Vestibular Physiology

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[Central Vestibular Pathways 1](#_Toc2987424)

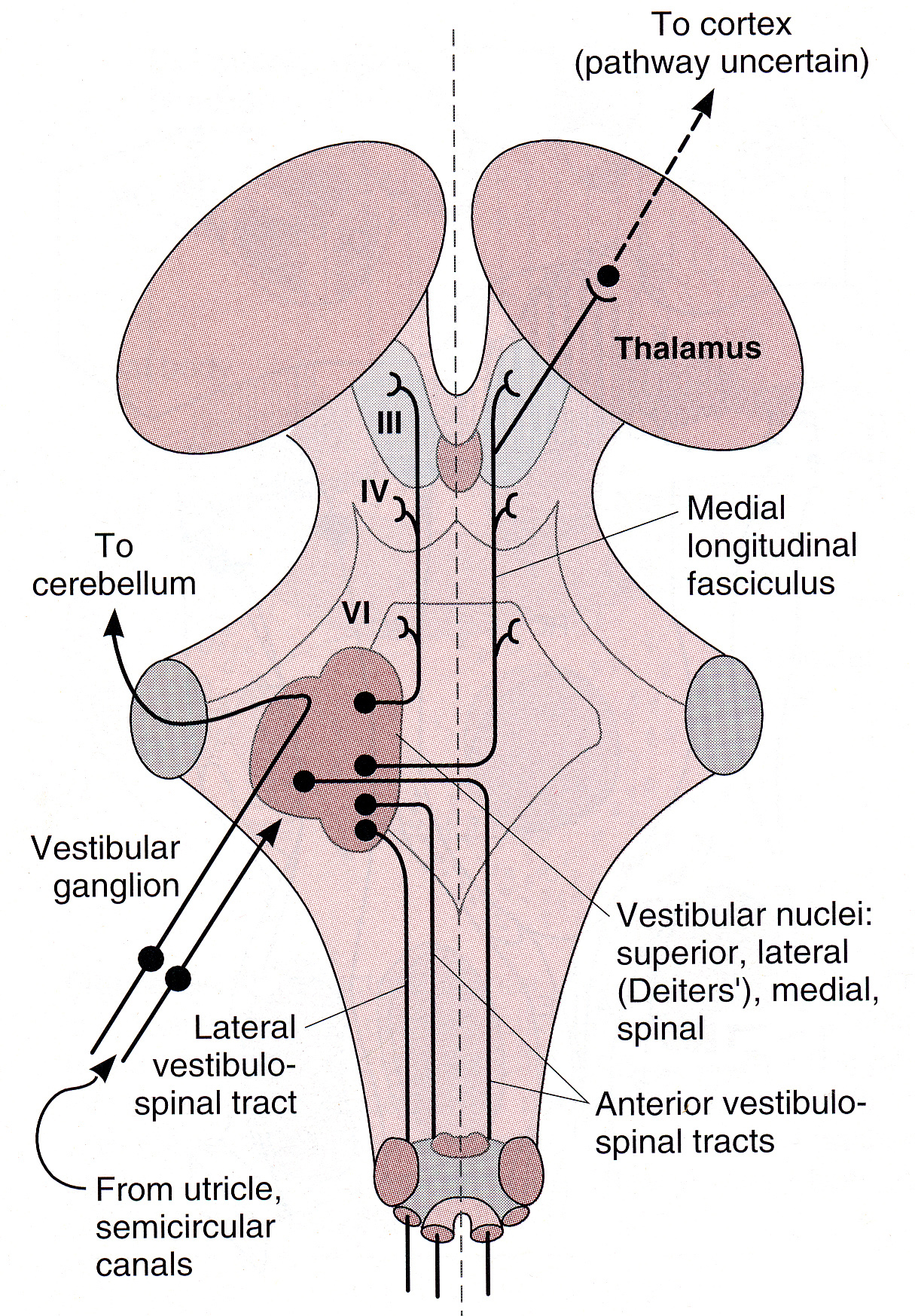
[Rotational Acceleration 1](#_Toc2987425)

[Linear Acceleration 1](#_Toc2987426)

[Labyrinthectomy 1](#_Toc2987427)

Although most of responses to stimulation of vestibular receptors are ***reflex*** in nature, vestibular impulses also ***reach cerebral cortex*** - conscious perception of motion + orientation in space.

