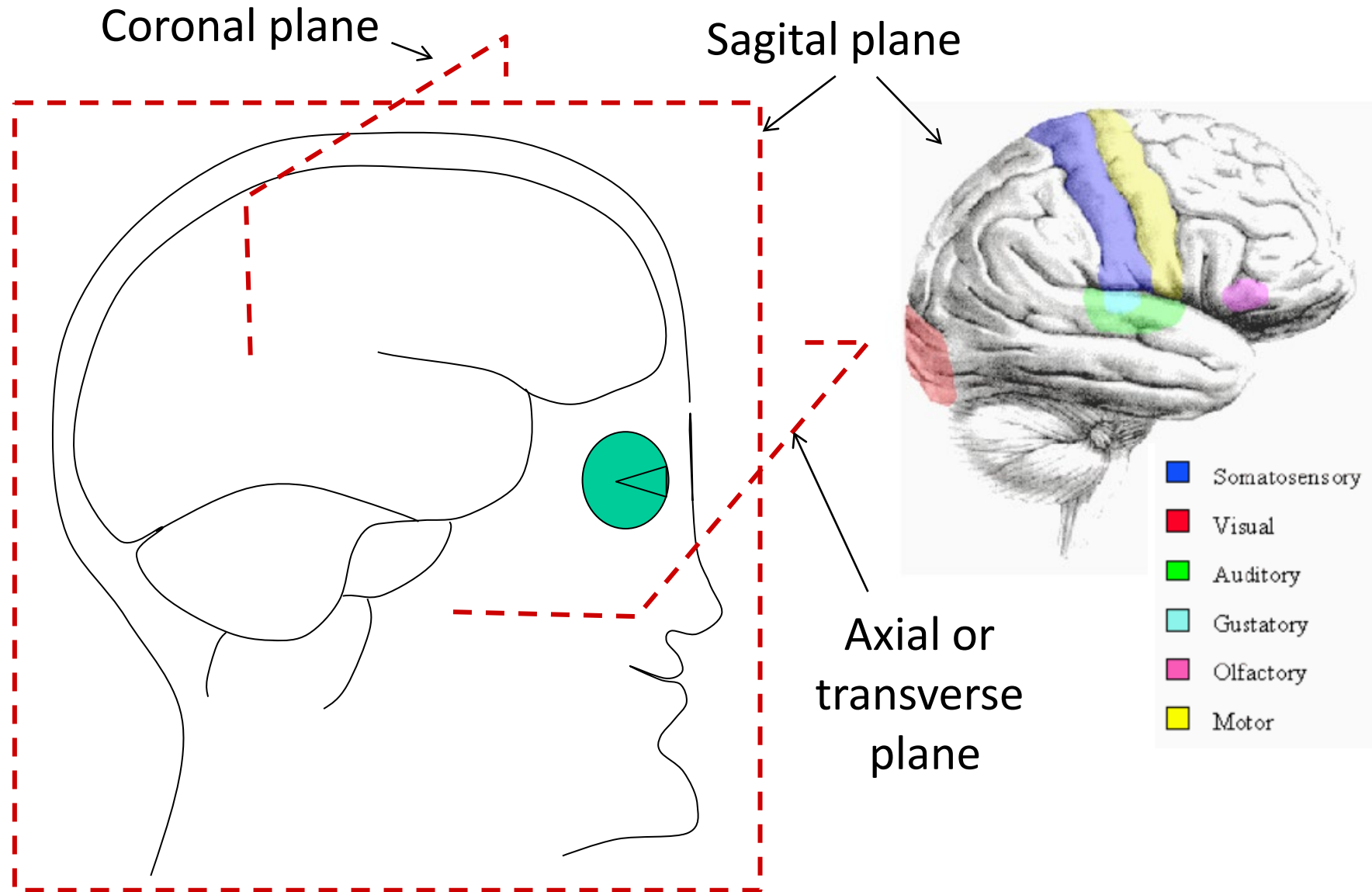


Perception and Action

- video1*
- 1. Anatomic conventions & Lateralization
 - 2. Perception & Action in the brain
 - 3. Perception of biological motion
 - 4. Conclusion

[références]

1. Anatomic conventions [W1]



1. Lateralization [W1]

The right hemisphere
senses/controls the
left body side

The left hemisphere
senses/controls the
right body side

Brain Laterality:

