SUBJECTIVE STRAIGHT AHEAD ORIENTATION IN MICROGRAVITY

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INTRODUCTION

This joint ESA NASA study will address adaptive changes in spatial orientation related to the subjective straight ahead and the use of a vibrotactile sensory aid to reduce perceptual errors. The study will be conducted before and after long-duration expeditions to the International Space Station (ISS) to examine how spatial processing of target location is altered following exposure to microgravity. This study addresses the sensorimotor research gap to "determine the changes in sensorimotor function over the course of a mission and during recovery after landing."

RESEARCH PLANS

Eight ISS crewmembers will be requested to participate in three preflight sessions (between 120 and 60 days before launch) and then three postflight sessions on R+0/1 day, R+4 (±2) days, and R+8 (±2) days. The three specific aims include examination of adaptive changes in: (1) Fixation: The subject will be asked to look at actual targets in the straight-ahead direction or to imagine these targets in the dark. Targets will be located at near distance (arm's length) and far distance (beyond 2 m). This task will be successively performed with the subject's body aligned with the gravitational vertical, and with the subject's body tilted in pitch relative to the gravitational vertical using a tilt chair. Measures will then be compared with and without a vibrotactile sensory aid that indicates how far one has tilted relative to the straight-ahead direction. (2) Saccades: The subject will be asked to make horizontal and vertical eye (saccades) or arm movements, first relatively to the laboratory reference system, and then relatively to the subject's head reference system. This task will be successively performed with the subject's body aligned with the gravitational vertical, and with subject's body tilted in roll using a tilt chair. (3) Linear Vestibulo-Ocular Reflex: The subject will be asked to fixate actual visual targets at near and far distances in the straight-ahead direction. The subject will be asked to continue fixating the same imagined targets in darkness while he/she is passively accelerated up and down on a spring-loaded vertical linear accelerator. The initial crewmember has been recruited and preflight data collection will begin in March 2015.

APPLICATIONS

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 target location will have theoretical, operational, and even clinical implications for future space exploration missions. The use of vibrotactile feedback as a sensorimotor countermeasure is applicable to balance therapy applications for vestibular loss patients and the elderly to mitigate risks due to loss of spatial orientation.

ACKNOWLEDGEMENT

This work supported by Centre National d'Etudes Spatiales, the ESA Human Spaceflight Office, and NASA's Human Research Program Human Health Countermeasures Element.