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2 **Increasing the pleasure and enjoyment of exercise: A novel resistance training protocol**

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4 Jasmin C. Hutchinson^{1*}, Zachary Zenko², Sam Santich¹, & Paul C. Dalton³

5 ¹Springfield College, Department of Exercise Science and Sport Studies, Springfield, MA.

6 ²California State University Bakersfield, Department of Kinesiology, Bakersfield, CA.

7 ³Lebanon Valley College, Department of Exercise Science, Annville, PA.

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18 ***Corresponding Author:**

19 Jasmin C. Hutchinson

20 Springfield College

21 Department of Exercise and Sport Studies

22 Phone: 413-748-3601

23 E-mail: jhutchinson@springfieldcollege.edu

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Abstract

This study was designed to test the effect of an increasing (UP) or decreasing (DOWN) intensity resistance training (RT) protocol on pleasure and enjoyment of RT. Participants ($N = 40$; mean age = 35.0 ± 9.2 years) completed two RT sessions comprising 3 x 10 reps of six exercises. In the UP condition, load progressively increased from 55% to 75% of 1-repetition maximum (1-RM) while in the decreasing-intensity DOWN condition, this pattern was reversed (i.e., 75% to 55% 1-RM). The DOWN condition resulted in more overall pleasure compared to UP, and a slope of increasing pleasure while the UP condition resulted in decreasing pleasure. Enjoyment of RT, postexercise pleasure, and remembered pleasure were all significantly greater for DOWN compared to UP (all $p > .01$). These findings suggest that decreasing RT intensity throughout an exercise bout can elicit a positive slope of pleasure and enhance affective evaluations of exercise. (149 words)

Keywords: Affect, resistance exercise, behavioral economics, remembered utility

Regular resistance training (RT) is associated with a myriad of physical and psychological benefits, including improvements in muscular fitness, body composition, insulin sensitivity, bone mineral density, and mental health (Westcott, 2012). Despite these benefits, only 21.9% of men and 17.5% of women in the USA report regular participation in RT (Centers for Disease Control, 2006), with similar estimates for other industrialized nations (e.g. Dalbo et al., 2015). Accordingly, there is a pressing need for new and innovative methods to promote RT that might complement existing cognitive-behavioral strategies. One approach, that has experienced a recent surge of interest and empirical support, considers the importance of exercise-related affect and automatic associations of exercise as important determinants of exercise behavior (e.g., Brand & Ekkekakis, 2018; Rhodes & Kates, 2015).

Core affect is described as a simple non-reflective state with two underlying dimensions of valence (pleasantness-unpleasantness) and arousal (activation) (Russell, 1980). “When considering affective response to exercise as a potential determinant of exercise behavior... it is most useful to focus on affective valence” (Lee, Emerson, & Williams, 2016, p.4); therefore, our discussion of affective responses to exercise will concentrate on core affective valence. Affective experiences associated with a particular behavior (e.g., feeling good when walking) can be distinguished from cognitive or reflective attitudes (e.g., walking is good for my health). Hedonic theories of motivation propose that affective responses play an integral role in behavioral decision-making. It is theorized that positive affective responses during exercise will increase participation because people tend to engage in behaviors that bring them pleasure and avoid activities that are accompanied by feelings of displeasure (Ekkekakis & Dafermos, 2012). This notion was supported in a systematic review, which found that a positive change in affect during moderate-intensity exercise was linked to future exercise behavior (Rhodes & Kates, 2015).

1 **Affective Responses to Resistance Training**

2 Affective responses to RT are understudied; one reason for this is the lack of guiding
3 conceptual framework (Greene & Petruzzello, 2015). Affective responses to aerobic exercise
4 have been shown to be intensity dependent. The dual-mode model (DMM; Ekkekakis, 2009)
5 posits that affective valence is largely positive during low intensity exercise, at least at the group
6 level, but high intensity exercise (i.e., that which exceeds the ventilatory threshold) elicits
7 negative shifts in affective valence, due to the increasing influence of interoceptive cues that
8 signal homeostatic disruption. At exercise intensities that approximate VT, there is considerable
9 inter-individual variability in affective responses. These differences can be accounted for, in part,
10 by cognitive strategies and individual differences in preference for and tolerance of the somatic
11 sensations associated with vigorous exercise (Ekkekakis, Parfitt, & Petruzzello, 2011). The
12 DMM has been effective in predicting affective responses during aerobic exercise, but there is
13 less evidence on how (or indeed if) this theory may apply to RT (Cavarretta, Hall, & Bixby,
14 2018). Nonetheless, research evidence to date suggests that a similar dose–response relationship
15 exists between intensity and affect for RT.

16 Exercise-induced affective change associated with three different RT protocols (40%,
17 70%, and 100% of 10-repetition maximum [RM]) was examined by Arent, Landers, Matt, and
18 Etner (2005). A curvilinear dose-response relationship between intensity and affective responses
19 was reported, with moderate intensity (70% 10-RM) training producing the greatest pre- to post-
20 exercise improvement in affective valence, compared to training loads at 40% and 100% 10-RM.
21 Recognizing the need to also assess affect *during* exercise, Greene and Petruzzello (2015)
22 examined affective responses to RT before, during, and after RT protocols at 70% and 100% 10-
23 RM. Again, a dose-response relationship was supported; participants felt more positive in
24 response to RT loads corresponding to 70% 10-RM, compared to higher training loads

corresponding to 100% of their 10-RM, and exercise enjoyment was significantly greater following 70% vs. 100% 10-RM conditions. Divergent patterns of affective response emerged as a function of RT load when comparing 40% 1-RM, 70% 1-RM, and a self-selected (SS) load (Focht et al, 2015). In the SS condition, participants were instructed to select a load that would be comfortable, yet still provide a good challenging workout; the mean selected intensity was 57% 1-RM. Ratings of pleasure (affective valence) increased from baseline during the 40% 1-RM and SS conditions but decreased from baseline during the 70% 1-RM condition.

