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Affective response to exercise and preferred exercise intensity among adolescents

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Abstract

Background—Little information exists as to the exercise intensity that adolescents enjoy and whether identifiable subgroups of adolescents will choose higher-intensity exercise.

Methods—Healthy adolescents (N = 74; mean age = 11.09) completed a cardiorespiratory fitness test, a moderate-intensity exercise task, and an exercise task at an intensity that felt “good”. Heart rate (HR), work rate (WR) and ratings of perceived exertion (RPE) were assessed every 3 minutes.

Results—During the “feels good” task, adolescents exercised at a HR recognized as beneficial for cardiovascular health (Mean HR = 66-72% of HR at VO_2peak). Adolescents who experienced a positive affective shift during the moderate-intensity task engaged in higher-intensity exercise during the “feels-good” task as compared to those whose affective response to moderate-intensity exercise was neutral or negative (76% of peak HR vs. 70% of peak HR, $p < .01$).There was no difference between groups in RPE.

Conclusions—Adolescents tend to select an exercise intensity associated with fitness benefits when afforded the opportunity to choose an intensity that feels good. An identified subgroup engaged in higher-intensity exercise without a commensurate perception of working harder. Encouraging adolescents to exercise at an intensity that feels “good” may increase future exercise without sacrificing fitness.

Introduction

The recently released Physical Activity Guidelines for Americans Midcourse Report on Strategies to Increase Physical Activity among Youth [1] draws attention to the role of exercise-associated affect as a consideration in programs to encourage greater activity levels among children and adolescents: “It is important to encourage young people to participate in physical activities that are appropriate for their age, that are enjoyable, and that offer variety (p.9).” This advice echoes recent theoretical and empirical work drawing attention to the important role that affect plays in determining exercise behavior [2,3]. Whereas the explicit emphasis on affect in the exercise literature is relatively new, it is a natural outgrowth of the theories that have dominated the field for some time.

There are no conflicts of interest to disclose.

This study is registered at www.clinicaltrials.gov (No. NCT01876602).

Many theories of health behavior rest on the assumption that individuals choose to engage in certain patterns of behavior because the behavior is associated with a desired outcome. Self-Determination Theory [4](SDT), for example, posits that individuals will be motivated to engage in behaviors that are intrinsically rewarding. Rewards can be social, as in the sense of relatedness to others that individuals feel during physical activity (e.g., during team sports). A personal sense of mastery that is experienced during an activity also can generate an internal reward through the resulting perception of personal competence. Exercising choice and control over an activity can further contribute to an internal motivation to engage in an activity, as it fulfills a basic psychological need to be autonomous. As specified by SDT, these three psychological needs (relatedness, competence, and autonomy) form the foundation of intrinsic motivation (i.e., enjoyment of an activity in and of itself) and therefore factor strongly into the likelihood that an individual will adopt and/or persist in a given activity.

On the basis of theories such as SDT, interventions are developed to create a context that will support a target behavior by enhancing participants' enjoyment of that activity. For example, sedentary adolescent girls may be offered the opportunity to join a special girls-only PE class (thus maximizing the potential for relatedness), may be exempted from PE activities that negatively impact perceived competence (e.g., the timed mile run), and may be given a voice in choosing PE activities (promoting autonomy). One program that deployed these strategies [5] was successful in increasing physical activity and physical fitness among a group of sedentary adolescent girls over the course of a school year. A close analysis of the data, however, revealed that participation in vigorous physical activity only increased among those girls who reported lower enjoyment of exercise at baseline, before the intervention began [6]. The results suggest that adolescent girls who enjoy exercise will engage in similar vigorous activity regardless of the context, whereas girls who enjoy exercise less may require greater contextual support to promote vigorous activity. This finding raises the very important question as to whether a certain subgroup of adolescents is predisposed to minimize their own participation in physical activity because of a characteristic (negative) affective association with exercise.