- 2 symmetric hemispheres
- **Lateralization** is the tendency for some neural functions or cognitive processes to be specialized to one side of the brain or the other.
- Sensing, motor control and lateral visual field are handled by the contralateral brain hemisphere



2 Perception & Action in the brain

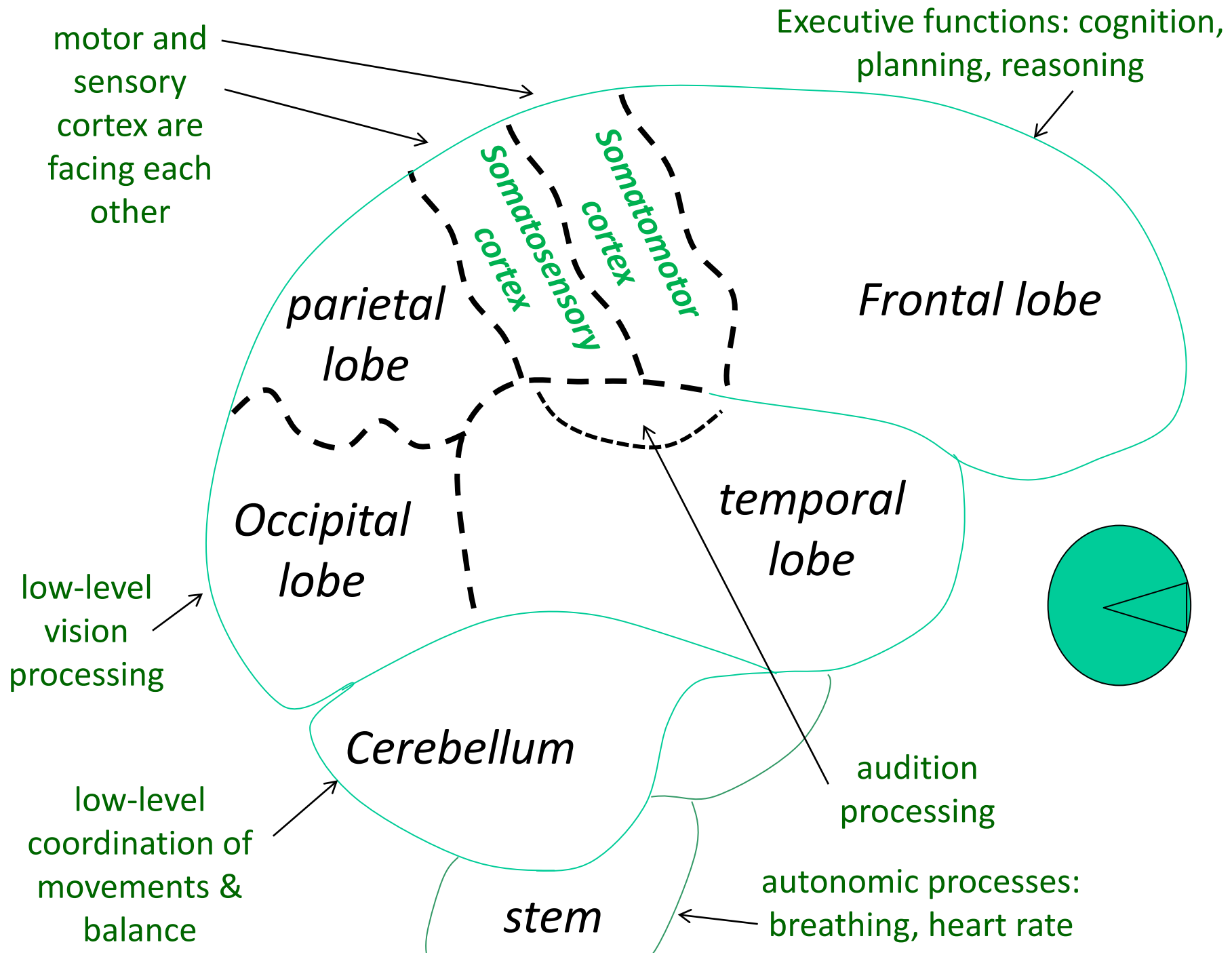
2.1 Perception-action mapping [W2]

Somato (from greek *soma*) : body

Somatosensory system: all *bodily sensations*, i.e. *tactile* (all skin sensors), *proprioceptive* (joint , tendon, muscles and other sensors related to posture and movement of the body) or *internal organ sensations*.

