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THINK LIKE A TEAM: SHARED MENTAL MODELS PREDICT CREATIVITY AND
PROBLEM-SOLVING IN HERA AND SIRIUS '19

Abstract

Long distance space exploration will require highly autonomous crews to work collaboratively on complex tasks. Crew members will be diverse along many dimensions. These sources of diversity can enable them to solve a wider range of problems, both those foreseen before launch, as well as the unforeseen challenges that must be solved with minimal help from Earth. Previous research in ground-based analogs documents declining team performance over time. Thus, it is important to identify predictors of team performance - properties of teams that can be monitored during space flight to anticipate performance decrements. Monitoring predictive conditions of team performance allows crews to anticipate potential challenges and to improve team states required for high performance. The most robust team state predicting performance in the team effectiveness literature is shared mental models. We developed a measure of shared mental models for use in ground-based analogs. It was administered in NASA's HERA Campaign 4, Campaign 5, and the SIRIUS'19 analog. HERA included 4-member crews in isolation for 45 days; SIRIUS included a 6-member crew isolated for 120 days. We assessed crew shared mental models 38 times in HERA and 35 times in SIRIUS. In order to track performance variations, we administered two team tasks: a problem solving task and a creative thinking task. Shared mental models were elicited by each crew member using pairwise comparisons of 8 task elements. The measure captures each person's mental understanding of the task. Then we used Euclidean Distance measures between each pair of crew, and then aggregated to the team level, to represent the degree to which their mental models are dissimilar (distance). Problem-solving performance was measured with survival tasks, and the team score was the deviation from the expert rating. Creative performance was assessed with alternative uses tasks, using three indices: fluency, flexibility, and originality. We found substantial positive correlations of shared mental models and both dimensions of team performance in HERA and in SIRIUS '19. Though shared mental models are a strong predictor of team performance across mission stages, we found some nuanced shifts. First, shared mental models are the most strongly predictive of performance on creative thinking tasks before and after communication delay. Second, on problem solving tasks, shared mental models increase in predictive power continuously throughout the mission. Third, of all the outcomes, fluency is the most predicted by shared mental models. Implications for crew performance on long-distance space missions are discussed.