There is, in fact, evidence that individuals who manifest a more negative affective response to a standardized exercise task will engage in less physical activity. Among adults, the affective response to a cardiorespiratory fitness test was used to predict activity levels at 6 and 12 months into an exercise intervention [7], and adolescents who experienced a positive affective shift in response to a moderate-intensity exercise task engaged in greater amounts of physical activity compared to adolescents with a neutral or negative affective response to the task [8]. These studies provide support for the supposition that some individuals are predisposed to engage in greater amounts of activity owing to their acute affective experience during exercise. Questions remain, however, as to whether individuals who are given the opportunity to choose an intensity of activity that feels good to them will continue to manifest this difference in exercise behavior.

It has been suggested that individuals can calibrate their own exertions to an intensity that feels good, and that exercise interventions may have a greater likelihood of long-term success if they promote activity at this self-regulated intensity[2,9,10]. This approach runs

counter to most traditional exercise prescriptions, which are typically based on a non-tailored prescribed intensity expected to yield gains in physical fitness. Physical activity guidelines released by the United States Department of Health and Human Services in 2008[11] stipulate that youth should engage in 60 minutes or more of activity daily, of which most should be moderate-to-vigorous activity. In translating these guidelines to school standards, the California Department of Education [12] prescribes moderate-to-vigorous physical activity a minimum of four days each week in middle school (p. 26) and high school (p. 37), and specifies that students must measure and evaluate changes in health-related physical fitness with the goal of improving or maintaining physical fitness "according to the principles of exercise (p.47)".

In practice, these Education Code Standards typically result in a preoccupation with assessing performance on field-based fitness assessments. In a document translating the Educational Code into curriculum frameworks, the California Department of Education summarizes the fitness-oriented Overarching Standard for middle school as follows [13]:

> Overarching Standard 3: Students assess and maintain a level of physical fitness to improve health and performance.
>
> Students in sixth grade perform moderate to vigorous physical activities a minimum of four days each week. They assess their own level of health-related physical fitness, including the intensity of their heart rate during physical activity, and compare themselves with established, research-based standards for good health. Students use this information to generate personal goals for each fitness component (muscle strength/endurance, flexibility, aerobic capacity, and body composition). As students continue to participate in fitness activities, they monitor and evaluate changes in their fitness status.

Despite the fact that this Overarching Standard has both a behavioral (MVPA a minimum of four days each week) and a fitness component, the emphasis in terms of accountability tends to be on the fitness component. Many states, including California, have adopted the Fitnessgram® as a means of meeting this standard, with a considerable proportion of class time devoted to practicing the fitness tests and the actual test being implemented periodically throughout the year. The emphasis is on a certain level of performance, without regard to individual differences in preferences or ability for physical activity. According to hedonic theory, which suggests that people will shy away from activities that are unpleasant, PE programs that over-emphasize performance on a standardized fitness assessment incur the risk that they will generate negative affect during exercise and create a cadre of youth who may gravitate toward sedentary lifestyles once released from the requirements of the school environment.

One alternative is to encourage adolescents to exercise at a level that generates positive affect. Among adults, there is evidence that such affect-regulated exercise results in a level of intensity that is defined as moderate-to-vigorous-physical activity [14]. Studies among adult women have suggested that women who are instructed to exercise at a level that feels "good" will select an intensity that would be expected to confer health benefits [9] and that encouraging exercise at a level that feels "good" may in fact lead to meaningful gains in

fitness over time [10]. Hence, exercise at an intensity that feels good would still be expected to result in meaningful health benefits, and has the additional benefit of increasing the likelihood of future volitional activity.

There is some evidence to suggest that adolescents also will voluntarily choose to engage in exercise of an intensity that would be expected to positively impact fitness when offered the opportunity to select exercise intensity. Though conducted in a small sample (11 girls and 11 boys) of relatively fit adolescents, a study by Sheppard and Parfitt [15] showed that towards the end of a 15-minute task at a self-selected intensity, adolescents tended to reach an exercise intensity that was significantly higher than a prescribed low-intensity exercise task, while manifesting no difference in ratings of affect and/or perceived exertion. The present study extends these findings by quantifying adolescents' self-selected exercise intensity during a 30-minute exercise task among a larger sample that over-samples adolescents who do not participate in sports, thus focusing attention on adolescents at risk for becoming sedentary. In addition, adolescents in the present study were characterized according to their affective response to a standard moderate-intensity exercise task to examine the hypothesis that those predisposed to respond to exercise with a positive affective shift would subsequently choose to engage in higher-intensity exercise when afforded the opportunity to choose exercise intensity.

