Perceptually Regulated Training at RPE13 Is Pleasant and Improves Physical Health

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ABSTRACT

PARFITT, G., H. EVANS, and R. ESTON. Perceptually Regulated Training at RPE13 Is Pleasant and Improves Physical Health. Med. Sci. Sports Exerc., Vol. 44, No. 8, pp. 1613–1618, 2012. Purpose: Despite endorsement by various health organizations, there is a lack of research on the effectiveness of perceptually regulated exercise training (PRET) as a method of exercise intensity prescription. The purpose of this study was to confirm the efficacy of an 8-wk PRET program clamped at RPE13 to improve aerobic fitness and cardiovascular health. The affective response to this method of exercise prescription was also assessed. Methods: Sedentary volunteers (age = 34.3 ± 13.0 yr, weight = 72.5 ± 13.7 kg, height = 1.7 ± 0.1 m) were randomly assigned to either a training (n = 16) or a control (n = 10) group. All participants completed a graded exercise test to determine aerobic capacity at baseline and after the intervention. Participants allocated to the training group performed 30 min of PRET at RPE13 on the Borg 6–20 RPE Scale on three occasions per week for 8 wk. Affective valence was measured using the Feeling Scale. Results: The RPE-regulated training resulted in improvements (P < 0.01) in VO2max, mean arterial pressure, total cholesterol, and body mass index in the training group across time. During training at RPE13, VO2 increased (P < 0.01) from week 1 (19.2 ± 1.1 mL·kg⁻¹·min⁻¹) to week 8 (23.4 ± 1.1 mL·kg⁻¹·min⁻¹). On average, affect was positive and stable throughout training (3.4 ± 1.2). Affect measured at RPE13 in the baseline and postintervention graded exercise tests increased in the training group (3.1 ± 0.9 to 3.7 ± 1.1, P < 0.05), whereas it decreased in the control group (2.8 ± 1.1 to 2.6 ± 1). Conclusions: Sedentary individuals were able to use PRET at RPE13 to improve their cardiovascular health and fitness, and on average, the exercise intensities selected were perceived to feel pleasant. Key Words: AFFECT, PERCEIVED EXERTION, MEAN ARTERIAL PRESSURE, TOTAL CHOLESTEROl, FITNESS

Exercise intensity is described as the most important exercise prescription variable to maintain a cardiovascular training response (1, p. 161). However, it is recognized that the training response needs to be considered alongside other factors that may influence long-term exercise behavior change and that exercise prescription may not sit comfortably with these factors (1,3). Among the factors identified are “individual choice, preference and enjoyment” (3, p. 1346): constructs that support motivational processes. In this regard, the American College of Sports Medicine (ACSM) has reported that exercise that is pleasant and enjoyable can improve adoption and adherence to prescribed exercise programs (3, p. 1334).

According to self-determination theory (9), autonomy (perceived choice) is one of three psychological needs required to support the development of intrinsically motivated behavior. A prescribed exercise intensity is unlikely to meet this need for autonomy. Recent research has also linked the affective responses to exercise (how pleasant/unpleasant it was perceived to be) to future exercise behavior (27,36,41), with affect proposed to be the first link in the exercise adherence chain (40). Underpinned by hedonic theory (26), that individuals will seek to repeat behaviors that are pleasant and avoid those that are not, it is logical that if an exercise experience has been pleasant then the individual will wish to repeat it. If it has been unpleasant, this is less likely to be the case.

Research has demonstrated different affective responses to an exercise stimulus dependent on the individual and the metabolic strain associated with the stimulus (13,15,29,32). High interindividual variability has been recorded when individuals are prescribed intensities that would be described as moderate (46%–63% VO2max) (3), with some individuals reporting positive affective responses and some reporting negative (34,35,40). Furthermore, when exercise intensity is prescribed and exceeds the preferred intensity by a small degree (e.g., 10% higher than the preferred intensity), affective responses decrease significantly (16,28). According to the dual-mode theory, which can explain the affective responses to the exercise stimulus, this variability and pattern of responses is due to the interplay between cognitive...
factors (e.g., personality, competence, experience) and interoceptive (e.g., muscular, respiratory) cues and how the cues are interpreted. Allowing individuals to self-select a preferred exercise intensity has been shown to result in more positive affective responses than when a similar exercise intensity has been prescribed (16,28,32,35), potentially because the cognitive factors are actively engaged in the process of regulation.

