Fiscal Year:	FY 2023	**Task Last Updated:**	FY 12/14/2022
PI Name:	Carter, Dorothy Ph.D.		
Project Title:	Project FUSION: Facilitating Unified Systems of Interdependent Organizational Networks		
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:	(1) **HSIA**:Risk of Adverse Outcomes Due to Inadequate Human Systems Integration Architecture (2) **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:	The Principal Investigator (PI) was previously at the University of Georgia.		
Project Type:	GROUND	**Solicitation / Funding Source:**	2016-2017 HERO NNJ16ZSA001N-Crew Health (FLAGSHIP, OMNIBUS). Appendix A-Omnibus, Appendix B-Flagship
Start Date:	02/12/2018	**End Date:**	03/31/2023
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No. of PhD Candidates:	2	**No. of Master' Degrees:**	4
No. of Master's Candidates:	2	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	12	**Monitoring Center:**	NASA JSC
Contact Monitor:	Whitmire, Alexandra	**Contact Phone:**	
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Flight Program:			
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Key Personnel Changes/Previous PI:			
COI Name (Institution):	Contractor, Noshir Ph.D. (Northwestern University) Schecter, Aaron Ph.D. (University of Georgia) DeChurch, Leslie Ph.D. (Northwestern University) Shuffler, Marissa Ph.D. (Clemson University)		
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Task Description:	As we set our sights on Mars, and other destinations beyond lower Earth orbit, we must enable extreme forms of teamwork across Spaceflight Multiteam Systems (SFMTSs) composed of teams that are separated by unprecedented degrees of space and time. In "Project FUSION: Facilitating Unified Systems of Interdependent Organizational Networks," we are engaging in a transformative research program rooted in the past decade of theory and research on MTSs, but breaking new ground in how MTSs are conceptualized and studied. Our programmatic research aims to illuminate the underlying forces that give rise to the psycho-social relational states (e.g., influence, trust, shared cognition) within and between teams that underpin mission success. These crucial relationships, and the drivers of their emergence, will need to be understood, monitored, and at times, circumvented using countermeasures in order to enable coordinated efforts across the SFMTSs involved in Long-duration Exploration Mission (LDEMs). Project FUSION is a multi-pronged, multi-method, interdisciplinary project with three main research foci: (1) field investigations using NASA personnel; (2) development of an agent-based computational model capturing the drivers of relational states; and (3) controlled laboratory experiments and analog studies. Our research design is intended to be iterative. Findings within each foci are continually infusing the refinement and design of research in other foci. Further, Project FUSION is an applied research project with the ultimate goal of translating findings from three research foci in order to provide NASA with a "countermeasure toolkit" comprised of validated interventions that can be used to facilitate effective teamwork in SFMTSs. The countermeasure toolkit under development in this project consists of: (1) a SFMTS task analysis procedure, (2) a decision-making guidebook based on our agent-based computational model of SFMTS dynamics, (3) a multiteam training countermeasure ready for operational implementation with astronauts and mission controllers, and (4) a multiteam debriefing protocol ready for operational implementation with astronauts and mission controllers.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The findings from this project will have substantial implications for human life on Earth, and in particular, for the effectiveness of teams and larger systems of teams in organizations operating in high-stakes environments. The field studies, laboratory studies, and computer simulation studies aim to better understand the patterns of social relationships (e.g., trust, influence, information sharing) that are likely to form within and across teams in large interdependent organizational systems. By better understanding the patterns of relationships that are likely, we can help determine when and where teamwork interventions or "countermeasures" are necessary. Moreover, the ultimate goal of this applied research project is to develop and validate a toolkit of countermeasures, including training, debriefing procedures, and decision-making protocols that are designed to facilitate team and inter-team collaboration in complex organizational systems. These countermeasures will be able to be utilized widely across many organizational contexts beyond NASA (e.g., healthcare, the military, corporations).
	NOTE: The Project FUSION research is continued in Grant #80NSSC23K1124 (PI: Carter). See the new grant for most recent report information (Ed., 1/24/24).

"Project FUSION: Facilitating Unified Systems of Interdependent Organizational Networks" aims to provide an evidence-based countermeasure toolkit to NASA to help facilitate the patterns of psychological relationships (e.g., shared understanding, influence) and behavioral interactions (e.g., coordination, information sharing) across Spaceflight Multiteam Systems (SFMTSs) that are needed to support long-duration/long-distance exploration missions. The Project FUSION research program is focused on establishing an understanding of the key drivers of relational state networks in SFMTSs as well as the patterns of relational state networks that are likely to support Long-duration Exploration Mission (LDEM) success. In turn, the overarching practical goal of Project FUSION is to provide an empirically-derived countermeasure toolkit designed to facilitate the relational state networks needed to support LDEM success.