Central Vestibular Pathways



Source of picture: William F. Ganong “LANGE Review of Medical Physiology”, 21st ed. (2003); Publisher: McGraw-Hill / Appleton & Lange; ISBN-10: 0071402365; ISBN-13: 978-0071402361 [>>](http://www.amazon.com/gp/product/0071605673)

Rotational Acceleration

**rotational acceleration** in plane of given semicircular canal stimulates its **ampullar crista**.

[**linear acceleration** fails to displace cupula and therefore does not stimulate cristae].

Movement of cupula in one direction causes ***increased spike rate*** in single nerve fibers from its crista, whereas movement in opposite direction ***inhibits neural activity***.

Since canals on one side of head are *mirror image* of those on other side, endolymph is displaced toward ampulla on one side and away from it on other.

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| D:\Viktoro\Neuroscience\Ear. Otology\00. Pictures\Crista Ampullaris.jpg  Cupula on crista top closes off ampulla and is flexible. | D:\Viktoro\Neuroscience\Ear. Otology\00. Pictures\Ampullary responses to rotation.jpg  Average time course of impulse discharge from ampulla of two semicircular canals during rotational acceleration, steady rotation, and deceleration. |

* when rotation is started, **endolymph**, because of its inertia, is displaced in ***direction opposite to rotation*** → fluid pushes on cupula, deforming it → this bends processes of hair cells.
* when constant speed of rotation is reached (no acceleration), fluid spins at same rate as body and cupula swings back into upright mid position.
* when rotation is stopped, deceleration produces displacement of endolymph in ***direction of rotation*** → cupula is deformed in direction opposite to that during acceleration → returns to mid position in 25-30 seconds.
* start and end of rotation are accompanied by ***nystagmus*** (see [p. Eye64 >>](http://www.neurosurgeryresident.net/Eye.%20Ophthalmology\Eye64.%20Gaze%20and%20Autonomic%20Innervation%20Disorders.pdf)) - it is consequence of **vestibulo-ocular reflex** that maintains visual fixation on stationary points while body rotates, although it is not initiated by visual impulses and is *present even in blind individuals*.
* ***vertigo*** is sensation of rotation in absence of actual rotation and is prominent symptom when one labyrinth is inflamed.
* semicircular canals can be stimulated experimentally by ***caloric irrigation test*** (see [p. S30 >>](http://www.neurosurgeryresident.net/S.%20Symptoms,%20Signs,%20Syndromes\S30-34.%20Alterations%20of%20Consciousness,%20Coma,%20Vegetative%20State,%20Brain%20Death\S30.%20Alterations%20in%20Level%20of%20Consciousness,%20Coma.pdf)) – this causes nystagmus, vertigo, nausea [to avoid these symptoms when irrigating ear canals in treatment of ear infections, it is important to use fluid at body temperature].

Linear Acceleration

**linear acceleration** stimulates utricular and saccular **maculas**.

* utricle responds to ***horizontal acceleration*** and saccule to ***vertical acceleration***.
* **otoliths** are more dense than endolymph, and acceleration in any direction causes them to be displaced in opposite direction, distorting hair cell processes + maculae also discharge tonically in ***absence of head movement*** (because of gravity pull on otoliths).
* excessive stimulation causes ***motion sickness***.

Labyrinthectomy

**Unilateral Labyrinthectomy** → unbalanced discharge from remaining normal side.

* *rats* develop abnormal body postures and roll over and over as they continuously attempt to right themselves.
* postural changes are less marked in *humans*, but ***symptoms are distressing***; motion aggravates symptoms, but efforts to minimize stimulation by lying absolutely still are constantly thwarted by waves of nausea, vomiting, diarrhea; fortunately, compensation occurs and ***after 1-2 months symptoms disappear completely***.

**Bilateral Labyrinthectomy** → defects of orientation in space.

* especially *hazardous during diving* – vision is the only remaining tool to orient where water surface is (water pressure sensed by cutaneous receptors is equal over the body); if vision is obscured, drowning may occur due to disorientation.

Bibliography for ch. “Otology” → follow this [link >>](http://www.neurosurgeryresident.net/Ear.%20Otology\Ear.%20Bibliography.pdf)

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