Role of Self-Reported Individual Differences in Preference for and Tolerance of Exercise Intensity in Fitness Testing Performance

Eric E. Hall,[1] Steven J. Petruzzello,[2] Panteleimon Ekkekakis,[3] Paul C. Miller,[1] and Walter R. Bixby[1]

[1]Department of Exercise Science, Elon University, Elon, North Carolina; [2]Department of Kinesiology and Community Health, University of Illinois at Urbana-Champaign, Urbana, Illinois; and [3]Department of Kinesiology, Iowa State University, Ames, Iowa

Abstract

Hall, EE, Petruzzello, SJ, Ekkekakis, P, Miller, PC, and Bixby, WR. Role of self-reported individual differences in preference for and tolerance of exercise intensity in fitness testing performance. *J Strength Cond Res* 28(9): 2443–2451, 2014—Performance in fitness tests could depend on factors beyond the bioenergetic and skeletomuscular systems, such as individual differences in preference for and tolerance of different levels of exercise-induced somatosensory stimulation. Although such individual-difference variables could play a role in exercise testing and prescription, they have been understudied. The purpose of these studies was to examine the relationships of self-reported preference for and tolerance of exercise intensity with performance in fitness tests. Participants in study I were 516 men and women volunteers from a campus community, and participants in study II were 42 men recruit firefighters undergoing a 6-week training program. Both the Preference and Tolerance scores exhibited significant relationships with performance in several fitness tests and with body composition and physical activity participation. Preference and Tolerance did not change after the training program in study II, despite improvements in objective and perceived fitness, supporting their conceptualization as dispositional traits. Preference and Tolerance scores could be useful not only in ameliorating the current understanding of the determinants of physical performance, but also in personalizing exercise prescriptions and, thus, delivering exercise experiences that are more pleasant, tolerable, and sustainable.

Key Words exercise performance, personality, traits, somatosensory modulation, physical activity

Address correspondence to: Eric E. Hall, ehall@elon.edu.

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Introduction

Exercise prescription guidelines (1) are replete with reminders about the importance of taking into account what different individuals prefer and can tolerate when developing exercise plans. However, this guidance remains unaccompanied by specific measures for assessing relevant individual differences and procedures for tailoring the exercise prescriptions. Although research in sport psychology has highlighted the importance of a multitude of psychological factors in sport and exercise performance, these consist mainly of situational appraisals (e.g., self-efficacy and goal-setting) as opposed to more stable individual differences, such as traits.

The relative dearth of research on the role of psychological traits in physical performance can probably be attributed to the inconsistent findings of early investigations on personality factors during the 1960s and 1970s. For example, extraversion, a personality dimension with a theorized biological basis, has long been hypothesized to influence various aspects of sport and exercise performance (12). Indeed, some studies found that extraversion was associated with lower ratings of perceived exertion (16,27), higher persistence in demanding physical tasks (2,17,38), a propensity for more active forms of recreation (14) or sports (5,22), and higher exercise participation and adherence (3,32,33). Other studies, however, found no relationship with perceived exertion (43), persistence in physical tasks (13,39), or exercise participation and adherence (31,44,45). Although studies have suggested that other traits, including perceptual augmentation-reduction (34,35), locus of control (29), and pain catastrophizing (40), may also be involved in exercise performance, there have been no attempts to replicate these initial findings.

The phenomenon of inconsistent associations between general personality traits and responses to somatosensory stimuli is not unique to exercise. For example, although in theory, personality factors should be related to pain perception and tolerance, the results have been contradictory (30). In trying to explain these inconsistencies, authors have often pointed to how personality traits are measured (4,21,28,30) as the possible culprit. In particular, the standard self-report measures of most relevant personality traits (e.g., extraversion) seem to overemphasize social functioning and responses to exteroceptive (i.e., visual, auditory) rather than interoceptive stimuli (i.e., those emerging from within the body).

Based on this observation, it was suggested that the development of measures that specifically target individual differences in how exercise-induced somatic stimuli are processed could help advance research in this area (6). Thus, 2 correlated (i.e., "oblique") constructs were proposed, namely (a) preference for exercise intensity and (b) tolerance of exercise intensity. Intensity preference was defined as a predisposition to select a particular level of exercise intensity (when intensity is self-regulated rather than externally imposed). Intensity tolerance was defined as a trait that influences the ability to continue exercising at levels of intensity associated with displeasure or discomfort (e.g., when exercise intensity is externally imposed or when one is approaching his or her physiological limits).

