NIH Award from the National Eye Institute

Principal investigator: Chi-Ju C. Huang, physiology
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- **Project**: Neural Mechanisms of 3-D Linear Vestibulo-ocular Reflex
- **Start Date**: August 1, 2009
- **Total Award Amount**: $130,192

**How the results of this project will benefit society:**
Our vision provides us with information in a wide three-dimensional space with high acuity. Thus, redirecting our eyes to retain images while we are in motion becomes a crucial motor function. Since slight head movement is present all the time, the vestibulo-ocular reflexes (VORs) are very important for stabilizing vision. Patients whose VOR is impaired find it difficult to read print, because they cannot stabilize their eyes during small head tremors. This research will address questions regarding coordinated VOR responses to angular and linear head motions.

**The problem the project is trying to solve:**
The nervous system solves the problem of head movement by using short-latency VORs to generate eye movements that compensate for angular (angular VOR or AVOR) or linear (linear VOR or LVOR) motions of the head. Sensory inputs driving the AVOR and LVOR arise from different labyrinthine sensors (the semicircular canals and otolith organs, respectively). This means that, if as existing evidence suggests, the compensatory LVOR is built upon the phylogenetically older AVOR brainstem circuitry and thus both share a common premotor pathway, the linear acceleration signals coded by otolith afferents must be transformed to match the velocity-position signals generally observed on AVOR neurons. Likewise, the three-dimensional spatial directions of angular and linear motion signals must be brought into alignment. Complexity arises since different patterns of eye movements are evoked in response to high frequency linear motions, which generate translational LVORs, and to low frequency linear motions, which generate orienting (tilt) responses. Alternatively, AVOR, LVOR and tilt-related signals might be carried via separate VOR pathways converging upon extraocular motoneurons. Another unresolved issue is that the bilateral organization of otolith and canal sensory epithelia is quite different, and thus the bilateral “push-pull” mechanism in AVOR may not apply to LVOR.

**How this project will work:**
The four aims that follow are designed to address these and other related questions regarding coordinated VOR responses to angular and linear head motions. These aims are: Identify the synaptic connections of VOR neurons that project to oculomotor nuclei and receive direct VIIIth nerve inputs. Examine the spatial and temporal tuning properties of VORNs during the AVOR, LVOR, smooth pursuit and fixation of targets at various viewing distances. Examine the bilateral organization of utriculus-related inputs to VOR neurons. Examine responses of VOR neurons during static tilts and low frequency earth-horizontal rotations that produce comparable acceleration to translations and examine how translation and tilt related signals are distributed in VOR pathways.

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