Fiscal Year:	FY 2005	**Task Last Updated:**	FY 06/22/2005
PI Name:	Young, Laurence R. Sc.D.		
Project Title:	Neurovestibular aspects of short-radius artificial gravity: Toward a comprehensive countermeasure		
Division Name:	Human Research		
Program/Discipline:	NSBRI Teams		
Program/Discipline--Element/Subdiscipline:	NSBRI Teams--Sensorimotor Adaptation Team		
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:	Cambridge	**State:**	MA
Zip Code:	02139-4301	**Congressional District:**	8
Comments:	Deceased as of August 2021.		
Project Type:	GROUND	**Solicitation / Funding Source:**	2003 Biomedical Research & Countermeasures 03-OBPR-04
Start Date:	04/01/2004	**End Date:**	03/31/2007
No. of Post Docs:	1	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**No. of Master' Degrees:**	2
No. of Master's Candidates:	2	**No. of Bachelor's Degrees:**	7
No. of Bachelor's Candidates:	7	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:	0		
COI Name (Institution):	Natapoff, Alan (Massachusetts Institute of Technology) Oman, Charles (Massachusetts Institute of Technology) Cohen, Bernard (Mount Sinai School of Medicine) Dai, Mingjia (Mount Sinai School of Medicine) DiZio, Paul (Brandeis University) Hecht, Heiko (Massachusetts Institute of Technology) Mast, Fred (Massachusetts Institute of Technology) Jarchow, Thomas (Massachusetts Institute of Technology) Newby, Nathaniel (Wyle Laboratories)		
Grant/Contract No.:	NCC 9-58-NA00406		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Artificial gravity (AG), produced by centrifugal force on a rotating spacecraft or an on-board centrifuge, is a promising general countermeasure to the debilitating effects of weightlessness. However, high speed rotation above 180 deg/sec., is necessary to produce 1-g or more on a short radius (1.5-3m) centrifuge. Any astronaut head movement not parallel to the plane of rotation can induce strong cross-coupled spatial disorientation, motion sickness, postural disturbance and non-stabilizing compensatory eye movements. This project addresses the issues of adaptation to Coriolis forces and cross-coupled accelerations in accordance with the artificial gravity aim of the NSBRI's Neurovestibular Adaptation Team. The goal of this project is to understand the side-effects caused by cross-coupled stimulation that produce motion sickness and could interfere with cognitive and motor function. A further goal is to develop efficient means of adapting astronauts safely to repeated transitions into and out of AG without excessive motion sickness. Basic understanding of the roles played by vestibular and other sensors in adaptation to unusual environments, and the associated disorientation and motion sickness, will contribute to astronaut comfort and safety in all phases of flight. Fundamental studies of the process of sensory-motor adaptation and practical means of controlling motions sickness and sway during rotation are combined in our 5 Specific Aims. 1) Acquisition, Generalization and Retention of Adaptation (MIT). 2) Cognitive Influences on Adaptation, and Effects of AG on Human Performance (JSC and MIT). 3) Spatial Orientation as Influenced by AG (MIT and Brandeis). 4) Adaptation of Postural Sway during AG (Brandeis). 5) Effectiveness of Baclofen in Controlling Motion Sickness by Shortening the Vestibulo-Ocular Reflex Time Constant. Human rotators spinning about an earth vertical axis provide the stimuli for each investigation: a rotating bed at MIT, an on-axis chair at Mt. Sinai, a 3m radius rotating room at Brandeis, and a 1.5m centrifuge at JSC. Measurements are made of compensatory eye movements, dynamic visual acuity, reading comprehension, illusory body motions, subjective motion sickness and postural sway.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Head movements in a moving or rotating environment, such as boats, airplanes, and automobiles often provoke symptoms of motion sickness or other discomfort. The ability to control susceptibility to motion sickness by controlling the central time constant of the vestibular system is a major advance and has broad application on Earth.
