Fiscal Year:	FY 2012	**Task Last Updated:**	FY 04/16/2012
PI Name:	Bloomberg, Jacob J. Ph.D.		
Project Title:	Physiological Factors Contributing to Postflight Changes in Functional Performance (Functional Task Test)		
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		
PI Email:	jacob.j.bloomberg@nasa.gov	**Fax:**	FY 281-244-5734
PI Organization Type:	NASA CENTER	**Phone:**	281-483-0436
Organization Name:	NASA Johnson Space Center		
PI Address 1:	NASA Emeritus Scientist, Biomedical Research and Environmental Sciences Div		
PI Address 2:	2101 NASA Parkway, SK272		
PI Web Page:			
City:	Houston	**State:**	TX
Zip Code:	77058-3607	**Congressional District:**	36
Comments:			
Project Type:	FLIGHT	**Solicitation / Funding Source:**	Directed Research
Start Date:	06/19/2008	**End Date:**	05/05/2015
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**No. of Master' Degrees:**	0
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA JSC
Contact Monitor:	Norsk, Peter	**Contact Phone:**	
Contact Email:	Peter.norsk@nasa.gov		
Flight Program:	Shuttle/ISS		
Flight Assignment:	ISS NOTE: End date changed to 5/5/2015 and Risk/Gaps changed per JSC MTL dtd 11/11/11 (Ed., 11/18/2011) NOTE: End date changed to 3/17/2014 (previously 9/30/13) per JSC (2/2010)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Feeback, Daniel (NASA Johnson Space Center) Feiveson, Alan (NASA Johnson Space Center) Lee, Stuart (Wyle Laboratories/NASA Johnson Space Center) Mulavara, Ajitkumar (USRA) Peters, Brian (Wyle Labs/NASA Johnson Space Center) Platts, Steven (NASA Johnson Space Center) Reschke, Millard (NASA Johnson Space Center) Ryder, Jeffrey (USRA) Spiering, Barry (Wyle Labs/NASA Johnson Space Center) Stenger, Michael (Wyle Labs/NASA Johnson Space Center) Ploutz-Snyder, Lori (USRA)		
Grant/Contract No.:	Directed Research		

Performance Goal No.:	
Performance Goal Text:	
Task Description:	Exposure to space flight causes alterations in multiple physiological systems including changes in sensorimotor, cardiovascular, and neuromuscular systems. These changes can affect the ability of crewmembers to perform critical mission tasks immediately after landing on a planetary surface. The overall goal of this project is to determine the effects of space flight on functional tests that are representative of critical mission tasks and to identify the key underlying physiological factors that contribute to decrements in performance. To achieve this goal we developed an interdisciplinary testing regimen (Functional Task Test, FTT) that evaluates both astronaut functional performance and related physiological changes. A set of functional tests were designed to test astronauts in tasks that simulate high priority exploration mission activities. These include ladder climbing, hatch opening, jump down, manual manipulation of objects and tool use, emergency vehicle egress, recovery from a fall and object translation tasks. Corresponding physiological measures include assessments of postural and gait control, dynamic visual acuity, fine motor control, plasma volume, orthostatic intolerance, upper- and lower-body muscle strength, power, endurance, control, and neuromuscular drive. Crewmembers were tested before and after Shuttle missions. Currently astronauts are participating in this study before and after ISS flights. Data were collected on two sessions before flight, on landing day (Shuttle only) and 1, 6 and 30 days after landing. Using a multivariate regression model we will identify which physiological systems contribute the most to impaired performance on each functional test. This will allow us to identify the physiological systems that play the largest role in decrement in functional performance. Using this information we can then design and implement countermeasures that specifically target the physiological systems most responsible for the altered functional performance associated with space flight.
Rationale for HRP Directed Research:	This research is directed because it contains highly constrained research, which requires focused and constrained data gathering and analysis that is more appropriately obtained through a non-competitive proposal.
Research Impact/Earth Benefits:	This study will identify which physiological systems contribute the most to impaired performance on mission critical functional tasks. This will allow us to identify the physiological systems that play the largest roles in decrements in overall functional performance. Using this information we can design and implement countermeasures that specifically target the physiological systems most responsible for the altered functional performance associated with space flight. In terms of Earth benefits this research will provide a better understanding of the underlying physiological mechanisms that contribute to changes in functional performance. For example, in the elderly population activities of daily living are often impaired by mutifactorial physiological causes. The information obtained from this interdisciplinary study will aid in identifying the relative contributions of sensorimotor, cardiovascular, and muscle function on comprehensive performance outcomes. This has direct application in the design of clinical interventions and rehabilitation programs that can target specific systems responsible for decline in functional performance.