One limitation of the aforementioned research is that in-task affect ratings were taken during rest-periods between exercise sets, rather than during the actual exercise itself. Such ratings might be influenced by so-called *affective-rebound*, which describes “a pronounced and instantaneous rebound from affective negativity to affective positivity” as soon as the exercise stimulus is terminated (Hall, Ekkekakis, & Petruzzello, 2002, p.60). This phenomenon is described by the opponent-process theory of affect (Solomon & Corbit, 1974) which posits that all sensations consist of a primary process and an ‘opponent process’ of opposite valence. The opponent process activates after the primary process is quieted, for example, when a painful sensation is abruptly terminated it is immediately replaced by a pleasant feeling of pain relief (Leknes, Brooks, Wiech, & Tracey, 2008).

Patterns of Pleasure-Displeasure

Findings from the field of behavioral economics indicate that the slope of pleasure (i.e., rate and direction of pleasure change during an experience) can influence the overall retrospective evaluation of affectively salient tasks (Zauberman, Diehl, & Ariely, 2006). When evaluating an experience, individuals are more likely to prefer an unpleasant experience followed by a more pleasant experience (i.e., an improving pattern) than a pleasant experience followed by a less pleasant experience (i.e., a declining pattern) (Zauberman et al., 2006). This finding

1 indicates a *recency effect*, wherein the pleasure or displeasure experienced at the end of an
2 experience is heavily weighted in the overall affective evaluation of the experience (Kahneman,
3 Fredrickson, Schreiber, & Redelmeier, 1993); a notion that has received some initial support in
4 an exercise context (Brewer, Manos, McDevitt, Cornelius, & Van Raalte, 2000; Hargreaves &
5 Stych, 2013).

6 **Manipulating the Slope of Intensity and Pleasure**

7 To date, no study has examined the impact of RT load manipulations on the *slope* of
8 affective valence during RT. This is an important question because it may be possible to create
9 an improving pattern of affect during a RT session, which might enhance the overall memory
10 and evaluation of the exercise session. Beginning an exercise session with a heavy load and
11 ending with a lighter load may allow participants to experience increasing pleasure during RT,
12 while still exposing them to a load and repetition range that is associated with strength and
13 hypertrophic gains (Schoenfeld, Wilson, Lowery, & Krieger, 2016) and a low risk of injury (da
14 Silva et al., 2010). When comparing increasing and decreasing intensity RT protocols, past
15 researchers have reported no significant differences between protocols on strength gains, enzyme
16 activity, or electromyography amplitude (da Silva et al., 2010; Pereira, Mendel, Schettino,
17 Machado, & Augusto-Silva, 2013). Therefore, it seems possible to improve the affective
18 experience of an RT session while keeping the exercise load constant. Such an approach was
19 taken with aerobic exercise by Zenko, Ekkekakis, and Ariely (2016).

20 Zenko et al. (2016) manipulated pleasure responses by randomizing participants to either
21 an increasing or a decreasing intensity protocol during a 15-min bout of recumbent cycling. In
22 the increasing-intensity protocol, exercise intensity was gradually increased from low (0
23 Watts) to high (120% of the Watts corresponding to the ventilatory threshold [VT]) intensity. In
24 the decreasing-intensity protocol, this pattern was reversed, and intensity was continuously

1 decreased from high (120% of VT Watts) to low (0 Watts). The increasing-intensity group felt
2 progressively less pleasant (or more unpleasant) while the opposite was true for the decreasing-
3 intensity group; thus, there was an inverse relation between pleasure and intensity. Despite
4 having similar mean affective responses *during* exercise, the decreasing-intensity group reported
5 more positive postexercise pleasure, remembered pleasure, forecasted pleasure, and enjoyment
6 of exercise.

7 Based upon the contributions of Greene and Petruzzello (2015), Focht et al. (2015) and
8 Zenko et al. (2016), we predicted that people would feel increasingly more pleasant in response
9 to decreasing RT intensities compared to increasing RT intensities. A training method known as
10 the Oxford technique, or Reverse Pyramid Training (RPT), emphasizes training from a high load
11 to a lighter load (e.g., Pour & Naghibi, 2015). However, RPT involves one or more sets of one
12 particular exercise before moving on to complete a *different* exercise. This creates a pattern of
13 multiple cycles of high-to-low training loads for the duration of the session. In contrast, we were
14 interested in testing the effectiveness of a Modified Reverse Pyramid Training protocol on
15 affective responses to RT.

16 In the Modified RPT protocol (henceforth “DOWN”), participants completed the RT
17 exercises in a circuit, beginning with one set at a high load (75% 1-RM), then one set a medium
18 load (65% 1-RM), and ending with one set at a low load (55% 1-RM). See Figure 1 for an
19 example comparison between RPT and DOWN. Participants served as their own control using a
20 modified pyramid training (henceforth “UP”) protocol with progressively heavier loads for each
21 circuit (i.e. 55% 1-RM, 65% 1-RM, 75% 1-RM). Thus, unlike previous research (Focht et al.,
22 2015; Greene & Petruzzello, 2015), which has investigated the effect of intensity on affect
23 without equating for volume (Cavarretta et al., 2018), the total training volume (number of
24 repetitions and number of sets) was identical in both RT sessions.

