Fiscal Year:	FY 2016	**Task Last Updated:**	FY 11/30/2015
PI Name:	Hayman née Anderson, Allison Ph.D.		
Project Title:	Feasibility of DPOAE Mapping as an In-Flight Measure of Intracranial Pressure in Space		
Division Name:	Human Research		
Program/Discipline:	NSBRI		
Program/Discipline--Element/Subdiscipline:	NSBRI--Smart Medical Systems and Technology Team		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	None		
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:	NOTE: name change to Hayman née Anderson (Ed., March 2025). PI moved to University of Colorado from Dartmouth College in early 2017.		
Project Type:	Ground	**Solicitation / Funding Source:**	2014 NSBRI-RFA-14-02 First Award Fellowships
Start Date:	11/01/2014	**End Date:**	10/31/2016
No. of Post Docs:	1	**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:	4	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Buckey, Jay M.D. (MENTOR/ Dartmouth College)		
Grant/Contract No.:	NCC 9-58-PF04103		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	POSTDOCTORAL FELLOWSHIP This project focuses on assessing distortion product otoacoustic emissions (DPOAE) as a non-invasive measure of intracranial pressure changes. The long-term interaction between intracranial pressure (ICP) and the ocular globe may cause visual acuity changes in spaceflight. However, there is no noninvasive, easy-to-perform, on-orbit measure of ICP to test this hypothesis. Changes in DPOAE responses have been shown to correlate with changes in ICP, potentially making DPOAEs very useful as a proxy measure. The technique used here, DPOAE level/phase mapping (DPOAE L/P maps), collects DPOAE data at multiple sites throughout the cochlea and so provides a comprehensive picture of cochlear responses to ICP changes. We will statistically assess DPOAE L/P maps as a tool to measure ICP noninvasively by isolating the effects of fluid shifts and changes in hydrostatic gradients--two separate response mechanisms--by altering body position (hydrostatic gradients) and lower body pressure (fluid shift). We also consider time as a relevant variable in each of these postures. In conjunction with this work, we will also be collecting measures of cerebrovascular flow, ocular geometry/structures, middle ear status, and cardiovascular function to look for anatomical and physiological predictors for changes in the DPOAE L/P maps. This work will be done in conjunction with an existing National Space Biomedical Research Institute (NSBRI)-funded set of experiments, Cranial Venous Modeling (CA03401). This study will provide a novel way to make detailed DPOAE level/phase mapping measurements in association with multiple ocular and cranial vascular measurements. Specific Aim 1: Create DPOAE level/phase maps to characterize changes as a result of the isolated effects of fluid shifts and alterations in hydrostatic gradients. During the reporting year, we have collected DPOAE level/phase maps in two experiments. Eight subjects were asked to lie in the supine and prone positions for an hour and two maps were collected (at 30 minutes and 45 minutes). We also performed a parabolic flight experiment with 14 subjects. In this experiment, pared-down maps were collected seated, and immediately upon entering the supine, prone, and microgravity conditions. We are beginning a 3rd experiment where ten subjects will experience lower body negative and positive pressure in both the supine and prone positions. In this way, the individual effects of time, gravitational direction, and fluid shifts on the DPOAE L/P maps can be isolated. Specific Aim 2: Determine the DPOAE L/P map response signature to fluid shifts and hydrostatic gradient changes. Statistical analysis thus far has focused on amplitude maps. Data from ten subjects in the prolonged posture study were analyzed for differences from the seated baseline. Regions within the cochlea most sensitive to DPOAE amplitude changes were found. These regions are consistent with regions most sensitive to changes in stapes velocity and basilar membrane stiffness. Further analysis is ongoing for parabolic flight experimental data. Several statistical strategies have been identified to analyze DPOAE phase data. Due to its cyclical response, phase data may be broken down into characteristic parameters using two-dimensional Fourier transforms. The coefficients of the characteristic equations in different postures may be analyzed using the F test. Specific Aim 3: Explore the relationship between ocular and cranial vascular measurements to changes seen in DPOAE level/phase maps. In conjunction with each experiment, additional ocular measures were taken, including intraocular pressure (IOP), choroidal area, and ocular geometry such as axial length and aqueous depth. Data from both the prolonged and acute posture studies indicate hydrostatic gradients, tissue offloading, and aqueous humor dynamics are contributing factors beyond fluid shift to change ocular structures. Future experiments will include data on cerebrohemodynamics taken with MRI (magnetic resonance imaging).
