Fiscal Year:	FY 2005	**Task Last Updated:**	FY 11/22/2005
PI Name:	Bloomberg, Jacob J. Ph.D.		
Project Title:	Promoting Sensorimotor Response Generalizability: A Countermeasure to Mitigate Locomotor Dysfunction After Long-Duration Spaceflight		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Behavior and performance		
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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City:	Houston	**State:**	TX
Zip Code:	77058-3607	**Congressional District:**	36
Comments:			
Project Type:	Flight	**Solicitation / Funding Source:**	98-HEDS-02
Start Date:	05/01/2000	**End Date:**	09/30/2008
No. of Post Docs:	1	**No. of PhD Degrees:**	
No. of PhD Candidates:	0	**No. of Master' Degrees:**	
No. of Master's Candidates:	1	**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA JSC
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Flight Program:	ISS		
Flight Assignment:	ISS In flight development phase (data collection has begun) NOTE: end date changed to 9/30/2008, from 9/01/2010, per PI (10/08)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Mulavara, Ajitkumar Ph.D. (Baylor College of Medicine, National Space Biomedical Research Institute) Cohen, Helen Ph.D. (Baylor College of Medicine)		
Grant/Contract No.:	None		
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Performance Goal Text:			

Task Description:	Following space flight, astronauts experience disturbances in balance and walking control during the postflight readaptation period due in part to changes in the way the central nervous system processes sensory information as a result of exposure to microgravity. These changes can pose risks to crew safety and mission objectives if nominal or emergency vehicle egress is required immediately following space flight. At present, no operational countermeasure is available to mitigate these risks by facilitating rapid sensorimotor re-adaptation to gravitational environments. Therefore, the goal of this study is to develop an in-flight treadmill training program that facilitates recovery of locomotor function after space flight. The proposed training program is based on the concept of adaptive generalization. During this type of training the subject gains experience producing the appropriate adaptive behavior under a variety of sensory conditions and balance challenges. As a result of this training a subject learns to solve a class of balance and walking problems, rather than producing a single solution to one problem. Therefore, the subject gains the ability to "learn to learn" under a variety of conditions that challenge the balance and walking control systems. This study will develop an in-flight countermeasure built around the ISS treadmill exercise activities. By manipulating the sensory conditions of exercise (by varying visual flow patterns during walking) and modifying the task constraints (reading, head movements) this training regimen will systematically and repeatedly promote adaptive change in walking performance improving the ability of the astronaut to adapt to a novel gravity environment. It is anticipated that this training regimen will facilitate neural adaptation to planetary environments after space flight. The Mobility protocol is performed by two sets of ISS subjects comprising Control and Experimental groups. All participating subjects (Control and Experimental) perform two tests of locomotor performance both pre and postflight: the Integrated Treadmill Locomotion Test and the Functional Mobility Test. The Experimental Group will also perform the in-flight training protocol throughout the increment and an inflight test of Dynamic Visual Acuity. Comparisons will then be made between recovery rates in the Control vs. Experimental groups. Operational Protocols: Pre and Postflight Testing Locomotor function in both Control and Experimental groups will be assessed before and after space flight using two tests of gait function. The Integrated Treadmill Locomotion Test characterizes alterations in the integrated function of multiple sensorimotor sub-systems. This test calls for subjects to walk on a motorized treadmill while we assess changes in dynamic postural stability, head-trunk coordination, visual acuity and lower limb coordination strategies. The Functional Mobility Test provides a corresponding assessment of the functional and operational changes in locomotor function by testing subject's ability to negotiate an obstacle course placed over a medium-density foam floor. Test 1: Integrated Treadmill Locomotion Test Subjects walk at 6.4 km/h on a motorized treadmill while performing a visual task consisting of identifying the position of the gap in the letter "C" that is presented centrally on a laptop computer positioned 4 meters in front at eye level. Each trial lasts approximately 30 seconds and is repeated four times. Subjects also walk at 6.4 km/h on the treadmill while performing the same visual task described above but in this case with the letter "C" is presented centrally on a micro-display positioned 50 centimeters in front at eye level. Each of these trials last approximately 30 