We are conducting a programmatic stream of research that aims to identify: (Aim #1) the key factors affecting the networks of relational states within and between teams that support SFMTS coordination and performance (Team Gap 1); (Aim #2) the key developmental factors that trigger shifts in networks of relational states in SFMTSs over time (Team Gap 1); (Aim #3) the ways in which networks of relational states affect team and system coordination and performance (Team Gap 1); and (Aim #4) validated proactive and/or reactive countermeasures targeting relational states in order to support SFMTS coordination and mission success that are multicultural and able to be implemented into existing systems (Team Gaps 3, 4, 5, 6, 8, MPTASK-01 and -02).

To achieve these aims, we are connecting findings from three research foci:

Research Foci #1 comprises field research involving analyses of archival documents, interviews, and observations with NASA personnel and personnel in analog environments (e.g., hospital systems). The goal of Research Foci #1 is to provide contextually rich, in-depth information gathered from relevant academic literature and archival resources as well as NASA, analog, and international spaceflight personnel in order to (1) define the key characteristics, potential triggers, and performance outcomes for SFMTSs; (2) better understand existing countermeasures (e.g., training/debriefing); (3) evaluate how best to incorporate FUSION countermeasures into existing protocols; and (4) develop and refine our recommendations for two of our countermeasures (i.e., Countermeasure #1 FUSION SFMTS Task Analysis and Countermeasure #4 FUSION Multiteam Debriefing).

Research Foci #2 aims to supplement findings from Research Foci #1 in order to build Agent-Based Models (ABMs) of SFMTS dynamics that can be used to make predictions about the functioning of SFMTSs and, in particular, when and among whom mission-critical breakdowns in collaboration and coordination are likely to occur. In our FUSION SFMTS ABM, the people or "agents" in the model interact with one another in accordance with rules derived from our theoretical framework of multiteam functioning. The agents' interactions will generate networks of important psycho-social relationships, like trust, influence, communication, or information sharing, within and between teams. The key goal of our FUSION SFMTS is to better understand the patterns of psycho-social relationships that are likely to arise in SFMTSs under different circumstances. We will compare the patterns of psycho-social relationships that are likely to occur to the patterns that are likely to be effective. We aim to help NASA identify situations in which the patterns of relationships that are likely to occur are unlikely to be effective and, therefore, help determine when certain countermeasures (e.g., training, debriefing) need to be implemented in order to facilitate multiteam coordination and performance. The human-subjects data collected in Research Foci #3 serves as the basis for the models developed in Research Foci #2.

In Research Foci #3, we are conducting laboratory and analog environment experiments with human subjects, which are designed to better understand the drivers and outcomes of relational state networks in SFMTSs. Research Foci #3 consists of a series of experiments with human subjects located in university laboratories and/or the Human Exploration

Research Analog (HERA) environment. These experiments are intended to: (1) collect data from human subjects needed to refine and validate the model parameters in our SFMTS ABM (Foci #2); (2) test hypotheses about the drivers of psycho-social relationships in SFMTSs; (3) test hypotheses about the antecedents of SFMTS coordination and performance; and (4) evaluate the validity of our third countermeasure (i.e., Countermeasure #3 Project Red FUSION Multiteam Systems/MTS Training).

We are leveraging findings from the three research foci to develop, evaluate, and deliver a countermeasure toolkit aimed at steering patterns of relational states within and across SFMTS component teams to support LDEMs. Our toolkit will include four countermeasures:

Countermeasure #1: FUSION SFMTS Task Analysis Procedure: A structured procedure for understanding the characteristics and requirements of SFMTSs.

Countermeasure #2: Project RED FUSION MTS Training: A training tool designed to enhance understanding of the communication, leadership, coordination, and risk assessment demands of working in MTS contexts.

Countermeasure #3: FUSION Multiteam Pre-Brief/Debrief Recommendations: Recommendations for multiteam pre-briefing/debriefing procedures that reinforce lessons learned related to multiteam collaboration.

