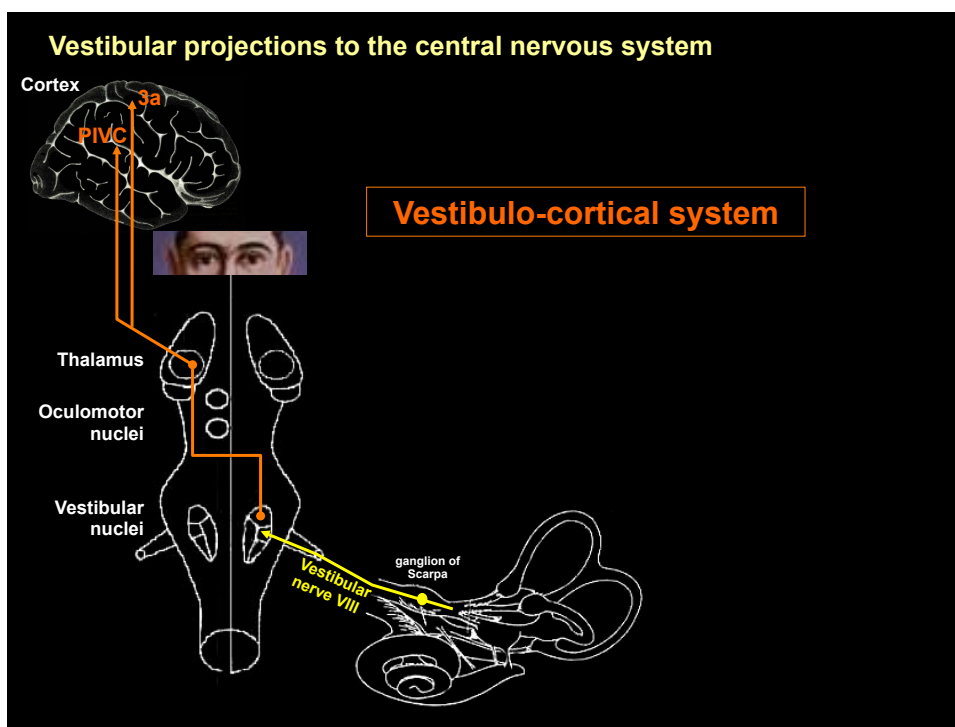


Explorations du cortex vestibulaire

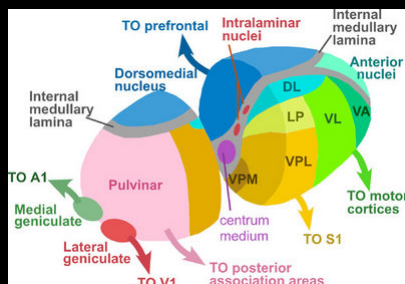
Christophe Lopez

CR CNRS

Laboratoire de neurosciences
intégratives et adaptatives
UMR 7260



The vestibular thalamus



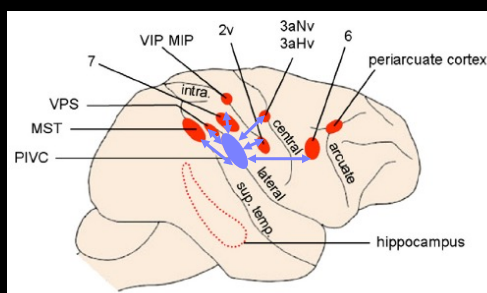
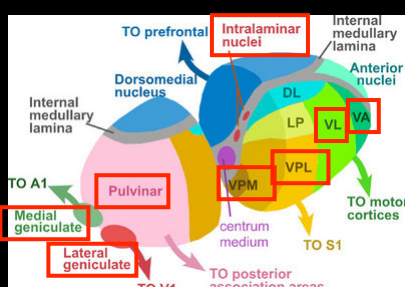
Vestibular neurons are organized in small patches distributed in the thalamus rather than in clearly identified nuclei

The vestibular cortex

Parieto-insular vestibular cortex (PIVC)

