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| **Fiscal Year:** | FY 2012 | **Task Last Updated:** | FY 05/30/2012 |
| **PI Name:** | Boyle, Richard Ph.D. | | |
| **Project Title:** | Inner Ear Otoconia Response in Mice to Micro- and Hyper-gravity | | |
| **Division Name:** | Human Research | | |
| **Program/Discipline:** | HUMAN RESEARCH | | |
| **Program/Discipline--Element/Subdiscipline:** | HUMAN RESEARCH--Biomedical countermeasures | | |
| **Joint Agency Name:** | | **TechPort:** | No |
| **Human Research Program Elements:** | (1) **HHC**:Human Health Countermeasures | | |
| **Human Research Program Risks:** | (1) **Sensorimotor**:Risk of Altered Sensorimotor/Vestibular Function Impacting Critical Mission Tasks | | |
| **Space Biology Element:** | None | | |
| **Space Biology Cross-Element Discipline:** | None | | |
| **Space Biology Special Category:** | None | | |
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| **Zip Code:** | 94035-1000 | **Congressional District:** | 18 |
| **Comments:** | | | |
| **Project Type:** | GROUND | **Solicitation / Funding Source:** | 2011 Crew Health NNJ11ZSA002NA |
| **Start Date:** | 07/01/2012 | **End Date:** | 03/31/2014 |
| **No. of Post Docs:** | | **No. of PhD Degrees:** | |
| **No. of PhD Candidates:** | | **No. of Master' Degrees:** | |
| **No. of Master's Candidates:** | | **No. of Bachelor's Degrees:** | |
| **No. of Bachelor's Candidates:** | | **Monitoring Center:** | NASA ARC |
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| **Flight Program:** | | | |
| **Flight Assignment:** | NOTE: Extended to 3/31/2014 (original end date was 6/30/2013) per A. Chu/ARC (Ed., 6/11/13) | | |
| **Key Personnel Changes/Previous PI:** | | | |
| **COI Name (Institution):** | | | |
| **Grant/Contract No.:** | Internal Project | | |
| **Performance Goal No.:** | | | |
| **Performance Goal Text:** | | | |
| | Does exposure to long-duration spaceflight lead to neural structural alterations and does this remodeling impact cognitive and functional performance? This knowledge gap (SM26) recognizes an inherent risk to crew health and performance due to neural structural plasticity associated with space flight. Otoconia crystals of the mammalian inner ear otolith sensory organs are critical for spatial orientation and balance. Because of their normal biomineralization and their density is related to neural sensitivity, exposure to long-duration spaceflight puts them at risk to structural remodeling. A widely considered mechanism by which the nervous system responds to a change in gravity load is a change in the weight-lending otoconia. When subjected to weightlessness, it is argued the organism counters the loss of gravity load by increasing calcium carbonate production, thereby seen as a means to increase the "system gain". Our hypothesis is: weightlessness over a significant period of time triggers a compensatory mechanism that leads to a constructive process | | |

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| **Task Description:** | of ion deposition and an increase of otoconia mass. Upon entry to a novel gravity environment and later return to Earth, this response is maladaptive and will have a severely negative impact on cognitive and functional performance of the crew during the mission and on health and wellness at home. Although not mutually exclusive, we also hypothesize that long-duration hypergravity exposure leads to an ablative process and loss of otoconia mass. On Earth the clinical syndrome of canalithiasis, the most common single cause of vertigo, is now clearly biomechanical in origin and occurs when otoconia or fragments from them are displaced from their normal location. Despite this significant morbidity, the potential exists for structural remodeling of otoconia by the intensity and duration of gravity loading to which the animal is exposed? To address this risk we have one specific aim, namely to specify the structural integrity of otoconia as a result of short- and long-duration exposures to altered gravity conditions. Until recently, mammalian studies were confined to space missions and ground-based centrifugation studies of relatively short duration, and as a result studies have reached mixed conclusions. The Mouse Drawer System (MDS) housed mice on the International Space Station (ISS) for 91 days, roughly 20% of the lifespan of a mouse in the wild. Preliminary results of inner ears of MDS flight mice showed a dramatic alteration of symmetry and topographical surface features of otoconia; controls were normal in appearance. Subsequent studies have acquired otoconia samples from: 1) equivalent mouse models of MDS mission to 2G centrifugation and hindlimb unloading for 91 days in two separate series; and 2) inner ear samples of mice flown on the 13-day STS-133 and -135 missions. Preliminary results of inner ears of 2G mice also showed a dramatic alteration in topographical features of otoconia, but in the opposite sense in support of our hypothesis. The proposed research is a one year ground-based study from existing tissues and addresses fundamental mechanisms of neural compensation that directly effect crew health and performance during the exploration missions and on return to Earth. We will apply scanning and transmission electron microscopy and microstructural-crystallographic techniques to evaluate the possible mechanisms of otoconia restructuring in response to gravity loading. We specifically seek to answer the following questions: are there structural changes in otoconia as a result of experimental altered gravity conditions? If so, is the change due to a constructive or destructive process? And, is the process dependent on length of exposure to altered gravity loading? It is anticipated that the study will produce both a path toward quantification of a crew health and performance risk and provide the basis for valid ground-based studies for countermeasure development. |
| **Rationale for HRP Directed Research:** | |
| **Research Impact/Earth Benefits:** | |
| **Task Progress:** | New project for FY2012. |
| **Bibliography Type:** | Description: (Last Updated: 09/17/2021) |