Countermeasure #4: FUSION Communication & Coordination Recommendations: Based on our series of archival studies, interviews, observations, experiments with human subjects, and virtual experiments using agent-based models (ABMs) of SFMTS dynamics, we will provide a series of recommendations regarding MTS communication and coordination protocols.

2.1. Analyses of NASA Archival Documents to Understand Effects of Spaceflight Multiteam Differentiation on MTS Adaptive Performance (Research Foci #1 and Countermeasure #4)

As part of Research Foci #1, we conducted a series of archival studies of NASA documents. In Y5, we continued to refine the results of these archival studies to identify key insights which can be presented to NASA to inform preparations for LDEMs. The results of the following study have implications for all four of our countermeasure toolkit recommendations.

Citation: Pendergraft JG, Carter DR, Pearman J, Shuffler M. 2022 Jul. Project FUSION: NASA critical incidents reveal the nature of multiteam system adaptation [Paper presentation]. The Interdisciplinary Network for Groups Research (INGRoup) Conference, Hamburg, Germany.

Background. High-reliability organizations (HROs; Weick, Sutcliffe, and Obstfeld, 1999), such as National Aeronautics and Space Administration (NASA), rely on multiteam system work structures to tackle complex goals under uncertain, and often dangerous, circumstances that require members and teams to adapt to dynamically changing task demands. For obvious reasons, the stakes and circumstances which characterize these operations are difficult to simulate convincingly in a laboratory setting. However, by leveraging retrospective accounts of real-world operations within such environments, we can gain crucial insights into the characteristics of challenges experienced by organizations and MTSs operating under those circumstances and the attributes of MTSs which are able to successfully contend with these uncertain environments. Given the unique potential of this type of data source, we asked, "What MTS attributes and actions support (vs. detract from) adaptation in complex dynamic environments?"

Methods. To evaluate our research questions, we used a historiometric approach drawing on a large pool of 1,299 publicly available archived interviews. Our historiometric approach consisted of two phases. In Phase I, research assistants identified and extracted a body of critical incidents for analysis. In Phase II, five research assistants coded these incidents on 21 initial dimensions. These included attributes of the MTS itself (i.e., compositional, developmental, differentiation, and dynamism attributes) as well as those of the operational circumstances (e.g., the type of challenge encountered by the system, the outcome of the episode, etc.).

Results. The results of this study pointed towards three major insights. These insights provide important indications of major needs and risks in advance of planned LDEMs. In the following section, we discuss these insights in greater detail, as well as their projected implications for LDEM planning and execution. Insight #1: Unsuccessful adaptive performance appears to be more associated with social challenges than technical challenges. Insight #2: Effective adaptive performance was less likely when SFMTSs had high levels of norm/policy diversity between teams and took longer to resolve when they were successful. Insight #3: MTSs incorporating a dedicated integration team leading decision-making were more likely to adapt successfully to challenging situations.

Implications. During LDEMs, crews will face missions of unprecedented duration and distance, as well as an accompanying increased level of isolation and prolonged confinement within a relatively small space. These factors are likely to increase interpersonal strain and exacerbate social challenges above and beyond the level currently present in spaceflight missions. Given that social challenges have been shown to present the greatest challenges to NASA SFMTSs under current conditions, the increased level of social strain likely to be caused by LDEM conditions bears special consideration.

There is likely to be a substantial degree of norm and cultural diversity present within the systems executing LDEMs. Systems exhibiting a strong degree of norm diversity struggled to adapt to unforeseen challenges to a greater degree than norm-unified systems, as well as taking longer to adapt. The impacts of social challenges present in LDEMs may be mitigated through the use of targeted countermeasures focusing specifically on improving multiteam processes.

Finally, the vast distances traveled in LDEMs will impose the novel challenge of extended communication delays between the crew and Earth-bound teams at some points of the mission timeline. This lack of instantaneous communication will mean that the crew must operate with a greater degree of autonomy compared to previous missions, without immediate access to a dedicated integrative team which has proven so useful to NASA SFMTSs in the past. Lanaj and colleagues (2013) demonstrated that decentralized planning and related autonomous activities among component teams of an MTS could sometimes result in lower efficiency and performance, particularly due to the strong negative effects of excessive risk-seeking and coordination failures. Both of these factors (i.e., greater risk-seeking and lower coordination) have the potential to result in devastating consequences for SFMTSs. Organizations must be cautious when implementing training to equip MTS component teams to act independently of the larger organizational unit. While such independent action is one of the inherent benefits of the MTS structure, permitting or incentivizing too much independent action may have severe consequences. In the context of LDEMs, targeted preparatory training for

more autonomous operations will be necessary but must be accompanied by training which mitigates its anticipated negative consequences.