The Preference for and Tolerance of the Intensity of Exercise Questionnaire (PRETIE-Q) (6,11) was developed as a measure of these constructs. Consistent with the conceptualization of preference and tolerance as traits, test-retest reliability estimates were found to be high (3 months: 0.67 and 0.85; 4 months: 0.80 and 0.72, for Preference and Tolerance, respectively). Both traits were related to the self-reported intensity of habitual physical activity and personality trait measures of sensory modulation (i.e., individual differences, such as a tendency toward amplification or attenuation, in the relation between the physical intensity of sensory stimuli and the magnitude of associated perceptions).

Furthermore, Preference and Tolerance have been found to be correlated with physical fitness variables. In a study of 146 adolescents, Preference and Tolerance were found to be positively correlated with peak oxygen uptake and negatively correlated with percent body fat (36). Similarly, a study of university students found Tolerance, but not Preference, to be related to shuttle run performance and self-reported strenuous exercise (24). Additionally, Preference, but not Tolerance, predicted the intensity of physical activity (percentage of the oxygen uptake at the ventilatory threshold) that a sample of middle-aged women selected (9). Finally, primarily the Tolerance and, to a lesser extent, the Preference scale predicted the period of time that 2 samples of individuals persevered during incremental treadmill tests to volitional exhaustion beyond the point at which they reached their ventilatory threshold (8).

The purpose of the 2 studies described in this article was to examine the associations of scores on the Preference and Tolerance scales of the PRETIE-Q with performance on fitness tests. The studies were designed as an extension of previous research on the construct validity of the PRETIE-Q scales by examining the associations of Preference and Tolerance with performance across a range of physical fitness tests. A preference for higher exercise intensity could contribute to higher fitness testing performance by predisposing an individual to typically exercise at a higher level of intensity, thus creating greater training overload. A higher level of tolerance for somatosensory stimuli associated with strenuous exercise (i.e., higher intensity) could contribute to higher performance through one or both of the following 2 routes: (a) it would permit an individual to routinely attain a higher level of overload during training by being able to withstand the aversive physical symptoms associated with strenuous levels of intensity for a longer period of time or (b) it would be beneficial during the fitness test itself by allowing an individual to more closely approach his or her actual physiological maximum.

It is important to emphasize that performance in a fitness test represents a complex behavior that depends on a myriad of factors. Predispositions for exercise intensity preference and intensity tolerance are only 2 of these. Other possible contributing factors include anatomical and physiological differences, level of training, previous experiences (e.g., acquired coping styles or performance strategies), lifestyle factors (e.g., sleep, nutrition), situational cognitive (e.g., self-efficacy) and social-psychological (e.g., presence of peers) influences, as well as interactions between these factors. Therefore, although we hypothesized that Preference and Tolerance would account for significant portions of the variance in performance, this by no means should be interpreted to imply that these variables were hypothesized to account for all or most of the variance.

Methods

Experimental Approach to the Problem

The first study was a cross-sectional study that examined individuals from a college campus community who underwent fitness testing voluntarily at an on-campus free exercise clinic. The second study used a pretest/posttest design and focused on a group of men recruit firefighters who underwent a similar battery of fitness tests at the beginning and end of a 6-week training course organized by a university-affiliated fire service institute. This also permitted a test of whether Preference and Tolerance could be modified as a result of a period of intense physical training (6-week, progressively challenging program consisting of cardiovascular endurance and musculoskeletal strength training, performed 4 days per week for 30 minutes per day).

Subjects

Study I. A total of 516 participants (327 women, 189 men) volunteered by attending a free fitness testing program open to the campus community at a private university in the Southeastern United States. Participant characteristics are shown in Table 1. All participants read and signed an informed consent form approved by the university's Institutional Review Board. To qualify, all participants also

Table 1. Demographic and anthropometric characteristics of the participants in study I and study II.

