Affective Responses to Repeated Sessions of High-Intensity Interval Training

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ABSTRACT

SAANIJOKI, T., L. NUMMENMAA, J.-J. ESKELINEN, A. M. SAVOLAINEN, T. VAHLBERG, K. K. KALLIOKOSKI, AND J. C. HANNUKAINEN. Affective Responses to Repeated Sessions of High-Intensity Interval Training. *Med. Sci. Sports Exerc.*, Vol. 47, No. 12, pp. 00–00, 2015. **Purpose**: Vigorous exercise feels unpleasant, and negative emotions may discourage adherence to regular exercise. We quantified the subjective affective responses to short-term high-intensity interval training (HIT) in comparison with moderate-intensity continuous training (MIT). **Methods**: Twenty-six healthy middle-age (mean age, 47 ± 5 yr; mean $\dot{V}O_{2peak}$, 34.2 ± 4.1 mL·kg^{-1}·min^{-1}) sedentary men were randomized into HIT (n = 13, 4–6 × 30 s of all-out cycling efforts at approximately 180% of peak workload with 4-min recovery) or MIT (n = 13, 40- to 60-min continuous cycling at 60% of peak workload) groups, performing six sessions within two weeks. Perceived exertion, stress, and affective state were recorded before, during, and after each session. **Results**: Perceived exertion and arousal were higher, and affective state, more negative during the HIT than that during MIT sessions (P < 0.001). HIT versus MIT exercise acutely increased the experience of stress, tension, and irritation and decreased positive affect (P < 0.05). In addition, satisfaction was lower and pain and negative affect were higher in the HIT than those in the MIT group (P < 0.05). However, perceived exertion and displeasure experienced during exercise alleviated similarly in response to HIT and MIT over the 6 d of training. Peak oxygen consumption increased (P < 0.001) after intervention (HIT, 34.7 ± 3.9 vs 36.7 ± 4.5; MIT, 33.9 ± 4.6 vs 35.0 ± 4.6) and was not different between HIT and MIT (P = 0.28 for group × training). **Conclusions**: Short-term HIT and MIT are equally effective in improving aerobic fitness, but HIT increases experience of negative emotions and exertion in sedentary middle-age men. This may limit the adherence to this time-effective training mode, even though displeasure lessens over time and suggests similar mental adaptations to both MIT and HIT. **Key Words:** EXERCISE INTENSITY, EXERCISE MODE, PERCEIVED EXERTION, AFFECTIVE VALENCE, TRAINING ADAPTATION

A considerable amount of literature shows that exercise training is beneficial for physical and mental health (29). In addition to the well-known cardiovascular and metabolic benefits (31), exercise also improves psychological health by improving mood, lowering stress levels, and reducing depression and anxiety (28). Despite these significant beneficial effects, one-third of the population worldwide remains sedentary and do not meet the current physical activity recommendations (16). The reasons for insufficient physical activity are often lack of enjoyment and lack of time (1,23,35).

Enjoyment is an important motive for engaging in leisure-time physical activity (1). Affective responses during exercise predict future physical exercise participation, and consequently, positive affect, improved mood, and decreased stress levels associated with exercise can improve exercise engagement in the long term (22,38). One of the key mediators of affective response to exercise is the intensity at which exercise is performed (33). High-intensity exercise is generally associated with more negative affective responses than low- and moderate-intensity exercise (15,20,27), and exercising above the ventilatory threshold is usually accompanied by a sudden and marked increase of negative affect, which, however, recovers to baseline or beyond after exercise completion (15).

High-intensity interval training (HIT) has recently emerged as a time-saving and effective method for improving aerobic fitness (17). It is broadly defined as repeated sessions of brief, intermittent vigorous bouts of exercise often performed with an “all-out” effort or at an intensity close to that which elicits HR_{max} and significant accumulation of lactate (13). Experimental work has confirmed that one of the ultimate forms of HIT used experimentally, characterized by repeated 30-s Wingate tests, improves aerobic fitness at least similarly to more time-demanding aerobic endurance training (6,7,14,21). However, the effects of HIT on mood and stress have remained poorly understood, and, up to date, only a few studies (4,19,25) have compared the psychological effects in response to HIT and moderate-intensity training (MIT).

