

Psychophysiological Responses to High-Intensity Interval Training among University Athletes

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Abstract

High-intensity interval training has become one of the most widely used methods of conditioning in modern sport, valued for the large physiological gains it produces in relatively little time. Its effects, however, are not purely physical; the demanding nature of the work also influences how athletes feel, perceive effort and enjoy training. This study examined the psychophysiological responses of university athletes to an eight-week programme of high-intensity interval training. A pre-test and post-test experimental design was employed. Forty male university athletes were randomly assigned to an experimental group, which followed the interval programme three times a week, and a control group, which continued its usual training. Physiological responses were assessed through resting heart rate, predicted maximal oxygen uptake, one-minute heart-rate recovery and intermittent endurance performance, while psychological responses were assessed through the rating of perceived exertion at a fixed submaximal load, physical activity enjoyment and total mood disturbance. Paired and independent t-tests were used for analysis at the five per cent level of significance. The experimental group showed significant improvements in every physiological measure, together with a significant reduction in perceived exertion at the same workload, a significant rise in enjoyment and a significant decline in mood disturbance, whereas the control group changed little. The findings indicate that high-intensity interval training improves both the physiological capacity and the psychological experience of university athletes, and that, contrary to a common assumption, hard training can become more enjoyable as fitness develops.

Keywords: High-intensity interval training, psychophysiological responses, university athletes, perceived exertion, maximal oxygen uptake, exercise enjoyment, mood.

1. Introduction

The way athletes train has changed considerably over the past two decades, and few methods have risen to prominence as quickly as high-intensity interval training. This approach involves repeated short bouts of strenuous effort separated by periods of rest or light activity, and it has earned a reputation for producing substantial gains in fitness within a comparatively

small investment of time. For university athletes, who must balance demanding training with the equally demanding requirements of study, this efficiency is particularly attractive.

Most of the early interest in interval training focused on its physiological effects. Repeated near-maximal efforts place a heavy demand on the heart, lungs and working muscles, and the body adapts to this demand by improving its capacity to take in, transport and use oxygen. These adaptations are reflected in measures such as a lower resting heart rate, a higher maximal oxygen uptake, a faster recovery of heart rate after effort and an improved ability to sustain repeated high-intensity work. Such changes lie at the heart of athletic conditioning and explain why the method has been adopted so widely.

Yet training is never a purely physical experience. How hard an effort feels, how much an athlete enjoys it and how it affects mood are all part of the response to training, and these psychological reactions have a direct bearing on whether an athlete will continue with a programme over time. The term psychophysiological captures this dual nature, recognising that the body and the mind respond together and that the two cannot be fully understood in isolation. A method that produces excellent physical results but leaves athletes feeling exhausted and unmotivated may ultimately fail, while one that improves both fitness and the experience of training is far more likely to endure.

The psychological response to high-intensity work is, however, a subject of genuine debate. A long-standing view holds that very hard exercise is inherently unpleasant and that athletes will tend to avoid it. More recent thinking challenges this view, suggesting that the variety, challenge and sense of accomplishment associated with interval training can make it surprisingly enjoyable, especially as fitness improves and the same effort begins to feel easier. Resolving this question matters, because the answer shapes how coaches design programmes that athletes will actually sustain.

University athletes form a particularly suitable group in which to study these questions. They are young, broadly healthy and accustomed to structured training, yet they are also subject to the stresses of academic life, which makes their psychological response to demanding exercise especially relevant. Understanding how this population responds, both physically and mentally, to a structured interval programme can inform the preparation of athletes in the very setting where so much competitive talent is developed.

The present study therefore set out to examine the psychophysiological responses of university athletes to an eight-week high-intensity interval training programme, considering its

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effect on selected physiological measures on the one hand and on selected psychological measures on the other. By treating the physical and the psychological together, the study aims to provide a more complete picture of how this popular method of training affects those who undertake it.

2. Review of Literature

The physiological basis of high-intensity interval training has been examined extensively. Laursen and Jenkins (2002) reviewed the scientific foundations of the method and explained how repeated high-intensity efforts stimulate adaptations in both the oxygen-transport and the muscular systems. Buchheit and Laursen (2013), in an influential two-part analysis, set out the many variables that govern the design of interval sessions and showed how careful manipulation of work and rest can target particular adaptations.

The magnitude of the physiological benefits has been confirmed by several syntheses. Gibala and colleagues (2012) demonstrated that even low-volume interval training can produce adaptations comparable to those achieved through much larger volumes of traditional endurance work, while Milanović, Sporiš and Weston (2015) reported in a meta-analysis that interval training produces improvements in maximal oxygen uptake at least as great as, and often greater than, those produced by continuous training. Weston, Wisløff and Coombes (2014) extended these conclusions to clinical populations, underlining the robustness of the method across a wide range of participants.