We hypothesized several psychological benefits of Modified RPT. First, DOWN would result in greater postexercise pleasure (H1) and enjoyment (H2) than UP. Second, DOWN would be remembered as more pleasant immediately following the exercise session (H3) and 24 hr later (H4) compared to UP. We also had exploratory hypotheses, including a positive association between the slope of affective responses experienced during exercise and postexercise pleasure, enjoyment, and remembered pleasure (H5) and a stronger association of affective valence toward the end of exercise (vs. beginning) with postexercise pleasure, enjoyment, and remembered pleasure (H6).

Method

Prior to data collection, the experimental design and analyses were registered and made public on AsPredicted.org (<https://aspredicted.org/vj7ps.pdf>). The Institutional Review Board of the first author approved the study protocol on June 26, 2017. Each participant provided informed consent and completed a prescreening questionnaire (Riebe et al., 2015) to establish absence of known cardiovascular, metabolic, or renal disease and/or symptoms suggestive of these conditions.

A statistical power analysis was conducted using G*Power software (Faul, Erdfelder, Buchner, & Lang, 2009) to establish appropriate sample size for a one-way repeated-measures (RM) multivariate analysis of variance (MANOVA). Assuming a medium effect size ($f = 0.25$; Greene and Petruzzello, 2015), with an alpha level of 0.05, power at 0.8, and anticipating moderately correlated repeated measures ($r = 0.40$) the power analysis indicated that a minimum of 40 participants would be required.

Participants

Volunteer participants were recruited using social media posts and flyers distributed on a college campus. Fifty-two participants were screened for eligibility using an online survey

platform (Qualtrics, Provo, UT, USA). Eligibility criteria included age 18–50 yr, nonsmoking, and reporting < 3 days per week of moderate to vigorous aerobic exercise and < 2 days per week of resistance training over the past 6 months. Exclusion criteria were pregnancy and signs or symptoms of and/or known cardiovascular, metabolic or renal disease. After this initial screening, eligible participants ($n = 45$) were scheduled for testing. Five participants withdrew from the study during testing, therefore 40 participants were retained (30 women, 9 men and 1 participant who identified as transgender; mean $\pm$ *SD*; age = 35.0 ± 9.2 yr, height = 166.5 ± 7.7 cm, body mass = 77.1 ± 18.7 kg/m²). The racial distribution was 75.0% White, 23.3% Black or African American, 1.7% other; and 1.0% were Hispanic. Most participants were overweight (37.5%) or had obesity (25.0%) according to BMI guidelines, while 37.5% were of normal weight.

Measures

The main dependent variables for hypothesis testing were affective valence (pleasure), enjoyment, and remembered pleasure. Affective valence (during- and post-exercise) was assessed using the Feeling Scale (FS; Hardy & Rejeski, 1989). The FS is a single-item scale that utilizes the stem ‘How do you feel right now, at this moment?’ with possible responses ranging from -5 (*very bad*) to +5 (*very good*) and verbal anchors at zero (*neutral*) and odd numbers. Drawing on the results of a discriminant function analysis, Hardy and Rejeski concluded that the good/bad dimension of the FS was representative of a core affective expression (Russell, 1980).

Exercise enjoyment was measured using the Physical Activity Enjoyment Scale-8 (PACES-8; Mullen et al., 2011). Respondents were asked to rate "how you feel at the moment about the physical activity you have been doing" using a 7-point bipolar rating scale (three items are reverse scored). Higher PACES-8 scores reflect greater levels of enjoyment. Group and

longitudinal invariance has been established for the PACES-8 (Mullen et al., 2011). Internal consistency in the present sample was very good (Chronbach's $\alpha = .86 - .92$).

Remembered pleasure was measured with the Empirical Valence Scale (EVS; Lishner, Cooter, & Zald, 2008), which is a bipolar rating scale with empirically spaced verbal descriptors along a continuum ranging from "*most unpleasant imaginable*" to "*most pleasant imaginable*". Respondents were administered the question, "How did you feel during the exercise session you just completed?" and they marked their response on the 200 mm EVS using a pencil. EVS scores range from -100 to 100, corresponding to the distance in millimeters from the neutral 0-point in the unpleasant and pleasant directions, respectively. The use of a different measurement format to that of the FS served to minimize common-method variance (Zenko et al., 2016). Participants were also contacted 24 hr postexercise via text message for a second assessment of remembered pleasure (24-hr remembered pleasure) and asked, "Think back to how you felt during the strength exercise circuit yesterday. Please rate how this session felt using a scale from 0 (most unpleasant) to 10 (most pleasant)" (cf. Kwan, Stevens & Bryan, 2017). Participants were required to reply within 1 hr for a response to be considered valid, and all participants did so. Initial plans also included sending text messages 1- and 6-hr postexercise to measure remembered pleasure, but this was not done to avoid potentially irritating participants.

