

Systems Neuroscience

24.10.2023

Vestibular system

Daniel C. Kiper
kiper@ini.ethz.ch

[http: www.ini.unizh.ch/~kiper/system_neurosci.html](http://www.ini.unizh.ch/~kiper/system_neurosci.html)

VESTIBULAR SYSTEM

A central role in the maintenance of equilibrium and gaze stability.

The vestibular system, by means of its receptors for the perception of linear and angular acceleration, plays a central role in **orientation**.

Designed to answer two basic questions:

Which way is up?

In which direction am I moving?



VESTIBULAR SYSTEM

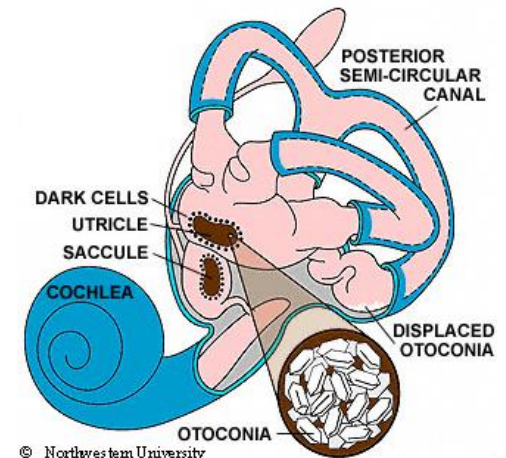
Very elusive to test

Five peripheral “receptors” (three semicircular canals, utricle, saccule)

Nerve (sub-divisions)

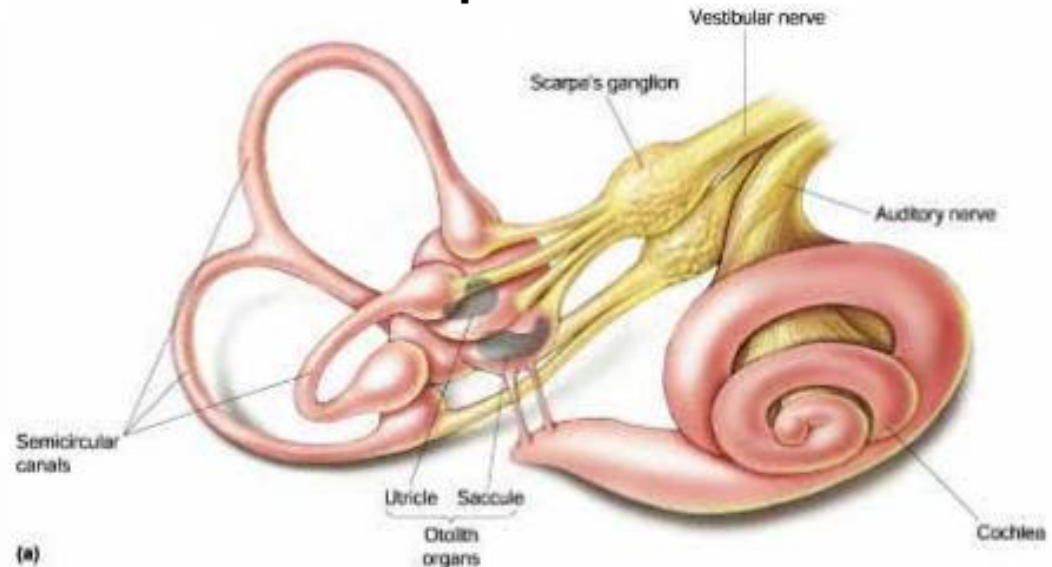
Central connections

Cortical area



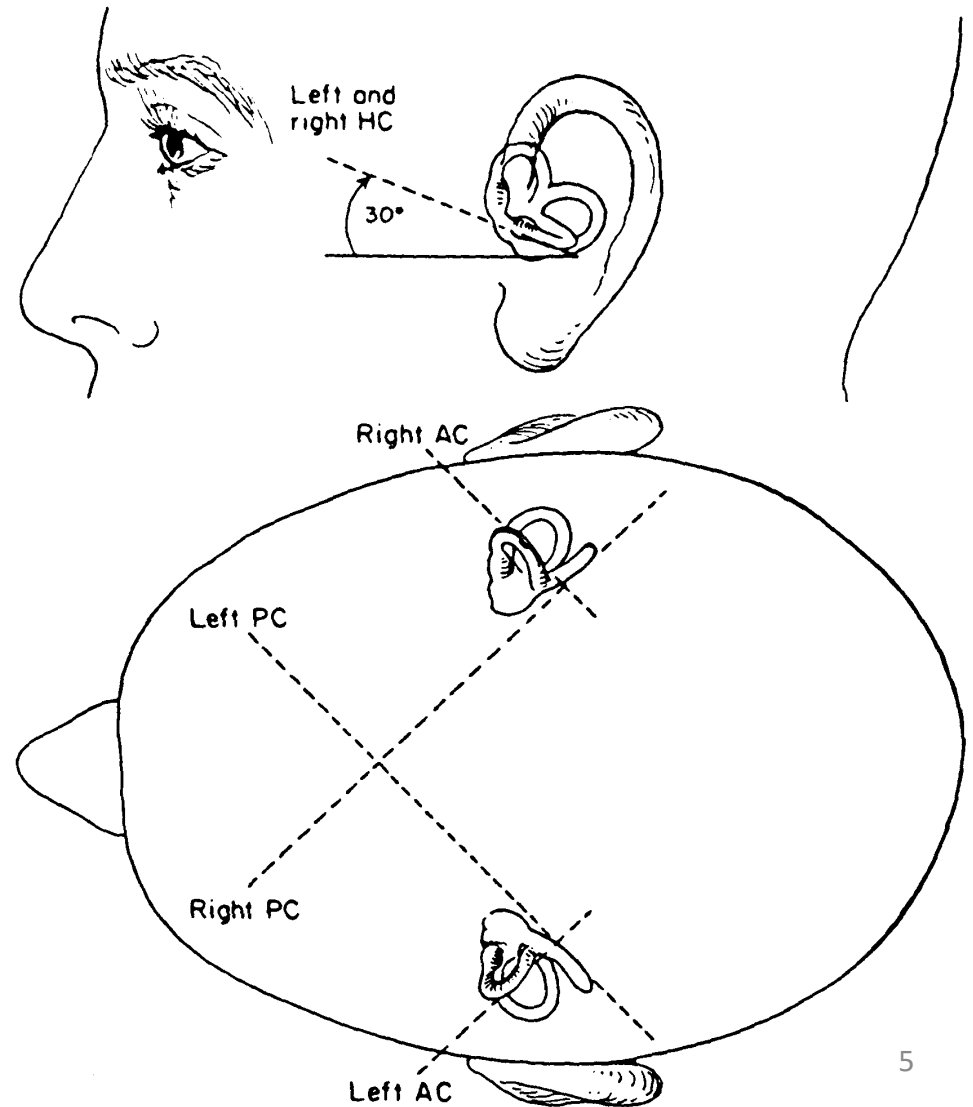
Vestibular system

- Semicircular canals: respond to rotation acceleration of the head
- Otolith organs: respond to linear acceleration and static position
 - Utricle
 - Saccule