	Study I Women ($n = 327$)	Study I Men ($n = 189$)	Study II Men ($n = 42$)
Age (y)	19.6 ± 5.7	20.1 ± 6.2	27.1 ± 4.3
Height (cm)	166.4 ± 7.1	179.5 ± 9.6*	177.8 ± 7.6
Body mass (kg)	63.4 ± 9.8	79.3 ± 15.2*	87.8 ± 17.4
Body mass index ($kg \cdot m^{-2}$)	22.9 ± 3.5	24.7 ± 5.7*	27.7 ± 4.6

*Indicate comparisons between men and women in study I, $p < 0.001$.

completed the Physical Activity Readiness Questionnaire (PAR-Q) (41) and were deemed "low risk," according to American College of Sports Medicine risk stratification criteria (1). Given the voluntary nature of participation, some participants decided not to complete the full battery of fitness tests. The most common reasons given for not completing a particular task were because of previous or present injury or not being appropriately dressed to do all the tasks. The sample sizes per test are shown in Table 2.

Measures. ***Preference for and Tolerance of Exercise Intensity.*** The PRETIE-Q (6) consists of two 8-item scales: (a) Preference for Exercise Intensity (e.g., "I would rather have a short, intense workout than a long, low-intensity workout") and (b) Tolerance of Exercise Intensity (e.g., "When exercising, I try to keep going even after I feel exhausted"). Each item is accompanied by a 5-point response scale, ranging from 1 ("I totally disagree") to 5 ("I totally agree"). In this study, Cronbach's alpha coefficient of internal consistency was 0.84 for the Preference scale and 0.80 for the Tolerance scale.

Muscular Strength. A handgrip dynamometer was used to assess handgrip muscular strength (Model Grip-A; Takei, Tokyo, Japan). The participants performed 3 maximum voluntary contractions with their dominant hand, and the best performance of the 3 was recorded. Strength was expressed in kilograms.

Upper Body Muscular Endurance. The endurance of the muscles of the shoulders and upper torso was evaluated with a 1-minute push-up test (for the general procedure, see 1). The men performed as many "full push-ups" and the women performed as many "knee push-ups" as possible within 1 minute.

Abdominal Muscular Endurance. The endurance of the abdominal muscles was evaluated with a 1-minute curl-up test (for the general procedure, see 1). The participants assumed a supine position, with the knees at a 90° angle and the arms at the side with the palms facing down. The shoulder blades had to be lifted off the mat until the trunk made a 30° angle with the mat. The participants performed as many curl-ups as possible within 1 minute.

Cardiovascular Endurance. The Forestry Step Test was used to estimate cardiovascular endurance (37). Participants stepped up onto a step (33 cm for women and 40 cm for men) and back to the floor after the pace set by a metronome. The metronome was set to 90 $b \cdot min^{-1}$ and a full cycle of stepping onto the step and back to the floor was completed in 4 counts (first leg up, second leg up, first leg down, and second leg down). This procedure was continued

Table 2. Sample sizes, descriptive statistics (mean ± *SD*), and gender comparisons for study I.

	Women		Men	
	n	mean ± *SD*	*n*	mean ± *SD*
Preference (5–40)*	319	25.7 ± 5.7	179	27.8 ± 4.6
Tolerance (5–40)*	319	24.4 ± 4.9	179	27.3 ± 4.8
Handgrip strength (kg)*	303	29.9 ± 4.6	162	48.9 ± 8.0
Push-ups (repetitions in 1 min)*	305	31.3 ± 12.8	176	41.8 ± 14.0
Curl-ups (repetitions in 1 min)*	312	42.1 ± 15.6	176	48.5 ± 15.0
Estimated $\dot{V}O_2max$ ($ml \cdot kg^{-1} \cdot min^{-1}$)*	300	43.2 ± 7.6	173	47.7 ± 6.9
Sit-and-reach (cm)*	315	43.6 ± 10.3	177	37.1 ± 11.7
Body fat (%)*	274	26.2 ± 7.0	147	14.7 ± 6.7
Physical activity (MET, $h \cdot wk^{-1}$)*	313	45.7 ± 34.1	174	63.9 ± 43.2

*$p < 0.001$ for gender comparison.

TABLE 3. Bivariate correlations (r) and partial correlations (r_{part}, controlling for age and body mass index) of preference and tolerance with fitness variables and physical activity in study I.

