Research Quarterly for Exercise and Sport
©2006 by the American Alliance for Health,
Physical Education, Recreation and Dance
Vol. 77, No. 1, pp. 81–90

Can Self-Reported Preference for Exercise Intensity Predict Physiologically Defined Self-Selected Exercise Intensity?

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Exercise prescription guidelines emphasize the importance of individual preferences for different intensities, but such preferences have not been studied systematically. This study examined the hypothesis that the preference scale of the Preference for and Tolerance of the Intensity of Exercise Questionnaire would predict self-selected exercise intensity. Twenty-three previously sedentary middle-aged women participated in a treadmill test and a 20-min session at a self-selected intensity. After controlling for age, body mass index, and peak oxygen uptake, the preference scale accounted for significant portions of the variance in the percentage of oxygen uptake associated with the ventilatory threshold at Minute 15 and Minute 20 of the session at self-selected intensity.

Key words: aerobic-anaerobic transition, physical activity, tolerance, ventilatory threshold

According to the World Health Organization (2003), physical inactivity is a key factor contributing to global morbidity and mortality from noncommunicable diseases, with 1.9 million deaths and 19 million disability-adjusted life-year losses attributed to it annually. In the United States, in particular, according to the 1998–99 review of the Healthy People 2000 program, over the past 15 years "the proportion of the population reporting physical activity has remained essentially unchanged, and progress is very limited" (United States National Center for Health Statistics, 1999, p. 29). An estimated 40% of adults participate in no regular physical activity (U.S. Department of Health and Human Services [USDHHS], 1996, 2000) and two thirds do not meet the current recommendation of at least 30 min of moderate activity on 5–7 days per week (Jones et al., 1998).

The problem of physical inactivity consists of two components, namely the low rates of initial engagement and the high rates of dropout. Although more research attention over the past decade has been devoted to the former rather than the latter (Dishman, 2001), the problem of dropout is just as severe, with the average rate based on clinical trials conducted over the past quarter century estimated at 50% (Dishman & Buckworth, 1996). One approach taken in recent physical activity recommendations to address this problem is the emphasis on moderate intensity and the accumulation of activity in multiple short bouts during the day (Pate et al., 1995; USDHHS, 1996). The intensity of the activity, in particular, has been found to have a significant negative impact on adherence (Cox, Burke, Gorely, Beilin, & Puddey, 2003; Lee et al., 1996; Sallis et al., 1986), whereas other components of the activity "dose," such as its frequency (Perri et al., 2002), do not seem to have a similar effect. Thus, according to recommendations, "each person should recognize that starting out slowly with an activity that is enjoyable and gradually increasing the frequency and duration [note: not the intensity] of the activity are central to the adoption and maintenance of physical activity behavior" (USDHHS, 2000, p. 22–4).

The problem is complicated by the fact that many individuals find it difficult to accurately estimate or pro-

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Submitted: May 10, 2004
Accepted: April 5, 2005

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duce a given level of intensity, particularly during the critical early stages of participation (Dishman, 1994; Duncan, Sydeman, Perri, Limacher, & Martin, 2001; Kollenbaum, 1994; Kollenbaum, Dahme, & Kirchner, 1996; Kosiek, Szymanski, Lox, Kelley, & Macfarlane, 1999). Exercising at a lower than recommended intensity can decelerate the accumulation of benefits, cause frustration, and, eventually, lead to dropout. Likewise, exercising at a higher than recommended intensity can lead to dropout due to overexertion, aversion, or injury (including the possibility of a cardiac event). A factor possibly underlying such "inaccuracies" may be the individual differences in the preference for different intensity levels. Trials comparing different prescribed intensity levels have demonstrated the effect of such preferences. In those studies, researchers noted that participants tended to deviate from the prescribed levels in favor of other, apparently preferred, levels (Cox et al., 2003; King, Haskell, Taylor, Kraemer, & DeBusk, 1991).

The American College of Sports Medicine (ACSM, 2000) acknowledged that exercise prescription guidelines "cannot be implemented in an overly rigid fashion by simply applying mathematical calculations to test data" (p. 139) and "individual preferences for exercise must be considered to improve the likelihood that the individual will adhere to the exercise program" (p. 145). However, the factors underlying such preferences are not well understood. This represents a considerable void, because, as several authors in exercise psychology have noted over the years, taking individual preferences into account could improve the quality of the experience participants derive, thus potentially leading to improved long-term adherence (e.g., Dishman, Farquhar, & Cureton, 1994; King & Martin, 1993; Morgan, 1997; Van Landuyt, Ekkekakis, Hall, & Petruzzello, 2000). For example, according to King and Martin (1993), "…ways of enhancing enjoyability include the tailoring of...the actual exercise regimen...to individual preferences" (p. 447). Likewise, according to Dishman and his coworkers (1994), "a preferred intensity of exercise...may better promote adherence than a strict prescription based on more precise physiological criteria if those criteria conflict with a person's intensity preference" (p. 1093; also see Dishman, 1994, p. 783).

