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Microgravity Experiments from Sub-Orbital to Orbital Platforms (3)

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GRAVITY AND DIRECTION OF BODY ACCELERATION INFLUENCE PERCEPTION OF DISTANCES DURING A PARABOLIC FLIGHT.

Abstract

When we reach for an object, one of the fundamental requirements is to understand the absolute distance from our body to that object (i.e. egocentric distance). However, our perceived distance to the object may not always be the same as the actual physical distance. Many factors have been shown to contribute to such disparity including visual cues, aerial and linear perspectives, as well as head position and orientation relative to gravity. This suggests that gravity can change perceived distances and thus we can find differences between physical and perceived distances to an object in microgravity. The misperception of distances can pose real threats to the astronauts' well-being on board ISS or on the surface of the Moon or Mars. With the foreseen increase in the number of Human spaceflights in the near future, we believe this is a topic worth investigating, in order to safeguard the astronauts' health. In this work, we investigated the effect of gravity on the perceived representation of the absolute distance from observers to objects within the range from 1.5–6 m. Experiments were conducted during 12 Parabolic Flights on board the CNES Airbus Zero-G where participant's perception of distances was tested under microgravity (0 g), hypergravity (1.8 g), and normal gravity (1 g). Distance estimation was collect using both verbal reports and visually directed motion toward a memorised visual target. For the latter method, we developed a setup where blindfolded participants laid or sat on a sledge and translated toward the visual target by pulling on a rope with their arms. Three setup configurations were used to assess the influence of motion acceleration on the axes of the participants' bodies (anterior-posterior, superior-inferior and left-right). The results show that distance estimates using both verbal reports and blind pulling were significantly different between 1g, 0g and 2g. On the anterior-posterior axis, compared to the 1 g measurements, the estimates of perceived distance using blind pulling were shorter for all distances in 1.8 g, whereas in 0 g they were longer for distances up to 4 m and shorter for distances beyond. On the superior-inferior axis, perceived distances were significantly different for the up and down direction in 1g, however, this asymmetry was no longer present in 0g. These findings suggest that gravity plays a role in both the sensorimotor system and the perceptual/cognitive system for estimating egocentric distance.