

Can You Have Your Vigorous Exercise and Enjoy It Too? Ramping Intensity Down Increases Postexercise, Remembered, and Forecasted Pleasure

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There is a paucity of methods for improving the affective experience of exercise. We tested a novel method based on discoveries about the relation between exercise intensity and pleasure, and lessons from behavioral economics. We examined the effect of reversing the slope of pleasure during exercise from negative to positive on pleasure and enjoyment, remembered pleasure, and forecasted pleasure. Forty-six adults were randomly assigned to a 15-min bout of recumbent cycling of either increasing intensity (0–120% of watts corresponding to the ventilatory threshold) or decreasing intensity (120–0%). Ramping intensity down, thereby eliciting a positive slope of pleasure during exercise, improved postexercise pleasure and enjoyment, remembered pleasure, and forecasted pleasure. The slope of pleasure accounted for 35–46% of the variance in remembered and forecasted pleasure from 15 min to 7 days postexercise. Ramping intensity down makes it possible to combine exposure to vigorous and moderate intensities with a pleasant affective experience.

Keywords: affective forecasting, behavioral economics, remembered utility, predicted utility

Most theories of behavior change used in the domain of public health rest on the assumption that, once provided with appropriate, accurate, and adequate information, most individuals will act to alter their behavior. When judged from the standpoint of such theories, the case of exercise appears paradoxical. While nearly everyone in western societies reports awareness of the health benefits of exercise (Martin, Morrow, Jackson, & Dunn, 2000; O'Donovan & Shave, 2007), the rates of participation are extremely low. A nationwide study in the United States, using objective assessment of physical activity with accelerometers, showed that only 3.2% of adults are active at levels recommended for health promotion (Tudor-Locke, Brashear, Johnson, & Katzmarzyk, 2010). Moreover, dropout from short-term interventions averages 45% (Marcus et al., 2006) and is even higher in field settings (Edmunds, Ntoumanis, & Duda, 2007).

Interventions designed to increase exercise and physical activity (PA) have mainly targeted cognitive constructs, such as appraisals of self-efficacy, outcome expectations, perceptions of social support, and anticipated benefits versus costs. The results of these interventions so far have been modest (Marcus et al., 2006). Thus, it seems reasonable to suggest that an expansion

of the theoretical perspective through which the problem of activity promotion is approached may be warranted.

In particular, the theories that are commonly used to explain, predict, and change PA and exercise behavior rely on the assumption that, in making behavioral decisions, people act as rational decision makers: they seek, collect, and analyze relevant information; methodically weigh pros and cons; and make probabilistic predictions about the future consequences of their actions or inactions. However, research from behavioral economics has cast doubt on the assumption that decision making is based solely on the rational evaluation of information (Stanovich & West, 2000). Explaining the notion of *bounded rationality*, Simon (1983) argued that “human beings have neither the facts nor the consistent structure of values nor the reasoning power at their disposal that would be required [to behave rationally]” (p. 17). Building on this idea, Kahneman (2003) proposed that, rather than always relying on rationality, humans use a set of *heuristics* and *biases*, which, although occasionally disadvantageous, bring the complexity of problems down to a manageable scale and help people navigate their world. One such device, called the *affect heuristic* (e.g., Finucane, Alhakami, Slovic, & Johnson, 2000), has been singled out as “probably the most important development in the study of judgment heuristics in the past few decades” (Kahneman, 2003, p. 710). The simple but powerful idea behind the affect heuristic is that judgments and decisions are influenced by affective responses (Finucane et al., 2000).

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Prompted by the desire to uncover sources of behavioral variation not captured by cognitive appraisals, researchers have started focusing on the role of affective constructs, such as pleasure and enjoyment. Despite considerable heterogeneity in their methodologies, early studies have found positive associations between affective responses during exercise bouts and subsequent PA (for reviews, see Ekkekakis & Dafermos, 2012; Rhodes & Kates, 2015). Likewise, a meta-analysis on the relationship of enjoyment and related variables (e.g., affective component of attitude, intrinsic motivation) with PA found an average correlation of 0.42, which is larger than those for self-efficacy, social and sociodemographic variables, personality factors, and attributes of the built environment (Rhodes, Fiala, & Conner, 2009). Other studies have shown that affective associations (e.g., “When I think of exercise, I feel . . .”; Kiviniemi, Voss-Humke, & Seifert, 2007) and anticipated affective responses (e.g., “I will feel regret if I do not exercise over the next four weeks”; Conner, McEachan, Taylor, O’Hara, & Lawton, 2015; Dunton & Vaughan, 2008) are also significantly associated with PA participation.

This preliminary evidence demonstrates that targeting affective constructs in interventions aimed at promoting PA may hold promise. However, there is presently a surprising dearth of information on *how* to make PA and exercise more pleasant. Many researchers consider reduced pleasure and enjoyment during the early stages of exercise interventions as more-or-less unavoidable. For example, Wilson, Rodgers, Blanchard, and Gessell (2003) wrote that, at the initial stages, exercise is “unlikely to be construed as inherently pleasurable or enjoyable” (p. 2375). Indeed, research with chronically sedentary and/or low-fitness participants shows declines in pleasure over most of the range of exercise intensity (e.g., Ekkekakis, Lind, & Vazou, 2010; Sheppard & Parfitt, 2008; Welch, Hulley, Ferguson, & Beauchamp, 2007). Likewise, interventions with formerly sedentary adults have found reductions in enjoyment (Castro, Sallis, Hickmann, Lee, & Chen, 1999; Stevens, Lemmink, van Heuvelen, de Jong, & Rispen, 2003).

The present study was designed to examine the effect of manipulating the slope of pleasure–displeasure during an exercise bout on how pleasant or unpleasant the bout is later remembered (“remembered utility” in behavioral-economic terms) and how pleasant or unpleasant future bouts are expected to be (“predicted utility” in behavioral-economic terms, typically referred to as *affective forecasting* in psychology). In behavioral economics, it has been theorized that both the remembered utility and the predicted utility of an experience predict whether a behavior will be repeated (Ariely & Carmon, 2000; Kahneman, Wakker, & Sarin, 1997). Accumulating evidence indicates that anticipated affect and enjoyment are indeed associated with PA intentions and behavior (Conner et al., 2015; Dunton & Vaughan, 2008; Helfer, Elhai, & Geers, 2015; Loehr & Baldwin, 2014).