At this point, the number of studies examining the exercise intensity level participants tend to select remains small (e.g., Glass & Chvala, 2001; Murtagh, Boreham, & Murphy, 2002; Parfitt, Rose, & Markland, 2000; Spelman, Pate, Macera, & Ward, 1993; Zamparo, Perini, Peano, & di Prampero, 2001). Of these, most have focused on physiological factors that can predict self-selected intensity, such as age, aerobic capacity, or body mass and composition (Cunningham, Rechnitzer, Pearce, & Donner, 1982; Dishman et al., 1994; Malatesta et al., 2004; Michael & Eckardt, 1972; Michael & Hackett, 1972; Parise, Sternfeld, Samuels, & Tager, 2004; Pearce et al., 1983; Swaine, Emmett, Murty, Dickinson, & Dudfield, 1995). Few studies have examined the role of psychological constructs, some concentrating on dispositional and some on situational or task-specific variables. Among dispositional variables, an early report by Morgan (1973) focused on the personality dimension of introversion-extraversion. In that study, nine male participants exercised on a cycle ergometer against five resistance levels (300, 600, 900, 1,200, and 1,500 kpm) for 1 min each. When the participants were later asked which intensity level they would have chosen if the exercise session was to last for 30 min, the selected intensity level was significantly related to the participants' scores on a self-report measure of extraversion ($r = .70$). A more recent study found that an index of the asymmetric activation of the frontal brain hemispheres, typically associated with dispositional approach motivation, was related to the selection of walking speed and reports of perceived exertion (Hall, Ekkekakis, Van Landuyt, & Petruzzello, 2000). Among situational and task-specific variables, Ewart et al. (1986) found that self-efficacy predicted the number of minutes cardiac patients spent exercising above or below their target heart rate range. Others have focused on social-environmental conditions, showing that being observed by a bystander (Worringham & Messick, 1983) and exercising in a public exercise facility, as opposed to the relative social isolation of a laboratory (Focht & Hausenblas, 2003), tended to increase the level of self-selected exercise intensity.

The present investigation pertains specifically to dispositional factors that influence the preferences for different exercise intensity levels. Although several traits underlying individual differences in arousability and sensory modulation are theoretically relevant to the preference for exercise intensity, including the personality dimensions of introversion-extraversion, sensation seeking, and sensory augmentation-reduction, among others, it appears the literature contains only the aforementioned study by Morgan (1973), focusing on the role of extraversion. The reasons for this shortage of research are unclear. However, based on our own experience with extensive preliminary studies, one possible reason may be that scores on the standard self-report measures of these traits generally do not correlate well with behavioral responses in the exercise context. An explanation for this may be found in these questionnaires, as their item pools focus almost exclusively on responses to *exteroceptive* stimuli (e.g., visual, auditory, tactile, etc.), mainly of a social nature (such as sociability, novelty seeking, or risk taking), to the exclusion of *interoceptive* stimuli, or sensory cues, arising from the body itself (such as the muscular and respiratory sensations associated with exercise). Others (Lucas, Diener, Grob, Suh, & Shao, 2000) have also cited the overemphasis on social behavior, to the extent that other more central attributes of the trait are overlooked. Given that the brain systems involved in processing interoceptive and exteroceptive stimuli are, to a large extent, anatomically and functionally distinct, it is possible that behavioral dispositions in the context of social interactions and physical activity may be, at least in part, unrelated. At the same time, there is considerable evidence from both human and animal research of substantial *interindividual* variability in the amount and intensity of locomotor activity (and, importantly, consistently less *intraindividual* variability) that cannot be attributed to physiological differences alone (for a review, see Ekkekakis, Hall, & Petruzzello, 2005).

Citing the need for a self-report measure relevant to the physical activity context, researchers developed the Preference for and Tolerance of the Intensity of Exercise Questionnaire (PRETIE-Q; Ekkekakis et al., 2005). According to the conceptual basis of the PRETIE-Q, intensity preference and intensity tolerance are moderately interrelated heritable traits. Preference for exercise intensity was defined as a predisposition to select a particular exercise intensity level when engaging in unsupervised exercise. Tolerance of exercise intensity was defined as a trait that influences one's ability to continue exercising at an imposed intensity level beyond the point at which the activity becomes uncomfortable or unpleasant. The PRETIE-Q possessed simple structure (i.e., no cross-loadings between the two factors), exhibited adequate internal consistency and test-retest reliability, and showed promising signs of construct, convergent, and discriminant validity.

