Fiscal Year:	FY 2023	**Task Last Updated:**	FY 04/03/2023
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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Zip Code:	30332-0165	**Congressional District:**	5
Comments:	NOTE: The NSSC also lists the PI as Ute Fischer-Loss (Ed., March 2025).		
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 facilitating space-ground communication 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:	As missions travel further 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. Signal latency severely disrupts the communication between crewmembers in space and their partners on Earth, irrespective of medium (voice or text) or delay duration. Braiding is a novel, text-based software designed to facilitate communication between crewmembers in space and mission support on Earth under signal latency. The goal of the present research was to provide a proof of concept demonstrating the usability of this novel technological support system for space/ground communication as a potential protection from the communication errors associated with time-delayed communication. The original study design called for assessing braiding in an analog mission; a design that could not be implemented due to Covid-19 related delays. As a result, we pivoted the study as an online human-in-the-loop (HITL) investigation involving flight surgeons FS/Mission Support personnel and former participants in space exploration analog simulations (Crew). The HITL evaluation was conducted online with pairs of volunteers (one crewmember and one FS/Mission Support personnel as MCC) collaborating under communication delay on operationally relevant task situations, contrasting a texting tool (functionally comparable to the one currently used in NASA analog missions) with braiding. Volunteers received fictional but realistic information for each task to help them perform in their assigned role (MCC or Crew). The study involved two test sessions over two days, each presenting participants with three task events. Data collected included participants' post-session ratings of their time-delayed communication and a 30-45 min exit interview. Quantitative analyses indicated that participants rated braiding more favorably than texting with respect to the quality of their time-delayed communication and its ability to mitigate the impact of communication delay and support teamwork. Qualitative analyses revealed that participants appreciated the affordances of braiding—that the software organized their conversation by topic, maintained the chronological order of related messages, and brought continuity and a natural feel to their conversation—but were less comfortable with some of its constraints. These findings suggest that braiding can be an effective communication tool under time delay and also point to specific training issues to ensure that users feel at ease not only with braiding's resources but also its medium-specific restrictions.
Bibliography Type:	Description: (Last Updated: 03/22/2024)
Abstracts for Journals and Proceedings	Fischer U, Mosier K, Schmid J, Smithsimmons D, Brougham R. "Technological support for Crew/MCC communication and collaboration during space exploration operations- Results of a usability study." 2023 NASA Human Research Program Investigators' Workshop, Galveston, Texas, February 7-9. Abstracts. 2023 NASA Human Research Program Investigators' Workshop, Galveston, Texas, February 7-9. , Feb-2023

Abstracts for Journals and Proceedings	Fischer U, Mosier K, Schmid J, Smithsimmons, A, Brougham R. "Braiding: A novel technology to facilitate space/ground collaboration under signal latency." International Conference of Aerospace Medicine, Paris, France, September 22-24, 2022. Abstracts. International Conference of Aerospace Medicine, Paris, France, September 22-24, 2022. , Sep-2022
Articles in Peer-reviewed Journals	Fischer U, Mosier K, Schmid J, Smithsimmons D, Brougham, R. "Braiding - A novel approach to supporting space/ground communication under signal latency." Acta Astronautica. Jun;207:411-24. https://doi.org/10.1016/j.actaastro.2023.03.023 , Jun-2023
Books/Book Chapters	Fischer U, Mosier K. "Mitigating the impact of communication delay." in "Psychology and Human Performance in Space Programs: Extreme Application." Ed. L.B. Landon, K.J. Slack, E. Salas. Boca Raton, FL: CRC Press, 2020. p. 101-114. Book doi: https://doi.org/10.1201/9780429440854 , Oct-2020