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MULTI-SENSORY VIRTUAL REALITY ENVIRONMENT FOR THE MAINTENANCE OF LONG-TERM BEHAVIORAL HEALTH

Abstract

Astronauts on long-duration missions are at an increased risk of developing adverse behavioral conditions due to prolonged periods spent in isolated, confined, and extreme environments. Sleep loss, work schedule, and loss in social connectedness can further exacerbate their conditions and decrement performance, thus jeopardizing mission success. Currently, astronauts can receive care packages, but future missions will require crews to travel distances that make this impossible. Significant communication delays will also make maintaining meaningful contact with loved ones increasingly difficult, and astronauts will no longer be able to receive real-time care from mission control.

To investigate tools that maintain the long-term behavioral health of astronauts, we have developed a multi-sensory virtual reality environment (VRE) incorporating digital scents. We conducted a within-subjects pilot study (n=4) to compare the effectiveness of our VRE with and without the addition of digital scents. Before the VRE experience, subjects were required to undergo a modified Trier Social Stress Test to induce elevated stress levels and emulate the stressful conditions that astronauts might encounter on a mission. After the stress test, subjects were placed in the VRE (with or without scents). Subjects then repeated the stress test and VRE experience with the alternative condition (with or without scents). The VRE features approximately 0.01 square kilometers of forested area with various key markers such as a campsite, river, and a cabin. The Olorama Scent Generator dispersed scents in conjunction with the user's location in the VRE. For example, floral scents were emitted when the user was by the field of flowers. The Positive and Negative Affect Schedule (PANAS) and the short-form State-Trait Anxiety Inventory (STAI) questionnaires were administered to record subjective data on the participant's perceived stress levels and mood throughout the experiment. The order in which the participants completed the experiment (with or without scents first) was counterbalanced.

Preliminary results show that, after the VRE, all subjects reported a lower PANAS negative affect ($p < 0.001$) compared to before the VRE (i.e., after the stress test). Additionally, subjects reported lower levels of stress on the STAI after their VR experience with scents ($p < 0.01$). Most notably, subjects' STAI scores also indicated that the VRE with scents was more effective at reducing stress levels than the VRE without scents ($p < 0.02$). These results suggest that the use of digital scent technology combined with VR is a promising countermeasure to support behavioral health during long-duration exploration missions.