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CHANGES IN FUNCTIONAL BRAIN ACTIVATION AFTER 30 DAYS OF ISOLATION AND CONFINEMENT

Abstract

The change in mission duration for trips to Mars or asteroids requires substantial knowledge of potential perils and their mitigation to ensure mission success. Various stressors can be tested and prepared in terrestrial space analogs. Isolation and confinement is considered to be one of the main stressor affecting crew health and performance and may lead to depression, insomnia, emotional instability and cognitive impairments. We therefore aimed to investigate how neuronal activity and cognitive performance is affected by isolation and confinement using a high-fidelity space analog. A series of four identical missions was carried out in the Human Exploration Research Analog (HERA) located at NASA Johnson Space Center, Houston, US. Each mission consisted of a 30 days (simulated) space mission and was completed by crews of 4 (total N=16, 9 men and 7 women; age 29 to 52 yrs). Brain imaging was performed on a Siemens Verio 3T scanner 5 days prior to the mission (MD-5) and immediately after completion of the mission (MD+1). In order to determine the neuronal activity, blood oxygen level dependent (BOLD) changes were measured while participants performed a continuous memory recognition task. fMRI preprocessing and analysis were conducted in SPM12. Whole brain analysis was assessed using a primary threshold of P=0.01, and a cluster size probability of P=0.05 to correct for multiple comparisons. The results show that 30 days of isolation and confinement decreased memory recognition (P=0.023), but not pattern separation performance (P=0.119). BOLD fMRI data showed a significant increase in the middle frontal gyrus and in bilateral parietal lobe including the precuneus. Given the role of the precuneus for processing, the imaging data seem somewhat contradict our behavioral findings. However, previous studies employing a pattern separation task have observed an elevated BOLD fMRI response in older adults and patients with memory impairments. Moreover, increased activity was correlated with decreased task performance. These findings are well in line with the present findings, suggesting that the increased activity is not an indication of improved brain function or compensatory reaction, but a marker of network dysfunction during memory recognition. These data further highlight the neurobehavioral risks associated with long-duration spaceflight, the need for the development of sensory augmentation countermeasures, and the application of this research to clinical settings on Earth such as research on degenerative brain diseases in the aging population.