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60 DAYS OF BED REST IMPAIR HIPPOCAMPAL PLASTICITY AND SPATIAL COGNITION

Abstract

Head down tilt bed rest (HDBR) has been effectively used to assess the physiological changes related to spaceflight. Given the positive relationship between physical activity and neuroplasticity and cognitive performance, it could be expected that HDBR exhibits considerable neurobehavioral impairments. These effects could be particularly pronounced for spatial learning and memory as recent data indicate that physical activity interventions strongly affect the hippocampus. The aim of the present study was therefore to quantify the magnitude and time course of 60 days of HDBR with and without an exercise countermeasure on hippocampal plasticity and its behavioral significance. As part of the ESA/DLR sponsored 60 days bed rest study 'Reactive Jumps in a Sledge Jump System as a Countermeasure During Long-term Bed Rest (RSL)' neuroimaging was performed on a 3T Siemens mMR Biograph scanner 4 days before the start of bed rest (BDC-4), and after 58 days of HDBR (HDT58), with and without drop jumps as a countermeasure, in N=23 male subjects (age: 29+/-6 yrs) at the DLR :envihab. Structural brain differences were analyzed using T1 MPRAGE images and Voxel-Based Morphometry (VBM). For the measurement of hippocampal subfields, we performed a high resolution T2 weighted fast spin echo sequence and analyzed these data with an automated segmentation tool. Cognitive performance was assessed using a wayfinding task. The task allows the investigation of how good subjects are able to consolidate new spatial memories into accurate cognitive maps. We found that 60 days of HDBR induced a significant decrease in hippocampal subfield volume, i.e. right dentate gyrus. Moreover, VBM revealed significant bilateral volume decreases in the caudate nucleus and insula as well decreases in the left parahippocampal gyrus and intraparietal lobule. Wayfinding performance was also significantly impaired at the end of bed rest. These performance scores were correlated with insula and parahippocampal volumes. These findings

are very much in line with our results from other spaceflight analogs involving isolation and confinement (i.e. Neumayer station in Antarctica and HERA). They highlight the vulnerability of the hippocampus and associated structures to immobility, which could explain various social and neurobehavioral changes observed in spaceflight. Moreover, these data highlight the importance of monitoring spatial cognition during exploratory space missions, as well as the need to develop target-specific countermeasures for maintaining neurobehavioral performance.