	Total		Women		Men	
	r	r_{part}	r	r_{part}	r	r_{part}
Preference						
Handgrip strength	0.21**	0.25**	0.08	0.12*	0.12	0.14
Push-ups	0.26**	0.22**	0.20**	0.15***	0.23***	0.14
Curl-ups	0.24**	0.21**	0.21**	0.19**	0.22***	0.12
Estimated $\dot{V}O_2$max	0.19**	0.19**	0.11*	0.10	0.21***	0.17*
Sit-and-reach	−0.09	−0.11*	−0.09	−0.08	0.05	0.01
Body fat	−0.37**	−0.33**	−0.33**	−0.28**	−0.29**	−0.09
Physical activity	0.29**	0.27**	0.25**	0.25**	0.29**	0.23***
Tolerance						
Handgrip strength	0.25**	0.27**	0.11*	0.14*	0.02	0.01
Push-ups	0.38**	0.36**	0.29**	0.26**	0.36**	0.30**
Curl-ups	0.24**	0.21**	0.22**	0.19**	0.17*	0.06
Estimated $\dot{V}O_2$max	0.17**	0.16**	0.11*	0.09	0.09	0.03
Sit-and-reach	0.03	0.01	0.08	0.07	0.17*	0.14
Body fat	−0.35**	−0.31**	−0.23**	−0.15***	−0.24***	−0.04
Physical activity	0.29**	0.28**	0.26**	0.26**	0.26**	0.19*

*$p < 0.05$.
**$p < 0.001$.
***$p < 0.01$.

for 5 minutes. On termination of the test, an investigator palpated the participant's pulse from the 15th to the 30th second of recovery while the participant was seated. The recovery heart rate was then used to estimate maximal oxygen uptake (in $ml \cdot kg^{-1} \cdot min^{-1}$), also taking into account gender and age (37).

Flexibility. The sit-and-reach test was used to assess hamstring and hip-joint flexibility (1). A sit-and-reach box was used with the "zero" point set at 23 cm. This test was included as a "negative control," since the preference for and tolerance of exercise intensity were hypothesized to be unrelated to flexibility.

Body Composition. The percentage of body fat was estimated by using skinfold calipers at 3 sites. The 3 sites for the men were chest, abdomen, and thigh and for women, triceps, superiliac, and thigh. The procedures and formulas recommended by the American College of Sports Medicine were used (1).

Physical Activity. Physical activity levels were measured with the Aerobics Center Longitudinal Study Physical Activity Questionnaire (23). This survey inquires about the physical activities (e.g., walking, stair climbing, jogging, running, bicycling, swimming, sports, weight training, and yard and house work activities) in which the respondent has participated regularly during the previous 3 months. The responses were converted to metabolic equivalent unit hours per week (MET $h \cdot wk^{-1}$).

Procedures. On arrival at the testing site, each participant was asked to complete the informed consent form, which described all the assessment procedures to be followed. The participants were then asked to complete the PRETIE-Q and the Aerobics Center Longitudinal Study Physical Activity Questionnaire. Subsequently, the participants began the fitness assessments, following the order recommended by the American College of Sports Medicine (1); (i.e., body composition, cardiorespiratory endurance, muscular fitness, and flexibility). However, as noted earlier, they could opt to do the entire battery of tests or only certain components.

Statistical Analyses. Differences between the genders in demographic, anthropometric, and performance variables were examined by independent sample t-tests. The association of Preference and Tolerance with performance on the fitness tests was examined with bivariate and partial correlations, controlling for variance because of age and body mass index (BMI). The statistical power for detecting a "medium" correlation ($r = 0.30$) with $\alpha = 0.05$ (2-tailed test) afforded by a sample size of $N = 516$ is 0.999. Given the substantial anticipated differences in performance between men and women, dividing the sample by gender entailed possibly examining the relationship of Preference and Tolerance with fitness testing performance over a restricted range. The effect of range restriction is that it attenuates the magnitude of correlations. Nevertheless, analyses were conducted both on the entire sample and within each gender. Coefficients of determination (r^2) are reported as an index of the meaningfulness of the associations. Alpha was set at 0.05.

