Science & Cycling
29-30 June 2016, Caen, France

The impact of mental fatigue on a preloaded cycling-time trial in the heat.

INTRODUCTION: Mental fatigue is a change in psychobiological state caused by prolonged periods of demanding cognitive activity and has been observed to decrease whole-body endurance performance [1-5]. Recently a decreased resting-state cerebral blood-flow in the fronto-parietal cortex in the heat compared to in thermoneutral temperature was observed [6], raising the question whether mental fatigue may be even more detrimental for wholebody endurance performance in the heat. In normal ambient temperatures, performancedecrements of 5% [2] and 2% [4] have been observed in self-paced time trials (TT) due to mental fatigue.

AIM: To examine the effect of mental fatigue on a subsequent whole-body endurance performance and brain activity in the heat.

METHODS: In 30°C and 30% relative humidity, ten endurance-trained male athletes (Age: 22 ± 3y; W_{max}: 332 ± 41W; PL 3 [7]) completed two experimental trials in a single blind, randomized, cross-over design. A 5min Flanker was completed preceding and immediately following a 45min Stroop task [mental fatigue (MF)] or watching a documentary [control (C)]. Thereafter subjects cycled for 45min at a fixed pace equal to 60% W_{max}, immediately followed by a self-paced TT in which they had to produce a fixed amount of energy (equal to cycling 15min at 80% W_{max}) as fast as possible. In the TT subjects started at 80% of their W_{max} and were free to in- or decrease the resistance as desired from outset.
Electroencephalographic measures (32 electrodes) were recorded continuously during the cognitive tasks. Power output, heart rate, blood lactate, core and skin temperature, thermal sensation, ratings of perceived exertion, NASA-TLX and mental fatigue-VAS-scale (M-VAS) were assessed throughout the protocol.

RESULTS: Electroencephalographic (P3b-amplitude decreased and α1-activity increased ($p<0,05$; fig. 1)) and perceptual (M-VAS increased ($p<0,05$)) measures were significantly altered in the Stroop compared to during the documentary. M-VAS was also significantly increased in the first 15min of the fixed intensity part of the physical performance. The induced mental fatigue did however not influence any physiological (heart rate, blood lactate, core or skin temperature) or perceptual (ratings of perceived exertion and thermal sensation) measure during the fixed intensity part. TT-time also did not differ between conditions (MF: 906 ± 30s, C: 916 ± 29s; Fig. 2). Individually three participants performed worse when mentally fatigued, four better and three replicated the same TT-time within a 5s-marge in both conditions (Fig. 2).

CONCLUSION: Although a mild mental fatigue was induced in the heat, no negative effect was observed on physiological, perceptual or behavioral measures during the fixed intensity part or the TT. There are three possible explanations for these results. Firstly, the mild mental fatigue was insufficient to alter endurance performance and/or endurance trained athletes are resistant to the negative effects of mental exertion on subsequent endurance performance [8]. Another plausible explanation is that mild mental fatigue does not reduce endurance performance when the brain is already stressed by a hot environment.

Key words: exercise, whole-body endurance performance, heat, mental exertion, electroencephalography

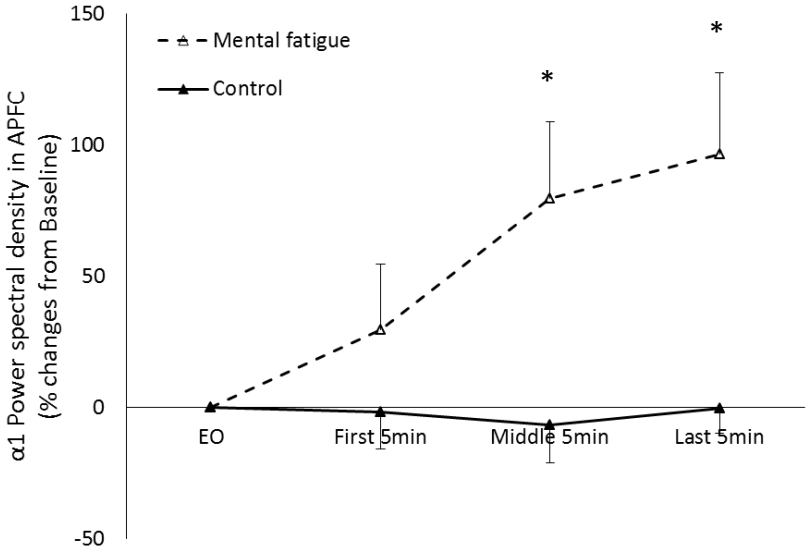

Fig. 1 α1-power spectral density in the anterior prefrontal cortex (APFC) during eyes open (EO), first, middle and last 5min of the Stroop task and the documentary. * Denotes a significant difference between conditions ($p<0,05$). Data are presented as means ± SE.

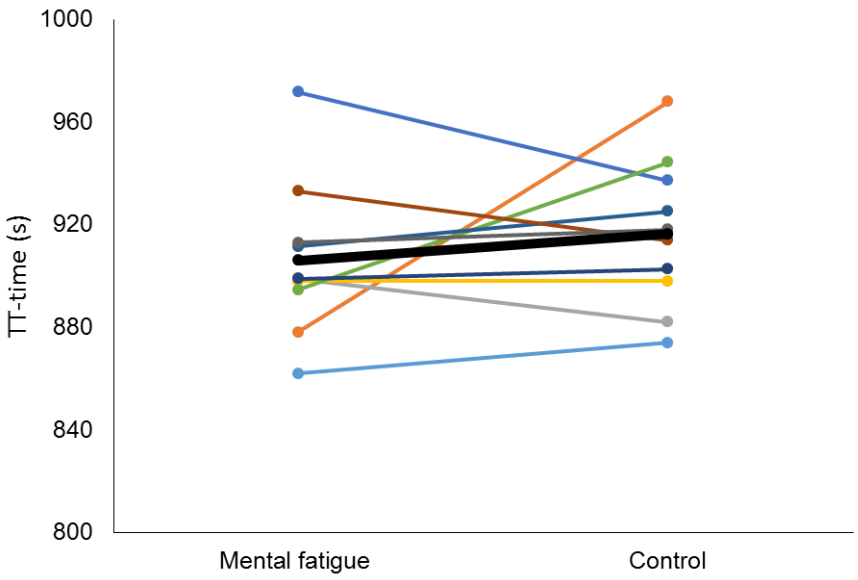

Fig. 2 Individual TT-time of each participant in both conditions. — Indicates the mean TTtime performance in both conditions.

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