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Behaviour, Performance and Psychosocial Issues in Space (1)

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STRUCTURAL BRAIN PLASTICITY DURING ISOLATION AND CONFINEMENT - DOES GENDER PLAY A ROLE?

Abstract

The potential development of adverse behavioral conditions and psychiatric disorders are considered one of the most serious, but also least understood risks in future long-duration space missions (LDSM). Reduced sensory stimulation and sensory monotony experienced in isolated, confined, and extreme (ICE) environments are expected to be major contributors to this unmitigated risk. Both acute and chronic social stress can alter neurogenesis as well as dendritic and synaptic turnover in brain regions, such as the hippocampus and amygdala. We recently showed that distinct hippocampal subfields are highly vulnerable to the effects of isolation and confinement associated with long-duration overwintering in Antarctica. However, the nature of these dynamics is currently unclear, and likely to be the result of a combination of different stressors. To investigate whether similar changes can also be observed after much shorter durations, but in an environment with high fidelity to spaceflight operations, we assessed the effects of 30 days of isolation and confinement in the HERA isolation chamber at NASA Johnson Space Center. We hypothesized that due to the high degree of isolation and confinement, brain plasticity would be significantly impaired, and that these changes would manifest as reductions in amygdala and hippocampal volumes. Crew members (N=16, age: 29 to 52yrs) as part of the 30-day HERA campaign C3 underwent neuroimaging 5 days before (MD-5) and on the first day after the mission (MD+1). Neuroimages were acquired on a Siemens Verio 3T scanner (Erlangen, Germany). Structural brain differences were analyzed using Voxel-Based Morphometry (VBM) and an automatic segmentation tool for hippocampal subfields. We found that 30 days of isolation and confinement in the HERA facility had detrimental subregion-specific effects on brain plasticity in healthy human adults. High-resolution hippocampal imaging revealed significant decreases in the left hippocampal head volume ($P<0.05$). These changes were also confirmed by VBM, which revealed a significant reduction of a cluster of voxels covering the hippocampal head and amygdala ($P<0.05$). These differences were particularly prevalent in women. These results confirm our previous findings from high-fidelity space analogs in Antarctica and highlight the vulnerability of

the hippocampus during exploratory space missions. These subregion-specific effects on brain plasticity could provide the biological basis to explain changes in psychosocial and neurobehavioral coping during spaceflight.