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Even though HIT may trigger feelings of light-headedness, dizziness, severe fatigue, and nausea (2,34), Wingate-based HIT is well tolerated among recreationally active men and women (2). On the other hand, increased negative feelings have been observed during and immediately after HIT sessions (19,25), but data regarding HIT-related exercise enjoyment remain elusive (4,19,25). Because high-intensity exercise in general is associated with increased negative feelings and exercise dropout (30), it is critical to understand whether HIT triggers feelings that might influence exercise adherence and whether and what kind of HIT protocol is rational for sedentary subjects without high motivation to exercise training.

The aims of the present study were to compare the acute affective responses to 2 wk (six training sessions) of MIT versus HIT performed by sedentary middle-age men. We hypothesized that 1) perceived exertion and arousal increase more and affective valence decrease more during HIT sessions compared with MIT, 2) an HIT intervention acutely increases perceived stress and negative affect and decreases positive affect more than MIT, and 3) negative psychological changes are associated with less improvements in aerobic fitness.

METHODS

This study was a part of a larger study entitled "The effects of short-time high-intensity interval training on tissue glucose and fat metabolism in healthy subjects and in patients with type 2 diabetes" (NCT01344928). The study was conducted at the Turku PET Centre, University of Turku and Turku University Hospital (Turku, Finland), according to the Declaration of Helsinki, and the study protocol was approved by the ethics committee of the Hospital District of Southwest Finland (decision 95/180/2010 §228). The purpose and potential risks of the study were explained to the subjects, and written informed consents were obtained.

Subjects. Twenty-eight healthy sedentary men participated in this study (age, 47 ± 5 yr; body mass index (BMI), 26.1 ± 2.5 $kg \cdot m^{-2}$; $\dot{V}O_{2peak}$, 34.2 ± 4.1 $mL \cdot kg^{-1} \cdot min^{-1}$). The inclusion criteria consisted of age 40–55 yr, BMI of 18.5–30 $kg \cdot m^{-2}$, normal fasting blood glucose concentration, and sedentary life lifestyle assessed with Baecke physical activity questionnaire (3). The exclusion criteria were blood pressure > 140/90 mm Hg, any chronic disease, regular use of tobacco products, significant use of alcohol, contraindications to vigorous exercise, claustrophobia, and presence of any ferromagnetic objects that would contraindicate magnetic resonance imaging (magnetic resonance imaging results not reported in this article). The subjects were randomized into the HIT (n = 14) or MIT (n = 14) group. During the intervention, one subject from both groups dropped out; thus, 26 subjects completed the study.

Training intervention. The training intervention is composed of six supervised exercise sessions within 2 wk. The HIT group subjects performed progressive HIT exercises consisting of 4–6 × 30-s maximal sprints on a cycle ergometer (Monark 894E, Vansbro, Sweden) against a resistance equivalent to 7.5% of whole body weight in kilograms, with 4 min of recovery between the sprints. The number of sprints, starting from 4, increased by one in every second training session. The subjects were verbally encouraged to continue pedaling as fast as possible throughout each 30-s sprint. They were familiarized with the HIT training before the intervention (2 × 30-s sprints) and were asked to refrain from any other exercise during the intervention. The MIT group performed 40- to 60-min continuous aerobic cycling exercises (Tunturi E85; Tunturi Fitness, Almere, the Netherlands) at the intensity of 60% of peak workload predetermined individually in a maximal exercise test (21). Training duration increased by 10 min in every second training session starting from 40 min in the first session. Blood lactate concentration was determined from capillary samples before and within 1 min after each training session using a handheld lactate analyzer (Lactate Pro; Arkray KDK, Kyoto, Japan). All six exercise sessions were performed by all participants except one MIT participant who performed only four exercise sessions.

Questionnaires and other measurements. During each training session, the participants' subjective exertion was assessed using the Borg RPE 6–20 scale and subjective feelings of affective valence (pleasantness vs unpleasantness) and arousal (calm vs excited) dimensions were assessed via the Self-Assessment Manikin rating scale (5). The RPE and Self-Assessment Manikin scales were administrated after each sprint in the HIT group and in every 10 min in the MIT group to get equal numbers of measurements from the both groups. Furthermore, experienced stress and pleasant versus unpleasant emotions were measured using the Finnish translations of the Perceived Stress Questionnaire (PSQ) (24), the Positive and Negative Affect Schedule (PANAS) (36), and a visual analog scale (VAS; separate scales for tension, irritation, pain, exhaustion, satisfaction, and motivation to exercise) before and within 5 min after each training session. Scales were familiarized to participants on the first training day, and participants were asked to respond to the questionnaires according to how they felt "now, at this point in time." A ramp exercise test to exhaustion was performed to determine $\dot{V}O_{2peak}$ about 1 wk before the training intervention and 4 d after the last training session, as previously described in detail (21). The criteria for $\dot{V}O_{2peak}$ were peak RQ over 1.15 and peak blood lactate over 8 $mmol \cdot L^{-1}$.