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	A non-invasive, easy to administer measure of ICP is useful for patients with idiopathic intracranial hypertension, a population of patients with elevated ICP resulting in similar visual acuity and structural changes seen in astronauts. It could also be a useful monitoring tool for patients with traumatic brain injury and hydrocephalus. The technology is easy to use, noninvasive, and can be quickly administered, allowing multiple measurements to be taken so changes in ICP can be easily tracked over time. Our DPOAE mapping hardware is also used for evaluating hearing loss in patients with high noise exposure, such as members of the Navy, and with pathology, such as ototoxicity for cancer patients and HIV. Current studies include subjects in Tanzania, China, Washington DC, and New Hampshire.
Task Progress:	Specific Aim 1: Create DPOAE level/phase maps to characterize changes as a result of the isolated effects of fluid shifts and alterations in hydrostatic gradients. During the reporting year, we have collected DPOAE level/phase maps in two experiments. Eight subjects were asked to lie in the supine and prone positions for an hour and two maps were collected (at 30 minutes and 45 minutes). We also performed a parabolic flight experiment with 14 subjects. In this experiment, pared-down maps were collected seated, and immediately upon entering the supine, prone, and microgravity conditions. We are beginning a 3rd experiment where ten subjects will experience lower body negative and positive pressure in both the supine and prone positions. In this way, the individual effects of time, gravitational direction and fluid shifts on the DPOAE L/P maps can be isolated. Specific Aim 2: Determine the DPOAE L/P map response signature to fluid shifts and hydrostatic gradient changes. Statistical analysis thus far has focused on amplitude maps. Data from ten subjects in the prolonged posture study were analyzed for differences from the seated baseline. Regions within the cochlea most sensitive to DPOAE amplitude changes were found. These regions are consistent with regions most sensitive to changes in stapes velocity and basilar membrane stiffness. Further analysis is ongoing for parabolic flight experimental data. Several statistical strategies have been identified to analyze DPOAE phase data. Due to its cyclical response, phase data may be broken down into characteristic parameters using two-dimensional Fourier transforms. The coefficients of the characteristic equations in different postures may be analyzed using the F test. Specific Aim 3: Explore the relationship between ocular and cranial vascular measurements to changes seen in DPOAE level/phase maps. In conjunction with each experiment, additional ocular measures were taken, including intraocular pressure (IOP), choroidal area, and ocular geometry such as axial length and aqueous depth. Data from both the prolonged and acute posture studies indicate hydrostatic gradients, tissue offloading, and aqueous humor dynamics are contributing factors beyond fluid shift to change ocular structures. Future experiments will include data on cerebrohemodynamics taken with MRI.
Bibliography Type:	Description: (Last Updated: 03/26/2025)

Abstracts for Journals and Proceedings	Anderson A, Buckey J, Swan J, Fellows A, Phillips S, Kattamis NT, Klaus DA, Zegans ME. "Ocular and Cerebrovascular Changes in Microgravity." 86th Scientific Meeting of the Aerospace Medical Association, Lake Buena Vista, Florida, May 10-14, 2015. Aerospace Medicine and Human Performance. 2015 Mar;86(3):280. See http://www.ingentaconnect.com/content/asma/amhp/2015/00000086/00000003/art00010 for searching table of contents; accessed 12/2/15. , Mar-2015
Abstracts for Journals and Proceedings	Anderson AP, Fellows AM, Buckey JC. "Feasibility of DPOAE Mapping as an In-Flight Measure of Intracranial Pressure in Space." 2015 NASA Human Research Program Investigators' Workshop, Galveston, TX, January 13-15, 2015. 2015 NASA Human Research Program Investigators' Workshop, Galveston, TX, January 13-15, 2015. , Jan-2015
Abstracts for Journals and Proceedings	Anderson AP, Fellows AM, Buckey JC. "DPOAE Mapping as a Measure of Cochlear Sensitivity to Postural Changes." Association for Research in Otolaryngology 39th MidWinter Meeting, San Diego, CA, February 20-24, 2016. Association for Research in Otolaryngology 39th MidWinter Meeting, San Diego, CA, February 20-24, 2016. In press as of September 2015. , Sep-2015
Abstracts for Journals and Proceedings	Anderson AP, Swan JG, Phillips SD, Kattamis NT, Knaus DA, Zegans ME, Fellows AM, Buckey JC. "Effect of posture and microgravity on the eye and cranial vascular system." 2015 NASA Human Research Program Investigators' Workshop, Galveston, TX, January 13-15, 2015. 2015 NASA Human Research Program Investigators' Workshop, Galveston, TX, January 13-15, 2015. , Jan-2015
Papers from Meeting Proceedings	Anderson A, Newman D. "Pressure Characterization Between the Upper Body and Space Suit During Mission-Realistic Movements." 2015 IEEE Aerospace Conference, Big Sky, MT, March 7-14, 2015. In: 2015 IEEE Aerospace Conference, March 2015. http://dx.doi.org/10.1109/AERO.2015.7119174 , Mar-2015