The Semicircular Canals

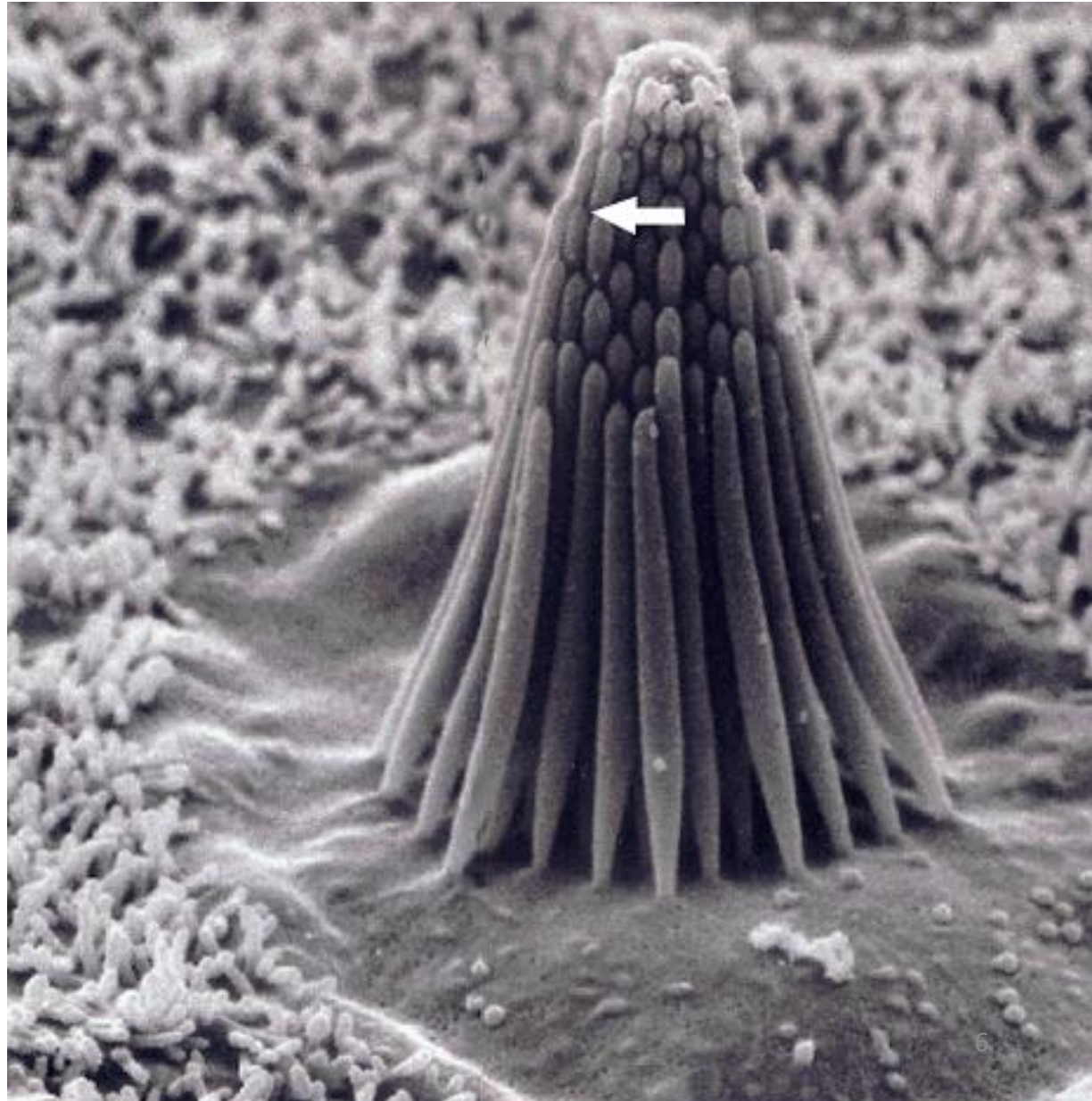
- posterior canal shares plane with contralateral anterior canal.
- horizontal canals share plane.

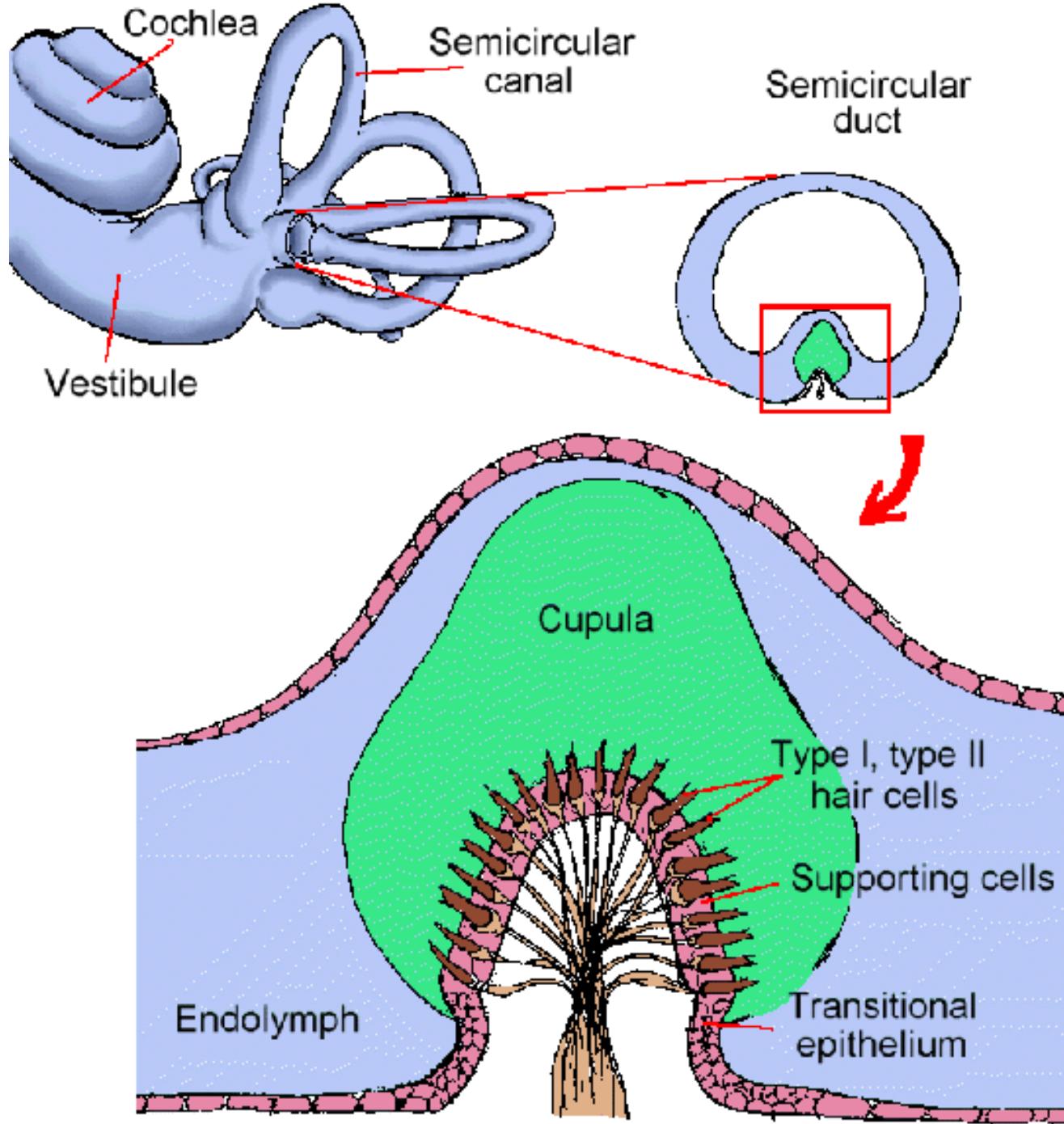


Vestibular Hair Cells

- Type I
(aka inner)
- Type II
(aka outer)