Methods

Procedures

Healthy adolescents (N = 74; mean age = 11.09 (SD=.05); 48% males; 48.6% Latino, 17.5% non-Latino White, 12% African-American, 21.6% Mixed or Other) were recruited from among 6th graders at a public middle school. To join the study, students could not be on a sports team or involved in individual competitive sports at the time of recruitment. Because the study also included electroencephalograms for an unrelated study aim, participants were further required to be right-handed and free of a history of depression. Students provided a signed informed assent, and a parent or guardian provided a signed consent. All procedures were reviewed and approved by a University-based Institutional Review Board as well as by the School District Research Review Committee.

All assessments were completed at the school site in an empty classroom that had been converted into a clinical laboratory with fitness testing equipment. Students were excused from PE classes to complete the assessments. Each assessment was conducted during a single PE period and the assessments were spaced approximately one week apart. Assessments were ordered as follows: 1) height, weight, and a cardiorespiratory fitness assessment; 2) behavioral questionnaires; 3) a moderate-intensity 30-minute exercise task; and 4) a 30-minute preferred-intensity exercise task. At baseline and every three minutes during each exercise assessment, participants reported their rating of perceived exertion and a rating on the Feeling Scale and a research assistant recorded the participant's heart rate.

Cardiorespiratory Fitness. Participants performed a ramp-type progressive cycle-ergometer exercise test [16]. Breath-to-breath measurement of gas exchange (ventilation, oxygen uptake, and carbon dioxide output) was viewed online and subsequently analyzed using a Sensor

Medics® metabolic system (Yorba Linda, CA) to determine peak VO_2. Participants were verbally encouraged to exercise until their limit of tolerance was reached.

Moderate-Intensity Exercise Task. Students completed a 30-minute exercise task on a stationary cycle during which the work rate (Watts) was set at a level that corresponded to 50% of the oxygen uptake reserve (VO_2R; computed as VO2peak- VO2rest). This level of exertion was selected to approximate an intensity just below the estimated ventilatory threshold [17]; the approximate transition from easily sustainable activity to exertion that is likely to generate negative affect [18].

Feels-good Exercise task. Students completed a 30-minute exercise task on a stationary cycle, during which they were given an opportunity to adjust the resistance (i.e. work rate in Watts) every 3 minutes in increments of 10 Watts. The initial work rate was calibrated to 20% of VO_2R.

Prior to commencing, participants were given the following instructions

"Today you are going to be asked to pedal the bike for 30 minutes at 60-80 RPM. Every 3 minutes we are going to show you a scale, and ask you to tell us how hard you think you are working. Right after that we are going to show you another scale, and ask you to tell us how you are feeling at that moment. Then we will ask you if you want to keep the resistance where it is or if you want to change it by increasing it or decreasing it. We will ask you these questions every 3 minutes until your 30 minutes are over.

The goal of this task is for you to exercise at a level that feels good to you. We want you to find a level that feels good to you, so if you need to increase or decrease the resistance to stay feeling good just let us know, okay? We want to know how you are really feeling, so please be honest and tell us the number that truly reflects how you feel. Do you have any questions?"

Measures

Body Mass Index (BMI) percentile. Students were weighed using a calibrated digital scale (Seca 869, Chino, CA) and height was measured using a stadiometer (PE-AIM-101, Perspective Enterprises, Portage, MI). BMI percentile was computed according to the normative values provided by the CDC [19].

