Self-reported tolerance of the intensity of exercise influences affective responses to and intentions to engage with high-intensity interval exercise

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Self-Reported Tolerance of the Intensity of Exercise Influences Affective Responses to and Intentions to Engage with High-Intensity Interval Exercise

Running title: tolerance of exercise intensity, affect, & high-intensity interval exercise

Abstract

This study investigated the effect of self-reported tolerance of the intensity of exercise on affective responses to, self-efficacy for and intention to repeat low-volume high-intensity interval exercise (HIIE). Thirty-six healthy participants (mean age 21 ± 2 years) were split into high tolerance (HT; *n* = 19), low tolerance (LT; *n* = 9), and very low tolerance (VLT; *n* = 8) of exercise intensity groups. Participants completed 10 x 6 s cycle sprints with 60 s recovery. Affective valence and perceived activation were measured before exercise, after sprints 2, 4, 6, 8, 10, and 20 min post-HIIE. Intention and self-efficacy were assessed 20 min post-HIIE. Affective valence was significantly lower in VLT vs. LT ($P = 0.034$, $d = 1.01$-1.14) and HT ($P = 0.018$, $d = 1.34$-1.70). Circumplex profiles showed a negative affective state in VLT only. The VLT group had lower intentions to repeat HIIE once and three times per week than HT ($P < 0.001$, $d = 1.87$ and 1.81, respectively) and LT ($P = 0.107$, $d = 0.85$; $P = 0.295$, $d = 0.53$, respectively). Self-efficacy was not influenced by tolerance. Self-reported tolerance of exercise intensity influences affective responses to and intentions to engage with HIIE.

KEYWORDS: interval training; intermittent training; adherence; psychological responses.

INTRODUCTION

Low volume high-intensity interval exercise (HIIE) encompasses a range of protocols that involve brief repeated bouts of relatively intense or all-out exercise separated by rest or low-intensity exercise, with total intense exercise time ≤ 10 min per session and total session time ≤ 30 min (Gillen & Gibala, 2014). Growing evidence supports the physical health benefits of low volume HIIE in clinical (Little et al., 2011) and inactive (Allison et al., 2017; Smith-Ryan, Trexler, Wingfield, & Blue, 2016) groups. These benefits are often comparable to or greater than moderate-intensity continuous exercise (Jelleyman et al., 2015; Weston, Wisloff, & Coombes, 2014), but with the benefit of greatly reduced total training time. Several researchers have argued that the time-efficiency of HIIE may reduce barriers, such as lack of time, which contribute to population inactivity and poor public health (Biddle & Batterham, 2015).

The public health potential of HIIE has been subject to debate with opponents arguing that its high-intensity nature will likely mean that participants will find it unpleasant and therefore have poor adherence (Biddle & Batterham, 2015; Hardcastle, Ray, Beale, & Hagger, 2014). This argument draws from Dual Mode Theory (DMT) (Ekkekakis, 2003), which demonstrates that intensity is a key mediator of affective responses to exercise. Dual mode theory postulates that affective responses to exercise are based on the interplay between cognitive parameters (e.g., self-efficacy), and interoceptive (e.g. muscular and respiratory) cues. The role that these factors play on affect during exercise is dependent on exercise intensity, with increased reliance on anaerobic metabolism (often operationalised as ventilatory threshold; VT) identified as a critical tipping point (Ekkekakis, Hall, & Petruzzello, 2008; Ekkekakis, Hall, & Petruzzello, 2005b). According to DMT, cognitive parameters influence affect at intensities < VT, and affective responses are consistently positive (Ekkekakis et al., 2008). As exercise intensity approaches VT, there is variation in affective responses with some individuals reporting increases and others decreases (Ekkekakis et al., 2008). As exercise exceeds VT interoceptive cues gain salience and most individuals report reduced affect (Ekkekakis, Parfitt, & Petruzzello, 2011).

