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LEADING THE CREW TO MARS: EVIDENCE FROM NASA HERA ANALOG CREWS

Abstract

Extreme autonomy awaits the human crews who will someday set out to explore deep space. These crews will be largely self-regulating, relying on one another to overcome the innumerable challenges they'll face along the way. One of the most consequential social dynamics in self-regulating crews is leadership. In contrast to the formal and hierarchical leadership arrangements of current and past space missions, future missions may benefit from shared forms of leadership, whereby multiple crew members engage in the regulation of the crew over time. Prior research on groups finds that while shared leadership may be advantageous, it may also be unstable. This study investigates the likelihood of shared leadership emerging and persisting in self-organizing groups living and working in NASA's Human Exploration Research Analog (HERA). The HERA crew includes a nominal commander lacking formal authority or responsibility. We observed leadership in 13 crews participating in HERA campaigns between 2016 and 2020. Campaign 3 includes 4, 30-day missions; Campaigns 4 and 5 each included 4, 45 day missions. Leadership was measured via sociometric surveys administered every few days, asking: "Who do you rely on for leadership?" We then derived a measure of the number of leaders in the crew at each time point from 0 to 4. The crew leadership network was shared if there were at least two leaders, hierarchical if only one, and fragmented if there was no crew member recognized as a leader by all crew-mates. We discovered two organizing principles. First, shared leadership was likely to emerge. The most prevalent leadership structure across all crews and observation periods was shared (58%), followed by hierarchical (28%) leadership. Fragmented leadership was the least prevalent, though we did observe it in 13% of cases, and at one point or another in 5 of 13 crews. Using 10,000 random networks as a baseline distribution, we used a chi-square test to compare the percentages observed in HERA to those expected by chance and found significantly more shared leadership in HERA. Second, shared leadership involving two leaders was unlikely to persist. Either hierarchy or co-leadership involving three or more leaders was more stable than two leaders. We formally tested this with a series of logistic regressions where each number of possible leaders at time t was regressed on the number of leaders at time t-1. Regressions indicate that leadership was stable across time except in the case of two leaders.