq 0.05$) with lower values for the NAA trial at all time points (Table 2). Furthermore, there was no significant main effect for condition, however, there was a main effect for time ($p < 0.001$) in addition to a main interaction of time and condition for VO_2 ($p = 0.005$). Post hoc analyses revealed a significant difference in VO_2 at time point 10 ($p = 0.005$). However, although significant at some time points, the differences observed in HR, lactate, and VO_2 (Table 2) between the PAA trial and the intensity matched NAA trial were negligible and therefore lacked meaningful significance in the paradigm tested.

Table 1. Descriptive characteristics for participants

Variable	Females (n = 19)	Males (n = 5)	Total (n = 24)
Age (yr)	27.8 ± 9.9	26.6 ± 6.3	27.6 ± 9.1
Height (cm)	161.8 ± 7.5	177.6 ± 6.1	65.0 ± 9.7
Mass (kg)	73.9 ± 18.5	94.8 ± 13.4	78.3 ± 19.3
Body Fat (%)	29.6 ± 7.3	26.5 ± 6.6	28.9 ± 7.1
VO_2 peak (ml×kg^{-1}×min^{-1})	25.7 ± 4.3	29.3 ± 4.0	26.4 ± 4.4

Values are means and standard deviations

SRPE estimation was significantly lower ($p = 0.008$) for the PAA vs. NAA (Figure 1). In addition, for acute RPE there was no interaction or observed main effect of condition, however, there was an observed main effect of time ($p < 0.001$) for perceptual responses RPE-O (Figure 2), RPE-L (Figure 3), and RPE-B (Figure 4). Post hoc t-tests revealed a significant difference for RPE-B at time point 30 ($p = 0.05$). In addition, RPE-O values approached significance ($p = 0.07$) at time points 20 and 30. Further analyses of perceived duration revealed no significant differences between PAA and NAA (PAA 30.6 ± 15.0 min; NAA 33.0 ± 9.6 min; $p = 0.15$). There was, however, a significant ($p \leq 0.05$) difference in all PACES questionnaire responses with the exception of one question (pertaining to feelings of being absorbed) with values indicating greater amounts of positive feelings associated with the PAA vs. NAA (Table 3).

Table 2. Participant intensity data between trials (n = 24)

Variable	Time Point	PAA	NAA
VO_2 (ml×kg^{-1}×min^{-1})	Rest	3.9 ± 0.7	3.6 ± 0.5
	5 min	13.3 ± 2.2	13.3 ± 2.5
	10 min	17.6 ± 3.7*	16.8 ± 3.7
	15 min	18.6 ± 3.7	18.6 ± 4.2
	20 min	18.2 ± 3.7	18.6 ± 4.1
	25 min	18.6 ± 4.1	19.1 ± 4.3
	30 min	19.2 ± 3.8	19.2 ± 4.5
HR (bpm)	Rest	85 ± 12	84 ± 14
	5 min	124 ± 21	122 ± 17
	10 min	144 ± 24	139 ± 23
	15 min	152 ± 21	160 ± 21
	20 min	151 ± 20	151 ± 20
	25 min	155 ± 18	153 ± 19
	30 min	159 ± 17	156 ± 18
Lactate (mmol×dL^{-1})	Rest	1.4 ± 0.6	1.3 ± 0.5
	5 min	3.1 ± 1.1	2.8 ± 1.7
	10 min	5.0 ± 2.2*	4.4 ± 2.4
	15 min	5.8 ± 2.6*	5.0 ± 2.4
	20 min	5.7 ± 2.5	5.4 ± 2.5
	25 min	5.9 ± 2.7	5.5 ± 2.5
	30 min	6.1 ± 2.5*	5.4 ± 2.7

Data reported as means and standard deviations; PAA (Peloton App Alone Trial), NAA (No App Alone Trial); * = $p \leq 0.05$.

