STRAIGHT AHEAD IN MICROGRAVITY

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INTRODUCTION

The subjective straight-ahead direction is a very basic perceptual reference for spatial orientation and locomotion. The perceived straight-ahead along the horizontal and vertical meridian is largely determined by both otolith and somatosensory inputs which are altered in microgravity. The Straight Ahead in Microgravity (SAM) experiment will be conducted on the International Space Station (ISS) to examine how this spatial processing changes as a function of spaceflight.

METHODS

Data will be collected before the flight, at one-month intervals during long-duration stay (180 days) on board ISS, and after return to Earth. Control studies will also be performed during parabolic flights. Three different protocols will be used in each test session: (1) Fixation: The subject will be asked to look at actual targets (normal vision) and then to imagine these same targets (occluded vision) in the straight-ahead direction. Targets will be located at near distance (arm's length, ~0.5m), medium distance (~1 m), and far distance (beyond 2 m). This task will be successively performed with subject's body aligned with the spacecraft interior, and with subject's body tilted forward and backward by an operator. (2) Saccades: The subject will be asked to make horizontal and vertical saccades, first relative to the spacecraft interior reference system, and then relative to the subject's head reference system. This task will be successively performed with subject's body aligned with the spacecraft interior, and with subject's body tilted in roll or in pitch by an operator. (3) Linear Vestibulo-Ocular Reflex (VOR): The subject will be asked to stare at actual visual targets (normal vision) at various distances (near, medium, far) in the straight-ahead direction. Vision will then be occluded, and the subject will be asked to continue staring at the same imagined targets while he/she is passively translated forward-backward, up-down, or side-to-side. The subject's body motion will be performed by the restrained operator while the subject is free-floating.

EXPECTED RESULTS

The coupling of downward gaze with vergence eye movements observed on Earth is expected to increase in microgravity. Saccadic eye movements made in darkness along perceived axes are expected to be more closely aligned with the body's longitudinal axis in 0g compared to 1g, as the reference system for spatial orientation moves from an allocentric (gravitational) to an egocentric (idiotropic) vector. Changes in the linear VOR will reflect adaptive changes in otolith-ocular reflex contributions to the perceived straight-ahead.

DISCUSSION

A change in an individual's egocentric reference might have negative consequences on evaluating the direction of an approaching object or on the accuracy of reaching movements or locomotion. Consequently, investigating how microgravity affects the egocenter is important for understanding the problems associated with long-term effects of microgravity on astronauts' and how they re-adapt to the return of gravitational forces on Earth or other planetary surfaces. This project therefore has theoretical, practical and even clinical implications for the sensorimotor research gap "*What are the changes in sensorimotor function over the course of a mission*?"

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