

Fiscal Year:	FY 2014	Task Last Updated:	FY 09/02/2013
PI Name:	Miller, Christopher Ph.D.		
Project Title:	AD ASTRA: Automated Detection of Attitudes and States through Transaction Recordings Analysis		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Behavior and performance		
Joint Agency Name:	TechPort:	No	
Human Research Program Elements:	(1) BHP :Behavioral Health & Performance (archival in 2017)		
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		
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Zip Code:	55401-1480	Congressional District:	5
Comments:			
Project Type:	GROUND	Solicitation / Funding Source:	2010 Crew Health NNJ10ZSA003N
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No. of PhD Candidates:	1	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
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Flight Program:			
Flight Assignment:	NOTE: Extended to 2/28/2015 per NSSC information (Ed., 8/5/14)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Wu, Peggy (Smart Information Flow Technologies, LLC) Schmer-Galunder, Sonja (Smart Information Flow Technologies) Rye, Jeffry (Smart Information Flow Technologies) Tammy, Ott (Smart Information Flow Technologies)		
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Task Description:

Long duration missions present unique challenges to the behavioral health of astronauts. Factors such as lack of team coherence, workload, social monotony, access to family and psychosocial support, and interpersonal and cultural differences can affect both crew welfare and task performance. Metrics and methods for assessing these factors are difficult to obtain because some are inherently qualitative, while others may not be amendable to self reports. Since these factors are affected, even largely the product of, interpersonal communication, it is not surprising that interpersonal communications are our primary key to them. There are already rich sources of interpersonal communication data--both intra-crew and between flight crew and ground-- which are created and archived during International Space Station (ISS) missions. Recent research suggests that verbal and non-verbal communications can be automatically processed in a variety of ways to provide insight into team cohesion, affective and cognitive states and team performance. Our project focuses upon the identification of suitable combinations of processing techniques (which we call "Non-Intrusive Psycho-Social State Assessors" or NIPSSAs) and data streams for assessing psycho-social states. We leverage prior work of our own and others in cultural and socio-linguistic theory to develop standardized, non-intrusive and largely automated methods for data collection and knowledge extraction of data about team interactions, relationships and individual psycho-social states from existing data streams captured as a part of normal space operations--primarily, as determined in our first program year, verbal task interactions originating in or converted to text and personal journal entries. The created assessment technologies enable the identification and tracking of serious threats to individual and group behavioral health and task performance in order to provide empirical data with which countermeasures, training and crew selection approaches can be systematically created to aid team performance and coherence in long duration space missions. Last year we identified candidate assessment techniques, assessed likely data streams and desired state assessments to identify promising combinations, and prototyped and assessed these techniques on archival data representative of NASA missions and operational contexts. This year we participated in 4 analog studies to validate these techniques on "live" data for which we also obtained concurrent survey data from participants. While we intended to study data representative of individualized logs and interactive task communications in text to date the majority of our analyses and findings have involved automated assessment of journal data. For this data type, we have substantial validation support for our approaches, as well as a range of results pertinent to the psychological states of subjects in long term bed rest and team habitat environments.

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

The ability to non-intrusively assess individual psychological and team social states would be a huge benefit to a wide range of business and government endeavors. Systems based on our NIPSSA processing techniques could be used in many different environments where information about team interactions, relationships and individual psycho-social states would be useful to improve behavioral health and task performance. Since the start of the program we have received interest from military agencies seeking to assess the readiness and performance of their own teams, to train military personnel in team interactions within or outside their own culture, and to assess the character and relationships of those in the enemy camp. Additionally, we conversed with marketing research and organizational management evaluation firms who wished to make use of our approaches to assess opinion leaders and team performance and have been in discussions to utilize our techniques in the area of health care teams and human-automation interaction and/or training approaches. During this program year, we have begun analysis of transcribed communications among surgical and emergency medical teams and have provided preliminary demonstrations of the ability of our leadership and "comfort/routine" NIPSSA detectors to identify valid data in these domains. This work has led to a recent proposal to the U.S. Army for a non-intrusive medical team training and analysis tool and multiple additional, opportunistic analysis efforts within NASA this year.