Results. Men and women differed significantly on height, body mass, and BMI (Table 1, p values <0.001). They also differed significantly on all fitness variables (Table 2, p values <0.001). Specifically, men exhibited greater muscular strength, muscular endurance, and cardiorespiratory endurance, as well as lower body fat, compared with women. However, men had less flexibility than women. Furthermore,

Table 4. Descriptive statistics (Mean ± *SD*) and week 1 to week 6 comparisons for study II.

	Week 1 Mean ± *SD*	Week 6 Mean ± *SD*
Preference (5–40)	25.6 ± 4.3	26.2 ± 4.1
Tolerance (5–40)	26.7 ± 4.9	27.6 ± 5.1
Push-ups (repetitions in 1 min)*	37.6 ± 13.0	51.8 ± 14.3
Bench press (repetitions in 1 min)	28.8 ± 11.5	30.5 ± 11.9
Sit-ups (repetitions in 1 min)*	28.2 ± 9.6	36.0 ± 9.9
1.5-mile run (min:s)*	13:12 ± 1:54	11:50 ± 1:18
Sit-and-reach (cm)*	30.9 ± 8.7	34.3 ± 8.3
Body fat (%)*	20.9 ± 8.8	18.0 ± 9.9
Perceived fitness index (1–7)*†	3.6 ± 1.1	3.0 ± 1.1

*$p < 0.001$.
†Lower scores indicate better perceived fitness.

the men had significantly higher scores on both Preference and Tolerance.

The correlations of Preference and Tolerance with the fitness performance variables are shown in Table 3. With the exception of the sit-and-reach test and estimated maximal oxygen uptake, for which the correlations were below |0.20|, Preference and Tolerance exhibited significant correlations with all fitness variables, body composition, and physical activity. The coefficients of determination (r^2) ranged from 0.04 to 0.14. The relationships remained significant and were minimally affected after controlling for age and BMI.

Among women, both Preference and Tolerance were related mainly to push-ups, curl-ups, the percentage of body fat, and physical activity. The results were similar among men but, unlike in the women, controlling for age and BMI weakened most relationships.

Table 5. Bivariate correlations (*r*) and partial correlations (r_{part}, controlling for age and body mass index) of preference and tolerance with fitness variables and perceived fitness in Study II.

	Preference				Tolerance			
	Week 1		Week 6		Week 1		Week 6	
	r	r_{part}	*r*	r_{part}	*r*	r_{part}	*r*	r_{part}
Push-ups	0.12	0.15	0.23	0.27	0.29	0.35*	0.30	0.26
Bench press	0.25	0.25	0.11	0.11	0.27	0.27	−0.07	−0.08
Sit-ups	0.44**	0.48**	0.25	0.28	0.44**	0.48**	0.38*	0.36*
1.5-mile run	−0.24	−0.34*	−0.13	−0.22	−0.40**	−0.56***	−0.41**	−0.45**
Sit-and-reach	0.09	0.10	0.14	0.16	−0.01	0.00	0.01	−0.03
Body fat	−0.20	−0.31*	−0.03	−0.10	−0.22	−0.36*	−0.34*	−0.38*
Perceived fitness index†	−0.14	−0.16	−0.18	−0.21	−0.35*	−0.40**	−0.35*	−0.32*

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.
†Lower scores indicate better perceived fitness.

Subjects

Study II. Forty-two men recruit firefighters participated in the study. Participant characteristics are shown in Table 1. All participants read and signed an informed consent approved by a university Institutional Review Board.

Measures. ***Preference for and Tolerance of Exercise Intensity.*** The PRETIE-Q was used, as described in the Methods section of Study I. In this study, Cronbach's alpha coefficients of internal consistency were 0.80 and 0.80 for the Preference scale and 0.82 and 0.86 for the Tolerance scale, at weeks 1 and 6, respectively.

Upper Body Muscular Endurance. The endurance of the muscles of the shoulders and upper torso was evaluated with an 1-minute push-up test (as described in the Method section of Study I) and a modified version of the Young Men's Christian Association's (YMCA) bench press test. For the bench press test, the participants, while lying in supine position on a bench, had to lower and then push a standard weightlifting bar off their chests until their arms were fully extended at a 90° angle to their body. This cycle was continued at a rhythm of 30 repetitions per minute until the point of failure or until the participants could no longer keep up with the pace or maintain the proper form (1). The modification (which was due to logistic reasons) consisted in loading the bar with 85 lbs (38.6 kg) instead of the 80 lbs (36.4 kg) used in the standard version of the test.

