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# A psychosocial investigation of exercise preferences in real and virtual environments

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ABSTRACT

Three studies explored exercise preferences in real-world and virtual environments, and their relationship with social physique anxiety (SPA), social comparison, and self-presentational efficacy (SPE). In Study 1 ($N = 230$), real-world exercise preferences were explored. Study 2 ($N = 228$) measured preferences for real-world and virtual reality (VR) exercise, and Study 3 ($N = 249$) investigated preferences for avatar embodiment and virtual companions within VR. Results revealed that participants who preferred home-based exercise had lower exercise behaviour, more negative fitness-related social comparisons, or lower SPE expectancy and outcome value (Study 1). Individuals with lower exercise behaviour, more negative fitness-related social comparisons, lower SPE expectancy, or higher SPA were also more likely to choose VR than real-world exercise (Study 2). In a VR exercise setting, participants with higher SPA and more negative social comparisons also preferred to embody a non-human and fantasy avatar more than a realistic avatar. A heightened threat of negative social comparison when imagining exercise with a physically superior virtual companion resulted in the strongest preference to embody a fantasy avatar (Study 3). The results suggest that individuals who place high importance on self-presentation and have low belief in their capacity to project an image of competence to others, are more likely to prefer exercise contexts that minimise physique- and fitness-related evaluation. Moreover, VR may afford a less psychosocially threatening context for individuals who feel self-conscious or comparatively inferior to others during exercise.

## 1. Introduction

The physical and psychological benefits of regular exercise, and the health consequences of physical inactivity, are significant (Auster-Gussman et al., 2021; Diehl et al., 2001; Gammage et al., 2014). Globally, approximately 1 in 4 adults are insufficiently active, and exercise programs are plagued by low adherence and high drop-out (Koulouris et al., 2020; Othman et al., 2022; Qian et al., 2020). Various reasons for low physical activity have been identified, such as lack of time, low motivation, and low enjoyment (Bushman & Brandenburg, 2009). However, psychosocial factors such as self-consciousness, embarrassment, or social discomfort have also emerged as important barriers (Max et al., 2016; Othman et al., 2022; Perey & Koenigstorfer, 2022). Individuals can have strong preferences for exercise setting and social context and tailoring experiences according to these preferences is one way to improve affective responses and motivation to exercise, and consequently, exercise participation (Banks et al., 2012; Cohen-Mansfield et al., 2004; Dunlop & Schmader, 2014; Miller et al., 2005). The current research aimed to contribute to our understanding of individual differences in exercise preferences by exploring how these preferences relate to exercise behaviour and psychosocial variables in real and virtual exercise contexts.

In general, individuals prefer moderate-intensity exercise that is flexible in how and when the exercise is done (Othman et al., 2022). However, preferences are also heterogeneous, and context dependent. For instance, research has suggested that older women and breast cancer patients and survivors preferred to exercise alone (Cohen-Mansfield et al., 2004; Rogers et al., 2007, 2009), whereas stroke survivors preferred to exercise in a gym or fitness centre (Banks et al., 2012), and older adults with or without cognitive impairment preferred to exercise in a group (Chong et al., 2012). Preferences research with younger adult populations is also mixed; Bushman and Brandenburg (2009) indicated that females preferred to exercise with a partner more than did males, whereas Diehl et al. (2001) found that most women preferred to exercise alone. One factor that has not been given enough consideration in existing preferences research is the psychosocial aspect of exercise

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participation and, specifically, the influence of self-presentational concerns (Gammage et al., 2014; Perey & Koenigstorfer, 2022).

Self-presentation refers to the degree to which an individual may be sensitive to, or try to control, others' impressions of them (Gammage et al., 2004, 2014). Self-presentational concerns are common in exercise contexts where much attention is directed towards evaluating how one looks in terms of shape and appearance, and how one performs in terms of physical fitness and skill (Pila et al., 2014; Sabiston et al., 2014). Concern over others' impressions and one's standing relative to others can influence motivation to exercise, the type of exercise undertaken, the amount of effort expended, and affective responses (Gammage et al., 2004; Gammage et al., 2014). However, the social and evaluative nature of exercise environments is not consistently impactful; it can motivate an individual to increase exercise frequency or effort to achieve more positive impression management, or it can create anxiety and demotivate an individual, thus promoting exercise avoidance (Gammage et al., 2014; Meadows & Bombak, 2019; Pila et al., 2014). Three psychosocial considerations that influence the directional impact of self-presentational concerns are social physique anxiety (SPA), social comparison, and self-presentational efficacy (SPE).

SPA is the worry or concern that others may be negatively evaluating one's body (Gammage et al., 2014; Ginis et al., 2011; Sabiston et al., 2014). SPA is a relatively stable tendency, but it can fluctuate across situations. For instance, it may become heightened when exercising in the presence of others (Diehl et al., 2001; Kroon et al., 2022) or when exercising in a fitness setting with mirrors and revealing attire (Focht & Hausenblas, 2004; Sabiston et al., 2014). Indeed, state anxiety (Focht & Hausenblas, 2003) and negative feeling states (Focht & Hausenblas, 2006) were found to be higher when a sample of women with high SPA exercised in a fitness facility in the presence of others whilst facing a full-length mirror, than when the same participants exercised in a private experimental laboratory. Enjoyment and positive affect were also higher when a sample of women with high SPA participated in an exercise class with an instructor who emphasised health rather than appearance (Raedeke et al., 2007, 2009). Focht (2009) further revealed that positive affect, enjoyment, and future exercise intention were higher when a sample of active young women walked outdoors than in a laboratory environment. Taken together, current research has linked higher SPA with lower exercise participation along with a stronger preference to exercise alone or privately, in an outdoor setting rather than in a gym or fitness centre, or in a context that de-emphasises having one's physique evaluated by others (Diehl et al., 2001; Kroon et al., 2022; O'Hara et al., 2014; Spink, 1992).

The evaluative nature of exercise settings can also prompt social comparisons, which involve upward (with a superior target) or downward (with an inferior target) comparisons with others (Allan & Gilbert, 1995; Gibbons & Buunk, 1999). These comparisons typically focus on strength, power, attractiveness, and talent. In an exercise context, an individual may engage in comparisons of physical fitness and strength, coordination and skill, or characteristics of appearance and physique such as muscularity or leanness. A tendency to compare oneself unfavourably against others has been associated with a range of psychological difficulties (Allan & Gilbert, 1995). However, social comparisons in exercise can be helpful when they promote effort or highlight elements of similarity with superior individuals (Allan & Gilbert, 1995). For instance, exercising with a moderately more physically capable partner has been shown to increase exercise persistence relative to exercising alone (Feltz et al., 2011; Feltz et al., 2020). Perey and Koenigstorfer (2022) further found that focusing on dissimilarity with a downward comparison and similarity with an upward comparison boosted exercise self-efficacy. The mixed findings for the effects of both SPA and social comparison in an exercise context may be, at least partly, influenced by differences in SPE.

SPE relates to confidence in one's ability to convey an impression of physical fitness, physical coordination, and physical attractiveness (Gammage et al., 2014). Individuals who have confidence in their capacity to portray themselves as a regular exerciser (self-presentational efficacy expectancy; SPEE), believe that engaging in exercise will lead others to view them as an exerciser (self-presentational outcome expectancy; SPOE), and who more highly value being positively appraised by others as an exerciser (self-presentational outcome value; SPOV), report higher exercise participation (Gammage et al., 2004; Gammage et al., 2014; Hausenblas et al., 2004; Maddux et al., 1988). The self-presentational aspects of an exercise context (i.e., the presence of more or less physically fit, fit-looking or attractive, and physically capable others) can also interact to influence SPA, the outcome of social comparisons, SPE, and thus, individual exercise preferences. For example, the desire to be seen as physically attractive or a competent exerciser (or more attractive and competent relative to others) combined with a low belief in one's ability to convey this impression is associated with higher levels of anxiety (Gammage et al., 2004; Maddux et al., 1988). As argued by Auster-Gussman et al. (2021), "individuals may be more likely to work out despite their high SPA as long as it is in an environment in which feelings of inclusivity of all body types is promoted, and feelings of body judgment and judgment from other gym-goers are limited" (p. 198). However, few studies have investigated this link between SPA, self-presentational concerns, and exercise preferences (Hausenblas et al., 2004).