seconds and are repeated four times. While subjects are walking on the treadmill and performing the visual task 3-dimensional full-body motion data are acquired using a video-based motion analysis system; gait cycle timing is measured using foot switches placed in the shoes and dynamic visual acuity is assessed by the visual task described above. Test 2: Functional Mobility Test Subjects walk at a preferred pace through an obstacle course set up on a base of 10 cm thick medium density foam. The foam provides an unstable surface that increases the challenge of the test. The 6.0 m X 4.0 m course consist of several pylons and obstacles made of foam. Subjects are instructed to walk through the course as fast as possible without touching any of the objects on the course. This task is repeated three times in the clockwise direction and 3 times in the counterclockwise direction. The dependent measures are time to complete the course and the number of obstacles touched or knocked down. Variable Training Protocol (done on orbit during regular treadmill exercise): Using a visual display (Mobility Graphics Display, MGD) mounted at eye level over the ISS treadmill (TVIS, Treadmill with Vibration and Isolation System), crewmembers will see a visual representation of a virtual scene varying in yaw, pitch and roll motions. Subjects will be exposed to this stimulus during the 10 minute warm up and cool down period of their regular treadmill exercise period. The goal of this study is to develop an in-flight treadmill training program designed to improve adaptability of balance and gait function facilitating recovery of functional mobility after long-duration space flight. Following space flight, crewmembers have trouble standing and walking. The magnitude and duration of post-flight instability increases with longer exposure to microgravity and can pose a risk to crew safety and to mission objectives if normal or emergency exit is required immediately following space flight. Presently, no operational countermeasure is available to mitigate these balance and locomotor disturbances. This study proposes to develop a unified, multi-disciplinary countermeasure system designed to enhance post-flight adaptive locomotor function that can be easily integrated with the existing International Space Station (ISS) treadmill procedures, without requiring more commitment of valuable crew resources. If successful, this experiment will provide methods for impoving postflight functional mobility.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	As people age on Earth, they sometimes experience instabilities in standing and walking. The development of unique walking and balance training procedures like the ones proposed in this study can be used to help prevent falling and injury in the elderly population. An associated study being conducted at the University of Texas Medical Branch, funded by the NASA Graduate Student Research Program, is currently investigating this issue.

Task Progress:	We have collected pre and postflight locomotion data from the Expeditions 5, 6 7, 8, 9, 10 and 11 crews who will serve as part of the control group for this study. We have collected preflight data for the Expeditions 12 crews. We are also currently developing the inflight visual display system (Mobility Graphics Display), Dynamic Visual Acuity Measurement System and associated software. We have also developed a Joint Research Protocol with our colleagues from the Institute of Biomedical Problems, Moscow, Russia to integrate the experimental operations of the Russian study “Locomotion” with that of Mobility.
Bibliography Type:	Description: (Last Updated: 06/03/2025)
Abstracts for Journals and Proceedings	Bloomberg, J.J.;Mulavara A.P.; Cohen H.S.;Richards J.T.; Miller C.A.;Peters B.T.;Marshburn A.;Brady R.A "Patterns of recovery in locomotor function following long-duration spaceflight" Barany Society XXIII International Congress, Paris, France none , Jul-2004
Abstracts for Journals and Proceedings	Bloomberg J.J.;Mulavara A.P.;Peters, B.T.;Cohen H.S.;Richards, J.T.;Miller, C.A. Brady R, Warren L.E "Development of an inflight countermeasure to mitigate postflight gait dysfunction" NASA Bioastronautics Meeting, Galveston, TX None , Jan-2005
Abstracts for Journals and Proceedings	Bloomberg, J.J.;Mulavara A.P.;Peters, B.T.;Cohen H.S.;Richards J.T.; Miller C.A., Brady R, Warren L. ". Development of training programs to mitigate post space flight gait dysfunction" American College of Sports Medicine Annual Meeting, Nashville, TN None , Jun-2005
Abstracts for Journals and Proceedings	Buccello, R.R., Cromwell, R.L., Bloomberg, J.J "The effects of sensorimotor adaptation training on functional mobility in older adults" Gerontological Society of America's 58th Annual Scientific Meeting, Orlando, FLA None , Nov-2005
Articles in Peer-reviewed Journals	Richards JT, Mulavara AP, Bloomberg JJ. "Postural stability during treadmill locomotion as a function of the visual polarity and rotation of a three-dimensional virtual environment." Presence, 2004 Jun;13(3):371-84. http://dx.doi.org/10.1162/1054746041422299 , Jun-2004