Astronauts have surprising ability to know how far they 'fly' in space

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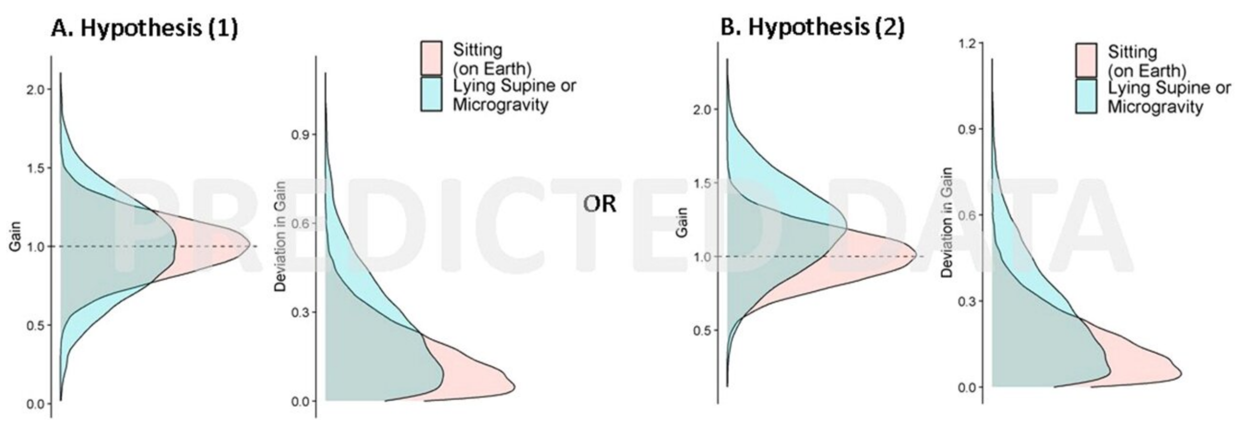

Predictions. Predicted distributions of the self-motion gains (as a measure of accuracy, see methods for definitions) and the self-motion deviations (as a measure of precision, higher deviations mean lower precision) for the two postures sitting upright (red) and supine (blue). Exposure to microgravity was hypothesized to show the same trends as when supine. Either the gain may become noisier (Hypothesis 1, see panel A) or both noisier and with a higher gain (Hypothesis 2, see panel B). Different panels depict the expected data when Hypotheses 1a and 1b are true (**A**) or when Hypotheses 2a and 2b are true (**B**). Credit: *npj Microgravity* (2024). DOI: 10.1038/s41526-024-00376-6

New research led by York University finds astronauts have a surprising ability to orient themselves and gauge distance traveled while free from the pull of gravity.

The findings of the study, done in collaboration with the Canadian Space Agency and NASA, have implications for crew safety in space and could potentially give clues to how aging affects people's balance systems here on Earth, says the study's lead Faculty of Health Professor Laurence Harris.

"It has been repeatedly shown that the perception of gravity influences perceptual skill. The most profound way of looking at the influence of gravity is to take it away, which is why we took our research into space," says Harris, an expert on vision and the perception of motion who also heads up the Multisensory Integration Lab and is the former director of the Centre for Vision Research at York.

"We've had a steady presence for close to a quarter century in space, and with space efforts only increasing as we plan to go back to the moon and beyond, answering health-and-safety questions only becomes more important. Based on our findings it seems as though humans are surprisingly able to compensate adequately for the lack of an Earth-normal environment using vision."

Harris and collaborators—who include Lassonde School of Engineering professors Robert Allison and Michael Jenkin and two generations of York postdocs and graduate students Björn Jörges, Nils Bury, Meaghan McManus, and Ambika Bansal—studied a dozen astronauts aboard the International Space Station, which orbits about 400 kilometers from the Earth's surface.

Here, Earth's gravity is approximately canceled out by centrifugal force generated by the orbiting of the station. In the resulting microgravity, the way people move is more like flying, says Harris.

"People have previously anecdotally reported that they felt they were moving faster or further than they really were in space, so this provided some motivation actually to record this," he explains.

The researchers compared the performance of a dozen astronauts—six men and six women—before, during, and after their year-long missions to the space station and found that their sense of how far they traveled remained largely intact.

Space missions are busy endeavors and it took the researchers several days to connect with the astronauts once they arrived at the space station. Harris says that it's possible their research was unable to capture early adaptation that may have occurred in those first few days, and "it's still a good news message because it says that whatever adaptation happens, happens very quickly."

Space missions are not without risk. As the ISS orbits the Earth, it is sometimes hit with small objects that could penetrate the vessel, requiring astronauts to move to safety.

"On a number of occasions during our experiment, the ISS had to perform evasive maneuvers," recalls Harris. "Astronauts need to be able to go to safe places or escape hatches on the ISS quickly and efficiently in an emergency. So, it was very reassuring to find that they were actually able to do this quite precisely."

The study, published recently in *npj Microgravity*, has been a decade in the making and represents the first of three papers that will emerge from the research investigating the effects of microgravity exposure on different perceptual skills including the estimation of body tilt, traveled distance, and object size.

Harris says research shows exposure to microgravity mimics the aging process on a largely physiological level—wasting of bones and muscles, changes in hormonal functioning, and increased susceptibility to infection—but this paper finds that self-motion is mainly unaffected, suggesting the balance issues that frequently come from old age may not be related to the vestibular system.

"It suggests that the mechanism for the perception of movement in older people should be relatively unaffected and that the issues involved in falling may not be so much in terms of the perception of how far they've moved, but perhaps more to do with how they're able to convert that into a balance reflex."

More information: Björn Jörges et al, The effects of long-term exposure to microgravity and body orientation relative to gravity on perceived traveled distance, *npj Microgravity* (2024). DOI: 10.1038/s41526-024-00376-6

Provided by York University

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