One method of exercise intensity regulation that has the potential to support motivation and also the maintenance of a more pleasant affect is the use of perceived exertion in a production mode. In the production mode, participants regulate the exercise intensity (speed and gradient on a treadmill, resistance on a cycle ergometer) in accordance with specified RPE on the Borg 6–20 RPE Scale (4) based on their own perceptual sense. Such a method is within the participants’ own control and has the potential to reduce the interindividual differences that may be present in studies when intensity is set relative to aerobic capacity. Indeed, data suggest that, when allowed to self-select, participants typically select an intensity that they would rate as between RPE10 and RPE14 on the Borg 6–20 RPE Scale, which is associated with a positive affective response (12). Furthermore, in production paradigm studies, research has demonstrated that, when regulating at an RPE13 (somewhat hard), affective responses are positive in both active and inactive participants (31). An RPE13 equates to intensities around 50%–70% $\dot{V}O_{2\text{max}}$ (18–20,30). Within the recent ACSM Position Stand (3), the use of RPE and affect for exercise prescription is acknowledged, but it is noted that “evidence is insufficient to support these methods as a primary method of exercise prescription” (p. 1344). Furthermore, based on a decade of research (and building on the decade before), Ekkekakis et al. (17) call for a tripartite rationale to exercise prescription with the addition of “pleasure” to the standard criteria that the exercise has to be effective and safe.

The utility of the RPE in a production mode was first confirmed in patients with cardiac diseases (5) and later in studies using healthy adults during treadmill (19,22,38) and cycling (11,20,31) exercises. Despite this conceptual evidence, there is currently little research regarding the efficacy of a perceptually regulated training program to increase aerobic capacity. Celine et al. (6) reported a 10% increase in $\dot{V}O_{2\text{max}}$ after 6 wk in nine healthy young (22.4 ± 2.7 yr) women, who perceptually regulated exercise intensity on a cycle ergometer at the RPE corresponding to the ventilatory threshold (VT). A 20-wk pilot study (10) on six elderly (70 ± 7.1 yr) postmenopausal women used the RPE equating to 40%, 50%, and 60% of $\dot{V}O_{2\text{max}}$ (measured on a cycle ergometer) as the basis for controlling exercise intensity across a combination of treadmill walking, cycling, and stair climbing. Application of the RPE in this way is inapposite because it assumes equivalence of the intensity–RPE relationship across different modes of exercise. The above studies are also limited by their small and homogenous sample sizes of either fit young women or elderly women. Further, they have prescribed an intensity (%$\dot{V}O_{2\text{max}}$ or VT) based on extrapolation of a previously determined RPE–intensity relationship.

The objective of this study was to examine if perceptually regulated training intensity on a treadmill, anchored to a common semantic descriptor (“somewhat hard,” RPE13), would lead to cardiovascular health improvements. A perceptually regulated exercise training (PRET) program clamped at 13 on the RPE scale should equate to significant increases in aerobic fitness in sedentary men and women. The procedure permits the participant to dictate the intensity by controlling the speed and gradient during the training session and thereby achieve a sense of autonomy. Previous research suggests that this method of self-regulation should also support the maintenance of positive affect. Therefore, the aims of this study were to 1) confirm the efficacy of an 8-wk, ambulatory PRET program clamped at RPE13 to improve aerobic fitness and cardiovascular health and 2) assess the affective responses to this method of exercise prescription. It was hypothesized that participants who trained using RPE13 to regulate their exercise intensity would improve in fitness and cardiovascular health and would maintain a positive affective response during training.

**METHODS**

**Participants.** Twenty-six (seven men) sedentary volunteers (age = 34.3 ± 13.0 yr, weight = 72.5 ± 13.7 kg, height = 1.7 ± 0.1 m) were recruited from the local community. Participants were classified as sedentary if they did not meet the current physical activity guidelines (at least 30 min of moderate-intensity activity on ≥5 d wk$^{-1}$, in bouts of at least 10 min; or 20 min of vigorous-intensity activity on ≥3 d wk$^{-1}$) for the United Kingdom (7). To ensure that participants were sedentary, and not too close to the boundaries—only participants who completed <30 min of moderate-intensity activity on <3 d wk$^{-1}$ were used. All participants completed a medical history questionnaire and provided written informed consent in accordance with institutional policy. The ACSM’s (2, p. 302) risk stratification procedures were undertaken for all participants before commencing exercise testing. For men ≥45 yr and women ≥55 yr, written physician consent was obtained. The physical activity readiness questionnaire (PAR-Q [11]) was used to confirm that all participants were asymptomatic of illness or disease and free from acute or chronic injury.