Grüsser et al. 1991 *J Physiol*

Guldin and Grüsser 1998, *Trends Neurosci*



Lopez and Blanke 2011 *Brain Res Reviews*

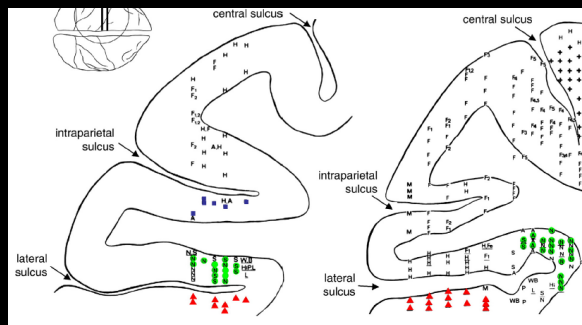
The vestibular cortex

Parieto-insular vestibular cortex (PIVC)

Grüsser et al. 1991 *J Physiol*

Guldin and Grüsser 1998, *Trends Neurosci*

● vestibular neurons



Macaca fascicularis
Grüsser et al. 1991, *J Physiol*

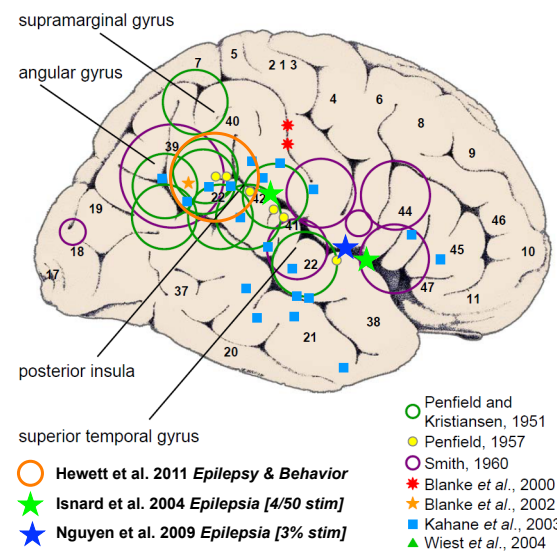
Electrophysiology:

vestibular neurons were “in the upper bank of the lateral sulcus around the **posterior end of the insula**, [... and] more posteriorly in the **retroinsular region** or more anteriorly in the **parietal operculum**.”

Where are the vestibular areas in the human cortex?
Where is the human analog of the monkey PIVC?

Epileptic vertigo and intracranial stimulation in epileptic patients

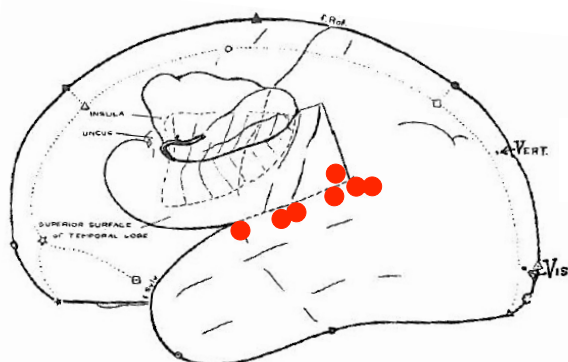
Vestibular vertigo



Lopez and Blanke, 2011 *Brain Research Reviews*

Intracranial stimulation in epileptic patients

Penfield, W. "Vestibular Sensation and the Cerebral Cortex."
Ann Otol Rhinol Laryngol 66 (1957): 691–698.



