Fiscal Year:	FY 2023	**Task Last Updated:**	FY 06/01/2023
PI Name:	Diaz Artiles, Ana Ph.D.		
Project Title:	Effects of Altered-Gravity on Perception and Bi-manual Coordination: Impacts on Functional Performance		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
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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Zip Code:	77843-0001	**Congressional District:**	17
Comments:			
Project Type:	FLIGHT,GROUND	**Solicitation / Funding Source:**	2019 HERO 80JSC019N0001-FLAGSHIP & OMNIBUS: Human Research Program Crew Health. Appendix A&B
Start Date:	08/01/2020	**End Date:**	07/31/2024
No. of Post Docs:		**No. of PhD Degrees:**	
No. of PhD Candidates:	4	**No. of Master' Degrees:**	
No. of Master's Candidates:	1	**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NASA JSC
Contact Monitor:	Stenger, Michael	**Contact Phone:**	281-483-1311
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Flight Program:	Parabolic		
Flight Assignment:	NOTE: End date changed to 7/31/2024 per NSSC information (Ed., 6/15/22) NOTE: End date changed to 7/31/2022 per NSSC information (Ed., 7/6/21)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Dunbar, Bonnie Ph.D. (Texas A&M University) Kennedy, Deanna Ph.D. (Texas A&M University)		
Grant/Contract No.:	80NSSC20K1499		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Many of the activities associated with spaceflight require individuals to use both limbs simultaneously to accomplish the task. Motor control, as well as visual performance and spatial orientation are disrupted by gravitational transitions between 1 G and 0 G, but very little is known about the sensorimotor deficits between 0 G and 1 G. The objective of this analog-based research effort is to investigate the impact of partial G-levels on bimanual coordination tasks that are operationally relevant for spaceflight. The same set of human subjects will participate in two different bimanual coordination tasks during parabolic flight, which will deliver G-levels of 0, 0.25, 0.5, 0.75, 1, and 1.8 G. Sensorimotor dose-response curves will be generated between bimanual coordination operational variables as a function of G-level, and G-thresholds (which indicate when performance decrements occur) will be determined. We will also quantify the risk associated with the use of a common motion sickness drug (promethazine) during bimanual coordination tasks. Results will provide critical information for current and future countermeasure development and in-flight prescriptions.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This project investigates the influence of gravity on bimanual coordination using a variety of altered-gravity analogs. Results will provide critical information for current and future sensorimotor-related countermeasures and in-flight prescription. In addition, this research effort has direct application to bimanual coordination tasks on Earth, for example during complex tasks that require a coordinated two-limb movement, as well as for rehabilitation purposes.
Task Progress:	At the end of year 3, we are in final preparations for the parabolic flight. We have continued to work with NASA and Novespace throughout this phase, providing the necessary inputs from our science and, in general, any aspect of our experiment. In collaboration with Novespace, we have continued to refine our experiment, experiment protocol, and flight schedule, and we have also conceived our final experimental apparatus (i.e., customizing chairs provided by Novespace with our necessary hardware and software) to be used by our subjects during the parabolic flights. The NASA Institutional Review Board (IRB) was updated in the Spring of 2023 following the small adjustments in the protocol. We have also updated and renewed the TAMU IRB paperwork. In addition, we have also worked with Novespace on the necessary paperwork for the French IRB. Since Fall 2022 we have been preparing and finalizing all the operational aspects involved in the upcoming parabolic flight campaign. We have worked closely with Novespace during the development of the Experimental Safety Data Package (ESDP) document to ensure that all safety and operational constraints have been accounted for. Safety considerations include physical volume, mass, electricity, fire, vibration, electromagnetic fields, light, odors, and noise considerations, as well as operational considerations such as positioning and stowage. The current experimental design and team readiness reflect a flexibility to adapt to complications such as airsickness among participants or experimenters, hardware and software anomalies, or any changes to the campaign schedule due to unforeseen events such as inclement weather or aircraft maintenance. In addition, to practice our operations during parabolic flight, we have designated floor space in our lab to match the dimensions of our designated area of the Airbus 310 cabin, hardware mounting rails, seats, and baseplates. This has allowed us to iterate our protocol checklists and practice anomaly resolution in as similar an environment as we can without the actual aircraft. Thus, the experimental hardware, software, and the experimental protocol have undergone extensive testing during our weekly rehearsals. Minor bugs have been corrected and optimization adjustments have been made