

Effects of Extended Reality (XR) Technology on Affective and Perceptual Responses to Physical Activity

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Introduction

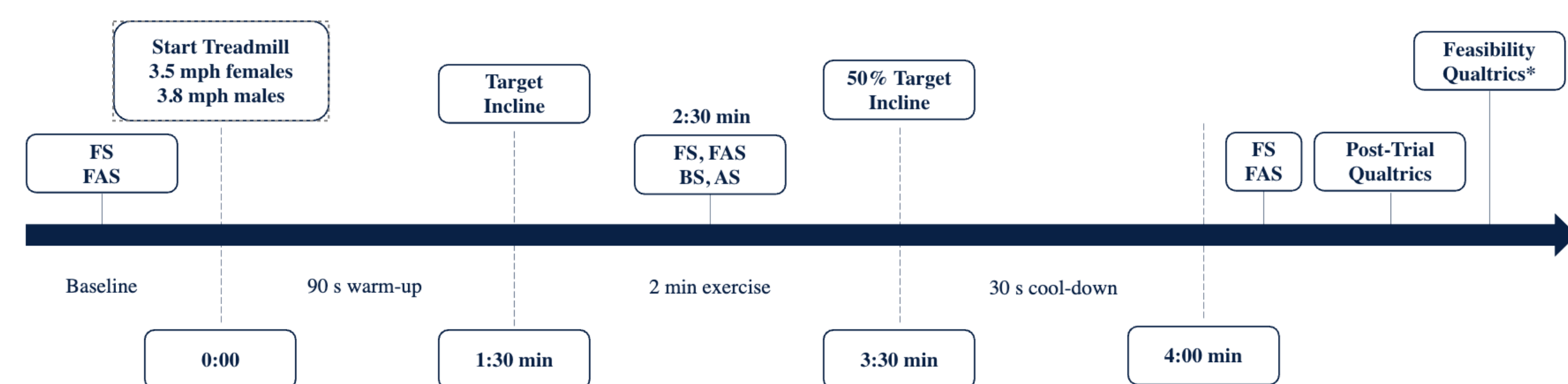


Physical inactivity remains common despite strong evidence that regular exercise improves health [17]. Researchers have suggested that feeling states (e.g., affective valence) experienced during exercise are indicative of future exercise behaviour [16]. The Dual Mode Theory suggests that feelings during exercise are a product of the intensity of that exercise and can be broken down using metabolic markers such as gas-exchange ventilatory threshold (VT) and respiratory compensation point (RCP) [3]. This study tests whether immersive technology can enhance affective responses to physical activity between the VT and RCP.

Methods

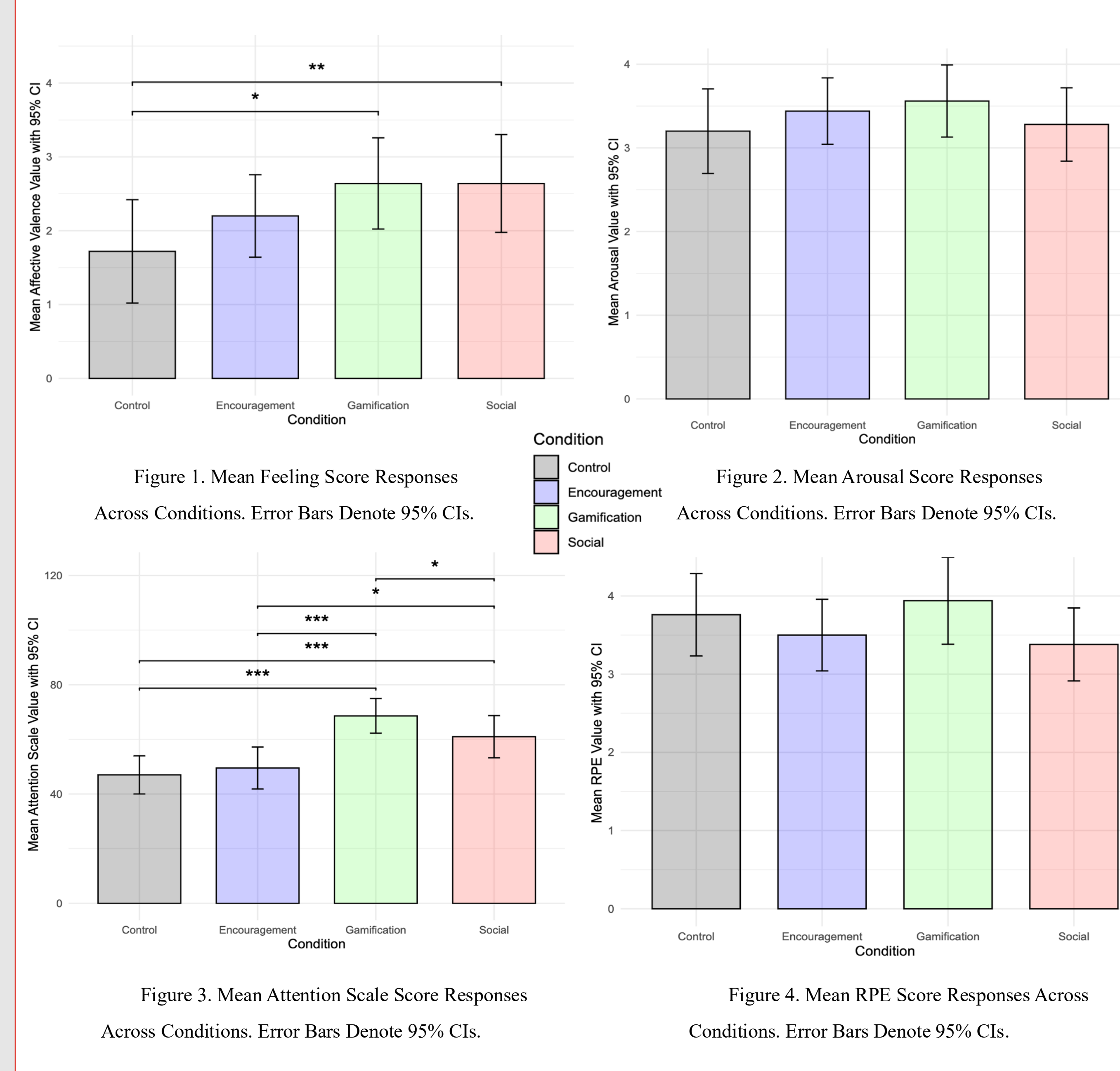
Participants were recruited through UCL flyers, word of mouth, and social media (LinkedIn, WeChat). The study is a repeated-measure design, where all participants complete four trials of high-intensity treadmill walking with the correctly loaded condition (i.e., encouragement, social, or gamification) or control (no condition) on an immersive technology headset. Twenty-four adult volunteers were recruited to facilitate a fully counterbalanced design ($M_{age} = 25.82$ years, $SD_{age} = 3.59$ years, $N_{female} = 10$, $M_{BMI} = 21.50$, $SD_{BMI} = 3.62\text{kg/m}^2$). A baseline assessment allowed us to identify the target heart rate (THR), which was used in the submaximal exercise test. THR was identified as 77% of the participant's maximum heart rate, which was calculated using Tanaka's formula: $208 - (0.7 \times \text{Age})$ [13]. The target incline was identified using a submaximal exercise test, where the exercise test began at a 0% incline, and at 1 minute, the incline of the treadmill was increased to 2%. Subsequently, the incline was increased by 1% until the THR was achieved. The treadmill speed was set at 3.5 mph for females and 3.8 mph for males. Participants were introduced to the four psychometric scales that were administered during the Main Experiment phase: Affective valence was measured with the Feeling Scale (*from -5 to +5*) [9], arousal with the FAS (*from 1 to 6*) [19], RPE using the Borg CR10 scale (*from 0 to 11*) [8], and state attentional focus with the AS (*from 0 to 100*) [20].

