

<b>Fiscal Year:</b>	FY 2017	<b>Task Last Updated:</b>	FY 01/24/2018
<b>PI Name:</b>	Buckey, Jay C. M.D.		
<b>Project Title:</b>	Autonomous Behavioral Health Countermeasures for Spaceflight		
<b>Division Name:</b>	Human Research		
<b>Program/Discipline:</b>	NSBRI		
<b>Program/Discipline--Element/Subdiscipline:</b>	NSBRI--Neurobehavioral and Psychosocial Factors Team		
<b>Joint Agency Name:</b>	<b>TechPort:</b>	Yes	
<b>Human Research Program Elements:</b>	(1) <b>HFBP</b> :Human Factors & Behavioral Performance (IRP Rev H)		
<b>Human Research Program Risks:</b>	(1) <b>Bmed</b> :Risk of Adverse Behavioral Conditions and Psychiatric Disorders		
<b>Space Biology Element:</b>	None		
<b>Space Biology Cross-Element Discipline:</b>	None		
<b>Space Biology Special Category:</b>	None		
<b>PI Email:</b>	<a href="mailto:jav.buckey@dartmouth.edu">jav.buckey@dartmouth.edu</a>	<b>Fax:</b>	FY 603-650-6013
<b>PI Organization Type:</b>	UNIVERSITY	<b>Phone:</b>	603-650-6012
<b>Organization Name:</b>	Dartmouth College		
<b>PI Address 1:</b>	Department of Medicine		
<b>PI Address 2:</b>	1 Medical Center Drive		
<b>PI Web Page:</b>			
<b>City:</b>	Lebanon	<b>State:</b>	NH
<b>Zip Code:</b>	03756-0001	<b>Congressional District:</b>	2
<b>Comments:</b>	Address updated 9/2008		
<b>Project Type:</b>	GROUND	<b>Solicitation:</b>	2013 HERO NNJ13ZSA002N-Crew Health (FLAGSHIP & NSBRI)
<b>Start Date:</b>	06/01/2014	<b>End Date:</b>	05/31/2017
<b>No. of Post Docs:</b>	2	<b>No. of PhD Degrees:</b>	0
<b>No. of PhD Candidates:</b>	0	<b>No. of Master' Degrees:</b>	0
<b>No. of Master's Candidates:</b>	0	<b>No. of Bachelor's Degrees:</b>	1
<b>No. of Bachelor's Candidates:</b>	7	<b>Monitoring Center:</b>	NSBRI
<b>Contact Monitor:</b>	<b>Contact Phone:</b>		
<b>Contact Email:</b>			
<b>Flight Program:</b>			
<b>Flight Assignment:</b>	NOTE: Element change to Human Factors & Behavioral Performance; previously Behavioral Health & Performance (Ed., 1/18/17)		
<b>Key Personnel Changes/Previous PI:</b>			
<b>COI Name (Institution):</b>	Hegel, Mark Ph.D. ( Dartmouth College ) Loeb, Lorie M.A. ( Dartmouth College )		
<b>Grant/Contract No.:</b>	NCC 9-58-NBPF03801		
<b>Performance Goal No.:</b>			
<b>Performance Goal Text:</b>			

Over several years with National Space Biomedical Research Institute (NSBRI) support, the investigator team (in collaboration with others) has developed a suite of behavioral health countermeasures called the Virtual Space Station (VSS) designed for use by astronauts. The programs include conflict management training, depression treatment, and stress management modules. Each of these modules has been tested in relevant settings: The conflict content has been tested for usability and acceptability with astronauts. The stress management module has been evaluated in a randomized trial with business and law students. The 6-session, depression treatment module has been tested in a Phase II trial at Dartmouth with depressed employees, and in a randomized controlled trial in Boston. Currently, the VSS contains a validated suite of products that have been designed for ultimate use by astronauts. Our objective is to expand and customize the VSS for implementation with astronauts to provide a clinically validated tool to autonomously administer behavioral health countermeasures.