The purpose of the present study was to investigate the ability of the PRETIE-Q preference scale to predict the self-selection of exercise intensity. As such, the study also represents a continuation of the validation of the questionnaire, providing evidence for the construct validity of the preference scale and the discriminant validity of the preference and tolerance scales.

Unlike the earlier study by Morgan (1973), in which participants self-reported selecting a preferred exercise intensity level, in the present investigation we aimed to predict the selection of actual, physiologically defined exercise intensity. Specifically, we chose to operationalize exercise intensity not as a percentage of peak aerobic capacity (%VO_2peak) but rather as a percentage of the oxygen uptake associated with the ventilatory threshold (%VO_2-at-VT). This decision was based on the following rationale. First, we assumed that selecting a workload depends primarily on maximizing pleasure and/or minimizing displeasure, a principle initially proposed by Cabanac (1986; Cabanac & Leblanc, 1983). Second, evidence from several laboratories indicates that once intensity exceeds the level that can be maintained through aerobic metabolism and reaches a level requiring anaerobic supplementation, variously operationalized as the VT or the lactate threshold, significant declines in self-reported pleasure begin to occur (Acevedo, Kraemer, Haltom, & Tryniecki, 2003; Bixby, Spalding, & Hatfield, 2001; Ekkekakis, Hall, & Petruzzello, 2004; Hall, Ekkekakis, & Petruzzello, 2002). On the other hand, studies examining affective responses to various arbitrarily selected percentages of maximal exercise capacity have failed to find a reliable connection between a particular percentage and a change in pleasure-displeasure (Ekkekakis & Petruzzello, 1999). Third, in a previous investigation, Dishman et al. (1994) found that a sample of physically active college-age participants chose to exercise at an intensity centered on the VT (i.e., between 90 and 110% of the intensity corresponding to the VT). Therefore, we assumed that the distribution of self-selected exercise intensities would center near the VT, as this would be the highest intensity one could maintain without discomfort or displeasure. We aimed to account for the dispersion of individuals around the VT level by the PRETIE-Q preference scale.

The hypothesis tested in the present study was that the PRETIE-Q preference scale scores, not tolerance, would predict the %VO_2-at-VT, not %VO_2peak, that previously sedentary, middle-aged women select, after variance due to demographic (age), anthropometric (body mass index; BMI) and physiological (VO_2peak) variables are partialled out. Previous studies have shown that age (Malatesta et al., 2004; Parisse et al., 2004; Pearce et al., 1983) and BMI (Parisse et al., 2004; Pearce et al., 1983) are negatively related to the self-selected intensity level. VO_2peak has been found to have a positive relationship with intensity expressed as %VO_2peak (i.e., with more fit participants exercising at a higher %VO_2peak and vice versa) and a negative relationship with intensity expressed as %VO_2-at-VT (i.e., with more fit participants exercising at a lower %VO_2-at-VT and vice versa; Dishman et al., 1994; Swaine et al., 1995).

Method

Participants

An initial sample of 50 women expressed interest in participating in the study and contacted the investigators, after seeing posters, receiving an electronic mail message (sent to the faculty and staff of a large state university), or being informed about the study through word of mouth. The purpose of the first telephone interview was to ascertain that the women satisfied the inclusion criteria for the study. Specifically, they (a) responded to a 7-day physical activity recall interview (Blair et al., 1985), to ensure they expended less than the recommended 200 kcal (Pate et al., 1995) or participated in less than 30 min of moderate physical activity per day on most weekdays (ACSM, 2000; USDHHS, 1996), (b) reported they had not changed their physical activity habits in the previous 12 months (and, thus, based on the 7-day physical activity recall, were sedentary), (c) signed a statement, certifying they had had a physical examination in the previous 12 months that revealed no contraindications to vigorous physical activity, (d) gave all negative responses to all the questions of the Physical Activity Readiness Questionnaire (Thomas, Reading, & Shephard, 1992), indicating they were apparently healthy, (e) certified they had no history of cardiovascular, respiratory, musculoskeletal, or metabolic conditions, (f) were not suffering from any injuries or other ailments at the time, and (g) were nonsmokers. Following this initial screening, 27 women were scheduled for testing. Of these, however, 3 terminated the incremental treadmill test without reaching a true peak (see the Procedures section), and 1 did not return for a second session. These 4 women were not considered in further analyses, leaving a final sample of 23. Their demographic, anthropometric, and physiological characteristics appear in Table 1. The participants received no monetary compensation but were given the results of their fitness assessment and an individualized exercise prescription on completing the study.

