

Can Virtual Reality Increase Engagement with Physical Activity? Exploring VR Boxing

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Abstract

Many people struggle with staying motivated to exercise regularly, but one promising way to make exercise more enjoyable is to combine it with immersive technology- an approach known as ‘exergaming’. Previous literature contains few studies comparing how different types of immersive technology affect people’s mood and effort during exercise. This study therefore examines how mixed reality (MR) and virtual reality (VR) exergaming affect how people feel while exercising, compared to a standard television-based workout. 42 healthy adults will complete three short exercise sessions using VR, MR, and TV in a randomised order, rating their mood, effort, excitement and focus (internal or external) throughout on standardised scales. Data collection and analysis is currently ongoing. This research aims to help exercise and health professionals understand whether immersive technology can make exercise feel more enjoyable and less effortful, offering insight into new ways to encourage people to stay physically active. Future work can build on these findings to test whether improvements in mood and enjoyment cause people to exercise more often and for longer.

Introduction

Currently, one third of adults globally do not meet physical activity recommendations (Strain et al., 2024). Physical inactivity remains a leading contributor to conditions like heart disease, type 2 diabetes and certain cancers (Santos et al. 2023). The World Health Organization has set a goal of a 15% relative reduction in inactivity by 2030, hoping to tackle this significant issue (WHO, 2018). Therefore, it is a priority to try understand how to promote sustained engagement with physical activity.

Most behaviour change theories use the cognitive paradigm, which takes people as rational decision-makers who act on information (Ekkekakis, 2017). However, the knowledge that exercise is beneficial rarely means people will then engage consistently with it. This contributes to the well-documented intention-behaviour gap (Rhodes & Brennan, 2026). Interventions built on this assumption have been not yet been highly effective (Sheeran et al., 2025). Researchers have therefore shifted their focus to affective responses, particularly core affect: a simple, non-reflective feeling comprising valence (displeasure to pleasure) and arousal (low to high; Russell, 1980, 2009). According to psychological hedonism, people tend to repeat experiences that feel good and avoid those that feel bad (Kahneman, 1999). Supporting this, it was also found that greater negative affect during physical activity predicted around 18 fewer daily minutes of moderate-to-vigorous activity a year later (Liao et al., 2017), and an intervention designed to enhance pleasure during exercise increased fitness facility attendance by 77% over eight weeks (Teixeira et al., 2024). Dual-process models such as the Physical Activity Adoption and Maintenance model 2.0 express these findings, summarising that affect experienced during activity shapes habit formation, while anticipated affect shapes intention (Jekauc et al., 2026).

Exercise intensity strongly influences these responses. Under the Dual-Mode Theory, affect is mostly positive at moderate intensities, becomes highly variable between the ventilatory threshold and the respiratory compensation point, and declines for most beyond it (Ekkekakis, 2003). Making exercise feel better is therefore a potential way to sustain participation. One approach is to change the exercise environment, for example with music or video, which can direct attention outwards and away from unpleasant bodily sensations, a process known as attentional dissociation (Hutchinson & De Lucia, 2025; Terry et al., 2020).

Extended reality (XR) technologies are an increasingly popular way of achieving this. Virtual reality (VR) immerses users in a simulated environment, whereas augmented and mixed reality (MR) blend digital content with the physical world (Alex et al., 2026; Rauschnabel et al., 2022). Evidence for VR use is encouraging. A meta-analysis of clinical trials found that immersive VR exercise gave more positive affective valence and greater enjoyment than traditional exercise (Bitencourt et al., 2026). Bird et al. (2024) used the Embodiment-Presence-Interactivity Cube (Flavián et al., 2019) to compare television, augmented reality, 360° video and VR during cycling at ventilatory threshold. Greater embodiment of the device was associated with more positive valence, and devices offering greater presence and interactivity were associated with higher enjoyment and remembered pleasure. VR produced the most pleasurable experience overall, while television showed the steepest decline in valence during exercise. Perceived exertion did not differ between conditions, even though attentional focus did, suggesting that immersive technology changes how exercise feels rather than how hard it feels.

VR-based boxing is a particularly attractive application because it combines vigorous, whole-body movement with game mechanics. Instructor-led VR boxing has produced higher pleasure and fun ratings than the same workout on a 2D screen (Barbour et al., 2024), and a larger crossover trial reported more positive valence, greater arousal and higher enjoyment with VR than with a traditional screen (Teixeira et al., 2025).