There is also some evidence that these psychosocial influences may be attenuated, or at least different, in virtual reality (VR) exercise environments. VR is an immersive and interactive three-dimensional computer-mediated environment, which is designed to simulate a real environment. VR enables synchronisation of movement and effort by a user with virtual movement, and can be systematically manipulated (i.e., through the presence or absence, or physical inferiority or superiority, of exercise companions) to control the user experience (Kroon et al., 2022; Max et al., 2016; Seymour et al., 2021). Effects are often moderated by various factors including level of immersion and attentional focus, however, there is some evidence that VR exercise can be more engaging, enjoyable, and motivating than real-world exercise (Lugrin et al., 2015; Mouatt et al., 2020; Neumann et al., 2018; Neumann & Moffitt, 2018). One mechanism through which VR exercise can achieve enhanced motivation and performance is by distracting from the physical pain and exertion associated with exercise (Czub & Janeta, 2021; Koulouris et al., 2020). VR exercise has demonstrated benefits for physiological (fitness, strength, balance), psychological (reduced tension, fatigue, depression and enhanced calmness and quality of life), and rehabilitative outcomes, relative to real-world exercise (Qian et al., 2020). Moreover, exercising with a virtual avatar, rather than a real human exercise companion, affords advantages in relation to availability and adaptability (Neumann et al., 2018; Samendinger et al., 2018).

Importantly, there are also documented psychosocial benefits to exercising in VR. Exercising in VR with a virtual companion who has been programmed to be moderately physically superior has resulted in increased persistence relative to exercising alone (Feltz et al., 2011; Max et al., 2016). Exercisers have also expended more effort (Czub & Janeta, 2021), reported lower perceived exertion (Kocur et al., 2020), and reported higher immediate and next-day exercise self-efficacy when embodying a muscular (i.e., with a six pack) than normal (i.e., non-muscular) avatar in VR (Lin et al., 2021). In addition, Song et al. (2014) found a reduction in SPA from pre-to post-exercise with Nintendo Wii's computer-generated boxing video game, and that this reduction was more pronounced for individuals high in body image dissatisfaction. Moreover, individuals both high and low in body dissatisfaction reported benefits to mood and perceived exercise accomplishment post-exercise relative to pre-exercise, but enjoyment levels when exercising in the computer-generated environment were higher among those with high body dissatisfaction. In further support of the attenuating psychosocial effects of VR exercise, Kroon et al. (2022) found that participants with high SPA reported preferring an overweight rather than normal weight companion in a real-world exercise setting. In contrast, this same preference was not observed in a VR setting. VR may thus encourage exercise performance improvements through changes in perceived self-efficacy and effort whilst concurrently reducing perceptions of social and evaluative threat and a focus on one's appearance and body during exercise (Auster-Gussman et al., 2021; Focht & Hausenblas, 2004; Kroon et al., 2022; O'Hara et al., 2014).

Within VR, avatars can also be customised to vary identification, embodiment (i.e., the degree to which we perceive an avatar's virtual body is our own physical body), and ultimately engagement, and motivation (Koulouris et al., 2020; Lin et al., 2021; Seymour et al., 2021). Individuals generally identify more strongly with realistic virtual avatars who are most like themselves (i.e., a mirror) or who represent their ideal or wishful self (i.e., a magic mirror) provided the idealised representation maintains a sense of attainability (Koulouris et al., 2020). Individuals with lower psychological well-being are more likely to prefer idealised or wishful avatar representations (Ho & MacDorman, 2010; Lin et al., 2021). There is also evidence that, when exercisers positively identify with their virtual avatar, they will adopt attitudes and behaviours (i.e., exercise persistence and effort) that are consistent with the physical traits of their virtual avatar (Koulouris et al., 2020; Lin et al., 2021; Song et al., 2014; Suh et al., 2011). Lugrin et al. (2015) found that realistic (i.e., human-looking) avatars elicited higher exercise performance and acceptance, but that non-realistic avatars (i.e., a warrior or robot) elicited higher feelings of power. Schneider and Kummert (2016; 2018) have also provided evidence that participants exercised for longer and with more effort and reported a stronger preference to exercise with a robot companion than a virtual partner. Participants reported liking and feeling more comfortable with a robot companion than a human exercise companion because "the robot is not evaluating or judging them while exercising" (p. 9).

The applications of VR exercise are diverse; VR exercise has proven acceptable and effective for motor learning and postural control (Prasertsakul et al., 2018), physical performance and quality of life in post-COVID-19 patients (Groenveld et al., 2022), and the physical and mental health of adults (Yen & Chiu, 2021) and children (Mouatt et al., 2020). There has also been some research demonstrating a preference for VR exercise over real-world exercise. Hassandra et al. (2021), for example, found that both a sample of university students and a sample of patients with mild cognitive impairment reported more positive attitudes, higher enjoyment, and a stronger preference to exercise in VR than in a laboratory setting. Virtual exercise via immersive active video games was also found to be highly acceptable, and rated as more enjoyable than conventional video games, among a sample of obese children (Polechoński et al., 2020). In addition, Touloudi et al. (2022) found that office workers preferred to engage in VR cycling than cycling on a static bicycle when exercising during work breaks. To date, however, few studies have investigated whether preferences for real or virtual exercise, or for the realism or physical attributes of a virtual exercise companion, are influenced by prior level of engagement in exercise and psychosocial variables.

The aim of the current research was to investigate exercise preferences in real and virtual environments, and how these preferences related to prior exercise behaviour and psychosocial variables (SPA, social comparison, and SPE). In Study 1, real-world exercise preferences for setting, social context, and the superiority of an exercise companion were measured whilst participants imagined undertaking aerobic (i.e., for energy expenditure and cardiorespiratory fitness) and resistance (i.e., for muscle size, strength, endurance, and power) exercise (Kang & Ratamess, 2014). In Study 2, preferences for real-world or virtual exercise, and within VR, preferences for the presence or absence of exercise companions and their physical superiority were explored. Study 3 focused on VR exercise and investigated avatar preferences in relation to realism and humanness. In all studies, the association between exercise preferences and prior engagement in exercise behaviour, SPA, social comparison, and SPE was explored.

## 2. Study 1

Study 1 investigated exercise preferences in real-world settings. Based on earlier findings from the preferences literature, it was anticipated that most participants would prefer to exercise alone. However, it was expected that this preference for solidarity, along with a preference to exercise at home or in an outdoor setting rather than a fitness centre, would be stronger among those who exercised less, compared themselves unfavourably with others, had higher SPA, and lower SPE. It was also anticipated that, when exercising with a companion, participants would prefer the companion to be somewhat superior in fitness and strength, but that this desire for a superior companion would be lower for those who exercised less, compared themselves unfavourably with others, had higher SPA and lower SPE. Due to the exploratory nature of varying exercise type, there were no hypotheses made regarding differences between aerobic or resistance exercise modes.

### 2.1. Method

**Participants.** Participants were undergraduate students ($N = 230$) who were offered partial course credit as incentive to complete the study. Participants ranged in age from 17 to 66 years ($M = 22.14$, $SD = 7.54$) with an average Body Mass Index (BMI) in the healthy range ($M = 23.72$, $SD = 4.37$). Most participants identified as female ($n = 185$; 80%); the remaining participants identified as male ($n = 43$; 19%), gender diverse ($n = 1$; 0.5%), or non-binary ($n = 1$; 0.5%).

### 2.2. Measures

***Exercise Preferences.*** Participants indicated their exercise preferences using items adapted from earlier research (i.e., Banks et al., 2012; Diehl et al., 2001). Participants were asked whether they would prefer to workout at home or outside of the home (i.e., a gym/fitness centre or outdoors). Participants were also asked, if they were to exercise outside of the home, whether they would prefer to workout in a gym/fitness centre setting or an outdoor (i.e., nature) setting. In relation to social context, participants were asked whether they would prefer to workout alone, with a partner (i.e., one other person), or in a group setting (i.e., two or more other people).

Two additional questions were used to measure participants preference for the fitness level of an exercise partner when engaging in aerobic exercise (i.e., brisk walking, jogging, rowing, or cycling) and the strength of an exercise partner when engaging in resistance exercise (i.e., using free weights, weight machines, resistance bands or body weight) using a scale from 0 (*inferior to you in fitness/strength*) to 100 (*superior to you in fitness/strength*). Responses were dichotomised into a preference for an inferior (<50) or superior (≥50) exercise companion. Although there can be limitations of dichotomisation (i.e., loss of information and reduced statistical power), this approach is appropriate with sufficient samples sizes and where "there exists a true binary typology" (Iacobucci et al., 2015, p. 659). In the current research, understanding preferences for an inferior vs superior exercise companion provides a useful taxonomy for research communication and practical application in the field (DeCoster et al., 2011). The data were also analysed in continuous form to reduce potential loss of information regarding individual variability.