7/108 stimulations

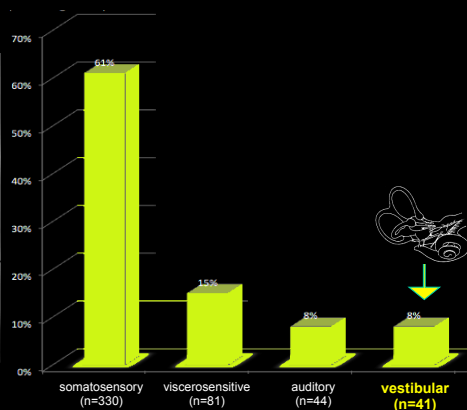
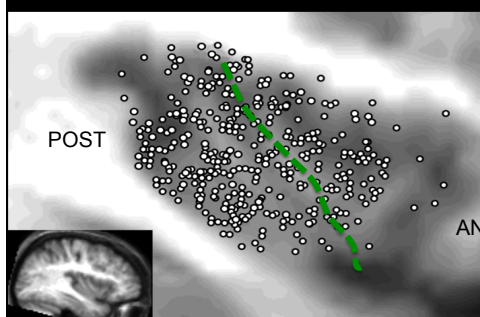
Fig. 3.—Labyrinthine responses which occurred in a series of 108 temporal explorations. The letter 'L' indicates a point where threshold stimulation produces such a sensation. The patients' descriptions follow: Case 5—sinking feeling and sensation of full head; 25—head rest seems to be jumping up and down; 47—"a dizziness all over"; 67—"etourdi" things turning around, whirling; 72—dizziness; 77—moving around; 94—dizziness, swinging, spinning. (From Penfield and Jasper, 1954)

Vestibular representations in the human insula: intracranial stimulation

Annals of
NEUROLOGY

- 219 epileptic patients
- 641 electrical stimulations in the insula

Mazzola*, Lopez* et al. 2014



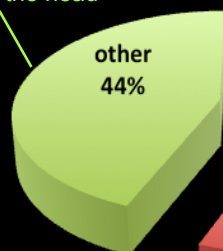
Mazzola, Lopez et al. (2014) *Annals of Neurology*

Vestibular representations in the human insula: intracranial stimulation

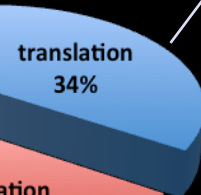
Clinical responses:

642 stimulations / 541 evoked a clinical response / 41 vestibular sensations

instability
spinning sensation
restricted to the head



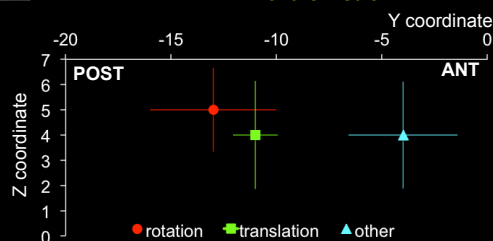
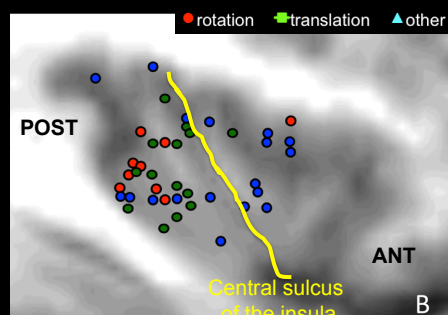
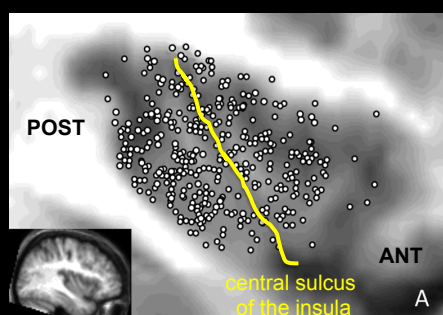
levitation
body rising
falling

