System uses electrical trickery on the brain to induce realistic spaceflight effects (w/ Video)

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The Galvanic vestibular stimulation (GVS) system delivers small amounts of current to a person's vestibular nerve, mimicking the sensorimotor disturbances that can affect an astronaut's ability to walk and stand and impact their ability to land a spacecraft, making it an excellent tool to train astronauts before missions. Mount Sinai School of Medicine's Dr. Steven Moore leads this National Space Biomedical Research Institute-funded project. (Photo courtesy of Eric Wolfe Photography.)

What does it feel like to return to Earth after a long stay in space? Until now, it has been difficult during astronaut training to realistically simulate the dizzying effects the human body can experience.

Dr. Steven Moore leads a research group that has developed a Galvanic vestibular stimulation (GVS) system that safely induces the sensory and mobility disturbances commonly experienced by astronauts after returning to Earth's gravity, making it an excellent operational training tool.

When returning to gravity, these disturbances could affect an astronaut's vision and neurological function, impacting the ability to land a spacecraft. Once on the ground, astronauts often have trouble keeping their balance and walking.

"You can train for spaceflight tasks under normal conditions on Earth, b ut that will not give you an indication of what an astronaut will feel like," said Moore, a member of the National Space Biomedical Research Institute's (NSBRI) Sensorimotor Adaptation Team. "The GVS system will make mission simulations more realistic. This will be quite useful for astronaut training, especially for astronauts that have not flown before."

The system developed by Moore, who is an associate professor of neurology at Mount Sinai School of Medicine in New York, uses electrodes placed behind the ear to deliver small amounts of electricity to the vestibular nerve, which then sends the signals to the brain, resulting in sensorimotor disturbances.

"We know that GVS is a good model of how microgravity affects astronauts," Moore said. "What we didn't know is how good of an operational analog GVS is for the effects of spaceflight. We now have a validated, ground-based analog for the effects of spaceflight on neurological function that is not just posture, balance and eye movement."

The concept of tricking the brain with Galvanic vestibular stimulation has been around for a long time. However, the system developed by Moore has several unique aspects in addition to simulating spaceflight's effects. First, it uses large electrodes to deliver the stimulus, which have proven to be more comfortable than smaller electrodes. Second, the module, which can deliver up to a 5 milliamp current, is portable and about the size of a box of tissues, making it easy for people to use it while walking.

In order to determine the viability of using GVS as an analog, Moore tested 12 subjects in the Vertical Motion Simulator at NASA Ames Research Center at Moffett Field, Calif. Each subject flew 16 simulated shuttle landings, with the pilots experiencing the GVS analog during eight of the simulations. The subjects included a veteran shuttle commander, NASA test pilots and U.S. Air Force pilots. The results were compared to data collected from more than 100 shuttle landings.

According to Moore, one out of five shuttle landings have been outside the optimal performance range, such as touchdown speed and sink rate. He said the pilots using GVS during landing simulations experienced sensorimotor disturbances similar to the shuttle pilots.

For example, GVS generated a significant increase in touchdown speed consistent with that observed in actual shuttle landings. "Without GVS, they were right on the target - around 204 knots," Moore said. "With GVS, the average speed was pushed up to about 210 knots, which is at the upper limit of the target range."

The study subjects also experienced GVS-induced problems during a routine landing approach braking maneuver that required the pilots to bring the craft from a 20-degree glideslope angle to a 1.5-degree angle. This is a point during actual shuttle landing approaches at which pilots experienced sensorimotor issues and increased gravitational forces from acceleration.

"The GVS stimulation of the nerves is making the simulator pilots think the spacecraft is moving around. We are happy with that result," he said. "GVS induced similar decrements in simulator landings to those during actual shuttle landings."

Even though the research used shuttle landings as the test bed, Moore said the GVS is a viable analog for other space vehicles and operations, such as landing on Mars.

In addition to testing the system's viability as a spaceflight analog, the researchers tested 60 subjects to determine their tolerance to the GVS stimulation during 15- to 20-minute sessions. More than 90 percent of those tested had a high tolerance, and the results showed that GVS stimulation impairs cognitive abilities related to spatial processing. The next step for the researchers is to study whether people have the ability to adapt to the use of GVS over multiple sessions.

The GVS system also has potential use in training aircraft pilots and in preparing people with vestibular disorders for the effects following surgery.

Provided by National Space Biomedical Research Institute

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