2.2. Evaluation of Prebriefing/Debriefing Procedures within Healthcare Multiteam Systems (Research Foci #1 and Countermeasure #3)

Citation: Wolf AV, Hedrick KN, Begerowski SR, Wiper DW 3rd, Carter DR, Shuffler M. L. Making every meeting count: A qualitative investigation of multiteam meeting events and their role in supporting coordinated cancer care delivery. Online ahead of print. JCO oncology practice. DOI: 10.1200/OP.22.00388.

As part of Research Foci #1, we conducted a series of interviews and observations with subject matter experts in hospital multiteam systems. The results of this work were published in The Journal of Oncology Practice.

Purpose and Background. This research considers how cross-disciplinary cancer care meetings can facilitate coordination within the multiteam systems (MTSs) that provide inpatient hospital care. We conducted a series of interviews and observations with members of a single cancer care MTS to address the following research questions: (1) what are the key characteristics of MTS cancer care meetings (with regard to composition, focus, and structure)? and (2) how is cross-team coordination acknowledged and addressed during these meetings?

Methods. In this single-site case study of a MTS operating to provide gynecologic oncology care within a teaching hospital, two types of meetings, called rounds and huddles, were held consistently. We used qualitative methods, including interviews with healthcare professional subject matter experts and 30 hours of observations of cancer care meetings, and analyzed the data in three stages of qualitative coding.

Results. Our analyses resulted in a thematic framework detailing key processes and subprocesses identified as central to the activities of observed cancer care meetings. Key processes include information sharing, gaining clarity, strategizing, and pedagogy. Discussions and explanations of this framework showcase the ways in which MTS meetings can bolster cross-team coordination and facilitate MTS activities.

Conclusion. Inpatient cancer care meetings provide opportunities to facilitate MTS coordination in several ways, yet doing so does not come without challenges. Considering these results, together with insights from meeting science and MTS research, this article concludes by putting forward practical recommendations for leveraging opportunities and overcoming challenges to use cancer care meetings as tools to support cross-team coordination.

2.3. HERA C6 Data Collection (Research Foci #2 and #3 and Countermeasure #4)

Research Foci #3 consists of a series of experiments with human subjects located in university laboratories and/or the Human Exploration Research Analog (HERA) environment. Research Foci #2 is focused on building ABMs based on the data collected in Research Foci #3. Continuing into HERA C6, data collection was completed for Missions 2 and 3 during Y5.

Methods. The HERA/laboratory studies in Y2-Y5 leveraged the Project RED (Red planet Exploration & Development) computerized SFMTS simulation. In a Project RED simulation, four interdisciplinary teams work interdependently as a 12-person SFMTS to solve a complex task: designing a well to support a human colony on Mars. The Project RED simulation has been implemented in other NASA-funded projects and has demonstrated utility in examining the teamwork risks present in LDEMs. The simulation provides metrics of individual, team, and system performance. In a Project RED experimental session, four 3-member interdisciplinary teams work interdependently to solve a complex task: the design of a well to support a human colony on Mars. The Project RED software provides metrics of individual, team, and system performance. Participants complete a series of self-report surveys which provide information about individual differences and affective, cognitive, and instrumental states and relationships within and across teams throughout the simulation. The software interface provides digital traces to index information sharing and utilization, team attention allocation, and problem-solving unobtrusively. Chat, video, and audio data can also be used to examine intra- and inter-team interaction as it unfolds over time and in response to dynamic environments and triggers during subsequent analyses. Experience sampling surveys complement digital trace and coded data. Additionally, so as to better inform an eventual report on the individual differences related to inter-team processes, we are collecting an extensive battery of cognitive and non-cognitive individual differences and are evaluating the impact of these individual differences on relational states within and between teams and individual performance markers.

2.4. The Effects of Increasing Communication Delay on Multiteam Network Connectivity (Research Foci #3 and Countermeasure #4)

Task Progress:

Citation: Carter D, Schecter A, Pendergraft JG, Pearman J, Dechurch L, Contractor N. 2022 August. Increasing communication delay decreases team network connectivity [Paper presentation]. Annual Meeting of the Academy of Management, Seattle, Washington.

