Fiscal Year:	FY 2019	**Task Last Updated:**	FY 09/20/2019
PI Name:	Rosen, Michael Ph.D.		
Project Title:	Developing and Validating Sensor-based Measurement Strategies for Team Member Selection		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Behavior and performance		
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) **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:**	2014-15 HERO NNJ14ZSA001N-MIXEDTOPICS. Appendix E: Behavioral Health & Human Health Countermeasures Topics
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Flight Assignment:			
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Task Description:	Selection of astronauts for Long Duration Spaceflight Exploration (LSDE) missions poses challenges for NASA including the need to define and select candidates based on a new set of behavioral competencies underpinning effective performance in these extended and isolated missions. Additionally, an effective selection system will require new measurement methods capable of discriminating between individuals in a population already exhibiting extreme range restriction. Sensor-based, sociometric, and more generally, unobtrusive measurement methods hold promise as valuable tools for addressing these needs and complementing existing competency assessment methods. The proposed work seeks to advance the science and practice surrounding diagnostic measurement of LDSE competencies using a blended approach where sociometric techniques are combined with traditional assessment methods. We will leverage our team's extensive, transdisciplinary experience in signal processing and analysis of complex dynamic network data, psychometrics, performance assessment, and developing theory and strategies for LDSE team improvement to: (1) generate predictive validity evidence for LDSE behavioral competencies, (2) develop sociometric indices of those competencies and provide evidence of their validity, (3) develop an open architecture system for integrating sensor-based measurement systems and extracting sociometric indices, and (4) generate guidelines for the use of sociometric measures in the selection process. Our technical approach for achieving these aims involves metric development, metric validation, assessment architecture system design, and selection guideline development. First, metric development will involve updating our current literature review of unobtrusive measurement to incorporate findings from recent NASA efforts. We will also apply reactive systems modeling to systematically map sensor-based measurement system requirements with potential metrics for assessment. Next, we will conduct exploratory human in the loop analyses to identify additional candidate measures using tensor-decomposition methods of archival data to detect performance patterns. Metric validation will occur in a LDSE analog (HERA--Human Exploration Research Analog) as well as two clinical residency programs in order to increase the sample size needed for analysis. Specifically, we will prospectively collect the following from each context: traditional assessments of competencies (self-report, observation), sociometric assessments of competencies, and multi-dimensional outcomes (task outcome measures, multiple rater assessments). Validation studies will be conducted to establish the link between LDSE competencies and performance outcomes, demonstrate the relationships between sociometric and traditional measures of LDSE competencies, as well as index the amount of variability in outcome measures accounted for by sociometric indices above and beyond traditional measures. The next phase of this project involves advancing methodology and analytic capabilities for competency assessment using sociometric indices. The analytics developed will distill meaningful metrics from complex, dynamic sensor data that can be used across a range of sensor devices, providing a generalizable ‘middle layer’ architecture for processing these data. This analytic process involves integrating and mapping these diverse measurement sources to generate a valid and actionable depiction of performance (i.e., to guide selection). Findings from these efforts will result in evidence-based, practical, and validated guidelines for incorporating unobtrusive measurement into the astronaut selection process. Overall, successful completion of this project will advance the science and practice of multi-method individual and team LDSE competency assessment.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Final products from this work will advance evidence-based selection practices for currently difficult to assess teamwork related competencies. This will result in an astronaut corps more prepared to meet the demands of long duration space exploration. Additionally, these practices can benefit other professions where these competencies are germane.
Task Progress:	Reporting for the period 11/7/16-11/6/18 To date, project efforts have centered on clarifying program focus with research and operational sponsors, and building the evidence-base for assessment and selection practices through literature review. Task 1.1. Finalize competencies, tasks, and timescales and performance criteria for each analog. Per discussions with NASA research and operational sponsors, this work focuses on three main LDSE competencies and their sub-competencies: teamwork (including team orientation, team care, communication), leadership / followership, and operational problem solving (including judgment, adaptability). Task 1.2. Finalize traditional competency measures. This task is largely complete. We have reviewed the literature for team orientation, team care, communication, leadership / followership, and adaptability. Some of these competencies map clearly on to constructs reported in the literature (e.g., team orientation, communication) while others are more complex (e.g., team care). For these more complex competencies, we have generated a list of component constructs related to this competency and preformed literature reviews on those. The goal of these reviews was to identify specific scales or measurement practices used for focal constructs and their associated validity evidence. We are in the process of generating white papers detailing best measurement and assessment practices for each of these areas. Task 1.3.1 Map LDSE competencies to existing sociometric evidence and theory. This task is largely completed--we have conducted two literature reviews to synthesize available validity evidence and measurement practices for unobtrusive measures. The first focuses on the use of physiological measurement within teams. This review was systematic, as search terms are relatively definable and the literature is reasonably well organized. The second review focused on unobtrusive measures of team communication including content-based analysis methods (lexical analysis, supervised learning, and generative modeling techniques) and paralinguistic features of speech (communication flow, vocal features, gesture and posture, facial expression, and gaze behavior). This review is narrative as the literature is not well organized and spread across multiple literatures. Each of these reviews has informed study design and measurement planning for this work and will be submitted as white papers to NASA and developed as peer reviewed articles. Task 1.3.2 Reactive systems task analysis method. We had proposed to develop a method for team task analysis that mapped unobtrusive measurement practices to a given team’s configuration and workflow. After discussion with operational team, it was decided that a scenario design method would be more helpful. We are reframing the deliverables of this task to include guidance on how to design scenarios that tap targeted LDSE competencies by generating scenario events (task conditions) representing opportunities to enact competencies linked to traditional and unobtrusive measurement practices. We are currently developing this approach by linking the findings of literature reviews described above. Task 1.3.3 Sensor pilots. As unobtrusive measurement methods are relatively new, and there are unanswered questions about their psychometric properties, we are designing and conducting a series of studies to rigorously assess the error structure of data generated with these methods. We have identified (through literature review and task analysis) four

	categories of measurement facets that could systematically influence data: 1) device, equipment, and processing factors, 2) environmental and physical layout factors, 3) team characteristics, and 4) task and work process factors. We will be conducting a G-study in the upcoming months to determine the magnitude of variance associated with each of these measurement facets. Task 4. Develop open architecture assessment system. One of the final project deliverables includes an open 'middle layer' system for extracting unobtrusive measures of LDSE competencies from multiple sensor systems. We have developed the first iteration of database linking data from physiological, communication, and location-detection systems. This is necessary to enable upcoming data collection efforts and sensor pilot studies. This version of the database is implemented in SQLite for rapid prototyping. The next major iteration will be developed using PostgreSQL to improve scalability for data collection across multiple sites and afford the ability to include complex data extraction methods (e.g., pre-processing of physiological signals, generating measures of synchrony across data streams for a team) within the database itself.
Bibliography Type:	Description: (Last Updated: 11/25/2023)
Articles in Peer-reviewed Journals	Rosen MA, DiazGranados D, Dietz AS, Benishek LE, Thompson D, Pronovost PJ, Weaver SJ. "Teamwork in healthcare: Key discoveries enabling safer, high-quality care." Am Psychol. 2018 May-Jun;73(4):433-50. Review. https://doi.org/10.1037/amp0000298 ; PubMed PMID: 29792459; PubMed Central PMCID: PMC6361117 , Jan-2019
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