Empirical research supports tenets of DMT. Continuous exercise > VT typically leads to more unpleasant affective responses than continuous exercise at and < VT (Ekkekakis et al., 2005b; Kilpatrick, Kraemer, Bartholomew, Acevedo, & Jarreau, 2007). However, DMT is based on continuous exercise, and may not be directly applicable to the intermittent nature of HIIE that allows periods of recovery between high-intensity bouts (Jung, Little, & Batterham, 2016). Based on DMT, it may be expected that during intervals >VT, interoceptive cues would dominate and participants would experience negative affect. However studies that have examined affective response to HIIE compared with moderate-intensity continuous exercise, have reported mixed findings (Stork, Banfield, Gibala, & Ginis, 2017). Some studies reported affect was more negative during HIIE compared to moderate-intensity continuous exercise (Decker & Ekkekakis, 2017; Greene, Greenlee, & Petruzzello, 2018; Jung, Bourne, & Little, 2014; Niven, Thow, Holroyd, Turner, & Phillips, 2018), and others reported no difference between conditions (Astorino & Thum, 2016; Little, Jung, Wright, Wright, & Manders, 2014). The lack of consistency in findings may partly be due to the influence of individual differences in affective responses to a given exercise challenge. Several studies report wide variation in the affective response of participants, particularly to high-intensity continuous exercise and HIIE (Decker & Ekkekakis, 2017; Greene et al., 2018).

Drawing from personality theories that highlight variation in individuals' arousability and sensory modulation, Ekkekakis, Hall, and Petruzzello (2005a) introduced the concepts of exercise preference and tolerance to examine variations in affective responses to interoceptive stimuli during exercise. In a series of studies, the researchers demonstrated the validity and reliability of the Preference for and Tolerance of the Intensity of Exercise Questionnaire (PRETIE-Q) to assess these constructs (Ekkekakis, et al., 2005a). The researchers reported that the preference and tolerance scales significantly predicted affective responses at VT, but only the tolerance scale predicted affective responses > VT. That is, a higher tolerance was associated with more positive affective responses > VT. More recently, Tempest and Parfitt (2016) and Tempest and Parfitt (2017) demonstrated a biological basis for the influence of tolerance of the intensity of exercise on affective responses to continuous exercise at VT.

The finding that individual differences in tolerance of the intensity of exercise may influence affective responses has implications for understanding the relationship between HIIE and affect. Although this relationship has been alluded to in the growing literature (Frazao et al., 2016), to date no study has investigated the influence of tolerance of the intensity of exercise on affective responses to HIIE. Additionally, no HIIE research has considered the influence of tolerance of the intensity of exercise on self-efficacy and intention, which are cognitive antecedents of physical activity and may provide insight into the likelihood of future engagement in HIIE (Rhodes & Kates, 2015).

The aim of this study was to examine the influence of self-reported tolerance of the intensity of exercise on affective responses to low volume HIIE, and also consider how tolerance may influence self-efficacy for and intention to engage in future HIIE. We hypothesised that self-reported tolerance of the intensity of exercise would significantly influence A) the affective responses to low volume HIIE, and B) self-efficacy for and intentions to repeat low-volume HIIE.

METHODS

Participant screening

The research was approved by the University of Edinburgh, Moray House School of Education Ethics Committee. To identify high and low tolerance participants, we screened a sample (n=114) of healthy (confirmed via Physical Activity Readiness Questionnaire) participants aged 18-35 and unfamiliar with HIIE (confirmed via self-report of unfamiliarity with undertaking HIIE as defined by Gillen & Gibala (2014)). Participants were recruited through University social media platforms to complete the PRETIE-Q (Ekkekakis et al., 2005a). This 16-item questionnaire focuses on an individual's interpretation of interoceptive stimuli during exercise in order to separately quantify their preference for and tolerance of the intensity of exercise (Ekkekakis et al., 2005a). Each item comprises a five-point response scale (1 = I totally disagree to 5 = I strongly agree). The eight items relating to tolerance of the intensity of exercise were used in the current study, as the tolerance scale of the PRETIE-Q has been shown to predict affective responses > VT (Ekkekakis et al., 2005a). Participants received a tolerance score ranging from 8 (lowest tolerance) to 40 (highest tolerance). The PRETIE-Q has a test-retest reliability coefficient of 0.85 (Ekkekakis et al., 2005a), and in the current study had an internal consistency (Cronbach's alpha) of 0.72. Participants' responses to the PRETIE-Q were ranked and the highest 25 and lowest 25 scoring participants were invited to participate in the HIIE protocol. Splitting the sample in this way allowed the production of two distinct groups: high tolerance (HT, n = 25) and low tolerance (LT, n = 25) (Tempest & Parfitt, 2016) and provided the study with the power to detect a moderate effect ($\eta^2 = 0.5$) with $\alpha = 0.05$ and $\beta = 0.20$ (Tempest & Parfitt, 2016). Participants were blinded to their grouping, and those who were not invited for the second phase were fully debriefed.

