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ACUTE EFFECTS OF PHYSICAL EXERCISE ON COGNITIVE PERFORMANCE IN SIMULATED
WEIGHTLESSNESS BY FULL WATER IMMERSION

Abstract

It is well-known that cognitive abilities can be modulated by a short bout of whole-body physical exercise. While the mechanistic pathways that are responsible for such a modulation are still under debate, meta-analytical findings clearly underpin that one bout of exercise with moderate intensity lasting about 20 min has positive effects on cognitive performance. Whether such a positive relationship is maintained in exceptional and extreme environmental conditions such as weightlessness or underwater has never been systematically addressed in the past. However, this relationship - in terms of safety and mission success - is not only of high relevance during astronaut's extra vehicular activities (EVAs) or during underwater EVA training but also for all people during underwater activities on earth such as in recreational and occupational diving. Therefore, the study purpose was to investigate physical exercise-induced modulation of cognitive performance in shallow water-immersion. 12 young, medically fit-to-dive (8 male; 28.75 ± 3.7 years; 74.58 ± 142.93 dives), volunteers participated. In a Pre-Post within-subject design they performed (counterbalanced order, 48 hours interval) once a 20min rest condition in dry land condition in the laboratory and once a 20min bout of exercise underwater (about 3.5m) by fin-swimming (standard diving equipment) around a 30 meters round-parkour of a swimming pool. Moderate exercise intensity was predefined by 65% of age-predicted heart-rate and was self-controlled using a Polar® V800 watch. Cognitive performance was assessed by a modified Eriksen flanker test (inhibition: ability to suppress responses to irrelevant information) and a modified 2-back test (updating: a special kind of working memory ability) directly before (Pre) the 20min exercise or rest condition and directly after (Post). Tests were performed with an underwater fully functional tablet computer (Alleco®). ANOVAs (Time: Pre/Post and Condition: Dry/Wet) for reaction times (Rt) and error scores revealed a significant Time*Condition interaction for Rt of the incompatible stimuli in the inhibition test ($F(1,11) = 6.95$; $p = 0.023$; $\eta^2 = 0.38$) indicating superior performance for the Wet condition after exercising. No other relevant effects were found. From this we conclude that even in exceptional environments such as underwater, cognitive abilities can be positively modulated by a short bout of moderate-intensity exercise. However, this effect was specific to only one cognitive function (no effects in the updating ability) and it needs more research in other conditions such as real weightlessness and using other exercise protocols (intensity, duration and modality).