The overall objective for the project is to identify suitable combinations of processing techniques (which we call "Non-Intrusive Psycho-Social State Assessors" or NIPSSAs) and data streams for assessing psycho-social states of interest to NASA. The second year of our project was targeted at transitioning the promising NIPSSA techniques we found with last year's work on historical data to validation studies with newly collected "live" data from ongoing studies in analog environments.

During the last program year, we identified three potential analog studies and were attempting to prioritize and select among them. To date, in partial testimony to the ease and speed with which data can be analyzed using our tools, we have participated to some extent in all three, and are examining data from a fourth as well.

1. A bed rest analog allowed us develop our general techniques and to collect long-duration journal data for evaluating NIPSSA techniques for individual psychological state data under controlled and monitored conditions which included some of the physical duress and isolation that astronauts suffer. Data has been collected on 11 subjects to date and analyzed.

2. The UCF/gOE team roles experiment is allowing us to extend our techniques to collect interactive communications from a team involved in tasks analogous to ship mission operations and generate novel team task- or function-based NIPSSA's. Data collection is beginning this month.

3. HI-SEAS team habitat analog offered the best analog to true astronaut living and working conditions and allowed the capture of crew-to-ground communications, as well as individual journals. The study is complete but to date we have only received journal and survey data (no crew-ground communications) and have begun analysis of this.

4. AMO is an ongoing study of simulated crew-mission operations under varying time lag conditions. We have recently begun examining transcribed speech data from this study to both validate our NIPSSA techniques and seek effects of time lag on social interaction behaviors.

Due to timing of the studies most findings from this year come from the bed rest analog journal data, with some additions from HI-SEAS. A summary of our findings follows:

- Correlations between our assessments of subjects' psychological states and attitudes using NIPSSA techniques from free-form journal entries are proving to be regularly correlated with subjects' own survey responses in the bed rest and, to a lesser degree, HI SEAS studies. This serves to validate our general approach, at least to the extent that it can glean information that more intrusive surveys or more time-intensive human reading and processing of journal entries might. It also serves to focus us on which kinds of NIPSSA analyzers for maximal reliability. States which we can assess through automated journal analysis validated with subject survey data include negative emotion and anxiety, past vs. present focus, focus and positive/negative affect about the (bed rest) study and their participation in it, focus on and sentiment

