

Fiscal Year:	FY 2017	Task Last Updated:	FY 01/24/2018
PI Name:	Salas, Eduardo Ph.D.		
Project Title:	Using Real-Time Lexical Indicators to Detect Performance Decrements in Spaceflight Teams: A Methodology to Dynamically Monitor Cognitive, Emotional, and Social Mechanisms That Influence Performance		
Division Name:	Human Research		
Program/Discipline:	NSBRI		
Program/Discipline--Element/Subdiscipline:	NSBRI--Neurobehavioral and Psychosocial Factors Team		
Joint Agency Name:	TechPort:	Yes	
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) 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		
PI Email:	eduardo.salas@rice.edu	Fax:	FY
PI Organization Type:	UNIVERSITY	Phone:	713-348-3917
Organization Name:	Rice University		
PI Address 1:	Department of Psychology		
PI Address 2:	6100 Main Street MS25		
PI Web Page:			
City:	Houston	State:	TX
Zip Code:	77005	Congressional District:	7
Comments:	NOTE: Previous affiliation was University of Central Florida, until mid-2015		
Project Type:	GROUND	Solicitation / Funding Source:	2012 Crew Health NNJ12ZSA002N
Start Date:	08/01/2013	End Date:	05/31/2017
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:	NSBRI
Contact Monitor:	Contact Phone:		
Contact Email:			
Flight Program:			
Flight Assignment:	NOTE: Element change to Human Factors & Behavioral Performance; previously Behavioral Health & Performance (Ed., 1/18/17) NOTE: End date changed to 5/31/2017 per NSBRI (Ed., 2/21/17) NOTE: End date changed to 1/31/2017 per NSBRI (Ed., 8/31/15) NOTE: End date is now 7/31/2016 (previously 11/30/2014) per NSBRI (Ed., 12/8/14) NOTE: End date is now 11/30/2014 per NSBRI (Ed., 7/15/14)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Driskell, James Ph.D. (Florida Maxima Corp.)		
Grant/Contract No.:	NCC 9-58-NBPF03402		
Performance Goal No.:			
Performance Goal Text:			

Task Description:

Future exploratory long-duration missions will incorporate a crew of six on a mission length of approximately 2.5 years. Challenges include the requirement for the crew to function autonomously, under significant communication delays, and with the potential for increased crew and interpersonal friction or tension. The specific aims of this research are to (1) develop a methodology to assess cognitive and emotional state at a distance through analysis of spontaneous verbal output in real-time communications and (2) test the feasibility of a real-time assessment tool, STRESSnet, to detect cognitive performance deficits, stress, fatigue, anxiety, and depression in the spaceflight operational setting. Because the health and well-being of crew members directly affects mission success, it is important to track cognitive/emotional changes that may indicate a deficit. One problem with many existing assessment methods is that most require direct observation of behavior or performance or self-assessment by a pen and paper-type instrument. The requirement to assess individual and team functioning at a distance suggests the potential efficacy of a methodology to assess cognitive and emotional state in real-time from ongoing or spontaneous verbal output. The basic premise of this work is that spontaneous verbal output provides a natural and valid indicator of basic cognitive processes. Natural word use is not prone to the typical limitations of self-report measurements. That is, natural language use is less subject to social desirability bias, and can be derived in real-time without interfering with the cognitive processes being measured, and without interrupting crew performance. Moreover, natural word use is reliable and consistent across time and context, and can be meaningfully measured in individuals and teams.

STRESSnet is a lexical analysis tool designed to provide a non-obtrusive means of detecting stress and related deficits in long-duration spaceflight through the assessment of spontaneous verbal output in real-time crew communications. The research builds on existing work on text and sentiment analysis; however, STRESSnet is unique in that (1) it is specifically designed to assess stress and related cognitive/emotional states, (2) we draw on existing astronaut communications and mission logs to develop a lexicon that includes terms unique to this environment, and (3) we developed STRESSnet with the specific goal of application as a tool to assess user state and provide automatic schedule recommendations for crew work/leisure activities to counter identified deficits.