Basic anthropometric (height and body mass; Seca, Hamburg, Germany) and health measurements (blood pressure and total cholesterol) were performed at baseline and after the intervention. After a 10-min period of sitting on a hardback chair with both feet on the floor and the left arm supported at heart level, blood pressure was measured using an automatic blood pressure monitor (UA-767; A&D Company, Ltd, Tokyo, Japan) following the manufacturer’s guidelines. The air hose of the arm cuff was aligned with the brachial artery at a point 2–3 cm above the elbow. The mean blood pressure from two separate
measures (with a minimum of 10 min between each measure) was calculated. A 30-μL sample of capillary blood collected from a finger prick was applied to a disposable test strip and used to measure total cholesterol via a handheld portable blood analyzer (Cardiocheck P.A. & PTS PANELS test strips; Polymer Technology systems, Inc., Indianapolis, IN). In line with recommendations (2), all health measurements were recorded within the same visit and before the VO₂max test. Participants had refrained from eating, smoking cigarettes, or ingesting caffeine preceding their visit to the laboratory. If participants had two or more risk factors, written physician consent was obtained before exercise testing. The ethics committee of the School of Sport and Health Sciences at the University of Exeter approved the study, where all data were collected.

Baseline and postintervention measures. All participants performed a graded exercise test (GXT) to allow for the direct measurement of VO₂max at the preintervention and postintervention phases. The Balke–Ware protocol was followed. The treadmill speed was fixed at 5.3 km h⁻¹ with the gradient commencing at 0% for the first minute and increased by 1%·min⁻¹ thereafter. All tests were terminated when participants reported volitional exhaustion. In conjunction with this, a maximum effort was confirmed with a plateau in oxygen consumption, an HR within ±10 bpm of age-predicted maximum, an RER of 1.15, or an inability to maintain the required treadmill speed (8). During the final 15 s of each increment of the GXT, the participant estimated his/her overall RPE. The RPE was recorded by requesting the participant to point to a numerical value that reflected how strenuous the exercise felt. In a similar fashion, the affective state was recorded each minute using the Feeling Scale (FS) (25). Online respiratory gas analysis was used in each test via a breath-by-breath automatic gas exchange system (Cortex Metalyser II; Biophysik, Leipzig, Germany). HR was continuously monitored using a wireless chest strap telemetry system (Polar Electro T31, Kempele, Finland).

Exercise training intervention. After the initial GXT, participants were randomly allocated to either a control (n = 10; male = 3) or training (n = 16; male = 4) group. Participants in the control group continued their normal physical activity habits (as they did before the study began) for 8 wk. Participants allocated to the training group performed 30 min of exercise on three occasions per week for 8 wk. Throughout each session, participants continuously adjusted speed and gradient to perceptually regulate at an exercise intensity at the RPE of 13 “somewhat hard” on the Borg 6–20 RPE Scale. In the first and last exercise sessions, acute data (affect, HR, treadmill speed, and gradient) were recorded every 5 min.

All sessions were completed using a motorized treadmill (PPS 55 sport slat-belt treadmill; Woodway GmbH, Weil am Rhein, Germany); the display screen of the treadmill (time, distance, speed, and gradient) was masked from the participant throughout the whole period of investigation. The RPE scale was mounted on the wall directly in front of the participants throughout the study. Participants had no prior experience with perceptual scaling before participation. Each participant received standardized written and verbal instructions on how to report the “overall” feelings of exertion (4). All physiological outputs were concealed from the participant.

Statistical analysis. From the recorded treadmill speed and gradients chosen by the participants, indirect measures of VO₂ were calculated using the ACSM (2) metabolic equation (p. 458). In line with recent research that has examined acute responses to exercise intensity (15), this VO₂ value was then represented as a percentage of the participants’ VO₂ above or below the VO₂ at VT. The VT was determined using the three-method (ventilatory equivalent, excess CO₂, and modified V’ slope) procedure (21). The statistical software package SPSS 18.0 for Windows (SPSS, Inc., Chicago, IL) was used to analyze the data. For all analyses, α was set at P < 0.05. A series of two-factor (group × test) ANOVA, with repeated measures on test, were conducted to assess for interactions on each of the health (BMI, total cholesterol, and mean arterial pressure) and fitness (VO₂max, VO₂ at VT, and HRmax) variables. ANOVA was also conducted on the FS data to examine if affective responses remained the same at specific intensities (RPE13 and VT) from baseline to after the intervention.