Background/Hypotheses. The success of an organizational team can hinge on whether team members develop and maintain dense patterns of connectivity in expressive (e.g., liking, trust) as well as instrumental (e.g., leadership, workflow) networks within multiteam systems. Unfortunately, developing and maintaining high levels of connectivity in multiteam systems may be extremely difficult for experiencing disruptions to synchronous (i.e., real-time) team communication. Asynchronous communication can be particularly problematic for highly interdependent multiteam systems where team members may depend on real-time interactions with one another to accomplish their own tasks (Rico and Cohen, 2005), such as the disruptions to communication that spaceflight crews are expected to face during long-duration exploration missions to deep-space destinations like Mars (den Otter and Emmitt, 2007; Fischer and Mosier, 2014, 2015; Kintz et al., 2016; Love and Reagan, 2013).

At present, crew members on the International Space Station (ISS) are able to communicate nearly instantaneously with fellow teammates who are located on the ground at Mission Control. However, long-duration missions will present major disruptions to these "normal" operations. As the crew travels further from Earth, the time it takes for radio waves to travel the distance (for messages to be sent and received) will increase dramatically—from about 2.5 seconds each way at the distance of the Moon to about 14 minutes each way at the distance of Mars itself (Love and Reagan, 2013). Potentially, these delays will wreak havoc on the expressive and instrumental interpersonal intrateam relationships that are needed to accomplish the mission (Maynard and Kennedy, 2016; Landon, Slack, and Barrett, 2018).

This research explores the impact of increasing delays in communication (i.e., decreasing synchrony) on expressive and instrumental multiteam systems over time in the spaceflight context. Building on prior research on virtual teams, which

suggests that asynchronous communication can have negative effects on collaboration and coordination (Fischer and Mosier, 2014; Kintz et al., 2016), we expect communication delays to be negatively associated with network connectivity (H1). However, we also propose that multiteam members may recognize the potential negative effects of communication delays on their interpersonal relationships and may modify their communication styles in order to mitigate those negative effects. That is, whereas multiteam members who are able to communicate with one another in real-time may use complex, task-focused language and not feel the need to "sugar-coat" their messages, multiteam members communicating asynchronously may rely more heavily on positive and less complex language in order to maintain positive relationships with their fellow teammates (H2).

Hypothesis 1: Communication delay is negatively associated with connectivity in instrumental (H1a) and expressive (H1b) networks. Hypothesis 2: Communication delay is positively associated with positive sentiment (H2a) but negatively associated with language complexity (H2b).

Methods. We tested our hypotheses using data collected during six 45-day missions conducted in collaboration with NASA's Human Exploration Research Analog (HERA). In each mission, 4 HERA participants (the "crew") collaborated four times on a simulation called "Project RED" with a group of 8 participants (i.e., the "ground"). Participants at different data collection sites or different rooms communicated using a text-based chat portal. Across the four sessions of each study, the degree of communication delay between the crew and ground was manipulated in each experimental session. At three time points during the course of each Project RED experimental session, participants responded to two sociometric items assessing instrumental network ties and expressive network ties, respectively. Participants were presented with a list of all 11 other team members and asked to select all other individuals to whom the item applied.

Analytic Approach. We analyzed the text of the messages sent from each participant A to each other participant B by calculating two metrics. The first metric, a "positivity" score, was calculated by counting the number of positive words in messages from A to B (based on Young and Soroka, 2012), subtracting the number of negative words, and dividing by the total number of words in the corpus. The second metric, "complexity," was calculated using the Flesch readability ease score (Flesch, 1948). We then examined the effects of time delay on network connectivity and communication using mixed-effects regression models in R (Bates et al., 2015). For the network-dependent variables, we used a logistic model due to the binary nature of the data, and for the communication variables we used a linear model. The communication variables were standardized for ease of comparison. In all models, we include the time delay as an independent variable. We also controlled for whether or not participants were in the HERA environment, what functional team in the multiteam system they were members of, and what mission phase they were in. We also controlled for the number of messages exchanged between participants. To account for the nested nature of the data (observations over time and within participants), we used mixed effects models, with a random intercept term included for each participant.

Results/Implications. Our analysis of network connectivity indicated that a greater time delay negatively impacts the formation of both instrumental and expressive ties. Specifically, the coefficient for delay in the regression model predicting leadership was negative and significant (b=-0.121, p<0.05). Interpreting this value as an odds ratio, we predict that an additional communication delay of one minute corresponds to an 11.4% reduction in the likelihood of an instrumental tie being reported, all else equal. The coefficient for delay in the regression model predicting enjoyment was also negative and significant (b=-0.203, p<0.01), corresponding to an 18.4% reduction in the likelihood of a tie for every additional minute of communication delay. Thus, we find support for Hypothesis 1.