***Exercise Behaviour***. The Archer-Garcia Ratio (A-G Ratio; Garcia et al., 2017) was used to measure exercise behaviour. The measure included two items: "*how often do you exercise?*" to which participants responded on a scale from 1 (*never*) to 5 (*5 times/week or more*), and "*estimate the level of effort when you exercise?*" to which participants responded on a scale from 1 (*none or very low*) to 10 (*very high*). Responses to both questions were converted to a *z*-score and summed, where higher scores represented higher exercise behaviour. The A-G Ratio has demonstrated both concurrent (i.e., moderate correlations with other self-report measures of exercise behaviour) and predictive (i.

e., capacity to predict both retrospective and prospective gym attendance) validity (Garcia et al., 2017). The two items comprising the A-G Ratio were moderately positively correlated in the current study, $r(230) = .60$, $p < .001$.

***Social Physique Anxiety.*** The 9-item Social Physique Anxiety Scale (SPAS; Hart et al., 1989; Ginis et al., 2011) asked participants to indicate the degree to which each statement (i.e., "*I wish I wasn't so uptight about my physique/figure*") was characteristic or true of themselves on scale from 1 (*not at all*) to 5 (*extremely*). Negatively worded items were reverse coded, and a total score was calculated where higher scores represented higher SPA. Cronbach's alpha revealed excellent internal consistency ($\alpha = .90$).

***Social Comparison.*** The 11-item Social Comparison Scale (SCS; Allan & Gilbert, 1995) used the question stem "*When it comes to exercising and fitness, in relation to others I generally feel*" to which participants responded on a series of 10-point semantic differential scales (i.e., "*inferior-superior*"). Responses were summed and higher scores indicated more favourable comparisons with others. Internal consistency was excellent ($\alpha = .95$).

***Self-Presentational Efficacy.*** The 3 subscales of the Self-Presentation in Exercise Questionnaire (SPEQ; Gammage et al., 2004; Ginis et al., 2011) were used to assess motivation for exercise self-presentation. The 5-item Self-Presentational Efficacy Expectancy (SPEE) subscale asked participants to indicate, on a scale from 0% (*not at all confident*) to 100% (*completely confident*), their confidence that other people would rate their physique and fitness highly during a workout (i.e., "*When you workout, how confident are you that other people will think that your body looks fit and toned?*") A mean score was calculated where higher scores represented higher exercise self-presentational efficacy expectancy. The Self-Presentational Outcome Expectancy (SPOE) subscale asked participants to indicate their agreement with 5 statements (i.e., "*By exercising regularly, other people will think that I am in good shape*") assessing outcome expectancy and the Self-Presentational Outcome Value (SPOV) subscale asked participants to rate their agreement with 4 statements (i.e., "*I place a lot of value on having a body that looks physically fit*") assessing value placed upon favourable evaluations from others. The SPOE and SPOV used a response scale from 1 (*strongly disagree*) to 6 (*strongly agree*) and a mean score was calculated for each subscale where higher scores indicated higher outcome expectancy and higher outcome value, respectively. Internal consistency for the SPEE ($\alpha = .94$) SPOE ($\alpha = .91$) and SPOV ($\alpha = .90$) were excellent.

**Procedure.** Study procedures (Studies 1–3) received Griffith University HREC approval (GU ethics reference number: 2022/043) prior to the commencement of data collection. Participants completed the study electronically, and informed consent was implied through completion of the survey. Participants were asked to provide demographic information, after which they reported their exercise preferences, and completed the A-G Ratio, SPAS, SCS, and SPEQ questionnaires.

**Statistical Analyses.** Analyses for Studies 1–3 were conducted using SPSS Version 27. In Study 1, A-G Ratio, SPAS, SCS, SPEE, SPOE, and SPOV scores were compared across exercise preference groups (i.e., home vs outside home, gym/fitness setting vs outdoors) using independent-samples *t*-tests, and across social context (i.e., alone vs partner vs group) using a one-way between-groups ANOVA. A paired-sample *t*-test (using continuous data) and a 2 (exercise type: aerobic, resistance) × 2 (companion preference: inferior, superior) McNemar's test (using dichotomised data) compared companion preferences when engaging in aerobic and resistance exercise. Two multiple regression analyses further explored whether A-G Ratio, SPAS, SCS, SPEE, SPOE, and SPOV scores predicted exercise companion preferences when engaging in aerobic and resistance exercise. *A priori* power analyses in G*Power 3.1.9.7 using a medium effect size, $\alpha = .05$, and 80% power indicated that the obtained sample sizes (in Studies 1–3) provided sufficient power for the independent-samples *t*-tests (required sample $N = 128$), paired samples *t*-tests (required sample $N = 34$), one-way ANOVAs (required sample $N = 159$), and multiple regression analyses with six predictors (required sample $N = 98$).

Assumption checking revealed no univariate outliers. SPOE scores were negatively skewed. However, the square root transformed SPOE variable did not produce a different pattern of results so untransformed data have been used in the analyses to maximise interpretability. One multivariate outlier was removed for the aerobic exercise regression analysis. All other assumptions of the analyses were met.

## 2.3. Results

**Exercise Preferences.** More participants ($n = 166$, 72%) reported preferring to exercise outside of the home (i.e., a gym/fitness centre or outdoors) than at home ($n = 64$, 28%). When exercising outside of the home, there was a stronger preference to exercise in a gym or fitness centre ($n = 151$, 66%) than an outdoor (i.e., nature) setting ($n = 79$, 34%). The least preferred social context was a group exercise setting ($n = 26$, 11%), and exercising alone ($n = 103$, 45%) or with a partner ($n = 101$, 44%) were similarly preferred. When categorised, more participants preferred a superior exercise companion when completing either aerobic (inferior: $n = 55$, 24%; superior: $n = 175$, 76%) or resistance (inferior: $n = 37$, 16%; superior: $n = 193$, 84%) exercise.

**Predictors of Exercise Preferences.** As revealed in Table 1, AG-Ratio, SCS, SPEE, and SPOV scores were significantly higher for participants who preferred to exercise outside of the home than at home. These effects were moderate in size. AG-Ratio was also significantly higher among participants who, when exercising outside of the home, preferred to exercise in a gym or fitness centre than an outdoor (i.e., nature) setting. This effect size was small to moderate. No other variables reached significance for exercise location or setting. There were also no significant differences between groups for social context.

On average, participants preferred a companion who was superior to them in fitness (aerobic exercise) and strength (resistance exercise); participants also preferred a significantly more superior companion when undertaking resistance ($M = 60.37$, $SD = 18.51$) than aerobic exercise ($M = 55.20$, $SD = 16.70$), $t(229) = -4.67$, $p < .001$, $d = -0.31$. However, 21% ($n = 48$) of participants reported different preferences depending on the type of exercise. Of these participants, significantly more ($n = 33$, 14%) preferred a superior partner for resistance exercise but an inferior partner for aerobic exercise, and fewer ($n = 15$, 7%) preferred the reverse pattern (i.e., a superior partner for aerobic exercise but inferior partner for resistance exercise), $\chi^2$ (1, $N = 230$) $= 6.02$, $p = .014$.

A-G Ratio, SPAS, SCS, SPEE, SPOE, and SPOV scores together explained significant variance in partner preferences during aerobic exercise, $F(6, 221) = 6.67$, $p < .001$, $R^2 = .153$. As shown in Table 2, only A-G Ratio significantly contributed to the model; participants who reported higher exercise behaviour preferred a more superior aerobic exercise partner. The predictors also explained significant variance in partner preferences during resistance exercise, $F(6, 222) = 3.59$, $p = .002$, $R^2 = .088$. SPAS scores were the only predictor to significantly contribute to the model; higher SPAS scores predicted a preference for a more inferior resistance exercise partner.

## 2.4. Discussion

Study 1 revealed that most participants preferred to exercise outside of the home than at home, and when exercising outside the home preferred a gym or fitness centre more than an outdoor setting. Participants similarly preferred individual or single-partnered exercise, least preferred group exercise, and on average, preferred a slightly superior exercise companion for both resistance (strength) and aerobic (fitness) exercise. Future research could explore the extent to which these preferences are influenced by individual differences in logistical factors that were not measured in our study including accessibility to facilities, exercise equipment, and exercise companions.

