Fiscal Year:	FY 2022	**Task Last Updated:**	FY 06/07/2022
PI Name:	Simpson, Richard Ph.D.		
Project Title:	Promoting Behavioral Health, Cognitive, Sensorimotor and Immune Function Using Guided Imagery to Augment Exercise Training in an Isolated and Confined Spaceflight Analog Environment		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HFBP**:Human Factors & Behavioral Performance (IRP Rev H)		
Human Research Program Risks:	(1) **BMed**:Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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PI Organization Type:	UNIVERSITY	**Phone:**	713-397-0121
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City:	Tucson	**State:**	AZ
Zip Code:	85721-0001	**Congressional District:**	3
Comments:	NOTE: Formerly at University of Houston until September 2017 move to University of Arizona.		
Project Type:	FLIGHT	**Solicitation / Funding Source:**	2017-2018 HERO 80JSC017N0001-HHCHFBP: Human Health Countermeasures, Human Factors, Behavioral Performance. Appendix D
Start Date:	08/05/2019	**End Date:**	06/30/2023
No. of Post Docs:	3	**No. of PhD Degrees:**	3
No. of PhD Candidates:	5	**No. of Master' Degrees:**	1
No. of Master's Candidates:	2	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	2	**Monitoring Center:**	NASA JSC
Contact Monitor:	Whitmire, Alexandra	**Contact Phone:**	
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Flight Program:			
Flight Assignment:	NOTE: End date changed to 06/30/2023 per NSSC information (Ed., 3/3/23) NOTE: End date changed to 01/31/2023 per NSSC information (Ed., 3/10/21)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Germain, Anne Ph.D. (University of Pittsburgh) Gordon, Judith Ph.D. (University of Arizona) Connaboy, Christopher Ph.D. (University of Pittsburgh)		
Grant/Contract No.:	80NSSC19K1480		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Operating in isolated, confined, and controlled (ICC) or extreme (ICE) environments impacts physical status, psychological symptoms, and cognitive function, all serving to degrade crew performance and jeopardize mission success. Countermeasures, such as exercise training help to reduce such risk, but individuals are still susceptible to problems adapting to and operating in ICC/ICE environments. Physical training has been shown to have positive benefits on cognitive and immune functions, and psychological status of individuals. However, importantly, increased stress levels have been shown to substantially limit individual engagement with these types of physical activity. Therefore, to ensure the efficacy of a physical training countermeasure, strategies need to be developed to ensure crewmembers maintain sufficient levels of training stimuli to provide these protective effects, while in the presence of the increased levels of stress associated with operating in ICC/ICE environments. The overarching hypothesis of this proposal is that structured exercise training performed in an isolated and confined spaceflight analog will ameliorate stress-induced changes in behavioral health, cognitive, sensorimotor, and immune system function. We further posit that adding a guided imagery (GI) intervention component to the exercise training regimen will increase exercise adherence and positive affective responses, and that the beneficial effects of exercise on behavioral health, cognitive, and immune system function will be mediated by reductions in stress and improvements/maintenance of physical health. The specific aims are as follows: SA1. Determine the effects of an in-flight validated exercise regimen ('SPRINT') on behavioral health, fatigue, cognitive, sensorimotor, and immune system function in an ICC spaceflight analog; SA2. Determine the impact of guided imagery on exercise adherence and positive affective responses to exercise in the ICC spaceflight analog. We will also explore the effects of adding guided imagery to the exercise regimen on behavioral health, fatigue, cognitive, sensorimotor, and immune system function; SA3. Determine if exercise training, with or without guided imagery, has a positive impact on biomarkers of stress and central nervous system function in the ICC spaceflight analog and can increase resilience during an acute stress model of sleep deprivation relative to the control group. We will use the Human Exploration Research Analog (HERA) and recruit crewmembers over 12 separate 45-day HERA missions. We anticipate enrolling participants from 3 campaigns (4 crewmembers per mission) over a 3-year period (n= 48). Four HERA missions (n=16) will receive the in-flight validated Integrated Aerobic and Resistance Exercise Training Prescription ('SPRINT') protocol only; Four HERA missions (n=16) will receive the same training regimen but with GI to augment the exercise response; And four HERA missions (n=16) will serve as the control group, receiving access to the exercise equipment but no GI or 'SPRINT' protocol. Measures of behavioral health, cognitive, sensorimotor, and immune (NK-cell cytotoxicity) function will be measured before, during, and after the mission, and the mediating/correlating effects of stress and central nervous system function will be determined by measuring biomarkers (cortisol, dehydroepiandrosterone (DHEA), Macrophage Inflammatory Protein (MIP), brain-derived neurotrophic factor (BDNF)) longitudinally in saliva. On completion of this project we expect to: (1) determine if the 'SPRINT' protocol is sufficient to maintain behavioral health of individuals during a spaceflight stress analog; and (2) ascertain whether or not the addition of a GI can augment the exercise training effects on ameliorating stress (including acute stress derived from sleep deprivation) and central nervous system dysfunction to maintain behavioral health, cognitive, sensorimotor, and immune system function in a high fidelity, isolated, confined, and controlled spaceflight simulation analog.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This project will increase understanding of how exercise training can offset the deleterious effects of isolation and confinement stress on immune system dysfunction and detriments in behavioral health. This has multiple applications to life on Earth, particularly in light of global lock-down procedures that were implemented during the COVID-19 pandemic.