Statistical analyses. Statistical analyses were performed using the IBM SPSS Statistics 21 for Windows (IBM Corp., Chicago, IL) and SAS System for Windows 9.4 (SAS Institute Inc., Cary, NC). The training adaptations ($\dot{V}O_{2peak}$ test results) were assessed by repeated-measures ANOVA, with training (before vs after intervention) as repeated factor and group (HIT vs MIT) as between-subjects factor. Because of skewed distributions, PANAS negative, tension, irritation, and pain values were log-transformed and satisfaction and motivation χ^2-tranformed for statistical analyses. The changes in the parameters measured during exercise (RPE, valence, and AQ1 arousal) were analyzed with linear mixed model where bout (1–4 maximal sprints in the HIT group and 10-, 20-, 30-, and 40-min time intervals in the MIT group) and training session (1–6) were used as repeated factors using unstructured@ compound symmetry covariance structure and group as between-subjects factor. The changes in the parameters measured before and after every training session (PSQ, PANAS scores, VAS percentages, and lactate) were analyzed with linear mixed model with time (before vs after training) and training session as repeated factors (unstructured@compound symmetry covariance structure) and group as between-subjects factor. Random intercept for subject was included in all mixed models to fit subject-specific models. The association of lactate with RPE, valence, arousal, and changes in other mood parameters were analyzed with linear mixed model. Linear model was used to test the association between the mood parameters and the changes in $\dot{V}O_{2peak}$ and $Load_{peak}$. Model included the mean value of the PSQ, PANAS, and VAS scores measured before every training session as covariate and group as between-subject factor and the change in $\dot{V}O_{2peak}$ and $Load_{peak}$ as the dependent variables. An alpha level of $P \leq 0.05$ and two-sided tests was used in all statistical testing.

RESULTS

Subject characteristics and training adaptations in the HIT and MIT study groups. Subject characteristics, which have been previously reported (21), are shown
T1 in Table 1. The HIT and the MIT groups did not differ significantly in age, BMI, $\dot{V}O_{2peak}$, and psychological test scores assessed before the training intervention. The training intervention increased $\dot{V}O_{2peak}$ (P = 0.002) and $Load_{peak}$ (P < 0.001) in the study groups without significant difference in training response between the groups (P = 0.28 and 0.18), as reported previously (21) (Table 1). As expected, for blood lactate concentration, significant interaction of group and time (P < 0.0001) was found, showing that the increase in lactate was higher in the HIT group than that in the MIT group after exercise sessions (least squares means: HIT_{pre}, 1.39 ± 0.12 $mmol \cdot L^{-1}$; HIT_{post}, 13.71 ± 0.29 $mmol \cdot L^{-1}$; MIT_{pre}, 1.47 ± 0.12 $mmol \cdot L^{-1}$; MIT_{post}, 3.27 ± 0.29 $mmol \cdot L^{-1}$).

Affective responses during exercise. The results
F1 T2 are summarized in Figure 1 and in Table 2. Perceived exertion (Fig. 1A) and arousal (Fig. 1C) increased, and valence (Fig. 1B) decreased more in the HIT than that in the MIT group during the training sessions. In addition, all three varied between the training sessions (P < 0.007) but not were not different between HIT and MIT, showing a decreasing trend in perceived exertion (Fig. 1D) and arousal (Fig. 1F) and an increasing trend in valence (Fig. 1E) toward the end of the training period.

Affective responses before and after exercise and during the training intervention. The data of affective responses before and after exercise and during the training intervention are summarized in Figures 2 and 3 and F2 F3
in Table 3. T3 Significant interactions between group and time showed that perceived stress (Fig. 2A) and feelings of tension (Fig. 2D) and irritation (Fig. 2E) increased and positive affect (Fig. 2B) decreased in the HIT group acutely after the training sessions, whereas they remained essentially unchanged in the MIT group. The main effect of time showed that also the feelings of pain (Fig. 2F), exhaustion (Fig. 2G), and satisfaction increased (Fig. 2H) acutely after the training sessions but were similar between the groups. The main effect of group showed that the participants in the HIT group experienced more negative affect (Fig. 2C) and pain (Fig. 2F) and less satisfaction (Fig. 2H) than the subjects in the MIT group. In addition, significant interactions between group and session demonstrated that exhaustion (Fig. 3) was higher in the HIT group than that in the MIT group during the training intervention, except in the second and sixth sessions. The main effect of session showed that positive and negative affect both declined during the intervention but were similar between the groups. In motivation to exercise (Fig. 2I), no significant differences were observed.