Task Progress:	Specific Aim 1: Acquisition, Generalization and Context-Specificity of Adaptation 46 subjects were tested for transfer of pitch head turn adaptation to yaw head turn adaptation. Performing additional yaw head turns within a protocol that adapts subjects to pitch head turns does not interfere with the pitch adaptation. 15 subjects participated in a incremental 5-day protocol. All of the subjects were less motion sick. 21 subjects were tested on the effect that the amount head turn has: A head turn about an angle of 30 deg is less provocative and less intense than a head turn about 60 deg or 90 deg. The adaptive effects induced by our newly standardized protocol (MIT & JSC) were tested with a control group of six subjects. A pilot test series with six subjects for the 6-month study was started. We adapted six subjects to left yaw head turns and re-tested them doing right head turns. A preliminary analysis indicates a limited transfer of adaptation from left to right. Six subjects were adapted to right yaw head turns 37 cm off-center. The data analysis is still in progress. Also six subjects were adapted to radial movements while rotating. No effect on adaptation for head turns in the right quadrant was found. The hardware alterations that allow us to spin at 30 rpm were finished in December 2004. Safety checks and testing 30 rpm protocols are planned for February 2005, and we expect experiments spinning at 30 rpm starting in March 2005. Specific Aim 2: AG and Cognition: Effects of Cross-Coupled Stimulation (CCS) on Performance and Influence of Cognition on Adaptation to AG Planning and preparation of experiments has finished (December 2004.) Experiments will begin in February or March 2005. Specific Aim 3: Does Cross-Coupled Stimulation (CCS) Interfere with Spatial Orientation? Preliminary testing of the SVV-device took place in November, and a first series of experiments in December 2005. At present we have run 10 subjects and have partially analyzed their data. Specific Aim 4: Adaptation of whole-body movements: experiments in a slow rotation room Ten subjects have been tested in three different sessions apiece, in balanced order, at least two weeks apart. Each session involved 5 pre-, 20 per- and 10 post-rotation (10 rpm) trials, 20 s per trial. The results of these experiments promise to yield guidelines for prescribing whole-body exercises to which astronauts can adapt quickly, to avoid risks of falling of incurring injury due to lateral joint stress and unwanted transfer to other tasks. Specific Aim 5: Reduction of the Vestibular Time Constant as a Countermeasure against Motion Sickness. Six subjects were on seven days for 1 hour tested after they had been treated with placebo and 10, 20, and 30mg baclofen. The analysis for VOR time constants is almost done for all tested subjects and we are still analyzing the data of the VOR gain and the velocity storage coupling gain.
Bibliography Type:	Description: (Last Updated: 02/08/2021)
Dissertations and Theses	Bruni, S. "Artificial Gravity: Neurovestibular Adaptation to Incremental Exposure to Centrifugation. Master of Science in Aeronautics and Astronautics at the MASSACHUSETTS INSTITUTE OF TECHNOLOGY" 1-172 , Sep-2004
Dissertations and Theses	Garrick-Bethell, I. "Cross plane transfer of vestibular adaptation to human centrifugation. " Master of Science in Aeronautics and Astronautics at the MASSACHUSETTS INSTITUTE OF TECHNOLOGY" 1-161 , Jun-2004
Presentation	Dai, M.; Kunin, M.; Raphan, T.; Cohen, B. "Using baclofen as a countermeasure against motion sickness. " Sep-2004
Presentation	Di Zio, P. "Aim 4, Rationale and proposed work. " Sep-2004
Presentation	Garrick-Bethell, I.; Hecht, H.; Jarchow, T.; Young, L. R. "Aim 1: Generalization. " Sep-2004
Presentation	Jarchow, T. "Adaptation to head movements during short radius centrifugation. " Sep-2004
Presentation	Jarchow, T., Young, L. R. "Adaptation to head movements during short radius centrifugation. " Oct-2004
Presentation	Mast, F.; Newby, N. "Cognitive Influences and Artificial Gravity (Part I, Introduction). " Sep-2004
Presentation	Newby, N.; Mast, F. "Cognitive Influences and Artificial Gravity (Part II, Project Presentation). " Sep-2004
Presentation	Young, L. R. "Artifical Gravity " Oct-2005
Presentation	Young, L. R. "Neurovestibular Aspects of Artificial Gravity. " Sep-2004

Presentation	Young, L. R.; Oman, C. M.; Jarchow, T.; Natapoff, A.; Hecht , H.; Cohen, B.; Dai, M.; Di Zio, P.; Mast, M.; Newby, N. "Neurovestibular Aspects of Short-radius Artificial Gravity: Toward a Comprehensive Countermeasure. " Oct-2005