A SUCCESSFUL CREW COMPOSITION COUNTERMEASURE VALIDATED IN HERA

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BACKGROUND

Throughout long-duration missions, crews will need to collaborate to complete various tasks. Prior work has demonstrated that interpersonal relationships - in particular, affect towards team members and leadership between team members - impact the ability of a crew to function effectively [1].

Over the past three years, we developed and validated an agent-based model to predict team composition in long-duration space exploration (LDSE) [2]. Our model, based on analog data gathered from eight HERA crews, allows us to perform computational simulations predicting which crews are likely to maintain positive patterns of social relationships (positive affect, hindrance, leadership, and followership) during extended missions. In addition to advancing our substantive understanding of teamwork in LDSE, these models can recommend specific in-mission countermeasures and risk mitigation strategies for a future crew. Today, we present results of experiments testing the use of our model to recommend in-mission scheduling to improve team outcomes.

STUDY DESIGN

To validate the model as a countermeasure, we conducted an experiment on 4 crews completing 45-day missions in Campaign 5 of the Human Exploration Research Analog (HERA). We ingested the crewmembers' baseline data (e.g., personality, demographics) into the model and used it to make predictions, before crew ingress, about the relationships that would develop among members of the crew. We conducted "what - if" simulations systematically varying who was paired together on two high-interdependence tasks: (i) The *Phobos Sampling task*, in which crew members completed analysis on a simulated asteroid sample, and (ii) the *Rover task*, in which crew members constructed and tested a mechanical rover. The model identified a "best case" and "worst case" pairing. We then divided the mission into 4 periods. In two of the quarters, crew members in the "best pairing" based on our model were assigned to work on the tasks together. In the remaining two quarters, crew members in the "worst pairing" were assigned to work together. Work experience and relationship quality were measured following each task.

RESULTS

When the "best pairings" of individuals, recommended by our model, completed tasks together, they exhibited better relational outcomes than did the "worst pairings" selected by our models. On the Phobos sampling task, the best pairings reported greater agreement with the item "Working with my partner on the Phobos task was a positive experience" than the worst pairings (mean difference $\mu = 0.75$, $p = 0.07$), and less agreement with "Spending time with my partner on the Phobos taks was damaging to our relationship" (mean difference $\mu = -0.88$, $p = 0.07$). A similar pattern occurred for the Rover task. Best pairings reported greater agreement with the item "I enjoyed working with my partner on the Rover task" than the worst pairings (mean difference $\mu = 0.38$, $p = 0.20$). Best pairings reported less agreement with the item "Spending time with my partner on the Rover task was damaging to our relationship" than the worst pairings (mean difference $\mu = -0.07$, $p = 0.42$).

These results provide a proof-of-concept for how agent-based models can support future space exploration crews. Even minor alterations to in-mission scheduling have demonstrable effects on crew outcomes. Computational models have high potential to shape larger decisions in task scheduling or crew composition.

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REFERENCES

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Summary: The CREWS computational model was parameterized on data from HERA C3 and C4 and then subsequently used as a successful crew composition countermeasure to predict and improve crew relations in HERA C5.