Mixed model did not reveal any significant associations between the acute exercise responses in mood and the changes in $\dot{V}O_{2peak}$ or $Load_{peak}$. Furthermore, lactate was not significantly associated with perceived exertion, valence, arousal, and other mood parameters.

DISCUSSION

We showed that in sedentary participants, perceived exertion and arousal increase and affective valence decreases more during HIT compared with those during MIT sessions. In addition, HIT acutely increases perceived stress and

TABLE 1. Demographic characteristics and training adaptations in the HIT and MIT study groups.

	HIT, *n* = 13		MIT, *n* = 13		Repeated-Measures ANOVA Results (*P*)		
	Pretraining	**Posttraining**	**Pretraining**	**Posttraining**	**Training**	**Group**	**Training × Group**
Age (yr)	48 ± 5	—	48 ± 5	—	—	0.78	—
Height (cm)	180 ± 5	—	179 ± 4	—	—	0.61	—
Weight (kg)	82.5 ± 9.6	81.9 ± 9.5	83.5 ± 8.2	83.5 ± 7.9	0.16	0.7	0.17
BMI	25.6 ± 2.7	25.4 ± 2.8	26.1 ± 2.0	26.1 ± 1.9	0.16	0.55	0.19
$Load_{peak}$ (W)	225 ± 36	245 ± 32	224 ± 29	238 ± 29	**<0.001**	0.73	0.28
$\dot{V}O_{2peak}$ ($mL \cdot kg^{-1} \cdot min^{-1}$)	34.7 ± 3.9	36.7 ± 4.5	33.9 ± 4.6	35.0 ± 4.6	**0.001**	0.45	0.26

AQ2

AQ3 Reprinted from Kiviniemi AM, Tulppo MP, Eskelinen JJ, et al. Cardiac autonomic function and high-intensity interval training in middle-age men. *Med Sci Sports Exerc.* 2014;46(10):1960–7.

Values are presented as mean ± SD.

AQ4 Load, workload; $\dot{V}O_{2peak}$, peak oxygen consumption value during exercise test.