As anticipated, preferences also differed as a function of psychosocial

**Table 1**
Descriptive and inferential statistics for outcome variables across physical location, setting, and social context real-world exercise preference groups (Study 1).

| | AG-Ratio $N = 230$ | | SPAS $N = 230$ | | SCS $N = 230$ | | SPEE $N = 229$ | | SPOE $N = 229$ | | SPOV $N = 229$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Physical Location | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | |
| Home | −0.96 (1.60) | | 32.80 (7.96) | | 46.25 (20.29) | | 37.88 (22.91) | | 4.36 (0.93) | | 3.45 (1.21) | |
| Outside home | 0.37 (1.72) | | 31.17 (8.27) | | 56.34 (18.91) | | 49.58 (23.16) | | 4.49 (0.95) | | 3.97 (1.19) | |
| | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* |
| | −5.35* | −0.79 | 1.35 | 0.20 | −3.56* | −0.52 | −3.44* | −0.51 | −0.96 | −0.14 | −2.96* | −0.44 |
| Exercise Setting | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | |
| Gym | 0.23 (1.82) | | 31.68 (8.48) | | 53.29 (21.31) | | 46.25 (25.41) | | 4.50 (0.97) | | 3.91 (1.23) | |
| Outdoors | −0.44 (1.64) | | 31.53 (7.69) | | 54.00 (16.59) | | 46.43 (20.00) | | 4.37 (0.90) | | 3.68 (1.18) | |
| | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* |
| | 2.76* | 0.38 | 0.13 | 0.02 | −0.28 | −0.04 | −0.06 | −0.01 | 0.99 | 0.14 | 1.34 | 0.19 |
| Social Context | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | |
| Alone | 0.26 (1.69) | | 31.76 (8.63) | | 55.20 (19.94) | | 49.17 (24.41) | | 4.38 (1.00) | | 3.86 (1.22) | |
| Partner | −0.30 (1.84) | | 31.33 (8.00) | | 51.95 (19.56) | | 42.95 (21.99) | | 4.53 (0.92) | | 3.84 (1.21) | |
| Group | 0.14 (1.82) | | 32.27 (7.42) | | 53.08 (20.25) | | 47.92 (25.85) | | 4.44 (0.79) | | 3.64 (1.25) | |
| | *F* | $\eta^2$ | *F* | $\eta^2$ | *F* | $\eta^2$ | *F* | $\eta^2$ | *F* | $\eta^2$ | *F* | $\eta^2$ |
| | 2.70 | 0.02 | 0.16 | 0.00 | 0.70 | 0.01 | 1.84 | 0.02 | 0.57 | 0.01 | 0.34 | 0.00 |

Note: $p < .05$*; AG-Ratio = Archer-Garcia Ratio of Exercise Behaviour, SPAS = Social Physique Anxiety Scale, SCS = Social Comparison Scale, SPEE = Self-Presentational Efficacy Expectancy, SPOE = Self-Presentational Outcome Expectancy, SPOV = Self-Presentational Outcome Value

**Table 2**
Predictors of preferred superiority of exercise companion during real-world aerobic and resistance exercise (Study 1).

| Predictors | *B (SE)* | 95% CI | *β* | *t* | *p* |
|---|---|---|---|---|---|
| Aerobic Exercise ($N = 228$) | | | | | |
| AG-Ratio | 2.17 (0.74) | [0.70,3.64] | 0.24 | 2.92 | .004* |
| SPAS | −0.19 (0.19) | [-0.55,0.18] | −0.08 | −1.01 | .314 |
| SCS | 0.15 (0.10) | [-0.05,0.36] | 0.18 | 1.47 | .144 |
| SPEE | 0.00 (0.09) | [-0.17,0.17] | 0.00 | 0.00 | .999 |
| SPOE | 0.78 (1.28) | [-1.75,3.30] | 0.05 | 0.61 | .545 |
| SPOV | −0.42 (1.11) | [-2.62,1.77] | −0.03 | −0.38 | .703 |
| Resistance Exercise ($N = 229$) | | | | | |
| AG-Ratio | 1.26 (0.87) | [-0.46,2.98] | 0.12 | 1.45 | .149 |
| SPAS | −0.39 (0.19) | [-0.76,-0.02] | −0.17 | −2.07 | .039* |
| SCS | −0.08 (0.12) | [-0.32,0.17] | −0.08 | −0.61 | .542 |
| SPEE | 0.14 (0.10) | [-0.06,0.35] | 0.18 | 1.39 | .166 |
| SPOE | −0.18 (1.50) | [-3.14,2.78] | −0.01 | −0.12 | .904 |
| SPOV | −0.32 (1.30) | [-2.89,2.26] | −0.02 | −0.24 | .810 |

Note: $p < .05$*; AG-Ratio = Archer-Garcia Ratio of Exercise Behaviour, SPAS = Social Physique Anxiety Scale, SCS = Social Comparison Scale, SPEE = Self-Presentational Efficacy Expectancy, SPOE = Self-Presentational Outcome Expectancy, SPOV = Self-Presentational Outcome Value

variables. Higher exercise behaviour, more favourable social comparisons, and higher SPEE and SPOV were present among those who preferred to exercise outside of the home. Higher exercise behaviour was also present among those who preferred a gym or fitness centre over an outdoor exercise setting. Moreover, higher exercise behaviour predicted a stronger preference for a superior aerobic exercise companion, and lower SPA predicted a stronger preference for a superior resistance exercise companion. These results have supported existing literature that has demonstrated a preference for single or partnered exercise over group exercise (Bushman & Brandenburg, 2009; Cohen-Mansfield et al., 2004; Diehl et al., 2001; Rogers et al., 2007, 2009), and for the motivational benefits of a moderately superior single exercise companion (Feltz et al., 2011; Max et al., 2016). The findings have advanced our knowledge of the complexity of individual differences in exercise preferences by demonstrating that these preferences are influenced by exercise behaviour, exercise mode (i.e., aerobic vs resistance), and psychosocial variables such as self-perception of physical appearance in real-world exercise contexts. This information could be used to design more effective exercise interventions and to understand why different exercisers may prefer certain exercise tasks and exercise companions.

## 3. Study 2

Study 2 explored whether exercise behaviour and psychosocial variables influenced preferences to exercise in real-world or virtual contexts, and preferences for exercise companions within a VR setting. It was expected that, due to evidence of the less socially and physically evaluative nature of VR exercise (Auster-Gussman et al., 2021; Focht & Hausenblas, 2004; Kroon et al., 2022; O'Hara et al., 2014), participants who exercised less, were more likely to compare themselves unfavourably with others, or had higher SPA and lower SPE would prefer VR exercise over real-world exercise, would prefer to exercise alone in VR, and would prefer a more inferior exercise companion for both aerobic and resistance modes of VR exercise.

### 3.1. Method

**Participants.** Participants were undergraduate students ($N = 228$) who had not participated in Study 1 and who received partial course credit in exchange for their involvement. Participants ranged in age from 17 to 54 years ($M = 20.84$, $SD = 5.84$) and had an average BMI in the healthy range ($M = 23.24$, $SD = 4.27$). Participants identified as female ($n = 161$; 71%), male ($n = 59$; 26%), gender diverse ($n = 3$; 1%), or non-binary ($n = 5$; 2%).

### 3.2. Measures

***Exercise Preferences.*** Participants were given a definition of real-world and VR exercise. Real-world exercise was described as "*in-person and face-to-face. Real-world exercise can be completed on your own or with others, in any real physical setting. If you exercise with others, your exercise companions are real people who are in the same physical location as you*". VR exercise was defined as "*a technologically simulated experience viewed via a projection on a screen or wall, or through a virtual reality headset or helmet. Scenes and objects in the virtual reality are computer-generated, but appear to be real, thus making you feel immersed in your surroundings. In a virtual reality, there may be nobody else present in the environment, or you may be able to see virtual companions (i.e., avatars – which are graphical representations of other people)*". Participants were asked to indicate whether they would prefer to workout in a real-world setting (with others also present face-to-face) or a VR setting (with others also present as avatars in the virtual world) when imagining completing aerobic and resistance exercise in the presence of others.

Participants were also asked to indicate, if exercising in a VR setting, whether they would prefer to workout alone (i.e., with no-one else present in the virtual world), with a partner (i.e., with a virtual exercise companion who was also exercising in the virtual world), or in a group setting (i.e., with a group of virtual exercise companions who were also exercising in the virtual world). Preferences for the fitness level of an exercise partner when engaging in aerobic exercise in a VR setting and the strength of an exercise partner when engaging in resistance exercise in a VR setting, using a scale from 0 (*inferior to you in fitness/strength*) to 100 (*superior to you in fitness/strength*), were also measured. Responses were dichotomised into a preference for an inferior (<50) or superior (≥50) companion.

***Additional Questionnaires***. The remaining questionnaires were the same as those used in Study 1. All measures demonstrated excellent reliability: A-G Ratio, $r(228) = .63$, $p < .001$, SPAS ($\alpha = .88$), SCS ($\alpha = .94$), SPEE ($\alpha = .94$), SPOE ($\alpha = .92$), and SPOV ($\alpha = .89$).