Abdominal Muscular Endurance. The endurance of the abdominal muscles was evaluated with a 1-minute sit-up test. The participants were lying on their backs, with the knees bent at a 90° angle and with an assistant holding their ankles. The fingers were interlocked behind the head. The upper body had to be raised forward to, or beyond, the vertical position and then return to the supine position until the shoulder blades touched the ground. The participants performed as many sit-ups as possible within 1 minute.

Cardiovascular Endurance. The 1.5-mile run test was used to estimate cardiovascular endurance (1). The participants ran 1.5 mile (6 laps) on a quarter-mile outdoor track as quickly as possible, and their time was recorded.

Flexibility. The standard sit-and-reach test was used to assess hamstring and hip-joint flexibility, as described by the American College of Sports Medicine (1). A sit-and-reach box was used with the "zero" point set at 23 cm. As in study I, this test was included as a "negative control," because the preference for and tolerance of exercise intensity were hypothesized to be unrelated to flexibility.

Body Composition. The percentage of body fat was estimated by skinfold measurements (chest, abdomen, and thigh, all on the right side of the body). The procedures and formulas recommended by the American College of Sports Medicine (1) were used.

Perceived Physical Fitness. Perceptions of fitness were assessed, to examine whether changes in perceived fitness would be associated with changes in the preference for and tolerance of the intensity of exercise. The Perceived Fitness Index (PFI) (26) was used for this purpose. The PFI is a 7-point, single-item rating scale ranging from excellent (1) to very poor (7). Thus, lower scores indicate better perceived fitness (26).

Procedures. The participants underwent fitness testing on 2 occasions, once during the first and once during the sixth week of a 6-week training program conducted as part of a firefighting training course. Testing was conducted over 2 days. The 1.5-mile run, 1-minute sit-up test, and 1-minute push-up test were conducted on the first day. The sit-and-reach test, skinfold measurement, and modified YMCA bench press test were conducted on the second day. Fitness training consisted of a 6-week, progressively challenging multicomponent exercise program, performed 4 days per week for 30 minutes per day.

Statistical Analyses. The training program–induced changes in Preference and Tolerance, as well as the fitness variables, were examined with t-tests for dependent means (repeated measures). The statistical power for detecting a "medium" difference ($d = 0.50$; *SD*s) between 2 dependent means (for $\alpha = 0.05$, 2-tailed test) afforded by a sample size of $N = 42$ is 0.89 (i.e., above the recommended level of 0.80). The association of Preference and Tolerance with performance on the fitness tests was examined with bivariate and partial correlations, controlling for variance because of age and BMI. Alpha was set at 0.05.

Results. The 6-week training program was effective in improving performance on most fitness variables, with the sole exception of the bench press test (Table 4). Notably, although perceived fitness also improved (i.e., lower scores on the PFI), scores on the Preference and Tolerance scales of the PRETIE-Q did not change significantly.

The bivariate and partial correlations of Preference and Tolerance with the fitness variables are shown in Table 5. Preference was related to performance in the sit-up and 1.5-mile run tests at week 1 but not week 6. Tolerance was related to push-ups at week 1 and sit-ups, the 1.5-mile run, body fat, and the PFI both at week 1 and at week 6. Among these relationships, the coefficients of determination (r^2) ranged from 0.10 to 0.30.

Discussion

The primary purpose of the studies reported here was to determine whether individual differences in the preference for and tolerance of exercise intensity, as assessed by the respective scales of the PRETIE-Q, could account for significant portions of the variance in fitness testing performance, beyond the variance accounted for by age and BMI. A secondary purpose, addressed in study II, was to examine whether a short-term training program designed to improve fitness would also change the scores on the Preference and Tolerance scales.

The results were generally consistent with expectations. In both studies, Preference and Tolerance exhibited significant correlations with performance in several fitness tests. As noted in the introduction, performance in any fitness test depends on a multitude of factors and does not depend entirely, or even mainly, on individual differences in preference for and tolerance of exercise intensity. The modest magnitude of the correlations is consistent with this postulate. Tolerance and Preference accounted for 5–30% of the variance in fitness testing performance.