It is generally assumed that predictions of how pleasant or unpleasant an experience will feel depends on

how similar past experiences have registered in memory. From the standpoint of intervention, the question, then, is how the affective memories of and the affective forecasts for exercise can be improved. Intuition perhaps suggests that the entire exercise session should be made more pleasant. However, research shows that not all aspects of an episode are equally influential in shaping the memory of that episode. Evidence from behavioral economics has shown that people prefer experiences during which pleasure increases over time to those that involve decreasing pleasure, even if the total amount of derived pleasure is the same (Ariely & Carmon, 2000; Ariely & Zauberman, 2003; Zauberman, Diehl, & Ariely, 2006). This finding is relevant to exercise since, among individuals with a low level of cardiorespiratory fitness, even relatively low workloads can result in the inability to maintain a physiological “steady state.” In such cases, physiological variables associated with metabolic strain, including heart rate, oxygen uptake, and blood lactate, exhibit a continuous upward “drift.” In turn, this trend is associated with declining levels of pleasure (Ekkekakis, Parfitt, & Petruzzello, 2011) and the rising desire to stop. Thus, exercise bouts with nonathletic participants typically culminate with the highest level of physiological strain and perceived exertion, as well as the lowest level of pleasure (e.g., Lind, Joens-Matre, & Ekkekakis, 2005).

Thus, the purpose of the current study was to explore the psychological implications of changing the pattern of exercise intensity during a bout, from the typical increasing slope to a decreasing slope. In a between-subject design, we compared two bouts of similar physiological demands but opposite intensity slopes, one increasing (intended as a simulation of a typical bout) and the other decreasing. Based on evidence from exercise-psychological research (Ekkekakis et al., 2011), we expected that this manipulation would result in opposite slopes of pleasure ratings, with continuous during-exercise decline in the increasing-intensity group but continuous improvement in the decreasing-intensity group. In turn, based on evidence from behavioral economics (Ariely & Carmon, 2000), we hypothesized that participants in the decreasing-intensity (increasing-pleasure) group would report more postexercise pleasure and enjoyment, would remember the exercise bout as having been more pleasant, and would forecast that a future bout would be more pleasant than participants in the increasing-intensity (decreasing-pleasure) group.

Method

Participants

Power calculations for a between-within interaction in a 2 (groups) by 5 (time points) design, anticipating a “small” to “medium” effect ($f = 0.15$), $\alpha = .05$, $1 - \beta = 0.80$, correlated dependent variables ($r = .70$), and a violation of the assumption of sphericity ($\epsilon = 0.70$) indicated a required total sample size of 44. Participants were deemed eligible if they (a) were between the ages of 18

and 40 years, (b) were not pregnant, (c) had no history of cardiometabolic disease, (d) experienced no pain or dizziness during exercise, (e) did not use supplemental oxygen for breathing, and (f) had no metal allergies or implanted electromagnetic devices. No restriction was placed on gender or habitual PA. We opted for a heterogeneous sample and thus a more stringent test of our hypotheses (i.e., under conditions of unrestricted within-group variance).

Following Institutional Review Board approval, 54 members of a university community (21 women and 33 men, mainly staff members) responded to e-mail solicitations and satisfied the inclusion/exclusion criteria. After the initial exercise test (as described below), the ventilatory threshold could not be determined unambiguously in seven cases, so these individuals were not scheduled for additional sessions. One additional individual suffered an injury unrelated to the study. Thus, 46 individuals (15 women, 31 men) completed all sessions and were included in the analyses. Of them, 6 women and 16 men ($n = 22$) were randomly allocated to the increasing-intensity group, whereas 9 women and 15 men ($n = 24$) were allocated to the decreasing-intensity group. Additional characteristics are presented in Table 1.

Measures

Pleasure during and after exercise. The core affective dimension of valence is conceptualized as bipolar, ranging from pleasure to displeasure (Russell, 1980). It was assessed with the Feeling Scale (FS; Hardy & Rejeski, 1989), a single-item, 11-point bipolar rating scale ranging from +5 (I feel *very good*) to -5 (I feel *very bad*) and verbal anchors at zero (*neutral*) and odd numbers. Concurrent validity data have been reported by Hardy and Rejeski (1989). The use of a single-item rating scale was

deemed necessary, as it allowed the collection of data with adequate temporal resolution during the exercise bouts, while minimizing respondent burden.

Remembered pleasure. To minimize common-method variance, remembered pleasure–displeasure was assessed using a scale with a different format than the FS. Specifically, a visual analog scale (VAS) was used, in response to the question, “How did the exercise session in the laboratory make you feel?” The scale ranged from *very pleasant* (+100) to *very unpleasant* (-100) in intervals of 1. Participants responded using a computer by moving an on-screen slider. The slider was initially positioned in the middle (0). The verbal descriptors and slider were visible to participants but the numbers were not.

Forecasted pleasure. Again, to minimize common-method variance, forecasted pleasure was assessed using a scale with a different format than the scales used during exercise (i.e., FS) and for the assessment of remembered pleasure (i.e., VAS). Specifically, participants responded to the question, “If you repeated the exercise session again, how do you think it would make you feel?” using the Empirical Valence Scale (EVS; Lishner, Cooter, & Zald, 2008) presented on a computer screen. Respondents chose from 15 empirically spaced verbal anchors, ranging from *most unpleasant imaginable* (-100) to *most pleasant imaginable* (+100). The value associated with each verbal anchor corresponded to the values specified by Lishner et al. (2008).