Main Experiment Phase



Note. FS = Feeling Scale, FAS = Felt Arousal Scale, BS = Borg Scale, AS = Attentional Scale
* Feasibility survey only administered once, after all four conditions (and post-trial surveys) have been completed.

Results



Discussion

Evidence showed that augmented reality (AR) conditions (gamification/social) improved affective valence (at $p < 0.05$ and 0.01 , respectively) and attentional dissociation (at $p < 0.001$) relative to control (see Table 1, Figures 1 and 3). Arousal and RPE did not differ significantly across conditions (see Table 1). These findings suggest that immersive technology can enhance positive feelings and increase attentional dissociation when exercising without increasing perceived effort. These improvements may carry significant cardio-metabolic health benefits by motivating more consistent physical activity. Future work should test whether these findings generalize to real-world settings (i.e. at home). It may be interesting to also investigate why the encouragement condition was not as effective in eliciting higher affective valence and attentional dissociation compared to the other two conditions. This would shed light on understanding what specific qualities of immersive technology may elicit the greatest positive feeling during moderately intense exercise and the adoption of immersive technology in daily life.

Results

Dependent Variable	Source	Df	Sum Sq	Mean Sq	F value	Pr(> F)
Affective Valence	Residuals (Within Condition)	24	170.50	7.104	—	—
	Condition	3	14.44	4.813	5.969	0.00108 **
	Residuals (Between Conditions)	72	58.06	0.806	—	—
Arousal	Residuals (Within Condition)	24	68.06	2.836	—	—
	Condition	3	1.95	0.6500	1.081	0.363
	Residuals (Between Conditions)	72	43.30	0.6014	—	—
RPE	Residuals (Within Condition)	24	95.96	3.998	—	—
	Condition	3	4.79	1.596	2.450	0.0704
	Residuals (Between Conditions)	72	46.90	0.6514	—	—
Attention Scale	Residuals (Within Condition)	24	21243	885.10	—	—
	Condition	3	7641	2547.00	22.95	1.57×10^{-10} ***
	Residuals (Between Conditions)	72	7991	111.00	—	—

Table 1. ANOVA Results for Affective Valence, Arousal, RPE, and Attention Scale

Comparison	Affective Valence			
	Control	Encouragement	Gamification	Social
Encouragement	0.2574	—	—	—
Gamification	0.0273	0.4654	—	—
Social	0.0093	0.5142	1.0000	—
Comparison	Attention Scale			
	Control	Encouragement	Gamification	Social
Encouragement	1.00000	—	—	—
Gamification	5e-07	1e-05	—	—
Social	0.00037	0.03425	0.01431	—

Table 2. Pairwise Comparisons (Bonferroni-adjusted) for Affective Valence and Attention Scale

Conclusion

We tested the effects of immersive technology on affective valence, arousal, attentional dissociation, and perceived exertion during lifestyle exercise between VT and RCP across four conditions (gamification, social, encouragement, control). Our results showed that gamification and social conditions notably improved affective valence and attentional dissociation compared to control, but arousal and perceived exertion (RPE) did not differ significantly across conditions. Given the widespread challenge of sedentary behaviour, such interventions will help bridge the gap between the known health benefits of physical activity and the application of healthy behaviours and physiological habits in daily life.

References

[Link to References](#)