Tolerance was meaningfully related to performance on the 1.5-mile run both before and after the training in study II (31 and 20% of the variance, respectively). This finding is consistent with previous research in adolescents, which showed that both Preference and Tolerance were related to peak oxygen uptake (36). However, the relationship of Tolerance to performance on the 5-minute Forestry Step Test (study I) was weak (less than 3% of the variance). A possible explanation for this discrepancy is that performance on the Forestry Step Test was less dependent on tolerance (i.e., the disposition to "continue exercising at levels of intensity associated with discomfort or displeasure"). This is because the pace was set by a metronome, and the main outcome variable was recovery heart rate. In other words, neither the procedure nor the outcome could reflect any tendency on the part of the participants to persevere or voluntarily "push" their physiological limits. By comparison, performance in the 1.5-mile run probably depended on tolerance because the pace was set by the participants themselves, and the outcome variable was the time it took for them to cover the distance. Another possible explanation is that, although the analysis for the 1.5-mile run was based on the "raw" times the participants took to finish the distance, the data for the Forestry Step Test were regression-based estimates of maximal oxygen consumption (based on heart rate, gender, and age) with presumably less than optimal reliability and validity. Measurement error (including prediction error associated with the regression-based formula) has an attenuating effect on correlation coefficients, including validity coefficients. For example, previous research has found correlations ranging from 0.46 to 0.66 between step tests and direct measurement of maximal aerobic capacity (19).

Preference and Tolerance were significantly related to performance in the grip-strength test across the entire sample in study I but the relationship was greatly weakened when examined within each gender. As noted earlier, this attenuation is to be expected given the restriction in the range of the grip-strength variable caused by the division of the sample by gender.

Neither Preference nor Tolerance exhibited a significant relationship to performance in the bench press test (in study II) (i.e., in men only). This finding from study II seems to contradict the results for push-up performance in study I. In study II, the correlation was positive, but it was not significant for either subscale or at either time point. It should be kept in mind, however, that study II had a much smaller sample and, therefore, reduced statistical power (correlations lower than 0.30 were not deemed statistically significant). However, in both studies, curl-ups and sit-ups were significantly correlated with both Preference and Tolerance (except for the correlation between Preference and sits-ups at the end of the training program in study II, which only approached significance).

Performance on flexibility tests was unrelated to Preference and Tolerance scores in both studies. This result was expected because neither flexibility training nor performance in the sit-and-reach test seems relevant to intensity tolerance or intensity preference.

The relationship of Preference and Tolerance with body composition was consistent with previous research (36). It is possible that individuals with high percent body fat perceive that they have lower levels of Preference for and Tolerance of exercise intensity (7,10). Conversely, it is also possible that high Preference and Tolerance act as predispositions for more physical activity or more intense physical activity, and the relationship to the percentage of body fat could be the result of the higher level of energy expenditure of those individuals reporting higher Preference and Tolerance. There is some support for this latter possibility. Habitual physical activity was assessed in study I using the Aerobics Center Longitudinal Study Physical Activity Questionnaire (23). Both Preference and Tolerance were significantly related to physical activity over the previous 3 months, although the magnitude of the relationships was modest (7–8% of the variance).

Only 1 previous study has examined the relationship of the PRETIE-Q factors to a global index of physical activity participation. Ekkekakis et al. (11) administered the PRETIE-Q and the Godin Leisure-Time Exercise Questionnaire to 601 college women and reported that Tolerance accounted for 9% and Preference accounted for 3% of the variance in the total physical activity score. These modest numbers are not unexpected because the scales of the PRETIE-Q tend to be related specifically to the intensity of physical activity. As reported by Ekkekakis et al. (6), across 4 samples, Preference and Tolerance exhibited generally stronger relationships to the intensity of habitual physical activity (0.32–0.55 for Preference and 0.28–0.55 for Tolerance) than to frequency (0.18–0.33 for Preference and 0.22–0.39 for Tolerance), session duration (0.19–0.21 for Preference and 0.21–0.28 for Tolerance), or the duration of lifetime involvement in regular physical activity (0.13–0.27 for Preference and 0.12–0.20 for Tolerance). Likewise, Ekkekakis et al. (11) found that Preference (0.30) and Tolerance (0.36) were significantly related to the weekly frequency of strenuous exercise but not the frequency of moderate or mild exercise, as reported on the Godin Leisure-Time Exercise Questionnaire. A similar finding was obtained by Lochbaum et al. (24), who found Tolerance to be related to self-reported strenuous physical activity. However, the bulk of daily energy expenditure is due to moderate- or mild-intensity activities (42). This may explain the modest relationships of Tolerance and Preference to global indices of physical activity.