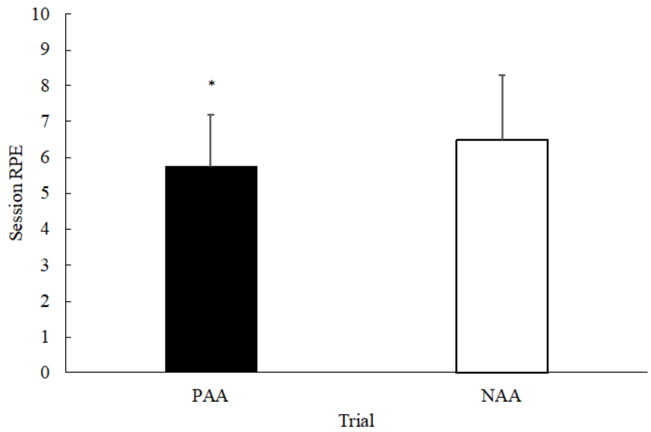

Figure 1. Mean ± SD Session RPE between PAA and NAA Trials. *$p \leq 0.001$

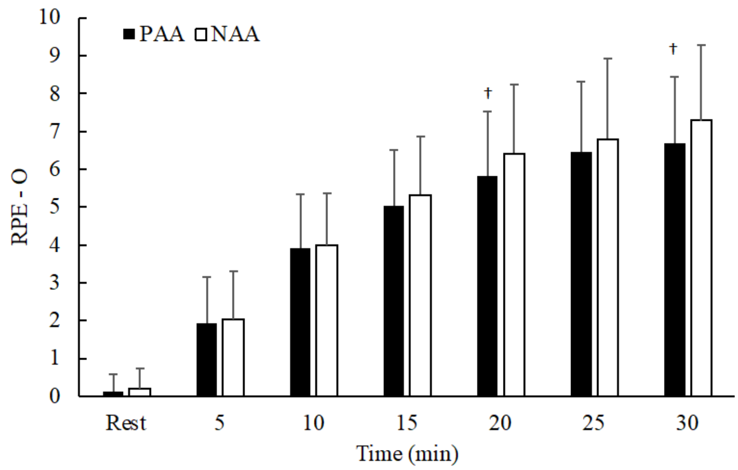

Figure 2. Mean ± SD RPE-O between PAA and NAA Trials. $^{\dagger}p = 0.07$

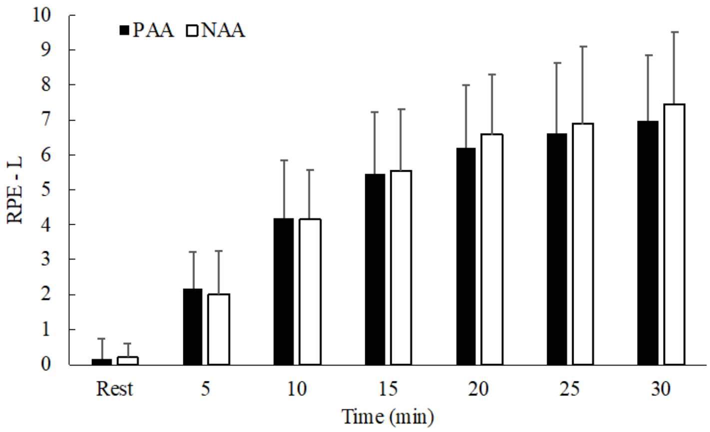

Figure 3. Mean ± SD RPE-L between PAA and NAA Trials

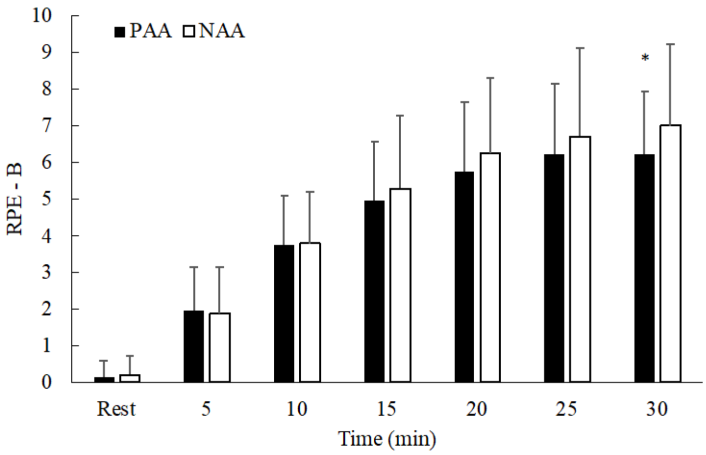

Figure 4. Mean ± SD RPE-B between PAA and NAA Trials. *p = 0.05

Table 3. PACES Questionnaire (n = 24)

