Fiscal Year:	FY 2022	**Task Last Updated:**	FY 11/29/2021
PI Name:	Fischer, Ute Ph.D.		
Project Title:	Technological Support for Crew/MCC Communication and Collaboration During Space Exploration Operations		
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:	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:**	2019-2020 HERO 80JSC019N0001-HHCBPSR, OMNIBUS2: Human Health Countermeasures, Behavioral Performance, and Space Radiation-Appendix C; Omnibus2-Appendix D
Start Date:	02/01/2021	**End Date:**	01/31/2023
No. of Post Docs:	0	**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:	0	**Monitoring Center:**	NASA JSC
Contact Monitor:	Whitmire, Alexandra	**Contact Phone:**	
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Flight Program:			
Flight Assignment:	NOTE: End date changed to 1/31/2023 per A. Beitman/HFBP/HRP/JSC and NSSC information (Ed., 12/6/21)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Mosier, Kathleen Ph.D. (Teamscape LLC)		
Grant/Contract No.:	80NSSC21K0444		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	The proposed effort will examine a novel technology, Braiding, for enhancing space-ground communication challenge during future exploration missions to destinations beyond Low-Earth Orbit. As missions travel farther from Earth, the communication between space crewmembers and ground support will be significantly delayed; for a mission to Mars the time lag can be up to 20 minutes one way. The presence of communication delays will require that crewmembers be given more autonomy in these missions than they have in current operations. However, the requirement for space-ground collaboration will remain, given the complexity of the endeavor and the chance that unforeseen problems may arise –as has happened from the Apollo missions to the present day—for which crews will need assistance from ground. Communication delays pose a formidable challenge to the collaboration between space crewmembers and ground support because they impede team members' communication efficiency and may ultimately hinder their joint task success. Previous work by the research team on crew/mission control (Mission Control Center : MCC) communication under time delay identified errors in three critical features of communication: Timing (when to expect a response); Thread (tracking and maintaining conversational threads); and Transmission Efficiency ('chunking' relevant information in a single message). This work led to the development of a communication protocol and a training module to help space crews and MCC personnel communicate and collaborate during time delay. The proposed effort will build on this earlier work through the introduction of a novel, software-delivered communication tool called Braiding that will help space crews and ground support personnel organize and track their time-delayed communications. Braiding enables remote team members to structure their communication into revolving braids (topics) and thus prevents topics from getting 'tangled.' In the proposed work we will assess the feasibility, acceptability, and benefits of Braiding during one analog mission. The study design includes two Braiding and two control sessions. During the former, crew and MCC will communicate via Braiding while collaborating on designated operational tasks and engaging in daily planning conferences (DPCs). Control sessions will involve comparable operational tasks and DPCs with crew and MCC using currently available media for their communication. Data collected will include participants' ratings of their communications' quality during tasks and DPCs, quantitative and qualitative analyses (i.e., duration, completeness, and efficiency) of crew/MCC communications and post-mission interviews with participants to elicit user feedback. In short, we will provide a proof-of-concept that will be comprehensive as it will be based on both subjective and objective assessments of Braiding in comparison to the current communication technologies available to crew and MCC during time-delayed conditions. Further testing and refinement may be accomplished in future work using controlled experiments in analog environments.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	While we hypothesize that Braiding is well suited to mitigate the detrimental effects of communication delay on the collaboration between crew and ground support, its applicability extends to many professional settings (e.g., telemedicine, online psychotherapy, military operations) in which individuals need to collaborate remotely and communication efficiency is critical. By structuring the communication of remote partners into topics (so-called "braids"), Braiding helps them to keep their interaction focused and orderly and ensures that all relevant topics are addressed -- benefits that extend beyond the specific context of our research.
Task Progress:	Due to Covid-19 constraints we were not able to include our research in an analog mission, as was originally proposed. As a result, we had to redesign our study as an online human-in-the-loop (HITL) investigation. The HITL evaluation will involve pairs of volunteers (one acting as crew member and one acting as flight surgeon or flight controller) who will be asked to communicate with each other under delayed conditions, contrasting a traditional texting tool (comparable to the one currently used in NASA analog missions) with Braiding. During the first two scenarios, volunteers will use the traditional texting tool as the standard against which to compare Braiding, the tool they will use in the remaining scenarios. Scenarios involving standard texting and Braiding will present volunteers with comparable tasks and equivalent task-related information. A suite of data will be collected to assess Braiding. Data will include volunteers' ratings of the communication process, the impact of communication delay and tool usability comparing Braiding to standard texting, as well as quantitative and qualitative measures of their communications (e.g., word count and communication efficiency), and post-test interviews to elicit user-feedback. The change in research methodology did not impact the overall project objective –i.e., to assess the feasibility and benefits of Braiding in comparison to a traditional texting tool—but brought with it additional tasks that necessitated a one-year no-cost extension of the project, with a new end date of 01/31/2023. Additional tasks completed during Year 1 include (1) the development of four test scenarios that are operationally relevant and can be completed by remote partners in an online environment; (2) the development of a texting tool that is comparable to NASA's mission log as this application is not available for use outside an analog facility; and (3) because we had to abandon the analog environment, the recruitment of study volunteers that are comparable to the originally intended study population (i.e., astronauts and mission control personnel). Presently, 5 former Human Experimental Research Analog (HERA) and Hawai'i Space Exploration Analog and Simulation (HI-SEAS) crew members and 2 flight surgeons responded to our advertisement and identified days on which they could participate in test sessions. We anticipate starting the study at the middle of December 2021.
Bibliography Type:	Description: (Last Updated: 03/22/2024)
Articles in Peer-reviewed Journals	Mosier KL, Fischer UM. "Meeting the challenge of transmission delay: Communication protocols for space operations." Human Factors. 2021 Oct 19;187208211047085. Online first. https://doi.org/10.1177/00187208211047085 ; PMID: 34663105 , Oct-2021