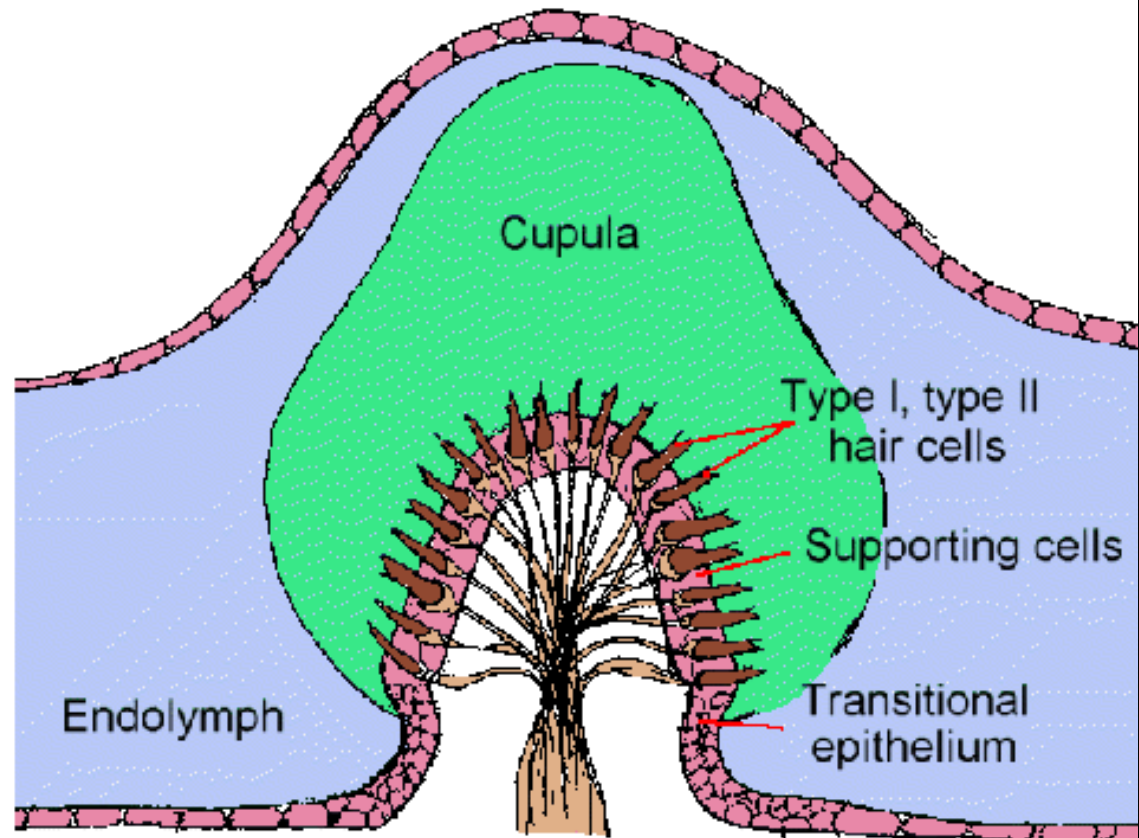
With
Kinocilium



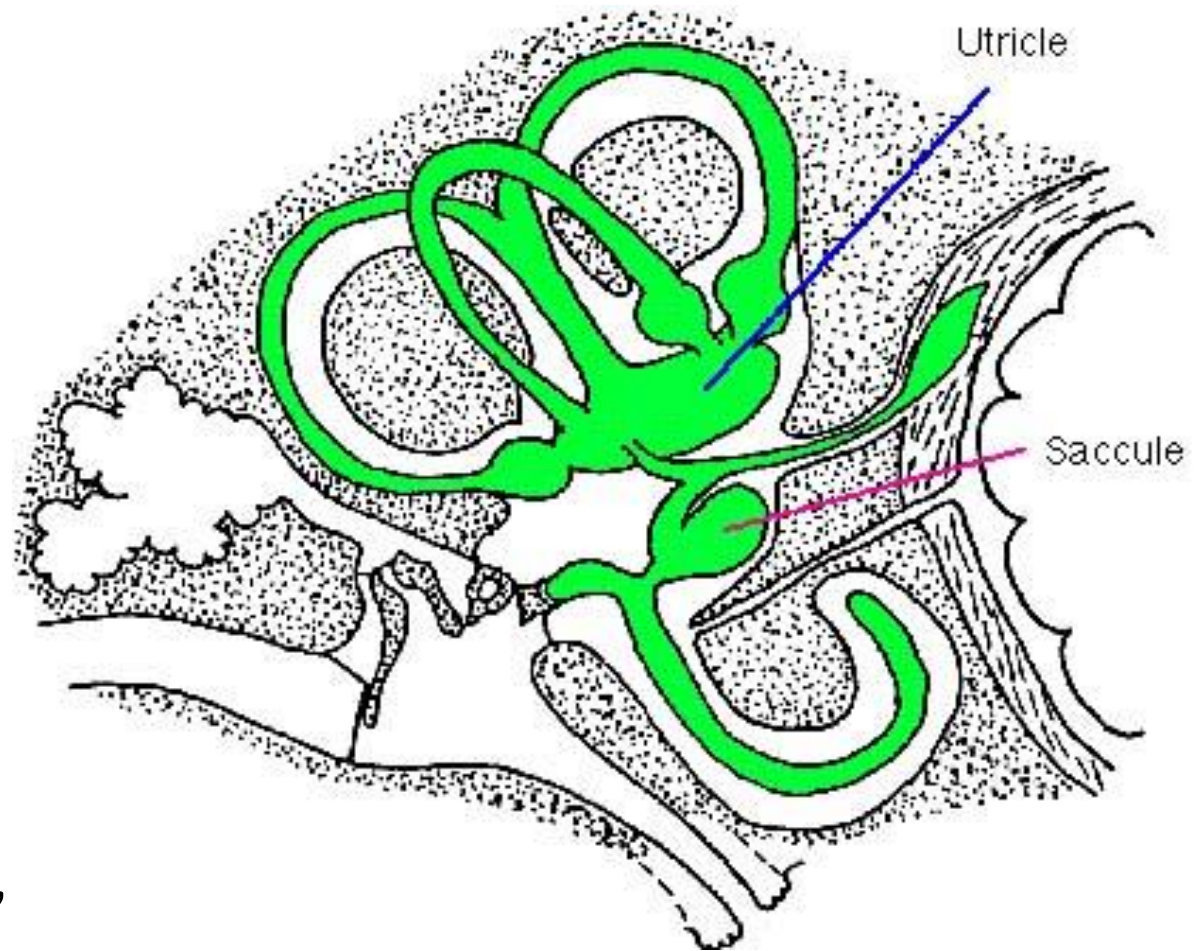


Responses of the Cristae

- All kinocilia are oriented in the same direction
- Crista in each pair of canals respond inversely to each other

