Neuro-Vestibular Examination During and Following Spaceflight (Vestibular Health)

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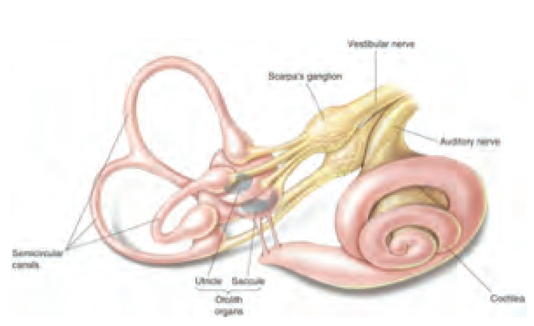
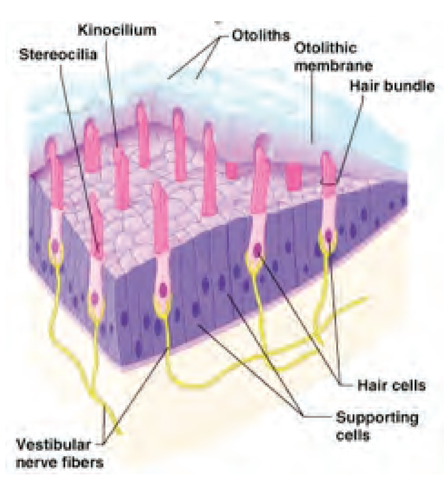
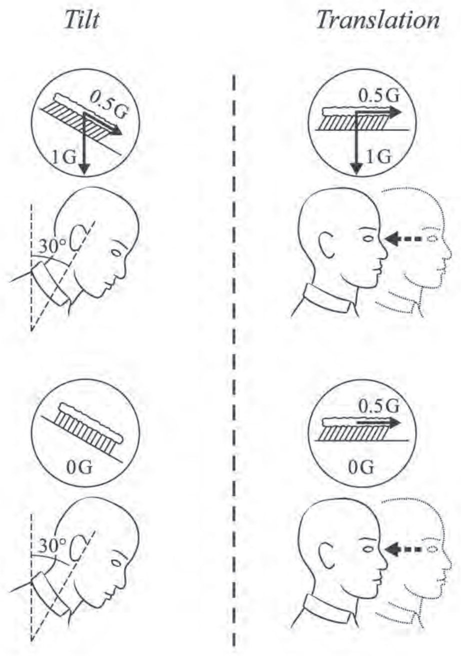
Background

Adaptation to microgravity during spaceflight causes neurological disturbances that are either directly or indirectly mediated by the vestibular system. These disturbances could include space motion sickness, spatial disorientation, cognitive impairment, as well as changes in head-eye coordination, vestibulo-ocular reflex, and strategies for controlling posture and locomotion. It seems that otolith-mediated reflex gain adapts rapidly over time during spaceflight and after landing. However, animal studies have shown that structural modifications of the vestibular sensory apparatus develop during long-duration spaceflight. To date, no studies have characterized the severity of vestibular syndromes experienced by astronauts as a function of the duration of spaceflight, or whether the effects are caused by changes at the peripheral end organs, midbrain, cerebellum, or vestibular cortex.