During this reporting year, we have made progress on each of our three specific aims:

**Aim #1:** Customize the Virtual Space Station (VSS) program for use by astronauts by evaluating the program in an isolated environment and collecting detailed information on program use, including user choices, ease of navigation, usability, and acceptability.

In this reporting year we have deployed the VSS in three space analog environments: The Hawaii Space Exploration Analog and Simulation (HI-SEAS) Mars Analog IV and V missions, the Canada Forces Alert Arctic Station, and the South Pole Station in Antarctica for use as a treatment resource. Each of these environments is isolated and confined with limited communication and access to the outside world. Our results from the HI-SEAS III mission were published this year.

#### Task Description:

**Aim #2:** Modify the existing VSS conflict management program to add enhanced conflict resolution content and an integrated behavioral health assessment. We have designed and built the integrated behavioral health assessment and it is currently being used in the HI-SEAS V mission. We have also expanded the VSS Conflict resolution content with a new module on interest-based negotiation. The module teaches negotiation techniques in an interactive scenario to guide users through techniques for achieving better conflict outcomes. This module is being evaluated at HI-SEAS V and at the South Pole station. The VSS has been converted to a web-based format, with the Conflict and Depression modules fully converted, and the Stress module conversion underway. The program has been placed on a permanent, secure server so it can be hosted online. This allows greater flexibility and easier deployment, as well as alleviating compatibility and continuity issues.

**Aim #3:** Enhance the VSS program to include a mood enhancement system that allows users to experience immersive relaxing situations using virtual reality. We have developed several virtual reality scenes in-house: Fall in New England, an Urban Retreat filmed around Houston public spaces, an indoor Control scene for experimental evaluation, a Boston scene, a Hawaii scene, a scene on Gile mountain, an evening pond scene, a rendered forest relaxation scene, a kittens scene, a scene in a park, a winter dog scene, and a rendered daytime lake scene with and without animals. We have also purchased several natural scenes filmed in Ireland, Bavaria, and Australia. All VR films greater than 15 minutes in length are on deployment in our analog environments. We have also performed a lab-based evaluation using physiologic measures to validate the use of VR for stress reduction and relaxation. The results from this laboratory evaluation were published this year.

#### Rationale for HRP Directed Research:

Anyone can develop behavioral health problems. Factors such as confinement, under- or over- work, sleep loss, and monotony can combine to worsen interpersonal tensions or even lead to frank depression. Additionally, behavioral health problems are some of the most common and costly problems in the workplace. Conflicts can arise with a resulting loss of trust and teamwork. A chronic dispute between people can destroy team functioning and lead to errors or lack of situational awareness. Suppressed anger or frustration can erupt unexpectedly and create potentially hazardous situations. Programs that can deliver behavioral health countermeasures autonomously, confidentially, and at a place and time of the user's choosing, would have many applications. Computer-based behavioral health countermeasures can offer an autonomous way for anyone to address psychological and interpersonal issues. Content within the VSS has been tested in trials with business and law students, and with depressed adults. The depression program has been evaluated for acceptability for an elderly population. The VSS provides a personalized experience seen in live therapies, while also lowering the barrier to use by being convenient and removing stigma. Furthermore, these kinds of treatments can be implemented in many different environments where there is limited access to behavioral health, such as in military, polar, or culturally-isolated settings. Virtual reality offers immersive experiences that mimic real-life exposure to nature and other relaxing settings. The final product from this research will provide an integrated, autonomous approach to behavioral health. The assessment component will begin with the assumption that the any issues are minor and transient, and can guide the user to a variety of options both within and outside of the program (movies/distraction, music, meals, photo/hobby, call home, VR retreat). For moderate severity problems, the program includes a variety of self-assessment tools the user can try, and offers programs to assist with conflict and/or stress management. For high-severity problems, the program includes a validated 6-session depression treatment program based on problem solving treatment.