Measures

The PRETIE-Q was used to assess the trait variables of preference for and tolerance of exercise intensity. The preference scale contains four items that tap preference for high intensity (e.g., "I would rather have a short, intense workout than a long, low-intensity workout") and four that tap preference for low intensity (e.g., "When I exercise, I usually prefer a slow, steady pace"). The tolerance scale contains four items that tap high tolerance for intense exercise (e.g., "I always push through muscle soreness and fatigue when working out") and four that tap low tolerance for intense exercise (e.g., "During exercise, if my muscles begin to burn excessively or if I find myself breathing very hard, it is time for me to ease off"). Each item is accompanied by a five-point response scale ranging from "I totally disagree" to "I totally agree." Ekkekakis et al. (2005) reported alpha coefficients of internal consistency ranging between .81 and .85 for the preference scale and between .82 and .87 for the tolerance scale. Ekkekakis et al. (2005) also reported the results of a confirmatory factor analysis that showed a reasonably close fit to the two-factor structure (goodness of fit index = .874, root mean square error of approximation = .078).

Table 1. Demographic, anthropometric, and physiological characteristics of the participants (*N* = 23)

	M	*SD*
Age (years)	43.43	4.85
Body mass (kg)	78.13	17.04
Height (cm)	166.76	5.89
Body mass index (m/kg^2)	28.03	6.25
Estimated percentage of body fat	27.42	5.69
VO_2peak (ml•kg^{-1}•min^{-1})	22.98	5.69
HRpeak (beats•min^{-1})	159.32	24.08
%VO_2peak at VT	70.50	10.73

Note. M = mean; *SD* = standard deviation; VO_2peak = maximal aerobic capacity; HRpeak = peak heart rate; %VO_2peak at VT = percentage of peak aerobic capacity at ventilatory threshold.

Oxygen uptake (VO_2) was assessed using an open-circuit computerized spirometry system (model TrueMax 2400, ParvoMedics, Salt Lake City, UT). The system consists of a paramagnetic O_2 analyzer, an infrared CO_2 analyzer, and a pneumotachometer (model 3813, Hans Rudolph, Kansas City, MO) to measure ventilation. The system was calibrated for O_2 and CO_2 using a gas with certified concentrations of O_2 and CO_2 and for ventilation with a standard 15-stroke calibration procedure, using a 3-L syringe (model 5530, Hans Rudolph, Kansas City, MO). A validation study of this system found the differences compared to the gold-standard Douglas bag method were "so small as to be not physiologically significant" (Bassett, et al., 2001, p. 221).

Procedures

Participation in the study required three visits to the laboratory. The first session involved an incremental treadmill test to volitional exhaustion to determine VO_2peak and VT. The second session involved a bout of treadmill exercise at a self-selected pace. The third visit involved completing the PRETIE-Q (as well as several other questionnaires not reported here).

Before starting the first session, all participants read and signed an informed consent form approved by the university's Institutional Review Board. Then, each participant was weighed and fitted with a heart rate monitor chest band (Polar Electro Oy, Kempele, Finland) and a nasal and mouth breathing face mask, made of silicone rubber (model 8920/30, Hans Rudolph, Kansas City, MO) and equipped with an ultra-low-resistance, T-shaped, two-way, nonrebreathing valve (model 2700, Hans Rudolph, Kansas City, MO). In turn, the mask was connected to the spirometry system via plastic tubing (3.5 cm in diameter). A gel sealant (model 7701, Hans Rudolph, Kansas City, MO) was applied to the face mask to prevent air leaks.

Two min of resting data were collected while the participant stood on the treadmill belt (model L8, Landice, Randolph, NJ) to ensure the proper functioning of the spirometry system. The incremental treadmill test began at a speed of 4 km•hr^{-1} and 0% grade for 2 min. Thereafter, the speed was increased by 0.64 km•hr^{-1} every second minute (while maintaining the grade at 0%) until each participant reached the point of volitional exhaustion. For 3 of the 27 participants, the criteria for reaching maximal capacity (i.e., reaching age-predicted maximal heart rate, plateau in oxygen consumption with increasing workloads, and a respiratory exchange ratio greater than 1.1) were not satisfied, as these women terminated the test due to musculoskeletal complaints (e.g., knee pain, perceived weakness in the legs). As previously noted, these 3 were excluded from further analyses.

