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Author: Ms. Borbála Tölgyesi
Institute of Cognitive Neuroscience and Psychology, RCNS HAS, Hungary, tolgyesi.borbala@ttk.hu

Dr. Tim Stuckenschneider
Carl von Ossietzky Universität Oldenburg, Germany, tim.stuckenschneider@uni-oldenburg.de
Dr. Anna Altbacker
Institute of Cognitive Neuroscience and Psychology, RCNS HAS, Hungary, altbacker.anna@ttk.hu
Dr. Irén Barkaszi
Institute of Cognitive Neuroscience and Psychology, RCNS HAS, Hungary, barkaszi.iren@ttk.hu
Mr. Leonard Braunsmann
German Sports University Cologne, Germany, l.braunsmann@dshs-koeln.de
Dr. Laszlo Balazs
Institute of Cognitive Neuroscience and Psychology, RCNS HAS, Hungary, balazs@cogpsyphy.hu
Dr. Vera Abeln
German Sports University Cologne, Germany, v.abeln@dshs-koeln.de

NEUROCOGNITIVE PERFORMANCE DURING 60 DAYS OF HEAD-DOWN TILT BED REST WITH ARTIFICIAL GRAVITY

Abstract

Optimal cognitive ability is essential for astronauts during space missions, but hard to maintain due to the detrimental effects of weightlessness. Thus, it is crucial to explore the negative consequences of microgravity and identify effective countermeasures. A possible countermeasure is artificial gravity (AG), but its effect on cognitive abilities has to be examined. We aimed to investigate changes of controlled and automatic attentional processes induced by both head-down tilt bed rest (HDBR) and two types of AG (continuous and intermittent) provided by short-arm human centrifuge during the space analog Artificial Gravity Bed Rest – European Space Agency (AGBRESA) project.

The study was conducted at the :envihab facility (German Aerospace Center (DLR) Cologne, Germany) with 60 consecutive days of strict 6 HDBR. 24 participants were randomly assigned to three bedrest groups: daily intermittent artificial gravity (iAG), daily continuous artificial gravity (cAG), and no artificial gravity (DLRctrl). Additionally, an ambulatory control group (AMBctrl, n= 9) completed the same test battery and schedule without HDBR or AG exposure. We used two cognitive tasks with two complexity levels (simple and complex) in two modalities (visual and auditory). The data were collected at nine time points: two during baseline data collection (BDC), four during head-down bed rest (HDT), and three during recovery phase (R). During all sessions, 32-channel electroencephalogram (EEG) was recorded and late positive event-related potentials (ERP, P3a - reflecting automatic attentional processes, and P3b – reflecting controlled automatic processes), as well as reaction time (RT) and accuracy (ACC) of cognitive testing have been analyzed.

The results show decreased P3a amplitude during HDT in the auditory modality and decreased P3b in both modalities. On contrary, the AMBctrl group showed no changes in the P3a, and the P3b amplitude decrement was only present in the auditory modality. RT during complex tasks was constantly decreasing over time in all groups, however, it was more pronounced in the AMBctrl group. On the other hand, RT tended to increase in the bedrest groups during simple tasks and to decrease in the AMBctrl. Accuracy

was somewhat increased during complex tasks and intact in simple tasks in the bedrest groups, while AMBctrl showed no changes.

Based on the present findings, ERP and RT results may indicate a slightly disturbed learning process during HDBR compared to AMBctrl. We found no evidence supporting AG as a countermeasure against cognitive deteriorations, or that intermittent and continuous AG protocols would affect cognitive performance differently.