However important gaps remain. Samples have mostly comprised young, healthy adults, even though inactive adults stand to gain the most from becoming active (Bird et al., 2021; Bird et al., 2026). Studies in inactive adults are few (Jones & Ekkekakis, 2019; Sauchelli & Brunstrom, 2022). VR boxing studies have typically compared VR with a 2D screen only, rather than with other immersive formats. Video see-through headsets such as the Meta Quest 3 now allow users to see their surroundings while interacting with virtual content (Azuma, 1997; Bird et al., 2026). Such headsets may offer less presence than VR, but more embodiment than a television, and they avoid the heat and enclosure problems of fully occluding headsets (Rupp, 2024). How MR compares with VR and standard screen-based exercise remains largely untested.

This study addresses these gaps by comparing VR, MR and television-based boxing in physically inactive adults. Participants completed each condition in a counterbalanced order, rating affective valence, arousal, perceived exertion and attentional focus during exercise, and enjoyment afterwards. Drawing on the Embodiment-Presence-Interactivity framework, it was hypothesised that VR would elicit the most positive affect and enjoyment, followed by MR, with television the least positive.

Method

The study takes 42 participants, counterbalanced within-subjects, who have been screened to produce a sample of physically inactive adults between the ages 18-45 years. Three eligibility questionnaires comprise the screen:

1. Godin-Shephard Leisure-Time PA Questionnaire. This screens out active individuals (those with scores ≥ 24)
2. Physical Activity Readiness Questionnaire (PAR-Q). This screens out those who need to seek medical advice prior to engaging in physical activity (respondents must select NO to each question to be eligible for the study)
3. Visually Induced Motion Sickness Susceptibility Questionnaire (VIMSSQ) screens out individuals who are susceptible to VR-related motion sickness

42 Participants complete different versions of a boxing game as 3 separate conditions: Virtual reality, Mixed reality and TV. This is run as an approximately 60 min lab session comprising (a) baseline assessment, (b) familiarisation, (c) the main experiment.

Before the participant arrives, responses from the initial eligibility survey are double-checked. This involves using Qualtrics to confirm that the participant is aged 18-45, is sufficiently inactive (Godin Shephard score < 24), and has no flagged responses on the PAR-Q or VIMSSQ. The scoring sheet (mrvr_scoring_sheet.doc) is printed to record responses during trials, and all relevant information (e.g., participant ID, date, time) is written down. Importantly, the blinds around the lab are lowered to control the lighting environment as much as possible.

Participants are met and greeted, then walked up to the lab space. The purpose of the study is briefly explained, namely that we are interested in how the experience of physical activity could be enhanced to increase engagement.

BASELINE ASSESSMENT

The participants heart rate is logged using a Polar chest strap and H9 sensor paired to the HRV Logger smartphone application. The resting heart rate is recorded, and a baseline survey is administered which collects age, sex and current immersive technology use. Preference for and Tolerability of the Intensity of Exercise (PRETIE-Q) is also measured, and height and weight is measured using the stadiometer in lab.

FAMILIARISATION

4 Psychometric scales are used during the exercise trials. The order is the same throughout:

1. Feeling Scale (+5- -5): While participating in exercise, it is common to experience changes in mood. Some individuals find exercise pleasurable, whereas others find it to be unpleasant. Additionally, feeling may fluctuate across time. That is, one might feel good and bad a number of times during exercise. Scientists have developed this scale to measure such responses.
2. Felt Arousal Scale (1-6): This scale is to estimate how much arousal is actually felt. This is done by pointing to the appropriate number. By “arousal” it is meant how “worked-up” the participant feels. One might experience high arousal in one of a variety of ways, for example as excitement or anxiety or anger. Low arousal might also be experienced in a number of different ways, for example as relaxation or boredom or calmness.
3. Borg CR10 Scale (0-11): This scale is used to measure the intensity of exercise and runs from 0-11. The numbers below relate to phrases used to rate how easy or difficult an activity is found. For example, 0 (nothing at all) would be how sitting in a chair feels; 10 (extremely strong) is how it feels at the end of an exercise stress test or after a very difficult activity.
4. Attentional Scale (0-100): 0 indicates an internal focus ie. bodily sensations, heart rate, breathing, etc. whereas 100 is external, indicating a focus externally (Daydreaming, external environment etc.)