Postexercise enjoyment. Enjoyment of the exercise session was measured with the Physical Activity Enjoyment Scale (PACES; Kendzierski & DeCarlo, 1991). In accordance with the standard instructions, respondents were asked to “rate how you feel at the moment about the physical activity you have been doing.” The PACES

Table 1 Participant Characteristics ($M \pm SD$)

	Intensity-Pattern Group	
	Increasing Intensity ($n = 22$)	Decreasing Intensity ($n = 24$)
Men/Women	16/6	15/9
Age (years)	28 \pm 5	27 \pm 4
Height (cm), Men	176 \pm 6	178 \pm 6
Height (cm), Women	164 \pm 8	167 \pm 6
Body Mass (kg), Men	82 \pm 17	78 \pm 9
Body Mass (kg), Women	69 \pm 13	67 \pm 16
Body Mass Index ($\text{kg}\cdot\text{m}^{-2}$), Men	26 \pm 5	25 \pm 2
Body Mass Index ($\text{kg}\cdot\text{m}^{-2}$), Women	25 \pm 3	24 \pm 4
Planned Exercise ($\text{min}\cdot\text{week}^{-1}$)	328 \pm 247	356 \pm 245
Incidental PA ($\text{min}\cdot\text{week}^{-1}$)	790 \pm 739	707 \pm 591
$\text{VO}_{2\text{peak}}$ ($\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$), Men	27 \pm 8	32 \pm 5
$\text{VO}_{2\text{peak}}$ ($\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$), Women	29 \pm 12	26 \pm 4
VT ($\%\text{VO}_{2\text{peak}}$)	62 \pm 11	56 \pm 9

Note. PA = physical activity; VT = ventilatory threshold. For all group comparisons, $p > .05$.

consists of 18 bipolar items (e.g., *I enjoy it* versus *I hate it*), with the polar opposites separated by a 7-point scale ("4" being the midpoint). Validation studies by Kendzierski and DeCarlo (1991) have shown a negative correlation with boredom and a significant prediction of choice between different activities. In the present sample, the PACES exhibited high internal consistency (Cronbach's $\alpha = .95$).

Perceived exertion. As a manipulation check, perceptions of exertion were assessed with the Rating of Perceived Exertion (RPE; Borg, 1998), which ranges from 6 (*No exertion at all*) to 20 (*Maximal exertion*). The validity of this scale has been established through correlations with physiological indices, including ventilation, oxygen uptake, and lactate accumulation (Chen, Fan, & Moe, 2002).

Physical activity. For descriptive purposes, the Incidental and Planned Exercise Questionnaire (IPEQ-WA; Delbaere, Hauer, & Lord, 2010) was used as a measure of habitual PA. The IPEQ-WA includes questions inquiring about both planned exercise (e.g., exercise classes) and weekly incidental PA behavior (e.g., walking for transportation).

Procedure

Using a computer algorithm, participants were randomly assigned to either an increasing-intensity or a decreasing-intensity group. Participation consisted of three visits to the laboratory: (a) an initial session for maximal exercise testing, (b) an experimental exercise session, and (c) a follow-up outcome-assessment session. The three visits were separated by 1 week and were scheduled at the same time of day for each participant, to control for possible diurnal variation.

Session 1: Maximal exercise test. The purposes of this session were to (a) collect anthropometric data; (b) determine peak aerobic capacity and ventilatory threshold, used in setting the workload for the subsequent experimental session; and (c) familiarize participants with the self-report measures. After completing the informed consent process and the IPEQ-WA, participants had their height (wall-mounted stadiometer) and weight (BF-626, Tanita, Tokyo, Japan) measured. Participants were then fitted with a heart rate monitor (Polar, Kempele, Finland) and a nose-and-mouth facemask for the collection of expired gases (Hans Rudolph, Kansas City, MO) and had the standard instructions for FS and RPE read to them.

Testing was conducted with a computer-controlled, electronically braked recumbent cycle ergometer (Corival Recumbent, Lode BV, Groningen, Netherlands). Oxygen uptake and carbon dioxide production were measured with a metabolic cart (TrueOne 2400, ParvoMedics, Salt Lake City, UT), which was calibrated before each use. After a 5-min warm-up (0 W), the workload increased in a ramp fashion (1 W every 4 s). To gain experience with the FS and RPE, participants reported their responses

to these scales each minute during the test by pointing on laminated poster-size versions of the scales (kept out of the field of vision at other times). Upon reaching volitional exhaustion, the facemask was removed and participants did a 5-min cool-down (0 W), followed by a 5-min rest period. Thereafter, the participants responded to the VAS and EVS, as an opportunity to familiarize themselves with these scales as well.

The ventilatory threshold was later determined by consensus by two judges who worked independently, analyzing the gas exchange data offline with the aid of a software program (WinBreak 3.7, Epistemic Mindworks, Ames, IA). The software combines three methods (V-slope, ventilatory equivalents, excess CO₂), as recommended by Gaskell, Ruby, Walker, Sanchez, Serfass, and Leon (2001). The ventilatory threshold could not be determined unambiguously (due to excessive noise in the gas exchange data) for seven individuals. Rather than subjecting these individuals to additional testing, they were excluded from the rest of the study.

Session 2: Experimental session. Participants returned 1 week later for the experimental session. Preparatory procedures identical to those of Session 1 were followed (i.e., fitting of heart rate monitor, rereading of instructions for FS and RPE), but no facemask was used (and no expired gases were collected), to enhance external validity. The exercise consisted of recumbent stationary cycling on the same ergometer used for maximal testing. The increasing-intensity group started at 0 W and progressed to 120% of the watts corresponding to the ventilatory threshold over 15 min. Conversely, the decreasing-intensity group started at 120% of the watts corresponding to the ventilatory threshold and progressed to 0 W over 15 min. The workload and time passed were not visible to participants. Participants responded to the FS immediately before exercise; during the last 15 s of Minutes 3, 6, 9, 12, and 15 of the 15-min bout; and 2, 5, and 10 min after exercise. The RPE data were collected at the during-exercise time points.