Participants

Of the 50 participants invited to complete the HIIE protocol, six from the HT and eight from the LT group did not complete the study, leaving *n* = 19 and *n* = 17 for HT and LT, respectively (Figure 1; descriptive statistics in Table 1).

INSERT FIGURE 1 HERE

INSERT TABLE 1 HERE

Predicted maximal oxygen uptake

Participants completed the Perceived Functional Ability (PFA) questionnaire, which quantifies participants' perceived ability to sustain an exercise intensity considered 'not too easy and not too hard' (George, Stone, & Burkett, 1997). An incremental submaximal cycle ergometer (Ergomedic 874E, Monark, Sweden) test was then performed (Nielson, George, Vehrs, Hager, & Webb, 2010). Participants began the test against a 1 kg resistance for 3 min. Each 3 min stage increased in resistance by 0.5 kg. Stages were completed until participants achieved an end-stage heart rate (HR) $\geq$ 70% but < 85% of age-predicted maximum. Cadence was maintained at 70 rev.min^{-1}. Heart rate, PFA, end-exercise power output, age, gender and body mass (BM) were used in the following $\dot{V}O_{2max}$ prediction equation:

$$\dot{V}O_{2max} = 54.513 + 9.752(\text{gender}, 1 = \text{male}, 0 = \text{female}) – 0.297(\text{BM, kg}) + 0.739(\text{PFA}) + 0.077(\text{power output, W}) – 0.071(\text{HR})$$

This equation reported a standard error of the estimate of 3.36 $ml.kg^{-1}.min^{-1}$ in a similar sample to that of the current study (Nielson et al., 2010). This prediction equation was used as it employed multiple key influencers of $\dot{V}O_{2max}$ (gender, BMI, habitual physical activity) as well as a self-reported measure of an individual's PFA, which meaningfully contributed to the accuracy of the equation (George et al., 1997).

We chose a submaximal $\dot{V}O_{2max}$ prediction test because 1) participants with low tolerance of the intensity of exercise may have terminated a maximal test prior to attaining $\dot{V}O_{2max}$ (Ekkekakis, Lind, Hall, & Petruzzello, 2007; Hall, Petruzzello, Ekkekakis, Miller, & Bixby, 2014), which would have reduced test validity and presented an ethical concern regarding the use of such a test in this sample, and 2) the $\dot{V}O_{2max}$ data was used as a comparative measure of fitness and not as a measure on which methodological decisions were made, precluding requirement for the potentially greater precision of a maximal test.

Low-volume high-intensity interval exercise

Participants visited the climate-controlled laboratory (~21ºC, 50% relative humidity) having abstained from alcohol and strenuous exercise for ≥ 24 h. The investigator gave a detailed explanation of the HIIE protocol, which included the requirement to complete each sprint maximally, and standardised explanations of the psychometric scales according to the original publications.

