

Crew Perceived Stress During Short-Duration Space Analog Missions

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ABSTRACT

Space mission simulations at facilities and locations analogous to spaceflight environments are commonly used to explore the impacts of stress on crew members and validate stress mitigation strategies. As part of a study monitoring crew psychological and behavioral indicators, twenty-four space analog mission crew members took pre-mission, during-mission, and post-mission Perceived Stress Questionnaires (PSQ). One mission was conducted at the Mars Desert Research Station (N=7), two missions at the Mars Arctic Research Station (N=8), and three missions at the Integrated Lunar/Mars Analog Habitat (N=9). Mission durations were between twelve and seventeen days. It was hypothesized that the space analogs' isolated, confined, and extreme environments would increase perceived stress. However, all three analog facilities' crew members experienced a non-statistically significant reduction in perceived stress (ANOVA $P=0.26$) while conducting the mission compared to the pre-mission and post-mission results. This observed reduction in perceived stress during the missions compared to the pre-mission and post-mission questionnaires suggests that short-duration space analog missions may not yield a stress response sufficiently analogous to spaceflight to conduct research concerning stress in spaceflight environments.

Keywords: Space, Analog, Mission, Stress, Arctic, Desert

Estrés percibido por la tripulación durante misiones análogas espaciales de corta duración

RESUMEN

Las simulaciones de misiones espaciales en instalaciones y lugares análogos a los entornos de los vuelos espaciales se utilizan comúnmente para explorar los impactos del estrés en los miembros de

la tripulación y validar estrategias de mitigación del estrés. Como parte de un estudio que monitorea los indicadores psicológicos y conductuales de la tripulación, veinticuatro miembros de la tripulación de misiones análogas espaciales realizaron Cuestionarios de Estrés Percibido (PSQ) antes, durante y después de la misión. Una misión se llevó a cabo en la Estación de Investigación del Desierto de Marte (N = 7), dos misiones en la Estación de Investigación del Ártico de Marte (N = 8) y tres misiones en el Hábitat Análogo Lunar/Marte Integrado (N = 9). La duración de las misiones fue de entre doce y diecisiete días. Se planteó la hipótesis de que los entornos aislados, confinados y extremos de los análogos espaciales aumentarían el estrés percibido. Sin embargo, los miembros de la tripulación de las tres instalaciones análogas experimentaron una reducción no estadísticamente significativa en el estrés percibido (ANOVA $P = 0,26$) mientras realizaban la misión en comparación con los resultados antes y después de la misión. Esta reducción observada en la percepción del estrés durante las misiones, en comparación con los cuestionarios previos y posteriores a la misión, sugiere que las misiones espaciales análogas de corta duración podrían no generar una respuesta al estrés lo suficientemente similar a la de los vuelos espaciales como para realizar investigaciones sobre el estrés en entornos espaciales.

Palabras clave: Espacio, Análogo, Misión, Estrés, Ártico, Desierto

机组人员在短期太空模拟任务中的感知压力

摘要

在类似航天环境的设施和地点进行太空任务模拟，通常用于探究压力对机组人员的影响并验证压力缓解策略。作为一项监测机组人员心理和行为指标的研究的一部分，24名太空模拟任务机组人员在任务前、任务中和任务后接受了感知压力问卷(PSQ)。一项任务在火星沙漠研究站(N=7)进行，两项任务在火星北极研究站(N=8)进行，三项任务在月球/火星综合模拟栖息地(N=9)进行。任务持续时间为12至17天。假设认为，太空模拟的孤立、密闭和极端环境会增加感知压力。然而，与任务前和任务后的结果相比，所有三个模拟设施的机组人员在执行任务时的感知压力出现了非统计性的显著降低(ANOVA $P=0.26$)。与任务前和任务后的问卷相比，任务期间感知压力的减少表明，短期太空模拟任务可能不会产生与太

空飞行足够类似的压力反应，因此无法开展有关太空飞行环境压力的研究。

关键词：空间，模拟，太空任务，压力，北极，沙漠

Background

Astronauts experience four types of stressors during space flight: physical, habitability, psychological, and interpersonal. Physical stressors include acceleration, microgravity, ionizing radiation, meteoroid impacts, and light/dark cycles. Habitability includes vibration, ambient noise, temperature, lighting, and air quality. Psychological stressors include isolation, confinement, danger, monotony, and workload. Interpersonal stressors include gender issues, cultural effects, personality conflicts, crew size, and leadership issues (Kanas & Manzey, 2008).

Space analog missions on Earth are commonly used to explore the impacts and mitigations of these stressors on crew members. Between 2019 and 2024, the Mars Desert Research Station (MDRS) conducted eighty-one missions. The post-mission reports of sixteen of those missions described at least one stress-related research study. To better understand the crew members' stress profiles during short-duration space analog missions to aid with research development, perceived stress was observed during missions at three different analog facilities.