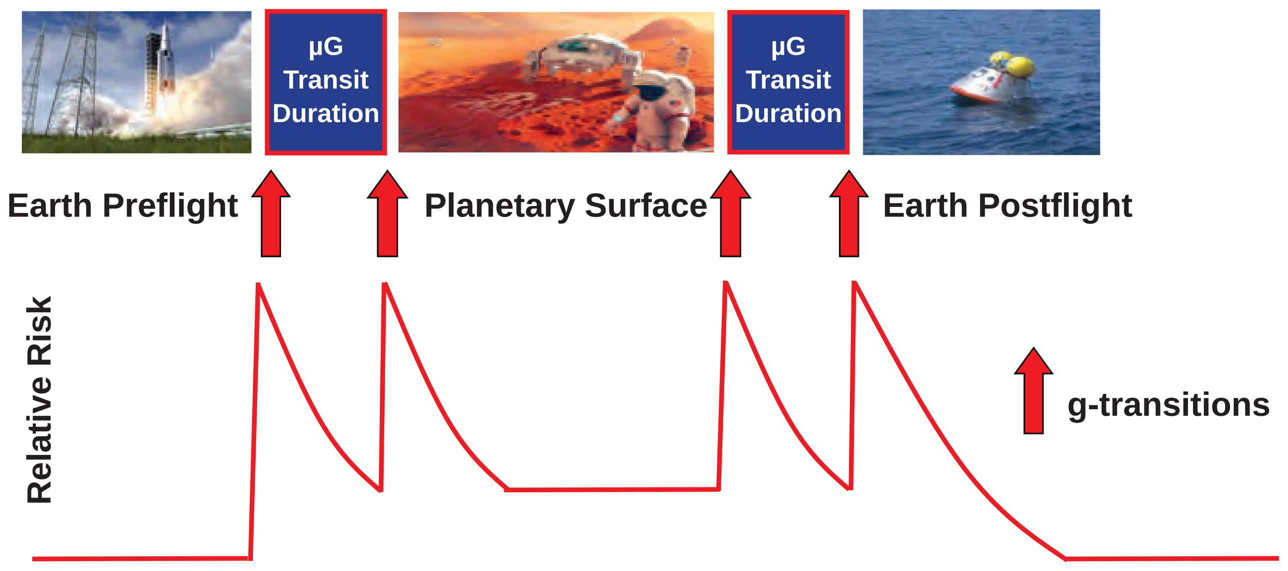


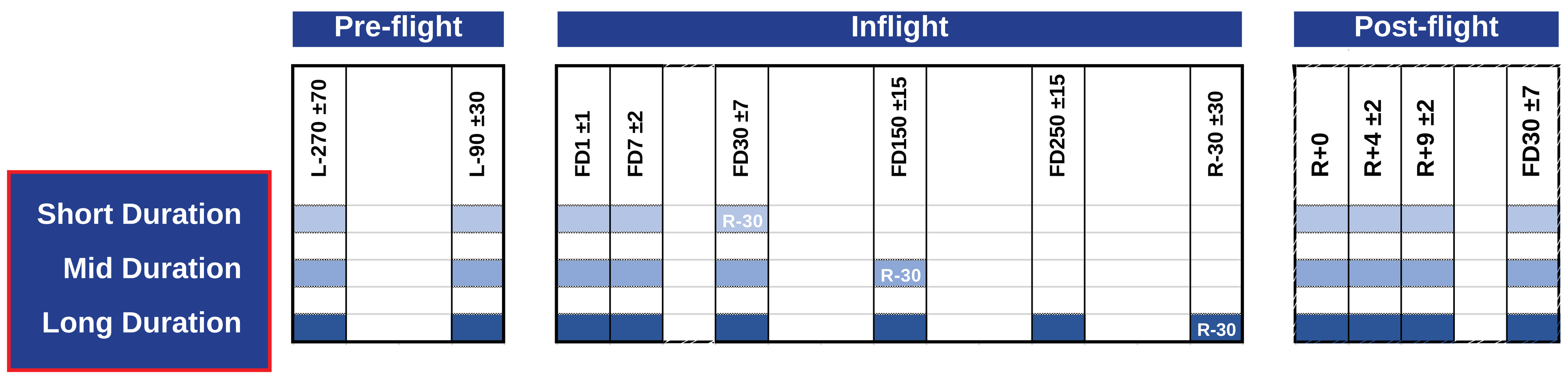




Objectives

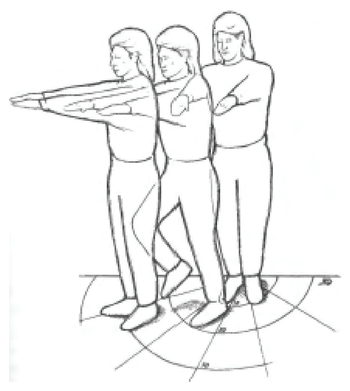
We will investigate temporal vestibular changes in crewmembers of short, six-month, and one-year missions to identify trends in adaptation of vestibular health and performance. The tests are designed to determine whether transitioning to a new gravitational environment induces peripheral and/or central vestibular system changes.