Anthropometric measures were recorded (BM: model 708; Seca, Hamburg, Germany; standing height: model 245; Seca, Hamburg, Germany). The cycle ergometer (Ergomedic 874E, Monark, Sweden) was then adjusted to fit the participant, followed by a 5 min warm-up at a self-selected cadence with 1 kg resistance. Participants then completed 3 x 6 sec familiarisation sprints against their individualised target resistance, interspersed with 60 sec recovery. Following a 10 min seated recovery, the HIIE protocol began. Participants completed 10 x 6 sec all-out efforts against 7.5% BM (males) or 6.5% BM (females) (Froese & Houston, 1987), interspersed with 60 sec recovery. The first 50 sec of recovery was passive. From 50-59 sec, participants cycled unloaded at 60 rev·min^{-1}. At 59 sec, participants cycled maximally for 1 sec unloaded, after which the resistance was added to the flywheel and the 6 sec sprint began. This low volume HIIE protocol has been shown to substantially improve $\dot{V}O_{2max}$ and metabolic health in untrained populations (Adamson, Lorimer, Cobley, & Babraj, 2014). The researcher was present throughout to add and remove weight to the flywheel, however no encouragement was provided.

Measures

Heart rate was recorded throughout at 5 sec intervals (Polar Team 2, Finland). The Borg CR-10 scale assessed ratings of perceived exertion (RPE) (Borg & Kaijser, 2006; Oliveira, Slama, Deslandes, Furtado, & Santos, 2013). Affective valence (pleasure/displeasure) was assessed using the Feeling Scale (FS), ranging from -5 (very bad) to +5 (very good) (Hardy & Rejeski, 1989). Perceived activation was measured using the Felt Arousal Scale (FAS) (Svebak & Murgatroyd, 1985), ranging from 1 (low arousal) to 6 (high arousal). Scales were administered at rest immediately prior to HIIE (except RPE), immediately after sprints 2, 4, 6, 8 and 10, and

20 min post-HIIE (except RPE). Scales were taken immediately following sprints due to the problem of collecting this information during an all-out cycling effort.

Data from the FS and FAS were represented in the circumplex model, describing a combined affective state (Russell, 1980) with associated qualitative descriptors (calmness; energy; tension; tiredness) (Oliveira et al., 2013). Ekkekakis et al. (2008) suggested that the circumplex model is particularly appropriate for assessing affect before, during, and after exercise.

Task self-efficacy was assessed using a two-item measure (Jung et al., 2014). Question one asked: "How confident are you that you can perform one bout of exercise a week for the next four weeks that is just like the one you completed today?'' Question two was identical, except the number of exercise bouts increased to three per week (Jung et al., 2014). Responses were scored on a scale of 0% (not at all) to 100% (extremely confident) in 10% increments. This measure has demonstrated good internal consistency (Cronbach's alpha ≥ 0.95) (Jung et al., 2014). Intention to engage in the HIIE just completed over the next month was assessed using a two-item measure (Jung et al., 2014), and consistent with other measures of intention (Fishbein & Ajzen, 2010). Participants were asked to rate the extent to which they agreed with the statement "I intend to engage in the type of exercise I performed today at least once per week during the next month", and the same statement but with a frequency of at least three times per week. Responses were scored on a 7-point scale ranging from 1 (very unlikely) to 7 (very likely). Task self-efficacy and intentions to repeat were measured 20 min post-exercise, which falls within the window of any affective rebound (Hall, Ekkekakis, & Petruzzello, 2002; Jung et al., 2014; Oliveira et al., 2013).

Statistical Analyses

Descriptive statistics

Initial observation of the data identified a larger range of PRETIE-Q scores in LT (range = 10) compared to HT (range = 5), as well as a greater variability in affective responses across participants in LT compared to HT. Therefore, the LT group was further subdivided using its median PRETIE-Q score into LT (n = 9; age 22.3 ± 2.2 years, height 1.68 ± 0.05 m, BM 67.3 ± 14.8 kg) and very low tolerance (VLT, n = 8; age 21.4 ± 1.7 years, height 1.72 ± 0.10 m, BM 72.7 ± 7.9 kg) groups.