The participant completes the “Box Studio Tutorial (2:57)” for familiarisation purposes.

MAIN EXPERIMENTAL PHASE

The FS, FAS, BS, and AT are administered and baseline values recorded. This is repeated at 1.5 min, 4 min, 9 min and post condition. After each trial, there is a Qualtrics survey to complete to collect more qualitative information about the experience. After a 5-min rest period, the next condition is set up and the process repeated.

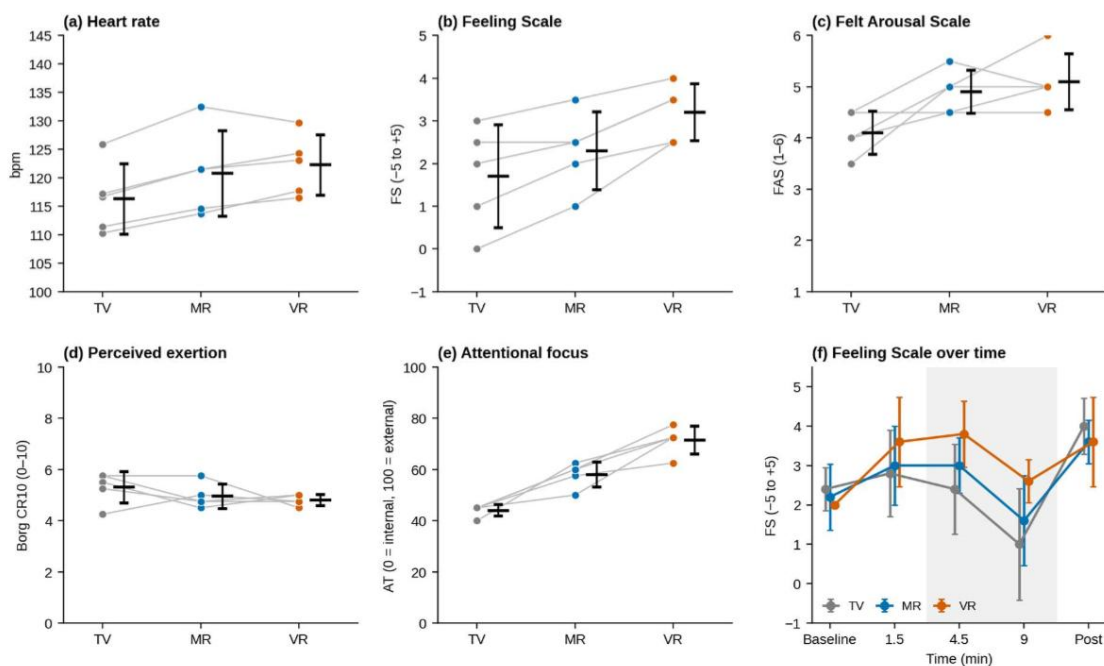
Results

Currently, 5 trials have taken place which can be used for preliminary analysis. Participants have been anonymised and their participant ID's have been used instead.

Table 1*Exercise-phase heart rate and psychological responses by participant and condition*

Participant	HR (bpm)	FS	FAS	RPE	AT
Television (TV)					
9701	125.9	1.0	4.0	5.8	40.0
9702	116.7	2.0	4.0	5.8	45.0
9703	110.3	0.0	3.5	5.5	45.0
9704	111.4	3.0	4.5	4.3	45.0
9705	117.2	2.5	4.5	5.3	45.0
Mean	116.3	1.7	4.1	5.3	44.0
SD	6.2	1.2	0.4	0.6	2.2
Mixed reality (MR)					
9701	132.5	2.0	4.5	5.8	62.5
9702	121.5	2.5	5.0	4.8	60.0
9703	113.7	1.0	5.0	4.5	50.0
9704	114.6	3.5	4.5	5.0	57.5
9705	121.5	2.5	5.5	4.8	60.0
Mean	120.8	2.3	4.9	5.0	58.0
SD	7.5	0.9	0.4	0.5	4.8
Virtual reality (VR)					
9701	129.7	2.5	5.0	4.5	72.5
9702	124.3	3.5	5.0	4.8	77.5
9703	117.7	2.5	6.0	5.0	72.5
9704	116.5	4.0	4.5	4.8	62.5
9705	123.1	3.5	5.0	5.0	72.5
Mean	122.3	3.2	5.1	4.8	71.5
SD	5.3	0.7	0.5	0.2	5.5

