The effect of physical and mental fatigue on cognitive processes

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Introduction
The effect of physical activity on young men's cognitive performance was examined and compared to the effect of mental fatigue in the same tasks. As previous research has indicated (Tomporowski, 2003), the effect is neither uniform nor inevitable but depends on the information processing stage, particular method of how the fatigue is induced and possibly also on observer's personal history.

Methods
Nine young healthy non-smoking normal weight men participated voluntarily in a series of experiments where effects of fatigue on cognition were studied. In a physical condition participants cycled 45 min at approximately 80% of heart rate of individual anaerobic threshold. In a mental condition a number comparison task (45 min) on a computer screen was conducted to induce the state of mental fatigue. A number of cognitive or psychological tests were administered as pre- and post-fatigue measures: electrophysiological event-related brain (ERP) responses to frequent (1000 Hz, 85% of cases) and rare (1128 Hz, 15%) auditory peeps, a critical flicker frequency test (CFF, a probable measure of the integration ability of the nervous system, Simonson & Brozek, 1952), simple reaction time (RT) to visual motion onset, Stroop’s colour-word interference test (Stroop, 1935), Borg’s scales (1998) for assessment of the perceived exertion and the state of fatigue (Borg RPE and CR10).

Results
Although the cycling was estimated as having been slightly bigger exertion than the number judging, observers did feel equally tired after both treatments: the post-treatment Borg’s RPE scores were 14.6 (+/-2.6) vs 13.2 (+/-1.5) and the Borg’s CR10 scores were 4.2 (+/-2.6) vs 3.8 (+/-1.4) for the physical and mental test, respectively. In the Stroop test the only statistically significant change emerged in the incongruent colour-word’s colour naming test that was quicker in the physical post-test (1.2 +/-1.4 s) than in the pre-test (1.4 +/-2.9 s, t(8)=2.5, p=.035).

In the RT task, the originally equal RT for the physical and mental condition (347.2 vs 347.7 ms, respectively) showed rise in mental fatigue condition (Fig. 1 left, 355.3 ms) but decreased negligibly in case of physical fatigue (Fig. 1 right, 344.7 ms). The effect of fatigue-procedure emerged most clearly in processing of stimuli that moved in the direction opposite to the previously presented one.

Changes in CFF frequencies were similar to changes in the RT due to the mental or physical fatigue procedure. The physical load did not change the CFF rate (34.8 vs 34.5 Hz in the pre- and post-test, respectively). However, in the mental fatigue condition the usual pre-test CFF value (35.3 Hz) dropped to a relatively low level (33.4 Hz) in the post-test that refers to the decreased integration ability of the visual information processing system.

Although the ERP pattern was not very consistent, some evidence for the differential effects of physical and mental fatigue on information processing were found also in the electrical activity of the brain while processing rare deviant signal as compared to the processing of the frequent standard signal.

Discussion/Conclusion
Altogether the results confirm that submaximal exercise performed less than 60 min tends to facilitate information processing (Tomporowski, 2003). The aid is evident at different levels of processing. At the same time, subjectively equal mental fatigue does not facilitate or even disturbs the same aspects of processing.

References