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Impact of 6-Week Brain Endurance Training on Cognitive and Cycling Performance in Highly Trained Individuals

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Abstract : Introduction: It has been proposed that acute negative effect of mental fatigue (MF) could potentially become a training stimulus for the brain (Brain endurance training (BET)) to adapt and improve its ability to attenuate MF states during sport competitions. Purpose: The aim of this study was to test the efficacy of 6 weeks of BET on cognitive and cycling tests in a group of well-trained subjects. We hypothesised that combination of BET and standard physical training (SPT) would increase cognitive capacity and cycling performance by reducing rating of perceived exertion (RPE) and increase resilience to fatigue more than SPT alone. Methods: In a randomized controlled trial design, 26 well trained participants, after a familiarization session, cycled to exhaustion (TTE) at 80% peak power output (PPO) and, after 90 min rest, at 65% PPO, before and after random allocation to a 6 week BET or active placebo control. Cognitive performance was measured using 30 min of STROOP coloured task performed before cycling performance. During the training, BET group performed a series of cognitive tasks for a total of 30 sessions (5 sessions per week) with duration increasing from 30 to 60 min per session. Placebo engaged in a breathing relaxation training. Both groups were monitored for physical training and were naïve to the purpose of the study. Physiological and perceptual parameters of heart rate, lactate (LA) and RPE were recorded during cycling performances, while subjective workload (NASA TLX scale) was measured during the training. Results: Group (BET vs. Placebo) x Test (Pre-test vs. Post-test) mixed model ANOVA's revealed significant interaction for performance at 80% PPO ($p = .038$) or 65% PPO ($p = .011$). In both tests, groups improved their TTE performance; however, BET group improved significantly more compared to placebo. No significant differences were found for heart rate during the TTE cycling tests. LA did not change significantly at rest in both groups. However, at completion of 65% TTE, it was significantly higher ($p = 0.043$) in the placebo condition compared to BET. RPE measured at ISO-time in BET was significantly lower (80% PPO, $p = 0.041$; 65% PPO $p= 0.021$) compared to placebo. Cognitive results in the STROOP task showed that reaction time in both groups decreased at post-test. However, BET decreased significantly ($p = 0.01$) more compared to placebo despite no differences accuracy. During training sessions, participants in the BET showed, through NASA TLX questionnaires, constantly significantly higher ($p < 0.01$) mental demand rates compared to placebo. No significant differences were found for physical demand. Conclusion: The results of this study provide evidences that combining BET and SPT seems to be more effective than SPT alone in increasing cognitive and cycling performance in well trained endurance participants. The cognitive overload produced during the 6-week training of BET can induce a reduction in perception of effort at a specific power, and thus improving cycling performance. Moreover, it provides evidence that including neurocognitive interventions will benefit athletes by increasing their mental resilience, without affecting their physical training load and routine.

Keywords : cognitive training, perception of effort, endurance performance, neuro-performance
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