Question	PAA	NAA
Enjoyed	2.48 ± 1.33*	3.42 ± 1.42
Liked	1.29 ± 0.98*	2.84 ± 1.59
Interested	1.56 ± 1.16*	3.59 ± 1.83
Pleasurable	2.91 ± 1.40*	4.20 ± 1.48
Absorbed	3.24 ± 1.28	3.83 ± 1.49
Fun	1.46 ± 0.84*	3.14 ± 1.49
Energizing	2.46 ± 1.46*	3.57 ± 1.60
Made me happy	1.49 ± 1.00*	2.19 ± 1.10
Pleasant	2.70 ± 1.29*	4.21 ± 1.40
Felt good	2.73 ± 1.50*	3.56 ± 1.32
Invigorating	2.52 ± 1.01*	3.74 ± 1.54
Not frustrating	1.09 ± 1.25*	2.75 ± 1.50
Gratifying	1.93 ± 0.79*	3.41 ± 1.39
Exhilarating	2.71 ± 0.89*	4.08 ± 1.47
Stimulating	1.80 ± 1.33*	4.44 ± 1.66
Accomplished	1.94 ± 1.06*	2.83 ± 1.39
Refreshing	2.26 ± 1.20*	3.33 ± 1.38
Nothing I would rather do	2.33 ± 1.09*	3.51 ± 1.47

Mean ± SD. Scale ranked from 1-7 with lower score meaning the participants agreed with the statement; PAA (Peloton App Alone Trial), NAA (No App Alone Trial); *p ≤ 0.05

4. Discussion

Participating in group exercise class, such as Spin, may offer similar benefits as a personal training session [14], with reduced cost. However, some may find exercising in group settings intimidating and therefore home-based group exercise classes via fitness applications such as the Peloton app may be preferable. Unfortunately, little is known about the effects of a virtually lead Spin class on perceived duration and exercise enjoyment. Therefore, this study compared a virtually simulated Spin class via the Peloton app (PAA) vs. a matched non virtual session (NAA) for perceived exercise duration and enjoyment of activity.

When comparing exercise conditions, there were significantly greater levels of enjoyment when participating in a virtually lead Spin class vs a workload matched standard cycling session (Table 3). Despite NAA being matched based off wattage data collected during PAA, intensity data for lactate and VO_2 showed significant differences between the two trials. However, post hoc t-test of intensity data revealed these changes to be minimal. With no significant differences in HR between trials, and only significance appearing at min 10 for VO_2 and min 10, 15 and 30 for lactate, specifically with differences of less than 1 $ml \times kg^{-1} \times min^{-1}$ for VO_2 and 0.8 $mmol \times dL^{-1}$ or less for lactate, it is reasonable to assume that PAA and NAA trials were similar in workload as intended (Table 2).

