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PI Name:	Clement, Gilles Ph.D.		
Project Title:	Functional Task Tests in Partial Gravity during Parabolic Flight		
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		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	gilles.r.clement@nasa.gov	**Fax:**	FY
PI Organization Type:	NASA CENTER	**Phone:**	281-244-5720
Organization Name:	KBR/NASA Johnson Space Center		
PI Address 1:	Neurosciences Laboratory		
PI Address 2:	2400 NASA Pkwy		
PI Web Page:			
City:	Houston	**State:**	TX
Zip Code:	77058-3711	**Congressional District:**	36
Comments:			
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No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA JSC
Contact Monitor:	Stenger, Michael	**Contact Phone:**	281-483-1311
Contact Email:	michael.b.stenger@nasa.gov		
Flight Program:			
Flight Assignment:	NOTE: End date changed to 09/30/2025 per M. Stenger/NASA HHC Element Scientist and C. Ribeiro/NASA HHC (Ed., 1/12/24) NOTE: End date changed to 12/31/2022 per PI; original end date was 9/30/2021 (Ed., 5/3/21)		
Key Personnel Changes/Previous PI:	May 2023 report: Gilles R. Clément, PhD, Principal Investigator, KBR, NASA Johnson Space Center, Houston TX; Timothy Macaulay, PhD, Co-Investigator, KBR, NASA Johnson Space Center, Houston TX; Austin Bollinge, KBR, NASA Johnson Space Center, Houston TX; Scott Wood, PhD, Co-Investigator, NASA Johnson Space Center, Houston TX. Marissa Rosenberg, Ph.D. has left KBR and left the project. Austin Bollinger has joined the project - he has helped building the equipment for the experiment and will support data collection.		
COI Name (Institution):	Macaulay, Timothy Ph.D. (KBR/NASA Johnson Space Center) Wood, Scott Ph.D. (NASA Johnson Space Center) Bollinger, Austin (KBR/NASA Johnson Space Center)		
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Performance Goal No.:			

Performance Goal Text:

Task Description:

Critical mission tasks that are required by crews immediately after landing on a planetary surface include egressing from a seat, jumping, and walking. To define an effective and comprehensive countermeasure strategy for preserving crew performance during exploration-class missions, there is a need to understand how these functional tasks are performed in partial gravity, such as on the Moon or Mars.
We will analyze the execution of four critical mission tasks (Seat Egress and Walk, Recovery from Fall and Stand, Jump Down, and Tandem Stance) during the partial gravity and normal gravity phases of parabolic flight by using the same equipment and procedures as those previously used on astronauts returning from International Space Station (ISS) missions and ground-based subjects during axial body unloading. Our hypothesis is that the limits of stability for these activities will be larger when the gravity level is reduced. The largest decreases in performance are expected at the lowest gravity level (0.25 g) because subjects will no longer be able to use the gravitational reference for their perception of upright. Ultimately, this information could be used to assess performance risks and inform the design of countermeasures for NASA exploration-class human missions.

The four specific aims include:

Specific Aim 1: Seat Egress and Walk. The purpose of this test is to measure the ability to rise from a seated position and walk while avoiding obstacles to test mobility. This test is identical to the Sit-to-Stand and Walk-&-Turn test used for Standard Measures after spaceflight and bed rest. In this test, subjects are requested to rise from a seated position as quickly as possible without using their hands and walk as quickly and safely as possible straight ahead towards a cone (4 m distance), walk around the cone, then return and sit back down in the chair. On the way to and back from the cone, subjects step over a 30-cm obstacle. Two trials will be performed per parabola. A video camera records each trial and body motion (head and torso) is recorded from triaxial inertial measurement units. Performance metrics include time to complete the trial, turn rate during the turn, obstacle contact, and head-torso coordination.

Specific Aim 2: Tandem Stance. The Tandem Stance test is a standard test of static postural stability. This test is similar to the Computerize Dynamic Posturography test performed on astronauts as part of their Medical Requirements and on bed rest subjects as part of the HRP Standard Measures (Postural Equilibrium Control). In this test, at the sound of a tone subjects are instructed to stand upright in a heel-to-toe fashion with their arms crossed on their chest. This test is performed with the eyes open and with the eyes closed. A video camera records each trial and body motion (head and torso) is recorded from triaxial inertial measurement units. The maximum time (prior to taking a step) as well as the medial-lateral peak-to-peak sway angle (p-p sway) is used to quantify postural stability.