After exercise, participants rested in a recliner. Fifteen minutes postexercise, after being left alone in the room, participants used a computer to respond to the VAS and EVS, for the assessment of remembered and forecasted pleasure, respectively. Next, participants completed the PACES. Finally, participants were informed that they would receive a follow-up e-mail message, 24 hr later, with an Internet link, for one more administration of the VAS and EVS.

Session 3: Follow-up outcome assessment. Participants returned to the laboratory 1 week later, to respond to the VAS and EVS. They were then thanked, debriefed, and released.

Statistical Analysis

As a manipulation check, an intensity-pattern (between) by time (within) MANOVA was used to investigate the effect of intensity pattern on the percentages of peak

heart rate ($\%HR_{\text{peak}}$), RPE, and FS at Minutes 3, 6, 9, 12, and 15 during exercise. To determine the effect of the experimental manipulation on postexercise pleasure, an intensity-pattern group (between) by time (within) ANOVA was used, with FS ratings obtained 2, 5, and 10 min after exercise as the dependent variable. For both the MANOVA and ANOVA, if the sphericity assumption was violated, the Greenhouse–Geisser adjustment was applied to the degrees of freedom. The individual slopes of FS during exercise (Minutes 3, 6, 9, 12, and 15) were calculated by linear regression. A series of regression analyses were then conducted to determine (a) the association of the slope of pleasure during exercise with ratings of remembered pleasure, (b) the association of remembered pleasure with forecasted pleasure, and (c) the association of the slope of pleasure during exercise with forecasted pleasure. Separate analyses were conducted for assessments completed 15 min, 24 hr, and 7 days postexercise. Likewise, a regression analysis was used to determine the association of the slope of pleasure during exercise with postexercise enjoyment. Finally, correlations were used to assess the association of the average pleasure ratings during exercise with remembered pleasure, forecasted pleasure, and postexercise enjoyment.

Results

Participant Characteristics

The two groups did not differ with respect to the assessed demographic, anthropometric, behavioral, and physiological characteristics (see Table 1). Half of the participants (48%) were overweight or obese. Although the average levels of planned exercise and incidental PA suggest an active sample, there was considerable heterogeneity and apparent discordance between self-reported PA and objectively assessed cardiorespiratory fitness. Based on self-reports (IPEQ-WA), 77% of participants reported never attending exercise classes. Only 3 of 46 reported attending exercise classes on three or more days per week. Most (61%) reported never doing any exercise at home. Only 4 of 46 reported doing some exercise at home on five or more days per week. Half (53%) reported never walking for exercise, while 31% reported some walking for exercise but on fewer than 5 days per week. Although 40% reported some walking for transportation on a daily basis, 83% walked for less than 30 min per day. The average level of cardiorespiratory fitness for both men ($29.33 \pm 7.30 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$) and women ($27.16 \pm 8.03 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$) was “poor” (bottom 25%) by normative standards for cycle ergometry (American College of Sports Medicine, 2013, p. 84).

Manipulation Checks

The MANOVA showed no significant effect of group, Pillai's $V = .15$, $F(3, 38) = 2.18$, $p = .11$, $\eta^2 = .15$, which suggests that the two groups were exposed to similar

overall levels of exercise intensity ($\%HR_{\text{peak}}$), perceived exertion (RPE), and during-exercise pleasure (FS). On the other hand, there was a significant group-by-time interaction, Pillai's $V = .83$, $F(12, 480) = 15.32$, $p < .001$, $\eta^2 = .28$. Univariate tests revealed that the interaction was significant for all three dependent variables: (a) $\%HR_{\text{peak}}$, $F(1.37, 54.79) = 129.78$, $p < .001$, $\eta^2 = .76$; (b) RPE, $F(1.32, 52.89) = 55.63$, $p < .001$, $\eta^2 = .58$; and (c) FS, $F(1.83, 72.99) = 31.85$, $p < .001$, $\eta^2 = .44$. As expected, in the increasing-intensity group, HR and RPE increased over time, whereas FS ratings declined over time. The opposite trends were evident in the decreasing-intensity group (see Figure 1). Importantly, the average FS ratings in the decreasing-intensity (1.91 ± 1.45) and increasing-intensity groups (2.04 ± 1.34) did not differ significantly, $t(44) = -0.31$, $p = .76$, $d = 0.09$, indicating that the total amount of reported pleasure was similar in the two groups. Moreover, baseline FS levels did not differ significantly (increasing intensity: 2.23 ± 1.95 ; decreasing intensity: 2.83 ± 1.88 , $t(44) = 1.07$, $p = .29$, $d = -0.32$), suggesting that subsequent changes in FS were unlikely to reflect the law of initial values or regression to the mean.

On the other hand, the individual slopes of during-exercise FS ratings differed significantly between the two groups, $t(44) = 7.24$, $p < .001$, $d = -2.14$. As expected, in the increasing-intensity group, the slope of FS was negative (-0.16 ± 0.17), whereas, in the decreasing-intensity group, the slope was positive ($+0.22 \pm 0.18$). Of the 22 participants allocated to the increasing-intensity group, 17 (77%) showed negative FS slopes (2 had slopes of zero and 3 had near-zero positive slopes, from 0.03 to 0.10). Conversely, of the 24 participants allocated to the decreasing-intensity group, 20 (83%) showed positive FS slopes (1 had a slope of zero and 3 had near-zero negative slopes, from -0.03 to -0.07). Following the intention-to-treat principle, all participants were analyzed in the group to which they were originally allocated.

Postexercise Pleasure

A 2 (groups) by 3 (time points: 2, 5, 10 min postexercise) ANOVA on postexercise FS ratings revealed no main effect of time, $F(1.19, 52.45) = 0.06$, $p = .84$, $\eta^2 = .001$, and no group-by-time interaction, $F(1.19, 52.45) = 0.06$, $p = .84$, $\eta^2 = .001$. There was, however, a significant main effect of group, $F(1, 44) = 4.39$, $p = .04$, $\eta^2 = .09$. The mean postexercise FS rating was 3.38 ± 1.25 for the decreasing-intensity group and 2.56 ± 1.39 for the increasing-intensity group, $t(44) = 2.09$, $p = .04$, $d = -0.62$.