In subsequent offline analyses of the data collected during the incremental treadmill test, the highest 30-s average value of VO_2 attained was designated as VO_2peak. Likewise, the average VO_2 associated with the 30-s period during which the VT occurred was designated as VT. Both VO_2peak and VT were used as reference points to determine the relative intensity selected during the second session.

The second session took place a minimum of 48 hr after the first (*M* = 7.00 days, *SD* = 4.77). For this session, the women were told to engage in a 20-min bout of treadmill activity, during which they would be able to select a preferred speed. Care was taken to avoid characterizing the intensity (e.g., referring to an intensity they "liked" or "enjoyed," felt "comfortable" with, or considered "beneficial"). After again being fitted with the heart rate monitor and face mask following the same procedures as in the first session, each participant was allowed to warm up by walking for 5 min at 4 km•hr^{-1} at a 0% grade. After the warm-up, each participant set a speed she preferred (0:00 min) and was allowed to adjust it (faster or slower, with the grade always fixed at 0%) every 5 min of the 20-min bout (Minute 5:00, 10:00, 15:00). After participants completed the 20-min bout, the face mask was removed and they were allowed to cool down by walking for 5 min at 4 km•hr^{-1} and a 0% grade. After a 20-min seated recovery and observation period, the participants were debriefed, thanked, and released. Offline, the average values of VO_2 from Minutes 4:30–5:00, 9:30–10:00, 14:30–15:00, and 19:30–20:00 were computed. These averages were then expressed as %VO_2-at-VT and %VO_2peak and used in subsequent analyses.

Determination of the Ventilatory Threshold

The VT was determined offline by a computerized version of the three-method combined procedure proposed by Gaskill et al. (2001). Specifically, the following methods were used: (a) the V-slope (i.e., plotting CO_2 production over O_2 use and identifying a breakpoint in the slope of the relationship between these two variables), (b) the method of the ventilatory equivalents (i.e., plotting the ventilatory equivalents for O_2 [V_E/VO_2] and CO_2 [V_E/VCO_2] over time or over O_2 use and identifying the exercise intensity level corresponding to the first rise in V_E/VO_2 that occurs without a concurrent rise in V_E/VCO_2), (c) the excess CO_2 method (i.e., plotting excess CO_2 over time or O_2 use and identifying the exercise intensity level corresponding to an increase in excess CO_2 from steady state). All data were converted to 20-s averages prior to analysis. The VT was determined to occur at the point where at least two of the three methods converged or produced the lowest mean square residual. The solution was verified by visual inspection after plotting regression lines through the pre- and postbreakpoint data segments.

Statistical Analysis

The data were analyzed with a series of hierarchical regression analyses. The dependent variables were: (a) the %VO_2peak attained at Minutes 5, 10, 15, and 20, and (b) the %VO_2-at-VT attained at Minutes 5, 10, 15, and 20 of the 20-min self-selected intensity session. Age (in years), BMI (in m/kg^2), and VO_2peak (in L•min^{-1}) were entered as predictors in the first step, and the scores on the PRETIE-Q preference or tolerance scales were entered as predictors in the second step. The standardized regression coefficients (β), multiple correlation coefficients (R), change in variance accounted for per step (R^2 change), and the associated F values and probability levels are reported.

Results

The mean, standard deviation, minimum, and maximum for %VO_2peak and %VO_2-at-VT at each time point during the session at self-selected intensity are shown in Table 2. For descriptive purposes, Table 2 also shows the values for the treadmill speed and ratings of perceived exertion (Borg, 1998). Analyses of variance showed the effect of time (Minutes 5, 10, 15, 20) was significant, both when self-selected intensity was expressed as %VO_2peak, $F(3, 63) = 9.694$, $p < .001$, $\eta^2 = .35$, and as %VO_2-at-VT, $F(3, 63) = 9.317$, $p < .001$, $\eta^2 = .35$. Follow-up pairwise comparisons with Bonferroni corrections showed that both %VO_2peak and %VO_2-at-VT increased significantly from Minute 5 to Minute 15, but showed no significant change from Minute 15 to Minute 20. At these two time points, as hypothesized, oxygen uptake did not differ significantly from the level associated with the VT, as determined from the incremental treadmill test. It is important to note, however, that, as shown in Table 2, there was substantial interindividual variability at each time point. For example, at Minute 20, %VO$_2$peak ranged from a low of 44% to a high of 92%, and %VO$_2$-at-VT ranged from a low of 62% to a high of 160%.