The vestibular system (sense of balance) is considered independently from the somatosensory system

Somatomotor system: all *voluntary control of body* movements (can be unconscious as in exertion of a skill). Opposed to *autonomic control* of breathing, heart rate....



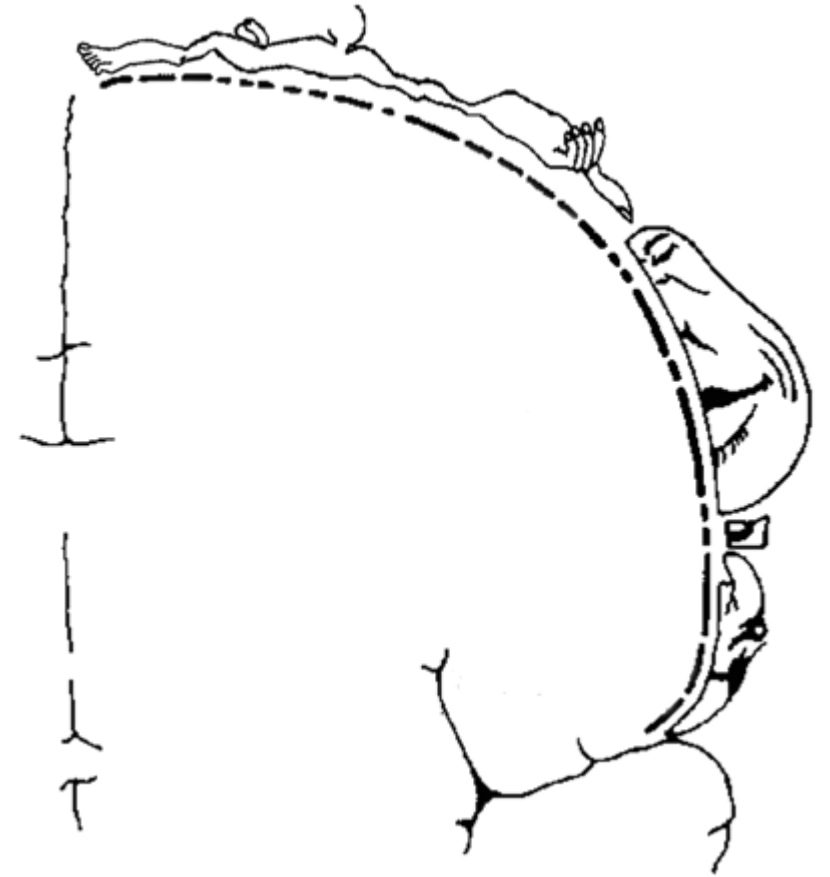
2.2 Homonculus [W. Penfield 1950s]

The somatosensory cortex is characterized by a point-to-point mapping of body areas to specialized neurons that are activated only when those body areas are stimulated,

e.g. each finger maps to its own region of neurons.

Two cortical Homonculi identified by W. Penfield in Montreal in the 50s:

A neural area in the **sensory homonculus** is **proportional to the density of sensors**, not to the body surface.



Slice in the coronal plane
Revised proposition of
Somatosensory cortex
[Kell et al 2005, Jneuro]



*Mrs H. P. Cantlie artist view of the sensory homunculus
identified by Wilder Penfield*

