

Fiscal Year:	FY 2018	Task Last Updated:	FY 01/12/2021
PI Name:	Fiore, Stephen Ph.D.		
Project Title:	Macroognition in Teams: Examining and Developing Team Cognitive Processes and Products in the Context of Long Duration Exploration Missions		
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 (2) HSIA :Risk of Adverse Outcomes Due to Inadequate Human Systems Integration Architecture (3) Team :Risk of Performance and Behavioral Health Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team		
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:	2015-16 HERO NNJ15ZSA001N-Crew Health (FLAGSHIP, NSBRI, OMNIBUS). Appendix A-Crew Health, Appendix B-NSBRI, Appendix C-Omnibus
Start Date:	08/01/2016	End Date:	05/31/2018
No. of Post Docs:	0	No. of PhD Degrees:	0
No. of PhD Candidates:	1	No. of Master' Degrees:	0
No. of Master's Candidates:	2	No. of Bachelor's Degrees:	3
No. of Bachelor's Candidates:	0	Monitoring Center:	NASA JSC
Contact Monitor:	Contact Phone:		
Contact Email:			
Flight Program:			
Flight Assignment:	NOTE: End date changed to 5/31/2018 per NSSC information (Ed., 5/7/19) NOTE: Element change to Human Factors & Behavioral Performance; previously Behavioral Health & Performance (Ed., 1/18/17)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Burke, Shawn Ph.D. (University of Central Florida) Salas, Eduardo Ph.D. (Rice University)		
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Task Description:

Teams conducting long-duration exploration missions (LDEM) face the pervasive risk of decrements due to inadequate collaboration within the spaceflight crew as well as between and across Mission Control teams. Given that team cognition has been shown to be a significant predictor of team performance across a number of domains and tasks (DeChurch et al., 2010; Salas & Fiore, 2004), it is critical to understand how team cognition occurs under LDEM conditions, how it shifts over time, and how to implement countermeasures to improve it. Fiore and colleagues developed the macrocognition in teams model (MITM) to integrate the more general literature on team cognition with a particular focus on complex real world collaborative cognition (Fiore et al., 2010a; Fiore et al., 2010b). Building off of this theory, the Principal Investigator (PI) recently examined this in the context of LDEM and detailed a set of team cognitive processes and team cognitive knowledge to explicate the form of team cognition that needed to be understood for LDEM (Fiore et al., 2015). In this proposal we describe a multidisciplinary approach designed to refine and validate the MITM in the context of LDEM and use this as the theoretical foundation to develop and validate training protocols that lead to resilient team cognitive processes. In doing so, we take a multi-pronged approach combining analysis of archival documents and qualitative coding of crew communication in analog environments with new ground-based and analog studies. Our goal is to: (1) provide a richer understanding of team cognition and its relation to team performance in space crews and the larger multi-team system and (2) use this understanding to refine and validate training to mitigate decrements in team cognition.

DeChurch, L., Hiller, N., Murase, T., Doty, D., & Salas, E. (2010). Leadership across levels Levels of leaders and their levels of impact. *Leadership Quarterly*, 21(6), 1069-1085.

Salas, E. E., & Fiore, S. M. (Eds.) (2004). *Team cognition: Understanding the factors that drive process and performance*. Washington, DC: American Psychological Association.

Fiore, S. M., Rosen, M. A., Smith-Jentsch, K. A., Salas, E., Letsky, M. & Warner, N. (2010a). Toward an understanding of macrocognition in teams: Predicting processes in complex collaborative contexts. *Human Factors*, 52(2), 203-224.

Fiore, S. M., Smith-Jentsch, K. A., Salas, E., Warner, N., & Letsky, M. (2010b). Toward an understanding of macrocognition in teams: Developing and defining complex collaborative processes and products. *Theoretical Issues in Ergonomic Science*, 11(4), 250-271.

Fiore, S. M., Wilshire, T. J., Sanz, E. J., & Pajank, M. E. (2015). Critical team cognitive processes for long-duration exploration missions. NASA/TM-2015-218583.

Rationale for HRP Directed Research:**Research Impact/Earth Benefits:**

The proposed effort will impact numerous areas of research need for NASA. First, this research will address theoretical gaps associated with how individual and team cognitive processes affect each other and change over time. The relevant gaps identified by NASA are: (1) The need to understand the key threats, indicators, and life cycle of the team for autonomous, long duration and/or distance exploration missions (Team Gap 1), (2) The need to identify psychological measures that can be used to select individuals most likely to maintain team function for autonomous, long duration, and/or distance exploration in missions (Team Gap 4), and (3) The need to identify validated ground-based training methods that can be both preparatory and continuing to maintain team function in autonomous, long duration and/or exploration missions (Team Gap 5). The current literature does not provide much information regarding longitudinal shifts in cognition, especially in the context of teams working in LDEM settings. Because of these knowledge gaps, it is essential to determine the causes that impact cognitive processes across the lifespan of teams throughout LDEM settings. This knowledge supports this effort's second contribution in the development of effective countermeasures aimed to maintain adequate levels of cognition at both the individual and team level. Finally, the third contribution will be the identification of a suite of measures for assessing individual and team cognitive processes and how these change over time. The elements of isolation and confinement in future LDEM warrant investigation of innovative and less intrusive assessments of cognition. Thus, this effort will attempt to identify the types of individual and team cognitive measures that can be implemented effectively in such environments. Findings from this research will contribute, not just to gaps identified by NASA, but will also enrich the broader area of team cognition research. In particular, by studying the inter-relation of individual and team cognition, and providing potential alternatives to traditional assessment techniques, this research will inform the general study of teams in complex contexts. The resultant knowledge gained will assist in facilitating crew performance by identifying the manner in which cognitive processes change over time, how individual decrements in cognition cascade to the team level to impact the crew's performance, and potential countermeasures for such effects. Additionally, it will also impact those on Earth as this awareness can be used to facilitate the interaction between crew and ground control so as to maximize the synergy present in these expert teams.

Task Progress:

Ed. note Jan 2021: Final reporting not received. See Bibliography for resulting publications since last report.

Bibliography Type:

Description: (Last Updated: 01/12/2021)

Articles in Peer-reviewed Journals

Wiltshire TJ, Steffensen SV, Fiore SM. "Multiscale movement coordination dynamics in collaborative team problem solving." *Appl Ergon*. 2019 Sep;79:143-51. Epub 2018 Aug 10. <https://doi.org/10.1016/j.apergo.2018.07.007> ; PMID: [30103905](https://pubmed.ncbi.nlm.nih.gov/30103905/) , Sep-2019

Articles in Peer-reviewed Journals

Hall KL, Vogel AL, Huang GC, Serrano KJ, Rice EL, Tsakraklides SP, Fiore SM. "The science of team science: A review of the empirical evidence and research gaps on collaboration in science." *Am Psychol*. 2018 May-Jun;73(4):532-48. <https://doi.org/10.1037/amp0000319> ; PMID: [29792466](https://pubmed.ncbi.nlm.nih.gov/29792466/) , May-2018