**Procedure.** The procedure was the same as for Study 1.

**Statistical Analyses.** A-G Ratio, SPAS, SCS, SPEE, SPOE, and SPOV scores were compared across exercise preference groups (i.e., real-world vs VR) when engaging in aerobic and resistance exercise using independent-samples *t*-tests. A 2 (exercise type: aerobic, resistance) × 2 (exercise preference: real-world vs VR) McNemar's test compared exercise preferences when completing aerobic and resistance exercise in VR. Preferences for social context (i.e., alone vs partner vs group) when exercising in VR were explored using a one-way between-groups ANOVA. Planned contrasts compared partner and group exercise combined against exercising alone, and partner exercise was compared to group exercise. A paired-sample *t*-test and a 2 (exercise type: aerobic, resistance) × 2 (companion preference: inferior, superior) McNemar's test compared companion preferences when completing aerobic and resistance exercise in VR. Two multiple regression analyses tested A-G Ratio, SPAS, SCS, SPEE, SPOE, and SPOV scores as predictors of companion preferences when engaging in aerobic and resistance exercise in VR.

There were no univariate outliers. Despite a negatively skewed distribution of SPOE scores, using a square root transformation for this variable produced no difference in the results. Thus, untransformed data have been reported. Multivariate outliers were identified and removed separately for the aerobic exercise ($n = 2$) and resistance exercise ($n = 2$) regression analyses. There were no other assumption violations.

### 3.3. Results

**Exercise Preferences.** When exercising with others, over 80% of participants reported preferring a real-world than a VR setting for both aerobic (real-world: $n = 197$, 87%; VR: $n = 30$, 13%) and resistance exercise (real-world: $n = 187$, 82%; VR: $n = 40$, 18%). When exercising in VR, participants least preferred a group setting ($n = 33$, 15%). A third of participants preferred to exercise with a partner ($n = 77$, 34%) and more than half the sample preferred to exercise alone ($n = 117$, 51%). A greater proportion of participants preferred a superior companion for both aerobic (inferior: $n = 59$, 26%; superior: $n = 168$, 74%) and resistance (inferior: $n = 66$, 29%; superior: $n = 161$, 71%) VR exercise.

**Predictors of Exercise Preferences.** For both aerobic and resistance exercise, AG-Ratio, SCS, and SPEE scores were significantly higher, and SPAS scores were significantly lower, among participants who preferred a real-world than VR exercise setting. These effects were all moderate to large. There was also a small main effect for social context; participants who preferred VR exercise with a partner or in a group had significantly higher SCS scores than those who preferred exercising in VR alone ($p = .007$). There was no difference in SCS scores for those who preferred group or partner exercise in VR ($p = .47$). These results are reported in Table 3.

Participants preferred a VR exercise companion who was slightly superior to them, on average. These preferences did not significantly differ for aerobic ($M = 54.48$, $SD = 17.74$) or resistance exercise ($M = 54.52$, $SD = 18.39$) using both continuous, $t(226) = -0.06$, $p = .95$, $d = -0.00$, and grouped data, $\chi^2 (1, N = 227) = 1.09$, $p = .30$. There was also no significant shift in participant preferences for a real-world or VR exercise setting when undertaking aerobic or resistance exercise, $\chi^2 (1, N = 227) = 2.13$, $p = .14$.

The predictor variables together explained significant variance in preferences for the fitness level of an aerobic exercise companion in VR, $F(6, 215) = 5.46$, $p < .001$, $R^2 = .132$. Higher SCS scores significantly predicted preference for a more superior aerobic exercise partner. The predictors also explained significant variance in preference for the strength of an exercise partner during resistance exercise in VR, $F(6, 215) = 3.83$, $p < .001$, $R^2 = .096$. Again, higher SCS scores predicted a preference for a resistance exercise companion more superior in strength. Table 4 reports the regression results.

### 3.4. Discussion

Study 2 revealed that most participants preferred real-world than VR exercise. Mirroring the results of Study 1 when participants were asked only about real-world exercise, for a VR exercise context most participants preferred to exercise alone, followed by exercise with a single virtual companion, and lastly in a virtual group. Participants were also more likely to prefer a superior virtual companion, on average, across both aerobic and resistance VR exercise modes. However, as anticipated,

**Table 3**
Descriptive and inferential statistics for outcome variables across aerobic and resistance exercise settings and social context in VR (Study 2).

| | AG-Ratio $N = 227$ | | SPAS $N = 226$ | | SCS $N = 226$ | | SPEE $N = 225$ | | SPOE $N = 224$ | | SPOV $N = 224$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aerobic Exercise | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | |
| Real-world | 0.15 (1.77) | | 30.19 (7.68) | | 57.90 (18.72) | | 49.59 (22.38) | | 4.43 (0.88) | | 3.82 (1.14) | |
| VR | −0.93 (1.73) | | 33.87 (7.05) | | 39.17 (20.37) | | 32.69 (24.51) | | 4.19 (1.24) | | 3.64 (1.37) | |
| | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* |
| | −3.13* | 0.61 | −2.46* | −0.48 | 5.05* | 0.99 | 3.80* | 0.75 | 1.34 | 0.26 | 0.76 | 0.15 |
| Resistance Exercise | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | |
| Real-world | 0.24 (1.79) | | 29.97 (7.59) | | 58.28 (19.03) | | 50.01 (23.05) | | 4.43 (0.90) | | 3.84 (1.15) | |
| VR | −1.06 (1.45) | | 34.00 (7.37) | | 42.08 (18.85) | | 34.98 (20.77) | | 4.28 (1.09) | | 3.59 (1.28) | |
| | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* |
| | 4.30* | 0.75 | −3.07* | −0.53 | 4.90* | 0.85 | 3.80* | 0.66 | 0.89 | 0.15 | 1.23 | 0.21 |
| VR Social Context | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | |
| Alone | −0.18 (1.70) | | 31.10 (8.37) | | 52.11 (19.48) | | 43.98 (24.12) | | 4.36 (1.03) | | 3.62 (1.22) | |
| Partner | 0.31 (1.95) | | 30.84 (6.63) | | 58.05 (21.42) | | 50.32 (21.99) | | 4.38 (0.89) | | 4.03 (1.15) | |
| Group | −0.01 (1.74) | | 28.82 (7.36) | | 61.06 (16.04) | | 52.27 (22.39) | | 4.60 (0.68) | | 3.86 (0.94) | |
| | *F* | $\eta^2$ | *F* | $\eta^2$ | *F* | $\eta^2$ | *F* | $\eta^2$ | *F* | $\eta^2$ | *F* | $\eta^2$ |
| | 1.73 | 0.02 | 1.16 | 0.01 | 3.68* | 0.03 | 2.60 | 0.02 | 0.90 | 0.01 | 2.90 | 0.03 |

Note: $p < .05$*; AG-Ratio = Archer-Garcia Ratio of Exercise Behaviour, SPAS = Social Physique Anxiety Scale, SCS = Social Comparison Scale, SPEE = Self-Presentational Efficacy Expectancy, SPOE = Self-Presentational Outcome Expectancy, SPOV = Self-Presentational Outcome Value

**Table 4**
Predictors of preferred superiority of exercise companion during aerobic and resistance exercise in VR (Study 2).

| Predictors | *B* (*SE*) | 95% CI | $\beta$ | *t* | *p* |
|---|---|---|---|---|---|
| Aerobic Exercise in VR ($N = 222$) | | | | | |
| AG-Ratio | −0.33 (0.77) | [-1.85,1.20] | −0.03 | −0.42 | .673 |
| SPAS | −0.03 (0.20) | [-0.43,0.38] | −0.01 | −0.13 | .894 |
| SCS | 0.33 (0.10) | [0.13,0.54] | 0.39 | 3.23 | .001* |
| SPEE | −0.05 (0.09) | [-0.22,0.13] | −0.06 | −0.50 | .615 |
| SPOE | 0.83 (1.30) | [-1.74,3.40] | 0.05 | 0.64 | .524 |
| SPOV | 1.15 (1.11) | [-1.03,3.33] | 0.08 | 1.04 | .301 |
| Resistance Exercise in VR ($N = 222$) | | | | | |
| AG-Ratio | −1.44 (0.81) | [-3.04,0.16] | −0.15 | −1.78 | .077 |
| SPAS | −0.11 (0.21) | [-0.53,0.31] | −0.04 | −0.51 | .610 |
| SCS | 0.25 (0.11) | [0.04,0.47] | 0.29 | 2.34 | .020* |
| SPEE | 0.02 (0.09) | [-0.17,0.20] | 0.02 | 0.17 | .867 |
| SPOE | 1.34 (1.37) | [-1.36,4.03] | 0.07 | 0.98 | .331 |
| SPOV | 0.87 (1.16) | [-1.43,3.16] | 0.06 | 0.75 | .457 |

Note: $p < .05$*; AG-Ratio = Archer-Garcia Ratio of Exercise Behaviour, SPAS = Social Physique Anxiety Scale, SCS = Social Comparison Scale, SPEE = Self-Presentational Efficacy Expectancy, SPOE = Self-Presentational Outcome Expectancy, SPOV = Self-Presentational Outcome Value

these preferences were influenced by psychosocial considerations. Across both aerobic and resistance exercise modes, those who chose VR exercise over real-world exercise had lower exercise behaviour, more unfavourable comparisons with others, lower SPE expectancy, and higher SPA. Those who chose solitary VR exercise and preferred an inferior virtual exercise companion across both exercise modes, also rated their exercise and fitness level unfavourably relative to others.

