Fiscal Year:	FY 2009	**Task Last Updated:**	FY 09/13/2010
PI Name:	Serrador, Jorge Manuel Ph.D.		
Project Title:	Vestibular-Cerebrovascular Interactions and Their Contribution to Post-Spaceflight Orthostatic Intolerance		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Physiology		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HHC**:Human Health Countermeasures		
Human Research Program Risks:	None		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Comments:			
Project Type:	Ground	**Solicitation / Funding Source:**	2003 Biomedical Research & Countermeasures 03-OBPR-04
Start Date:	08/16/2004	**End Date:**	08/23/2009
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	1	**No. of Master' Degrees:**	0
No. of Master's Candidates:	1	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA JSC
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:	NOTE: Received NCE to 08/23/2009 per J. Dardano/JSC (8/08)		
Key Personnel Changes/Previous PI:	None		
COI Name (Institution):	Black, Owen (Legacy Health System) Lipsitz, Lewis (Hebrew Rehabiliation Center for Aged) Schlegel, Todd (NASA Johnson Space Center) Wood, Scott (Naval Aerospace Medical Research Laboratory)		
Grant/Contract No.:	NNJ04HI13G		
Performance Goal No.:			
Performance Goal Text:			
Task Description:	Post-spaceflight orthostatic intolerance, a principal NASA safety concern, is a complex multi-factorial problem that continues to be poorly understood. Recent evidence clearly suggests that the vestibular otolith system, which is directly affec spaceflight, assists in both autonomic and blood pressure regulation during orthostatic stress. Vestibular activation has also has direct effects on cerebral blood flow suggesting that vestibular inputs also affect the cerebrovascular response to orthostasis. The goal of this research is to examine the role of vestibular inputs in cerebral blood flow regulation and the effect of these inputs on orthostatic tolerance. Our general hypothesis is that otolith mediated vestibular inputs act as a fe forward mechanism causing cerebral vasodilation to compensate for the decrease in cerebral perfusion pressure during the upright posture. This project's four specific aims are to: 1) Determine the effect of tilts in the pitch plane with and with visual feedback on cerebral blood flow and cerebral autoregulation in healthy elderly with and without vestibular hypofunction and healthy young subjects.; 2) Determine the effect of otolith vs otolith and canal stimulation on cerebral blood f healthy elderly with and without vestibular hypofunction and healthy young subjects. This aim will be accomplished by varying the radius of rotation of subjects on a short arm centrifuge; 3) Determine the effect of canal vs canal and otolith stimulation on cerebral blood flow in elderly subjects with normal and reduced vestibular function. This aim will be accomplished by using earth vertical axis rotations vs. head tilt while supine or prone; 4) Determine the effect of training sub associate otolith input as tilt on cerebral blood flow during orthostatic stress in elderly subjects with intact and impaired vestibular function. This aim will be accomplished by training subjects with tilt or centrifugation to interpret otolith signa either translation or tilt by providing visual scenes to reinforce this perception. The results of these studies will provide direct evidence on the role of vestibular inputs in cerebrovascular regulation. This work may lead to new methods to diagr and treat not only post-spaceflight orthostatic intolerance but also the ~500,000 otherwise healthy subjects that are affected by orthostatic intolerance.		
Rationale for HRP Directed Research:			
Research Impact/Earth Benefits:	Understanding the causes of orthostatic intolerance will directly benefit two groups of individuals. First, elderly individuals have increased risks of falls which are associated with decreased quality of life and increased mortality. Falls are the l cause of death for older adults. In fact, Almost 11,000 older adults a year, or 30 each day, die from a falls injury. Half of those who survive a fall never return to their prior level of mobility or independence. By reducing the likelihood that an individual will fall due to light headedness, i.e. orthostatic intolerance, we will be able to improve the quality of life and reduce the rate of fall induced mortality in this group, a significant advance for the aging population. In addition, almost 500,000 Americans suffer from orthostatic intolerance, often with poor treatment outcomes. Currently a possible vestibular role for orthostatic intolerance is not considered. This research could not only highlight a new cause of orthostatic intolerance but lead to new treatments including vestibular rehabilitation, etc.		