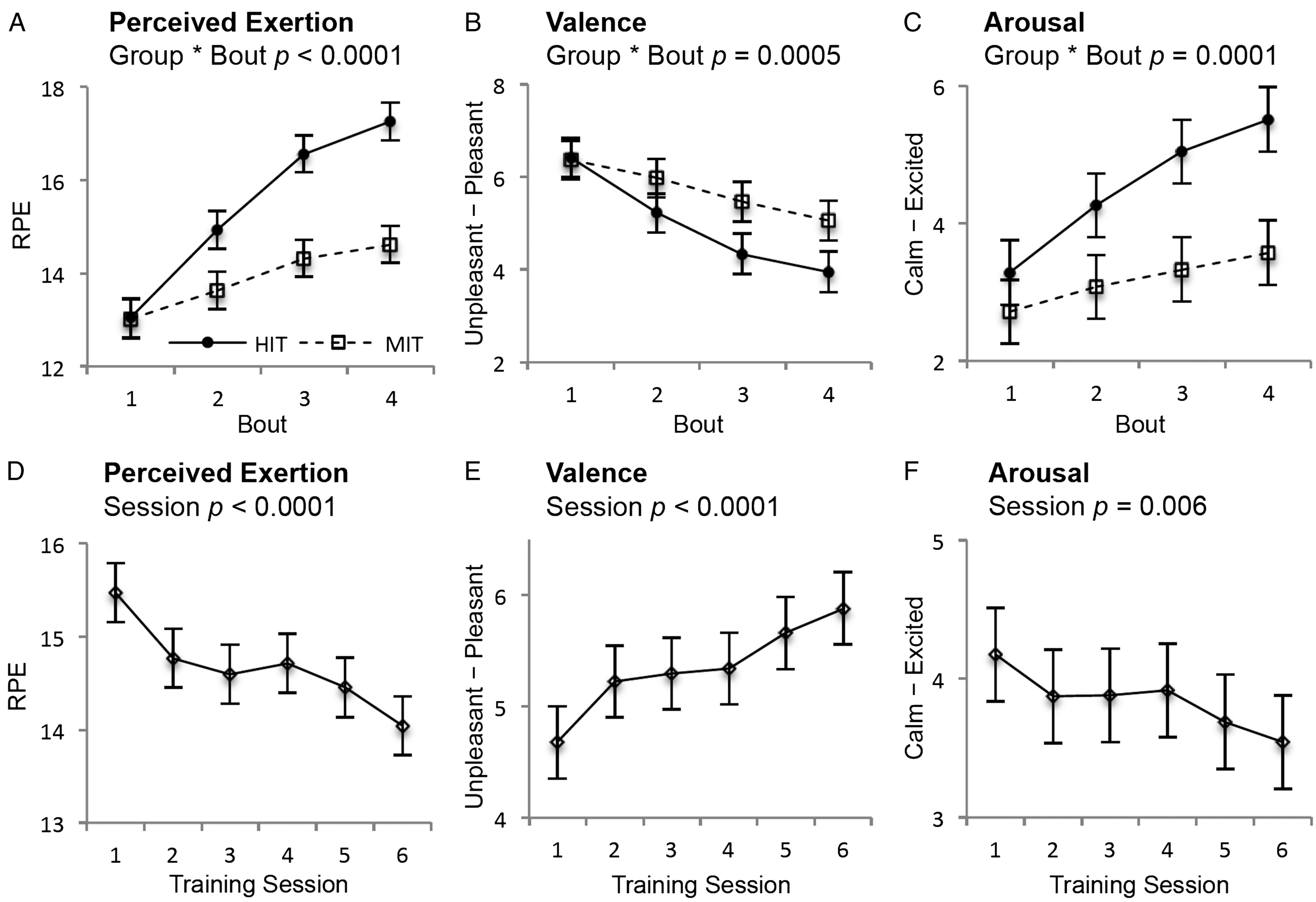

FIGURE 1—RPE (A), affective valence (B) and arousal (C) during exercise. In the HIT group, assessments were made after every 30-s bout; in the MIT group, assessments were made every 10 min. Only the first four bouts have been included for the analysis because these were completed across all six sessions of training. However, the results were similar when all six bouts were included using mixed model. Changes of RPE (D), valence (E), and arousal (F) during the training intervention (six training sessions) are also shown. No significant interaction of session and group was observed; thus, no significant group difference was found, so HIT and MIT groups are plotted together.

negative affect and decreases positive affect more than MIT. However, decreased affective valence was not found to be associated with less improvements in aerobic fitness. Nevertheless, we found that exertion, arousal, and unpleasantness diminish over time in both training groups as the exercise intervention goes on, which indicates both physical and mental adaptations to the training.

The present data accord with the hypothesis that perceived exertion and arousal increase more and valence decreases more during HIT sessions compared with those during MIT. Greater exercise intensity in the HIT sessions parallel with the higher RPE during HIT than that during MIT. In fact, already after the second bout of HIT, the RPE increases to a higher level comparable with what is observed after 40 min of MIT. This is noteworthy because exercise intensity can itself influence motivation to perform and continue physical exercise (11). RPE does not directly represent affective state, because although one may experience exercise to be too strenuous and overwhelming, another might enjoy the challenge (8). Despite this, high intensity is generally linked negatively to affect (12). The present study demonstrates that in addition to RPE, also displeasure (negative valence) and arousal are higher in the HIT group already after the second bout than after 40 min of MIT. A steep decline in valence is likely due to the greater exercise intensity as predicted by the relation between exercise intensity and affect (10,12,26). Decrease in affective valence, indicating negative emotions, was also observed in a recent study examining the affective response to HIT by Jung et al. (19). They compared affect between HIT, MIT, and continuous vigorous exercise and found that HIT was perceived as less pleasurable than MIT but more pleasurable than continuous vigorous exercise. However, opposite findings have been reported by Bartlett et al. (4), who demonstrated that retrospective perceived enjoyment of high-intensity interval running was greater than retrospective perceived enjoyment of continuous running despite higher RPE. Their participants, however, were recreationally active, which might account for the divergent results. Nonexercisers, such as the subjects of our study, have been found to experience less exercise-induced mood improvements compared with regular exercisers (18). In addition, a positive relation

TABLE 2. Summary of the results of the linear mixed model for perceived exertion, valence, and arousal during exercise sessions.