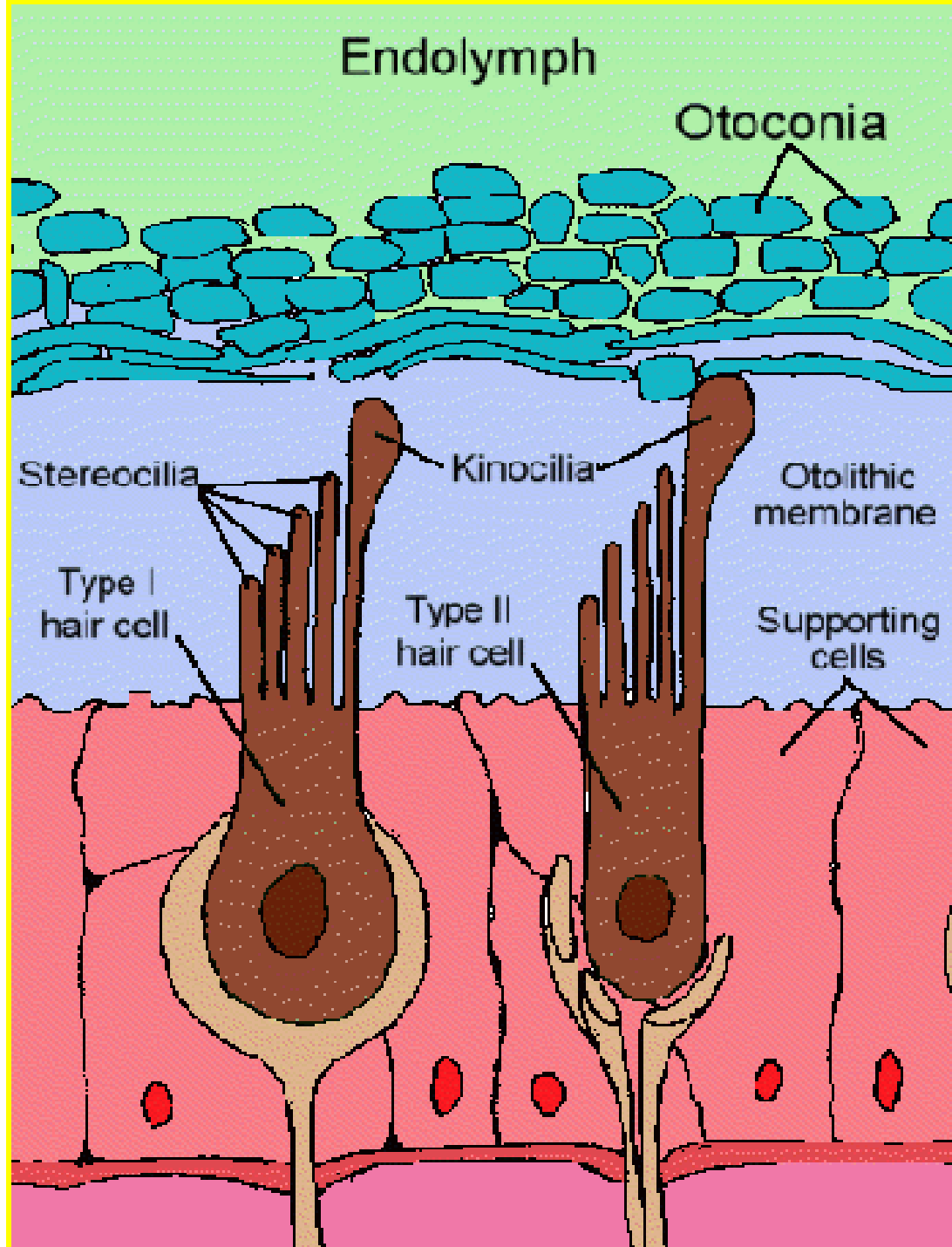


The Otolithic Organs

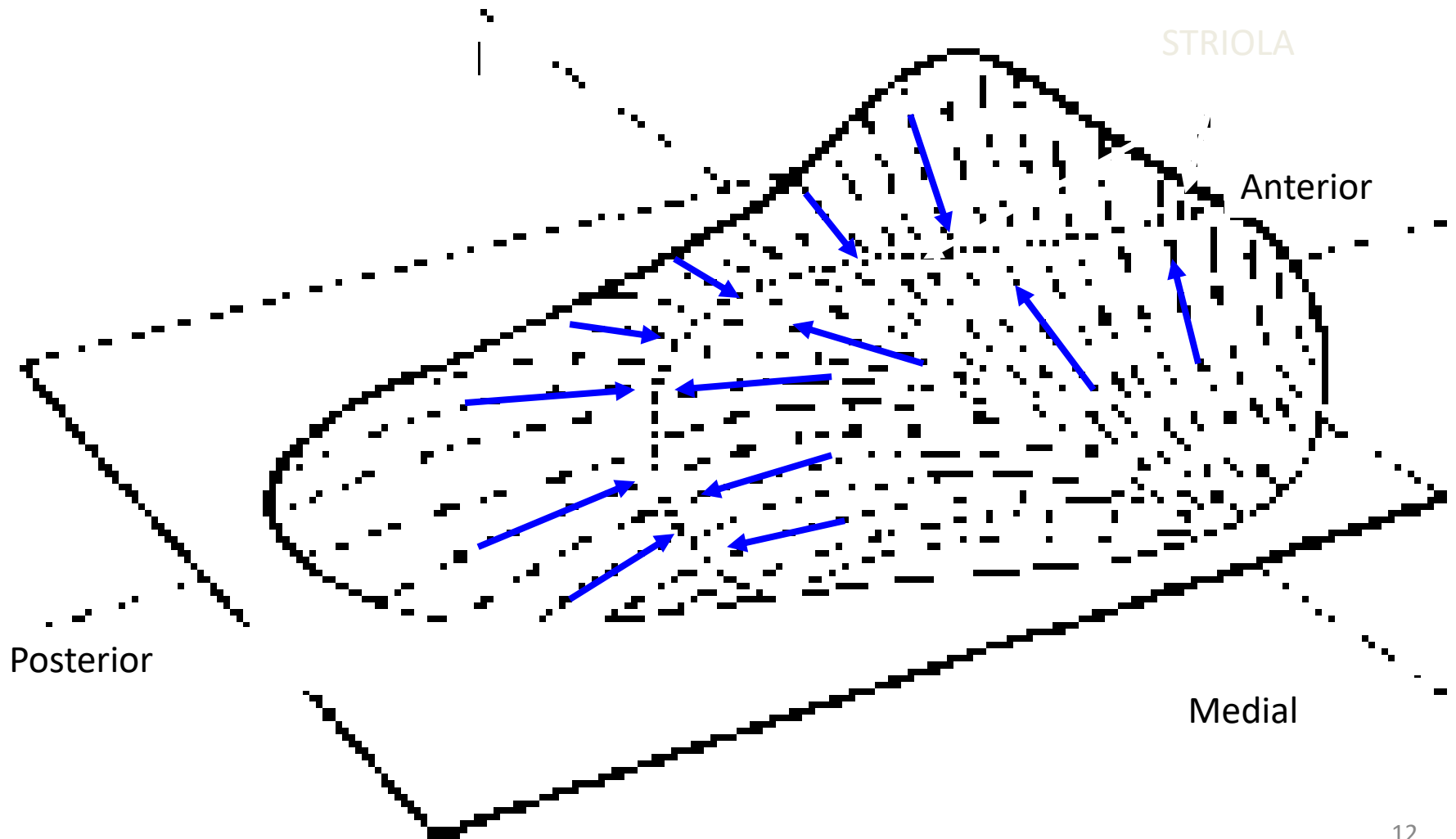


Saccule: roughly vertical orientation, responds