NEURO-VESTIBULAR EXAMINATION DURING AND AFTER SPACEFLIGHT

CIPHER: Complement of Integrated Protocols for Human Exploration Research

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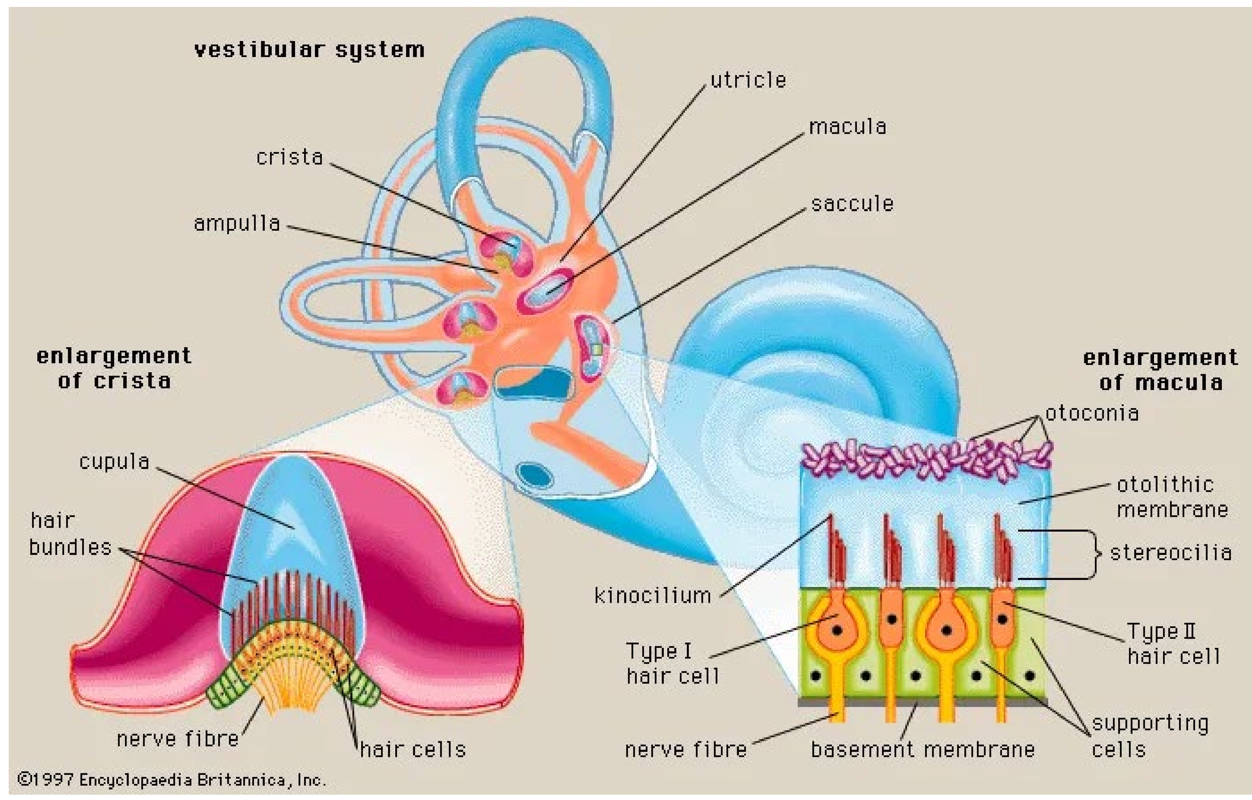
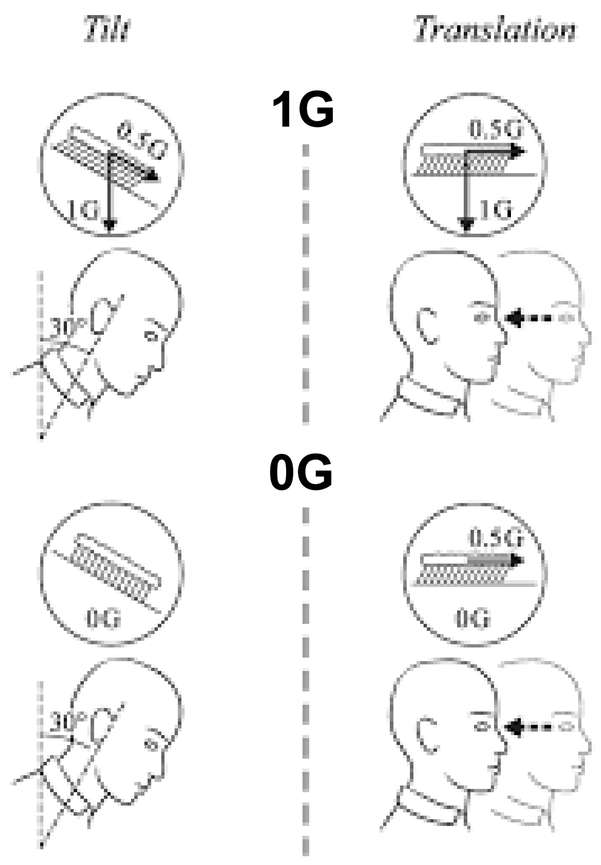
BACKGROUND

