Abstract 2019

Title: The combination of visual and external focused instructions, and positive feedback did not enhance training-induced improvements in forward standing sprint performance.

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Background: Peak velocity is likely to be an important factor in the outcome of road cycling sprints. Cycling velocity is dependent on the balance of power output and resistive forces including, aerodynamic drag (CdA), gravity, rolling resistance and mechanical inefficiencies (Martin et al. 2006). With air resistance known to present the greatest resistive force, the trade-off between power output and CdA is a critical aspect of cycling. Merkes et al. (2018) and Blocken et al. (2019) have shown that adopting a forward standing cycling sprint position (Figure 1) reduces CdA by approximately 23-26 % when compared with a seated and standing position. This reduction in CdA can result in an increase of up to 5 $km \cdot h^{-1}$ in sprint cycling velocity (Merkes et al. 2018). However, the impact of the forward standing position on the ability to generate power output is currently unclear. Yet, research from our group observed poor intra-day reliability in measurements of CdA, possible due to the cyclist's inability to consistently maintain the required position (Merkes et al. 2018).

In the process of learning a new motor skill the instructions and feedback an athlete receives from his/her coach are of high importance. When analysed individually visual instructions, instructions stimulating an external focus of attention, and positive feedback are well known to improve performance, coordination, rate of learning, self-confidence, perception of competence, and self-efficacy (Benjaminse et al. 2015; Hodges and Williams 2012; Marchant 2011; Wulf 2013; Wulf and Lewthwaite 2016). Additionally, combining visual and external focused verbal instructions has been shown to have a positive effect on learning (Benjaminse et al. 2015). Appropriate instruction and feedback may, therefore, benefit the cyclist's ability to maintain effective sprinting position and enhance power output during the unaccustomed forward standing sprint position.

Purpose: To determine if the provision of visual and external focused instructions, and positive feedback would enhance the training effects of short-term (6 sessions) forward standing sprint training sessions, when compared with neutral verbal instructions and feedback.

Methods: Twelve trained amateur male cyclists (mean ± SD: age, 44 ± 9 y; height, 180.8 ± 5.7 cm; weight, 90.5 ± 8.4 kg; $\dot{V}O_2max$, 50.4 ± 5.8 $mL \cdot kg^{-1} \cdot min^{-1}$; power output at $\dot{V}O_2max$ (PPO), 386 ± 27 W; HRmax, 173 ± 9 bpm, performance level 3 or higher (De Pauw et al. 2013)) were divided into two equally matched groups based on height and power output at $\dot{V}O_2max$. Both groups performed 2 weeks of sprint training (6 sessions) in the forward standing sprint position including 2-3 sets of 2-4 repetitions of maximal effort sprints ranging 5-20 s. One group received visual (once at the start of each session) and external focused verbal instructions (30 s before each sprint) as well as positive feedback (after each completed set) about their cycling sprint position (experimental group). The other group only received a neutral verbal instructions and feedback (control group). Prior to (pre-session) and following training (post-session) both groups performed a high-intensity sprint performance protocol. The sprint protocol has been described elsewhere (Menaspà et al. 2015), and includes 14 s sprints performed both prior to (non-fatigued) and following (fatigued) a 10 min lead-up, from which peak and mean power output and cadence were measured.

Results: No effect of training group on performance was found. An increase in mean power output was observed during the non-fatigued sprint of the post-session when compared to the pre-session ($p = 0.047$; Partial $\eta 2 = 0.580$). Pairwise comparisons revealed an increase in mean power output in the control group (1012±128 vs. 1095±121 W) but not in the experimental group (1042±157 vs. 1064±227 W; Figure 2). No differences were observed in cadence.

Discussion: The combination of visual and external focused instruction, and positive feedback within this study did not improve forward standing sprint performance. While some studies in elite athletes did not found a difference in performance after external vs. internal focused instructions (Keller et al. 2018) and positive vs. neutral and negative feedback (Halperin et al. 2019), most studies however, did show an improvement in performance among amateur athletes with visual and external focused instructions, and positive feedback (Benjaminse et al. 2015; Hodges and Williams 2012; Marchant 2011; Wulf 2013; Wulf and Lewthwaite 2016). It is plausible that the combination of visual and external focused instructions, and positive feedback might have interacted differently, when compared with research analysing these variables individually. Additionally, in most motor learning studies the participants complete a novel task in which they have little to no experience. While the forward standing position is a novel task for most cyclists, the participants in the current study were familiar with sprinting in a regular standing position. It is also possible that the duration of this pilot study was not long enough to induce sufficient learning of the motor task. More training sessions may be required to allow for the combined interventions to lead to a meaningful learning effect compared to the control group.