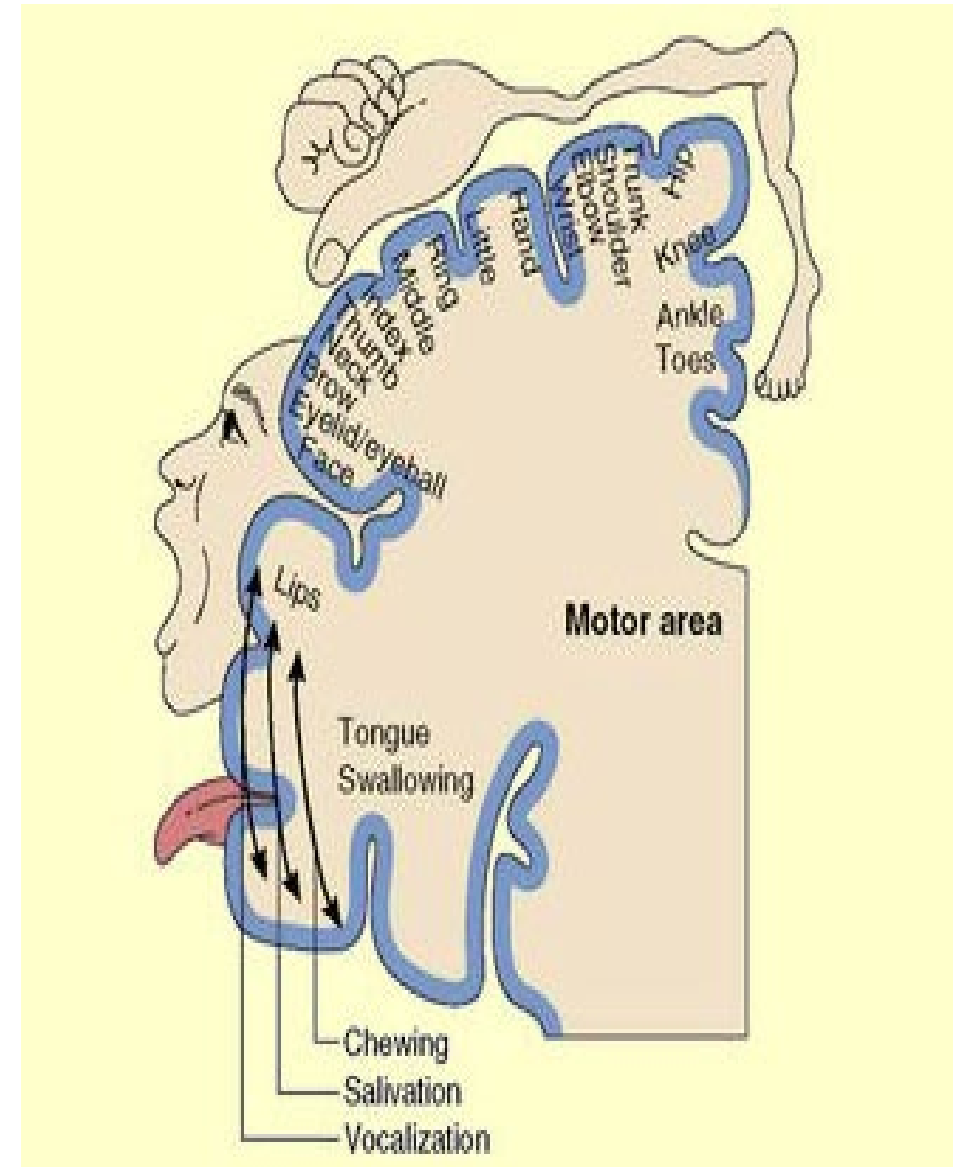
2.3 Homunculus [W. Penfield 1950s] (2)

Likewise, the **motor homunculus** characterizes the mapping of motor neurons to the muscle control system.

Muscles involved in **fine motor skills** (manual tasks) are controlled by **large neural areas**,

Small neural areas for muscles involved in a regular motion pattern.

Ex: locomotion is mostly encoded in the spine and tuned in the cerebellum.



Coronal plane slice [<http://thebrain.mcgill.ca>]

2.4 Body scheme [W3]

This concept integrates the knowledge of somatotopic maps into higher-order representations to describe « **organized models of ourselves** ».

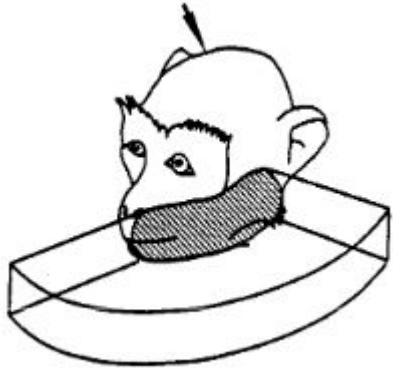
It consists of two schema:

- **registration of posture and movement**
- **localization of stimulated locations on the body surface**

Properties [HW 2005]:

- **Spatial encoding** : the body scheme represents both the position and configuration of the body as a 3D object in space
- **Plasticity** : adjust to body growth, skill training, accident recovery

2.5 Body sheme & adaptive extra-personal space



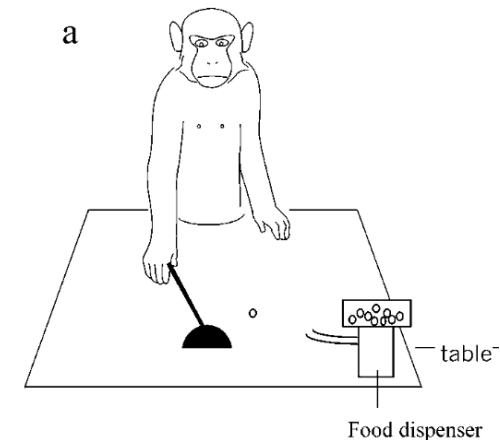
A model of the Extrapersonal space is possible with bimodal visual-tactile neurons:

Some proximity neurons becomes active both when an object is brought close to the body and when the object touches the body.

Iriki et al [O2001] have shown that a tool is integrated in the monkey body sheme after a short duration training (30 min).

The tool becomes an extension of the body

The Proximity neurons become active when an object is brought close to the tool, in the same way as when it is brought close to the body.



The use of a tool modifies the "body sheme" in the brain [O2001] [F2007]

2.6 Body scheme Pathology: Phantom Limb Pain

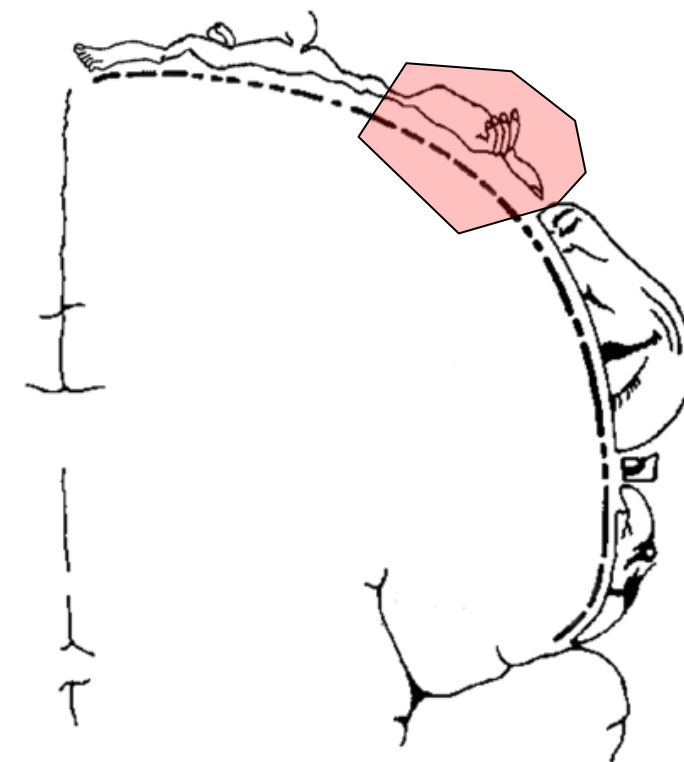
The loss of a body part (amputation) may lead to intense phantom pains (e.g. strong sensation of closing hand) because the body scheme couldn't adapt to the sudden change.

Various remapping have been observed through mechanisms of brain plasticity.

ex: after arm loss, a patient felt finger tips on the face

Ramachandran has proposed a mirror-box therapy to visually fool the brain about a restoration of the missing limb.