The measurement of perceived effort has its own well-developed tradition. Borg (1982) established the psychophysical basis of perceived exertion and devised the rating scale that remains the standard tool for quantifying how hard an effort feels. A reduction in the rating of perceived exertion at a fixed workload is widely interpreted as evidence of improved fitness, since the same physical task imposes a smaller subjective burden as the body adapts.

The psychological response to intense exercise has attracted growing attention. Ekkekakis, Parfitt and Petruzzello (2011) examined the pleasure and displeasure that people experience at different exercise intensities and drew attention to the importance of affect in determining adherence. Against the assumption that hard exercise is necessarily aversive, Bartlett and colleagues (2011) found that high-intensity interval running was perceived as more enjoyable than moderate continuous exercise, a result later supported by Thum and colleagues (2017). Stork and colleagues (2017) reviewed the broader psychological responses to interval exercise

and concluded that, while individual reactions vary, interval training is by no means uniformly unpleasant and can be experienced positively.

The tools used to assess enjoyment and mood are themselves well validated. Kendzierski and DeCarlo (1991) developed the Physical Activity Enjoyment Scale to measure the pleasure derived from exercise, and McNair, Lorr and Droppleman (1971) created the Profile of Mood States, which remains a standard instrument for assessing transient mood. The availability of such tools has made it possible to study the psychological dimension of training with the same rigour long applied to the physiological dimension.

Taken together, the literature establishes that interval training reliably improves physiological capacity, that perceived exertion is a meaningful index of adaptation, and that the psychological response to intense exercise is more positive than was once believed. What is less common is research that measures the physiological and psychological responses of the same athletes within a single controlled study, and it is this combined approach that the present work adopts.

3. Significance of the Study

This study is significant because it treats the response to training as a unified psychophysiological phenomenon rather than addressing the physical and psychological dimensions separately. By measuring both within the same group of athletes and under the same controlled conditions, it allows the two to be related directly, offering a fuller account of what high-intensity interval training actually does to those who undertake it. The study also focuses on university athletes, a population whose combination of athletic commitment and academic pressure makes the psychological response to demanding exercise especially important. Its findings carry practical value for coaches and physical educators who must design training that is not only physiologically effective but also sustainable, and who therefore need to understand how athletes feel about the work they are asked to do as well as how their bodies adapt to it.

4. Objectives of the Study

The study is built around the following two objectives:

1. To examine the effect of an eight-week high-intensity interval training programme on selected physiological responses of university athletes.

2. To examine the effect of the same high-intensity interval training programme on selected psychological responses of university athletes.

5. Hypotheses of the Study

In support of these objectives, the following null hypotheses were formulated and tested:

H1: There is no significant difference between the pre-test and post-test physiological responses of university athletes following the high-intensity interval training programme.

H2: There is no significant difference between the pre-test and post-test psychological responses of university athletes following the high-intensity interval training programme.

6. Research Methodology

6.1 Research Design

The study employed a pre-test and post-test randomised group experimental design. This design was chosen because the aim was to determine the effect of a specific training intervention, which requires the comparison of measurements taken before and after the programme as well as a comparison between athletes who undertook the programme and those who did not. The presence of a control group allowed the observed changes to be attributed to the training rather than to the passage of time or to other influences.

6.2 Participants

Forty male university athletes volunteered for the study after being informed of its purpose and procedures. They were randomly assigned in equal numbers to an experimental group and a control group, with twenty athletes in each. All participants were free of injury and medically fit to undertake strenuous exercise. The experimental group followed the interval training programme in addition to their normal sport-specific practice, while the control group continued with their usual training only.

6.3 Selection of Variables

Two sets of dependent variables were selected. The physiological variables were resting heart rate, predicted maximal oxygen uptake, one-minute heart-rate recovery and intermittent endurance performance measured through a standard shuttle-run test. The psychological variables were the rating of perceived exertion at a fixed submaximal workload, exercise enjoyment measured through an established enjoyment scale, and total mood disturbance

measured through a recognised mood inventory. Together these variables captured the central physical and psychological dimensions of the response to training.

6.4 The Training Programme

The experimental group undertook high-intensity interval training three times a week for eight weeks. Each session was preceded by a standard warm-up and followed by a cool-down. The work and rest periods, the intensity and the number of repetitions were progressed across the eight weeks so that the demand increased gradually as the athletes adapted. The structure of the programme is summarised in Table 2.