	<p>about their own physical state, and focus on self vs. others.</p> <ul style="list-style-type: none"> • Latent Semantic Analysis techniques are enabling us to assess the valence of subjects' writing about specific topics, and to determine some of the associations that drive those feelings. We demonstrate this with regards to the topics of food and ingestion, identifying subjects for whom food is a more central focus of attention and writing, but also those for whom it is a generally positive vs. generally negative topic, as well as specific time periods of more or less focus and affect about it. <p>Task Progress:</p> <ul style="list-style-type: none"> • Staff ratings for bed rest participant's mental states were reasonable predictors of subject's own ratings, but they sometimes differed significantly (especially about self-reported emotional state), while journals processed using our NIPSSA techniques were frequently better correlated. • We illustrated multiple, powerful capabilities to process individual subject's journal entries without a detailed human reading and report topics of interest, subject's feelings about and associations with those topics, what drives positive or negative valence in an entry (either in general or about a specific topic), etc. These capabilities provide a detailed insight into each unique individual's thought processes without a substantial investment in specialists' time. • We have used these techniques, and both the journal and survey data collected this year to begin identifying general trends across subjects—data that may serve to directly assist in retiring BHP gaps. Chief among these is the findings that (a) although word count for journal entries differed significantly across subjects, it did not regularly differ over time, indicating that there is no a priori reason to expect the effectiveness of journaling to diminish over time, (b) positive affect, the use of positive emotion terms, perception terms and affect terms in general diminish over the 100 day period of bed rest, but negative emotions do not necessarily increase and (c) mentions of physical state tend to correlate with negative feelings about physical state, but mentions decline over time, and (d) in open-topic journals such as these, crews tend to write more on abnormal days and days with good crew-ground interactions which implies that such writing may serve as an indicator of good interactions, but also that examination of bad interactions is not done as deeply. • Finally, we note that our NIPSSAs are delivering on their promise of rapid assessment of non-intrusive data. We were able to process 2 months of journal and survey data from 5 HI SEAS participants in less than 1 week. Human coding (not to mention reading) of such results could not begin to match that pace. Similarly, upon recently receiving interactive task communication data from the Autonomous Mission Operations study, we were able to process it with our existing power/leadership and team comfort NIPSSAs in under 2 hours, though those data have yet to be reviewed. <p>Additional progress includes the creation of tool for visualizing the resulting bed rest data to aid in understanding the change of psycho-social measures over time. We also continued NIPSSA development this year, including the definition of multiple recognition categories relevant to the analyses of bed rest and HI SEAS and the initial development of a novel type of interactive task communication NIPSSA which, if validated, will not require speech-to-text transcription. Finally, we are currently involved in planning for a series of team analog studies to be performed in the new Human Exploration Research Analog (HERA) facility during our next program year. HERA will provide unique tests to our techniques as it is planned to yield crew-crew communications (in speech recordings to be transcribed to text), videos, as well as structured variations in workload, tempo and potentially crew-ground interactions.</p> <p>The results achieved during this program year now demonstrate the viability of one class of non-intrusive psycho-social state detectors to streamline, speed and in some cases, enable, the collection of data to effectively monitor and measure team and individual health and performance fluctuations during autonomous, long duration exploration missions. For journal data, we have been successful at applying NIPSSA techniques to a variety of "live" analog settings to both validate them and learn more about what can be derived from them and, somewhat beyond initial expectations, we are already beginning to supply data relevant to retiring BHP gaps using these NIPSSA techniques. We have designed, identified and are beginning to collect and analyze data from additional analog studies pertinent to other classes of NIPSSAs.</p>
Bibliography Type:	Description: (Last Updated: 12/08/2015)
Abstracts for Journals and Proceedings	<p>Vessy WB, Tannenbaum S, Smith-Jentsch K, Kozlowski S, Miller C. "Looking Forward to Mars: Researching Teams for Future Exploration Missions." 2013 Meeting of the Society for Industrial and Organizational Psychology, Houston, TX, April 10-15, 2013.</p> <p>Proceedings of the 2013 Meeting of the Society for Industrial and Organizational Psychology. Houston, TX, April 10-15, 2013. , Apr-2013</p>
Abstracts for Journals and Proceedings	<p>Fisher U, Mosier K, Orasanu J, Morrow D, Miller C, Veinott B. "Exploring Communication in Remote Teams: Issues and Methods." 57th Annual Meeting of the Human Factors and Ergonomics Society, San Diego, CA, September 30-October 4, 2013.</p> <p>Proceedings of the 57th Annual Meeting of the Human Factors and Ergonomics Society, San Diego, CA, September 30-October 4, 2013. In press as of September 2013. , Sep-2013</p>
Articles in Peer-reviewed Journals	<p>Miller C, Wu P, Ott T. "Politeness in Teams: Implications for directive compliance behavior and associated attitudes." Journal of Cognitive Engineering and Decision Making. 2012 Jun;6(2):214-42.</p> <p>http://dx.doi.org/10.1177/1555343412440695 , Jun-2012</p>
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Papers from Meeting Proceedings	<p>Wu P, Rye J, Miller C, Schmer-Galunder S, Ott T. "Non-Intrusive Detection of Psycho-Social Dimensions using Sociolinguistics." 2013 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining, ASONAM 2013, Niagara Falls, Canada, August 25-28, 2013.</p> <p>2013 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining, ASONAM 2013, Niagara Falls, Canada, August 25-28, 2013. , Aug-2013</p>