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Task Progress:	Introduction: Post spaceflight orthostatic intolerance is an important NASA safety concern with as many as 60% of returning astronauts experiencing symptoms of cerebral hypoperfusion. While the mechanisms underlying this problem are likely multifact the goal of this research is to examine the role of vestibular inputs in cerebral blood flow regulation and the effect of these inputs on orthostatic tolerance. Our general hypothesis is that otolith mediated vestibular inputs act as a feed forward mechanism causing cerebral vasodilation to compensate for the decrease in cerebral perfusion pressure caused by the upright posture. We proposed four specific aims to address this hypothesis. Specific Aim 1: Determine the effect of orthostatic stress (tilts) on cerebral blood flow and cerebral autoregulation in elderly subjects with intact and impaired vestibular function. The purpose of this aim was to determine whether the vestibul system plays an important role in the changes in cerebral blood flow when you go from a supine to upright. Major Finding: Loss of vestibular function in both younger and older subjects is associated with greater decreases in cerebral blood flow when upright. Implications for Human Spaceflight: 1) Sensorimotor disturbances related to adaptation to microgravity are common among astronauts and may result in greater drops in cerebral blood flow when astronauts are upright upon returning to a 1-G environment Specific Aim 2: Determine the effect of static otolith stimulation on cerebral blood flow. The purpose of this aim was to determine whether continual stimulation of the otoliths without associated canal or other sensorimotor cues affects cereb blood flow. This aim was accomplished by performing centrifugation to selectively stimulate the otoliths. Major Finding: Changes in cerebral blood flow were consistent during otolith stimulation, even in the absence of other cues of tilt. Implications for Human Spaceflight: 1) Vestibular adaptations that occur during spaceflight could result in reduced otolith inputs and maladaptive cerebral blood flow responses. Since cerebral blood flow changes occur during otolith stimulat the absence of other cues of tilt, astronauts may be at greatest risk for orthostatic intolerance post spaceflight if other sensory cues of upright are missing to replace impaired otolith cues. Specific Aim 3: Determine the effect of dynamic canal plus otolith vs otolith stimulation on cerebral blood flow. This aim was accomplished by examining cerebral blood during both centrifugation (otolith stimulation) vs dynamic pitch tilt (o and canal stimulation) in a group of young subjects with intact vestibular function. Major Finding: Changes in cerebral blood flow were mediated primarily by otolith activation. Implications for Human Spaceflight: 1) Since vestibular adaptation to microgravity involves changes in interpretation of otolith and not canal cues, this further supports the possibility that changes in otolith inputs could cause problems in cere blood flow regulation Specific Aim 4: Determine the effect of training subjects to associate otolith input as tilt on cerebral blood flow during orthostatic stress in elderly subjects with intact and impaired vestibular function. The goal of this aim is to determine if enh vestibular function could be used as a countermeasure to improve cerebral blood flow when upright. Major Finding: Stimulation of the vestibular nerve with subsensory stochastic noise causes improvement in both vestibular function and cerebral blood flow responses to tilt. Implications for Human Spaceflight: 1) Greater reductions in cerebral blood flow associated with reduced vestibular function post spaceflight could be reduced by stimulation of the vestibular nerve
Bibliography Type:	Description: (Last Updated: 10/31/2019)
Abstracts for Journals and Proceedings	Serrador JM, Lipsitz L, Black FO, Wood SJ. "Decreases in Cerebral Blood Flow When Upright Are Related to Vestibular Function Regardless of Age." Presented at Experimental Biology 2009, New Orleans, LA, April 18-22, 2009. FASEB Journal 2009 Apr;23(1):613.35. http://www.fasebj.org/cgi/content/meeting_abstract/23/1_MeetingAbstracts/613.35?maxtoshow=&hits=10&RESULTFORMAT=&fulltext=serrador&searchid=1&FIRSTINDEX=0&volume=23&issue=1_MeetingAbstracts&resourcetype=HW , Apr-2009
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Articles in Peer-reviewed Journals	Serrador JM, Deegan BM, Geraghty MC, Wood SJ. "Enhancing vestibular function in the elderly with imperceptible electrical stimulation." Sci Rep. 2018 Jan 10;8(1):336. https://doi.org/10.1038/s41598-017-18653-8 ; PubMed PMID: 29321 PubMed Central PMCID: PMC5762876 , Jan-2018
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