To obtain a subjective measure of workload, participants' ratings of perceived exertion (RPE) were assessed using the CR-10 scale (Borg, 1998). As a manipulation check, these ratings were compared to ensure that the workload was perceived similarly between conditions. Several studies have validated the Borg CR-10 scale for measurement of the perceived intensity of resistance exercise (e.g. Buckley & Borg, 2011). Finally, for exploratory purposes, individual preference for and tolerance of the intensity of exercise was measured using the Preference for and Tolerance of the Intensity of Exercise Questionnaire (PRETIE-Q; Ekkekakis, Hall, &

Petruzzello, 2005). This two-factor measure is designed to assess individual differences in the preference for and tolerance of exercise intensity. Items indicative of low tolerance (Items 1, 3, 9, 13) and a preference for low intensity exercise (Items 2, 4, 8, 12) are reversed-scored; thus higher PRETIE-Q scores indicate greater preference for and tolerance of high-intensity exercise. Construct validity and concurrent validity data for the PRETIE-Q have been provided by Ekkekakis et al. (2005). Internal consistency in this sample was weak-to-acceptable (Cronbach's $\alpha = .654$ and $.780$ for the Preference and Tolerance subscales, respectively).

Procedure

Each participant completed three testing sessions that were scheduled 7 days apart and at the same time of day to account for any diurnal variation in the dependent variables. Each session began with a warm up consisting of a 5-min walk on a treadmill, and a series of dynamic stretches. All testing took place in a strength and conditioning facility during a time at which the facility was not in use to eliminate potential distractions (e.g., presence of others, background noise) and was overseen by a certified strength and conditioning specialist.

Session 1: Pre-experimental testing and familiarization. The purpose of the first session was (a) to collect anthropometric data; (b) determine 3-RM, to set the workload for the subsequent experimental sessions; and (c) familiarize participants with the self-report measures. Each participant's body mass (kg) and height (cm) were determined using a physician's scale (Detecto 437, Webb City, MO). Cybex VR3 selectorized machines (Cybex International, Medway, MA) and a hex bar with polyurethane coated Olympic plates (Perform Better, West Warwick, RI) were used for strength testing. 3-RM was determined by measuring the maximum mass that could be lifted for three repetitions on six different exercises; 45-degree leg press, hex bar deadlift, chest press, narrow-grip seated row, overhead press, latissimus dorsi (lat) pulldown, always performed in the described order. After receiving instruction about proper breathing and

1 lifting techniques, participants warmed up using a light load on each exercise. Weights were then
2 added successively until a participant could not complete the three lifts with good form. A 3-RM
3 test was chosen over a 1-RM for reasons of safety (Brzycki, 1993). The 3-RM was used to
4 estimate the 1-RM using Epley's (1985) formula and the load for each exercise was calculated as
5 a percentage of the 1-RM.

6 Participants were oriented to the FS and RPE scales using standardized instructions, were
7 provided examples to assist them in anchoring the perceptual range (see Borg, 1998), and were
8 given the opportunity to ask questions about the scales. To gain experience with the FS and RPE
9 scale, participants reported their responses to these scales during the warm up repetitions (reps)
10 and after each 3-RM attempt. At the end of the testing session participants also responded to the
11 EVS and PACES-8, as an opportunity to familiarize themselves with these scales as well.

12 **Sessions 2 and 3: Experimental testing.** For experimental testing, participants
13 completed a full body, push-pull, workout, comprising 3 x 10 reps of six exercises; 45-degree leg
14 press, hex bar deadlift (no straps, low handles), chest press, narrow grip seated row, overhead
15 press and lat pulldown. These exercises targeted the major muscle groups and the selected rep
16 range corresponds with recommendations for novice lifters (American College of Sports
17 Medicine [ACSM], 2009). The hex bar deadlift has fewer technical requirements than a
18 traditional straight bar deadlift and places less load on the lumbar spine, making it more
19 appropriate for the novice lifter (Swinton, Stewart, Agouris, Keogh, & Lloyd, 2011). During
20 testing, technical instruction was provided, but with no verbal encouragement.

21 Participants completed one set of each exercise in the order listed before moving on to
22 the next, with a 30s rest period between each set and a 3-min rest period between each circuit
23 (ACSM, 2009). Two experimental conditions (increasing-intensity and decreasing-intensity)
24 were administered using a fully counterbalanced repeated-measures design. In the increasing-

intensity (UP) condition, participants performed the first exercise circuit at 55% 1-RM, the second circuit at 65% 1-RM, and the third circuit at 75% 1-RM. In the decreasing-intensity (DOWN) condition, the circuits were performed in the opposite order (i.e. 75%, 65%, 55% 1-RM). Thus, exercise intensity either increased or decreased within specific exercises and throughout the overall exercise sessions, which allowed us to test our experimental hypotheses. The specific percentages of 1-RM were selected following pilot testing and in consultation with two strength and conditioning coaches and were designed to encompass low ($< 60\%$ 1-RM) and high ($>65\%$ 1-RM) loads (Schoenfeld et al., 2016).

To avoid conflating affective responses during exercise with rebound effects during recovery, affective valence was assessed 12 times during each circuit (six times each for the work and recovery phases). These assessments occurred during the last 10s of both the work and recovery intervals (i.e. during the last 2-3 reps of the exercise and during the last 10s of the 30s recovery period), which is consistent with previous examinations of affective response to interval workloads (Martinez, Kilpatrick, Salomon, Jung, & Little, 2015). Pilot testing indicated that this was feasible and safe. RPE was assessed immediately upon completion of each circuit. Postexercise pleasure, remembered pleasure, and enjoyment were assessed 5-min following the cessation of the exercise session. Remembered pleasure was assessed a second time 24-hr postexercise via SMS.