These results support existing literature demonstrating the attenuating effect of VR exercise in relation to exercise performance and efficacy beliefs (Auster-Gussman et al., 2021; Czub & Janeta, 2021; Focht & Hausenblas, 2004; Kocur et al., 2020; Kroon et al., 2022; Lin et al., 2021; O'Hara et al., 2014; Song et al., 2014). Study 2 extends these findings by revealing that participant preferences align with the perception that VR is a more appealing environment for those who experience heightened social and physical evaluative threats during exercise. The results also imply that aspects of the VR environment might be modified to increase motivation to exercise. For example, for the typical exerciser, it may be useful to create VR companions that are perceived as superior. However, in other cases, it may be useful to allow exercisers to customise the look or ability of their avatars (and those of their companions) according to their own preferences.

## 4. Study 3

Study 3 explored the role of avatar customisation in VR, and specifically, preferences for the realism and humanness of an avatar when exercising alone and with a virtual companion. As with Studies 1 and 2, the influence of exercise behaviour, SPA, social comparison, and SPE on preferences was explored. Based on existing literature (Koulouris et al., 2020), it was expected that participants would generally prefer a realistic human-looking virtual avatar. However, it was expected that these preferences would be impacted by psychosocial variables such that those who had lower exercise behaviour, more negative social comparison, lower SPE, and higher SPA would be more likely to choose a non-human avatar, and a fantasy or wishful avatar, when exercising alone and with a virtual companion. Study 3 further investigated whether these preferences differed when the virtual companion was similar, or superior, to the participant in strength and fitness.

### 4.1. Method

**Participants.** Participants were undergraduate students ($N = 249$) who had not participated in Study 1 or Study 2, and who were granted partial course credit in exchange for their time. The sample ranged in age from 17 to 76 years ($M = 23.73$, $SD = 9.04$) with an average BMI at the upper end of the healthy range ($M = 24.69$, $SD = 9.14$). Participants identified as female ($n = 205$; 82%), male ($n = 38$; 15%), gender diverse ($n = 1$; <1%), and non-binary ($n = 5$; 2%).

### 4.2. Measures

***Exercise Preferences***. Participants read the definition of VR exercise used in Study 2 and were asked to imagine exercising alone in a VR environment. In two separate questions, participants indicated whether they would prefer to workout as a realistic representation of themselves (i.e., "*a true and accurate representation of your physique and appearance*") or a fantasy representation of themselves (i.e., "*a dream or wishful representation of your physique and appearance*"), and whether they would prefer to workout as a customised human-looking avatar or a customised non-human avatar (i.e., a warrior, creature, or robot).

Participants were then asked to imagine exercising in VR in real-time with a real human exercise partner ("*you and your exercise partner are in different physical locations but can see each other's virtual representations exercising together in the virtual world*"). Using two questions, participants indicated whether they would prefer to workout as a realistic representation of themselves or a fantasy representation of themselves if their exercise companion was similar to them on all characteristics (i.e., in relation to gender, age, ethnicity, weight, and fitness and strength) and if their exercise companion was similar to them on most characteristics (i.e., in relation to gender, age, ethnicity, and weight) but physically fitter and stronger.

***Additional Questionnaires***. Participants completed the same questionnaires used in Study 1 and Study 2. The measures again had excellent reliability: A-G Ratio, $r(249) = .63$, $p < .001$, SPAS ($\alpha = .90$), SCS ($\alpha = .95$), SPEE ($\alpha = .94$), SPOE ($\alpha = .91$), and SPOV ($\alpha = .91$).

**Procedure.** The procedure was identical to Studies 1 and 2.

**Statistical Analyses.** Two independent-samples *t*-tests were used to compare A-G Ratio, SPAS, SCS, SPEE, SPOE, and SPOV across preferences for avatar humanness (human-looking vs non-human) and realism (realistic vs fantasy) when exercising alone in VR. Two additional independent samples *t*-tests compared outcomes across avatar preferences (realistic vs fantasy) when exercising in VR with a similar fitness/strength and a superior fitness/strength companion. A 2 (avatar: realistic, fantasy) × 3 (companion: none, physically similar, physically superior) Cochran's *Q* test, with follow-up pairwise comparisons using an automatic Bonferroni correction, further explored avatar preferences across social context.

No univariate outliers were detected. SPOE scores were again negatively skewed. However, raw data were used in the analyses because substituting square root transformed SPOE scores did not change the results. There were no other violations of assumptions.

### 4.3. Results

**Exercise Preferences.** When imagining exercising alone in a VR environment, 80% of participants preferred to be represented as a human-looking avatar ($n = 200$) and 20% as a non-human avatar (i.e., a warrior, creature, or robot; $n = 49$). Most participants also preferred a realistic than a fantasy representation of their physique and appearance when exercising alone in VR (realistic: $n = 160$, 64%; fantasy: $n = 89$, 36%), when exercising in VR with a companion similar in fitness and strength (realistic: $n = 177$, 71%; fantasy: $n = 72$, 29%), and when exercising in VR with a companion superior in fitness and strength (realistic: $n = 144$, 58%; fantasy: $n = 105$, 42%).

**Predictors of Exercise Preferences.** As shown in Table 5, AG-Ratio and SPOV scores were significantly higher among those participants who preferred to be represented by a human than a non-human avatar. When exercising alone in VR, participants who preferred a realistic avatar over a fantasy avatar were significantly lower in SPAS scores and higher in SCS scores. When exercising with a similarly matched exercise

**Table 5**
Descriptive and inferential statistics for outcome variables across VR avatar preferences in different social contexts (Study 3).

| | AG-Ratio $N = 249$ | | SPAS $N = 249$ | | SCS $N = 249$ | | SPEE $N = 249$ | | SPOE $N = 249$ | | SPOV $N = 249$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Humanness (Alone) | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | |
| Human | 0.16 (1.75) | | 30.97 (7.77) | | 53.98 (20.72) | | 47.69 (24.81) | | 4.41 (0.89) | | 3.90 (1.16) | |
| Non-human | −0.66 (1.91) | | 29.51 (8.76) | | 52.92 (18.69) | | 44.31 (22.59) | | 4.40 (0.94) | | 3.52 (1.35) | |
| | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* |
| | 2.89* | 0.46 | 1.15 | 0.18 | 0.33 | 0.05 | 0.87 | 0.14 | 0.01 | 0.00 | 2.04* | 0.33 |
| Realism (Alone) | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | |
| Realistic | 0.06 (1.81) | | 29.43 (7.76) | | 55.91 (19.52) | | 49.23 (23.83) | | 4.35 (0.90) | | 3.76 (1.18) | |
| Fantasy | −0.12 (1.82) | | 32.92 (7.91) | | 49.91 (21.23) | | 43.07 (24.99) | | 4.51 (0.90) | | 3.95 (1.24) | |
| | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* |
| | 0.75 | 0.10 | −3.38* | −0.45 | 2.25* | 0.30 | 1.92 | 0.25 | −1.35 | −0.18 | −1.17 | −0.15 |
| Realism (Similar Companion) | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | |
| Realistic | 0.11 (1.76) | | 29.63 (7.69) | | 56.36 (19.08) | | 50.03 (23.49) | | 4.39 (0.79) | | 3.79 (1.17) | |
| Fantasy | −0.27 (1.92) | | 33.25 (8.14) | | 47.40 (21.91) | | 39.64 (25.12) | | 4.43 (1.14) | | 3.91 (1.29) | |
| | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* |
| | 1.49 | 0.21 | −3.31* | −0.46 | 3.21* | 0.45 | 3.10* | 0.43 | −0.27 | −0.04 | −0.72 | −0.10 |
| Realism (Superior Companion) | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | | *M (SD)* | |
| Realistic | 0.15 (1.82) | | 29.00 (7.81) | | 57.90 (18.40) | | 50.93 (23.64) | | 4.38 (0.78) | | 3.84 (1.13) | |
| Fantasy | −0.20 (1.78) | | 32.98 (7.66) | | 48.10 (21.49) | | 41.68 (24.47) | | 4.44 (1.05) | | 3.81 (1.30) | |
| | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* | *t* | *d* |
| | 1.49 | 0.19 | −4.01* | −0.51 | 3.86* | 0.50 | 3.00* | 0.39 | −0.56 | −0.08 | 0.17 | 0.02 |

Note: $p < .05$*; AG-Ratio = Archer-Garcia Ratio of Exercise Behaviour, SPAS = Social Physique Anxiety Scale, SCS = Social Comparison Scale, SPEE = Self-Presentational Efficacy Expectancy, SPOE = Self-Presentational Outcome Expectancy, SPOV = Self-Presentational Outcome Value

companion and a physically superior companion, participants who preferred a realistic than a fantasy avatar were significantly lower in SPAS scores and significantly higher in both SCS and SPEE scores. These effects were small to moderate in size.