Physical Activity Participation. As a global assessment of adolescents' self-reported usual level of activity, participants completed a modified version of the Godin Leisure Time Activity Questionnaire [20]. This instrument has been used to distinguish between stages of exercise [20] and in the present study it correlated significantly with cardiorespiratory fitness (L/min, $r = .25$, $p < .05$) and MVPA as assessed via Actigraph ($r = .26$, $p < .05$). Moreover, reports of activity using the modified Godin assessment were correlated at baseline and four months later within the present sample ($r = .50$, $p < .001$). Separate items assessed the number of days in a week that the respondent typically engaged in vigorous (e.g., running), moderate (e.g., volleyball), and mild (e.g., walking) activity outside of school (range: 0 to 7 days). Within each category, respondents also indicated in 10-minute increments how many minutes per day were typically spent in this type of activity (range: 0 to 60+ minutes). The

total time of reported activity was combined to yield an estimate of the number of minutes per day that the adolescent engaged in moderate-to-vigorous physical activity (MVPA) outside of school. An objective assessment of activity also was conducted using Actigraph accelerometers. Participants were instructed to wear the Actigraph® accelerometer on the left hip for seven consecutive days, except while sleeping, swimming, or bathing. Data from the Actigraph® were analyzed using the Actilife software with the Freedson cutoff [21] to yield the average number of minutes daily that participants engaged in moderate-to-vigorous physical activity (MVPA). For a day to be included in the computation, a minimum of 8 valid hours must have been recorded. A minimum of 4 valid days (including at least one weekend day) of data was required.

Rating of Perceived Exertion (RPE). Borg's RPE scale [22] served to document participants' self-perceptions of their level of exertion during the preferred intensity exercise task. This scale ranges from 6 (no exertion at all) to 20 (maximal exertion). Baseline (pre-exercise) values were constrained at a value of 6 and participants were informed that subsequent ratings should be calibrated to a baseline RPE of 6.

Affective Response to Exercise. The Feeling Scale (FS) is a single-item 11-point bipolar measure of pleasure-displeasure used to assess affective valence [23]. The scale ranges from -5 (very bad) through 0 (neutral) to +5 (very good). It is only moderately related to RPE, suggesting that the two constructs are distinct, it is sensitive to alterations in exercise intensity among adolescents during exercise [15] and it is positively related to enjoyment of acute exercise [24].

Affective Style. Using the FS ratings obtained during the moderate-intensity task, study participants were categorized as either latent exercisers (i.e., those whose affect followed a positive trend during the moderate-intensity exercise task) or reluctant exercisers (i.e., those whose affect remained unchanged or followed a negative trend during the moderate-intensity exercise task).

Heart Rate. Study participants wore a Polar Heart Rate monitor (Polar Electro, Inc., Lake Success, NY) during the moderate-intensity and the feels-good exercise tasks. A research assistant manually recorded the heart rate every 3 minutes at the same time that the study participant reported FS and RPE ratings. Values obtained were converted into percent of maximal heart rate achieved during the cardiorespiratory fitness test for analyses.

Work Rate. Exercise tasks were conducted on an electronically braked cycle ergometer, which displays a continuous readout of the Watts. Every three minutes during the exercise tasks, a research assistant manually recorded the Watts from the electronic display. Values obtained were converted into percent of maximal work rate achieved during the cardiorespiratory fitness test for analyses.

Data Analyses

A series of 2 (Affective Style) X 9 (Time) repeated measures ANOVA was employed to examine changes in work rate (% of peak work rate achieved during the cardiorespiratory fitness test), RPE, FS, and heart rate (% of peak heart rate achieved during the

cardiorespiratory fitness test) over time, across affective style, and as a function of the interaction between time and affective style. Variables were assessed for violations of the assumption of sphericity, and the Greenhouse Geisser correction for evaluating statistical significance was used when appropriate. To adjust for multiple comparisons, a significance level of $p < .0125$ was employed as the criterion for statistical significance.

Results

Participant Characteristics

Table One shows the results of assessments related to physical activity and fitness at baseline. Males had higher cardiorespiratory fitness (before adjustment for weight) than females and engaged in greater MVPA as measured by the Actigraph, though not by self-report. Affective style was not associated with any of the fitness or activity measures.