Statistical Analysis

Slope determination and manipulation checks. To test the assumption that a decreasing training load would result in more pleasure over time (DOWN condition), and an increasing load would result in decreased pleasure over time (UP condition), a 2 (condition) by 3 (time) RM ANOVA was performed, with pleasure (mean FS ratings for each of the three training loads) used as the dependent variable. The Greenhouse-Geisser correction was used when the

sphericity assumption was violated. Pleasure slopes were calculated by determining the linear trend across the 36 affective valence ratings made during each exercise session, following the process used to calculate the slope of pleasure throughout an exercise session by Zenko et al. (2016). After visual inspection of the data, it was apparent that the slopes of pleasure were in similar directions for both the work and the recovery phases. Therefore, we calculated the pleasure slopes through the 36 total measurements (18 work and 18 recovery). For the UP-condition work intervals only, the affective slope equation was $y = -0.080x + 2.737$. For the UP-condition recovery intervals only, the affective slope equation was similar, $y = -0.085x + 3.049$. Similar slope equations were also evident for the work intervals ($y = 0.032x + 1.319$) and recovery intervals ($y = 0.019x + 1.742$) of the DOWN condition. In other words, the rebounds during recovery did not alter the direction of the slopes. As an additional manipulation check, the impact of condition (DOWN vs. UP) on mean RPE, overall pleasure (mean of all FS ratings during the exercise session) experienced during exercise, and the slope of pleasure experienced during exercise, was assessed using a RM MANOVA.

Primary analysis. For the main analysis, a RM MANOVA was used to determine the effect of condition on the primary dependent variables, namely (a) postexercise pleasure, (b) enjoyment, (c) remembered pleasure, and (d) 24-hr remembered pleasure. The original study preregistration proposed planned comparisons of the four dependent variables using paired t -tests. However, we utilized an updated analysis plan using RM-MANOVA to protect Type 1 error rate against multiple comparisons.

A series of exploratory correlation analyses were performed to determine the relations between several components of the affective experience and the primary dependent variables, including (a) the slope of pleasure experienced during the exercise sessions, (b) the mean pleasure experienced during the exercise sessions, and (c) the mean pleasure experienced at the

end of each session (i.e., during the final circuit). Affective responses during work and recovery intervals were assessed separately to avoid conflating affective responses during exercise with rebound effects. This allowed us to explore whether affective responses measured during work intervals influence memory differently than affective responses measured during recovery intervals. For example, the mean pleasure during the work intervals (Mean-Work) was calculated using the affective valence ratings made during the 18 work intervals, likewise, the mean pleasure experienced during the recovery intervals (Mean-Recovery) was calculated using the affective valence ratings made during the rest periods. To test for a recency effect, we examined the importance of timing (i.e. beginning versus ending affect) on the strength of association between real-time (in-task) and retrospective affective evaluations. Finally, a series of exploratory correlation analyses were performed to determine if preference for and tolerance of exercise was related to (a) the slope of pleasure during exercise, (b) postexercise pleasure, (c) enjoyment, (d) remembered pleasure, and (e) 24-hr remembered pleasure.

Results

Slope Determination and Manipulation Checks

The RM ANOVA for mean FS ratings at each of the three training loads yielded a significant effect of condition, $F(1, 39) = 7.05, p = .011, \eta_p^2 = .15$, a significant effect of time, $F(1.52, 59.13) = 20.37, p < .001, \eta_p^2 = .34$, and more importantly for our assumption of a relation between load and pleasure, a significant condition by time interaction, $F(1.20, 46.82) = 49.30, p < .001, \eta_p^2 = .56$. The interaction showed that reducing (increasing) training load over time resulted in increasing (decreasing) levels of pleasure. The shape of this relation was determined using within-subjects contrasts for the effect of time. Within-subjects contrasts indicated the existence of a significant linear component ($F(1, 39) = 25.11, p < .001, \eta_p^2 = .39$), but no significant quadratic component ($F(1, 39) = 3.32, p = .076, \eta_p^2 = .08$).

The impact of condition on mean RPE, overall pleasure, and the slope of pleasure experienced during exercise was assessed using a RM MANOVA. This analysis revealed a significant effect of condition, Pillai's $V = .60$, $F(3, 37) = 18.51$, $p < .001$, $\eta_p^2 = .60$. Follow-up univariate tests indicated no differences in RPE between conditions, $F(1, 39) = 1.55$, $p = .221$, $\eta_p^2 = .04$. There was, however, a significant difference in overall pleasure, $F(1, 39) = 9.25$, $p = .004$, $\eta_p^2 = .19$, and a significant difference in the slope of pleasure, $F(1, 39) = 53.49$, $p < .001$, $\eta_p^2 = .58$. This indicates that mean perceived exertion was not significantly different between conditions (4.07 ± 1.25 in the DOWN condition and 4.29 ± 1.12 in the UP condition). Mean RPEs for 55%, 65%, and 75% 1-RM indicated that these intensities were perceived as “moderate” (3.21 ± 1.68), “somewhat hard” (4.01 ± 1.48), and “hard” (5.40 ± 1.5), respectively based upon the Borg scale. The DOWN condition resulted in more positive affective valence during the exercise session than the UP condition (1.99 ± 1.47 FS units vs. 1.38 ± 1.49 FS units), as well as a more positive slope of pleasure (0.03 ± 0.05 FS units vs. -0.08 ± 0.07 FS units). In other words, with each of the 36 successive measurements during the DOWN condition, people were expected to feel slightly better than before, with an increase of approximately 0.03 FS units at each assessment point. In contrast, with each measurement during the UP condition, people were expected to feel slightly worse than before, with a decrease in approximately 0.08 units on the FS. See Figure 2. At the individual level, 37 (92.5%) of participants had more positive slopes in the DOWN condition than the UP condition.