to acceleration components within sagittal plane

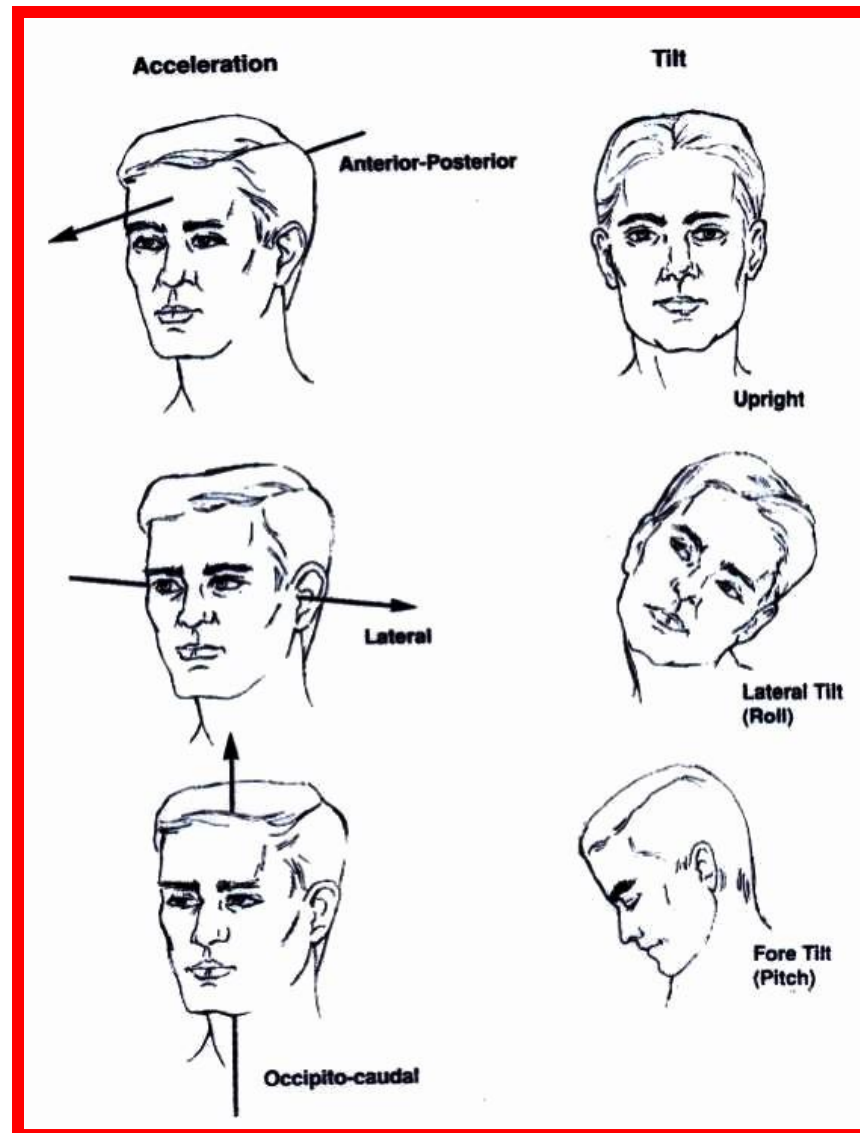
Utricle: horizontal (+ 30 deg.) orientation