to arrive at a final detailed experimental protocol. Following the submission of this report, we are eagerly anticipating the parabolic flight campaign, scheduled during June 5-17, 2023. During Year 3, we have also continued our ground experiment efforts. Using a tilt paradigm as an altered-gravity analog, we have completed another experiment on EMG coherence using a bimanual coordination frequency task. Results and conclusions from our previous ground experiments have been updated following generation of dose-response curves. Finally, we have also investigated bimanual coordination performance when exposed to a graded Lower Body Negative Pressure (LBNP) environment. Twenty-four (12M/12F) conducted the same bimanual coordination tasks that we will use in the upcoming parabolic flight when exposed to LBNP. Subjects were required to participate in two experimental sessions scheduled on consecutive days: one session was focused on frequency tasks (1:1 and 1:2), and the other session was focused on scanning tasks (180° and 90°). During the frequency tasks, participants were required to coordinate 1:1 (i.e., in-phase) and 1:2 rhythmical bimanual force production tasks when provided visual feedback in the form of Lissajous templates. For the in-phase or 1:1 bimanual force coordination task, participants were required to use both their left and right limbs to simultaneously produce continuous patterns of forces. The 1:2 task required participants to produce two patterns of force with the right limb for every one pattern of force produced by the left limb. During the scanning tasks, participants were required to coordinate left and right limb movement together in a continuous pattern at 90° and 180° of relative phase angle when provided visual feedback in the form of Lissajous templates. The order of the frequency and scanning sessions was counterbalanced across subjects. In the frequency tasks sessions, subjects were first exposed to -20 mmHg and asked to do four 30-second trials in the following order: 1:1, 1:2, 1:1, 1:2. After a 60-second break, the LBNP level was incremented by 10 mmHg and subjects were asked to repeat the same sequence of frequency tasks. This protocol is repeated, increasing the LBNP at a rate of 10 mmHg every 3 minutes until the LBNP chamber reached -100 mmHg, or early should presyncope develop. A similar protocol was implemented during the scanning tasks sessions in which subjects completed four 30-second trials in the following order: 180°, 90°, 180°, 90°. Both cardiovascular variables (blood pressure, cardiac output, heart rate variability, etc.) and bimanual coordination variables (timing variables, force variables, harmonicity, etc.) were collected continuously. Data collection have just been completed and data analysis is underway.
Bibliography Type:	Description: (Last Updated: 07/28/2023)
Abstracts for Journals and Proceedings	Keller N, Weinrich M, Abbott R, Wang Y, Wright TJ, Dunbar BJ, Kennedy DM, Diaz-Artiles A. "Bimanual task performance in hypogravity using a tilt paradigm." 2022 American Society for Gravitational and Space Research Conference, Houston, Texas, November 9-12, 2022. Abstracts. 2022 American Society for Gravitational and Space Research Conference, Houston, Texas, November 9-12, 2022. , Nov-2022
Abstracts for Journals and Proceedings	Kennedy DM, Neto OP, Weinrich MM, Keller N, Wang Y, Artiles-Diaz A. "EMG-EMG wavelet coherence analysis of muscle coupling during bimanual tasks performed in altered-gravity." 2022 Society for Neuroscience. San Diego, California, November 16, 2022. Abstracts. 2022 Society for Neuroscience. San Diego, California, November 16, 2022. , Nov-2022

Abstracts for Journals and Proceedings	Kennedy DM, Keller N, Weinrich MM, Wang Y, Abbott R, Wright T, Dunbar BJ, Diaz-Artiles A. "Bimanual coordination during partial gravity: Preparations for parabolic flight and preliminary results." 2023 NASA Human Research Program Investigators' Workshop, Galveston, Texas, February 7-9, 2023. Abstracts. 2023 NASA Human Research Program Investigators' Workshop, Galveston, Texas, February 7-9, 2023. , Feb-2023
Abstracts for Journals and Proceedings	Keller N, Kennedy DM, Diaz-Artiles A. "Cardiovascular and neuromotor responses to orthostatic challenge." 2023 NASA Human Research Program Investigators' Workshop, Galveston, Texas, February 7-9, 2023. Abstracts. 2023 NASA Human Research Program Investigators' Workshop, Galveston, Texas, February 7-9, 2023. , Feb-2023
Abstracts for Journals and Proceedings	Kennedy DM, Wang Y, Weinrich M, Abbott R, Diaz-Artiles A. "Bimanual force control in simulated Martian gravity." 2022 North American Society for Psychology of Sport and Physical Activity (NASPSPA) Conference, Aloha Hawaii, May 26-28, 2022. Abstracts. 2022 North American Society for Psychology of Sport and Physical Activity (NASPSPA) Conference, Aloha Hawaii, May 26-28, 2022. , May-2022
Abstracts for Journals and Proceedings	Kennedy DM, Neto OP, Weinrich MM, Keller N, Wang Y, Artiles-Diaz A. "Effects of simulated microgravity on bimanual force control." 2023 North American Society for the Psychology of Sport and Physical Activity (NASPSPA) Conference, Toronto, Canada, May 31-June 3, 2023. Abstracts. 2023 North American Society for the Psychology of Sport and Physical Activity (NASPSPA) Conference, Toronto, Canada, May 31-June 3, 2023. , May-2023