Primary Results

For the main analysis, a RM MANOVA was used to determine the effect of condition (DOWN vs. UP) on the primary dependent variables of postexercise pleasure, enjoyment, remembered pleasure, and 24-hr remembered pleasure. The RM MANOVA showed a significant effect of condition, Pillai's $V = .45$, $F(4, 33) = 6.77$, $p < .001$, $\eta_p^2 = .45$. Univariate tests revealed

a significant effect of condition on all four dependent variables: (a) postexercise pleasure, $F(1, 36) = 22.17, p < .001, \eta_p^2 = .38$; (b) enjoyment, $F(1, 36) = 12.13, p = .001, \eta_p^2 = .25$; (c) remembered pleasure, $F(1, 36) = 5.26, p = .028, \eta_p^2 = .13$; and (d) 24-hr remembered pleasure, $F(1, 36) = 11.57, p = .002, \eta_p^2 = .24$. As predicted, the DOWN condition resulted in more positive affective evaluations for all dependent variables (see Table 1).

Correlates of Remembered Pleasure, Enjoyment, and Postexercise Pleasure

The slope of pleasure during the UP condition significantly correlated with postexercise pleasure, enjoyment, remembered pleasure, and 24-hr remembered pleasure. In contrast, the slope of pleasure during the DOWN condition did not significantly relate to any of the dependent variables (see Table 2). In addition, the mean overall pleasure ratings and mean pleasure ratings at the end (i.e., during the final circuit) for both the UP and DOWN conditions were significantly related to postexercise pleasure, enjoyment, remembered pleasure, and 24-hr remembered pleasure (see Table 2). The magnitude and direction of the relations between the pleasure ratings during exercise and postexercise pleasure, enjoyment, remembered pleasure, and 24-hr remembered pleasure were similar for affective valence recorded during the work intervals and affective valence recorded during the recovery intervals.

End Significance

Experienced affect toward the end of the RT session proved to be more strongly related to the dependent variables than experienced affect toward the beginning for both the UP and DOWN conditions, which was in line with our hypothesis (H6). In the DOWN condition, mean affective valence during 55% 1-RM loads (i.e., the ending circuit) was more strongly correlated with each of the dependent variables ($r = .41-.60$) than mean affective valence during the initial circuit at 75% 1-RM loads ($r = .31-.37$). The opposite was true in the UP condition where the

magnitude of influence was strongest at 75% 1-RM ($r = .55-.78$) and weakest at 55% 1-RM ($r = .23-.45$). See Table 3.

Exploring Exercise Preference and Tolerance

Exercise preference and tolerance were not significantly related to the slope of pleasure during exercise in the DOWN condition (r s ranged from .01 to $-.16$), or to postexercise pleasure, enjoyment, or remembered pleasure following the UP condition (r s ranged from .02 to $-.18$). In contrast, exercise tolerance was significantly related to the slope of pleasure experienced during exercise in the UP condition ($r = -.36, p = .023$), suggesting the possibility that people with greater self-reported tolerance of exercise had a more negative affective slope during increasing intensity exercise. The relationship between preference for exercise intensity and the slope of pleasure in the UP condition was also in a negative direction ($-.28$) but was not statistically significant ($p = .082$). See Table 4.

Discussion

The present study compared the affective evaluations associated with RT protocols with increasing (UP) and decreasing (DOWN) loads. The expectation that the DOWN condition would elicit a positive mean slope of pleasure and the UP condition would elicit a negative mean slope of pleasure was confirmed and associated with a large effect size. This finding is consistent with previous reports of a negative relationship between RT intensity and affective responses (Focht et al., 2015; Greene & Petruzzello, 2015), and with slopes of pleasure associated with increasing and decreasing intensity aerobic exercise (Zenko et al., 2016).

Our confirmatory hypotheses that the DOWN condition would be associated with greater postexercise pleasure (H1) and would be rated as more enjoyable (H2) than the UP condition were fully supported. Likewise, our confirmatory hypotheses that the DOWN condition would be remembered as more pleasant, immediately following the exercise session (H3) and 24 hr later

(H4) compared to the UP condition was also fully supported. This effect may have been due to differences in experienced pleasure and/or end pleasure, but was not attributable to overall exertion. In contrast to Zenko et al. (2016), who used a between-subjects design, participants in this within-subjects study demonstrated differences in mean experienced pleasure between conditions despite matched training volume and similar levels of perceived exertion.

The finding that the DOWN protocol positively influenced both experienced and remembered pleasure, as well as enjoyment, may be of particular importance for RT adherence. Positive affective experiences associated with exercise have been shown to be important predictors of subsequent behavioral engagement (Rhodes & Kates, 2015). Experienced pleasure (i.e. affective valence experienced *during* physical activity) appears to be especially important in this regard (Van Cappellen, Rice, Catalino, & Fredrickson, 2017), and repeated bouts of pleasurable exercise are thought to result in positive, automatic, affective responses that might bias decision-making in favor of exercise (Brand & Ekkekakis, 2018). Remembered pleasure may be more indicative than experienced pleasure of how an experience registers in memory and informs subsequent decision making. Hedonic theory suggests that if an experience is expected to be pleasant, then it will be more likely to be repeated (Ekkekakis & Dafermos, 2012).

