This is Your Brain. This is Your Brain on Space.

David Z. Bushhouse ’19

Department of Biology, Hampden-Sydney College, Hampden-Sydney, VA 23943

Isolation and stress have been linked to psychological challenges for hundreds of years. Consider *The Bet*, one of Anton Chekhov’s very best short stories, in which a 15-year period of complete isolation drives a man to the brink of insanity. Or even consider what is more fitting to this journal’s theme, Matt Damon’s recent astronaut character, Dr. Mann of *Interstellar*, who, after 30+ years in isolation on a desolate planet, goes completely off the deep end.

But how do we predict those psychological effects before they become problems, especially in team situations? How do we design a group dynamic that is both relaxed *and* serious? comfortable and professional? diverse and efficient?

Occupational psychologists have come up with several theories, but the *best* way to scientifically test the effects of a Martian habitat, or any other long-term space vessel for that matter, is to design an analogous system. This article will review the findings of three analogous system studies, discussing the psychological problems of long-term space travel, as well as potential solutions.

F-XI LDM

The Flashline Mars Arctic Research Station (FMARS) on Devon Island has conducted many analogue experiments to test the human-factor implications of long-duration space flight. Their FMARS XI Long-Duration Mission was a 100-day experiment in the summer of 2007 (1). Seven scientists and engineers lived in a simulation Martian hab for the testing period, while conducting “a rigorous field research program,” which was a full geologic survey of the surrounding area intended to simulate the types of experiments an actual Martian research team would undertake (2). Regular excursions from the hab (EVAs) were made in order to assess local rock formations.

Researchers found that as the mission progressed, crewmembers experienced decreasing stability in their sleep patterns. Also, crewmembers demonstrated significantly worsened reaction time and decision speed in periodic cognitive assessments, while maintaining the same number of correct responses (3). Many crewmembers reported increased stress and pressure due to a lack of privacy. Even when the crew was scattered in separate rooms, conversations were easily heard throughout the entire hab (3).

There were also interpersonal conflicts that arose during the mission: some crewmembers felt marginalized by the command structure, which relegated two crewmembers to purely support roles; one crewmember spoke English as a second language, and struggled to feel accepted by the group; and one male crewmember was “a key player in persistent reoccurrences of unreciprocated sexual interest” (3). The latter cause of intergroup conflict indicates one large challenge in crews of mixed sex, which a Martian research team would likely be.

All in all, researchers concluded that an actual Martian hab would need a better means of allowing private communication within the group. Also, researchers noticed that crewmembers with previous experience in long-term isolation developed significantly less stress and anxiety, and had a better time integrating into the group than those without previous experience. Perhaps humans can be trained to flourish in isolation?

MARS500

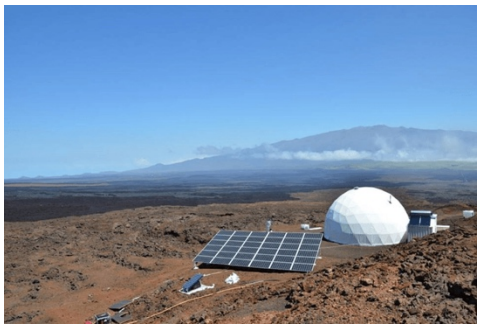
MARS500 was a long-term isolation experiment from June 2010 to November 2011 that placed 6 astronauts in a simulation spaceship for 520 days. The purpose of MARS500, which was not analogous to the conditions of a mission to Mars, was to test how well astronauts could handle isolation for the amount of time necessary for a round trip to Mars—five times the length of the F-XI LDM experiment. The all-male crew was made up of three Russians, an Italian, a Frenchman, and a Chinese man. Communication was carried out in English, though different crewmembers had varying capacities with the language. Careful attention was paid to every detail, down to a 20-minute communication delay between the crew and “mission control” to simulate the during the period that the crew was “on Mars” (4).