#### Research Impact/Earth Benefits:

1. Completed the conversion of the Virtual Space Station (VSS) to an online format.
2. Published the results from the evaluation of the VSS at HI-SEAS III.
3. Deployed the VSS and virtual reality components to HI-SEAS IV and HI-SEAS V.
4. Completed deployment of VSS and virtual reality to Canadian Forces Station Alert.
5. Deployed VSS and virtual reality components to the South Pole Station for use as a treatment resource.
6. Completed the Integrated Behavioral Health Assessment and deployed it to HI-SEAS V.
7. Completed the new module on Interest-Based Negotiation and deployed it to HI-SEAS V.
8. Published the laboratory evaluation of the virtual reality component.
9. Developed new virtual reality content for deployment to HI-SEAS V and South Pole Station.

#### Task Progress:

	10. Results from HI-SEAS IV and Canada Alert deployment being prepared for publication.
<b>Bibliography Type:</b>	Description: (Last Updated: 04/16/2019)
<b>Abstracts for Journals and Proceedings</b>	Anderson A, Cowan D, Fellows A, Binsted K, Hegel MT, Buckey J. "Autonomous Behavioral Health Countermeasures: Virtual Space Station." 2017 NASA Human Research Program Investigators' Workshop, Galveston, TX, January 23-26, 2017. 2017 NASA Human Research Program Investigators' Workshop, Galveston, TX, January 23-26, 2017. , Jan-2017
<b>Abstracts for Journals and Proceedings</b>	Anderson A, Fellows A, Hegel MT, Buckey J. "Virtual Reality with Natural Scenes to Reduce Stress in Isolated Confined Environments." International Society for Gravitational Physiology (ISGP), European Space Agency (ESA), Centre National d'Etudes Spatiales (CNES) Joint Life Science Meeting 'Life in Space for Life on Earth,' Toulouse, France, June 5-10, 2016. International Society for Gravitational Physiology (ISGP), European Space Agency (ESA), Centre National d'Etudes Spatiales (CNES) Joint Life Science Meeting 'Life in Space for Life on Earth,' Toulouse, France, June 5-10, 2016. , Jun-2016
<b>Abstracts for Journals and Proceedings</b>	Cowan D, Anderson A, Buckey J, Fellows A, Binsted K, Love R. "Evaluation of virtual nature for relaxation in isolated, confined environments." 88th Aerospace Medical Association Annual Meeting, Denver, CO, April 30-May 4, 2017. Aerospace Medicine and Human Performance. 2017;88(3):271. , Mar-2017
<b>Articles in Peer-reviewed Journals</b>	Anderson AP, Fellows AM, Binsted KA, Hegel MT, Buckey JC. "Autonomous, computer-based behavioral health countermeasure evaluation at HI-SEAS Mars Analog." Aerospace Medicine and Human Performance. 2016 Nov;87(11):912-20. <a href="https://">https://</a> ; PubMed <a href="https://pubmed.ncbi.nlm.nih.gov/27779949/">PMID: 27779949</a> , Nov-2016
<b>Articles in Peer-reviewed Journals</b>	Anderson AP, Mayer MD, Fellows AM, Cowan DR, Hegel MT, Buckey JC. "Relaxation with immersive natural scenes presented using virtual reality." Aerospace Medicine and Human Performance. 2017 Jun;88(6):520-6. <a href="https://">https://</a> ; PubMed <a href="https://pubmed.ncbi.nlm.nih.gov/28539139/">PMID: 28539139</a> , Jun-2017
<b>Articles in Peer-reviewed Journals</b>	Sandoval LR, Buckey JC, Ainslie R, Tombari M, Stone W, Hegel MT. "Randomized controlled trial of a computerized interactive media-based problem solving treatment for depression." Behavior Therapy. 2017 May;48(3):413-25. Epub 2016 May 3. <a href="http://dx.doi.org/">http://dx.doi.org/</a> ; <a href="https://pubmed.ncbi.nlm.nih.gov/28390503/">PMID:28390503</a> , May-2017
<b>Awards</b>	Buckey JC. (Jay C. Buckey) "Jeffrey P. Sutton Scientific Achievement Award, May 2016." May-2016
<b>Significant Media Coverage</b>	Koppel N, Capezzer N, Shastri V. "Life on Mars: Mirages of Earth. Article about HI-SEAS work and including PI's research." New York Times, May 31, 2017. <a href="https://">https://</a> , May-2017