Fiscal Year:	FY 2006	**Task Last Updated:**	FY 01/08/2007
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:**	04/30/2008
No. of Post Docs:	2	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**No. of Master' Degrees:**	8
No. of Master's Candidates:	4	**No. of Bachelor's Degrees:**	14
No. of Bachelor's Candidates:	7	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:	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) 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 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 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(MSSM). 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. Understanding motor adaptation to Coriolis forces in an artificial gravity environment is relevant for understanding clinical deficits of complex whole body movement on earth.
Task Progress:	Aim 1: To test for the effects that are induced by the protocol 8 subjects have been tested as a control group, not receiving adaptive stimulation. 24 subjects have been tested as a 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 for 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 thesis and papers are completed. Aim 2: 24 subjects have been successfully tested, data analysis almost finished, paper in preparation Aim 3: Preliminary testing of the SVV-device (subjective visual vertical) 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. Aim 4: The Year 1 sub-aim, which was to compare effects of rotation on quiet stance or voluntary postural oscillations during 10 rpm rotation in the center of a rotating room, was completed. Rotation initially increased sway during both tasks. Over 20 quiet stance trials, sway magnitude did not return to baseline, but in voluntary rocking trials the trajectory of body sway returned to baseline Catch trials showed that adaptation to rocking transferred to quiet stance but there was no transfer in the reverse direction. We have also conducted the experiment for our Year 2-3 sub-aim, which was to expose naïve subjects simultaneously to the vestibular and motor perturbations of posture during rotation or expose them sequentially to vestibular then motor perturbations. The data are being analyzed, and it appears motor adaptation occurs at the same rate in both conditions. Aim 5: The efficacy of 10, 20 and 30 mg baclofen on reduction of vestibular time constant and the coupling gain to velocity storage was tested. 6 subjects were tested and the results were published. Ongoing experiments test for the effect of 20 mg baclofen on resistance to motion sickness. Seven supine subjects performed head roll movements while spinning at 138°/s were tested with and without baclofen treatment. Preliminary data indicates that subjects made considerable more head movements with baclofen.
Bibliography Type:	Description: (Last Updated: 02/08/2021)
Articles in Peer-reviewed Journals	Dai M, Raphan T, Cohen B. "Effects of baclofen on the angular vestibulo-ocular reflex." Exp Brain Res. 2006 May;171(2):262-71. Epub 2005 Dec 8. PMID: 16341527 , May-2006
Articles in Peer-reviewed Journals	Edmonds, J L , T Jarchow, and L R Young. "Implementation and validation of a stair-stepper on a short radius centrifuge." Aviation, space, and environmental medicine . Submitted for Publication. , Jan-2006
Articles in Peer-reviewed Journals	Elias, P Z, T Jarchow, and L R Young. "Modeling Sensory Conflict and Motion Sickness in Artificial Gravity." Acta Astronautica . Submitted for Publication. , Jan-2006
Articles in Peer-reviewed Journals	Adenot S, Jarchow T, Young LR. "Adaptation of VOR to Coriolis stimulation." Ann N Y Acad Sci. 2005 Apr;1039:88-96. PMID: 15826964 , Apr-2005
Articles in Peer-reviewed Journals	Bakshi, A, P Di Zio, and Lackner, J R . "Goal oriented rocking in a rotating environment." Experimental Brain Research . Submitted for Publication. , Jan-2006
Articles in Peer-reviewed Journals	Jarchow, T and L Young. "Parameters determining neurovestibular daptation to short-radius artificial gravity." Acta Astronautica . Submitted for Publication. , Jan-2006
Articles in Peer-reviewed Journals	Kurtzer I, DiZio PA, Lackner JR. "Adaptation to a novel multi-force environment." Exp Brain Res. 2005 Jul;164(1):120-32. Epub 2005 Apr 16. PMID: 15834711 , Jul-2005
Awards	"Laurence R. Young, Fellow of the American Institute for Medical and Biological Engineering (AIMBE)." Jan-2006

Awards	"Laurence R. Young, Inaugural Fellow of the Biomedical Engineering Society." Jan-2006
Awards	"Laurence R. Young, Roberto Rocca Grantee (MIT- Politecnico di Milano)." Jan-2006
Papers from Meeting Proceedings	Jarchow T, Young L. "Neurovestibular adaptation to short radius centrifugation." 26th Annual Gravitational Physiology Meeting, Cologne, Germany, June 26-July 1, 2005. Journal of Gravitational Physiology. 2005 Jul;12(1):P11-4. , Jul-2005