Table 2. Mean, standard deviation, and minimum and maximum scores for indexes of intensity and the preference and tolerance scales of the Preference for and Tolerance of the Intensity of Exercise Questionnaire

	M	*SD*	Min-max
%VO$_2$peak			
Minute 5	54.67	10.43	37.43–74.32
Minute 10	59.56	10.87	38.50–82.10
Minute 15	64.23	12.54	40.64–91.36
Minute 20	67.16	13.63	44.30–91.98
%VO$_2$-at-VT			
Minute 5	78.43	14.25	54.10–101.54
Minute 10	85.43	14.70	55.81–109.02
Minute 15	92.50	19.16	58.91–125.00
Minute 20	97.24	24.54	62.07–160.00
Treadmill speed (km•hr^{-1})			
Minute 5	5.00	.80	3.20–6.72
Minute 10	5.45	1.08	3.20–8.48
Minute 15	5.75	1.33	3.20–9.60
Minute 20	5.91	1.59	3.20–10.56
RPE (6–20 scale)			
Minute 5	10.96	1.30	9–13
Minute 10	11.96	1.36	9–14
Minute 15	13.09	1.41	11–16
Minute 20	13.78	1.95	11–18
Preference (8–40 scale)	21.92	6.73	8–36
Tolerance (8–40 scale)	20.12	3.93	15–29

Note. *M* = mean; *SD* = standard deviation; Min-max = minimum and maximum scores; %VO$_2$peak = percentage of peak aerobic capacity; %VO$_2$-at-VT = percentage of oxygen uptake at the ventilatory threshold; RPE = rating of perceived exertion (Borg, 1998).

The results of the bivariate correlations between the key variables are shown in Table 3. In hierarchical regression analyses, preference for exercise intensity accounted for significant variance in self-selected intensity, expressed as %VO$_2$-at-VT, at Minute 15 and Minute 20, beyond the variance accounted for by age, BMI, and VO$_2$peak (see Table 4). Specifically, preference accounted for 17% of the variance at Minute 15 (β = .432; p = .052) and 18% at Minute 20 (β = .448; p = .038). Preference did not, however, account for a significant portion of the variance at Minutes 5 and 10, when the intensity was still increasing and had not started to stabilize to an apparently preferred level.

When intensity was expressed as %VO$_2$peak, preference did not account for a significant amount of variance at any time point. The considerable amounts of explained variance were almost entirely due to the contributions of VO$_2$peak in all the models, with betas of .594 (p < .05) at Minute 5 (total R^2 = .425), .578 (p < .01) at Minute 10 (total R^2 = .527), .727 (p < .001) at Minute 15 (total R^2 = .688), and .747 (p < .001) at Minute 20 (total R^2 = .685).

Tolerance of exercise intensity did not account for any significant portion of the variance at any time point, either when the intensity was expressed as %VO$_2$-at-VT or as %VO$_2$peak. The betas were consistently low, ranging from .089 to .393 and from -.085 to .212, respectively.

Discussion

A growing number of studies show that exercise intensity, in addition to influencing fitness and health benefits, also impacts adherence and dropout (Cox et al., 2003; Lee et al., 1996; Perri et al., 2002; Sallis et al., 1986). An important part of the rationale for the present

Table 3. Bivariate Pearson product-moment correlations between key variables

	1	2	3	4	5	6	7	8
1. Age (years)								
2. BMI (m/kg^2)	-.05							
3. VO$_2$peak (L•min^{-1})	-.22	-.59**						
4. Preference	-.10	-.20	.12					
5. Tolerance	-.13	.16	-.04	.33				
6. %VO$_2$-at-VT Minute 5	.08	.35	-.29	-.03	.34			
7. %VO$_2$-at-VT Minute 10	.05	.05	-.01	.29	.39	.71**		
8. %VO$_2$-at-VT Minute 15	-.25	.01	.31	.43*	.26	.45*	.84**	
9. %VO$_2$-at-VT Minute 20	-.09	-.12	.41	.46*	.13	.34	.71**	.88**

Note. BMI = body mass index; VO$_2$peak = peak aerobic capacity; %VO$_2$-at-VT = percentage of oxygen uptake at the ventilatory threshold.
*p < .05.
**p < .01.

study was the belief that some revision and refinement of the exercise prescription guidelines is warranted to reflect considerations related not only to biological adaptations and attaining health and fitness objectives but also to maintaining adherence and preventing dropout. In particular, the aim of the present study was to investigate the role of individual preferences in determining physiologically defined self-selected exercise intensity.