Our analysis of communication patterns also revealed significant changes as a result of greater time delay. The relationship between delay and sentiment was positive and significant (b=0.084, p<0.001), indicating that individuals used more positive language (i.e., a greater rate of words with a positive connotation) when the time delay increased. We also found that a greater time delay was associated with significantly higher readability (b=0.115, p<0.001), indicating a lower level of linguistic complexity. Thus, we find support for Hypothesis 2. This study suggests a two-fold effect of communication delay for collaboration processes in LDEM multiteam systems. First, we find that communication delay is associated with diminished connectivity in the system-wide network. This suggests that although the crew might need to rely on the ground (and vice versa) in these extreme circumstances, the necessary leadership relationships might not form and/or might decay if they existed previously. Second, we find that people often make attempts to compensate for communication disruptions by using more positive and simpler (less complex) language. Potentially, although these changes to communication content might support the re-activation of social relationships between ground and crew, they might also pose problems for problem-solving in extreme circumstances.

2.5. The Impact of Team Membership Changes on Team Affect and Functioning (Research Foci #3 and Countermeasure #4)

Citation: Liu Y, Song Y, Trainer H, Carter D, Zhou L, Wang Z, Chiang, JT-J. 2022. Feeling negative or positive about fresh blood? Understanding veterans' affective reactions toward newcomer entry in teams from an affective events perspective. Journal of Applied Psychology. Advance online publication.

Throughout long-duration/long-distance space exploration missions, the membership and composition of teams and multiteam systems are likely to shift over time, creating potential challenges for maintaining positive psycho-social relationships and coordination. However, the majority of published research on team and multiteam collaboration has assumed there will be stable memberships throughout the duration of the team/multiteam lifecycle. Building on our prior review of extant literature relevant to understanding team memberships changes (Trainer et al., 2020), this year, we published empirical research (Liu et al., 2022) that helps to reveal the impact of team membership changes on the effect and subsequent teamwork processes of existing teams.

Abstract. New employees are often placed into existing work teams to meet the ever-changing work demands in today's organizations. Although research on organizational socialization has advanced our understanding of how newcomers adjust after joining a team, it remains largely unclear how team veterans navigate the same period of adjustment. Drawing upon affective events theory, we conceptualize newcomer entry into a team as a salient affective event that can trigger multiplex affective reactions among team veterans and ultimately shape team functioning (i.e., team processes and team performance). We propose that when a newcomer differs more from veterans in relational characteristics, such as trait likeability, veterans will have stronger negative affective reactions (i.e., stronger negative affect and weaker positive affect), whereas when the newcomer differs more from veterans in task-related characteristics, such as educational background, veterans will have stronger positive affective reactions (i.e., weaker negative affect and stronger positive affect) after newcomer entry. In addition, we propose that team performance prior to newcomer entry attenuates

the strength of the relationships between newcomer-veteran dissimilarities and veteran affective reactions. We tested our hypotheses in a laboratory simulation (Study 1) and a field survey study (Study 2). The results provided support for our theoretical model that the entry of a newcomer can bring multiplex affective consequences for veterans, depending on the type of newcomer dissimilarity to the team and the team's prior performance. Theoretical and practical implications of our findings are discussed.

2.6. Evaluation of Project RED FUSION MTS Training (Research Foci #3 and Countermeasure #2)

Citation: Gerkin E, Carter D, DeChurch LA. (Defended 2022 June). Thesis: Project RED: Learning to lead multiteam systems. University of Georgia (Advisor: Carter, D).

Background. Our research team conducted an additional validation effort of the Project RED Training over two weeks with a sample of n=120 undergraduate students at the University of Georgia. Project RED Training is designed to develop trainees' declarative knowledge of multiteam definitional features, challenges–particularly those associated with component team differentiation (Luciano et al., 2018)–and strategies associated with working within a MTS context. The purpose of this study was to evaluate the degree to which Project RED training enhanced trainees' understanding of such MTS concepts, unique collaboration challenges, and cross-team interaction strategies in comparison to a similar single team-training activity called "Interstellar."