Task Progress:	The PHETI study was initiated in 2019 but experienced significant delays due to the COVID-19 pandemic. Whilst waiting on The Human Exploration Research Analog (HERA) Campaign 6 to begin, the study team focused on identifying psychological 'targets' that could manipulated through guided imagery to improve exercise adherence. This involved an extensive review of the literature which resulted in a completed MS thesis by student Jamie Lee-Elliot (advisors: Judith Gordon and Richard Simpson). This thesis is currently being re-formatted for publication in a scientific journal. HERA Campaign 6 Mission 1 began in October 1st 2021. We successfully performed data collection on all participants (n=4) as outlined in our study protocol. Similarly, Mission 2 was completed in March 2022 and data collection was successfully performed on all participants (n=4). Bio specimens collected from the crew have been transferred to the University of Arizona for analysis, which is currently ongoing. Mission 3 of Campaign 6 is ongoing at the time of submitting this task book report. The study will be complete when data has been collected and analyzed from all HERA crewmembers participating in Campaign 6, 7 and 8.
Bibliography Type:	Description: (Last Updated: 09/27/2023)
Articles in Peer-reviewed Journals	Batatinha H, Baker FL, Smith KA, Zúñiga TM, Pedlar CR, Burgess SC, Katsanis E, Simpson RJ. "Recent COVID-19 vaccination has minimal effects on the physiological responses to graded exercise in physically active healthy people. " J Appl Physiol. 2022 Jan 25;132(2):275-82. https://doi.org/10.1152/japplphysiol.00629.2021 ; PMID: 34882029 PMCID: PMC8799387 , Jan-2022
Articles in Peer-reviewed Journals	Krieger SS, Zwart SR, Mehta S, Wu H, Simpson RJ, Smith SM, Crucian B. "Alterations in saliva and plasma cytokine concentrations during long-duration spaceflight." Front Immunol. 2021 Aug 24;12:725748. https://doi.org/10.3389/fimmu.2021.725748 ; PMID: 34504500; PMCID: PMC8422944 , Aug-2021
Articles in Peer-reviewed Journals	Simpson RJ, Boßlau TK, Weyh C, Niemiro GM, Batatinha H, Smith KA, Krüger K. "Exercise and adrenergic regulation of immunity." Brain Behav Immun. 2021 Oct;97:303-18. https://doi.org/10.1016/j.bbi.2021.07.010 ; PMID: 34302965 , Oct-2021

Articles in Peer-reviewed Journals	Simpson RJ, Pawelec G. "Is mechanical loading essential for exercise to preserve the aging immune system?" Immun Ageing. 2021 Jun 5;18(1):26. https://doi.org/10.1186/s12979-021-00238-9 , Jun-2021
Articles in Peer-reviewed Journals	Simpson RJ, Katsanis E. "The immunological case for staying active during the COVID-19 pandemic. " Brain Behav Immun. 2020 Jul;87:6-7. https://doi.org/10.1016/j.bbi.2020.04.041 ; PMID: 32311497; PMCID: PMC7165095 , Jul-2020
Articles in Peer-reviewed Journals	Baker FL, Smith KA, Zúñiga TM, Batatinha H, Niemiro GM, Pedlar CR, Burgess SC, Katsanis E, Simpson RJ. "Acute exercise increases immune responses to SARS CoV-2 in a previously infected man." Brain Behav Immun Health. 2021 Dec;18:100343. https://doi.org/10.1016/j.bbih.2021.100343 ; PMID: 34514439; PMCID: PMC8423674 , Dec-2021