6.5 Testing Procedure

All participants were tested before the programme began and again after the eight weeks. Testing was conducted under similar conditions at the same time of day to reduce the influence of extraneous factors. The physiological tests were administered first, followed by the psychological measures, and participants were familiarised with all procedures beforehand to ensure reliable measurement.

6.6 Statistical Techniques

The paired t-test was used to compare pre-test and post-test scores within each group, and the independent t-test was used to compare the two groups at the post-test stage. The mean and standard deviation were calculated for every variable, and a significance level of five per cent was adopted throughout the analysis.

7. Results and Discussion

7.1 Baseline Characteristics of the Groups

Table 1 presents the baseline characteristics of the two groups. The experimental and control groups were closely matched on age, physique and training experience, and no significant differences existed between them at the outset, which confirms that the two groups were comparable before the intervention.

Table 1

Baseline Characteristics of the Experimental and Control Groups (Mean $\pm$ SD)

Characteristic	Experimental (n=20)	Control (n=20)
Age (years)	20.4 $\pm$ 1.5	20.6 $\pm$ 1.4
Height (cm)	172.6 $\pm$ 5.8	173.1 $\pm$ 6.1
Body mass (kg)	66.8 $\pm$ 6.4	67.2 $\pm$ 6.0

Characteristic	Experimental (n=20)	Control (n=20)
Body mass index (kg/m ²)	22.4 ± 1.6	22.5 ± 1.5
Training experience (years)	3.6 ± 1.2	3.5 ± 1.1

7.2 The Training Programme

The progression of the interval training programme is shown in Table 2. As the weeks advanced, the duration of the work intervals and the number of repetitions increased while the recovery periods shortened, producing a steady rise in the overall demand of each session.

Table 2

Structure of the Eight-Week Interval Training Programme

Weeks	Work : Rest	Intensity (% HRmax)	Repetitions
1 – 2	30 s : 90 s	85 – 90	6
3 – 4	30 s : 75 s	90	8
5 – 6	40 s : 60 s	90 – 95	8
7 – 8	40 s : 60 s	95	10

7.3 Physiological Responses (Objective 1)

The first objective concerned the physiological response to the programme. Table 3 reports the pre-test and post-test scores of the experimental group together with the results of the paired t-test.

Table 3

Pre-Test and Post-Test Physiological Responses of the Experimental Group (n = 20)

Variable	Pre-test	Post-test	t	p
Resting heart rate (bpm)	68.4 ± 5.2	63.1 ± 4.8	5.84	0.000
Predicted VO ₂ max (ml/kg/min)	48.6 ± 4.1	53.2 ± 4.3	7.21	0.000
1-min heart-rate recovery (beats)	28.3 ± 4.6	34.7 ± 4.2	6.05	0.000
Shuttle-run distance (m)	1180 ± 210	1460 ± 240	6.80	0.000

The experimental group improved significantly on every physiological measure. Resting heart rate fell, indicating a more efficient heart; predicted maximal oxygen uptake rose by almost five units, a substantial gain over eight weeks; heart-rate recovery quickened, showing improved autonomic function; and intermittent endurance performance increased markedly. These changes are exactly those expected from effective interval training and are consistent with the established physiological literature. For comparison, Table 4 reports the corresponding scores of the control group.

Table 4

Pre-Test and Post-Test Physiological Responses of the Control Group (n = 20)

Variable	Pre-test	Post-test	t	p
Resting heart rate (bpm)	67.9 ± 5.0	67.1 ± 5.1	1.12	0.28
Predicted VO ₂ max (ml/kg/min)	48.9 ± 4.0	49.6 ± 4.2	1.45	0.16
1-min heart-rate recovery (beats)	28.7 ± 4.4	29.5 ± 4.5	1.21	0.24
Shuttle-run distance (m)	1195 ± 205	1230 ± 215	1.58	0.13

The control group, by contrast, showed only small and statistically non-significant changes across all measures. The clear difference between the two groups confirms that the improvements seen in the experimental group were a genuine effect of the interval training rather than a result of ordinary practice or the simple passage of time.

7.4 Psychological Responses (Objective 2)

The second objective concerned the psychological response to the programme. Table 5 reports the pre-test and post-test psychological scores of the experimental group.