Postexercise Enjoyment

An independent-sample t test on postexercise PACES scores showed a significant difference between groups, $t(43) = 3.32$, $p = .002$, $d = -0.99$. Specifically, the decreasing-intensity group averaged 100.39 ± 11.46 , whereas the increasing-intensity group averaged 86.64

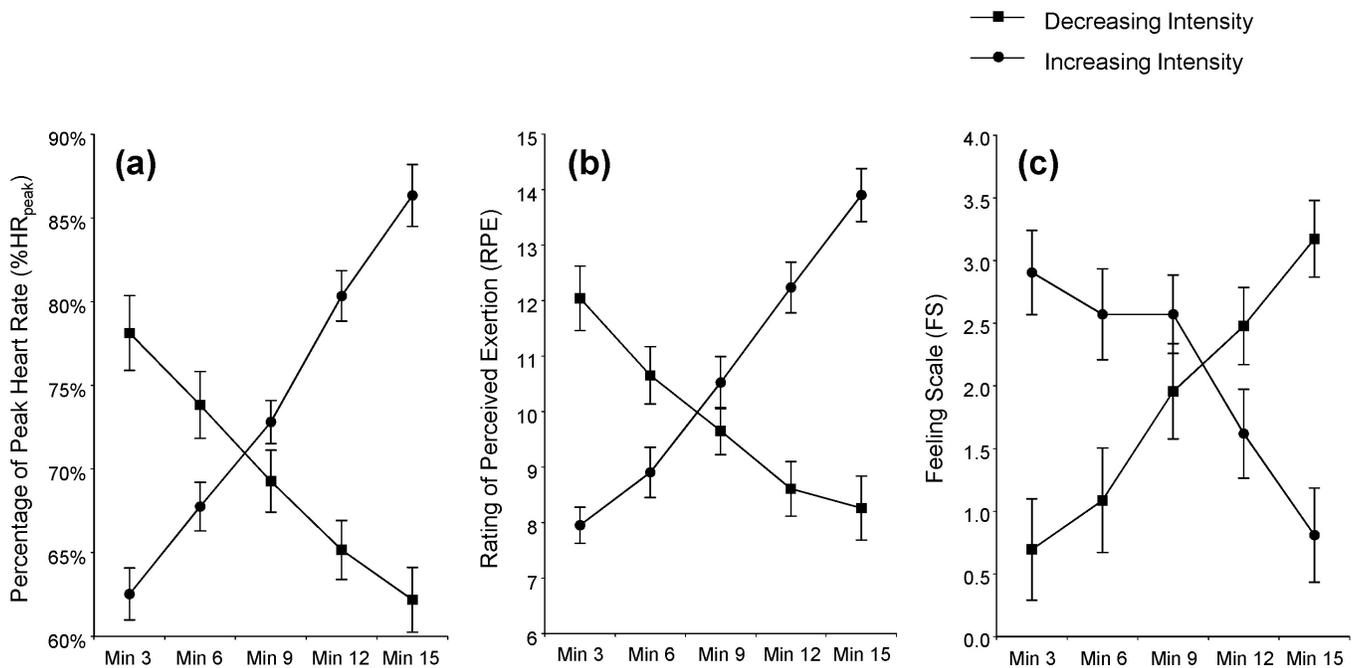


Figure 1 — Percentages of peak heart rate (Panel a), ratings of perceived exertion (Panel b), and Feeling Scale scores (Panel c) in the decreasing-intensity (filled squares) and increasing-intensity (filled circles) groups during exercise. The error bars indicate standard errors.

± 16.04 , on a scale on which 72 is the midpoint and 126 represents maximum enjoyment.

Remembered and Forecasted Pleasure

A 2 (groups) by 3 (time points: 15 min, 24 hr, 7 days) MANOVA on remembered (VAS) and forecasted pleasure (EVS) showed no significant main effect of time, Pillai's $V = .06$, $F(4, 168) = 1.31$, $p = .27$, $\eta^2 = .03$, but a significant main effect of group, Pillai's $V = .333$, $F(2, 41) = 10.22$, $p < .001$, $\eta^2 = .33$. The decreasing-intensity group averaged significantly higher levels of both remembered pleasure (55.51 ± 23.45 vs. 25.05 ± 27.95), $t(44) = 4.02$, $p < .001$, $d = -1.19$, and forecasted pleasure (51.75 ± 22.67 vs. 31.47 ± 26.05), $t(44) = 2.82$, $p = .007$, $d = -0.83$. There was also a significant group-by-time interaction, Pillai's $V = .14$, $F(4, 168) = 3.23$, $p = .014$, $\eta^2 = .07$. Follow-up univariate ANOVAs showed that the interaction was significant only for remembered pleasure, $F(2, 84) = 6.62$, $p = .002$, $\eta^2 = .14$. The interaction was driven by a gradual decline in the decreasing-intensity group from 65.09 ± 21.81 at 15 min postexercise to 56.77 ± 21.88 a day later, $t(21) = 3.00$, $p = .006$, and to 51.42 ± 25.40 a week later, $t(23) = 4.24$, $p < .001$. Conversely, the increasing-intensity group showed a smaller, non-significant improvement from 22.41 ± 30.02 at 15 min postexercise to 27.41 ± 26.09 a week later. Despite this convergence, even a week after the experimental session, the difference between groups was still significant and large, $t(44) = 3.16$, $p = .003$, $d = -0.93$.

