Researching the effects of simulated space habitats on crews under controlled and isolated conditions

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Analog astronaut performing an EVA in the LunAres EVA yard. Credit: *Space: Science & Technology*

Current international human space exploration roadmaps envisage month-

long crew stays on the moon within the next few decades, with crewed missions to Mars the long term goal. The psychological effects of human spaceflight, especially in the sense of isolation and confinement, need to be explored ahead of deep space crewed missions.

To allow astronauts not only to survive but to thrive in alien environments, practice is needed. Practice involves operations on the ISS, but the ISS cannot simulate all aspects of a Lunar or Martian mission, such as the surface operations or long periods without sunlight. Therefore, research is being carried out under controlled and isolated conditions within simulated space habitats, to gain insights into the effects of such conditions on the research subjects and their impacts on crews' well-being and success.

Similarly, an analog environment cannot fully replicate that of the moon or Mars, but a variety of analog environments that simulate different aspects of the off-world environment can be used in conjunction to prepare for future missions. In a review paper recently published in *Space: Science & Technology,* Matej Poliaček, an aerospace industry professional and independent researcher, reviewed the experiments conducted during two separate 15-day missions in the LunAres Research Base in Piła, Poland and introduced the background, methodology, results, and conclusions.

First of all, the author introduced material and methods, presenting the LunAres Habitat, the location, and the two different missions. The habitat was fully isolated from the external environment—the complete isolation from the outside world, including lack of any windows and thus complete absence of access to daylight, allowed for investigating the effects of full isolation on the crew, as well as experiments related to circadian rhythm in humans.

The habitat consisted of a domed living area, to which several modules

were attached. Two analog missions, ARES-III and LEARN, were conducted in the LunAres Habitat in the summer of 2018, for a duration of 2 weeks, each. Missions were run on Lunar/Martian time, meaning the crew go out of sync with the external mission control crew, which was based away from the habitat and continued to operate on Earth time.

The mission control crew (MCC) was responsible for coordinating the mission from the outside and communicating with the crew every day, just like in real crewed missions. ARES-III was a Mars simulation mission, with the crew consisting of six crew members. As a Mars analog, the crew was under a 20-minute time delay in communications with the mission control.

The primary method of communication was text communication and with voice communication used in some instances for updates. ARES-III crew was constrained to eating only lyophilized food at lunch and dinner. The LEARN mission was conducted by five crew members.

Due to there only being a 1.3-second communication time delay between the Earth and moon, communications between the crew and MCC were conducted by video and voice methods, as well as by text. The LEARN analog astronaut crew was also constrained to eating only lyophilized (freeze-dried) food for the entire duration of the mission.

Afterwards, the author presented all experiments led by the two crews, including research and non-research activities. This part was divided in three subparts, the first one concerned the joint activities which were common between the two crews. Using the same methodology, both collected cognitive function, environmental, physiological, and inventory data, resulting in a larger dataset allowing comparisons between the two missions in terms of varying human factors.

The joint activities consisted of stress and cognition in isolation

experiments, aiming to investigate and monitor stress responses (cortisol and oxidative stress) and cognitive performance in several cognitive domains (general, spatial, and nonspatial) over the course of isolation.

Food consumption, exercise, medical checking, daily reporting and several non-research activities also generated a larger dataset for future investigation.

The second data set concerned the ARES-III mission activities. Experiments included the following: effects of consuming lyophilized food on oral health and saliva production, influence of isolation on hearing capability, feelings on security in the isolated habitat, and research into earthworm growth in different soil compositions.

The main objective of this analog mission was to perform neuropsychological research into the effects of living in isolation and confinement and to study a low-resource environment on stress responses, group dynamics, circadian rhythm, cognition, and microbiota. As in most analog missions (such as in the Mars Desert Research Station), the main experiment is the observation of the crew dynamics.

Moreover, the Mars mission analyzed physical performances of the crew and compared them to performances realized during similar activities in Mars Research Desert Station missions and the impact of confinement on their efficiency performing a remote operation of a rover. The third one the LEARN mission activities.

Similar to ARES-III, the objectives were to perform neuropsychological research and study the effect of low-resource environment. In addition, the mission involved studies of the influence of freeze-dried food on the oral health of the crew, sense of security in isolation, and several biology-oriented experiments.

Finally, a brief discussion and conclusion on the corresponding challenges of the missions were given.

From the isolation conditions, experiments, and activities above, it was clear that a lot of work was being done to answer the biggest questions for future human exploration: how did isolation, truncated space, busy schedules, unique members, and personalities carrying their own social, cultural, and emotional background can affect the mission and astronaut health?

There were several questions pertaining to what type of crew can be considered ideal: was it a single-gendered crew? Did the crew members come from a variety of cultures and origins? Should their backgrounds be similar, or should they cover as broad a range of skills as possible? Should all of them be of approximately the same age?

Analog astronauts were the guinea pigs of these questions. Although the author did not directly answer the above questions, it was an example on how things were being carried out and then new, more detailed investigations to be proposed, in order to take action in solving these issues.

More information: Simon Bouriat et al, Overview of Activities: ARES-III and LEARN Analog Missions in the LunAres Hab, *Space: Science & Technology* (2022). DOI: 10.34133/2022/9763959

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