La neuroimagerie et l'enjeu pour l'homme

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Co-Director, EEG Brain Mapping Core
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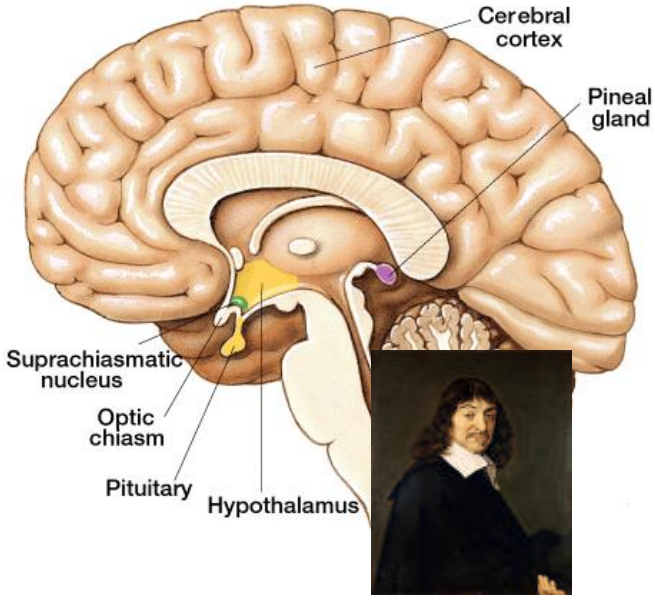
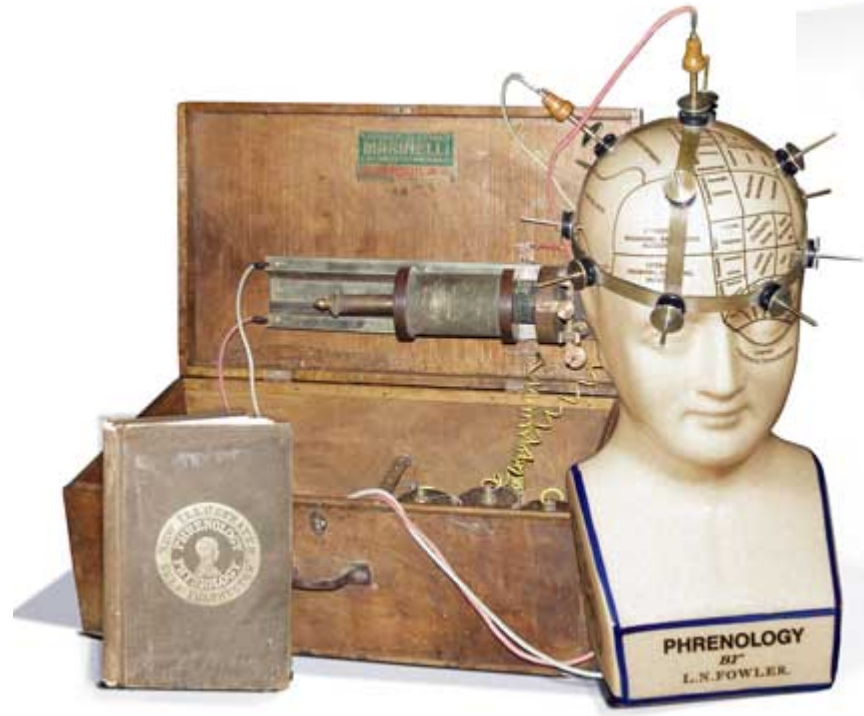
"In the face of this modern nihilism, Christians are often lacking in courage. We tend to give the impression that we will hold on to the outward forms whatever happens, even if god really is not there. But the opposite ought to be true of us, so that people can see that we demand the truth of what is there and that we are not dealing merely with platitudes. In other words, it should be understood that we take the question of truth and personality so seriously that **if God were not there we would be among the first of those who had the courage to step out of the queue.**"

Francis A. Schaeffer, *The God Who is There* (1968)

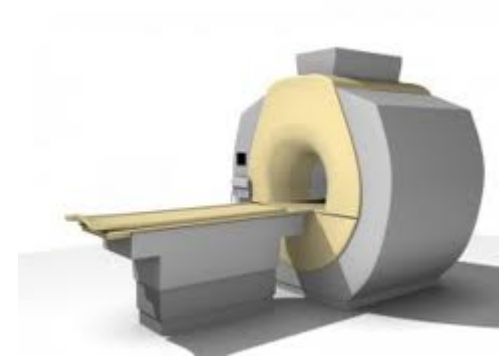
pour Edith Rachel Merritt Seville Schaeffer (Nov 3, 1914 – March 30, 2013)

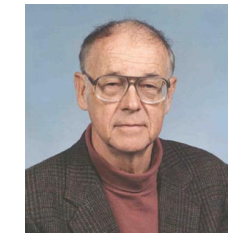


Descartes
(1596-1650)



Gall
(1758-1828)