To examine the acute affective (FS) and physiological (HR and VO₂) responses recorded during the PRET sessions, two-factor (session [week 1 vs week 8] × time [5, 10, 15, 20, 25, and 30 min]) repeated-measures ANOVA were conducted. VO₂ was extrapolated from the speed and gradient of the treadmill during training. Finally, to examine the variability in responses during training in week 1 and week 8, intraclass correlation coefficient (ICC) and the coefficient of variation (CV) were calculated for VO₂, HR, and FS from individual data at the 5-, 10-, 15-, 20-, 25-, and 30-min time points.

RESULTS

Two-factor (group × test) ANOVA, with repeated measures on test, were conducted for each of the health variables (BMI, total cholesterol, and mean arterial pressure) and fitness variables (VO₂max, VO₂ at VT, and HRmax). Significant interactions were recorded for BMI (F₁,24 = 7.3, P < 0.01, ηp² = 0.23), total cholesterol (F₁,24 = 10.5, P < 0.01, ηp² = 0.30), mean arterial pressure (F₁,24 = 9.81, P < 0.01, ηp² = 0.29), VO₂max (F₁,24 = 38.95, P < 0.01, ηp² = 0.61), and VO₂ at VT (F₁,24 = 35.53, P < 0.01, ηp² = 0.58). Post hoc follow-up tests indicated that the interactions were due to improvements in the training group across time, relative to the control group. See Table 1 for variable means and SD.

Analysis of the affect data from baseline to after the intervention in the GXT resulted in a significant interaction at RPE13 (F₁,24 = 4.39, P < 0.05, ηp² = 0.16) and an interaction that approached significance (F₁,24 = 3.8, P = 0.06, ηp² = 0.14) at VT. Follow-up tests indicated that affect was
more positive at RPE13 and at VT in the postintervention GXT \((3.1 \pm 0.9)\) to \(3.7 \pm 1.1\) and \(3.5 \pm 1.3\) to \(4.0 \pm 1.3\), respectively) for the training group, whereas it decreased in the control group \((2.8 \pm 1.1)\) to \(2.6 \pm 1.4\) and \(3.5 \pm 0.9\) to \(3.2 \pm 1.6\), respectively).

Two-factor (session [week 1, week 8] × time [5, 10, 15, 20, 25, and 30 min]) fully repeated-measures ANOVA were conducted on affect, HR, and \(\text{VO}_2\). A significant time main effect was recorded for HR \((F_{1.8,28.2} = 7.9, P < 0.01, \eta_p^2 = 0.35)\), with HR increasing across time during training from \(133.8 \pm 16.5\) bpm in the first 5 min to \(144.3 \pm 22.9\) bpm in the last 5 min. A significant session main effect was recorded for \(\text{VO}_2\) \((F_{1.15} = 17.29, P < 0.01, \eta_p^2 = 0.54)\) with \(\text{VO}_2\) higher in week 8 \((23.4 \pm 1.1 \text{ mL kg}^{-1} \text{min}^{-1})\) than in week 1 \((19.2 \pm 1.1 \text{ mL kg}^{-1} \text{min}^{-1})\); this was despite one participant feeling “slightly bad” (−1 on the FS) in the first 10 min of training in week 8 (Table 2). The ICC values were slightly higher in week 8 (0.98, 0.99, and 0.98) than in week 1 (0.91, 0.98, and 0.87) for HR, \(\text{VO}_2\), and affect, respectively. The CV during training in weeks 1 and 8 were small for HR and \(\text{VO}_2\) (<−6 ± 6) but larger for affect (21% ± 14% for week 1 to 12% ± 13% for week 8).

**DISCUSSION**

The aims of the study were to test whether an 8-wk PRET program (clamped at RPE13) would improve aerobic fitness and cardiovascular health and examine the acute affective responses elicited by this method of exercise prescription. Specifically, it was hypothesized that participants who trained using RPE13 to regulate their exercise intensity would improve in fitness and cardiovascular health and would maintain a positive affective response during training. Data support the hypotheses and demonstrate that both fitness and cardiovascular health improved during the 8-wk training program. Further, affective responses were more positive during the postintervention GXT than the baseline GXT in the trained participants. Affective responses also remained positive in the majority of participants during the RPE13 training sessions.