Cochran's *Q* revealed that the proportion of participants who preferred a fantasy avatar was significantly higher when imagining exercise with a physically superior companion compared to exercising alone ($p = .016$) or with a physically similar companion ($p < .001$). Significantly more participants also preferred a fantasy avatar when imagining exercising alone than with a similar companion ($p = .024$), $\chi 2$ $(2, N = 249) = 21.79$, $p < .001$.

### 4.4. Discussion

Study 3 revealed that, when exercising in VR, most participants preferred to be represented as a realistic and human-looking virtual avatar, regardless of whether they were exercising alone or with a physically similar or superior virtual companion. However, when exercising alone, participants who chose a non-human avatar were lower in exercise behaviour and placed a lower value on exercise self-presentation, and participants who chose a fantasy avatar had higher SPA and more negative exercise-related comparisons with others. Similar findings were observed when exercising with a companion; participants who preferred a fantasy avatar were higher in SPA, and lower in social comparison and SPE expectancy. The proportion of participants who chose a fantasy avatar was highest when there was the presence of a virtual companion who was physically superior. Preference for a fantasy avatar was also higher when imagining exercising alone, than with a physically similar virtual companion. Thus, more participants were comfortable exercising in VR whilst being represented as a realistic version of themselves when their virtual companion was similar to them (i.e., in relation to gender, age, ethnicity, weight, fitness and strength).

These findings support earlier studies reporting a preference for realistic human-looking avatars (Koulouris et al., 2020). The results are also congruent with literature demonstrating that exercisers can feel a strong sense of identification with a virtual representation of themselves to the extent that they receive a motivational boost and adopt the physical traits of their virtual avatar (Koulouris et al., 2020; Lin et al., 2021; Seymour et al., 2021; Song et al., 2014; Suh et al., 2011), and with the suggestion by Schneider and Kummert (2016; 2018) that fantasy or non-human avatars may alleviate concerns over evaluation, judgement, and self-presentation of one's fitness and physique. The findings provide evidence that these considerations extend to exercise preferences in a VR environment; the desire for virtual representation with an idealised appearance and physique was most prevalent among those with poorer exercise self-perceptions and negative self-presentational beliefs. Taken together, the findings suggest that VR developers and fitness trainers should enable customisations of avatars in ways that meet the motivational needs of individual exercisers.

## 5. General discussion

The current investigation has provided insight into the complex interplay between psychosocial factors and exercise preferences across real and virtual exercise contexts. Study 1 explored real-world exercise and demonstrated a moderate preference to exercise outside the home in a gym or fitness centre either alone or with a slightly superior partner. Higher exercise behaviour strengthened these preferences. Those participants who preferred to exercise at home exercised less, made more negative fitness-related social comparisons, and had lower SPE expectancy and outcome value. Higher SPA also predicted a stronger preference for an inferior resistance exercise companion. Study 2 revealed a preference to exercise alone or with a moderately superior partner, rather than in a group, when undertaking VR exercise. More negative social comparison was associated with a stronger desire to exercise alone, along with a preference for a less superior companion. Individuals with lower exercise behaviour, more negative fitness-related social comparisons, lower SPE expectancy, and higher SPA were also more likely to choose VR than real-world exercise. Importantly, these effects were all moderate to large, with the largest effects observed for social comparison. Study 3 demonstrated a general preference for avatars that were a realistic representation of one's physique and appearance over a non-human representation. However, there was a preference for a non-human and fantasy avatar among participants with higher SPA and more negative social comparisons. Participants who preferred a fantasy avatar also had lower SPE expectancy. A heightened threat of negative social comparison or evaluation (i.e., when contemplating exercise with a physically superior companion) resulted in the strongest preference for a fantasy avatar. In contrast, participants were most comfortable embodying a realistic virtual avatar when exercising with a similar companion. These effects were all small to moderately sized.

Taken together, all three studies revealed a general preference to exercise, either in the real-world or in VR, alone or with a somewhat superior partner. Group exercise was the least preferred option in both real-world and VR contexts. These results are aligned with earlier preferences research with healthy non-clinical young adult samples (Bushman & Brandenburg, 2009; Diehl et al., 2001), but our findings have extended our understanding of the stability of these preferences across both setting (i.e., real-world vs VR) and mode (i.e., aerobic vs resistance exercise). The congruence in these preferences across real-world and VR exercise settings suggests that, even when exercising in VR and being represented by a virtual avatar, individuals still perceive that elements of their exercise identity can be projected through the VR system. Thus, VR exercise and avatar embodiment may not provide a complete sense of anonymity or entirely ameliorate concerns around social comparison or self-presentation (Schneider & Kummert, 2016, 2018).

As anticipated, preferences for social context were influenced by prior engagement in exercise behaviour and self-presentational factors. For real-world exercise, participants with lower exercise behaviour, SPE expectancy and outcome value, and negative social comparisons chose a solitary home-based setting. This finding supports existing evidence that exercising in fitness settings can exacerbate feelings of threat, anxiety, and negative affectivity (Focht & Hausenblas, 2003, 2004, 2006). For VR exercise, more negative social comparisons resulted in a preference for solitary exercise. These findings are consistent with the suggestion that individuals with a higher investment in exercise self-presentation coupled with a low expectancy of creating an impression of being a competent exerciser, or a belief that they do not compare positively with others in relation to physique and fitness, are more likely to avoid exercise contexts that provide opportunity for evaluation and judgement (Gammage et al., 2004, 2014; Maddux et al., 1988; Pila et al., 2014; Sabiston et al., 2014). Again, creating a virtual environment to engage in exercise does not appear to entirely prevent the emergence of self-presentational concerns, at least under the VR contexts examined in the present study.

The general preference for the superiority of an exercise companion we have observed is also largely consistent with the literature regarding the benefits for exercise motivation, persistence, and performance of exercising with a moderately superior partner (Feltz et al., 2011; Feltz et al., 2020). Feltz et al. (2020) provided a recommendation for exercise professionals that the best motivational advantage would be achieved by pairing a client with a companion whose exercise intensity exceeds the client's by approximately 15%; the participants in the current research slightly underestimated this recommendation by reporting a preference for an exercise companion who was 5%–10% superior in real-world exercise and 4%–5% superior in VR exercise, on average. However, preferences were not uniform; more infrequent exercisers and individuals with higher SPA preferred an inferior companion, thus supporting existing literature that individuals with self-presentational concerns are more likely to prefer a social context that de-emphasises the evaluation of one's physique, fitness, or strength (Diehl et al., 2001; Focht & Hausenblas, 2003, 2004, 2006; Kroon et al., 2022; O'Hara et al., 2014; Spink, 1992). Interestingly, the current investigation has also provided preliminary evidence that participants were more likely to prefer superiority when undertaking resistance exercise than aerobic exercise. Superiority in strength may be motivating and inspiring (Czub & Janeta, 2021; Kocur et al., 2020; Lin et al., 2021), whereas exercising with someone who is superior in fitness may be more likely to accentuate outward signals of physical exertion (i.e., through a display of higher levels of puffing, sweating, or flushed face relative to the superior exerciser), thus heightening self-consciousness and embarrassment. Such signs of physical exertion are typically associated with stereotypes of low fitness, laziness, and poor health (Meadows & Bombak, 2019).

