Inter- and intra-individual reliability of a 30-minute RPE clamp cycling exercise

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Abstract

Purpose: Using exercise protocols at a fixed rating of perceived effort (RPE) is a useful method for exploring the psychophysical influences on exercise performance. However, studies that have employed this protocol have arbitrarily selected RPE values without consideration for physiological state and exercise domains. Therefore, incorporating a more validated and justified approach which aligns RPE intensities with established physiological boundaries seems beneficial but has yet to be assessed as a reliable measure at both the inter- and intra-individual level. *Methods*: Eight recreationally active cyclists completed two identical ramped incremental trials on a cycle ergometer to identify gas exchange threshold (GET). A linear regression model plotted RPE responses during this test alongside gas parameters to establish an RPE corresponding to GET (RPE_{GET}) and 15% above GET ($RPE_{+15\%GET}$). Participants then completed three trials at each intensity, in which performance, physiological, and psychological measures were taken obtained at five-minute intervals. Data were assessed for reliability using intraclass correlation coefficients (ICC), coefficient of variations (CoV) and 95% confidence intervals. *Results*: All performance and gas parameters showed excellent levels of test-retest reliability (ICCs = >.900) across both intensities. Performance, gas-related measures, and heart rate averaged over the entire 30-minute exercise demonstrated good intra-individual reliability (CoV = <5%). *Conclusion*: Recreationally trained cyclists can reliably replicate RPE-clamped efforts across multiple visits when RPE is aligned to physiological thresholds. Some evidence suggests that exercise within the $RPE_{+15\%GET}$ is more reliable than the RPE_{GET} condition.

Keywords: RPE-clamp; reliability; affective valence; self-efficacy; gas analysis.

Introduction

Perceived effort is a crucial determinant in the regulation of exercise intensity (Marcora 2008; Tucker 2009). In short, perceived effort is characterised as a psychophysiological phenomenon (Borg 1982) involving a complex interaction between physical stimuli (e.g., power/velocity) and perceptual responses (Gescheider 1997). Some studies have required participants to exercise at fixed ratings of perceived effort (RPE). These "RPE clamps" allow researchers to examine the influence of additional psychophysiological phenomena (other than effort) on exercise regulation within fixed intensity domains (Halperin and Emanuel 2019). However, studies that have employed this protocol have arbitrarily selected RPE values without consideration for physiological state and exercise domains. Therefore, incorporating a more validated and justified approach which aligns RPE intensities with established physiological boundaries seems beneficial but has yet to be assessed as a reliable measure at both the inter- and intra-individual level.

Methods and Materials

Subjects - Eight recreationally trained, active cyclists: (M ± SD) Age, 24 ± 2.6 years; stature, 175 ± 6.8 cm; mass, 72 ± 11.5 kg, provided written informed consent to take part in this ethically approved study. All procedures were in accordance with the Declaration of Helsinki.

Design – This study utilised a randomised repeated measures design, consisting of eight laboratory visits.

Methodology - Within the first two visits, participants underwent identical cycling ramped incremental tests to identify gas exchange threshold (GET). A linear regression model plotted RPE responses during this ramped test alongside gas parameters to establish individual RPE responses corresponding to GET (RPE_{GET}) and 15% above GET ($RPE_{+15\%GET}$). The next six experimental visits involved participants completing three randomised trials at each intensity. Performance (power output), physiological (gas parameters, heart rate [HR], blood lactate), and psychological (affect, self-efficacy) measures were obtained throughout and averaged across five- and thirty-minute intervals.

Analysis - Data from these RPE-clamped trials were assessed for reliability using intraclass correlation coefficients (ICC), coefficients of variation (CoV) and 95% confidence intervals (95% CI). Repeated measures ANOVAs and paired samples *t* tests assessed differences over time and between conditions. All data were checked form normality before analysis using Q – Q plots and Shapiro Wilk tests.

Results

Power output and all gas parameters showed excellent levels of test-retest reliability (ICC = >.900) across both intensities. Power output, gas parameters and heart rate demonstrated good intra-individual reliability (mean CoV = <5 %) in both conditions. Narrower 95% CI were observed in the $RPE_{+15\%GET}$ condition (range = 1.1 – 5.2 %) compared to the RPE_{GET} condition (range = 2.0 – 8.4 %). Plots of time-lapsed physiological data during the 30-minute RPE clamp exercise showed that blood lactate, $\dot{V}O_2$ and $\dot{V}O_2.kg^{-1}$ were closely aligned with power output changes in both conditions. Psychometric data showed significant differences (P = <.05) at all time intervals between conditions.

Discussion

Foremostly, results showed that 30-minute RPE-clamped cycling demonstrated good test-retest and intra-individual reliability by a cohort of active cyclists. This was supported by ICC values which evidenced that performance measures (e.g., PO) demonstrated an excellent degree of reliability (>.900) between visits. In addition, physiological variables such as $\dot{V}O_2$ and $\dot{V}O_2.kg^{-1}$ values also demonstrated an excellent degree of reliability (>.900), whilst test-retest reliability for HR also demonstrated good reliability (>.800). In addition, this study also observed low CoV values (≤5%) and narrow 95% CI for 30-minute averaged performance (PO) and physiological ($\dot{V}O_2$, $\dot{V}O_2.kg^{-1}$, and HR) variables. Furthermore, research can begin to conjecture the possible mechanisms that regulate exercise intensity according to effort based on the trajectories of psychophysical data.

Practical Applications

Researchers can utilise this novel RPE clamp method to further their assessments of the effort phenomenon and its effect on exercise regulation. In tandem with previous studies (e.g., Cochrane et al., 2015a, b), this RPE clamp method is both valid and reliable.

Conclusions

Recreationally trained, active cyclists can reliably replicate RPE clamp exercise when RPE is aligned to physiological thresholds. Evidence suggests that exercise at higher RPE values ($RPE_{+15\%GET}$) may be more reliable than lower RPE values (RPE_{GET}). Moreover, it appears that sensations emanating from the muscle (e.g., blood lactate) and oxygen demand ($\dot{V}O_2$) are the main regulators of exercise performance at a fixed RPE. However, to further substantiate this finding, future research could probe the underlying decision-making processes that determine exercise intensity during fixed RPE exercise to corroborate psychophysiological data.

Presentation: Oral

Topic(s): Exercise Physiology; Cycling Science Methodology