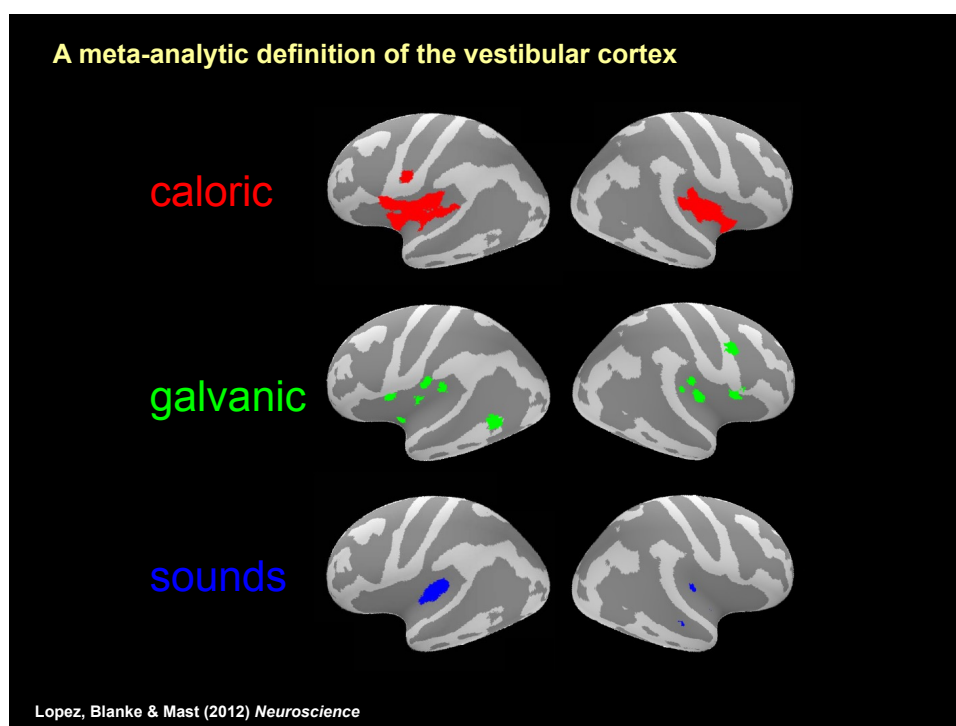
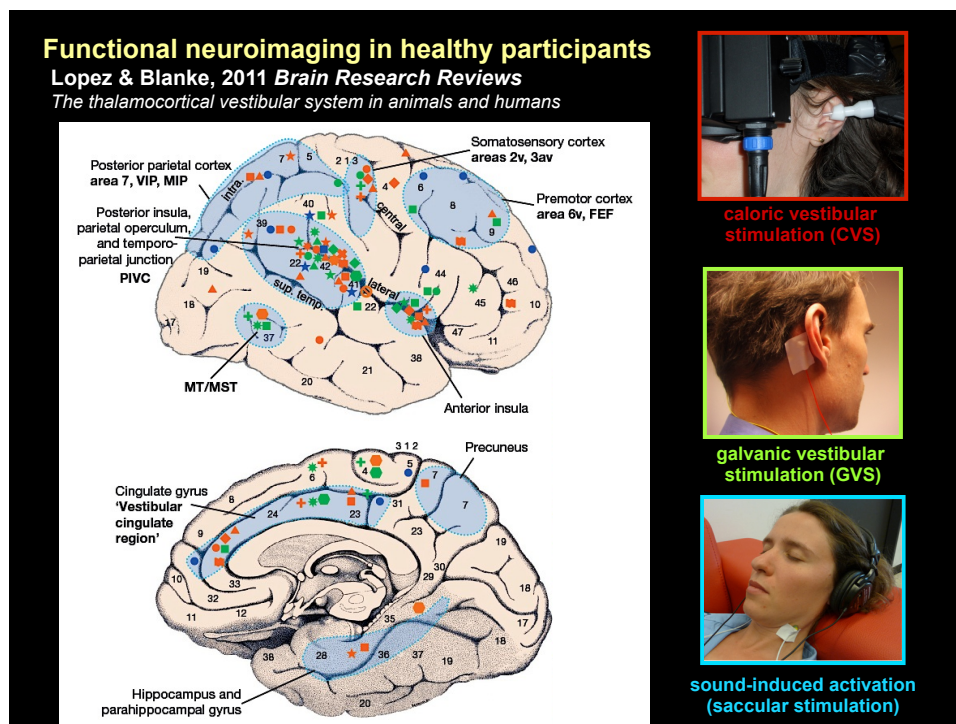