Work Rate

After beginning the feels-good exercise task at the assigned work rate of 20% of VO_2R, adolescents on average increased the work rate linearly to 29% of peak work rate at the end of the 30-minute task (SD = 16%). Repeated Measures ANOVA showed a main effect of time ($F_{(2.69, 65)} = 5.94$, $p < .01$), a marginally significant main effect of affective style ($F_{1,72} = 6.16$, $p = .01$), and a significant interaction between time and affective style ($F_{(2.69, 65)} = 5.62$, $p < .01$). As illustrated in Figure 1, the mean work rate for latent exercisers increased linearly to 34% of maximal work rate over the course of the exercise task, whereas reluctant exercisers remained below 27% maximal work rate throughout.

Heart Rate

The increase in work rate was reflected in an increase in percent of maximal heart rate from an overall mean of 66% (SD = 9%) at 3 minutes into the task to a mean of 72% (SD = 10%) at the end of the task. There was a main effect of time on HR ($F_{(1.99, 65)} = 19.21$, $p < .001$) and a significant interaction between time and affective style ($F_{(1.99, 65)} = 7.00$, $p < .01$). The main effect of affective style was not significant ($p > .05$). Consistent with the increase in work rate, the latent exercisers also manifested an increase in mean percent maximal heart rate to 76% at the end of the task, compared to the reluctant exercisers, among whom the mean heart rate never exceeded 70% of maximal heart rate (see Figure 1, second panel).

Affect

Study participants reported feeling good throughout the task, according to the Feeling Scale. From an overall baseline (pre-exercise) mean of 3.86 on the FS, responses deviated very little over time (see Figure 3). There was, however, a marginally significant main effect of time ($F_{(2.49, 64)} = 3.28$, $p < .05$) and an interaction between time and affective style ($F_{(2.49, 64)} = 9.55$, $p < .001$). The main effect of affective style was not significant ($p > .05$). Although all participants reported a Feeling Scale score of 3 (i.e., “good”) or higher throughout the task, latent exercisers’ FS scores became more positive over time, whereas reluctant exercisers’ FS scores declined over time (see Figure 1, third panel).

Perceived Exertion

Ratings of perceived exertion increased from a mean of 8.95 (SD = 2.92) at 3 minutes to a mean of 12.24 (SD = 4.06) at the end of the task. Repeated measures ANOVA revealed a main effect of time ($F_{(2.12, 65)} = 55.67$, $p < .001$), but no significant interaction between time and affective style, and no main effect of affective style (p's > .05)..

Discussion

The purpose of this study was to quantify the intensity of exercise that adolescents would choose to engage in when instructed to select an intensity that feels “good” and to test the hypothesis that those predisposed to respond to exercise with a positive affective shift would subsequently choose to engage in higher-intensity exercise when afforded the opportunity to choose exercise intensity. The response of the participants in this study to the opportunity to exercise at a level that felt “good” demonstrates that adolescents overall will voluntarily select an intensity that is typically associated with health benefits, including maintenance of cardiorespiratory fitness. The American College of Sports Medicine has reviewed the evidence for a threshold of intensity that is associated with health benefits[25], and has found that if such a threshold exists it may vary depending on fitness level, with more athletic individuals requiring higher-intensity exercise to improve cardiorespiratory fitness. Based on the available data, it is safe to say that exercise that elevates the heart rate above 70% of VO_2peak is likely to improve fitness among youth who do not participate in sports. Thus this study confirms the findings among adults that individuals will choose an intensity of exercise that is likely to generate health benefits when they are encouraged to select a level of exertion that feels “good”.

Equally important is the finding that there is an identifiable subgroup of adolescents who will voluntarily exert themselves at a higher level, as indicated by percent of peak heart rate and percent of peak work rate, while reporting a level of perceived exertion that does not differ from the subgroup of adolescents who will choose to work at a slightly lower intensity. The characteristic used to distinguish these two groups has been used in prior studies to identify adolescents who are more or less active [8], who score higher on a rating scale of approach motivation [26], and who manifest a pattern of brain activation associated with an approach-oriented affective style [27]. Specifically, adolescents who respond to a standardized moderate-intensity exercise task with a more positive shift in affect have now been found to be more active, more sensitive to cues of reward, and more left-dominant on a measure of frontal cortical brain asymmetry. The present study extends this work by demonstrating that these same individuals, whom we have called latent exercisers in deference to the apparent predisposition to enjoy exercising, will also work harder when offered a chance to exercise at a level that feels good.

