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EXPLORATORY STUDY OF NEUROPLASTICITY IN ASSOCIATION WITH HUMAN SPACEFLIGHT

Abstract

For commercial and uncommercial manned space missions to be successful and safe, human cognitive function is a crucial component. Due to changed vestibular inputs and body unloading during spaceflight, humans go through substantial sensorimotor adaptation. There has been much research on some organ systems in space, but little is known about how spaceflight affects the human central nervous system's morphology and functionality. Based on the wealth of research demonstrating experience-dependent brain plasticity, one can hypothesise that spaceflight induces neuroplasticity in the sensorimotor cortical regions. Indeed, studies on rodents have shown that spaceflight causes abnormalities in axonal terminal distribution in the somatosensory cortex and Purkinje cell dendrite degradation. A recent human case study found that spaceflight increased the functional connection between the motor cortex and the cerebellum. It is also likely that non-specific structural brain shrinkage or oedema would emerge from the associated cephalic fluid redistribution, sleep deprivation, and other stressors of spaceflight in addition to specialised sensorimotor structural plasticity. Given the increasing duration of human spaceflights, including advanced plans for remote expeditions of Mars, it is imperative to assess the amount and nature of structural changes to the human brain associated with spaceflight and how this relates to sensorimotor performance. Additionally, it offers a chance to examine brain changes brought on by sensorimotor adaptation over a significantly longer period than has previously been possible. In this study, we explore the scant information currently available on the neuroplastic alterations in the human central nervous system related to spaceflight, whether actual or simulated. We will make use of exploratory research from already existing data and balance tests to assess the impacts of spaceflight on human brain structure and see if any alterations are connected to the severity of balance declines seen between pre- and post-flight. Assessment of neurological reflexes, psychological adaptations and neurophysiological functions that regulates daily activities can also help us understand if spaceflight causes brain alterations and under what circumstances brain changes indicate dysfunctional or adaptive responses. We will further discuss the future perspectives, since this may inspire more investigation into this delicate and fascinating facet of space travel.