Physiological responses to "all-out" and even-paced cycling intervals

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This thesis is submitted as partial fulfilment of the requirements for the degree of Bachelor of Sports Science (Honours) at Murdoch University, Perth, Western Australia.

I declare that this thesis is my own account of my research and contains, as its main content, work which has not previously been submitted for a degree at any tertiary education institution.

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ABSTRACT

Background: Endurance cyclists typically devote ~20% of their training regimens to performing low-volume high-intensity interval training which is associated with large physiological and performance benefits. The relationship between intensity and duration is important during high-intensity interval training as both can profoundly influence metabolic energy expenditure, fatigue development and subsequent adaptations. **Purpose:** Within the literature, most interval training is delivered using either an "all-out" or even-paced approach; however, to the author's knowledge no study has yet compared the metabolic stress, perceived exertion and fatigue resulting from such intervals. Therefore, this study compared the physiological and perceptual responses to matched mechanical work interval bouts using "all-out" and two different even-paced methodologies (i.e. computer- and athlete-controlled). **Methods:** In a randomised design, 15 male trained cyclists (age: 39 ± 8 years, body mass: 79.4 ± 8.2kg, VO_{2max}: 59.8 ± 6.5 $ml \cdot kg^{-1} \cdot min^{-1}$, peak power: 436 ± 27 W) performed one incremental maximal exercise test, one familiarisation session and three experimental high-intensity interval sessions implementing one of three pacing strategies; (i) "all-out", (ii) computer-controlled and (iii) athlete-controlled. All experimental sessions were work- matched and consisted of three 3-minute intervals with three minutes of recovery. A 4 km time trial was completed twenty minutes following each experimental interval session to assess measured levels of latent fatigue. Oxygen consumption, heart rate and perceived exertion, pain and effort were recorded throughout the high-intensity interval sessions with average power output and heart rate measured throughout

the 4 km time trial. **Results:** Overall greater ($p<0.001$) oxygen consumption was observed in the "all-out" condition (54.1 ± 6.6 $ml.kg^{-1}.min^{-1}$) compared with the computer- (51.5 ± 5.7 $ml.kg^{-1}.min^{-1}$) and athlete-controlled conditions (53.0 ± 5.8 $ml.kg^{-1}.min^{-1}$). Furthermore, the time spent at 85% VO_{2max} was greater ($p<0.001$) during the "all-out" trial when compared with computer- and athlete-controlled trials. Sessional perceived exertion was greater in the "all-out" trial when compared with the computer- ($p<0.001$) and athlete-controlled ($p<0.05$) conditions. Average power output measured during the 4 km time trial was lower ($p<0.001$) after the "all-out" session compared with both even-pacing strategies. **Conclusion:** Our findings indicate irrespective of work completed, greater physiological stress was observed within an "all-out" interval training approach when compared with both athlete- and computer- controlled conditions, resulting in greater latent fatigue as measured by 4 km time trial performance. The selections of pacing strategies are likely to play a key role in interval training and should be acknowledged throughout exercise prescription.

DEFINITION OF TERMS

For consistency of interpretation the preceding words are defined:

Active recovery: Low-intensity exercise completed between interval repetitions.

"All-Out": A maximal acceleration produced over a set period of time with a higher power output at the beginning of an exercise/interval session.

Athlete-controlled: Pacing selection internally controlled via the manipulation of gear ratio and cadence to achieve a nominated power output.

Computer-Controlled: Pacing selection with a fixed power output externally controlled for a predetermined period of time.

High-Intensity interval training: Physical exercise that is characterized by brief, intermittent bursts of vigorous activity, interspersed by periods of rest/low-intensity exercise.

Interval training: Repeated bouts of vigorous exercise interspersed with recovery periods.

ABBREVIATIONS

Selected abbreviations used throughout the text

ANOVA: analysis of variance

AC: athlete-controlled

AO: "all-out"

CC: computer-controlled

CT: continuous training

D: day

dw: dry weight

EVA: exposure variation analysis

HIT: High-intensity interval training

HR: heart rate

HR_{max}: maximum heart rate

kJ: kilojoule

km: kilometer

m: meter

min: minute

mmol/L: millimoles per litre

PGC-1α:peroxisome-proliferator activated receptor *y* co-activator

P_{max}: power associated with maximal aerobic capacity

PPO: peak power output

PTS: peak treadmill speed

REP: repetitions

RPE: rating of perceived exertion

s: second

T_{max}: time associated with maximal aerobic capacity

TT: time trial

VAS: visual analogue scale

Ve BTPS: expired ventilation body temperature and pressure saturation

VO_{2max}: maximal aerobic capacity

VT_1: ventilatory threshold one

VT_2: ventilatory threshold two

W: watt

W:R: work to rest ratio

wk: week