This study found that as the mission progressed, astronauts slept longer, their workload ratings decreased, they reported higher stress and anxiety, and half of the subjects reported feeling sicker. Some crewmembers became less social, and hid from other members to avoid interactions. However, crewmembers did not have the opportunity

General conclusions included the necessity for improved coping skills to “hypostimulation and restricted social contacts” (5). That is, astronauts need better ways to be bored while not getting sick of each other. Also, behavioral researchers found that about 80% of the communication between the six subjects went through a core group of 2 subjects. Positive signs included the discovery that exercise significantly increased mood for short periods.

HI-SEAS

In order to make an even better Mars mission analogue, Kim Binsted, the head researcher of the F-XI LDM experiment, using funding from NASA, set up the Hawai'i Space Exploration Analog and Simulation (HI-SEAS) on the side of Mauna Loa. The terrain is rocky and desolate, devoid of plant or animal life.



After three simple experiments to establish standard operating procedures, the HI-SEAS IV mission, a year-long isolation experiment with a crew of three women and three men began. The crew was tasked with performing geologic surveys while living in a 1000ft2 dome for an entire year, with heavily restricted food and water sources.

To avoid some of the problems observed in previous analogue long-term isolation experiments, crewmembers were equipped with ANSIBLE Virtual Worlds (VW) technology. The system allows crewmembers to interact with friends and family members in avatar form, allowing for synchronous interaction. Since the 20-minute communications delay is one of the most challenging aspects of Martian-simulated long-term isolation, researchers were hopeful that VW would alleviate tension and stress while easing loneliness. Preliminary results showed that crewmembers using the ANSIBLE VW system felt closer and more satisfied with their friends and family than crewmembers not using the system (7). HI-SEAS IV officially ended in August of 2016, and no complete behavioral analyses have yet been published.

Conclusion

Space travel has always challenged us to see things differently and answer new questions about humans. NASA's *Psychology of Space Exploration* recounts how "The most conspicuous questions of the earliest days of spaceflight had to do with life support, the human-machine interface, and the optimization of human performance to ensure mission success. Certainly, these topics remain crucial today, but to them we may add many more. Topics such as habitability, loneliness, cultural conflicts, the need to sustain a high level of performance over the long haul, and postflight adjustment" (8).

The recent plunge into the psychology and sociology of long-term isolation is already yielding solutions: better criteria for the selection of mission candidates, improved role assignment to mitigate intergroup conflict, and Virtual World interaction designed to make crewmembers feel close to home. As it has always been with space travel, the further we ouch into space, the more we must reveal about what is buried within us.

REFERENCES

1) Battler, M., et al. (2008). Surface exploration metrics of a long duration polar analogue study: implications for future Moon and Mars missions. In *Proceedings of the International Astronautical Congress, Glasgow, Scotland*.
2) Schneider, S. (2010). Exercise as a countermeasure to psychosociologic deconditioning during long-term confinement. Behavioural brain research. 211 (2010) 208–214
3) Bishop, S. L., Kobrick, R., Battler, M., & Binsted, K. (2010). FMARS 2007: Stress and coping in an arctic Mars simulation. *Acta Astronautica*, *66*(9), 1353-1367.
4) Binsted, K., Kobrick, R. L., Griofa, M. Ó., Bishop, S., & Lapierre, J. (2010). Human factors research as part of a Mars exploration analogue mission on Devon Island. *Planetary and Space Science*, *58*(7), 994-1006.
5) Basner, M. (2014). Psychological and Behavioral Changes during Confinement in a 520-Day Simulated Interplanetary Mission to Mars. *Plos ONE*, (3), e93298
6) Feder, T. (2015). NASA Mars mockup explores team cohesion and performance. *Physics Today*, *68*(12), 29-30.
7) Wu, P., Ott, T., & Morie, J. ANSIBLE: A Virtual World for Enhancing Social Connectedness for Future Space Exploration Missions.
8) Vakoch, D. A. (Ed.). (2011). *Psychology of space exploration: Contemporary research in historical perspective* (Vol. 4411). Government Printing Office.

Image Source: HI-SEAS (n.d.), *Hawai'I Space Epoloration Analog and Simulation*. University of Hawaii. Retrieved from www.hi-seas.org.