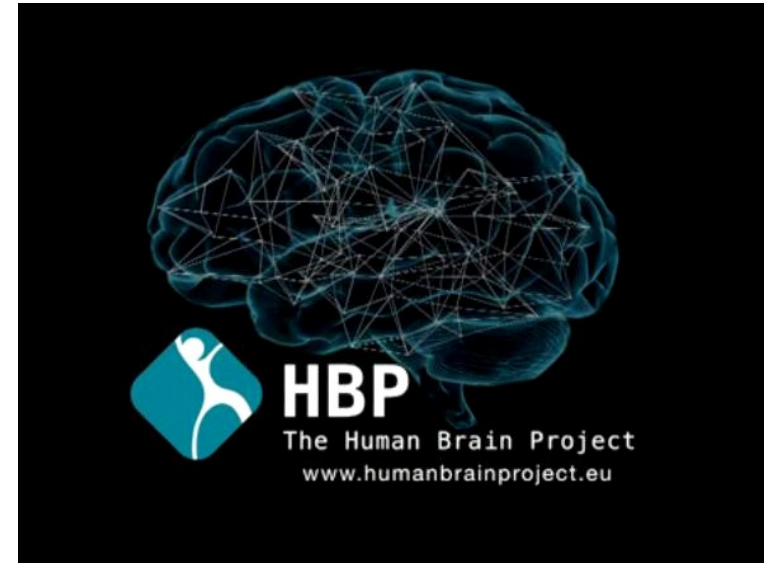




Carr
(1924-2008)