Methods

As part of a study monitoring several crew psychological and behavioral indicators, twenty-four analog crew members across six missions took Perceived Stress Questionnaires (PSQ) a week before ingress, during the mission, and a week after mission egress. One mission was conducted at the Mars Desert Research Station (N=7), two missions at the Mars Arctic Research Station (N=8), and three missions at the Integrated Lunar Mars Analog Habitat (N=9). Each subject's PSQ scores were averaged over their pre-mission, during-mission, and post-mission phases.

Results

During the mission, the crew members' average stress score was 0.354 with a standard deviation of 0.059. A small reduction in stress during the missions compared to pre-mission and post-mission scores was observed in the data aggregated between the three facilities (pre-mission = 0.372; during-mission = 0.354, post-mission = 0.384). MDRS and ILMAH both showed a stress reduction, while FMARS had no change. Figure 1 shows the change in stress at each facility throughout the mission lifecycle.

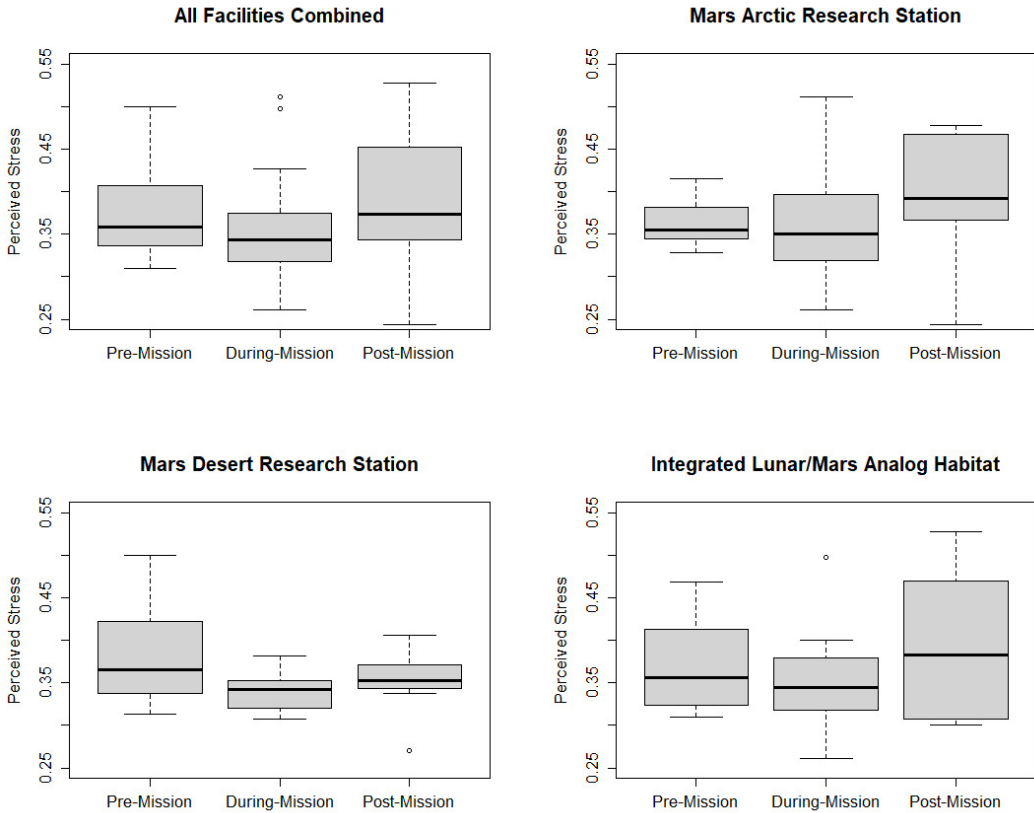


Figure 1. Pre-mission, During-mission, and Post-mission Perceived Stress Results.

An ANOVA using data from all three facilities showed that the during-mission perceived stress reduction was not statistically significant ($df = 71$, $P = 0.259$). ANOVA results for each specific habitat also did not yield statistical significance.

Discussion

For comparison, the crew members' PSQ scores were below the mean perceived stress observed in the healthcare environment. PSQ scores were taken at a hospital with 26 in-patients, 88 out-patients, 93 students, and 23 healthcare workers sur-

veyed, the mean stress score was 0.42 with a standard deviation of 0.15. The analog crew members' perceived stress was most comparable to the healthcare students who averaged a PSQ score of 0.36 (Levenstein et al, 1993).

The short-duration space analog missions in facilities at college campus, desert, and arctic environments do not show an increase in perceived stress compared to the weeks immediately preceding and following the mission. These facilities and missions may not offer a sufficiently analogous environment to the stressors of spaceflight to conduct relevant stress mitigation research. This information can aid with

analog research development related to stress through a better understanding of analog crew members' stress levels before, during, and after a mission.

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