SPACE LIFE SCIENCES SYMPOSIUM (A1)
Behaviour, Performance and Psychosocial Issues in Space (1)

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PHASE SHIFTS OF CIRCADIAN CORE BODY TEMPERATURE PROFILES DURING MARS500

Abstract

A growing body of research indicates that a misalignment of circadian rhythms can be detrimental to mental and physical health. Long-term space missions may also potentially alter circadian rhythms, and pose a critical risk to crew health and safety. The long-term impact of isolation and confinement on circadian rhythms has not been fully characterized. We here assessed the impact of the Mars500 study on the circadian phase of core body temperature (CBT). CBT was recorded continuously for 24 h at the forehead using a recently proposed heat-flux technique (Double Sensor) [1] before (BDC) and during (ISO-20, ISO-60, ISO-140, ISO-200, ISO-260, ISO-320, ISO-400, ISO-460) the mission. Each recording was then subjected to cosinor analysis to determine acrophase for each subject and session. A linear mixed model treating "Time" as fixed effect was fit to phase, including random effects (intercepts and slopes) to account for individual subject variation. To analyze whether the rate of change in CBT was characterized by nonlinear changes over time, quadratic and cubic models were also considered. In spite of substantial inter-individual variation, visual inspection of the data indicated a phase advance during the first half of the mission (+1.4 h), after which phase returned to baseline again (phase delay of about -1.2 h relative to first mission half). At ISO-460 phase sharply advanced again to similar levels observed during the first half of the mission. This pattern was confirmed by significant linear, quadratic and cubic components of the mixed model ($P<0.05$). This third degree polynomial trend is well in line with recent data, showing substantial differences for sleep-wake cycles between the first and last the part of the 520-d mission [2]. We suggest that this specific pattern is related to a highly controlled diet, which was administered during the first half of the mission. This diet required very strict meal times, which are well known to be strong nonphotic cues for circadian entrainment [3]. In contrast, we speculate that the sudden phase advance after 400 mission days could be related to the exposure of blue light, which was exclusively employed during days 439-499 only. In conclusion, the present results indicate that long-term isolation can induce significant changes in the circadian timing system, which might be attributed to specific nonphotic and photic cues of the Mars500 experiment.

[1] Respir Physiol Neurobiol, 169 (2009) S63-S68 [2] PNAS, 110 (2013) 2635-2640 [3] Science, 320 (2008) 1074–1077