Inferential analysis

The Shapiro-Wilk test assessed normality of distribution for all data sets. Exercise tolerance scores were assessed using the Mann-Whitney U test. Mean $\dot{V}O_{2max}$, mean power output and mean peak HR during HIIE was compared using one-way independent groups ANOVA. Post-hoc analysis used the Games-Howell test for pairwise comparisons, to account for uneven sample sizes across the tolerance groups (Games & Howell, 1976; Games, Keselman, & Rogan, 1981). Rating of perceived exertion, affective valence, and perceived activation were analysed using a mixed-method two-way (group x time) ANOVA, with Games-Howell post hoc analysis. Intentions to repeat and self-efficacy were assessed using Kruskall-Wallis tests with Mann Whitney-U post hoc tests for between-group differences. The Bonferroni correction was applied to the alpha level for post hoc tests. For all other tests, an alpha level of $P < 0.05$ was used. Partial eta^2 (ηp^2) effect size (ES) quantified the magnitude of main ANOVA effects. For select comparisons, Cohen's d ES for between-participants and within-participants designs

(Lakens, 2013) was used and defined as trivial (< 0.20), small (≥ 0.2 - < 0.5), medium (≥ 0.5 - < 0.8), and large (≥ 0.8) (Cohen, 1992).

RESULTS

Tolerance of the intensity of exercise, and predicted $\dot{V}O_{2max}$

By design, tolerance of the intensity of exercise in VLT (Mdn = 17.0, range 12-19) was significantly lower than LT (Mdn = 21.0, range 20 to 22; U = 0.0, z = 3.5, $P < 0.001$) and HT (Mdn = 32.0, range 31 to 36; U = 0.0, z = 4.1, $P < 0.001$), and was significantly lower in LT vs. HT (U = 0.0, z = 4.3, $P < 0.001$).

Predicted $\dot{V}O_{2max}$ in the HT, LT, and VLT groups was 54.8 ± 1.8, 49.9 ± 2.1, and 47.3 ± 2.0 $ml.kg^{-1}.min^{-1}$, respectively ($F_{2,33} = 10.266$, $P < 0.001$). In HT, $\dot{V}O_{2max}$ was significantly greater than LT ($P = 0.006$, $d = 0.64$) and VLT ($P < 0.001$, $d = 1.05$). There was no significant difference between LT and VLT ($P = 0.478$, $d = 0.42$).

Physiological demand

Mean power output during HIIE was 8.7 ± 1.9, 7.8 ± 1.9, and 6.3 ± 2.3 $W \cdot kg^{-1}$ for the HT, LT and VLT groups, respectively ($F_{2,31} = 3.913$, $P = 0.031$). There was a large ES for mean power output between HT and VLT ($P = 0.062$, $d = 1.26$), and a medium ES between HT and LT ($P = 0.526$, $d = 0.56$) and between LT and VLT ($P = 0.385$, $d = 0.68$). Mean peak HR during HIIE was 163 ± 13, 157 ± 7, and 157 ± 12 $b.min^{-1}$ for HT, LT, and VLT, respectively ($F_{2,27} = 1.067$,

P = 0.358). There was a medium ES for mean peak HR between HT and both LT and VLT (d = 0.50 – 0.52), and a trivial ES for LT and VLT (d = 0.05).

Rating of Perceived Exertion

Figure 2 shows RPE for the three tolerance groups. There was a significant main effect of time on RPE ($F_{2.9,95.0}$ = 140.118, $P < 0.001$, $\eta p^2 = 0.805$), with RPE at each time point significantly different to the previous time point ($P < 0.001$, d = 0.72 – 2.61). There was no statistically significant effect of tolerance ($F_{2,33}$ = 0.210, P = 0.812, $\eta p^2 = 0.013$) or tolerance x time interaction ($F_{5.8,95.0}$ = 0.833, P = 0.543, $\eta p^2 = 0.048$).

Figure 2 near here

Affective valence

Figure 3A shows affective valence for the three tolerance groups. There was a significant main effect of tolerance on affective valence ($F_{2,33}$ = 9.771, $P < 0.001$, $\eta p^2 = 0.372$). Affective valence was significantly lower in VLT vs. LT (P = 0.034, d = 1.01 - 1.14) and HT (P = 0.018, d = 1.34 - 1.70) at all time points during and post-exercise. There were no significant differences between LT and HT (P = 0.862, d = 0.07 – 0.19). There was also a significant main effect of time on affective valence ($F_{2.4,77.9}$ = 4.581, P = 0.009, $\eta p^2 = 0.122$). There was no significant tolerance x time interaction ($F_{4.7,6.4}$ = 1.329, P = 0.262, ηp^2=0.075)..

