PRIVACY IN SPACE

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Why Privacy is Important in Space: Astronaut missions require crew members, who come from various educational and social backgrounds, to co-exist and work with one another for a prolonged period of time in an extremely confined and isolated environment. In 2011, NASA identified issues of privacy as a top priority relating to habitability designs for long-duration exploration missions and that designs must accommodate the needs of crew member's mental well-being in order to assure mission safety and success [1]. Additionally, research suggests that the number of crew members, mission goals, and duration of a space mission play a role in determining the amount of volume required within a habitat and provided evidence to support that the larger the crew and the more crowded the environment, the more likely behavior and performance will be impaired [2]. NASA stipulated that "missions greater than 30 days in duration must have dedicated crew quarters that provide privacy."

Reduced Privacy in Space, the Psychological Impact and Its Threat to Crew Dynamics: Whilst working within the confined environment of space, astronauts experience further reduced access to privacy by being subjected and exposed to a number of environmental stressors such as continuous monitoring of their daily living activities and high ambient noise levels. Research suggests that issues of confinement and inefficient designs of working and living spaces contribute significantly to psychological stress and produce risk factors which have been shown to facilitate interpersonal conflict during missions [3].

Privacy's Role In Sleep Quality and Cognitive Performance: The effects of increasing the time spent confined within shared accommodation, with an increased lack of privacy and autonomy, has been seen to correlate with poorer sleep quality and shorter sleep duration [4] and it is regularly reported that astronauts experience reduced sleep duration and decreased sleep quality during long-duration missions [5]. Decreased sleep results in decreased cognitive function, decreased physical function and impaired social behavior [6] which actively hinders crew dynamics, crew productivity and efficiency and may reduce the overall likeliness of completing a successful mission.

Privacy and Its Role in Preventing Physiological Deconditioning:. Astronauts begin to experience physiological deconditioning almost instantly upon entering the extreme environment of space. Current accepted risk factors which facilitate physiological deconditioning within space environment include microgravity, radiation exposure and physical inactivity with the cardiovascular and neurological systems being some of the first physiological systems to become affected [7]. Reduced access to privacy during a spaceflight mission results in astronauts experiencing both increased levels of psychological stress and reduced levels of sleep quality and duration. It is well documented that increased sleep disturbance and reduced sleep quality correlate strongly with increased occurrence of cardiovascular and metabolic disorders [8] and that both acute and chronic psychological stress exposure results in physiological deconditioning via metabolic dysregulation and an increased inflammatory response within the body [9]. Therefore, increased access to privacy may act as a potential mitigating factor in the prevention of physiological deconditioning of astronauts during long-duration spaceflight missions.

Simulated Space Environment: Our simulated spaceflight mission took place at the Analog Astronaut Training Center (AATC), located in Rzepiennik, South of Poland. AATC is a private company, which accelerates human spaceflight scientific studies and was created by former European Space Agency professionals: engineers and scientists. In 2018, the company established a laboratory to simulate the space environment for scientific experiments focused on space biology and medicine. It specializes in operational trainings for scientists, engineers, space enthusiasts and future astronaut candidates and the habitat is fully equipped, including dedicated software, for long-term isolated crewed projects.

Fig.1 AATC Laboratory Module containing equipment to complete biomedical experiments, engineering projects and medical assessments.

Experiment: The present study evaluates how the implementation of a privacy shelter within the sleeping environment during an Analog Astronaut Mission may affect the sleep quality, physiological and psychological stress parameters of crew members during their period of isolation. The aim of this study is to gain a better insight into how potential mitigators to stress, such as privacy shelters within the bedroom module, may be introduced to further facilitate effective crew dynamics and physical wellbeing, and improve the overall likelihood of a space mission's success.

Fig. 2 Constructed Privacy Chambers exterior with all members of YURIJA EMMPOL 9 mission

Materials and Methods: 4 male and 2 female Analog Astronauts underwent mental state and cognitive function testing, sleep cycle recordings and physiological parameter analysis before, during and after sleeping within the shared bedroom module without a privacy shelter for the first three nights of their mission. Following this, 2 control subjects then continued the rest of their mission sleeping within the previous conditions and the 4 other test subjects were provided with a privacy shelter. Test parameters, along with crew mission reports were then analyzed to assess whether increased access to privacy during their sleeping hours would result in any significant effect on their psychological and physiological well-being as well as overall crew dynamics.

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