<http://endthepainproject.org/>



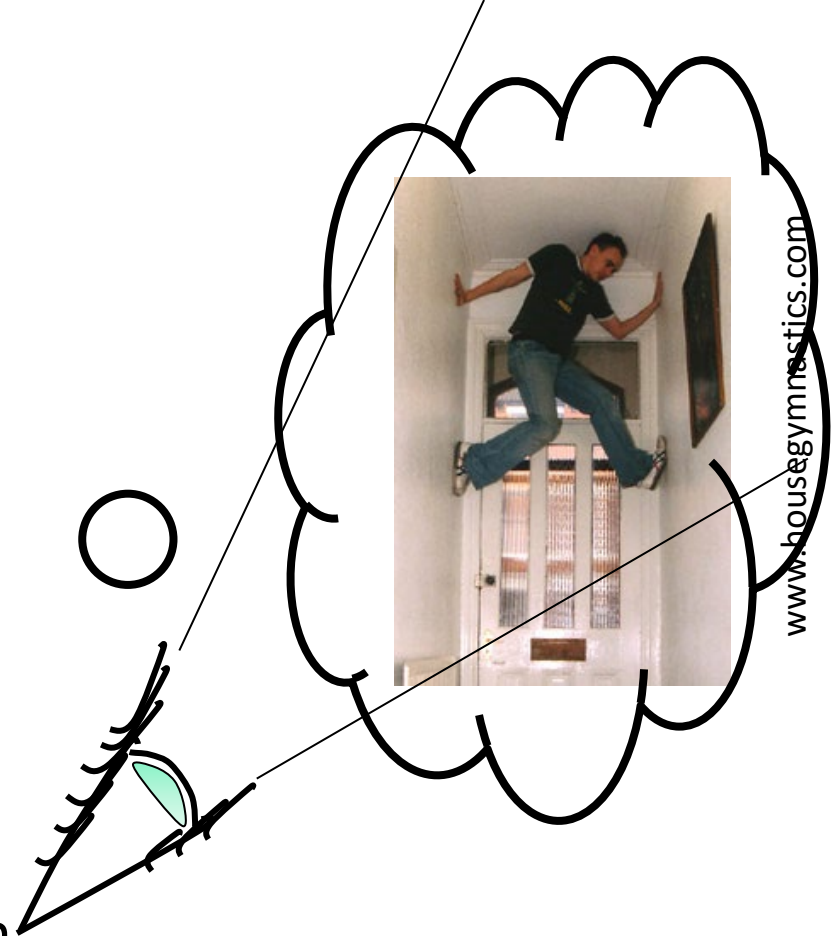
Slice in the coronal plane
Revised proposition of Somatosensory cortex [Kell et al 2005, Jneuro]

Alternatives of the box are being explored with Virtual Reality setups (more expensive & yet to be clinically validated)

2.7 Body scheme activation

The body scheme is actively and continuously updated when :

- Performing an action
- Thinking about performing that action (mental visualization)
- Perceiving **somebody else** performing that action (through *mirror neuron* [RS 2008]).



Simply viewing someone performing an action with efforts even induces heart and breath variations [PJ 2000].

[References]

- [B 2008] D. Badre, Cognitive control, hierarchy, and the rostro–caudal organization of the frontal lobes, Trends in Cognitive Sciences, Volume 12, Issue 5, 193-200, 1 May 2008
- [HW 2005] Haggard P & Wolpert DM (2005), Disorders of body scheme, in "Higher-Order Motor Disorders", Ed. Freund, Jeannerod, Hallett & Leiguarda, Oxford University press
- [O2001] Shigeru Obayashi, Tetsuya Suhara, Koichi Kawabe, Takashi Okauchi, Jun Maeda, Yoshihide Akine, Hirotaka Onoe, Atsushi Iriki, Functional Brain Mapping of Monkey Tool Use, NeuroImage, Volume 14, Issue 4, October 2001, Pages 853-861
- [PJ 2000] Paccalin, C., Jeannerod, M.:Changes in breathing during observation of effortfull actions. Brain Research, 862, 194--200 (2000)
- [RS 2008] Rizzolatti, G, Sinigaglia, C. Mirrors in the Brain. How We Share our Actions and Emotions. Oxford University Press 2008
- [TRV 2006] Traité de Réalité Virtuelle, Ed. P. Fuch, vol 1, chap 11 Eds A. Berthoz & J.L. Vercher
- <http://lecerveau.mcgill.ca/>
- http://www.lifesci.sussex.ac.uk/home/George_Mather/Motion/index.html
- [W1] http://en.wikipedia.org/wiki/Anatomical_terms_of_location: sagital, coronal, axial, dorsal, ventral...
- http://en.wikipedia.org/wiki/Lateralization_of_brain_function
- [W2] http://en.wikipedia.org/wiki/somatosensory_system: body senses mapping in the brain
- [W3] http://en.wikipedia.org/wiki/Body_schema : body spatial encoding