AQ5

Source	Num DF	Den DF	F	P
Perceived exertion				
Group	1	23.6	8.41	**0.008**
Bout	3	48.8	73.9	<**.0001**
Session	5	114	6.17	<**.0001**
Group × bout	3	48.8	15.03	<**.0001**
Group × session	5	114	0.79	0.56
Bout × session	15	217	0.97	0.49
Group × bout × session	15	217	1.23	0.25
Valence				
Group	1	24.7	1.59	0.22
Bout	3	50.4	50.28	<**.0001**
Session	5	113	7.2	<**.0001**
Group × bout	3	50.4	7.04	**0.0005**
Group × session	5	113	0.47	0.80
Bout × session	15	218	1.71	0.05
Group × bout × session	15	218	1.01	0.44
Arousal				
Group	1	23.5	4.41	**0.047**
Bout	3	48.4	38.97	<**.0001**
Session	5	112	3.43	**0.006**
Group × bout	3	48.4	8.32	**0.0001**
Group × session	5	112	0.58	0.72
Bout × session	15	214	1.16	0.30
Group × bout × session	15	214	0.46	0.96

AQ2

Bout, one to four 30-s maximal sprints in the HIT group and 10-, 20-, 30-, and 40-time intervals in the MIT group; group, HIT group and MIT group; session, 1–6 training sessions.

between higher RPE and enjoyment has been found in recreationally active participants (32).

The findings that HIT acutely increased perceived stress and negative feelings acutely after exercise more than MIT were also consistent with predictions. Because exercise intensity and affective state are linked (10,25), it is not surprising that feelings of stress, tenseness, irritation, and negative affect are increased acutely after HIT. An acute decline in valence was also demonstrated by Jung et al. (19). In addition to exercise intensity, however, it has been suggested that the dependence on anaerobic metabolism is likely one of the determinants of negative affective responses during vigorous exercise (15). Accordingly, blood lactate concentration—an indicator of the extent of anaerobic lactic energy supply—is associated with perceived exertion (39). Yet in the current study, such an association could not be established. Furthermore, neither an association between lactate and affective valence nor lactate and arousal or lactate and changes in other mood parameters were significant, suggesting that lactate does not play a significant role in the exercise-dependent negative affectivity.

Interestingly, the present data show that initially high levels of perceived exertion, displeasure, and arousal experienced during exercise attenuate similarly regardless of the training mode over the six-session intervention. Attenuated RPE over 6 d of Wingate-based HIT has previously been reported by Astorino et al. (2) in recreationally active participants, but here, we show for the first time that RPE, displeasure, and arousal elicited by HIT and MIT attenuate quickly even in nonexercisers. These alleviations are likely due to physiological and cognitive adaptation, leading to improved exercise tolerance, and suggest that even previously inactive people may get used to regular exercise rather