Therefore, we conducted a test of the construct validity of the PRETIE-Q preference scale, using a sample of middle-aged, healthy but previously sedentary women who were just beginning to engage in physical activity. We hypothesized that the PRETIE-Q preference, not tolerance, scale would predict the self-selected treadmill exercise intensity, when the intensity was expressed as %VO_2-at-VT, not as %VO_2peak. Consistent with our hypothesis, preference for exercise intensity was a significant predictor of the %VO_2-at-VT at Minutes 15 and 20 of the 20-min session, accounting for 17 and 18% of the variance, respectively, beyond that accounted for by age, BMI, and VO_2peak. Consistent with previous findings (e.g., Cabanac, 1986), intensity gradually increased during the first 10–15 min and only stabilized to a presumably preferred level during the last 5–10 min of the session. It is, therefore, not surprising that the ability of the preference scale to predict the intensity was limited to the assessments of intensity at Minutes 15 and 20. Also consistent with the hypothesis, the preference scale did not predict the %VO_2peak attained at any point during the 20-min session at self-selected intensity. This supports our contention that the VT is intuitively used as a reference point and guide in selecting preferred intensity. Presumably, this is because it is the highest intensity level that can be maintained without causing discomfort or displeasure (Acevedo et al., 2003; Bixby et al., 2001; Ekkekakis et al., 2004; Hall et al., 2002). It is also possible, however, that the inability of the reference scale to account for any significant portion of the variance in %VO_2peak was due to the strong correlations between VO_2peak and %VO_2peak at all time points during the exercise session, which limited the amount of variance that could be accounted for by other variables. The contribution of VO_2peak in predicting self-selected intensity is well established (Cunningham et al., 1982; Dishman et al., 1994; Pearce et al., 1983; Swaine et al., 1995). On the other hand, age and BMI did not account for a significant portion of the variance in self-selected intensity in any analysis. A similar lack of association has been reported in some (e.g., Cunningham et al., 1982), but not all (Malatesta et al., 2004; Parisse et al., 2004; Pearce et al., 1983), previous studies.

Table 4. Hierarchical regression analyses examining the variance in self-selected intensity at Minutes 5, 10, 15, and 20, expressed as the percentage of oxygen uptake at the ventilatory threshold, accounted for by preference for exercise intensity

	β	p	R	R^2_{change}	F_{change}	p
Minute 5						
Age	.046	.847	.368	.135	.938	.443
BMI	.285	.307				
VO_2peak	-.111	.701				
Age	.053	.828	.376	.006	.122	.731
BMI	.305	.298				
VO_2peak	-.114	.701				
Preference	.082	.731				
Minute 10						
Age	.062	.807	.077	.006	.036	.991
BMI	.074	.803				
VO_2peak	.050	.873				
Age	.092	.712	.328	.102	1.940	.182
BMI	.153	.603				
VO_2peak	.036	.904				
Preference	.333	.182				
Minute 15						
Age	-.135	.568	.401	.161	1.153	.355
BMI	.237	.388				
VO_2peak	.404	.167				
Age	-.096	.659	.577	.171	4.368	.052
BMI	.340	.192				
VO_2peak	.387	.152				
Preference	.432	.052				
Minute 20						
Age	.072	.753	.443	.196	1.466	.257
BMI	.190	.477				
VO_2peak	.544	.063				
Age	.113	.590	.617	.184	5.058	.038
BMI	.297	.235				
VO_2peak	.526	.049				
Preference	.448	.038				

Note. BMI = body mass index; VO_2peak = peak aerobic capacity.

