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The Mars Desert Research Station - ERAU Crew 160 Expedition

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Introduction

During the winter of Earth's New Year, six students were selected to participate in the Mars Desert Research Station, also known as MDRS which is located in the isolated environment of Hanksville, Utah. The MDRS is a two story capsule that is developed in an isolated area which is meant to simulate the type of environment astronauts would experience when on Mars. Research and development programs from different teams around the world attend missions that typically span a two-week period and conduct all sorts of experiments that expand humanity's knowledge of the red planet. The Mars Desert Research Station project focused on creating methods and obtaining data that would be utilized to further develop the knowledge of future exploration and habitats on Mars. The two main research questions that were considered during this project were "What effects do confined and isolated environments have on an astronaut's memory" and "What the influences of natural sunlight and limited extravehicular activities are regarding an astronaut's emotions and stress levels."

Methods

When conducting the research projects, it was important for each member to follow IGNITE's research initiative. It was important to ask realistic and valuable questions to begin the research, while ensuring proper ethical approaches were taken. Each member signed an agreement and were notified that they had absolutely no obligation to participate in the student's research and had the authority to stop any research if they felt the need to do so. The research projects conducted included both qualitative and quantitative properties (further explained in the next paragraph). The crew only went on Extravehicular Activities (EVAs) for an average about 1 hour per day, so the majority of the time was spent indoors which allowed the specific research topics to be easily conducted. Survey logs were created and completed almost daily to maintain logged information for both projects. All data was concluded based on gathered results and were distributed at research conventions, such as Discovery Day at ERAU.

Results

The memory tracking experiment required a qualitative approach to obtain detailed survey answers from each participant on a daily basis, which required collaboration from each crew member. With this method, each crew member provided specific data regarding their memory to the researcher. Only eleven days of acquired data could be gathered due to the failure of the crew mate's memory to remember to conduct the timed puzzle challenges as well as completing the surveys. The data also involved the recording of food and nutrient intake, dreams, stress quality, sleep quality, acquired injuries throughout the day, activities conducted throughout the day, out/indoor EVA recognition, memories of the previous day(s), and the amount of puzzle pieces correctly combined together. From the data obtained, it can be observed that the crew members' stress levels fluctuated to higher levels throughout the eleven day periods. Although stress increased throughout the mission, the crew members' quality of sleep increased as well.

The lack of details obtained throughout the two-week mission shows the impact of possible memory loss for the crew members to remember to simply complete the activities mentioned. It may have been caused from the prioritization of other daily tasks including EVAs that may have been causing stress or the boredom of the participants – possibly from the lack of other social interactions or the prolonged seclusion inside the isolated capsule. This project, along with the daily logs, were able to convey that the isolated environment and acquired stress negatively affected memory of these simulated astronauts. Vella's collaborative research gathered data from each crew member by allowing them to provide feedback on their own time throughout each day during the two-week rotation.

The natural light project required a quantitative data collection, which allowed for the creation of data plots for easier observation of results. Sugimoto's independent research included personal measurements on the natural light he was exposed to inside the habitat and during EVAs. From the results gathered, the data shows that the stress levels of Sugimoto were affected more by social relationships between other crew members. It seems that the reason behind this is due to the period of the expedition being only two weeks and relatively short when compared to the amount of time astronauts on Mars would be exposed to. The stress level was not yet affected by the isolated environment and therefore appears to be a function of other factors - the social factor in this case. It is Sugimoto's recommendation that the actual influences of sunlight and outside activities should be observed for longer duration of expeditions to observe the effects of isolation and social factors. Please see Figure 1 and Table 1 for more information of the data plotted.

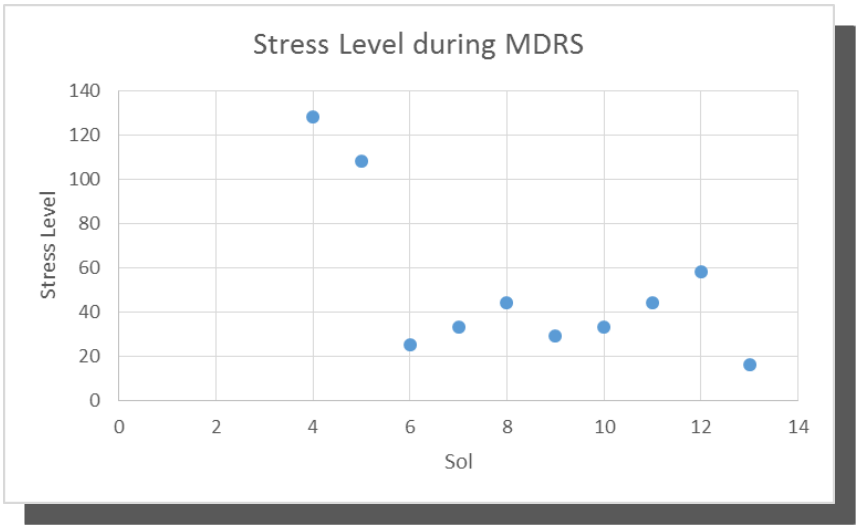

Figure 1*: This shows the plot of the daily stress levels. During Sol 4 and 5, the stress levels measured were extremely high, compared to the other Sol results. From Sol 6, the levels seemed to have dropped and stayed at around the same.*

Sol	Stress Level	EVA	Peak Intensity of Sunlight ($\mu W/cm^2$)
4	128	0	1693
5	108	0	1094
6	25	1	5091
7	33	1	4549
8	44	0	56
9	29	1	2595
10	33	1	Data Unavailable
11	44	0	81
12	58	1	2978
13	16	0	1171

Table 1*: This table shows the stress level and sunlight intensity measured on each Sol, including EVA/non-EVA participation. The values of the intensity of sunlight were measured from the inside of the capsule on days with no EVA participation and from outside the capsule on days with an EVA. In the EVA column, 0 indicates no EVA, and 1 represents going on an EVA. The sunlight intensity was measured with a spectrometer and configured to output the intensity in* $\mu W/cm^2$.

There were plenty of miscellaneous tasks that the crew participated in as well during the two-week simulation, including objectives from Mission Support and certain emergencies that emerged. The water system of the MDRS began to fail within the first day of arrival and the group had to work together to create a quick solution. The crew contacted Mission Support and suggested to help the system heat up, so the crew scavenged and looked for wire heaters to be used on the water piping which fixed the issue. The extreme cold of the winter caused the water to freeze and ineffectively pump water into the MDRS. There were some simulated communication relay EVAs as well as search and rescue EVAs which required an extraordinary amount of conductive planning and team collaboration. All these different tasks could have inadvertently affected the two research projects since they could have contributed an additional amount of stress within the two weeks – affecting sleep quality, memory, and social behaviors.

Discussion/Conclusion

ERAU Crew 160's two-week mission at the MDRS was successful. Even though there were times when certain life support systems such began to fail as well as simulated EVA missions that seemed to have turned for the worst, with constant team cooperation and critical thinking, the team was able pull through and thrive in the isolated environment. Each problem that created a possible simulation threat was tackled head on with the utmost commitment of the crew. It is important to note that astronauts would be exposed to very similar challenges and situations that they must be prepared for. The two research projects revealed that stress and memory were both affected when exposed to the isolated environment that would be similar to Mars. It is important to continue researching the significance human factor consequences regarding long expeditions that would take place, such on Mars, so that any foreseeable mission including the overall safety of future crews, is properly secured.