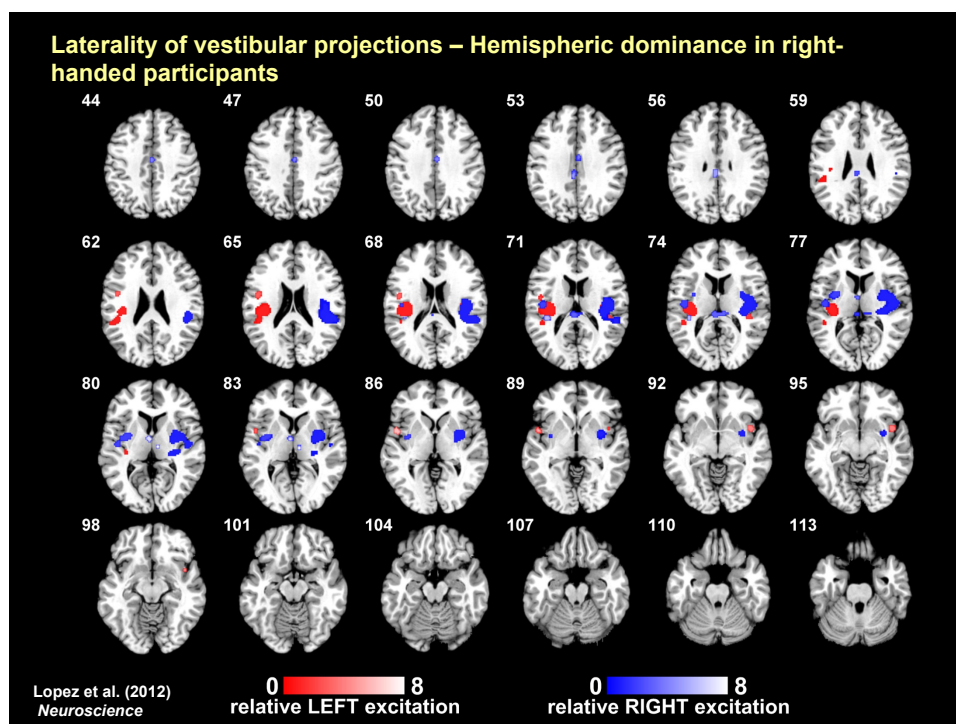
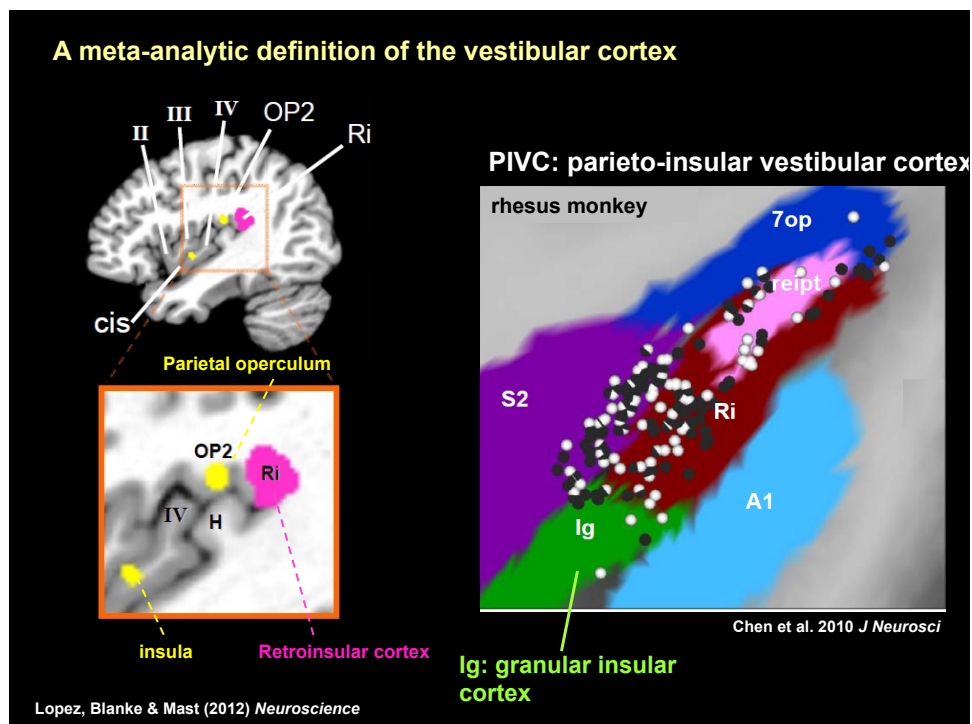
rotation
22%

yaw plane rotations (7)
roll plane rotations (2)