The secondary purpose of study II was to examine whether a short-term training program would change the scores on the Preference and Tolerance scales. It was hypothesized that, since Preference and Tolerance were conceptualized as dispositional traits, they should be unaffected by situational changes. This is an important consideration. The scales of the PRETIE-Q have previously exhibited relatively high test-retest reliability (6). However, this information does not suffice to substantiate the claim for the cross-situational stability of the Preference and Tolerance scores, because no intervening manipulation occurred that could have induced a change in relevant situational appraisals. Study II provided an opportunity to test the hypothesis of cross-situational stability. The 6-week training program induced significant improvements in most fitness indicators, including percentage of body fat, flexibility, sit-ups, push-ups, and 1.5-mile run (i.e., across the entire battery of fitness measures with the sole exception of the bench press test). It is also important to note that scores on the perceived fitness index were significantly improved at the conclusion of the training program, indicating that the recruit firefighters perceived themselves to be more physically fit. Nevertheless, the change in perceived fitness was unaccompanied by a significant change in Preference or Tolerance. This finding supports the fundamental postulate that these scores primarily reflect stable individual differences rather than transient situational appraisals.

In interpreting the findings reported herein, researchers should take into account the limitations of the methods that were employed. The results should not be assumed to apply to samples with different characteristics (e.g., age, activity, and health status) or to different types of fitness tests. An effort was made to provide evidence for the robustness of the relationships between the PRETIE-Q factors and test performance across populations by examining 2 diverse samples and employing somewhat different batteries of tests. However, the inconsistencies between the results from the 2 studies warrant scrutiny and preclude any definitive statements about the generalizability of the findings. Furthermore, it is important to underscore that testing took place in field conditions. Despite the fact that the tests were administered by qualified personnel under the close supervision of the investigators, field testing cannot afford the degree of control and standardization of conditions typically associated with a laboratory environment. Moreover, some of the tests (e.g., the 5-minute Forestry Step Test for the assessment of cardiorespiratory endurance or the skinfold caliper test for the assessment of body fat) are clearly inferior in terms of reliability and validity to the equivalent laboratory tests (e.g., spirometry and analysis of expired gases or underwater weighing). In study II, in particular, this limitation was accentuated because the researchers had no control over the battery of tests used by the fire service institute. Finally, the studies were correlational in nature, with all the limitations that correlational data entail. At present, whether Preference and Tolerance are amenable to experimental manipulations (perhaps longer or stronger than the training program in study II) and whether they interact with situational factors remains unknown.

In sum, the studies reported here were the first to demonstrate that the Preference and Tolerance scores can account for portions of the variance in performance across a variety of field-administered fitness tests. The generally low-to-moderate magnitude of the coefficients of determination (r^2) should be interpreted in light of the following 2 considerations: (a) the "predictors" (i.e., self-reported Preference and Tolerance) and the "criteria" (i.e., the fitness performance variables) do not share common method variance (as would have been the case if both were self-reported) and (b) self-reported psychological constructs generally account for modest portions of the variance in actual behavior. Therefore, it is reasonable to suggest that these dispositional constructs do warrant further research attention as possible determinants of physical performance.

Practical Applications

The findings of these studies may have implications for exercise prescription. According to the guidelines of the American College of Sports Medicine (1), the selection and progression of activities should be tailored to the preference and tolerance of each individual participant. The rationale for this recommendation is that individualization is expected to facilitate the adoption and improve long-term adherence to exercise prescriptions. Although considerably more research will be necessary, it is possible that the scales of the PRETIE-Q could be used for this purpose (e.g., to help identify participants with a predisposition to underexertion or overexertion). Moreover, Preference and Tolerance scores could be incorporated in regression models used to estimate cardiorespiratory fitness in various population segments. The accuracy of these models, presently based on such variables as sex, age, body composition, and self-report activity (15,18,20,25), could be further improved by taking into account individual differences in the preference for and tolerance of exercise intensity.

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