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EFFECTS OF COUNTERMEASURE-EXERCISE ON CARDIORESPIRATORY FITNESS AND
INHIBITORY CONTROL DURING 120 AND 240 DAYS OF SPACEFLIGHT SIMULATION –
RESULTS FROM TWO SIRIUS CAMPAIGNS

Abstract

PURPOSE During long-term spaceflight and planetary missions, cardiorespiratory fitness and intact cognitive processing are the cornerstone for sufficient performance and well-being. Despite exercise countermeasure training these parameters are still reduced after sojourns in microgravity (Hoffmann et al., 2016; Jones et al., 2019). Terrestrial spaceflight analogs (i.e., isolation studies) enable the systematic long-term investigation of specific exercise programs on their feasibility, effectiveness, and time efficiency. Positive effects on cardiovascular capacities and kinetics have been reported for both continuous (CON) and interval (INT) aerobic treadmill exercise in the laboratory, but the isolation, reduced physical activity and low external stimuli during spaceflight might alter these findings. Cognitive performance is affected by these parameters and interacts with acute exercise (Abeln et al., 2015; Pontifex et al., 2019). We expected (I) negative effects of isolation on cognition (II) physical fitness improvements from exercise countermeasure with benefits for INT. **METHODS** During the 120-d-mission, six participants (34y, 3f) conducted eight weeks of CON, followed by eight weeks of INT aerobic treadmill exercise in a crossover design. Changes in cardiorespiratory fitness and cognition were assessed with a test protocol including pseudo-random work rate changes (PRBS; kinetics analysis), constant work rate phases (0, 3, 6, and 9kmh⁻¹), and incremental exercise (peak-values) at Pre, mission day 9, 29, 57, 87, 117, and Post. HR (beat-to-beat) and VO₂ (breath-by-breath) were measured. Eriksen Flanker tasks for inhibitory control were conducted during steady-state exercise. **240-d-mission:** Countermeasures were extended by strength exercise and new INT exercise protocols on both active and passive treadmills. During Pre and Post, functional near-infrared spectroscopy (fNIRS; cerebral blood flow and oxygenation) was applied to look into the interaction of exercise and cognition. Results from this ongoing mission will additionally be presented at the congress. **RESULTS** Peak values showed significant time effects and were generally lower during isolation for HR (P=0.025), VO₂ (P=0.012), and respiratory exchange ratio (P=0.001). Analysis revealed accelerated HR kinetics during isolation following both INT (slightly greater effects) and CON exercise

and significant time effects for HR and VO₂ (both $p < 0.05$). No differences for inhibitory control could be observed. CONCLUSION Both INT and CON exercise proved sufficient to maintain and even elevate HR but not VO₂ kinetics during isolation in the absence of microgravity. Reduced physical activity in the confined space and high pre and post stress were identified as detrimental factors. Final conclusions including data from the 240-d mission will be presented at the conference.