The ACSM Position Stand (3) indicates that there is currently insufficient evidence to support the utility of the RPE as a “primary method of exercise prescription” (p. 1344). These data show that when previously sedentary participants used the RPE scale in a production protocol (to control exercise intensity) and trained at an RPE13, three times a week for 8 wk, fitness improved by 17%. These results compare favorably to those of Gormley et al. (23) who identified a 10% and 14% increase in the \(\text{VO}_{2\text{max}}\) of healthy young subjects exercising on the cycle ergometer during a 6-wk period at moderate (50% \(\text{VO}_2\) reserve) and vigorous (75% \(\text{VO}_2\) reserve) intensities, respectively. Participants exercised above their VT (7% ± 3%) and, as demonstrated by the ICC and CV, within-subject data demonstrated a high consistency in the exercise intensities associated with RPE13. The average exercise intensity produced during training at RPE13 was 61% ± 7% \(\text{VO}_{2\text{max}}\) in week 1 and 64% ± 7% \(\text{VO}_{2\text{max}}\) in week 8. These intensities would be classified as on the border between moderate and vigorous exercise intensity (3). Ekkekakis (12) has suggested “…that individuals might be inclined to perform more intense activity when allowed to set their own intensity” (p. 872), which may possibly be due to the sense of autonomy afforded in self-regulation situations. This comment was made following the observation of “moderate” exercise intensities (12) associated with RPE values of 9–11 in a review of studies where participants were permitted to self-select the exercise intensity.

In this study, the affective response associated with RPE13 was that the exercise intensity felt “good” (FS = 3.4 ± 1.2). Recent evidence indicates that the affective response to acute exercise can predict future exercise behavior (41) and the argument has been made that exercise prescription should consider the affective response associated with the exercise stimulus as well as whether the exercise intensity is safe and effective (17). The data support that PRET at RPE13 was perceived as pleasant throughout the two training sessions when affective responses were assessed in all but one participant. In the one participant who reported negative affect, this was in the first 10 min of the training session. In the same participant, affect improved to a feeling of “good” in the following 20 min of the 30-min session. This increase in affect, during an exercise session has been reported previously,
especially in participants with lower affect at the start of exercise (33).

The positive affect experienced during training seems to have influenced postintervention responses to the GXT. Affect was more positive in the trained participants at RPE13 and at VT in the postintervention data compared with the baseline data but did not change significantly in the control participants. Of interest is that the work rates were higher for both RPE13 and at VT in the postintervention GXT, but despite this affect also increased significantly. Given that affect typically decreases with increases in exercise intensity (14,24), this increase in affect suggests a physiological adaptation to the PRET at RPE13 and a more positive appraisal of the interoceptive cues generated by the exercise stimulus. This is in line with the proposed interplay of the cognitive factors and interoceptive cues of the dual-mode theory (14). Previous research, which has examined the cognitive processes that underlie affective responses during exercise, would suggest that changes in confidence, perceived achievement, as well as a more positive interpretation of the physiological cues, explain this result (34,39). Future research could assess exercise efficacy and perceived achievement to clarify the cognitive processes involved.

In addition to the significant interactions for affect and physiological fitness, the additional health variables were also affected by the training. However, the interactions recorded were due to changes in both the control group and training group data across the 8 wk. Although the improvements in health observed in the training group would be attributable to the PRET at RPE13, the decline observed in the control group could be attributed to the season. The study was conducted in the United Kingdom in winter. It is possible that the winter and Christmas season, with shorter days, more inclement weather, and festive-season food, all potentially contributed to the health changes (decreases) observed in the control group data (37).

This decline in the health of the control participants is a limitation to the study, as is the higher overall fitness of this group at baseline. The study would have been improved if stratified randomization had been used to allocate participants to groups. However, although the groups were significantly different at baseline on fitness, this difference was no longer present after the 8-wk training program, confirming that the PRET at RPE13 had successfully increased fitness. A further limitation of the study is the indirect measures of VO2 during the training session from the ACSM (2) metabolic equation (p. 458). Given that the perceptual sense and affective response were central to the study objectives, a reduced sensitivity in the measurement of VO2 was accepted to achieve greater external validity.

In conclusion, this study has shown that previously sedentary individuals are able to use PRET at RPE13 to improve their fitness and that this method of exercise intensity regulation is perceived to be "pleasant" during training. During the 8-wk training period, affective and physiological responses recorded during training indicated that most participants felt “good” and exercised at a moderate to vigorous exercise intensity. It is not known if this method of training will lead to better long-term adherence to exercise training, although theoretically, according to self-determination (9) and hedonic theory (26), it should. Future research that examines the long-term effects of PRET on motivational processes, health, and affect is encouraged. If PRET is shown to support motivational processes, then research could systematically examine its utility across populations (e.g., children, the elderly, rehabilitation, and training) and compare it to standard programs to identify which type of training program may be most suitable (e.g., effective, safe, and where motivation may be an issue, pleasurable) for a specific population.

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The authors have no conflicts of interest relevant to this study.

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REFERENCES