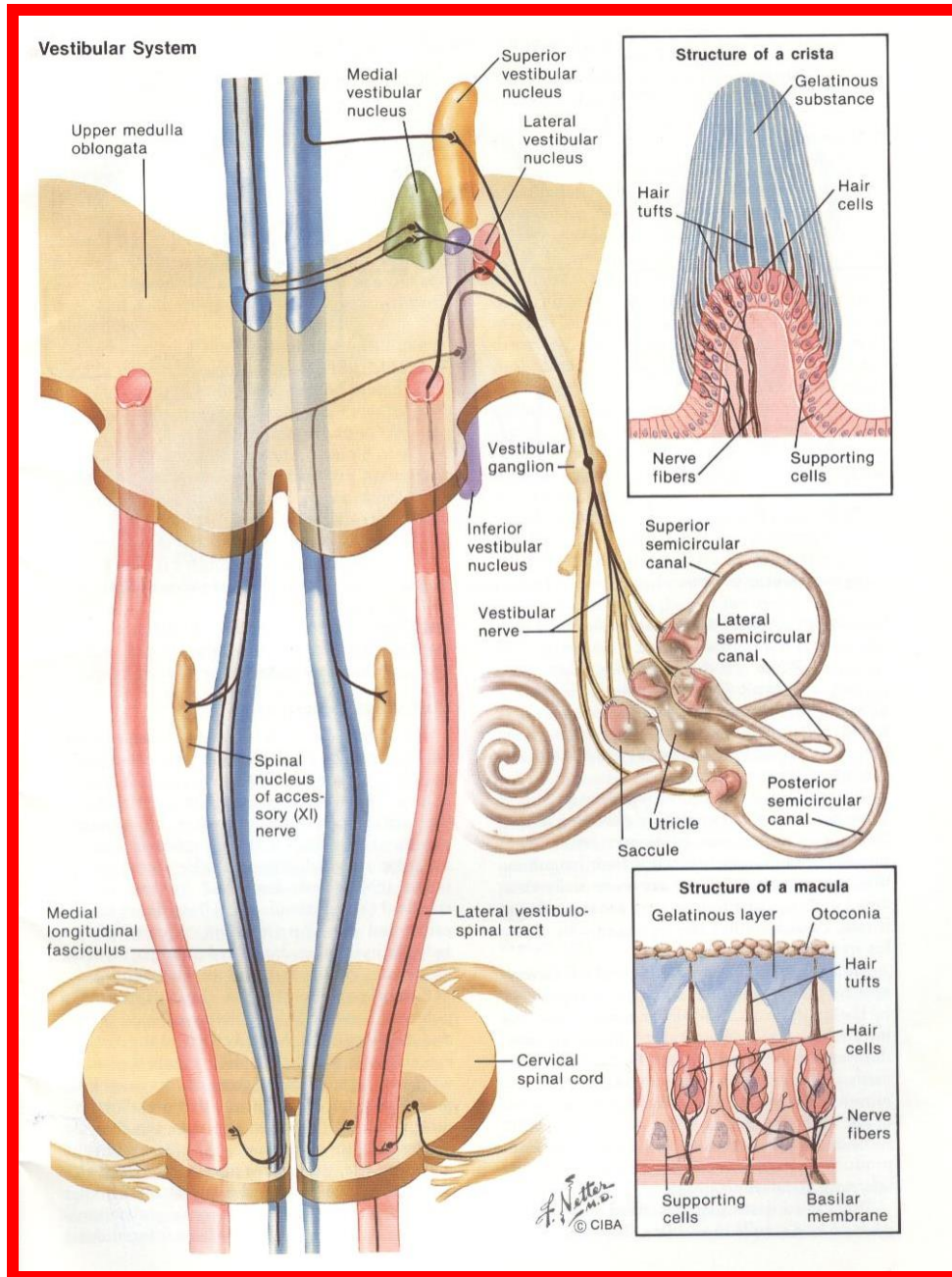
Excitation Patterns in the Utricle

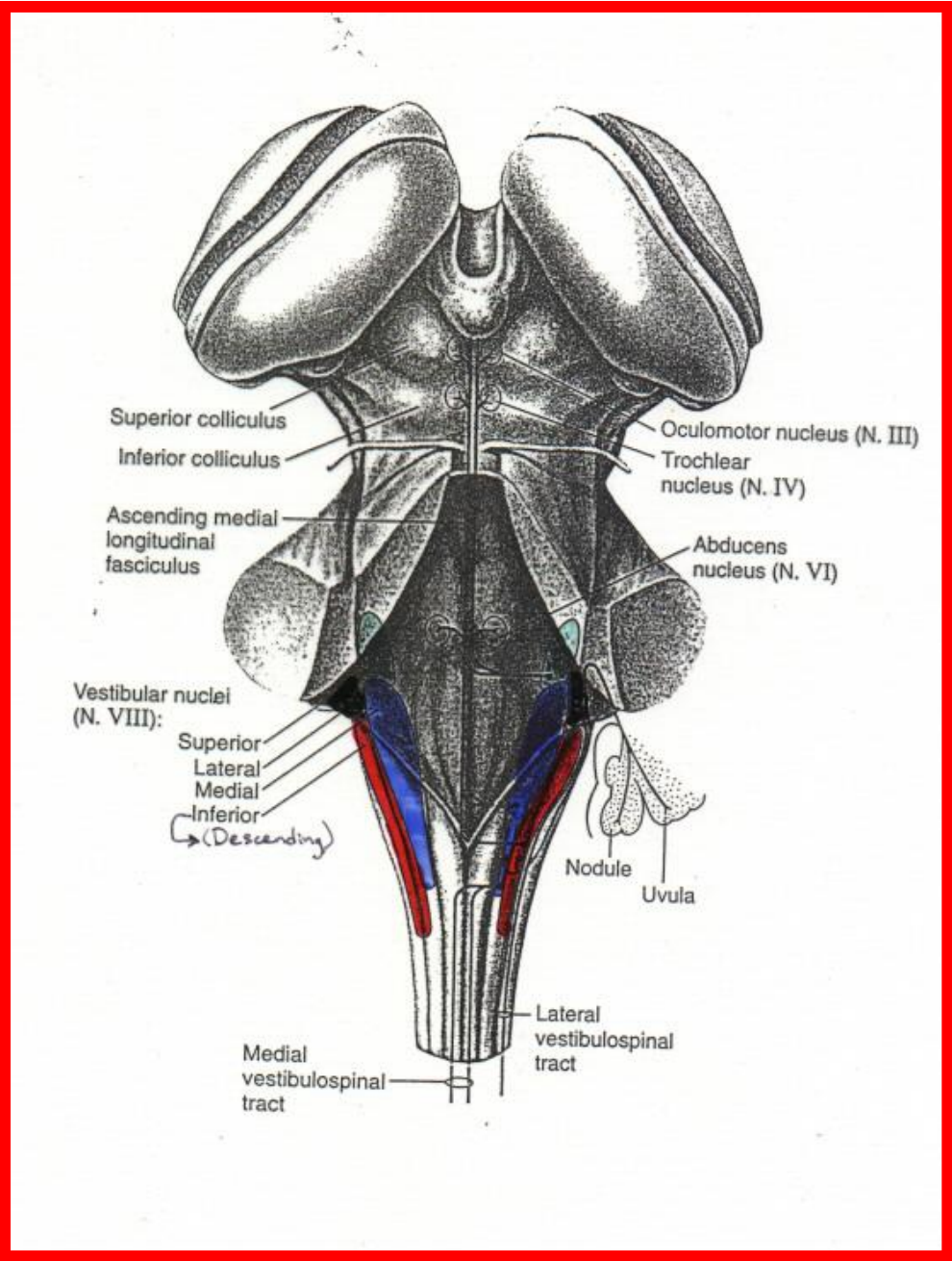


The otoliths register linear acceleration and static tilt

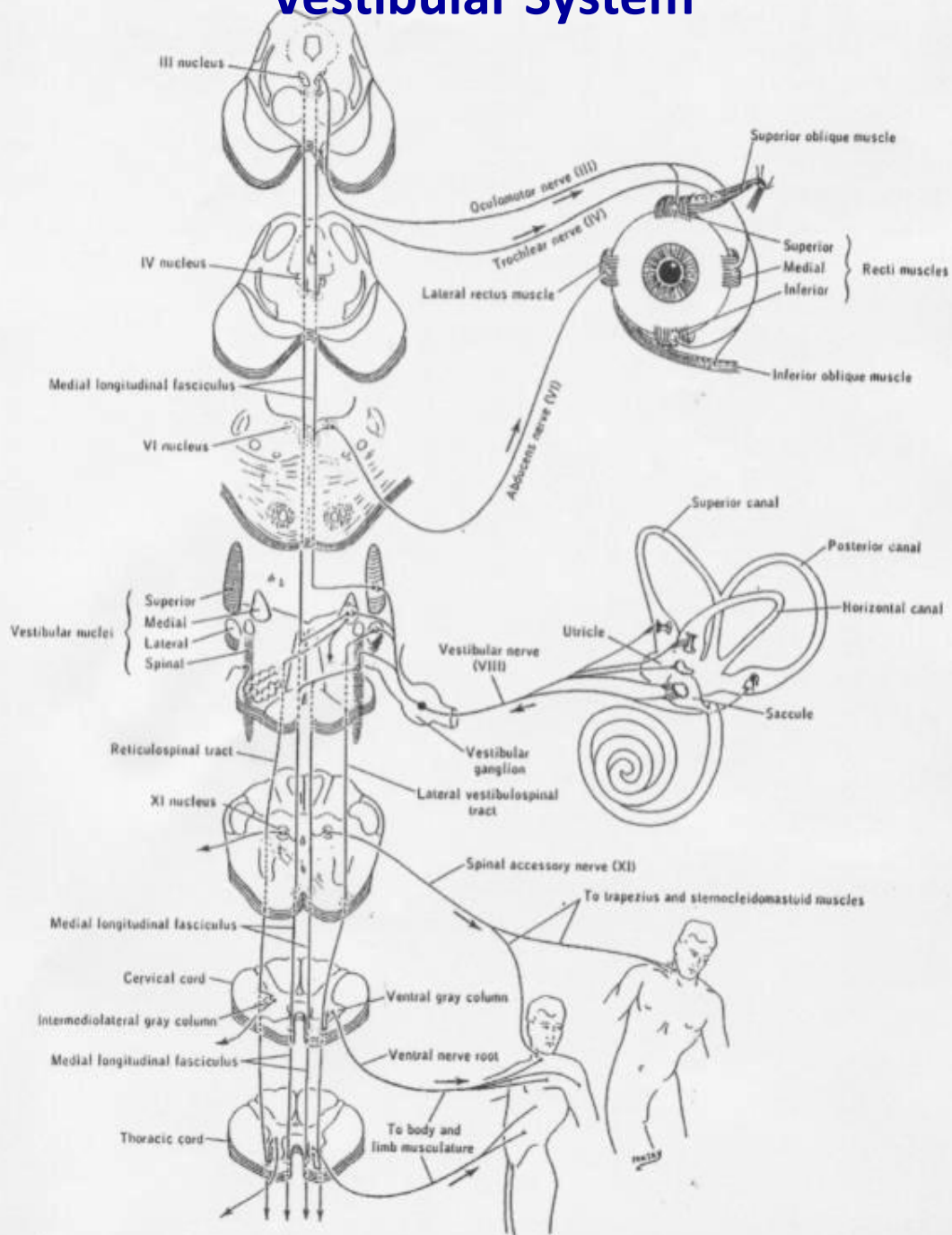


