Fiscal Year:	FY 2008	**Task Last Updated:**	FY 08/27/2008
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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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:**	04/30/2008
No. of Post Docs:	1	**No. of PhD Degrees:**	1
No. of PhD Candidates:	1	**No. of Master' Degrees:**	2
No. of Master's Candidates:	1	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:	NOTE: Element/Risk/Gap edits per HRP Master Task List information dtd 3/14/2012 (Ed., 4/13/12) NOTE: Received NCE to 4/30/2008 per K. Major/NSBRI (3/08)		
Key Personnel Changes/Previous PI:			
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) Jarchow, Thomas (Massachusetts Institute of Technology) Newby, Nathaniel (Wyle Laboratories) Mast, Fred (University of Lausanne)		
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 stimulation resulting in 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 Sensorimotor Adaptation Team. The goal is to develop efficient means of adapting astronauts safely to repeated transitions into and out of AG without excessive motion sickness. Another 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. 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 flight and after landing. Fundamental studies of the process of sensory-motor adaptation and practical means of controlling motions sickness and sway during rotation are combined in our Specific Aims. In the final year of this project we focused on the theme: Acquisition, Generalization and Retention of Adaptation. We have been able to demonstrate that, with sufficient training, most subjects can tolerate head movements while rotating at speeds up to 30 rpm. The adaptation process is achievable by incremental adjustment of either centrifuge speed, head turn angle or head turn speed. Furthermore, we demonstrate the effectiveness of sleep in consolidating the adaptation. In addition to the adaptation studies we have explored the effects of exercise on the centrifuge. Finally, we introduced a potentially valuable clinical method for increasing peripheral circulation in the feet during artificial gravity. We intend to continue investigation of this clinical application following termination of the current project. We also intend to explore the effect of gravity gradients in AG on the cardiovascular system through multi-segment dynamic models and experiments.
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. Understanding motor adaptation to Coriolis forces in an artificial gravity environment is relevant for understanding clinical deficits of whole body movement on earth, because normal body movements generate large inter-segmental Coriolis forces. Our preliminary results showing an increase in ankle level arterial pressure give promise for the utilization of AG or other related techniques to increase peripheral circulation to the feet, and to help relieve the symptoms felt by diabetics and other patients.
Task Progress:	Aim 1: To test for the effects that are induced by the head turn during AG protocol 8 subjects have been tested as control group, not receiving adaptive stimulation. 24 subjects have been tested as normative group adapted to right head turns only. 24 subjects have been tested for the left/right head turn experiments. 24 subjects have been adapted to a 3-day incremental protocol. 24 subjects have been tested to determine the effect of angle by which the head is turned and centrifuge velocity. 7 subjects have completed the 6-month retest, looking for long term retention of adaptation. Various theses and papers are in preparation or completed. Additionally, a controlled test of three adaptation sessions was conducted with a variation of the sleep period. We demonstrated the effectiveness of sleep in consolidating the previously acquired adaptation to head movements while rotating. Finally, a test was conducted to assess the increase in the ratio of blood pressure at the ankle to that at heart level during artificial gravity. The results support a clinical spin-off of artificial gravity for the improvement of peripheral circulation.
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