

Is it time to re-evaluate the training study?

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Prescribing training involves the manipulation of intensity, duration and frequency of the sessions to improve cycling performance. As sports scientists our ideal is to help provide an objective scientific basis for this training prescription. But whilst we have developed an intimate knowledge of training adaptations and their regulating molecular signals (Stepto et al., 2009), we do not appear to be moving closer to providing a scientific basis from which to design effective training programmes (Borreson and Lambert, 2009). Below we post 3 questions for future training related research studies to consider. 1) Are training studies using appropriate indices for specifying training intensity? 2) Should training studies take more account of individual variation? 3) Are training studies examining the right question?

There appears to be increasing agreement that the response to a standardised training programme can be remarkably diverse (Mann et al., 2014). This has led some to examine these training “responders” and “non-responders” and its genetic basis (Ehlert et al. 2013). Surprisingly, the alternative hypothesis that training has not been standardised appropriately appears to have been little considered (Mann et al. 2014). From this perspective the issue becomes not whether a cyclist is a responder or a non-responder, but rather what is his or her optimal training intensity. For example, it has long been established that cyclists’ time to exhaustion at the same relative intensity can vary hugely. Coyle et al. (1988) found that at 88% $\text{VO}_{2\text{max}}$ cyclists’ time to exhaustion varied from 12 min to 75 min. However, the method for prescribing training in most studies remains standardised as a percentage of maximum. Consequently, it seems unsurprising that the training response differs between two cyclists training at a standardised intensity that yields such a diverse response to even a single bout of exercise. Even where the ability to sustain a standardised training intensity is more carefully controlled, the underlying assumption that this is linked to a training response remains unproven. The relationship between submaximal and maximal laboratory measures (such as lactate threshold, or $\text{VO}_{2\text{max}}$) and endurance performance are well recognised (Joyner and Coyle, 2008). But a correlation with performance does not make these

indices appropriate benchmarks for setting training intensities. Rather the benchmarks for appropriate training intensities should be those that elicit a consistent training response. However, whether it is possible to normalise a training response by varying training intensity across different individuals does not appear to have been established.

Numerous strategies have been presented for monitoring the training status of competitive cyclists in order to evaluate training methods and their efficacy during a training and competitive season. However, the physiological responses to training that are observed over training and competitive seasons seem remarkably varied. In two long-term training studies, Lucia et al. (2000) reported that elite cyclists demonstrated significant changes in several submaximal parameters (6-9%), but not $\text{VO}_{2\text{max}}$. Similarly Barbeau et al. (1993) found significant reductions in the submaximal oxygen cost of cycling during the competitive phase of the season, but no change in $\text{VO}_{2\text{max}}$. Moreover Paton and Hopkins (2005) demonstrate significant variability in training induced changes in rider incremental peak and time trial power output during a competitive season. Indeed molecular markers that discriminate high and low responders to training have been shown to do so regardless of whether training is intensive intervals, moderately intense constant-load or incrementally load-adjusted moderate intense training (Timmons et al., 2010). These findings bring us to two related questions: do we know how cyclists actually train, and is there a need for individualized training intensities for optimal long-term performance development? The answer is we probably don’t have enough information available to determine this yet. Long-term training data from elite athletes is rare in the scientific literature (Jones, 1998; Mikulic, 2011; Pinot and Grappe, 2014), mostly likely due to the limited access to these individuals. It is hard therefore to establish exactly how they train, and thus what types of training might be more effective for certain individuals. However, from the above and preceding discussion we can presume that rather than specify training based upon group mean changes from short-term training intervention studies, it might be more effective to prescribe training on the basis of an individualised analysis.

Historically, training studies have typically been designed around the evaluation of structured training interventions (e.g. Stepto et al. 2001). The underlying hypothesis testing rested on establishing whether one training intervention leads to a greater effect than another. The dependent variable may have been a specific response, or performance itself. This kind of

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research has underpinned our detailed understanding of training. However, the outcome from this research cannot be used directly to inform training prescription. The number of interventions imposed and the generalizability of these studies understandably tends to be too limited. The method for prescribing a training programme from these empirical findings is not obvious. It would likely require a meta-analysis of all published training studies, evaluating their interventions, and effects. Even if such an analysis were possible, the error implicit in the assumptions required to reconcile the findings from diverse study methodologies, populations, and outcome variables will likely prevent conclusions of any value (Weston et al. 2014). Prospective studies performed on the same basis seem just as formidable. This conclusion perhaps challenges us to reflect whether a different approach to training studies might be required for further insight. To date the majority of research has explored the effects of specified training interventions. However, to prescribe training from a sound empirical basis, identifying optimal training intensities for individual athletes may present a more fruitful research challenge.

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