Results of the present study suggest that, despite participants cycling at similar workloads for 30 min, the audio and visual input from the virtual Spin class did not appear to significantly affect acute RPE measures with the exception of RPE-B at time point 30 (Figure 4).These findings coincide with previous literature which suggest no differences in RPE when cycling with and without music during a Spin class [21] and no differences in acute RPE when cycling with and without visual input via a cycling competition video [29]. However, further analyses of perceptual responses suggest that RPE-O approached significance at time points 20 and 30 ($p = 0.07$) with consistently lower values for the PAA trial at all timepoints and an overall trending lower RPE-O for PAA as time progressed (Figure 2). Similarly, Reason et al. found no changes in acute measures of RPE at any time point under 25 min when participating in a virtual trail ride vs. a standard cycling session [20]. A possible explanation for the lack of significant findings is that individuals, despite PA levels, were able to accurately discern perceptions of fatigue while cycling at shorter durations regardless of audio or visual input. However, it is possible that as time progresses (> 25 min), external factors such as distractive mechanisms may alter individuals' perception of fatigue. Furthermore, it is possible Reason et al. [20], found differences only at time points greater than 25 min, due to workload being clamped while Shaulov and Lufi [21], along with the present study, matched workloads in a manner which allowed intervals of varying as opposed to constant resistance. Although acute RPE remained unaffected apart from RPE-B at 30 min (Figure 4) and RPE-O approaching significance at 20 and 30 min (Figure 2), SRPE was significantly lower for PAA when compared to NAA (Figure 1). A possible explanation is that the 15 min passive rest period allowed individuals attentional focus to shift from sensations of fatigue toward the distractive mechanisms. Furthermore, in agreement with Reason et al., it is also possible that the lower in SRPE could be due to an increase in enjoyment of the activity [20]. SRPE is impacted by multiple factors including environment conditions [30] and caffeine supplementation [31] and it is plausible, though not documented, that enjoyment could also be influential. Further work is needed to examine this.

Results indicate there were significantly greater levels of positive feelings observed for the PAA vs the NAA with the exception of feeling absorbed by the activity which was not significantly different (Table 3). In this study, it is possible that the inclusion of both audio and visual components elicited greater levels of arousal which in turn resulted in greater levels of enjoyment as participants were instructed to follow along and adjust their cadence and resistance based on instructors' cues. In support of this explanation, previous literature suggests interactive components introduced into exercise may enhance levels of enjoyment when compared to a standard cycling session without interaction [20]. Future studies should include direct measures of arousal to add depth to the understanding of these differences.

Furthermore, despite PAA being perceived as more enjoyable, results from the current study parallel previous findings in suggesting individuals' ability to perceive the duration of exercise was unaffected by the inclusion of visual and audio components [20]. A potential explanation of the similar perceived durations could be explained by the Scalar Expectancy Theory (SET) [32,33], with previous research suggesting individuals can accurately estimate elapsed time during short periods [34], however, this may be altered based on an individual's overall mood [35]. This is further explained by previous findings which suggests perception of time elapsed can decrease (passing quicker) when experiencing emotions linked to happiness and increase (passing slower) when experiencing emotions linked to boredom [23]. It is possible that in the current study, participants' ability to estimate duration was unaffected as the level of enjoyment needed to elicit changes in elapsed time may not have been reached and therefore remained unchanged [20]. It should be noted that to our knowledge there has been no established level of enjoyment linked to changes in perceived duration. Another possible explanation is because the trials were time and workload matched, during the memory stage of the SET the reference memory was activated and individuals associated the two trials together and therefore perceived duration remained unaffected.

4.1. Limitations

By design, PAA was always completed first as the intensity data from this session was used to create the program for the intensity-matched NAA. Although participants were unaware that NAA was an intensity-matched replica of PAA there is the possibility of an unavoidable ordering effect. Furthermore, during PAA, participants were instructed to follow along with the Peloton Spin class regarding cadence and intensity based on cues from the instructor. Because wattage was the primary measurement of intensity, and NAA allowed for no instructional interaction with participants, cadence was not recorded or analyzed. Future research should investigate the differences in cadence selection between interactive and non-interactive cycling.

5. Conclusion

To our knowledge, this was the first study to examine the effects of a virtually lead Spin class on perceived duration and exercise enjoyment in sedentary individuals. Results suggest including a virtual Spin class in fitness routine has the potential to decrease RPE at longer durations and reduce SRPE. Such alterations in perceptual measures could lead to individuals selecting higher intensities to maintain a prescribed RPE. Furthermore, results indicate that including virtually led cycling into one's routine may elicit higher levels of enjoyment. In conjunction with the findings of McGloin & Embacher [36], who suggest enjoyment of activity was highly correlated with the desire to ride again ($r = 0.78$; $p < 0.001$), it is plausible that the inclusion of a virtual Spin class could increase exercise participation in sedentary individuals. However, further research is warranted. Future studies should expand to other modalities of virtual exercise classes and examine the link between exercise enjoyment and RPE during cycling-type exercise.

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