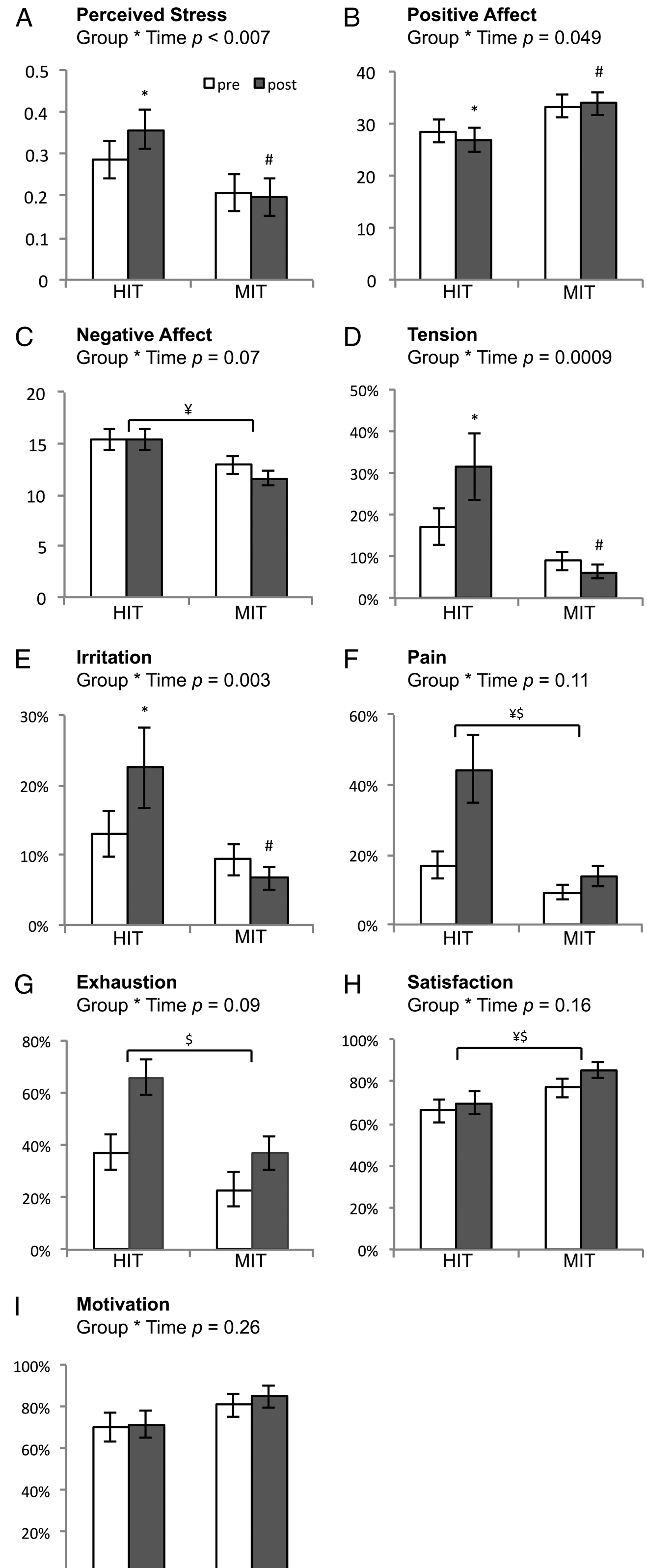

FIGURE 2—Affective response before and after HIT and MIT sessions. *Significantly different from HIT before ($P < 0.05$). #Significantly different from HIT after ($P < 0.05$). ¥Significant main effect of group (HIT and MIT) ($P < 0.05$). $Significant main effect of time (before and after) ($P < 0.05$).

AQ6

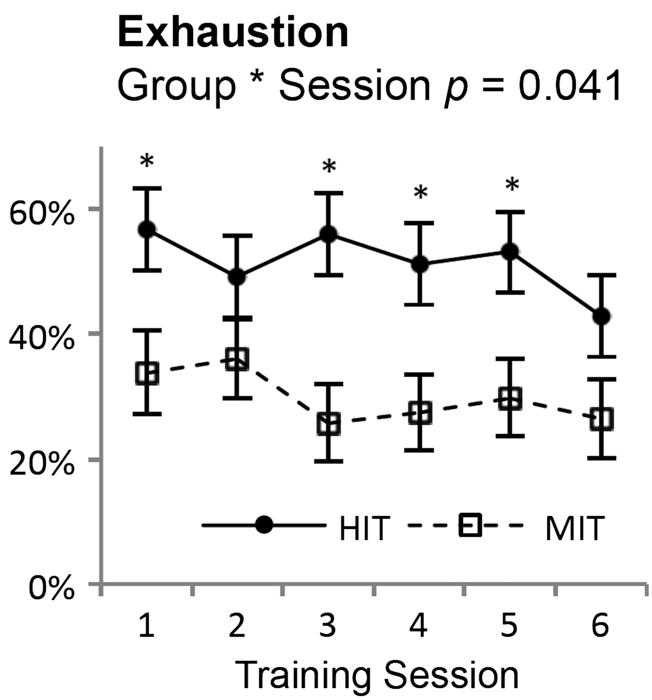

FIGURE 3—Perceived exhaustion in the HIT group and MIT group during the training intervention (six training sessions). *Significantly different from MIT group (P < 0.05).

quickly and in addition imply that exercising more may lead people to feel better during exercise.

In contrast with our hypothesis that negative affective experiences would be associated with less improvements in aerobic fitness, no significant relations between the changes in oxygen uptake or peak power and the decline in affect were observed. Oxygen uptake and peak workload increased significantly and were not statistically different between the groups even though generally, the affective response was more negative in the HIT than that in the MIT group. This shows that even though negative affect can influence adherence with training, it does not significantly influence the training response.

We recorded affective responses during exercise sessions as well as immediately after exercise (within 5 min), yet data were not acquired during the recovery time. Accordingly, the results display only acute affective responses and this limits our ability to generalize them from this point on, which would have been interesting, as Jung et al. reported a positive rebound effect 20 min after the HIT and MIT completion (19). In addition, mental well-being of the participants was not assessed before and after the intervention, and therefore, we cannot evaluate whether the intervention would influence mental health and mood changes in a broader extent. Future research should be extended to cover also the recovery time because it has been suggested that improvements in affect may not necessarily occur on the cessation of exercise but can be somewhat delayed especially in inactive individuals (37). If positive changes would be observed, it would also be worth experimenting whether the feelings stay positive longer after HIT or MIT, wherein

TABLE 3. Summary of the results of the linear mixed model for PSQ, PANAS, and VAS parameters before and after exercise sessions.

