IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Human Physiology in Space (2)

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BRAIN WHITE MATTER MICROSTRUCTURAL CHANGES AFTER LONG-DURATION

SPACEFLIGHT AS REVEALED BY ADVANCED DIFFUSION MRI TECHNIQUES – THE REWIRED BRAIN OF SPACE CREW.

Abstract

Magnetic resonance imaging (MRI) has proven to be a useful technique to investigate brain structural and functional changes after spaceflight in space crew [1]. Our group has contributed to this research by demonstrating such effects based on a prospective longitudinal brain MRI study. We have previously demonstrated structural changes after spaceflight based on data from 10 to 13 cosmonauts scanned before flight, early post-flight (average of 9 days), and at follow-up (average of 7 months). These studies showed widespread grey matter volume changes, cerebrospinal fluid redistribution, and ventricular enlargement based on anatomical T1-weighted MRI scans [2,3]. Using diffusion MRI (dMRI) techniques, we reported voxel-level macro- and microstructural changes indicative of neuroplasticity in the primary motor cortex, basal ganglia, and the cerebellum [4]. Another dMRI study looked at the level of white matter tracts through a technique called tractography, revealing structural changes in the corticostriatal tract, among others, which connects the motor cortex with the basal ganglia [5]. Our follow-up data reveal that some of the structural changes as observed early post-flight are not fully returned to baseline levels after 7 months after return to Earth. With this work, we aim to present findings based on the dMRI techniques previously used, though applied on a larger up to date sample size. We also aim to gain insights into the role of mission duration on the observed effects by including data from one-year missions. This analysis is currently pending until completion of an upcoming MRI measurement, planned in April 2022. Lastly, we aim to present results from additional diffusion MRI techniques, such as fixel-based analysis (FBA). This technique looks at voxel-level changes, while simultaneously taking into account the orientations of the underlying fibre tissue [6]. Using FBA, we have preliminary unpublished results showing changes in fibre density and fibre cross-section, providing complementary results to the previously demonstrated effects. To fully understand the changes that are occurring in cosmonaut's brains after spaceflight, it is essential to combine results from multiple complementary analyses. As one of the few groups in the world tackling the impact of spaceflight on the human brain we combine resting state functional MRI, diffusion MRI with DTI and FBA as well and anatomical voxel- and surface based morphometry MRI on a prospective MRI study in space crew. Using this broad approach, we have demonstrated first insights into space flight induced brain changes, including signs for neuroplasticity in brain motor regions. With this work, we aim to provide a synthesised status of current findings based on diffusion MRI, complemented by the latest results on FBA.