Paper ID: 63566
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IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Behaviour, Performance and Psychosocial Issues in Space (1)

Author: Ms. Lea Smart Miller
Embry-Riddle Aeronautical University, United States, millel32@my.erau.edu

Mr. Nikolas Blanks
Embry-Riddle Aeronautical University, United States, nikoblanks@gmail.com
Dr. Ryan Kobrick
Paragon Space Development Corporation, United States, ryanxpc@gmail.com
Dr. Erik Seedhouse
Embry-Riddle Aeronautical University, United States, seedhoue@erau.edu

ANALOGUE EVA RESULTS FROM HI-SEAS FOR DEVELOPMENT OF THE RXEVA HUMAN FACTORS SUBSYSTEM

Abstract

The RxEVA Project is a theoretical mission planning tool conceived in response to the technological gap "Risk of Injury and Compromised Performance Due to EVA Operations" stated by NASA in their Human Research Roadmap. The human factors subsystem of the RxEVA model is responsible for characterizing and quantifying human performance and incurred workload due to extravehicular activity (EVA) task difficulty. This paper details the results of the second iteration of high fidelity data collection during a simulated Moon mission (Sensoria M3 4-18 Dec 2020) at the Hawaii Space Exploration and Analog Simulation (HI-SEAS) research facility.

Further analogue EVA data was necessary to establish general performance limitations, create a standardized hierarchy of EVA task difficulty, and develop a predictive correlation between individual performance and EVA task intensity. Pilot data was collected from two Sensoria M3 crew members throughout 7 simulated EVAs. Hexoskin Smart shirts recorded heart rate (HR) and activity data, which were used to calculate total physical energy expenditure. A suite of cognitive workload tools including the Rate of Fatigue scale, Karolinska Sleepiness Scale, Comfort Affected Labeled Magnitude, and NASA Task Load index, were used to quantify perceived workload before, during, and after EVA's. Suited workout sessions were also conducted to provide standardized energy expenditure data sets that will be used to assess the validity and reliability of the Hexoskin Smart shirt.

Personalized performance maps were created using time-stamped notes of EVA activities to link average HR and energy expenditure to specific mission tasks. A predictable trend of gross energy deficit during singular excursions was established per person. EVA task difficulty varied by astronaut but was ultimately most influenced by the amount of time it took to perform a task rather than individual factors of the performing crewmember (i.e. age, height, weight, gender, physical fitness). Furthermore, mental and emotional workload impacted individuals' desire to perform consecutive EVAs but did not necessarily influence their physical performance.

Future work includes fortifying conclusions drawn from past analogue missions by collecting further performance data from a diverse group of analogue astronauts. To validate the Hexoskin data and account for future potential error, an indirect calorimetry test will be conducted on one participating crewmember and the data compared to their standardized workout sessions. The final goal of this project is to develop a mathematical model that can accurately predict a user's energy expenditure based on a series of assigned EVA tasks.