Slope of Pleasure, Postexercise Enjoyment, Remembered, and Forecasted Pleasure

The slope of FS ratings during exercise significantly predicted postexercise PACES scores, $r = .58$, $r^2 = .33$, $b = 33.86$, $F(1, 43) = 21.21$, $p < .001$. Similarly, in a series of simple regressions, the slope of FS ratings predicted all VAS ratings of remembered pleasure: (a) 15 min: $r = .68$, $r^2 = .46$, $b = 88.04$, $t = 6.17$, $p < .001$; (b) 24 hr: $r = .64$, $r^2 = .40$, $b = 77.31$, $t = 5.33$, $p < .001$; (c) 7 days: $r = .59$, $r^2 = .35$, $b = 64.57$, $t = 4.87$, $p < .001$. Likewise, the slope of FS ratings predicted all EVS ratings of forecasted pleasure: (a) 15 min: $r = .63$, $r^2 = .40$, $b = 72.89$, $t = 5.43$, $p < .001$; (b) 24 hr: $r = .61$, $r^2 = .37$, $b = 61.84$, $t = 4.94$, $p < .001$; (c) 7 days: $r = .61$, $r^2 = .37$, $b = 62.01$, $t = 5.04$, $p < .001$ (see Figures 2 and 3). Because the "24-hr" VAS and EVS ratings were not entered exactly 24 hr after exercise, hierarchical regressions were also conducted, with the actual time (in minutes) since the exercise session entered as the first step. Variation in the time of data entry was unrelated to predicted ($p = .30$) and forecasted ($p = .16$) pleasure, leaving the 24-hr VAS and EVS results essentially unchanged: $b = 76.50$, $t = 5.27$, $p < .001$, and $b = 60.85$, $t = 4.93$, $p < .001$, respectively. Despite the use of different ratings scales, remembered pleasure and forecasted pleasure at each time point were strongly interrelated: (a) 15 min: $r = .84$, $p < .001$; (b) 24 hr: $r = .85$, $p < .001$; (c) 7 days: $r = .88$, $p < .001$.

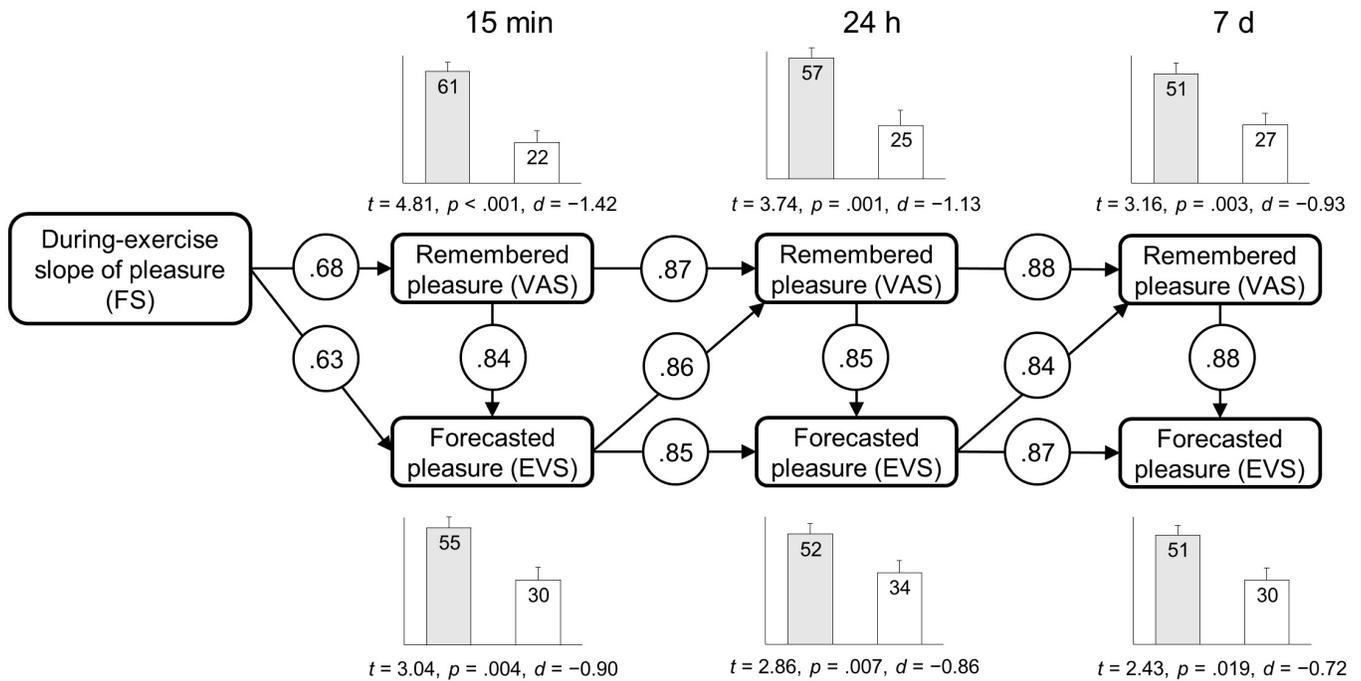


Figure 2 — Cross-lagged correlations of during-exercise slope of pleasure with remembered and forecasted pleasure, 15 min, 24 h, and 7 days after the exercise bout (for all correlation coefficients, $p < .001$). Comparisons of remembered and forecasted pleasure between the decreasing-intensity (gray bars) and increasing-intensity (white bars) groups at each of the three time points are shown in the bar graphs.

Mean Pleasure and Postexercise Enjoyment, Remembered, and Forecasted Pleasure

Unlike the slope of during-exercise FS ratings, the average FS rating during exercise was unrelated to enjoyment, remembered pleasure, and forecasted pleasure. The correlation coefficients ranged from $r = .14$, $p = .37$, to $r = .26$, $p = .09$.

Discussion

The exercise promotion literature seems to reflect a resignation to the idea that, for individuals who are chronically sedentary and/or have low cardiorespiratory fitness, exercise is unlikely to be experienced as pleasant. This is accepted as the unavoidable “price of admission,” a “necessary evil,” that new exercisers must endure. Most techniques being used to improve the exercise experience (i.e., mainly cognitive interventions, including manipulations of attentional focus) aim to attenuate the degree of unpleasantness, thus making the exercise more *tolerable*, though not necessarily *pleasant*. However, under conditions of self-determination, for exercise to be sustainable in the long term, it should be not just tolerable but more pleasant than sedentary alternatives competing for a portion of discretionary time (Ekkekakis & Dafermos, 2012).