Vestibular system





Vestibular System



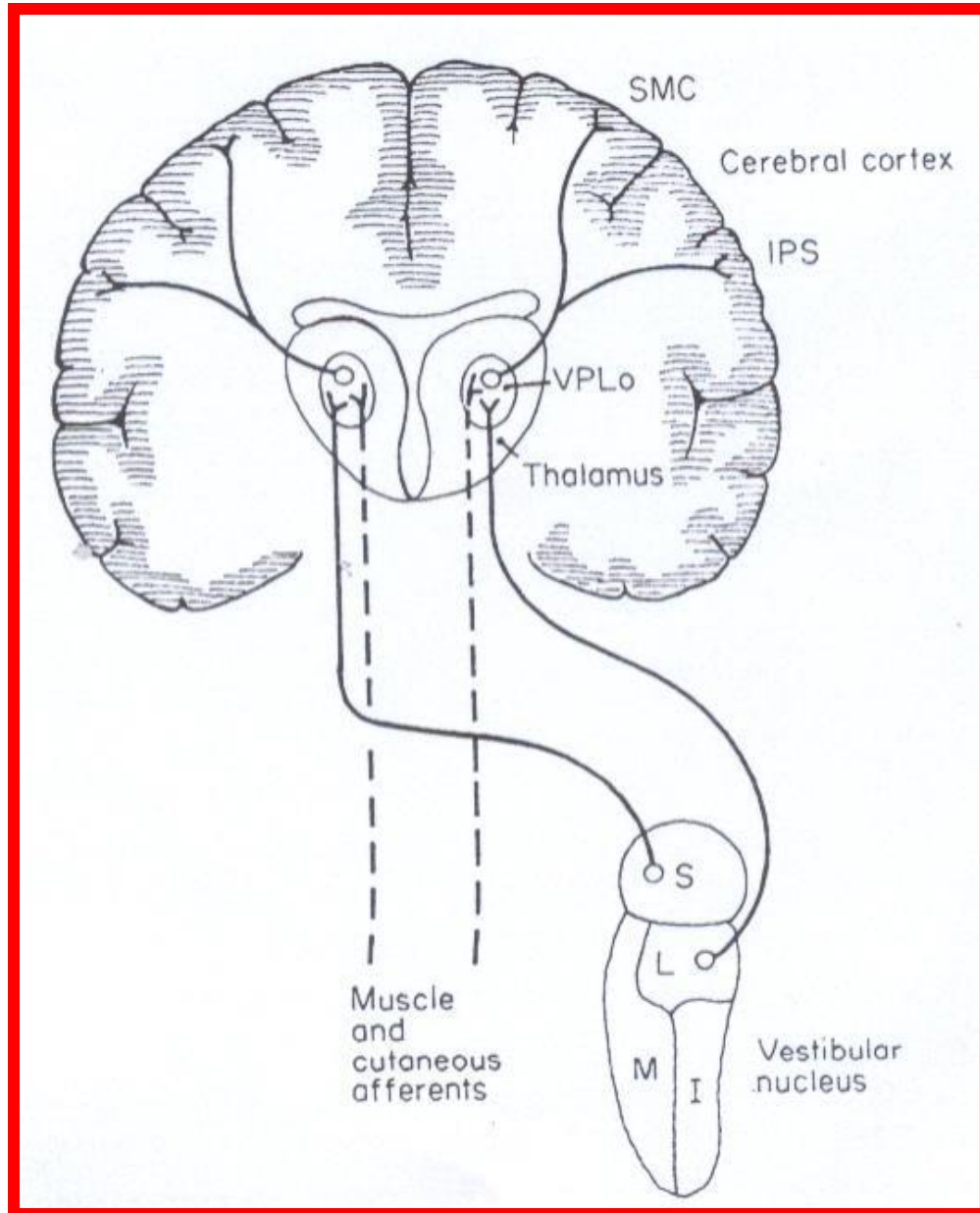
Vestibular Nuclei (VN)

Vestibular signals originating in the two labyrinths first interact with signals from other sensory systems in the VN.