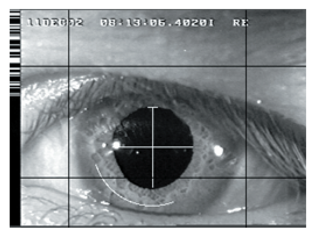


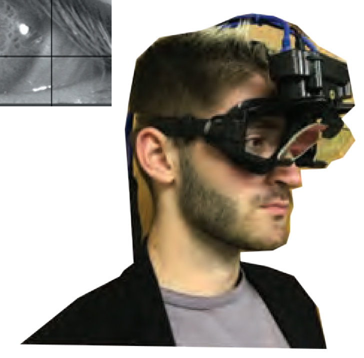
Methods

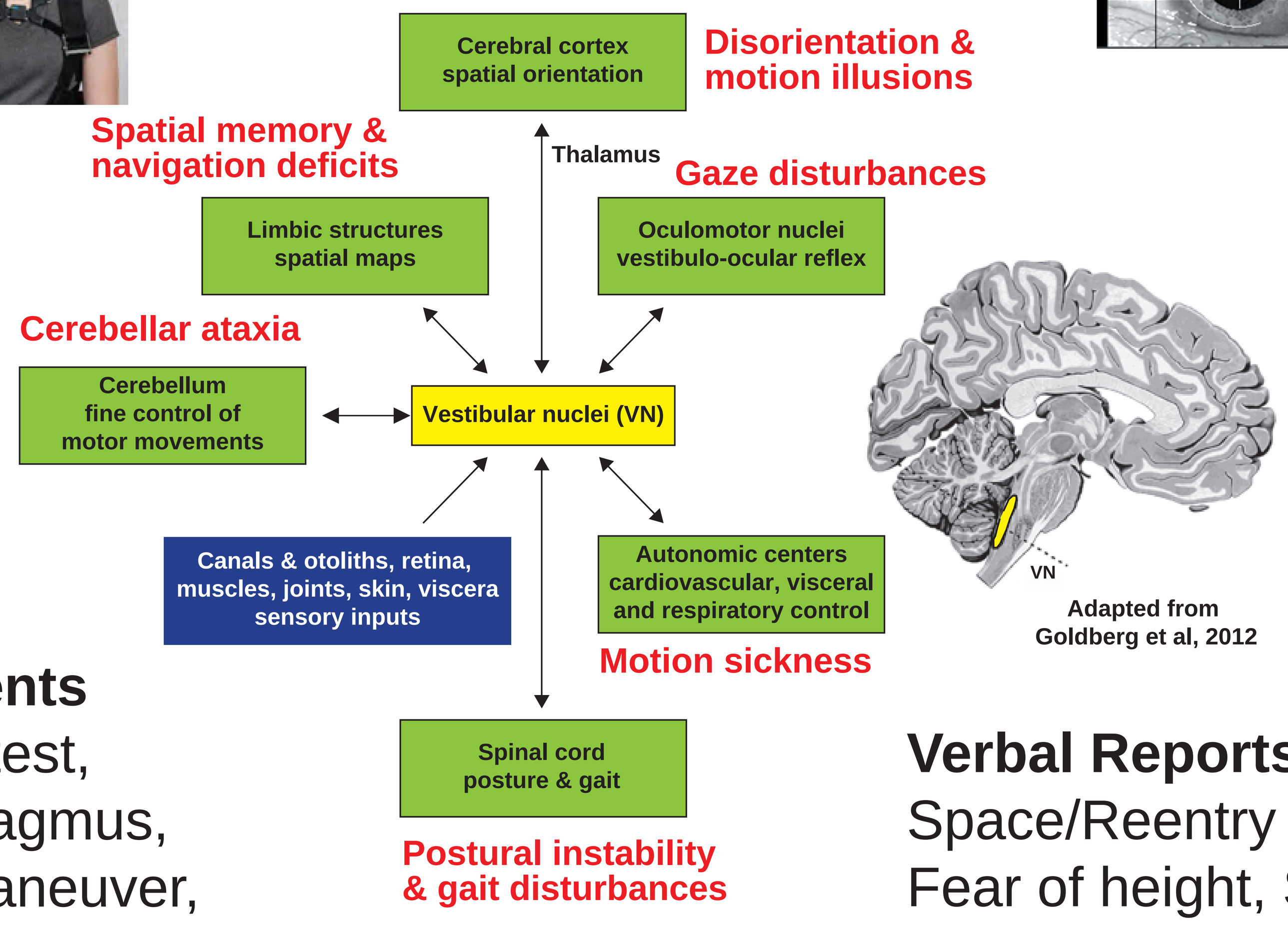
Body movements
Passive rotation (yaw, pitch, roll),
Passive translation (x, y, z),
Horizontal/Vertical subjective
Finger pointing test,
Fukuda Stepping Test



Oculomotor
Smooth pursuit, Saccades,
Spontaneous nystagmus,
Gaze-evoked nystagmus,
VOR (dark, light, suppression),
Skew deviation





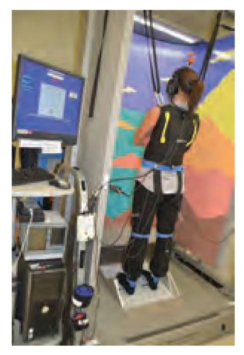


Head movements
Head-impulse test,
Positional nystagmus,
Dix-Hallpike maneuver,
Head posture (yaw, pitch, roll)

Verbal Reports
Space/Reentry motion sickness,
Fear of height, Space fog,
Illusions of self/surround motion,

Pre-/Post-Flight Only

Standard Measures



Posture (MedB)

UTMB Clinic

Relevance

We will use well established tests and validated protocols that are able to detect head-motion oscillopsia and predict acute or chronic vestibular syndromes. If the observed symptoms in the crewmembers are more deleterious after the yearlong International Space Station (ISS) missions than those documented after standard-duration ISS missions, then relevant countermeasures will be required to maintain the health of astronauts during longer missions. Depending on the etiology of the vestibular syndrome revealed by these tests, countermeasures will be proposed based on vestibular rehabilitation therapy currently used in patients with vestibular disorders, such as habituation, gaze stabilization, and/or balance training exercises.

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One Year Mission