National Space Biomedical Research Institute
Team Name: Neurobehavioral and Psychosocial Factors – Team Executive Summary
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Background/Scope
Astronauts on long missions will endure the isolation and confinement of the space environment to a greater degree than previous travelers, which will pose challenges to their behavioral health and performance. The Neurobehavioral and Psychosocial Factors (NBPF) Team works to find effective methods for crews to use to deal with stress during prolonged periods in space in order to optimize mission success. In addition to identifying neurobehavioral and psychosocial risks to crew health, safety and productivity, Team objectives include developing methods to monitor brain functions and behavior, countermeasures to enhance individual and crew performance, motivation and quality of life, and techniques to optimize behavioral health management, crew cohesion and communications during exploration missions.

Goals
NBPF Team goals derive from the Human Research Program (HRP) Program Requirements Document, the HRP Program Plan, and the Integrated Research Plan (IRP) for the HRP program element for Behavioral Health and Performance (BHP). The major BHP risks within the HRP IRP that relate to the Team are: 7.0 Risk of behavioral and psychiatric disorders; and 22.0 Risk of performance errors due to poor team cohesion and performance, inadequate selection/team composition, inadequate training, and poor psychosocial adaptation. The NBPF Team also has some cross-cutting risks related to 27.0 Risk of performance errors due to sleep loss, circadian desynchronization, fatigue, and work overload. Relative to the above risks, NBPF Team goals over the next 5-10 years include the following: (1) mitigate risks of stress, anxiety and depression in spaceflight by development of tools to monitor mood and predict risk for and management of behavioral and psychiatric conditions prior, during and following spaceflight; (2) mitigate risks of interpersonal conflict, ineffective communication and poor group cohesion through the development of tools, training and methods to maintain performance and mission success; (3) mitigate risks of cognitive performance deficits in space by development of techniques to prevent, detect and counter deficits due to radiation and fatigue in space; and (4) perform research necessary to enable development and validation of the Fitness for Duty Behavioral Health and Cognition standard.

Support of NASA Needs
The NBPF Team's development of technologies for monitoring and mitigating individual neurobehavioral problems and crew conflict and cohesion problems in space are well positioned to address NASA's near- and far-term exploration needs. Over the next five years, as laboratory validation is completed on a number of these technologies, they will be transitioned to testing in analog environments that simulate some of the key behavioral stressors in spaceflight. During the subsequent five years, transition to ISS is anticipated for a number of the technologies, which can also be made available for the Constellation Program. Technologies being developed are largely software based and designed to reduce the medical systems requirements for mass, volume, power and data—thereby meeting the NASA goal of reducing human systems resource requirements and the overall Constellation Program resource requirements. Thus, NBPF projects

are capable of addressing behavioral risks in multiple mission architectures (short-duration Earth-orbital missions, ISS six- and 12-month missions, short-duration and long-duration lunar missions, and Mars Mission).

Deliverables
NBPF Team deliverables for autonomous use by astronauts to maintain individual and crew behavioral health and performance during prolonged missions include the following: (1) brief neurobehavioral performance test to detect fatigue effects on psychomotor vigilance capability; (2) optical computer recognition software to unobtrusively track facial expressions of stress, emotions and fatigue; (3) noninvasive neuroimaging technology to detect depression; (4) computer-based self-guided depression treatment software; (5) interactive software to reduce interpersonal conflicts; (6) interactive software to detect and manage stress and anxiety; (7) communication countermeasures for crew performance under time pressure and during stressful conditions; and (8) detection of neurobehavioral deficits due to acute space radiation exposure. Deliverable 1 is being transitioned from an analog environment to ISS; deliverables 2, 4 and 5 are anticipated to transition to analog environments in the next five years; deliverables 3, 6, 7 and 8 are expected to transition in years six through 10.

Cross-Links
NBPF Team focus on identifying and mitigating factors that compromise cognitive and neurobehavioral functions, and on crew coordination and problem solving, results in synergistic cross-links to projects on the Human Factors and Performance Team, Radiation Effects Team and Sensorimotor Adaptation Team. The NBPF focus on software and small hardware technologies for autonomous astronaut use is a cross-link to the Smart Medical Systems and Technology Team. The NBFP Team works closely with the Behavioral Health and Performance program element and interfaces with the Exploration Medical Capability, Human Health Countermeasures, ISS Medical Project, Space Human Factors and Habitability, Space Radiation, Space Medicine and Behavioral Ops.

Enabling Capabilities and Gaps
NBPF Team strengths include a focus on prevention, detection and intervention for behavioral problems in spaceflight using state-of-the-art technologies designed to reduce the medical systems requirements for mass, volume, power and data; development of technologies and countermeasures for autonomous feedback about cognitive performance, affect and stress that can be delivered in the near term; and the capability to inform and support a Fitness for Duty Behavioral Health and Cognition standard. Current gaps include: (1) The need to better understand the manner in which crew cohesion occurs and the factors that facilitate it during different types of space missions; (2) Effective ways to facilitate crew interactions to ensure team problem solving is not affected by reduced performance in individual team members; (3) Determine how the physical effects of space missions (radiation, lunar dust, bone and muscle loss) affect individual and crew behavioral health; and (4) Identification of biomarkers and predictors of differential vulnerability to the behavioral effects of spaceflight.

Earth-Based Benefits
NBPF technologies being developed have the potential for extensive Earth-based benefits. Technologies that can unobtrusively detect performance deficits, stress, fatigue and mood shifts

can be of use in a wide range of scenarios in which humans must perform under adverse conditions (e.g., first/emergency responders, military, public safety) or conditions in which a human error can be catastrophic (e.g., transportation workers, medical teams, power plant operators). Individualized computer-based detection and treatments for stress, anxiety, depression and conflict resolution have significant potential for use in remote or isolated conditions, as well as to provide cost-effective access to behavioral management to millions of people who cannot otherwise afford treatment.