Whether these individual differences in affective disposition toward exercise are learned or inherited is yet to be determined. There is evidence that volitional exercise behavior has a significant genetic component. In a large study of monozygotic and dizygotic twins[28], the heritability of exercise behavior was found to average 67% across data from 7 countries. Although the mechanisms through which genetics may influence exercise behavior are most likely many and complex, recent genotyping research suggests that one pathway may be

through an impact on affective response to exercise [29]. A given genotype, therefore, may predispose an individual to a more positive affective experience during exercise and thus encourage him or her to seek out future exercise opportunities.

The absence of a difference between latent and reluctant exercisers on ratings of perceived exertion also merits discussion. The present results are consistent with prior research showing that affect and perceived exertion are distinct constructs [23]. The finding that individuals who respond to a moderate-intensity task with a positive affective shift choose to work harder during a "feels-good" task, yet report no greater perceived exertion than the individuals who, having responded to the moderate-intensity task with a negative affective shift, choose to work less hard, has implications for programs that encourage exercise participation. Instituting a uniform exercise intensity prescription across adolescents of differing affective styles threatens to create a situation in which the reluctant exercisers may feel as though they are working at an uncomfortably high intensity. As noted earlier, there is ample theoretical and empirical data to indicate that exercising at an intensity that generates negative affect is likely to decrease motivation for future activity. This study, then, offers some evidence in favor of allowing students to calibrate their exercise intensity so as to avoid the formation of a negative affective association with activity.

For physical educators motivated to get students moving and to improve physical fitness, the concept of allowing students to select their own intensity of activity may generate concerns about students who are inclined to choose very low-intensity activity. In our study, we found that 25% of the adolescents chose to exercise at an intensity that was below 20% of their peak work rate during the feels-good exercise task. It is important to note that as the initial work rate of the preferred-intensity task was calibrated to objectively determined fitness levels, the preference for a low-intensity exercise session cannot be attributed to differences in fitness level. Thus, it is likely that these individuals' gravitation away from higher-intensity exercise results from their cognitive and/or affective interpretation of the sensations associated with exercise. Pressuring these adolescents to be active at a higher intensity, therefore, would be likely to only exacerbate their aversion to higher-intensity exercise. Taking the long view, therefore, it would seem advisable that promoting life-long participation in physical activity may mean allowing adolescents some flexibility in exercise intensity while working to promote experiences that may enhance intrinsic motivation. In other words, rather than arbitrarily requiring students to exercise at a certain intensity, it may be more productive to provide a supportive environment for activity while building experiences of relatedness, autonomy, and competence associated with exercise. Such a long-range view adheres to the spirit of the 2008 Physical Activity Guidelines [11]which emphasize that any physical activity is better than none in terms of health benefits.

There are certain limitations to the present study that should be noted. Students who volunteered to participate in this study knew that they would be required to engage in a number of physical exercise tasks over the course of the school year. It could be argued, therefore, that students who were truly reluctant to engage in exercise would exclude themselves from the study. Anecdotal evidence, however, suggests otherwise. Individual interviews with study participants revealed that students often indicated that one of the aspects they liked best about the study was that they were able to skip occasional physical

education classes. Interestingly, however, these same students indicated that they enjoyed the assessments, including the exercise tasks, suggesting that they were intrigued by the novelty of the experiences. Another limitation of the present study is that the exercise tasks were laboratory-based, and therefore lack ecological validity. We cannot assume that students' responses to the stationary bike exercise would be identical to their response, for example, to jogging outdoors or to playing active games. Our intention with this approach was to isolate the exercise intensity as a factor, removed from considerations of social rewards or competitive motivation. The findings would be more generalizable if they were reproduced using exercise tasks that more closely resemble the type of activity in which these students normally engage.

