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THE BRAIN IN DEEP SPACE: IDENTIFYING "POTENTIAL" SYNERGISTIC RISKS OF SPACE RADIATION, ISOLATION & CONFINEMENT, AND ALTERED GRAVITY TO BEHAVIOR AND PERFORMANCE

Abstract

Planned human space exploration beyond the protection of the Van Allen Belt will significantly increase exposures to a spectrum of galactic cosmic radiation at levels known to cause decrements in behavioral performance in animal models. Given those identified risks, NASA's Johnson Space Center's Human Research Program (HRP) directed an integration of research efforts within three of its human research program risk areas risks to assess the potential for synergistic expression. These three risk areas include: Human Factors and Behavioral Performance (HFBP), Space Radiation (SR), and Human Health and Countermeasures (HHC). NASA's HRP directed this completely integrated approach to systematically identify and investigate the relationships amongst three risks: Risk of Acute (In-flight) and Late Central Nervous System Effects from Radiation (CNS), Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders (BMed), and Risk of Impaired Control of Spacecraft/Associated Systems and Decreased Mobility Due to Vestibular/Sensorimotor Alterations Associated with Spaceflight (SM) and (hereafter referred to the CBS Integrated Research Plan). The presentation reviews relevant animal research using simulated Galactic Cosmic Ray (GCR) fields, gravity modification simulations such as hindlimb unloading (for sensorimotor impacts), and isolation and confinement models. It also addresses how this integrated research focuses on identifying operationally-relevant behavioral performance measures along with assessments of brain physiology, neurovascular unit integrity, molecular signaling, biomarker changes, in order to generate data sets that can be incorporated into computational models. Evidence presented will address how a number of identified environmental stressors, including altered gravity, sleep loss, radiation exposure, and isolation and confinement stress may all lead to dysregulation of the brain's structure and microenvironment leading to imbalanced function of neuronal and glial networks and the neurovascular unit. The magnitude of physical and biological stressors is believed to vary by mission phases but are likely to simultaneously, perhaps synergistically, and cumulatively act on the human central nervous/physiological system and have the potential to adversely impact operationally-relevant crew performance. Therefore, NASA's HRP strategy is intended to identify the magnitude and types of interactions as they affect behavior, especially as it relates to operationally-relevant performance

domains (e.g., performance that depends on reaction time, procedural memory, etc.). NASA's research strategy and scientific rationale for integrating research approaches with proper schedule alignment and synchronization to meet NASA's anticipated Gateway mission and Mars Exploration milestones are placed within the context of risk reduction strategies.