Astronaut balancing act: Training to help explorers adapt to a return to gravity

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Astronauts returning from challenging long-duration missions face one more challenge when they get back to Earth - standing up and walking.

Upon returning to normal gravity, astronauts often suffer from balance problems that lead to dizziness and difficulty standing, walking and turning corners. Dr. Jacob Bloomberg is leading a group of National Space Biomedical Research Institute (NSBRI) scientists in a project to develop techniques to help astronauts adapt quickly to a new gravity environment and to overcome balance disturbances. This concept will also have benefits for non-astronaut populations such as the elderly or people with balance disorders.

Bloomberg of NASA Johnson Space Center Neurosciences Laboratory and his colleagues use a system that consists of a treadmill mounted on a base that can be actively moved in different directions to simulate balance disturbances. Called an Adaptability Training System, the treadmill has a projection screen in front of it that shows an image of a room or hallway that moves as the user walks. Disturbances are simulated by tilting the treadmill in one direction as the image is tilted in another.

"At first, people find it difficult to walk on the treadmill since its movement and images are out of sync. But over time, they learn to walk on it efficiently. We call this concept 'learning to learn,'" said Bloomberg, who is the associate team leader of NSBRI's Sensorimotor Adaptation Team and a senior research scientist at NASA.

In order to perform everyday activities, the brain interprets information provided by the body's sensory systems: the eyes, the inner ear balance organs, the skin and muscle movement receptors. Bloomberg said the problems for astronauts occur during the transition period in which the brain is trying to adapt to a new gravity environment - either returning to Earth or in the future adjusting to lunar or martian gravity.

"In space, information from the sensory systems is different, particularly when you take away gravity. The brain reinterprets that information, makes adjustments and allows you to do the activities you need to do in space," Bloomberg said. "The down side to that is when you return to Earth, the sensory systems are not used to a normal gravity environment."

Former NASA astronaut Dr. Leroy Chiao experienced balance disturbances following his four spaceflights, one of which was a six-month stay on the International Space Station (ISS). He compared the effects to those experienced after stepping off a fast-spinning playground merry-go-round. "After a merry-go-round ride, the effects go away pretty quickly," Chiao said. "But after a spaceflight, they linger."

Post-flight data collected indicates a correlation between the length of the mission and how long effects linger. Bloomberg said if an astronaut has been in space on a typical two-week shuttle mission, it may take several days to recover. For six-month stays aboard the ISS, it could take at least several weeks to return to normal.

In addition to maximizing training efficiency, Bloomberg is looking at how long the benefit of the adaptability training lasts. Once subjects master the treadmill, they come back periodically for testing to see how well they perform. He is investigating if subjects can retain the training for up to six months, which would allow the training to take place before

a long space mission.

Another goal of the researchers is to integrate a version of the system into the treadmill on a spacecraft, allowing astronauts to perform adaptability training on long missions. Integration would save space and power, both precious commodities on a spacecraft.

Chiao, who is the chairman of NSBRI's User Panel, said the research could provide insight about much longer missions. "On a flight to Mars, astronauts will be in zero-gravity for six months or more. When they get to Mars, they will experience one-third gravity," Chiao said. "Will systems like this allow them to go to work right away? Or will there need to be a recovery period or procedures before exploration can begin? These are important questions that this research is addressing."

Project co-investigator Dr. Helen Cohen, professor of otolaryngology at Baylor College of Medicine, said, "It will not be a good situation if an astronaut lands on a new planet and has problems maintaining balance. The training could help maintain astronaut safety and help them accomplish mission objectives."

Sensorimotor disturbances are not limited to standing up and walking. "Some people with inner ear trouble don't steer a vehicle well," said Cohen, associate director of the Center for Balance Disorders at BCM. "Adaptability training could also help people to perform these types of tasks better."

Even though the cause of the sensorimotor problems is different, Bloomberg said the adaptability training concept could help prevent falls in the elderly.

"For astronauts, the sensory systems are working just fine but the information is being interpreted differently. For the elderly, it could be a

combination of issues: the sensory systems may be deteriorated or the information may not be integrated by the brain as well as before," he said. "We might use this training to improve some of the deficits that the elderly might experience. There are definitely applications in the clinical world in terms of fall prevention with the elderly population."

Source: National Space Biomedical Research Institute