- The need to move and maintain spatial orientation in an altered gravity environment drives sensorimotor adaptations.
- This adaptation process can cause neurological disturbances that are mediated by the vestibular system:
  - ➢ Space motion sickness, spatial disorientation, and cognitive impairment, as well as changes in head-eye coordination, vestibulo-ocular reflexes, and control of posture and locomotion.
- Otolith-mediated reflex gains appear to adapt rapidly to g-transitions, but animal studies suggest that there are long-term structural modifications to the vestibular apparatus.
- What is the severity and mechanism of symptoms as a function of spaceflight duration?





OBJECTIVES

- Use well-established clinical and experimental procedures to:
  - ➢ Identify temporal trends in adaptation of vestibular health and performance.
  - ➢ Differentiate between peripheral and central vestibular forms of vertigo and oculomotor disorders.

SCHEDULE

- Testing Schedule for standard (6-month) flights:

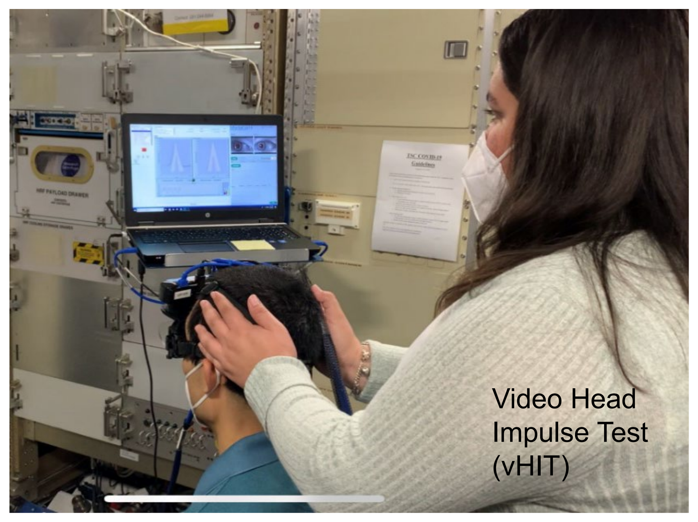
Preflight	Inflight	Postflight
Vestibular Evaluation: Launch-200 (60 min) Vestibular Exam: Launch-90 (50 min)	Flight Day 1 (45 min), Flight Day 30 (35 min), Return-30 (35 min)	Return+0, Return+4, Return+9, Return+30 (35 min)

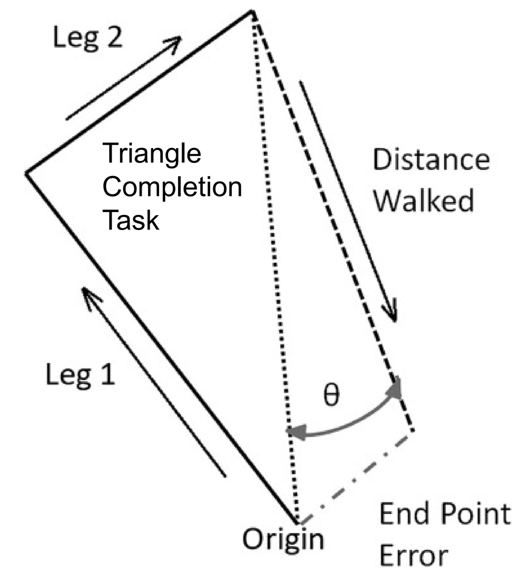
- The binocular video eye measurement system (DX Falcon, Neurolign Technologies Inc, Toronto, CN) was the first new flight CIPHER hardware certified for ISS. Pictured to the right is the inflight hardware functional checkout.