This report summarizes data derived from testing STRESSnet in the Human Exploration Research Analog (HERA) 3 campaign. In summary, the HERA 3 data results are consistent with and support the results observed in the HERA 1 and HERA 2 campaigns. Our overall research goals are to: (1) Demonstrate that the lexical indicator measure (STRESSnet) correlates with existing cognate pen-and-paper measures of stress. (2) Demonstrate that the lexical indicator measure (STRESSnet) is sensitive to differences in operational variability, such as levels of workload or stress. (3) Demonstrate that the lexical indicator measure (STRESSnet) is sensitive to other variables of interest, such as within-group or between-group differences.

The HERA 3 data described in the following sections indicate that the primary STRESSnet lexical measures of Social Impairment, Anxiety, Cognitive Load, and Attentional Focus were consistent with pen-and-paper measures of these same constructs. Negative affect as measured by Positive and Negative Affect Schedule (PANAS) was very low across Campaign 3 missions and this lack of variability resulted in inconsistent relationships with lexical measures of negative emotion. Second, STRESSnet measures for each primary facet consistently differentiate between high and low workload days in HERA. Third, STRESSnet measures were sensitive to differences in the type of communications (e.g., task-oriented vs. non-task oriented communications). Fourth, using STRESSnet measures of anger and cognitive anxiety, we were able to identify a reported elevated episode of anger in one mission, demonstrating the utility of this approach for diagnosing crew stress and well-being during long duration spaceflight.

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

Because the health and well-being of crew members directly affects mission success, it is important to track cognitive and emotional changes that may indicate a deficit. The requirement to assess individual and team functioning at a distance suggests the potential efficacy of a methodology to assess cognitive and emotional state in real-time from ongoing or spontaneous verbal output. The basic premise of this work is that spontaneous verbal output provides a natural and valid indicator of basic cognitive processes. Natural word use is not prone to the typical limitations of self-report measurements, which include social desirability bias, and it can be derived in real-time without interfering with the cognitive processes being measured, and without interrupting crew performance. Moreover, natural word use is reliable and consistent across time and context, and can be meaningfully measured in individuals and teams. The major accomplishments of this research project include (1) the development of a theoretical model of cognitive performance deficits, stress, fatigue, and anxiety in spaceflight based on existing research on lexical analysis and language usage in astronauts, (2) the development of a lexical analysis tool, STRESSnet, to unobtrusively track and assess stress in individuals and teams, and (3) the implementation and empirical testing of this approach in HERA1, HERA2, HERA3. The STRESSnet tool will permit dynamic, unobtrusive detection of stress and related cognitive deficits during spaceflight, and many Earth-based applications. It is expected that a real-time assessment and graphical display of stress effects, as well as measures of fatigue, mood, and team functioning drawn from ongoing verbal or textual communications, could be used in healthcare, military, education, law enforcement, and many other workplace applications. It also has the potential to contribute to the growing market for sentiment analysis tools in social media and online communications.

Task Progress:

The Year 1 tasking was to conduct a proof-of-concept study to demonstrate the feasibility of this approach in the HERA 1 analog. This was accomplished, demonstrating that (a) lexical measures can distinguish between high stress and nominal stress in HERA, (b) these measures are consistent with traditional pen and paper measures of stress, and (c) they show sensitivity to variations in stress levels (documented in the Year 1 technical report). Year 2 research efforts focused on extensive development of the lexical analysis tool, STRESSnet, that is specifically tailored to assess stress effects in the LDSF (long duration space flight) environment. This included the methodological development of the STRESSnet program and corresponding lexical dictionaries (documented in the Year 2 Annual Report). Year 2 tasks also included data collection and analysis testing this approach in the HERA 2 campaign.

Year 3 tasks included the HERA 3 campaign data collection and analysis. The project deliverables include: (1) STRESSnet program code, (2) validation data from three HERA campaigns: HERA1, HERA2, HERA3, (3) dictionaries of searchable terms that could be used by NASA for nonintrusive detection of performance-relevant changes in cognitive, emotional, and social interaction, and (4) Scientific reports describing the use of lexical measures to assess stress-related deficits in spaceflight.

