Fiscal Year:	FY 2023	**Task Last Updated:**	FY 06/23/2023
PI Name:	McLaughlin, Anne Ph.D.		
Project Title:	Cognitive Aid Design Using Augmented Reality to Support Attention		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	Yes
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:	27695-7650	**Congressional District:**	4
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	2019 HERO 80JSC019N0001-FLAGSHIP & OMNIBUS: Human Research Program Crew Health. Appendix A&B
Start Date:	08/20/2020	**End Date:**	02/28/2023
No. of Post Docs:	0	**No. of PhD Degrees:**	1
No. of PhD Candidates:	2	**No. of Master' Degrees:**	0
No. of Master's Candidates:	1	**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 02/28/2023 per NSSC information (Ed., 8/25/22) NOTE: End date changed to 08/19/2022 per L. Barnes-Moten/JSC and NSSC information (Ed., 8/2/21)		
Key Personnel Changes/Previous PI:	No changes		
COI Name (Institution):	Byrne, Vicky M.S. (KBR/NASA Johnson Space Center) Coleman, Maribeth Ph.D. (Georgia Tech Research Corporation)		
Grant/Contract No.:	80NSSC20K1715		
Performance Goal No.:			
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Task Description:	We propose to research and develop a cognitive aid to support performance of rare tasks, tasks that cannot be trained at length prior to flight, and any task that would be adversely affected by distraction or attention overload. Many of these tasks are complex, occur in cramped or filled environments, and require detection of patterns, incorporation of feedback into the next steps of the task, and high focus of attention. A preliminary list of these tasks across the 12 phases of an expedition to Mars can be found in the 2018 NASA final report by Stuster, Adolf, Byrne, and Greene. Some previously developed cognitive aids have incorporated augmented reality elements (such as the NASA supported IDEAS (Integrated Display and Environmental Awareness System) and NASA Sidekick)). Cognitive aids with augmented reality elements support attention by adding to the environment: this includes alarms, screen movement, highlighting, and other attention-capture methods. We focus our study and development of novel augmented reality incorporated into a cognitive aid: de-emphasis of auditory and visual clutter and distractions. The term for this type of aid is Diminished Reality (DR). This form of aid targets the cognitive processes most likely to be affected by long-term spaceflight: difficulty focusing, inhibiting distractors, and locating spatial information crucial to the task. DR displays and interaction techniques will be developed by Human–computer interaction (HCI) researchers and graduate students in human factors psychology. Prototypes will be tested with human subjects on the complex task of setting up novel medical equipment, an appropriately complex task listed in the 2018 Mars Expedition Task List. An advanced prototype will be user-tested by space-knowledgeable individuals at Johnson Space Center. Deliverables will include a prototype of the aid and generalized principles and guidelines for future incorporation of de-emphasis augmentations into cognitive aids. Stuster, J, Adolf J, Byrne V, Greene M. (2018). Human exploration of Mars: Preliminary lists of crew tasks. NASA/CR-2018-220043. https://
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This work will benefit the field of psychology by adding to the literature on the impact of stressors, interruptions, and distractions on human performance of complex, novel tasks. This work will benefit the field of computing by investigating these effects in the new technology of "diminished reality" (DR). Similar to augmented reality, DR uses computers and displays to change the appearance of the physical world. In DR, this means by altering or removing objects or sounds. This alteration occurs with various diminishment methods, from outright erasure to desaturation to blurring or to semi-transparency. Auditory stimuli are treated similarly, ranging from silence to diminishment of volume or changes in the spatial nature of the audio. The outcomes of our research will be to inform the design of DR technologies so that they may support work in space or on the ground -- anywhere that diminishment of distraction is desirable.