Source	Num DF	Den DF	F	P
Perceived stress				
Group	1	22.9	3.83	0.06
Session	5	102	1.01	0.42
Time	1	22.2	4.37	**0.048**
Group × session	5	102	0.76	0.58
Group × time	1	22.2	8.69	**0.007**
Session × time	5	102	0.13	0.96
Group × session × time	5	102	0.32	0.90
Positive affect				
Group	1	23.1	3.4	0.08
Session	5	96.8	6.81	<**0.0001**
Time	1	23.5	1.04	0.32
Group × session	5	96.8	0.54	0.74
Group × time	1	23.5	4.33	**0.049**
Session × time	5	99.1	1.61	0.16
Group × session × time	5	99.1	1.88	0.10
Negative affect				
Group	1	24	5.84	**0.024**
Session	5	99.1	9.18	<**0.0001**
Time	1	22.2	3.73	0.07
Group × session	5	99.1	0.74	0.59
Group × time	1	22.2	3.62	0.07
Session × time	5	97.8	1.91	0.10
Group × session × time	5	97.8	0.47	0.80
Exhaustion				
Group	1	22.5	6.75	**0.016**
Session	5	95.9	3.05	**0.013**
Time	1	22.7	25.3	<**0.0001**
Group × session	5	95.9	2.42	**0.041**
Group × time	1	22.7	3.12	0.09
Session × time	5	97	0.51	0.77
Group × session × time	5	97	1.11	0.36
Tension				
Group	1	22.8	6.41	**0.019**
Session	5	95.9	1.76	0.13
Time	1	20.9	1.17	0.29
Group × session	5	95.9	0.75	0.59
Group × time	1	20.9	14.96	**0.0009**
Session × time	5	95.9	0.74	0.60
Group × session × time	5	95.9	0.67	0.64
Irritation				
Group	1	22.8	2.84	0.11
Session	5	96.3	1.55	0.18
Time	1	22.2	0.7	0.41
Group × session	5	96.3	0.7	0.62
Group × time	1	22.2	11.19	**0.003**
Session × time	5	98.8	0.84	0.53
Group × session × time	5	98.8	1.41	0.23
Pain				
Group	1	23	6.85	**0.015**
Session	5	96.5	1.07	0.38
Time	1	22.5	17.17	**0.0004**
Group × session	5	96.5	0.53	0.76
Group × time	1	22.5	2.74	0.11
Session × time	5	96.9	1.06	0.39
Group × session × time	5	96.9	0.61	0.70
Satisfaction				
Group	1	22	5.73	**0.026**
Session	5	96	2.14	0.07
Time	1	23	9.13	**0.006**
Group × session	5	96	0.68	0.64
Group × time	1	23	2.08	0.16
Session × time	5	98.3	0.29	0.92
Group × session × time	5	98.3	1.4	0.23
Motivation				
Group	1	23.1	2.49	0.13
Session	5	96.1	0.59	0.71
Time	1	15.3	3.99	0.06
Group × session	5	96.1	0.07	0.99
Group × time	1	15.3	1.34	0.26
Session × time	5	88.3	1.33	0.26
Group × session × time	5	88.3	1.06	0.39

AQ7

Group, HIT group and MIT group; session, 1–6 training sessions; time, before and after exercise.

the improvements in affect can persist up to 2 h (9). The training period in the current study was limited to 2 wk and therefore does not provide evidence of exercise engagement and maintenance. Yet, observed improvement in valence during this short training period warrants future research to explore the development of positive affect in longer training interventions of HIT along with its influence on exercise adherence.

CONCLUSIONS

We conclude that in comparison with MIT, HIT exercise session leads to significant increase in negative emotions both during and after the exercise in sedentary subjects, even though both training modes leads to similar increase in aerobic fitness. Increased negative feelings may hinder the adherence to physical activity especially when starting an exercise program. The time-effective HIT should be practiced with caution in sedentary non–exercise-motivated subjects because the negative feelings during HIT may limit future exercise engagement. However, it would be arguable to assert that MIT is superior to HIT in providing better affective responses, considering the wide range of HIT designs available. Consequently, special attention should be paid to the participants' experiences and emotions when designing and optimizing HIT sessions.

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