Specific Aim 3: Recovery from Fall and Stand. The purpose of this test is to measure the ability to maintain postural control after standing up from a prone position. Impairment in the ability to rise from a prone position is one of the strongest independent risk factors associated with serious fall-related injuries. In this test, subjects rest in a prone position, then stand up as quickly as possible and maintain a quiet standing position. A video camera records each trial and body motion (head and torso) is recorded from triaxial inertial measurement units. The anterior-posterior and medial-lateral peak-to-peak sway angle (p-p sway) is used to compute the equilibrium score, where 12.5 is the maximum theoretical p-p sway. This test also induces an orthostatic challenge. Therefore, heart rate is collected continuously throughout this test. This cardiovascular data is used to detect potential signs of orthostatic intolerance during this active head-up tilt test.

Specific Aim 4: Jump Down. In the Jump Down test, at the sound of a tone subjects perform a two-footed hop from a height of 30 cm onto a force plate that measures the ground reaction forces on landing. After landing, subjects are instructed to remain still on the force plate, in the standing position, with arms at their sides for 10 s. After 10s, subjects will also perform a maximal voluntary lean in one direction to quantify changes in the limits of stability at different g-levels. Two jump-down trials will be performed per parabola. A video camera records each trial and body motion (head and torso) is recorded from triaxial inertial measurement units.

Study Participants. Twelve subjects (6 male, 6 female) will be tested during 3 flights of 30 parabolas, including 10 parabolas at 0.25 g, 10 parabolas at 0.5 g, and 10 parabolas at 0.75 g. In addition, each subject will perform all the functional task tests in 1 g during the flight between parabolas when the aircraft flies straight and level.

Risk Characterization, Quantification\Evidence. This study will contribute to gap closure by providing information regarding any functional task performance deficits in partial gravity. The dose-response relationship between gravity level and task performance decrement will also help in determining the gravity threshold for these functional tasks. These functional task tests are selected to simulate critical mission tasks that crewmembers may be required to perform when they land on another planet with partial gravity.

Countermeasure\Prototype Hardware or Software. This task will contribute to gap closure by determining the gravity threshold for these functional tasks.

Rationale for HRP Directed Research:

Research Impact/Earth Benefits:

The functional tasks tests in the proposed study will challenge balance control, a function that is paramount to the efficient completion of critical mission tasks. The vestibular and sensorimotor systems play a fundamental role in balance control, and the functioning of these systems is altered during parabolic flight. Knowledge gained from the proposed study will allow us to characterize the risk of balance impairments in various partial gravity levels, thus ensuring that a more effective and comprehensive countermeasure strategy can be developed for preserving crew performance during exploration-class missions.

Task Progress:	The experiment is in its final phase of preparation. The experiment is scheduled to fly aboard a NOVESPACE Airbus A310 Zero-G aircraft on June 13-15, 2023, in Bordeaux, France. Each flight will include 30 parabolas: 10 parabolas at 0.25 g, 10 parabolas at 0.5 g, and 10 parabolas at 0.75 g. Four subjects will be tested per flight, i.e., a total of 12 subjects. The protocol and informed consent have been approved by the NASA Institutional Review Board (eIRB) and the French Ethical Committee. The physical layout and the mechanical and electrical requirements of the experiment have been approved by NOVESPACE (the operator of the aircraft) and are documented in an Experimental Safety Data Package. This document served as the basis for a Test Readiness Review (TRR) conducted at NASA Johnson Space Center in the Biomedical Research and Environmental Sciences Division. All hardware and racks have been built and inspected per requirements. The equipment is being shipped to Bordeaux and the study team is planning to arrive at NOVESPACE during the week before the flights for the installation of equipment in the aircraft. Pilot testing and safety reviews will be completed on the aircraft prior to the parabolic flights.
Bibliography Type:	Description: (Last Updated: 06/20/2023)
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