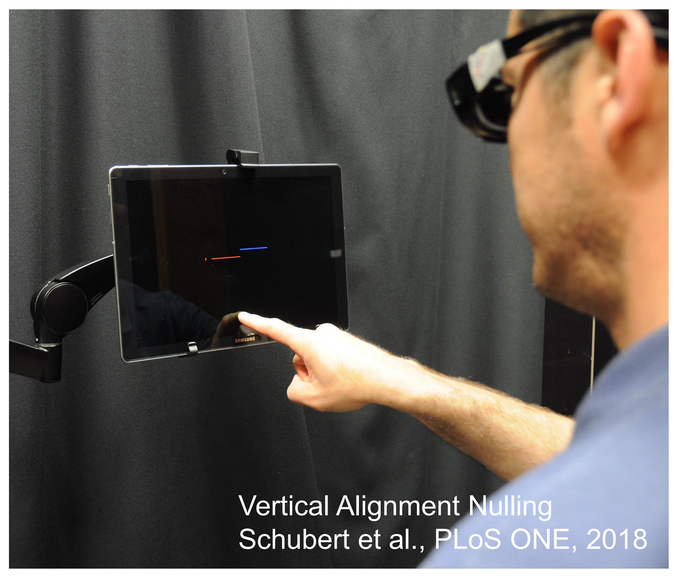
- To-date, 2 crewmembers have participated in inflight data collections.
- An additional 2 enrolled crewmembers have completed preflight data collections.
- The first postflight data collections are anticipated to take place in March 2024

METHODS

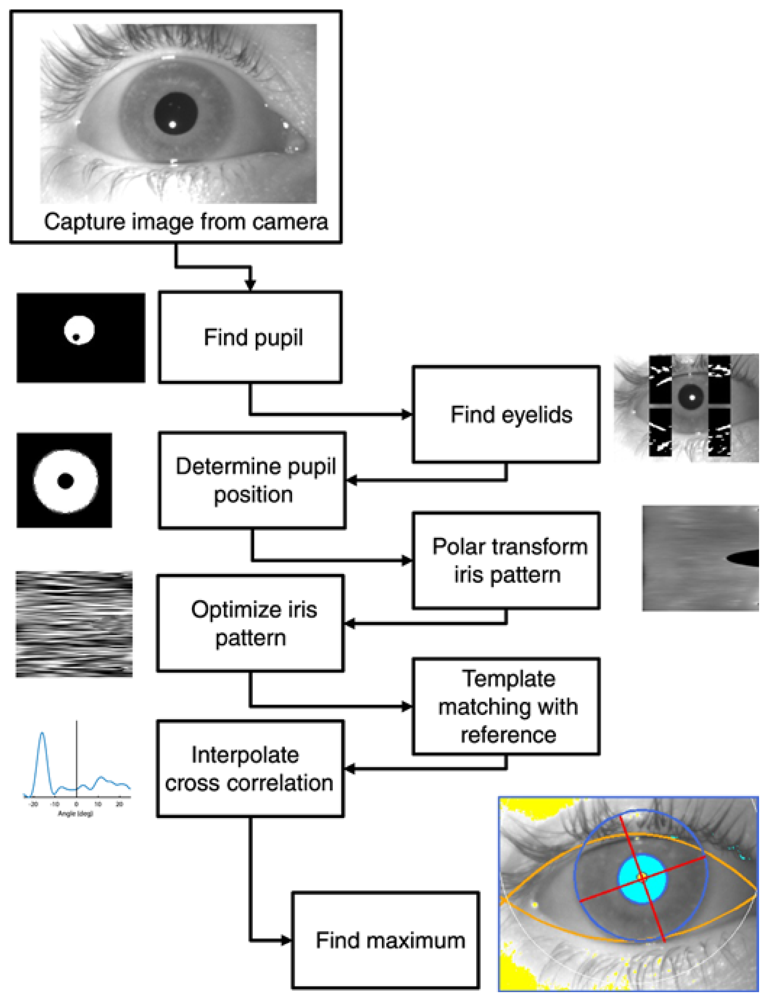
- Data collection:
  - ➢ Eye, head, and body movements, as well as subjective perception of motion.
- To determine the presence of:
  - ➢ Abnormal eye movements, dysmetria, motion sickness, and illusions of motion.
- This includes characterization of temporal trends in central compensation for vestibular (otolith) asymmetry.
- Ground-based control tests have been performed on healthy volunteers in the laboratory to estimate mean normative responses







- Data processing techniques are being refined. Our eye tracking method (Otero-Millan, J. Vision, 2015) for measuring three-dimensional eye movement takes advantage of modern computer vision software (OpenCV) and advances in the field of iris recognition to improve measurement of ocular-counterrolling.



RELEVANCE

- The flight data will help us characterize temporal changes, determine when countermeasures may be needed, and understand the etiology of vestibular syndromes.
- Countermeasures will be proposed based on vestibular rehabilitation currently used in patients with vestibular disorders.

ACKNOWLEDGEMENT: This work is supported by NASA's Human Research Program Human Health Countermeasures Element and Research Operations & Integration