Task Progress:	Summary of Progress - To date we have completed data collection on 7 Shuttle crewmembers and 4 ISS crewmembers (13 planned). - 7 additional ISS subjects in data collection phase. - Completed all Shuttle crew individual data debriefs. - Selected to be featured in the 2011 Annual Report for the Human Research Program. - Completed and submitted Shuttle Interim FTT Report (79 pages). - Presented Shuttle FTT data at the Human System Risk Board (March 28, 2012). - To data have completed 2 peer reviewed papers and 23 abstracts/presentations Summary of Preliminary Observations from Shuttle Subjects 1) Functional tests that required dynamic control of postural equilibrium to complete (Seat Egress and Walk, Recovery from Fall, Rock Translation, Jump Down) demonstrated the greatest postflight changes in performance. Functional Tests with reduced requirements for postural stability (Torque Generation, Ladder Climb) showed less reduction in performance. For these tests posture was stabilized while the task was being performed. In the Torque Generation Test posture was stabilized because the subject completed the task while gripping the hatch like wheel device. In the Ladder Climb Test postural instability was minimized because subjects performed the task with four points of stabilization (i.e. both hands and legs). 2) Sensorimotor tests sensitive to the vestibular component underlying postural and gait control showed the largest postflight alterations (Dynamic Posturography Test, Tandem Walk Test, Treadmill Locomotion/Dynamic Visual Acuity Test). Tests of fine motor control and force steadiness control did not change after space flight. Therefore, the observed changes in functional performance were linked to postflight alterations in vestibular function leading to decrement in performance for tasks with greater requirements for dynamic postural equilibrium control. 3) Astronauts showed postflight elevated heart rates and sympathovagal balance (an indication of the relative influence of the sympathetic and parasympathetic branches of the autonomic nervous system on the control of heart rate) during the Recovery from Fall/Stand Test while parasympathetic activity was decreased. This result indicates a postflight shift toward sympathetic activation and vagal withdrawal on R+0. Similarly, heart rate was consistently elevated during performance of all the other functional tests. There was no change in blood pressure at rest or during standing in the Recovery from Fall/Stand Test. There was also no change in plasma volume in this group of astronauts although previous investigators have reported that plasma volume is reduced after space flight. The lack of change in plasma volume for this study could have resulted from improved in-flight countermeasure compliance, stricter adherence to the fluid loading protocol, or medical intervention prior to testing. Importantly, the observations of elevated heart rate and

	altered autonomic responses during post-flight functional testing are more striking in that they are less likely to be linked solely to a decrease in plasma volume. 4) The muscle performance data indicate significant reductions in the leg press performance metrics of maximal isometric force, power, and total work. Bench press total work was also significantly impaired, although maximal isometric force and power were not significantly affected. No overall changes were noted for measurements of central activation or force steadiness. The muscle performance data show reductions in lower body muscle performance metrics and these alterations are likely contributors to impaired functional tasks that are ambulatory in nature. Interestingly, no changes in central activation capacity were detected. Therefore, impairments in muscle function in response to short-duration space flight are likely myocellular rather than neuromotor in nature. 5) Forward work includes completing data collection on ISS subjects (n=13). Once all the data are collected we will be able to create a multivariate regression model to describe the relationship between the physiological changes associated with space flight and decrement in functional task performance along with a comparison of recovery rates between short and long-duration crewmembers. This will allow is to identify the prime physiological factors that contribute most to alteration in functional task performance. This information will then be used to inform the design of targeted countermeasure systems to mitigate these physiological changes leading to improved task performance.