Bibliography Type:	Description: (Last Updated: 09/04/2023)
Articles in Peer-reviewed Journals	Driskell T, Driskell JE, Burke CS, Salas E. "Team roles: A review and integration." Small Group Research. 2017 Aug 1;48(4):482-511. https://doi.org/10.1177/1046496417711529 , Aug-2017
Articles in Peer-reviewed Journals	Driskell T, Salas E, Driskell JE. "Teams in extreme environments: Alterations in team development and teamwork." Human Resource Management Review. 2018 Dec;28(4):434-49. https://doi.org/10.1016/j.hrmr.2017.01.002 [originally reported in late 2017 as "2017 Feb 13 Available online. In press, corrected proof"] , Dec-2018
Articles in Peer-reviewed Journals	Marlow SL, Lacerenza CN, Salas E. "Communication in virtual teams: A conceptual framework and research agenda." Human Resource Management Review. 2017 Dec;27(4):575-89. https://doi.org/10.1016/j.hrmr.2016.12.005 , Dec-2017
Articles in Peer-reviewed Journals	Driskell JE, Salas E, Driskell T. "Foundations of teamwork and collaboration." American Psychologist. 2018 May-Jun;73(4):334-48. https://doi.org/10.1037/amp0000241 ; PubMed PMID: 29792452 , May-2018
Articles in Peer-reviewed Journals	O'Neill TA, Salas E. "Creating high performance teamwork in organizations." Hum Resour Manage Rev. 2018 Dec;28(4):325-31. Epub 2017 Oct 12. https://doi.org/10.1016/j.hrmr.2017.09.001 , Dec-2018
Books/Book Chapters	Salas E, Vessey WB, Landon LB, editors. "Team dynamics over time." Ed. E. Salas, W.B. Vessey, L.B. Landon. Bingley, UK: Emerald Publishing, 2017. 352 p. https://doi.org/10.1108/S1534-0856201618 , Aug-2017
Books/Book Chapters	Salas E, Rico R, Passmore J, editors. "The Wiley-Blackwell Handbook of the Psychology of Team Working and Collaborative Processes." Ed. E. Salas, R. Rico, J. Passmore. Malden, MA: Wiley-Blackwell, 2017. 640 p. https://doi.org/10.1002/9781118909997 , Apr-2017
Books/Book Chapters	Salas E, Reyes DL, Woods AL. "The assessment of team performance: Observations and needs." in "Innovative assessment of collaboration." Ed. A.A. Von Davier, M. Zhu, P.C. Kyllonen. New York: Springer Verlag, p. 21-36, 2017. https://doi.org/10.1007/978-3-319-33261-1_2 , Apr-2017
Books/Book Chapters	Dinh JV, Salas E. "Factors that influence teamwork." in "The Wiley Blackwell Handbook of the Psychology of Team Working and Collaborative Processes." Ed. E. Salas, R. Rico, J. Passmore. Malden, MA: Wiley-Blackwell, 2017. p. 15-42. https://doi.org/10.1002/9781118909997.ch2 , Mar-2017
Books/Book Chapters	Dietz A, Driskell JE, Sierra MJ, Weaver SJ, Driskell T, Salas E. "Teamwork under stress." in "The Wiley Blackwell Handbook of the Psychology of Team Working and Collaborative Processes." Ed. E. Salas, R. Rico, J. Passmore. Malden, MA: Wiley-Blackwell, 2017. p. 297-316. https://doi.org/10.1002/9781118909997.ch13 , Mar-2017
Books/Book Chapters	Driskell JE, Salas E. "Sustaining individual motivation in high-demand team environments." in "Individual Motivation within Groups : Social Loafing and Motivation Gains in Work, Academic, and Sports Teams." Ed. S. Karau. Cambridge, MA: Academic Press, 2019. p. 191-222. https://www.elsevier.com/books/individual-motivation-within-groups/karau/978-0-12-849867-5 [Note: reported originally in Jan 2018 as "in press" December 2017], Oct-2019
Books/Book Chapters	Driskell T, Driskell JE, Salas E. "Lexicon as a predictor of team dynamics." in "Team Dynamics over Time. (Research on Managing Groups and Teams, Volume 18)." Ed. E. Salas, B. Vessey, L. Landon. Bingley, UK: Emerald Group Publishing, 2017. p. 231-257. http://www.emeraldinsight.com/doi/full/10.1108/S1534-085620160000018010 , Aug-2017