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| **Fiscal Year:** | FY 2022 | **Task Last Updated:** | FY 08/12/2022 |
| **PI Name:** | Moudy, Sarah Ph.D. | | |
| **Project Title:** | Development of Sensorimotor Fitness for Duty Assessments Using Ground Analogs (PI: Moudy) | | |
| **Division Name:** | Human Research | | |
| **Program/Discipline:** | | | |
| **Program/Discipline--Element/Subdiscipline:** | | | |
| **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 (Revised as of IRP Rev M) | | |
| **Space Biology Element:** | None | | |
| **Space Biology Cross-Element Discipline:** | None | | |
| **Space Biology Special Category:** | None | | |
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| **PI Organization Type:** | GOVERNMENT | **Phone:** | |
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| **Zip Code:** | 77058 | **Congressional District:** | 22 |
| **Comments:** | | | |
| **Project Type:** | GROUND | **Solicitation / Funding Source:** | Directed Research |
| **Start Date:** | 05/27/2022 | **End Date:** | 09/30/2026 |
| **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 JSC |
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| **Flight Program:** | | | |
| **Flight Assignment:** | | | |
| **Key Personnel Changes/Previous PI:** | This investigation is a continuation of a Directed Research project with the same name under PI Marissa Rosenberg. Dr. Rosenberg has left NASA. The new PI is Sarah C. Moudy, Ph.D. with KBR. Millard Reschke, Ph.D. has retired from NASA so he no longer serves as CoInvestigator. | | |
| **COI Name (Institution):** | Wood, Scott Ph.D. ( NASA Johnson Space Center )<br>Peters, Brian Ph.D. ( NASA Johnson Space Center )<br>Clark, Torin Ph.D. ( University of Colorado, Boulder )<br>Schubert, Michael ( Johns Hopkins University ) | | |
| **Grant/Contract No.:** | Directed Research | | |
| **Performance Goal No.:** | | | |
| **Performance Goal Text:** | | | |

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| **Task Description:** | The first aim will assess the suitability of a proposed set of sensorimotor assessment tasks, or measures that would be feasible with the limited time, resources, and space of a lunar/Martian lander, for use in defining fitness for duty assessments. A Sensorimotor Adaptation Analog (SAA) that can provide different levels of acute disorientation through combined vestibular, visual, and proprioceptive disruptions will be used to increase the range of performance in sensorimotor assessment tasks, simulating the moderate-to-severe performance decrements observed post-spaceflight. The levels of SAA will be titrated and validated by comparison to gold standard measures that have a wealth of spaceflight data at different time points during recovery. Referencing existing post-flight data from the gold standard measures will help us characterize how each magnitude of SAA disorientation compares to recovery from long-term microgravity exposure. In the second aim of this study, we will utilize a similar approach as implemented by Ryder et al. (2019), where a weighted suit was used to map various strength-to-body-weight ratios with operational performance. Similarly, we will obtain the sensorimotor assessment tasks at varying levels of the SAA magnitude to map sensorimotor ability (strength equivalent) to the probability of completion of operational performance measures. Our third aim involves 90 minutes of prolonged +3GX centrifugation to mimic the vestibular alterations with gravity transitions. Our final aim will utilize the NASA Johnson Space Center (JSC) Active Response Gravity Offload System (ARGOS) to characterize the effects of a reduced gravity load on balance-related exploration and operational measures. The main deliverable from this project will be recommended sensorimotor assessments that provide a quantitative index of readiness to perform key operational tasks. 1. Specific Aim 1 a. The first session of this aim is exploratory in nature and focused on developing and testing the SAA by using astronaut first-hand experience. We aim to test astronauts with a wide range of postflight performances. We will vary the disorientation levels of the SAA and have the crewmembers identify which level most closely resembles their experience of disorientation at R+1-4h and R+24-48h. We will introduce each aspect of the SAA in an isolated manner, then will combine two aspects at a time. We will use the astronaut feedback to titrate the individual levels of SAA and determine if SAA is most realistic with all three aspects or if two or one aspects were most realistic to their experience post-flight. This is the only aim that will work with astronauts. b. This session will also be exploratory in nature. Each ground (non-astronaut) subject will perform the gold standard measures at each SAA magnitude: 1) zero (pre-flight, post-flight fully recovered), 2) low (R+24-48h), and 3) high (R+1-4h) magnitude of SAA. The order of tasks and order of disorientation level will be randomized and counterbalanced to the extent possible. If there is a clear performance decrement observed that worsens with increasing disorientation and the range of performances are similar to the range observed pre- to postflight in astronauts, we will keep the proposed levels of SAA. If adjustments need to be made, we will systematically either reduce or increase the level of disorientation to elicit clear changes in performance. c. Once the levels of SAA have been defined, we will test subjects' performance in the sensorimotor assessment tasks at each level of disorientation to assess the suitability of each measure as a fitness for duty assessment. Similarly to part (a), we will be looking for changes in performance that correlate to changes in disorientation. 