The present study tested an innovative method, derived from a cross-disciplinary evidence base, combining the fields of exercise psychology and behavioral economics. Specifically, research on the relation between exercise intensity and pleasure informed the intensity manipulations used in this study. This evidence indicates that an intensity that exceeds the ventilatory threshold results in declining pleasure ratings, whereas the cessation of suprathreshold exercise leads to a robust rebound in pleasure (Ekkekakis et al., 2011), reminiscent of the affective contrast effect described by Solomon (1980). On the other hand, evidence from behavioral economics has shown that the slope of change of pleasure–displeasure during an episode weighs heavily on subsequent retrospective evaluations of the experience (Ariely, 1998). Based on such findings, Ariely and Carmon (2000) suggested that “summary evaluations may benefit from an (unneeded) initial low point in the experience profile, since this allows for greater improvement over the duration of the experience” (p. 199). Ariely and Carmon (2000) anticipated reactions to the seemingly counterintuitive nature of their suggestion: “if we ask decision makers directly if they prefer to add an undesirable start to their experience, they will most likely say no” (p. 199). Yet, they predicted that “such an addition may be ‘better for them’ in terms of their global evaluations” (p. 199).

The present findings are consistent with this suggestion, as we observed robust benefits in the

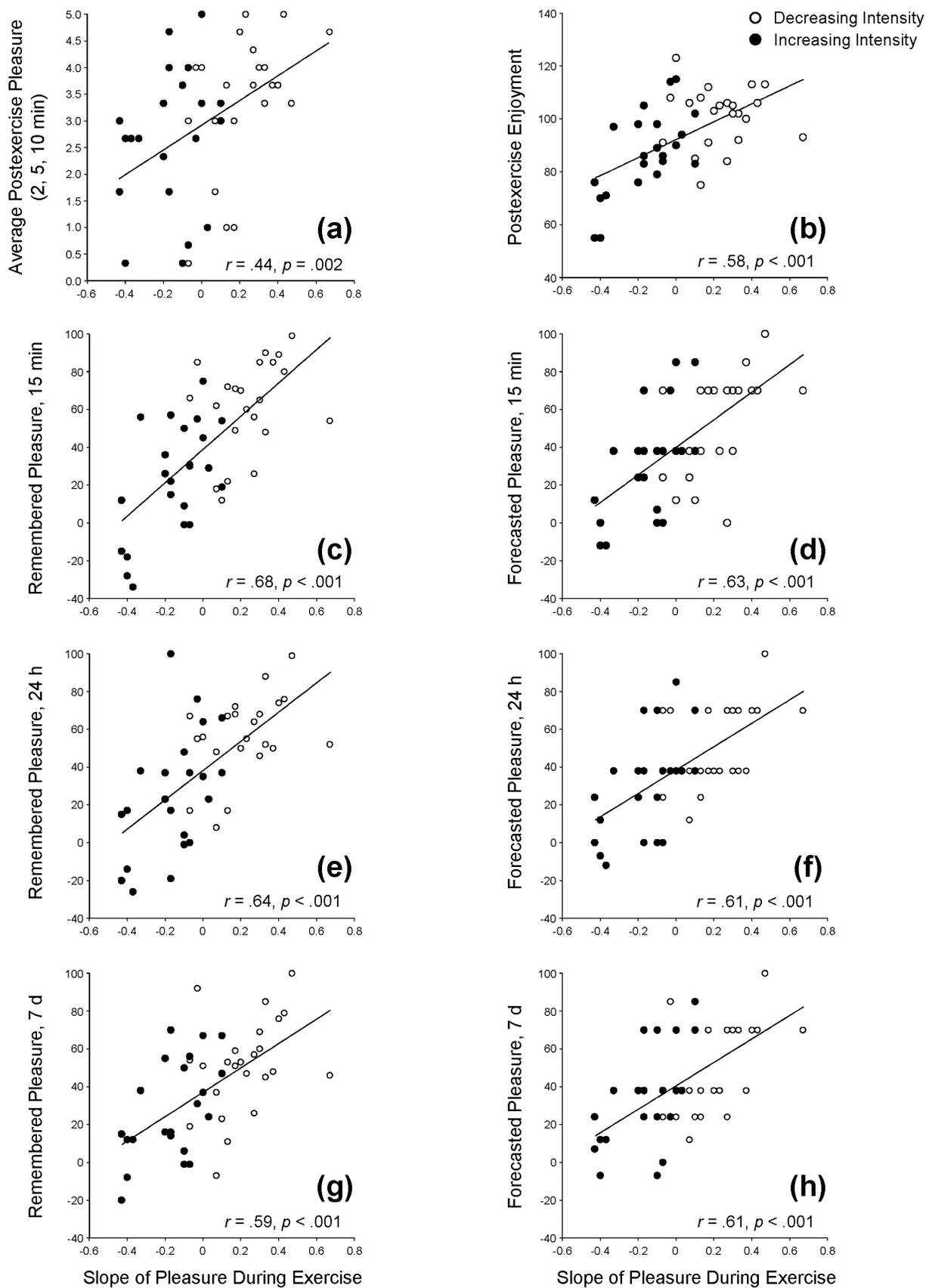


Figure 3 — Scatterplots illustrating the association of the slope of pleasure during the exercise bout with (a) postexercise pleasure (average of ratings at 2, 5, and 10 min postexercise), (b) postexercise enjoyment, (c) remembered pleasure (15 min postexercise), (d) forecasted pleasure (15 min postexercise), (e) remembered pleasure (24 hr postexercise), (f) forecasted pleasure (24 hr postexercise), (g) remembered pleasure (7 days postexercise), and (h) forecasted pleasure (7 days postexercise). Pearson product–moment correlation coefficients and associated probability values are shown for each graph.

decreasing-intensity (i.e., increasing-pleasure) group compared with the increasing-intensity (i.e., decreasing-pleasure) group in postexercise pleasure and enjoyment, as well as in remembered and forecasted pleasure for up to a week later. Moreover, consistent with the theoretical prediction (Ariely & Carmon, 2000), unlike the *slope* of pleasure, the *average* pleasure (and, therefore, also the total amount of derived pleasure) reported during the exercise bout was unrelated to postexercise enjoyment, remembered pleasure, and forecasted pleasure.

