DYNAMIC VISUAL ACUITY AND LANDING SICKNESS IN CREWMEMBERS RETURNING FROM LONG-DURATION SPACEFLIGHT

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Long-term exposure to microgravity causes sensorimotor adaptations that result in functional deficits upon returning to a gravitational environment. At landing the vestibular system and the central nervous system, responsible for coordinating head and eye movements, are adapted to microgravity and must re-adapt to the gravitational environment. This re-adaptation causes decrements in gaze control and dynamic visual acuity, with astronauts reporting oscillopsia and blurred vision.

Dynamic visual acuity (DVA) is assessed using an oscillating chair developed in the Neuroscience Laboratory at JSC. This chair is lightweight and easily portable for quick deployment in the field. The base of the chair is spring-loaded and allows for manual oscillation of the subject. Using a metronome, the chair is vertically oscillated ±2 cm at 2 Hz by an operator, to simulate walking. While the subject is being oscillated, they are asked to discern the direction of Landolt-C optotypes of varying sizes and record their direction using a gamepad.

The visual acuity thresholds are determined using an algorithm that alters the size of the optotype based on the previous response of the subject using a forced-choice best parameter estimation that is able to rapidly converge on the threshold value. Visual acuity thresholds were determined both for static (seated) and dynamic (oscillating) conditions. Dynamic visual acuity is defined as the difference between the dynamic and static conditions.

Dynamic visual acuity measures will be taken prior to flight (typically L-180, L-90, and L-60) and up to eight times after landing, including up to 3 times on R+0. Follow up measurements will be taken at R+1 (~36 hours after landing). Long-duration International Space Station crewmembers will be tested once at the refueling stop in Europe and once again upon return to Johnson Space Center. In addition to DVA, subjective ratings of motion sickness will be recorded throughout the testing.

Using the chair as a portable and reliable way to test DVA, we aim to test returning astronauts to assess the amount of retinal slip that they experience. By comparing these measurements to their motion sickness scores (using a scale of 1-20 where 20 is vomiting), we will correlate the amount of retinal slip to the level of motion sickness experienced. In addition to testing this in returning astronauts, we will perform ground-based studies to determine the effectiveness of stroboscopic goggles in reducing retinal slip and improving DVA. Finally, we will employ stroboscopic goggles in the field to astronauts experiencing high levels of motion sickness to minimize retinal slip and reduce their symptoms.

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