Methods. Project RED is a paper-and-pencil-based training simulation involving up to 6 trainees per MTS. The simulation progresses in a series of three phases. During Phase I, each participant is assigned one of six roles and given a briefing document outlining their expertise and goals. Participants use their brief when choosing a landing site from among four possible locations. After each phase, trainees complete a "preference form" in which they specify their top landing site choices. The simulation is designed such that trainees' preferences are likely to evolve after working within their teams (Phase II) and then again after working as a member of the multiteam system (Phase III). During Phase II, participants are assembled into two 3-person teams with differing goals. Participants then had 10 minutes to meet with their teams, discuss which Mars landing site they think is optimal, and fill out a team preference survey. In Phase III, the teams form a MTS or task force. Without knowing that teams had different goals, participants are informed that the teams in the training set are divided on the ideal landing site. Participants are then informed that the two teams must then work together to complete the same goal of choosing a landing site. Taskforces are given a new brief, which can be customized to teach how component teams' differing goals impact multiteam system performance. Trainers can manipulate the extent to which teams focus on their team-level goals versus the broader system-level superordinate goal. Participants had 15 minutes to discuss which landing site the task force thinks were best. The task force then filled out a new preference survey.

Within Project RED, we also explored the use of a team-priority manipulation that is a customizable aspect of the Project RED multiteam training simulation. Each team within a task force was assigned to one of three different priorities: Team-, Compromise-, or Collaboration-focus. The Team-Focus asked participants to focus only on their team goals and not make any compromises. Under the Compromise-Focus, participants were told they would have to make concessions to achieve the superordinate goal. Lastly, the Collaboration-Focus had participants work collaboratively while still maintaining their team goals. Different combinations of science team priorities were used to create 4 conditions. Participants were debriefed during the third day of class and then took the multiteam system declarative knowledge measure for a second time (n = 136).

In order to evaluate the cognitive learning benefits of Project RED FUSION training simulation for teaching key lessons about multiteam collaboration (Kraiger et al.,1993), we compared knowledge scores of the same set of participants completing a team simulation and a multiteam simulation. Specifically, participants completed a 17-item, multiple-choice measure of MTS declarative knowledge. The test contained three subscales assessing general knowledge of MTS features, understanding of common MTS collaboration challenges, and awareness of effective strategies for working in MTSs. Participants' declarative knowledge regarding MTS features and challenges was compared after trainees completed a comparable team-based training simulation ("Interstellar") to their performance on the same knowledge test after completing Project RED.

Interstellar is similar to Project RED FUSION in storyline–participants are tasked with choosing the best of three planets for a future human colony. Interstellar was completed in two phases. During Phase I, participants were assigned a role: A, B, C, or D and given a short brief outlining the activity's goal and information on each planet option. Each role corresponded to a hidden profile (Stasser and Titus, 1985). Thus, each participant's brief contained unique information about the planets. Participants then filled out an individual preference survey. Afterward, participants formed "elite planetary science teams" (Phase II). Each team consisted of one participant from each role (4-person teams). Teams were given a new brief and 20 minutes to discuss which planet would be best. Teams then filled out a team preference survey with their planetary choice.

Results/Implications. Results demonstrate trainees' knowledge of multiteam system concepts is greater after completing Project RED than after completing Interstellar. Specifically, knowledge of multiteam system definitional features was higher after Project RED than after Interstellar. Knowledge of multiteam system challenges was higher following Project RED than following Interstellar. Lastly, knowledge of multiteam system working strategies was higher after trainees completed Project RED than after completing Interstellar.

Further, the comparison of different priority conditions within Project RED suggests that trainees pursue their assigned priorities and that the systems may be less likely to succeed overall when one of the teams behaved competitively and the other was willing to make compromises. Project RED is designed such that Argyre is the best location for the Habitation team, Casius is the best location for the Discovery team, Eridania represents a neutral compromise, and Diacria is the most optimal location for the whole MTS. Findings indicated that MTSs with a competitive goal structure were split on choosing optimal and non-optimal landing sites. However, MTSs with an asymmetric goal structure chose more suboptimal landing sites if one component team was focused on their team-level goals while the other was instructed to make compromises. If the other component team had a more collaborative goal structure, the MTS chose less non-optimal landing sites. Asymmetric goal-structured MTSs with one team-focused and the other collaboration-focused, in fact, showed the same response frequencies as MTSs in the symmetric goal structure. Overall, these results provide evidence supporting the benefits of Project RED for training multiteam system lessons.

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