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NEURAL CORRELATES OF WORKING MEMORY CHANGES IN COSMONAUTS AFTER LONG DURATION SPACEFLIGHT

Abstract

INTRODUCTION: During the last several years, a previously unknown assembly of spaceflight-associated structural and functional changes to the brain has been uncovered through a number of studies applying MRI [1]. However, it is important to understand whether such changes are associated with changes at the behavioural or performance level. We investigated changes in working memory performance from pre- to post-flight and correlated them with functional connectivity changes observed in the same cosmonauts after a mission to the International Space Station (ISS).

MATERIAL AND METHODS: Thirteen cosmonauts who stayed 6 months in the ISS were included in this analysis. Brain MRI scans were acquired before the ISS mission and after 9 days. Working memory performance was assessed through an independent study before launch and 6 days after landing. Resting-state functional MRI (rsfMRI) data were acquired, which represents spontaneous neural fluctuations in the absence of specific task engagement. From these data, functional connectivity is inferred. Specifically, the intrinsic connectivity contrast (ICC) is computed, which is a measure of how strongly each voxel is connected with the rest of the brain. For the working memory task, the reaction time and errors were used as outcome values. Statistically, the pre- to post-flight difference in ICC was correlated with the pre- to post-flight difference of the working memory task. The voxel-level threshold was set at p¡0.001 uncorrected followed by a cluster-level threshold of p¡0.05 corrected with the false discovery rate (FDR).

RESULTS AND DISCUSSION: Our results show that the ICC change in the right angular gyrus correlates with changes in errors made on the working memory task of the third, most difficult, level (p(FDR)=0.009). The right angular gyrus is responsible for awareness of action discrepancy and action authorship, relates actions to their sensory outcomes, intersensory conflict detection, and delay detection performance [2-4]. Based on our data, cosmonauts either show decreased ICC in the right angular gyrus with decreased working memory performance after flight, or increased ICC with increased performance. Understanding this variability will be important to further uncover the brain's adaptive capacity to the extreme environment of space. Overall, these data show the involvement of the right angular gyrus in working memory performance in cosmonauts after long-duration spaceflight.