Table 5

Pre-Test and Post-Test Psychological Responses of the Experimental Group (n = 20)

Variable	Pre-test	Post-test	t	p
Perceived exertion at fixed load (6–20)	15.2 ± 1.4	13.4 ± 1.3	5.12	0.000
Exercise enjoyment score	72.1 ± 8.3	81.4 ± 7.6	4.78	0.000
Total mood disturbance	24.6 ± 9.1	16.8 ± 7.4	4.05	0.000

The psychological results are striking. The rating of perceived exertion at the same fixed workload fell significantly, which means that, after the programme, a given physical task felt noticeably easier; this is itself an indirect sign of improved fitness. At the same time, exercise enjoyment rose significantly and total mood disturbance fell significantly, indicating that the athletes not only found the training easier but also enjoyed it more and felt better in themselves. The control group, whose psychological scores changed little over the same period, did not show these effects. These findings support the more recent view in the literature that high-intensity training need not be experienced as unpleasant and may, as fitness develops, become a source of genuine satisfaction.

7.5 Comparison between the Groups

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To confirm that the experimental group had responded differently from the control group, the post-test scores of the two groups were compared using the independent t-test. The results are summarised in Table 6.

Table 6
Independent t-Test Comparison of Post-Test Scores between Groups

Variable (post-test)	Exp.	Control	t	p
Predicted VO ₂ max (ml/kg/min)	53.2	49.6	2.69	0.011
1-min heart-rate recovery (beats)	34.7	29.5	3.78	0.001
Perceived exertion at fixed load	13.4	15.0	3.41	0.002
Exercise enjoyment score	81.4	73.0	3.25	0.002

The experimental group scored significantly better than the control group on every measure compared, confirming that the interval programme produced effects that ordinary training did not. This between-group difference reinforces the conclusions drawn from the within-group analysis and strengthens confidence that the gains can be attributed to the training intervention itself.

7.6 Testing of Hypotheses

The first null hypothesis stated that there is no significant difference between the pre-test and post-test physiological responses of the athletes. Since the experimental group improved significantly on every physiological measure while the control group did not, this hypothesis was rejected. The second null hypothesis stated that there is no significant difference between the pre-test and post-test psychological responses. Since the experimental group showed significant improvements in perceived exertion, enjoyment and mood, this hypothesis was also rejected. Both objectives of the study were thereby fulfilled, and the evidence demonstrates that the high-intensity interval training programme produced significant and favourable changes in both the physiological and the psychological responses of the university athletes.

8. Major Findings

1. The eight-week interval programme produced significant improvements in resting heart rate, maximal oxygen uptake, heart-rate recovery and intermittent endurance performance in the experimental group.
2. The control group, following its usual training, showed only small and non-significant physiological changes over the same period.

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3. Perceived exertion at a fixed workload fell significantly after the programme, indicating that the same effort came to feel easier as fitness improved.
4. Exercise enjoyment rose significantly and total mood disturbance fell significantly in the experimental group, showing a positive psychological response to the training.
5. The experimental group scored significantly better than the control group on all post-test measures compared, confirming the effect of the intervention.
6. The results support the view that high-intensity training can improve both fitness and the experience of training rather than being inherently unpleasant.

9. Conclusion

This study set out to examine the psychophysiological responses of university athletes to an eight-week high-intensity interval training programme, considering both its physiological and its psychological effects. The evidence is clear and consistent. The programme produced significant gains in cardiovascular and endurance capacity, and these gains were accompanied by an equally significant improvement in the psychological experience of training, expressed through lower perceived exertion, greater enjoyment and better mood. The control group, which did not undertake the programme, showed no comparable changes, which allows the improvements to be confidently attributed to the interval training itself.

The wider significance of these findings lies in their union of body and mind. Interval training is often discussed only in terms of the physical adaptations it produces, but this study shows that its psychological effects are just as real and just as favourable. The finding that hard training became more enjoyable as fitness improved is particularly important for coaches, because it suggests that a well-designed and properly progressed interval programme can sustain itself by becoming more rewarding over time. For university athletes, who must train effectively within the limits of a demanding academic life, a method that improves fitness while also improving how training feels offers a genuinely valuable path to better performance and lasting engagement with sport.

10. Limitations and Suggestions for Future Research

The study has limitations that should be acknowledged. It involved a modest number of male athletes over a period of eight weeks, so the findings may not extend directly to female athletes, to other age groups or to much longer programmes. Maximal oxygen uptake was estimated from a field test rather than measured directly in a laboratory, and the psychological

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measures, though well validated, relied on self-report. Future research could include female and mixed samples, measure physiological variables directly, extend the programme over a full competitive season and examine whether the psychological benefits observed here help athletes to maintain their training over the long term. Studies of this kind would build on the present findings and deepen understanding of how high-intensity interval training affects athletes in both body and mind.

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