Task Progress:	We have completed the project as described in our initial proposal. The major accomplishments were: We built a remotely deployable virtual reality environment that could be experienced on an Android phone with a cardboard virtual reality (VR) headset. This lightweight, inexpensive, and instrumented environment allowed us to test the effects of our Diminished Reality (DR) aids remotely. Creating this software required work with 3-D models, networking, and sending signals to and from the environment. The environment could be controlled by experimenters on a computer while the participant was immersed in the environment, and visuals/sounds could be triggered in real-time by the study staff. This “Wizard of Oz” methodology made it possible to move beyond the typical difficulties in training participants to use controllers or input devices. Another benefit from this new software testbed is the ability to change the environment and run other experiments. The software is already being adapted for two studies funded by the NC Space Grant that answer new questions about training with cognitive aids in place. Two experiments were conducted to understand the effects of universal and selective (context-aware) diminishment of distraction on performance, situational awareness, and subjective experience of workload in a novel assembly task. In both experiments, participants used procedural instructions to assemble a medical ventilator for use during a simulated emergency in virtual reality. In both experiments, the type of diminishment was manipulated within participants, so that each participant experienced universal attenuation of visual and auditory distraction, context-aware diminishment of the same, and a control condition with all distractions present. In the first experiment, the participants were STEM graduate students at a large state university. In the second experiment, small changes were made to the task and context-aware diminishment and then run remotely with participants who were employees at Johnson Space Center. Our hypotheses were as follows: Performance would be supported in the DR conditions compared to a control condition. The workload would be lower in the DR conditions. Situational awareness would be lower in the DR conditions. Of the two DR conditions, the DR condition with universal attenuation would show the poorest situational awareness. The main difference between experiments was the type of sample. Both groups were highly educated; however, the JSC participants also had work experience in science and technology. The main difference in the results between the experiments was the lack of performance differences by condition for the JSC participants, while those STEM graduate programs accomplished more steps in the Context-Aware condition compared to Control and had lower errors in the Universal DR condition compared to control. The same was true for situational awareness measures: diminishment harmed situational awareness for label locations and knowledge of the external concurrent emergency for the STEM graduate students, but not for those at JSC. One explanation might be the smaller sample size of JSC participants in Experiment 2, though the within-subject design meant that both experiments were adequately powered. However, even when ignoring significance, there were no trends toward performance differences in Experiment 2. A better explanation comes from the measures of workload. In Experiment 1, workload was perceived to be lower in the Universal DR condition compared to the control. In Experiment 2, the JSC participants perceived lower workload in both DR conditions compared to control. In many studies, perceived workload changes when performance does not because participants are able to put forth the effort needed to perform (even when the task is extremely difficult, see Hancock and Matthews (2019) for a review of the varying relationships between performance and workload). The JSC participants, with their longer work histories and experience in problem-solving for ambiguous tasks, were likely able to keep up their performance even in the control condition, though they were also sensitive to how much harder they had to work to do so. Last, it is worth noting that participants in both studies were highly educated and accomplished. Their performance in the

	study is likely higher than would be expected from a random sample, and their workload measures are likely lower. Any benefit from DR would also likely be higher for a random sample; however, this should be investigated empirically.
Bibliography Type:	Description: (Last Updated: 07/10/2023)
Abstracts for Journals and Proceedings	McLaughlin AC, Gandy Coleman M, Byrne V. "Testing diminished reality cognitive aids." 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	Lodge F, Murph I, Richardson K, Benton R, Macedo Salas A, Gandy Coleman M, Robertson S, Byrne V, McLaughlin AC. "Remote user testing of diminished reality utilizing virtual reality." 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	McLaughlin AC. "An investigation of diminished reality techniques to guide attention." Meeting of the American Psychological Association, Minneapolis, MN, August 4-6, 2022. Abstracts. Meeting of the American Psychological Association, Minneapolis, MN, August 4-6, 2022. , Aug-2022
Abstracts for Journals and Proceedings	Murph I, Richardson K, McLaughlin AC. "Diminished reality (DR)." American Psychological Association Convention, Minneapolis, MN, August 4-6, 2022. Abstracts. American Psychological Association Convention, Minneapolis, MN, August 4-6, 2022. , Aug-2022
Papers from Meeting Proceedings	Murph I, Richardson K, McLaughlin AC. "Methods of Training to Overcome Distraction Via Diminished Reality. " Human Factors and Ergonomics Society 66th Annual Meeting, Atlanta, GA, October 10-14, 2022. Human Factors and Ergonomics Society 66th Annual Meeting, Atlanta, GA, October 10-14, 2022. , Oct-2022
Papers from Meeting Proceedings	Salas AM, Richardson K, McLaughlin AC. "The Effects of Augmented Reality Remapping on Individual Differences in Task Performance, Workload, and Error Frequency within ICU Nurses." Human Factors and Ergonomics Society 66th Annual Meeting, Atlanta, GA, October 10-14, 2022. Human Factors and Ergonomics Society 66th Annual Meeting, Atlanta, GA, October 10-14, 2022. , Oct-2022