When asked to choose, more participants preferred real-world over VR exercise. However, participants based their choice on a written description of what exercise in a VR would typically entail. Prior research where participants have completed exercise within both contexts has revealed high acceptability (Prasertsakul et al., 2018), benefits to physical and mental health (Groenveld et al., 2022; Yen & Chiu, 2021), higher enjoyment (Mouatt et al., 2020), and stronger preferences for VR over real-world exercise (Hassandra et al., 2021; Touloudi et al., 2022). It is possible that a different pattern of preferences may have been obtained if participants had immersed themselves in the exercise scenarios that were described. Nevertheless, individuals who reported preferring VR exercise engaged in less exercise behaviour, were more negative in their fitness-related social comparisons and had lower SPE expectancy and higher SPA than those who reported preferring real-world exercise. Moreover, these same self-presentational concerns strengthened participants preference to be represented as a non-human fantasy avatar whilst exercising in VR. These findings are congruent with existing literature demonstrating that exercisers with high SPA and appearance-related self-presentation concerns feel more anxious and negative when exercising in the presence of others, or in environmental settings where their own physique is emphasised (Focht & Hausenblas, 2003, 2004, 2006; Raedeke et al., 2007, 2009). The findings also supplement emerging research indicating that VR may provide a less confronting, less evaluative, and more inclusive exercise environment whereby focus on physical appearance and perceptions of body judgements can be reduced, albeit not eliminated entirely (Auster-Gussman et al., 2021; Kroon et al., 2022; O'Hara et al., 2014).

The evidence that participants with lower exercise behaviour and higher self-presentational concerns preferred a fantasy or wishful virtual representation of themselves, and that this was particularly the case when an exercise companion was physically superior, also supports the suggestion that VR exercise can provide benefits over real-world exercise. These advantages include programmability and control, adaptability and flexibility, and the overall psychosocial experience (Ho & MacDorman, 2010; Koulouris et al., 2020; Lin et al., 2021; Samendinger et al., 2018; Seymour et al., 2021; Song et al., 2014; Suh et al., 2011). Specifically, exercising in VR, and embodying a fantasy or wishful virtual avatar in a VR environment, may help to alleviate some self-presentational concerns associated with exercise (Lugrin et al., 2015). This is significant because it may encourage certain individuals to engage in exercise under the right circumstances (e.g., in VR, alone, and embodying a fantasy avatar) when they may otherwise not engage in exercise at all.

These results have broad and important implications for health and exercise behaviour. Given global concerns regarding physical inactivity, and the potential physical and psychological benefits of regular exercise (Auster-Gussman et al., 2021; Diehl et al., 2001; Gammage et al., 2014), providing insight into individual differences in exercise preferences, psychosocial moderators of those preferences, and innovative methods to facilitate higher exercise participation, is invaluable. The results reported here demonstrate that the design of partnered or group exercise programs in real-world and virtual contexts should consider current levels of exercise behaviour, along with the presence and intensity of self-presentational concerns (Pila et al., 2014; Sabiston et al., 2014). Moreover, the results have provided further evidence that VR exercise may provide a promising avenue through which to encourage individuals who feel self-conscious, embarrassed, or comparatively physically inferior during exercise with others to increase the frequency of their exercise participation, or work harder while exercising, in a less threatening and evaluative context (Max et al., 2016; Othman et al., 2022; Perey & Koenigstorfer, 2022). Specifically, VR technology could be used to gradually expose individuals to exercise modes and companions in a more controlled, and less threatening, way. This could, ultimately, facilitate exercise engagement in the real-world and with motivating companions who are superior in strength and fitness.

The findings can also inform the design of VR exercise software as they suggest that approaches that reduce feelings of self-consciousness could benefit exercisers. For example, VR developers may focus on creating human-looking avatars that closely match the user in physique and appearance given that a realistic avatar was the preferred representation for most participants. However, allowing the creation of non-human and fantasy avatars would also be valuable for those individuals with heightened self-presentational concerns. VR developers may consider collecting information related to self-presentational concerns and exercise self-efficacy as these factors were found to predict exercise preferences. Along with actual exercise behaviour (e.g., running speed), such information (including preferences for physical superiority of an exercise companion) could be used to better match individuals who might join a virtual exercise session over the internet. The results also suggest that preferences differ when exercising alone or with a companion, and this should be considered when designing VR environments.

However, the research reported here is not without limitations. Firstly, participants were asked to prospectively imagine the exercise contexts presented and were not exposed to any real-world or VR exercise contexts. Thus, the findings rely on self-reported preference rather than actual exercise behaviour. Some results were based on artificial dichotomisation of continuous data, which can reduce statistical power and lead to a reduction of information regarding individual variability (DeCoster et al., 2011; Iacobucci et al., 2015). However, these limitations were likely offset by sufficient sample sizes and analysing the data in both continuous and categorical form (Iacobucci et al., 2015). There is also not abundant evidence of the reliability and validity of the A-G Ratio, which was used to assess exercise behaviour in the current research. Future research could use an alternative measure of exercise with strong psychometric properties (i.e., the International Physical Activity Questionnaire, IPAQ, Dinger et al., 2006). Further, understanding preferences and matching participants to exercise contexts that align with individual preferences may be one way to enhance exercise participation (Banks et al., 2012; Cohen-Mansfield et al., 2004; Dunlop & Schmader, 2014; Miller et al., 2005), but it is possible that participants may not self-select exercise scenarios that elicit the maximum motivational, performance, or health benefit. This is a research question that warrants further empirical attention. The samples in all three studies also comprised young adults who were mostly female, and in the healthy BMI range. This restricts the generalisability of the findings to other samples or populations of exercisers with specific desires and needs (i.e., male exercisers, individuals with overweight or obesity who are experiencing weight stigma, or individuals rehabilitating from physical injury or with a chronic disease). It is possible that the preferences reported here may differ, or perhaps may be strengthened, in those exercise contexts or for those exercise populations where the potential for anticipated, perceived, or actual social and physical evaluations and stigma are heightened (Auster-Gussman et al., 2021; Meadows & Bombak, 2019).

Future research could further explore the replicability of the preferences reported here in individuals with high self-presentational concerns, overweight or obesity, or among individuals who are physically inactive and less motivated to exercise as they are more likely to feel stigmatised for their appearance, or level of physical fitness. Indeed, Auster-Gussman et al. (2021) found that SPA mediated the relationship between BMI and exercise behaviour whereby higher BMI led to higher SPA which ultimately resulted in lower exercise behaviour. Future research could also explore the applicability of the current findings to individuals who have a chronic condition or physical impairment that may make exercising in the presence of others embarrassing or uncomfortable (Chong et al., 2012; Rogers et al., 2007, 2009). Ongoing research in this area will further contribute to existing evidence that VR exercise can be an acceptable, enjoyable, and oftentimes preferred, mode of exercise than real-world exercise across a range of important applied contexts (i.e., Groenveld et al., 2022; Hassandra et al., 2021; Polechoński et al., 2020; Prasertsakul et al., 2018; Touloudi et al., 2022; Yen & Chiu, 2021; Mouatt et al., 2020).

SPA was originally considered a relatively stable trait, and SPA was measured using a trait-based questionnaire in the current research. However, self-presentational concerns, such as SPA, can fluctuate across situations (Ginis et al., 2011). It would be valuable to explore such fluctuations in state SPA during actual, rather than imagined, exercise in some of the real-world and VR contexts described in the current research. Such research would further elucidate the ideal exercise conditions for motivation and exercise performance among individuals who vary on important psychosocial variables. Moreover, given there were individual differences in responses to computer-generated avatars in the current research, future research could also be designed whereby virtual stimuli varying along dimensions of attractiveness, eeriness, humanness, and warmth are presented to participants to ascertain preferences to embody, or exercise alongside, these avatars in VR (Ho & MacDorman et al., 2010). In addition, as has been highlighted in the current research, these preferences are likely to interact with exercise behaviour and self-presentational concerns, and this possibility warrants further investigation.

In conclusion, the current research has provided the first psychosocial investigation of individual differences in exercise preferences in real and virtual exercise contexts. SPA, social comparison, and SPE are important factors that guide preferences across exercise setting, mode, and social context; specifically, individuals with higher SPA and self-presentational concerns prefer exercise environments that minimise opportunities for physique-related and fitness-related evaluation. Importantly, the current research has made a valuable contribution to existing literature which has demonstrated user preferences for VR over real-world exercise in diverse contexts; the current research has provided complementary evidence of the significant advantages that VR exercise may offer via the perceived attenuation of self-presentational concerns. This creates opportunities for further research to explore the extent to which matching with preferences translates to higher exercise behaviour, and the potential application of tailoring real-world and virtual exercise environments to the needs of special populations who may find exercise especially threatening, embarrassing, or socially uncomfortable.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

The authors do not have permission to share data.

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