Note. $n = 5$. HR = mean heart rate across the main exercise phase. FS = Feeling Scale (−5 to +5); FAS = Felt Arousal Scale (1–6); RPE = Borg CR10 rating of perceived exertion (0–10); AT = Attentional Scale (0 = internal focus, 100 = external focus). FS, FAS, RPE and AT are the mean of the 4.5-min and 9-min ratings. SD = sample standard deviation.

Figure 1*Exercise-phase responses by condition, and Feeling Scale responses over time*

Note. Panels (a)–(e): coloured points are individual participants (joined by grey lines); black bars show the condition mean $\pm$ SD. Panel (f): mean $\pm$ SD at each timepoint; shaded band marks the main exercise phase. TV = television; MR = mixed reality; VR = virtual reality.

During the main exercise phase, affective valence was highest in VR ($M = 3.2$), intermediate in MR ($M = 2.3$) and lowest in television ($M = 1.7$), and every participant rated VR above television. This is predicted by the Embodiment-Presence-Interactivity framework (Flavián et al., 2019), matches Bird et al. (2024), the meta-analysis of Bitencourt et al. (2026) and earlier VR boxing studies (Barbour et al., 2024; Teixeira et al., 2025). However, valence fell by a similar amount between 4.5 and 9 minutes in every condition (1.2–1.4 points), so VR raised the level of pleasure rather than preventing its decline. Valence then rebounded most after television (+3.0, versus +1.0 in VR), consistent with a larger recovery from a less pleasant bout (Bird et al., 2024).

Attentional focus was more external in VR ($M = 71.5$) and MR ($M = 58.0$) than in television ($M = 44.0$), supporting attentional dissociation as a mechanism (Hutchinson & De Lucia, 2025). Perceived exertion was similar across conditions (television 5.3, MR 5.0, VR 4.8), suggesting that immersion changed how exercise felt rather than how hard it felt.

One result was unexpected. Mean heart rate was about 6 bpm higher in VR (122.3) than in television (116.3) for all five participants, without higher perceived difficulty. Engaging game mechanics and an external focus may have encouraged harder punching because effort was less noticeable. Because intensity shapes affect (Ekkekakis, 2003), this is a confound, although VR remaining more pleasant despite a higher heart rate strengthens the finding. Arousal also rose with immersion (television 4.1, MR 4.9, VR 5.1), as in Bird et al. (2024).

The main limitations are the small sample, single laboratory sessions and possible novelty effects (Jones & Ekkekakis, 2019).

Conclusion

This study examined whether VR and MR boxing improve how physically inactive adults feel and perceive effort during exercise, compared with a television-based workout. Pleasant exercise experiences are increasingly seen as a route to sustained participation in exercise to combat global inactivity. Few studies have compared different immersive formats, particularly in inactive adults.

While data collection is ongoing, five participants have completed all three conditions. Preliminary data are consistent with an advantage for immersive boxing. Affective valence and external attentional focus increased from television to MR to VR, while perceived exertion did not. Heart rate and arousal were also higher in the immersive conditions, so intensity needs checking.

Once data collection is complete, the full sample will be analysed using repeated-measures ANOVAs with planned contrasts and effect sizes. Heart rate will be examined as a covariate, to check that differences in affect are not simply products of differences

in exercise intensity. Enjoyment and presence ratings will help show whether presence explains differences between conditions.

In the future, studies should test for long term advantages, as novelty may have increased early positive responses (Jones & Ekkekakis, 2019). Longitudinal and real-world studies are needed to establish whether better mood and enjoyment lead people to exercise more often and for longer, as dual-process models predict (Jekauc et al., 2026). Work should also extend to clinical groups, who may gain the most from becoming active (Bird et al., 2026). If exergaming can make exercise more enjoyable without feeling harder, it could become a practical way of helping inactive adults build a lasting exercise habit.

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