Bibliography Type:	Description: (Last Updated: 05/21/2021)
Abstracts for Journals and Proceedings	Ryder JW, Buxton RE, Redd E, Scott-Pandorf M, Hackney KJ, Fiedler J, Ploutz-Snyder R, Bloomberg JJ, Ploutz-Snyder LL. "Analysis of skeletal muscle metrics as predictors of functional task performance." American College of Sports Medicine 58th Annual Meeting, Denver, CO, May 31-June 4, 2011. Medicine & Science in Sports & Exercise. 2011 May;43(5 Suppl):821. http://dx.doi.org/10.1249/01.MSS.0000402287.01913.47 , May-2011
Abstracts for Journals and Proceedings	Miller CA, Peters BT, Feiveson A, Bloomberg JJ. "Functional Data Analysis of Spaceflight-Induced Changes in Coordination and Phase in Head Pitch Acceleration during Treadmill Walking." Progress in Motor Control VIII Meeting, Cincinnati, OH, July 21-23, 2011. Progress in Motor Control VIII Meeting, Cincinnati, OH, July 21- 23, 2011. http://homepages.uc.edu/~rileym/PMC/PMCVIIIPosterAbstracts.pdf , Jul-2011
Abstracts for Journals and Proceedings	Reschke MF, Fisher EA, Kofman IS, Cerisano JM, Harm DL, Bloomberg JJ. "Walk on floor eyes closed test: A unique test of spaceflight induced ataxia." Space Forum 2011 – Dedicated to the 50th Anniversary of the First Human Space Flight by Yury Gagarin, Moscow, Russia, October 18-21, 2011. Space Forum 2011 – Dedicated to the 50th Anniversary of the First Human Space Flight by Yury Gagarin, Moscow, Russia, October 18-21, 2011. , Oct-2011
Abstracts for Journals and Proceedings	Reschke MF, Harm DL, Kofman IS, Wood SJ, Bloomberg JJ. "A simple postflight measure of postural ataxia in astronauts." Space Forum 2011 – Dedicated to the 50th Anniversary of the First Human Space Flight by Yury Gagarin, Moscow, Russia, October 18-21, 2011. Space Forum 2011 – Dedicated to the 50th Anniversary of the First Human Space Flight by Yury Gagarin, Moscow, Russia, October 18-21, 2011. , Oct-2011
Abstracts for Journals and Proceedings	Reschke MF, Kofman IS, Cerisano JM, Fisher EA, Peters BT, Harm DL, Bloomberg JJ. "Jump-down performance alterations after space flight." The 32nd Annual International Gravitational Physiology Meeting and 27th Annual American Society for Gravitational and Space Biology Meeting, San Jose, CA, November 2-6, 2011. Program and Abstracts. The 32nd Annual International Gravitational Physiology Meeting and 27th Annual American Society for Gravitational and Space Biology Meeting, San Jose, CA, November 2-6, 2011. p. 60-61. , Nov-2011
Abstracts for Journals and Proceedings	Bloomberg JJ, Arzeno NM, Buxton RE, Feiveson AH, Kofman IS, Lee SMC, Miller CA, Mulavara AP, Peters BT, Phillips T, Platts SH, Ploutz-Snyder LL, Reschke MF, Ryder JW, Spiering BA, Stenger MB, Taylor LC, Wickwire PJ, Wood SJ. "Functional Task Test: 1) Sensorimotor changes associated with postflight alterations in astronaut functional task performance." 2012 NASA Human Research Program Investigators' Workshop, Houston, TX, February 14–16, 2012. 2012 NASA Human Research Program Investigators' Workshop, Houston, TX, February 14–16, 2012. , Feb-2012
Abstracts for Journals and Proceedings	Phillips TR, Arzeno NM, Stenger MB, Stuart SMC, Bloomberg JJ, Platts SH. "Functional Task Test: 2) Spaceflight-induced cardiovascular changes and recovery during NASA's Functional Task Test." 2012 NASA Human Research Program Investigators' Workshop, Houston, TX, February 14–16, 2012. 2012 NASA Human Research Program Investigators' Workshop, Houston, TX, February 14–16, 2012. , Feb-2012
Abstracts for Journals and Proceedings	Ryder JW, Wickwire PJ, Buxton RE, Bloomberg JJ, Ploutz-Snyder L. "Functional Task Test: 3) Skeletal muscle performance adaptations to space flight." 2012 NASA Human Research Program Investigators' Workshop, Houston, TX, February 14–16, 2012. 2012 NASA Human Research Program Investigators' Workshop, Houston, TX, February 14–16, 2012. , Feb-2012
Abstracts for Journals and Proceedings	Ploutz-Snyder L, Ryder J, Buxton R, Redd E, Scott-Pandorf M, Hackney K, Fiedler J, Ploutz-Snyder R, Bloomberg JJ. "Thresholds of muscle strength below which function is impaired." 2012 NASA Human Research Program Investigators' Workshop, Houston, TX, February 14–16, 2012. 2012 NASA Human Research Program Investigators' Workshop, Houston, TX, February 14–16, 2012. , Feb-2012
Articles in Peer-reviewed Journals	Arzeno NM, Stenger MB, Bloomberg JJ, Platts SH. "Spaceflight-induced cardiovascular changes and recovery during NASA's Functional Task Test." Acta Astronautica. 2013 Nov;92(1):10-4. http://dx.doi.org/10.1016/j.actaastro.2012.05.023 (originally reported as "in press" as of April 2012.) , Nov-2013