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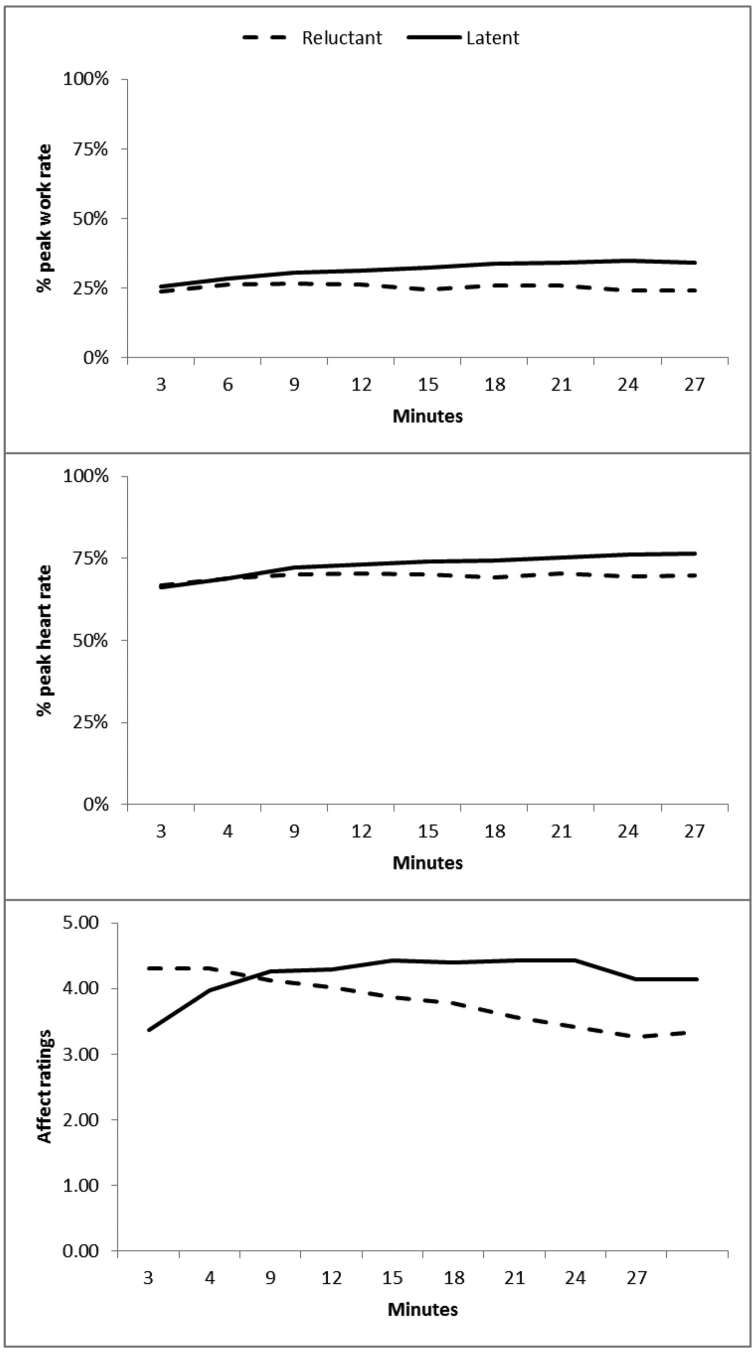

Figure One.
Percent peak work rate, percent peak heart rate, and affective ratings during the preferred-intensity exercise task.

Table 1

Participant characteristics M(SD)

	All N = 74	Males N = 36	Females N = 38
VO2peak (ml/kg/min)	37.30 (7.41)	39.08 (7.48)	35.62 (7.02)
VO2peak (L/min)*	1.73 (.31)	1.80 (.34)	1.66 (.25)
BMI %ile	71.66 (28.29)	70.36 (30.97)	72.89 (25.84)
MVPA self-report(min/day)	53.14 (37.90)	55.63 (40.19)	50.74 (35.77)
MVPA Actigraph (min/day)**	48.97 (19.78)	55.35 (21.84)	42.92 (15.61)

* $p < .05$

** $p < .01$ for t-test by gender