In the present study, a large effect size was noted for the influence of RT condition on 24-hr remembered pleasure. This finding is notable in that the effect persisted to a time point when behavioral decisions regarding exercise reengagement might be made. Recall of an affect-laden experience provides an effective competitor to one's current experience, meaning that "past episodes can compete with and be compared to an ongoing experience" with respect to feeling state and motivation (Seligman, Railton, Baumeister, & Sripada, 2013, p. 130). This is of particular importance in health-promoting behaviors where benefits are often gained far into the future (i.e., are temporally remote), and what is most salient at the crucial moment of decision-

1 making are proximal outcomes of exercise, which often include the inconvenience and potential
2 discomfort associated with exercising (Hall & Fong, 2007), particularly among inactive and unfit
3 individuals. In contrast, focusing on *positive* proximal exercise outcomes, such as experienced
4 pleasure, might increase intrinsic motivation for exercise (Evans, Cooke, Murray, & Wilson,
5 2014).

6 Behavioral decisions shaped by people's predictions about how they will feel in the future
7 draw heavily upon relevant past experiences (Dunn & Laham, 2006). Yet, memory is not a
8 simple rote or reproductive system, rather memory involves complex *constructive* processes that
9 can be prone to error and distortion (Schacter, 2012). Research examining affective forecasting
10 indicates that people tend to be inaccurate predictors of their affective experiences, typically
11 overestimating length or the intensity of future feeling states (Wilson & Gilbert, 2003). An
12 example of this in an exercise context is the observation that, prior to an exercise session, people
13 expect to enjoy exercise less than they report actually enjoying it after completing the exercise
14 (Ruby, Dunn, Perrino, Gillis, & Viel, 2011). The tendency to overestimate how unpleasant
15 exercise will be—an affective forecasting error—is thought to undermine motivation for regular
16 physical activity (Loehr & Baldwin, 2014; Ruby et al., 2011). Interestingly, inactive individuals
17 report significantly lower expected enjoyment than active individuals but similar levels of
18 experienced enjoyment (Loehr & Baldwin, 2014). This increased discrepancy between expected
19 and experienced enjoyment points to a larger affective forecasting gap in inactive individuals
20 compared to their active counterparts, suggesting the particular importance of affective
21 manipulations for people who are trying to initiate regular exercise.

22 Ruby et al. (2011) suggest that effortful activities might seem particularly unappealing
23 because their beginnings are often genuinely unpleasant; a phenomenon they term *forecasting*
24 *myopia*. They suggest that in situations where initiating an activity is difficult or unpleasant, such

as beginning to write a paper or jogging the first mile, people may “underestimate their enjoyment of the activity as a whole because their affective forecasts for the activity are anchored by these unpleasant beginnings” (Ruby et al., 2011, p. 67). Nonetheless, our data support a recency effect, whereby experienced affect at the end of the RT session was more strongly correlated with the dependent variables of experienced, recalled, and postexercise pleasure than experienced affect at the beginning of the session. A suggestion for future research might be to explore RT load manipulations where the session begins and ends with a lighter load (i.e., the load is progressively increased and then decreased over several sets). Finn & Miele (2016) examined this effect in the context of mental effort, reporting that math tests that begin or end with easier questions are preferred over tests with easier items embedded in the middle.

Additional ways to manipulate the slope of pleasure might warrant future research attention. For example, music can positively influence affective valence during and following exercise (Hutchinson et al., 2018), therefore listening to increasingly preferred music throughout an exercise bout (i.e. saving a favorite track for the end) might lead to a positive slope of pleasure. The use of enjoyment-focused imagery has been shown to improve pleasure during aerobic exercise (Stanley & Cumming, 2010) and might be implemented strategically in order to end an exercise session in a more positive feeling state.

Mean pleasure experienced during the exercise sessions, and at the end of each session was significantly and positively related to all dependent variables for both conditions. This finding supports the notion that pleasure experienced during exercise (Van Cappellen et al., 2017) and at the end of an exercise session (Hargreaves, & Stych, 2013) impacts global affective evaluations associated with exercise, which play an important role in adherence (Rhodes & Kates, 2015).

1 The slope of pleasure experienced during the exercise sessions was significantly and
2 positively related to all dependent variables in the UP condition, but not the DOWN condition.
3 Correlations in the DOWN condition were in the expected direction, although that they were
4 weak. This might suggest that negative slopes are more salient, that is, an increasingly
5 unpleasant experience weighs heavier on retrospective evaluations than an increasingly positive
6 one. Increased sensitivity to negative experiences and events is a well-observed phenomenon
7 termed *negativity bias*, which is thought to serve a critical adaptive function (Rozin & Royzman,
8 2001). In addition, the relations between the slope of pleasure and the dependent variables were
9 similar, whether affective valence recorded during work or during recovery was used to calculate
10 the slope. This may indicate that, in forming a retrospective evaluation of exercise, participants
11 rely on the affective experience of the entire exercise session and are not influenced by work and
12 recovery intervals differently. However, this is difficult to conclude based on our data because
13 the work and recovery slopes were similar. Future researchers may consider testing the
14 retrospective summary evaluations of exercise sessions consisting of pleasant (or unpleasant)
15 work intervals and unpleasant (or pleasant) recovery intervals.

16 A novel finding, which warrants further research attention, was the observed relationship
17 between exercise tolerance and affective slope during the UP condition. This exploratory
18 analysis indicated that greater self-reported tolerance of exercise was counterintuitively related to
19 feeling progressively worse as RT intensity increased. However, given that preference and
20 tolerance were not related to (a) the slope of pleasure, (b) postexercise pleasure, (c) enjoyment,
21 or (d) remembered pleasure during the DOWN condition, and tolerance was related only to the
22 affective slope in the UP condition, it is possible that this relation was spurious (i.e., the only
23 significant result out of 16 correlation analyses). Future confirmatory analyses should be

completed to further elucidate the relations between affective responses and self-reported preference for and tolerance of exercise intensity.