Figure 3 near here

Perceived Activation

There was no significant effect of tolerance on perceived activation ($F_{2,33}$ = 1.573, *P* = 0.223, ηp^2=0.372; Figure 3B). However, there was a significant effect of time ($F_{3.7,121.9}$ = 26.11, *P* < 0.001, ηp^2=0.442), with perceived activation increasing significantly between baseline and sprint 2 (*P* < 0.001, *d* = 1.20) and decreasing significantly from sprint 10 to 20 min post-exercise (*P* = 0.014, *d* = 0.83). There was no tolerance x time interaction ($F_{7.4,121.9}$ = 26.11, *P* = 0.723, ηp^2=0.038).

Circumplex

All groups began with a sense of calmness pre-HIIE (Figure 4). The VLT group progressed to a state of negative affect and low arousal by sprints 8 and 10, associated with tiredness. The LT group generated a similar pattern to the HT group, progressing to a state of energy from sprints 4-10. The VLT and LT groups returned to calmness post-HIIE, whereas the HT group remained in a state of energy.

Figure 4 near here

Intention to repeat and exercise task self-efficacy

Significant between-groups main effects were found for intention to repeat HIIE once ($\chi2$ = 14.3, *P* = 0.001) and three times per week ($\chi2$ = 14.8, *P* = 0.001). The VLT group had significantly lower intentions to repeat HIIE at both exercise frequencies than the HT group, and lower intentions to repeat at both frequencies than the LT group, with moderate to large

ES (Table 2). Exercise task self-efficacy (Table 2) was not significantly influenced by tolerance of the intensity of exercise once per week ($\chi2 = 2.3$, $P = 0.321$) or three times per week ($\chi2 = 2.8$, $P = 0.247$).

Table 2 near here

DISCUSSION

Research investigating affective responses to HIIE has produced inconsistent findings (Stork et al., 2017). This inconsistency may partly be explained by individual differences in affective responses to HIIE. The aim of this study was to investigate the effect of the individual difference measure self-reported tolerance of the intensity of exercise on affective responses during and after low-volume HIIE. The VLT group reported significantly lower affective valence during and after low-volume HIIE, and more negative circumplex responses, compared to LT and HT. The VLT group also showed lower intentions to repeat low-volume HIIE than the LT and HT groups, and the LT group showed lower intentions to repeat than the HT group. However, there was no effect of tolerance of the intensity of exercise on task self-efficacy.

The finding that VLT participants showed significantly more negative affect than HT and LT participants during and after low-volume HIIE suggests that self-reported tolerance of the intensity of exercise moderates affective responses to HIIE. An increase in exercise intensity, particularly to beyond VT, exacerbates the influence of interoceptive cues on an individual's perception of exercise demand, which may lead to a decline in affect (Ekkekakis et al., 2011). A logical extension of this tenet is that individuals who are more tolerant to the 'accumulation' of these interoceptive cues will be more able to defend against declines in affect. Evidence supporting this suggestion can be found in steady-state and incremental exercise protocols (Ekkekakis et al., 2007; Hall et al., 2014), with recent research suggesting this tolerance has a biological basis (Tempest & Parfitt, 2016). However, this is the first study to provide support for a potentially discriminatory role of VLT of the intensity of exercise on affective responses during HIIE. Our data also supports assertions previously articulated in the growing HIIE literature that tolerance of the intensity of exercise may explain variance in affective responses (Frazao et al., 2016).

The LT group did not differ in affective responses compared with HT, which is contrary to continuous exercise studies (Ekkekakis et al., 2007; Tempest & Parfitt, 2016). Affective responses to HIIE are known to be influenced by the number and duration of work bouts and the work/rest ratio (Frazao et al., 2016; Martinez, Kilpatrick, Salomon, Jung, & Little, 2015). Therefore, the lack of difference in affect between HT and LT may be as a consequence of the 'more palatable' (Martinez et al., 2015) nature of the low volume HIIE protocol employed in this study, which LT participants were able to tolerate.