These findings have considerable potential implications for exercise promotion. These become readily apparent when the study is placed within the context of the ongoing heated debate about the role of exercise intensity in exercise adoption and adherence. Since the mid-1990s, PA recommendations issued by scientific organizations and governmental agencies have focused primarily on moderate-intensity activity (approximately corresponding to “brisk” walking). This approach has been based on “the belief that the promotion of moderate-intensity exercise would lead to greater adoption and adherence to exercise [compared to vigorous-intensity exercise]” (Garber et al., 2011, pp. 1346–1347). However, with increased recognition of the added health benefits that can be achieved with higher levels of intensity (e.g., Swain & Franklin, 2006), since 2007 the American College of Sports Medicine and the American Heart Association have explicitly endorsed vigorous-intensity activity as an option, alongside moderate-intensity activity (Haskell et al., 2007). Moreover, for individuals with diabetes and other cardiovascular risk factors, the American Heart Association, citing evidence of robust cardiometabolic adaptations, has noted that “vigorous intensities should be targeted if tolerated and with consideration of contraindications” (Marwick et al., 2009, p. 3253).

To improve tolerability for nonathletic participants, high-intensity sessions are structured as a sequence of brief intense spurts interspersed with periods of rest or active recovery. This pattern has become known as *high-intensity interval training* (HIIT). Proponents argue that HIIT offers the opportunity for the accrual of cardiometabolic adaptations in a time-efficient manner because HIIT sessions can be of shorter total duration than typical moderate-intensity sessions (Jung, Bourne, & Little, 2014). In contrast, skeptics counter that HIIT might be of limited value as a public-health intervention because the inherent displeasure of high-intensity exercise could discourage most participants and adversely influence adherence (Biddle & Batterham, 2015; Hardcastle, Ray, Beale, & Hagger, 2014; Lunt et al., 2014).

The present study represents an attempt to advance the discourse beyond the seemingly stagnant and polarizing debate on moderate-versus-vigorous intensity. The pattern of intensity tested in this study (i.e., continuous ramp-down) is the first known attempt to respond to the challenge issued by Dishman (1982) over three decades ago, namely to devise a hitherto-elusive “compromise between the ideal physiological prescription and a manageable behavioral prescription” (p. 248). It is also

the first attempt to develop an exercise prescription that targets the promotion of pleasure as a central consideration alongside effectiveness and safety (as proposed by Ekkekakis et al., 2011) and the first prescription to directly incorporate theorizing from a discipline outside the exercise sciences (i.e., behavioral economics).

Participants in the decreasing-intensity group received, on average, approximately 5 min (i.e., 33%) of exercise within the “vigorous” range, defined by the American College of Sports Medicine (2013, p. 5) as extending from 77% to < 94% of maximal heart rate (i.e., Minute 2: 78% ± 10%; Minute 3: 78% ± 10%; Minute 4: 77% ± 10%; Minute 5: 76% ± 10%). Yet their ratings of affective valence, after the initial drop (pre: 2.83 ± 1.88; Minute 3: 0.67 ± 1.90), started an upward trend (Minute 6: 1.08 ± 1.95), responding to the progressively decreasing intensity, consistent with the affective contrast effect (Solomon, 1980). The participants remained, on average, within the range of “moderate” intensity, defined as extending from 64% to < 77% of maximal heart rate, until Minute 13 (Minute 12: 65% ± 8%; Minute 13: 64% ± 9%; Minute 14: 63% ± 8%). Overall, the bout of decreasing intensity provided a reasonable combination of vigorous and moderate intensity.

At the same time, the pattern of intensity observed in the increasing-intensity group represents a realistic simulation of a typical exercise bout exhibiting a continuous upward “drift” of physiological parameters. The percentage of peak heart rate increased from 63% ± 7% (Minute 3) to 86% ± 8% (Minute 15) and RPE increased from 8.04 ± 1.53 (Minute 3) to 14.00 ± 2.18 (Minute 15). For example, low-fitness middle-aged women ($\text{VO}_{2\text{peak}}$: 22.98 ± 5.69 ml·kg⁻¹·min⁻¹) who were asked to exercise on a treadmill at their self-selected pace for 20 min started from 67% ± 13% of peak heart rate after the warm-up and progressed to 83% ± 13% at Minute 20. Their RPE rose from 8.87 ± 1.77 to 13.78 ± 1.95 (Lind et al., 2005).

Limitations of the current study that future investigations should address include the following. First, while the sample consisted of community volunteers with heterogeneous PA profiles and “poor” average cardiorespiratory fitness, it remains to be seen whether the results can be replicated in samples with different characteristics (e.g., participants with higher cardiorespiratory fitness or participants with obesity, diabetes, or coronary artery disease). Second, even though this study demonstrated robust differences in during-exercise pleasure and immediate postexercise pleasure and enjoyment, as well as more distal remembered and forecasted pleasure, future investigations should examine the effects of repeated sessions involving intensity ramp-downs on PA behavior and exercise adherence.

In conclusion, we developed and tested an innovative and practical exercise bout that combines exposure to meaningful doses of vigorous and moderate intensity with significantly improved postexercise pleasure and enjoyment, remembered pleasure, and forecasted pleasure. Exercise resulting in more pleasure during the bout (Ekkekakis & Dafermos, 2012; Rhodes & Kates, 2015),

more enjoyment (Rhodes et al., 2009), more remembered pleasure (Brewer, Manos, McDevitt, Cornelius, & van Raalte, 2000), and more forecasted pleasure (Conner et al., 2015; Dunton & Vaughan, 2008; Helfer et al., 2015; Loehr & Baldwin, 2014) should lead to higher levels of subsequent PA and exercise participation.

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