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A WEARABLE-BASED SYSTEM TO REDUCE SPACE MOTION SICKNESS BY MULTI-SENSORY PRE-HABITUATION: ASSESSMENT OF ADAPTATION TO SMS IN ISOLATED CONDITION

Abstract

Motion sickness is a common disturbance occurring in healthy people exposed to specific motion conditions. The most widely accepted hypothesis suggests a sustained conflict between expected and actual sensory inputs as the triggering factor. In space, these mismatches cannot be resolved into a stable self-motion perception as the brain cannot sense gravity. Accordingly, each transition between gravity levels implies space motion sickness for roughly half of trained astronauts, significantly impairing missions and safety for days. Symptoms of motion sickness include vomiting and nausea, but also higher risk of disorientation, visual illusions and sopite syndrome. Although drugs diminish symptoms (e.g. meclizine, promethazine or scopolamine), they come with unwanted side-effects (sedation, drowsiness) and risks related to intolerances, adaptation and addiction. An alternative to ameliorate MS symptoms are training programs employing centrifuges or rotating chairs that were proven effective in aircraft pilots, but not in astronauts. The main aim of the project is to develop a wearable pre-rehabilitation device lessening Space Motion Sickness (SMS) by simultaneous manipulation of different sensory cues to create sensory conflict conditions that can be resolved when the subject adopts our desired reference frame. In practice, as astronauts with natural tendency to adopt an ego-referenced frame have been shown to suffer less SMS and adapt faster, the pre-rehabilitation should reinforce this reference frame against a visual-based one. Assessing how SMS affects cognitive functions is crucial for quantifying the effectiveness of our new adaptation protocol as well as more generally for ensuring mission success and safety. In this study, we aimed to collect data from a 6 days HI-SEAS analog astronaut simulation designed to investigate human cognitive performance adaptation to SMS. Our experiment employed a multidimensional approach, assessing key cognitive domains such as reaction time, sleepiness and mood affect, after inducing motion sickness by incongruent vestibular stimuli. These results are fundamental to assess the efficacy of our wearable adaptation to altered gravity levels. The Hawai'i Space Exploration Analog and Simulation (HI-SEAS) is a Mars and Moon exploration analogue research station, currently operated by the International MoonBase Alliance. Located at 2500 m above sea level on the Mauna Loa volcano, it allows a crew of six to perform experiments in a confined isolated environment, simulating a space mission where the outside atmosphere is non-breathable, resources such as food, water and energy need monitoring and communication with “the Earth” is limited.