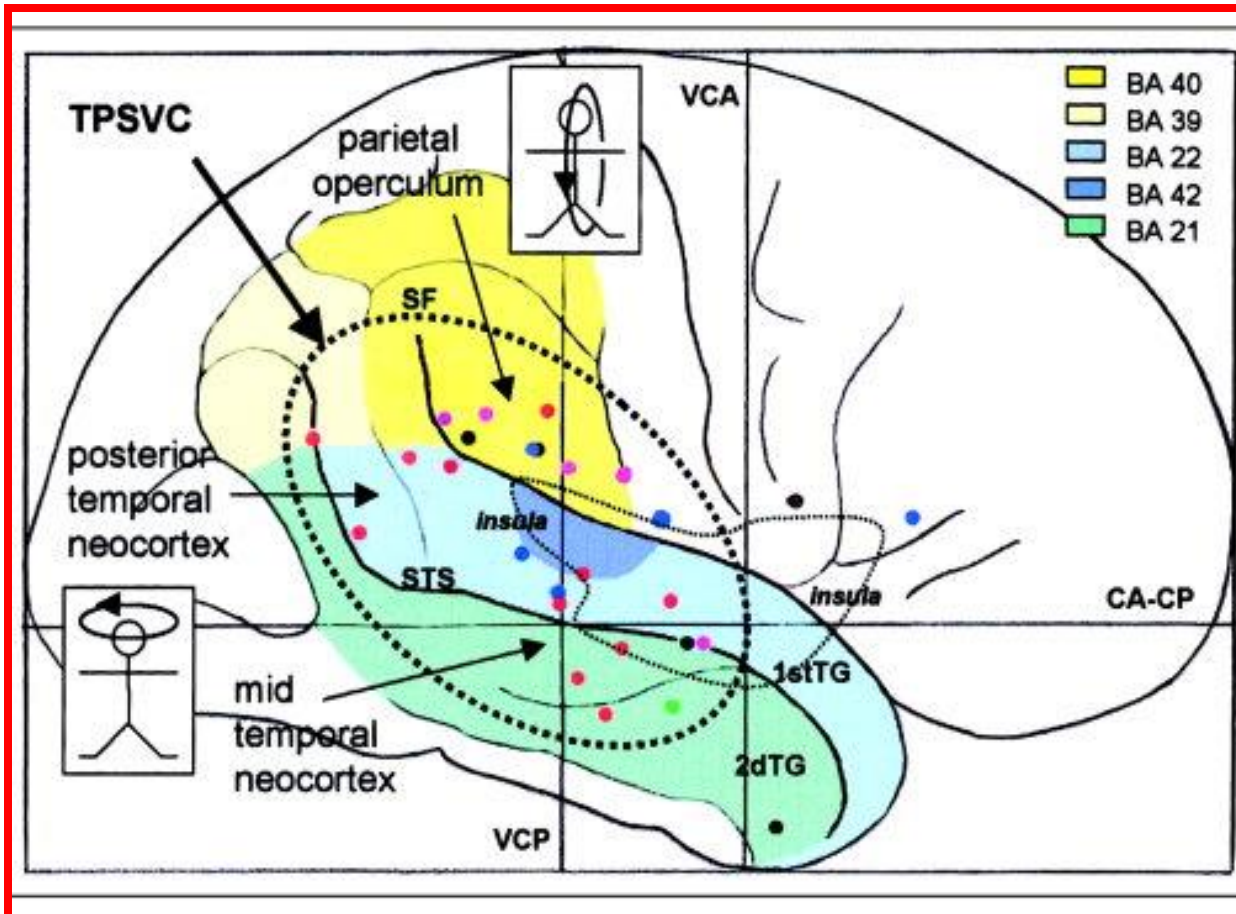
Only one fraction of the neurons in the VN receive direct vestibular input, and most neurons receive afferent input from other sensory systems (visual or proprioceptive) or regions of the CNS (cerebellum, reticular formation, spinal cord and contralateral VN).

Consequently the output of neurons from the VN reflect the interaction of many systems.

Vestibular Cortex

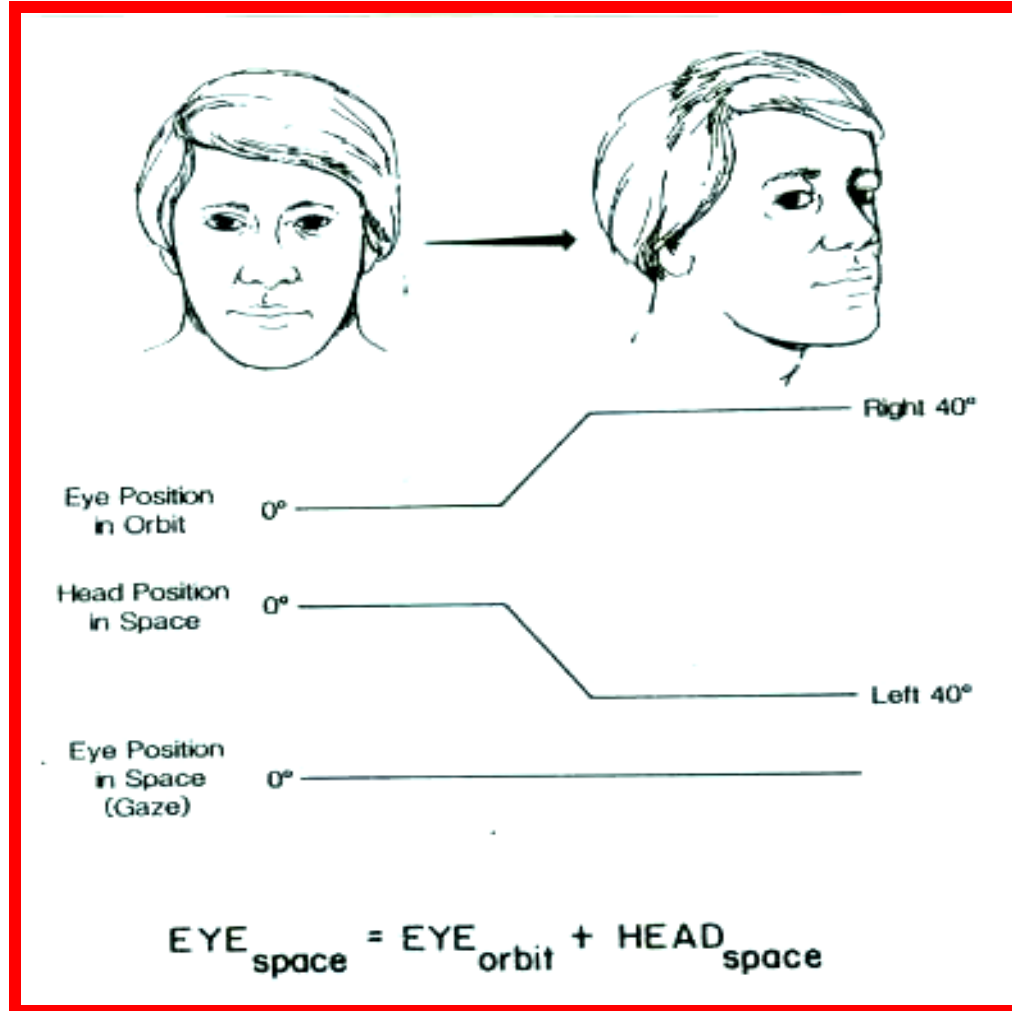


Vestibular Cortex



Schematic representation of the temporo-peri-Sylvian vestibular cortex (TPSVC). The vestibular sites located at the lateral aspect of the right or left hemispheres are projected on a lateral view of the right hemisphere normalized in the proportional stereotactic grid system of Talairach and Tournoux. BA = Brodmann area; CA-CP = anterior commissure-posterior commissure plane; VCA = vertical plane through CA; VCP = vertical plane through CP; SF = Sylvian fissure; STS = superior temporal sulcus; 1stTG = first (superior) temporal gyrus; 2dTG = second (mid) temporal gyrus. (*red dots*) Yaw plane illusions; (*pink dots*) pitch plane illusions; (*blue dots*) roll plane illusions; (*green dots*) translations; (*black dots*) indefinable sensations of body motion.

Vestibulo-Ocular Reflex (VOR)



To hold images of the seen world steady on the retina during brief head rotations

Dizziness – Vertigo - Disequilibrium