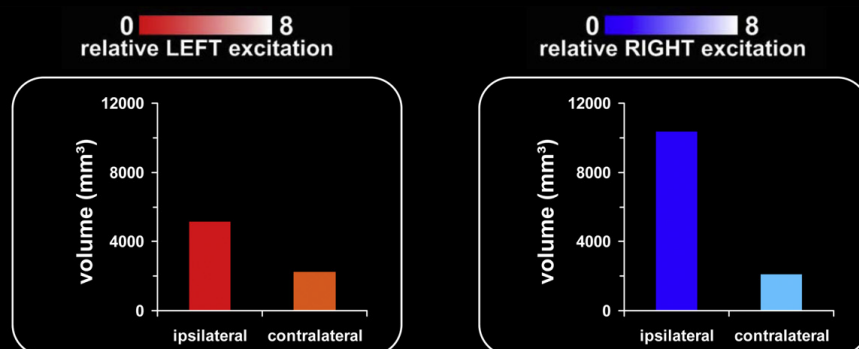
Vestibular representations in the human insula: intracranial stimulation





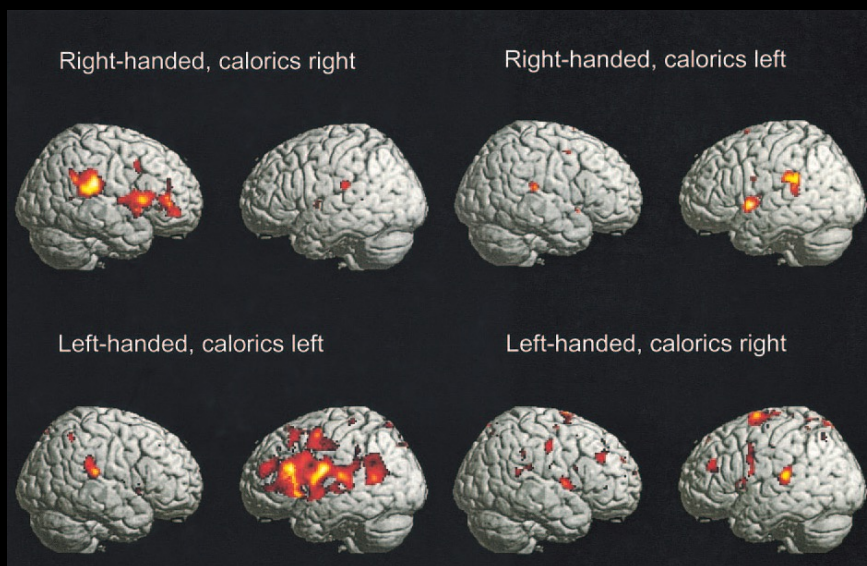


Laterality of vestibular projections – Hemispheric dominance in right-handed participants



Lopez et al. (2012)
Neuroscience

Laterality of vestibular projections – Effect of handedness



(100 ml of warm water at 44°C for ~50 s)
Dieterich et al. 2003 *Cerebral Cortex*

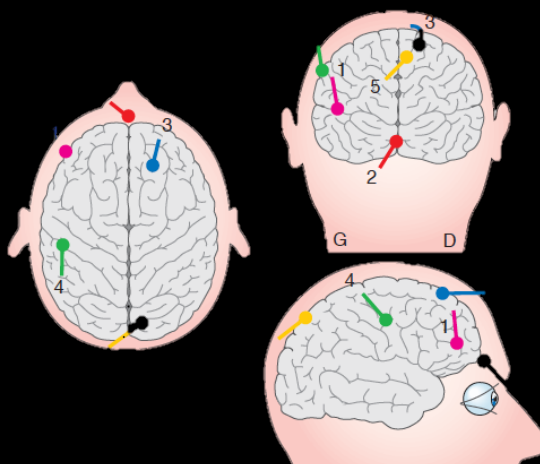
Spatio-temporal pattern of vestibular information processing

• electroencephalography

6 ms !!