It is plausible that the greater aerobic fitness of the HT and LT groups vs. the VLT group may have contributed to the better maintenance of affect, as recovery from work bouts during HIIE is enhanced with better aerobic fitness (Tomlin & Wenger, 2001). Less complete recovery in the VLT group compared to the HT group may have led to a progressively greater homeostatic disturbance as HIIE continued, thereby causing a progressively more negative affective state (figure 3A) (Ekkekakis et al., 2011; Gaitanos, Williams, Boobis, & Brooks, 1993; Martinez et al., 2015). However, the difference in aerobic fitness between LT and VLT was small, and there was no significant difference between the groups in RPE suggesting that participants perceived they were working at an equivalent intensity. These findings indicate that aerobic fitness may have a minor moderating influence on affective responses to HIIE, and should be controlled in order to further isolate the effect of tolerance of the intensity of exercise as a moderator of affective responses to HIIE.

Several researchers have argued that HIIE does not have public health potential because participants are unlikely to adhere to it (Biddle & Batterham, 2015). In our study intention to, but not self-efficacy for future engagement in HIIE differed across the tolerance groups. It is possible that the more negative affect experienced by the VLT group during HIIE influenced their weaker intention. In a systematic review, Rhodes and Kates (2015) reported a limited relationship between affective responses and intention. It is therefore plausible that there are other explanations for these differences such as past experiences, which may also help explain the difference between HT and LT. The lack of effect of tolerance of the intensity of exercise on self-efficacy for future HIIE could suggest that the different affective responses to HIIE between the groups did not impact on self-efficacy. Rhodes and Kates (2015) reported mixed findings regarding a relationship between affective responses and self-efficacy. Future research would be valuable to examine how individual differences in tolerance of the intensity of exercise, and other variables including exercise preference, moderate the relationship between affective responses to HIIE and intention to engage in and self-efficacy for future HIIE in fully powered studies, whilst controlling for both baseline affect and pre-exercise levels of these variables (Rhodes & Kates, 2015).

Although future research should aim to replicate the findings of the current study, our data have implications for research and practice. Firstly, future studies comparing the influence of HIIE and continuous exercise on affect should control for self-reported tolerance of the intensity of exercise as a confounding variable. Practitioners may screen potential HIIE participants for tolerance of the intensity of exercise using the PRETIE-Q to assist in the prescription of appropriate activities. Although there is evidence that some individuals have positive motivating experiences participating in HIIE (Burn & Niven, 2018), it is unsurprising that is not likely to be for everyone and very low tolerance of the intensity of exercise could be a key determinant. A limitation of this study is the sample size. We provided a power calculation for a two-group analysis as this was the original methodological intention of the study. However, the subsequent three-group analysis detected a statistical significance, therefore confirming sufficient power for the statistical test to detect the effect. Furthermore, ES and conservative post hoc tests for uneven sample sizes and variances were used. A second limitation is the use of healthy young (albeit untrained) participants. Future research should replicate the study with wider age and fitness ranges, clinical populations and different HIIE protocols.

Declaration of interest

The authors have no conflicts of interest related to this paper.

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FIGURE 1. Schematic detailing the flow of participants through the study (number of participants recruited, excluded based on pre-test screening, allocated to high tolerance and low tolerance groups, and who withdrew from the study).

FIGURE 2. Ratings of perceived exertion at all time points for all groups.

* Significant main effect of time. HT = high tolerance; LT = low tolerance; VLT = very low tolerance.

FIGURE 3. Affective valence (A) and perceived activation (B) at all time points for all groups.

** Significantly lower in VLT vs. LT and HT at all time points $P = 0.034$.

*** Significant difference between time-points, $P < 0.001$ and $P = 0.014$, respectively. HT = high tolerance; LT = low tolerance; VLT = very low tolerance.

FIGURE 4. Affective circumplex model applied to the all groups. HT = high tolerance; LT = low tolerance; VLT = very low tolerance.