

Reply to: The parabolic power–velocity relationship does apply to fatigued states

Samuele Maria Marcora · Walter Staiano

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We thank MacIntosh and Fletcher (2010) for sharing these previously unpublished power–cadence data. We concede that, on the basis of the only power–cadence data (Beelen and Sargeant 1991) available at the time of writing our reply to Burnley (2010), we may have underestimated the effect of cadence on the ability to produce maximal voluntary cycling power (MVCP) in a fatigued state (Marcora and Staiano 2010b). Nevertheless, the power–cadence data provided by MacIntosh and Fletcher (2010) strengthen, rather than weaken, our conclusion that muscle fatigue does not cause exhaustion during high-intensity aerobic exercise (Marcora and Staiano 2010a). In fact, according to the fatigued power–cadence relationship shown in Fig. 1 (open squares) (MacIntosh and Fletcher 2010), fatigued subjects that can produce 600 W at 108 RPM are able to produce 400 W at 40 RPM. Therefore, the fact that our subjects were able to produce 731 W at 108 RPM in the final MVCP test suggests that they were able to produce >400 W at exhaustion (40 RPM).

Whether our subjects were able to produce >400 or 731 W at exhaustion is totally irrelevant. What is relevant to our conclusion is that, despite significant muscle fatigue, they were able to produce more than 242 W at exhaustion. This finding goes against one of the most fundamental assumptions in exercise physiology: submaximal exercise terminates at the point commonly called exhaustion

because central and/or peripheral fatigue mechanisms reduce muscle function to the point that subjects are no longer capable of producing the force/power required by the task despite their maximal voluntary effort (task failure) (Allen et al. 2008; Jones and Burnley 2009).

We argue that exhaustion is a form of task disengagement, i.e. a conscious decision to withdraw effort when the effort required by exercise is beyond the maximal effort subjects are willing to produce in order to succeed in the task (potential motivation) (Marcora 2008; Marcora et al. 2008, 2009, Marcora and Staiano 2010a). Therefore, in well-motivated subjects, the main factor causing exhaustion is perception of effort, not muscle fatigue. In other words, it is mind over muscle. Accordingly, future research on what limits exercise tolerance should investigate the psychobiology of perceived exertion using appropriate psychophysical and neurophysiologic methods (Marcora 2009) rather than the central and peripheral mechanisms of muscle fatigue (Decorte et al. 2010; Jones and Burnley 2009).

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S. M. Marcora (✉) · W. Staiano
School of Sport, Health and Exercise Sciences, Bangor
University, George Building, Normal Site, Holyhead Road,
Bangor, Gwynedd LL57 2PZ, Wales, UK
e-mail: s.m.marcora@bangor.ac.uk

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