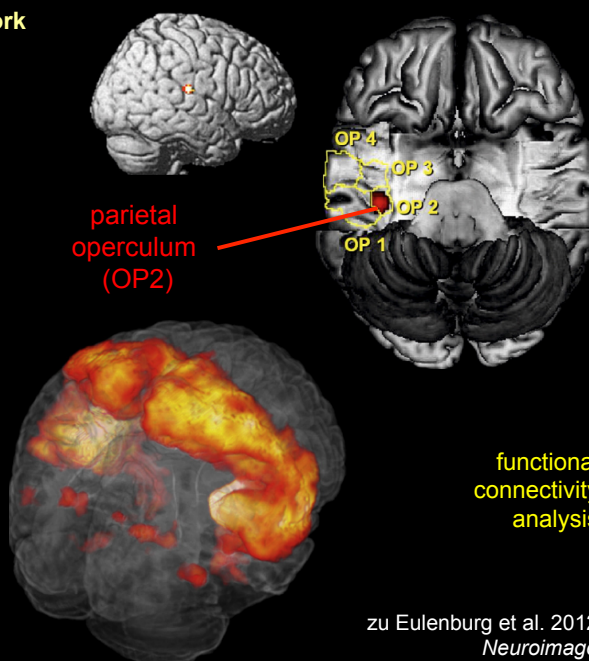
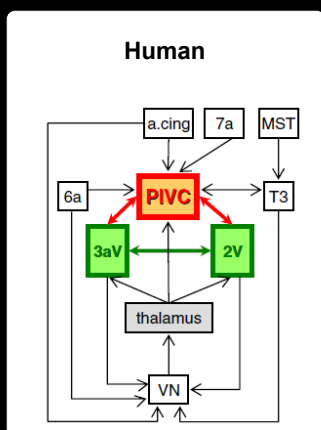
it's the latency for the activation of five distinct cortical zones:

- prefrontal cortex
- frontal cortex
- ipsilateral temporo-parietal cortex
- anterior SMA
- contralateral parietal cortex



de Waele et al. 2001 *Exp Brain Res*

A vestibular cortical network



zu Eulenburg et al. 2012
Neuroimage

A Comparison of Vestibular Spatiotemporal Tuning in PIVC, VIP and MSTd

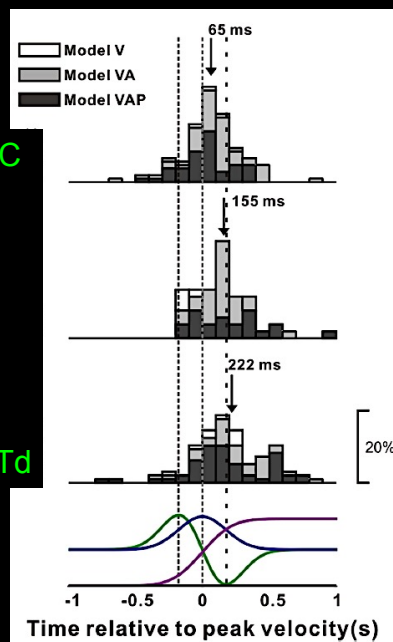
Chen et al 2011 *J Neuroscience*

Progressive shift toward longer peak times from PIVC to VIP to MSTd:

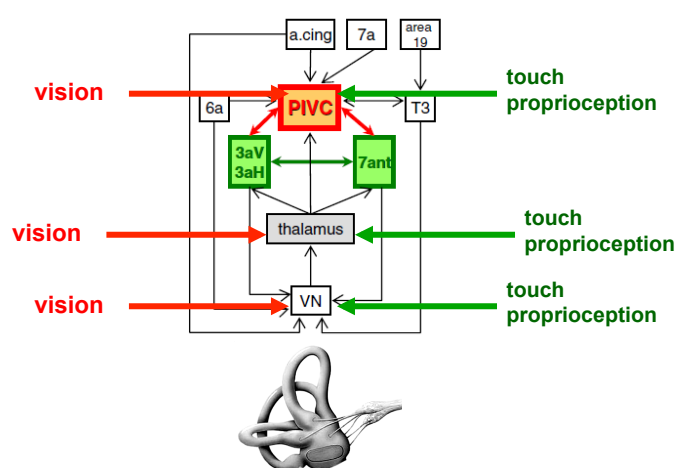
PIVC

VIP

MSTd



Multisensory integration in the vestibular system



Lopez and Blanke, 2011 *Brain Research Reviews*, adapted from Grüsser et al. 1994