This pilot study showed an improvement in mean power output during 14 s non-fatigued sprints is possible after only 2 weeks of sprint training in the forward standing position. However, no other improvements in power output or cadence were observed. The 2-week training period might not have been long enough to improve these variables. Furthermore, total training volume and overall content of the training week was not monitored during this study and could have impacted sprint performance. Figure 2 shows a significant amount of variability between the cyclists. While some cyclists improved after 2 weeks of training (up to 21.5%) others showed a decrease in performance (up to -14.8%). Greater performance inconsistency is also observed in amateurs when compared to elite athletes (Chapman et al. 2008). Although

power output and cadence were unaffected, it may be that other metrics may be more discriminatory, for example CdA and biomechanical variables. This presents opportunity for future research. The results might also be underpowered by the small number of participants and a power analysis should be conducted prior to future study.

Figure 1 The forward standing position

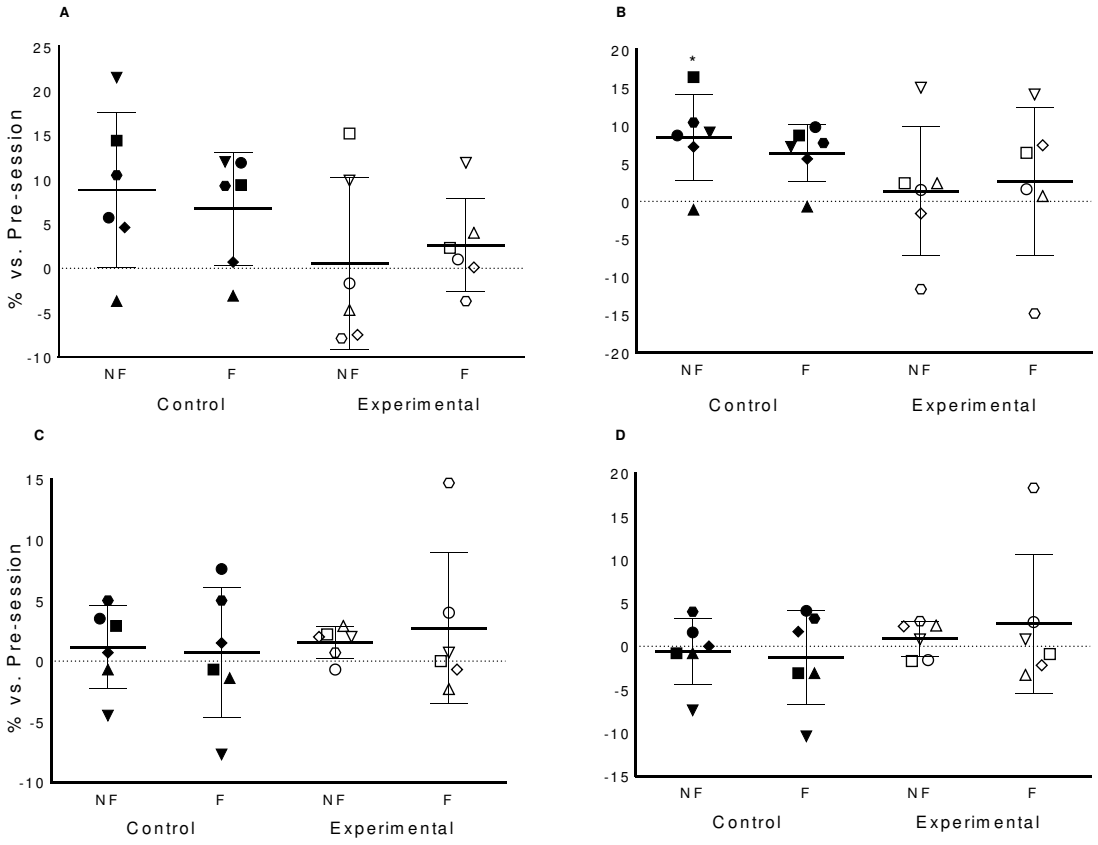

Figure 2 Percentages versus pre-session for A) Peak power output (W), B) Mean power output (W), C) Peak cadence (rpm), and D) Mean cadence (rpm); NF = non-fatigued; F = fatigued. * = $p \leq 0.05$ pre vs. post-session.

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