The present study showed that, although the distribution of self-selected exercise intensity centered on the VT as hypothesized (with an average of 97% of VO_2-at-VT at Minute 20), there was substantial interindividual variability (also see Spelman et al., 1993, on this topic). As shown in Table 2, individual percentages at Minute 20 ranged from a low of 62% to a high of 160%. Furthermore, to compare the intensity level selected in this study against the commonly recommended "moderate" level (USDHHS, 1996; Pate et al., 1995), we examined the percentages of peak heart rate our participants reached (as a physiological measure directly comparable to those used by the ACSM). These ranged, on average, from 74% at Minute 5 to 83% at Minute 20, with several individuals reaching and exceeding the peak value obtained during the incremental treadmill test. By comparison, the intensity the ACSM (2000, p. 150) characterized as "moderate" ranges from 55 to 69% of maximal heart rate. Likewise, the average rating of perceived exertion (Borg, 1998) reported in this study (see Table 2) approached 14, whereas "moderate" intensity is typically associated with a rating between 12 and 13. Therefore, even the average intensity reached in this study qualifies as "hard" rather than "moderate." Moreover, individual intensities varied greatly, with some being "light" and, therefore, unlikely to confer substantial health and fitness benefits, and some being "maximal" and, therefore, raising the risk of injury and cardiac complications. Collectively, these data suggest that, at least for women just starting an exercise program, recommendations to take individual preferences into account when developing an exercise prescription (ACSM, 2000, p. 145) and "tailor" intensity "to individual preferences" (King & Martin, 1993, p. 447) should not be interpreted as a call for universal transition to a model of self-selected exercise intensity. It is clear that some individuals, particularly in the early stages of participation, will inevitably select intensities either too low to be effective or too high to be safe. We suggest: (a) a paradigmatic shift in exercise prescription practices, moving away from a model based on percentages of maximal capacity toward one that targets the aerobic-anaerobic transition as a safe and effective intensity level for improving health (e.g., Ekkekakis et al., 2004) and fitness (e.g., Londeree, 1997), and (b) using a validated instrument, such as the PRETIE-Q preference scale, as a screening device to identify individuals who have a tendency to deviate substantially in either direction from this target intensity. Once such individuals are identified as high dropout risks, intervention strategies can be implemented to educate them on the appropriate intensity level (e.g., debunk the "no pain, no gain" slogan) and improve their self-monitoring and self-regulatory skills. Although a detailed discussion of such interventions is beyond the scope of the present study, it might be useful to note that appropriate models for improving people's ability to detect homeostatic perturbations exist. For example, Gonder-Frederick and Cox (1990, 1991) developed an "Error Grid" method to teach diabetes patients to detect changes in their blood glucose levels. Given that the aerobic-anaerobic transition is accompanied by a multitude of ventilatory, neuroendocrine, and cardiovascular changes, it provides a good basis for a similar intervention (Ekkekakis & Petruzzello, 2002).

As is the case with all laboratory-based studies, the present study also had inherent limitations, which researchers and practitioners should take into account. First, the generalizability of the findings is limited by the small size and other characteristics of the sample (see Table 1), the ecological setting (i.e., laboratory), and the exercise mode (i.e., treadmill) and protocol (i.e., 20 min, with permitted speed changes every 5 min) used. It should not be assumed that the findings reported herein would remain invariant in a sample of different characteristics (e.g., among men or in individuals with different demographic and anthropometric attributes), in naturalistic or clinical settings, or in different activity modes (e.g., cycling) or experimental protocols (e.g., shorter or longer bout, more or less frequent adjustments of speed). The ability of the PRETIE-Q to predict self-selected exercise intensity under such conditions should be investigated rather than assumed. Second, given the labile nature of correlational statistics, such as multiple regressions, particularly when used in conjunction with relatively small samples, replicating the present data with a different and preferably larger sample is desirable before establishing the ability of the PRETIE-Q to predict self-selected exercise intensity with certainty. This is also the reason we did not propose low and high "cut-off" scores indicative of preferences for intensities too low or too high, respectively.

The implications of the present findings can be categorized in two sets. First, the results are promising with respect to the validity of the PRETIE-Q preference scale and contribute to the evidence initially provided by Ekkekakis et al. (2005). Moreover, the study provided some evidence of discriminant validity for the preference and tolerance scales, because only the preference, not the tolerance, scale predicted self-selected exercise intensity. Second, the present findings have potential practical implications, because scores on the PRETIE-Q preference scale accounted for 17–18% of the variance in %VO_2-at-VT, beyond that accounted for by age, BMI, and VO_2peak. The total models accounted for 33–38% of the variance in %VO_2-at-VT. Arguably, the 17–18% variance contributed by the preference scale is a meaningful addition, particularly given the fact that the criterion variable used in the present study was not self-reported but rather physiologically defined exercise intensity. In conjunction with other variables, it would be possible to construct models that can identify individuals with a tendency to select intensities either too low or too high. Future studies should continue to investigate the interindividual differences in selecting exercise intensity, thus helping to improve the quality of exercise prescriptions and, ultimately, the rates of exercise adherence.

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Authors' Notes

This research study was supported by a Special Research Initiation Grant (SPRIG) from Iowa State University (Office of the Vice Provost for Research and Advanced Studies) and a Behavioral Science Track Award for Rapid Transition (B/START) from the National Institute of Mental Health (R03MH069724). Please address all correspondence concerning this article to Panteleimon Ekkekakis, 253 Barbara E. Forker Building, Department of Health and Human Performance, Iowa State University, Ames IA 50011.

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