Limitations

This study is not without limitations. The mean BMI was 28.1 kg/m², with 50% of the sample having a BMI greater than 27.25 kg/m². The eligibility criteria also required participants to be insufficiently active (i.e., not meeting the physical activity guidelines for cardiorespiratory and resistance exercise). Therefore, it is possible that these findings do not generalize to leaner or more active populations. Second, we did not assess EMG amplitude in the present study. Even though the training volume was consistent between conditions, it is possible that actual impact on muscle activity and potential strength gains may have differed between conditions. Still, as mentioned previously, prior research does not indicate the likelihood of significant differences between conditions in terms of strength gains, enzyme activity, or EMG amplitude (da Silva et al., 2010; Pereira et al., 2013).

Conclusions

The present study offers initial evidence that RT programming changes can successfully manipulate the experienced and remembered affect associated with a single bout of exercise. Further research is needed to explore the relative salience of positive and negative affective slopes during exercise in the context of retrospective evaluations and, ultimately, exercise behavior. Remembering an experience more positively, enjoying it more, and feeling better afterwards should theoretically predict better adherence, although this has not been tested using the ramp-down protocols demonstrated in this study or previously (Zenko et al. 2016). Thus, the next logical step is to test this effect in a longitudinal research design to see if adherence can be favorably impacted, and if this will have a meaningful impact upon health outcomes.

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1 Table 1.

2 *Means (95% confidence intervals) for Dependent Variables by Condition*

	Condition	
	UP	DOWN
Postexercise Pleasure	1.14 (0.41, 1.86)	2.84 (2.32, 3.36)**
Enjoyment	38.38 (35.93, 40.82)	42.16 (39.65, 44.67)**
Remembered Pleasure	16.78 (5.11, 28.46)	32.34 (20.60, 44.08)*
24-hr Remembered Pleasure	5.95 (5.41, 6.48)	6.72 (6.26, 7.18)**

3 Note: *significant at .05 level, **significant at .005 level. Bonferroni adjustment made for
 4 multiple comparisons.

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Table 2.

Pearson's Correlation Coefficients between Components of the Affective Experience and Dependent Variables by Condition.

	Postexercise Pleasure	Enjoyment	Remembered Pleasure	24-hr Remembered Pleasure
DOWN				
Slope-Work	.08	.24	.27	.04
Slope-Recovery	.10	.27	.29	.06
Mean-Work	.49**	.47**	.49**	.39*
Mean-Recovery	.51**	.50**	.55**	.49**
End-Work	.52**	.56**	.60**	.41*
End-Recovery	.52**	.58**	.63**	.47**
UP				
Slope-Work	.62**	.37*	.44**	.51**
Slope-Recovery	.64**	.32*	.42*	.55**
Mean-Work	.66**	.61**	.43*	.54**
Mean-Recovery	.71**	.51**	.38*	.60**
End-Work	.78**	.65**	.55**	.62**
End-Recovery	.81**	.53**	.48**	.66**

Note: Components of the affective experience are slope, mean, and end. Work refers to pleasure measured during the last 10 seconds of each work interval. Recovery refers to pleasure measured during the last 10 seconds of each recovery period. *significant at .05 level, **significant at .005 level.

Table 3.
Pearson's Correlation Coefficients between Beginning and Ending Experienced Affect and
Dependent Variables by Condition.

	Postexercise Pleasure	Enjoyment	Remembered Pleasure	24-hr Remembered Pleasure
DOWN				
Affect-beginning (75% 1-RM)	.37*	.31*	.32*	.35*
Affect-end (55% 1-RM)	.52**	.56**	.60**	.41*
UP				
Affect-beginning (55% 1-RM)	.40*	.45**	.23	.33*
Affect-end (75% 1-RM)	.78**	.65**	.55**	.62**

Note: *significant at .05 level, **significant at .005 level.

1 Table 4.
 2 Pearson's Correlation Coefficients between Preference for and Tolerance of Higher Intensity
 3 Exercise and the Slope of Affect, Postexercise Pleasure, Enjoyment, and Remembered Pleasure.

	Affective Slope	Postexercise Pleasure	Enjoyment	Remembered Pleasure	24-hr Remembered Pleasure
DOWN					
Preference ¹	.08	.02	.11	-.16	.01
Tolerance ²	.04	.01	.06	-.16	.06
UP					
Preference ¹	-.28	-.18	.06	-.02	-.18
Tolerance ²	-.36*	-.09	.11	.02	-.18

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 5 Note: *significant at .05 level. ¹Higher scores on the Preference subscale indicate preference for
 6 higher exercise intensities. ²Higher scores on the Tolerance subscale indicate greater tolerance of
 7 high-intensity exercise.

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Figure 1. Comparison between example reverse pyramid training and modified reverse pyramid training protocols (RM: Repetition Maximum)

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2 *Figure 2. Feeling Scale ratings over time*

3 Note: Lines of Best Fit are shown for each of the conditions and interval types, from the beginning of the
4 exercise session (0% completed) to the end (100% completed). Dotted line: UP (work intervals); Solid
5 line: UP (recovery intervals); Small-dashed line: DOWN (work intervals); Large-dashed line: DOWN
6 (recovery intervals). Each slope was calculated by finding the line of best fit through 18 Feeling Scale
7 ratings.

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