2. Specific Aim 2 Each subject will perform the sensorimotor assessment tasks and operational performance measures in one session under three different disorientation conditions: 1) zero, 2) low, and 3) high magnitudes of SAA. Depending on the results of Specific Aim 1, we may identify that one or more of the measures and/or one of the SAA levels is not particularly sensitive or useful. We will decide to exclude those measures and/or SAA level to simplify this Specific Aim. The order of tasks within each block will be randomized and the order of disorientation magnitude will be counter balanced. 3. Specific Aim 3 Subjects will undergo 90 minutes of sustained +3GX centrifugation. Immediately after egress from the centrifuge, subjects will perform a subset of the sensorimotor assessment tasks followed by the operational performance tasks. These measures are planned to be performed using the Disorientation Research Device (also known as "Kraken"), located at the Naval Aerospace Medical Research Unit - Dayton. 4. Specific Aim 4 subjects will be offloaded to lunar and Martian gravity. Subjects will perform a subset of the sensorimotor assessment tasks, followed by the emergency extravehicular activity (EVA) operational performance measure. This operational performance measure was selected since it is the most relevant task to be affected by partial gravity. 5. Specific Aim 5 will build on the lunar landing simulations that will be developed for the Manual Crew Override study (PI: Wood) and the human lander systems training simulations to support the Flight Operations Directorate for Artemis mission training. Similar to Aim 1a, this aim anticipates working with astronaut crewmembers to satisfy some of the generic lunar landing task training. The testing will involve two pre-test familiarization sessions focused on developing proficiency to perform the landing task through multiple landings with both the full simulator and the Just In Time (JIT) trainer platform. Following recommended guidelines for Artemis sustaining mission, crewmembers will then wait 75 days before performing the same lunar landing following a g-state analog (sustained centrifugation). The outcome of this aim is to characterize the relationship between the performance on the JIT platform with the Kraken lunar landing performance to inform what performance threshold is required to mitigate risk associated with vertigo and disorientation with manual crew override during landings. |
| **Rationale for HRP Directed Research:** | This research is directed because it contains highly constrained research. This project is in direct response to the baselined Human Research Program (HRP) Path to Risk Reduction milestone of providing updates to the NASA Fitness For Duty Standards. The new standards should be tied to fitness for duty for exploration tasks and provide a quantitative index of readiness to perform key exploration tasks. This research effort will leverage expertise based upon HRP-funded flight research investigations including Functional Tasks Test, Field Test, Standard Measures, and Manual Control, as well as MedB computerized dynamic posturography. This project will leverage critical mission tasks previously established by Ryder et al. ("A novel approach for establishing fitness standards for occupational task performance." Eur J Appl Physiol, 2019) for standards related to the risk of reduced muscle mass, strength, and endurance. This project must also leverage experience with vestibular spaceflight analogs (e.g., Galvanic vestibular stimulation, sustained 3Gx centrifugation) to characterize how the deconditioned state following G-transitions (e.g., postural instability, motion sickness, head movement restrictions) map to functional performance. |
| **Research Impact/Earth Benefits:** | This research is directed because it contains highly constrained research. This project is in direct response to the baselined Human Research Program (HRP) Path to Risk Reduction milestone of providing updates to the NASA Fitness For Duty Standards. The new standards should be tied to fitness for duty for exploration tasks and provide a quantitative index of readiness to perform key exploration tasks. This research effort will leverage expertise based upon HRP-funded flight research investigations including Functional Tasks Test, Field Test, Standard Measures, and Manual Control, as well as MedB computerized dynamic posturography. This project will leverage critical mission tasks previously established by Ryder et al. ("A novel approach for establishing fitness standards for occupational task performance." Eur J Appl Physiol, 2019) for standards related to the risk of reduced muscle mass, strength, and endurance. This project must also leverage experience with vestibular spaceflight analogs (e.g., Galvanic vestibular stimulation, sustained 3Gx centrifugation) to characterize how the deconditioned state following G-transitions (e.g., postural instability, motion sickness, head movement restrictions) map to functional performance. |

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| **Task Progress:** | Continuation of "Development of Sensorimotor Fitness for Duty Assessments Using Ground Analogs" with Dr. Moudy as new Principal Investigator (PI). Former PI was Dr. Rosenberg. |
| **Bibliography Type:** | Description: (Last Updated: ) |