NEURO|NSIGHT

mountainview learning
teaching brain science to business



NO LIE MRI

neurosense
LEADERS IN APPLIED NEUROSCIENCE

Méthodes d'investigation d'imagerie fonctionnelle

HEMODYNAMIQUE

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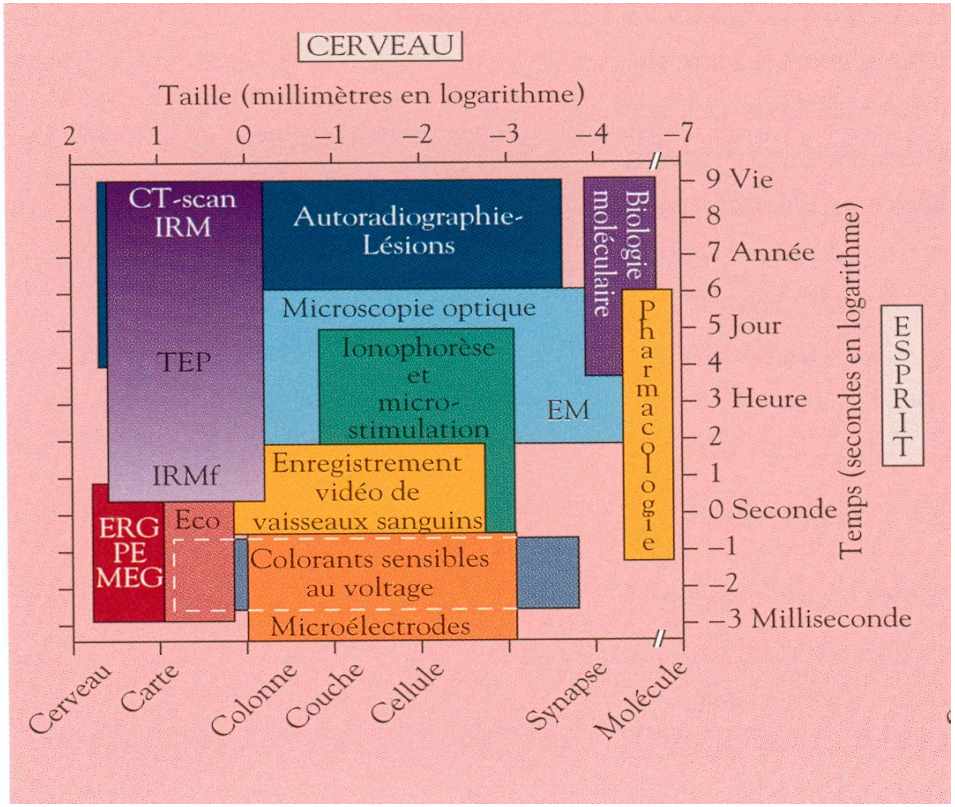
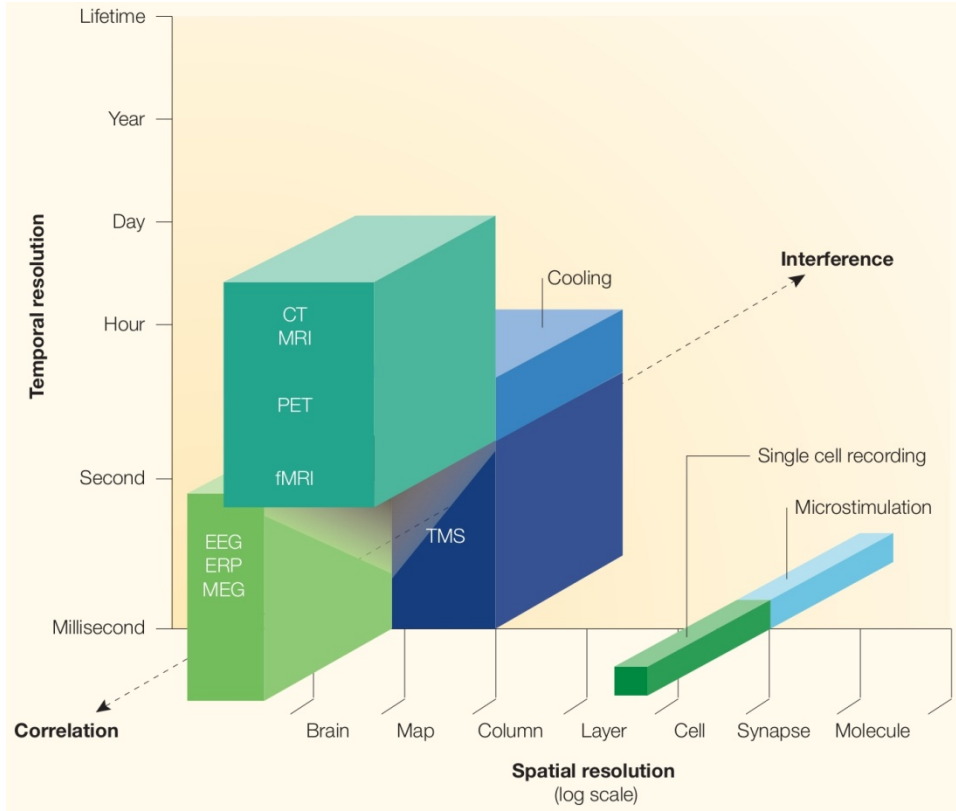
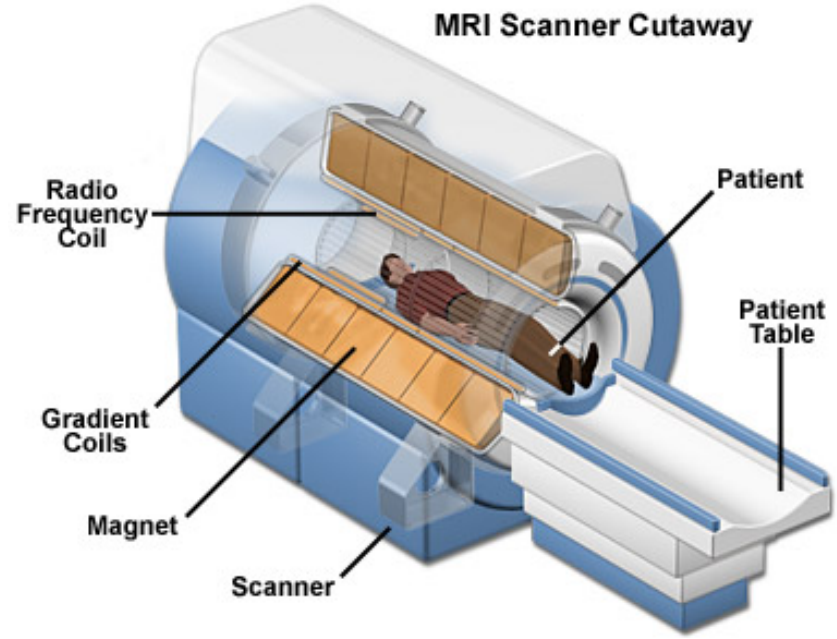

CERVEAU
Taille (millimètres en logarithme)
2
1
0
−1
−2
−3
−4
−7
CT-scan
IRM
TEP
IRMf
Autoradiographie-
Lésions
Microscopie optique
Ionophorèse
et
micro-
stimulation
EM
Enregistrement
vidéo de
vaisseaux sanguins
ERG
PE
MEG
Eco
Colorants sensibles
au voltage
Microélectrodes
Biologie
moléculaire
Pharmacologie
9 Vie
8
7 Année
6
5 Jour
4
3 Heure
2
1
0 Seconde
−1
−2
−3 Milliseconde
Temps (secondes en logarithme)
ESPRIT
Cerveau
Carte
Colonne
Couche
Cellule
Synapse
Molécule


Lifetime
Year
Day
Hour
Second
Millisecond
Temporal resolution
Interference
Cooling
CT
MRI
PET
fMRI
EEG
ERP
MEG
TMS
Single cell recording
Microstimulation
Correlation
Brain
Map
Column
Layer
Cell
Synapse
Molecule
Spatial resolution
(log scale)

Imagerie par Résonance Magnétique (IRM)



Les tissus magnétisés deviennent

les transmetteurs/receveurs radios

Imagerie par Résonance Magnétique (IRM)

L'aspect physique:

La précession est la rotation d'un atome

Les atomes alignés tournent à une fréquence **Larmor** unique **($f_L = \gamma B_0$)**

La résonance est la capacité des atomes en précession d'absorber et d'émettre de l'énergie à une fréquence spécifique

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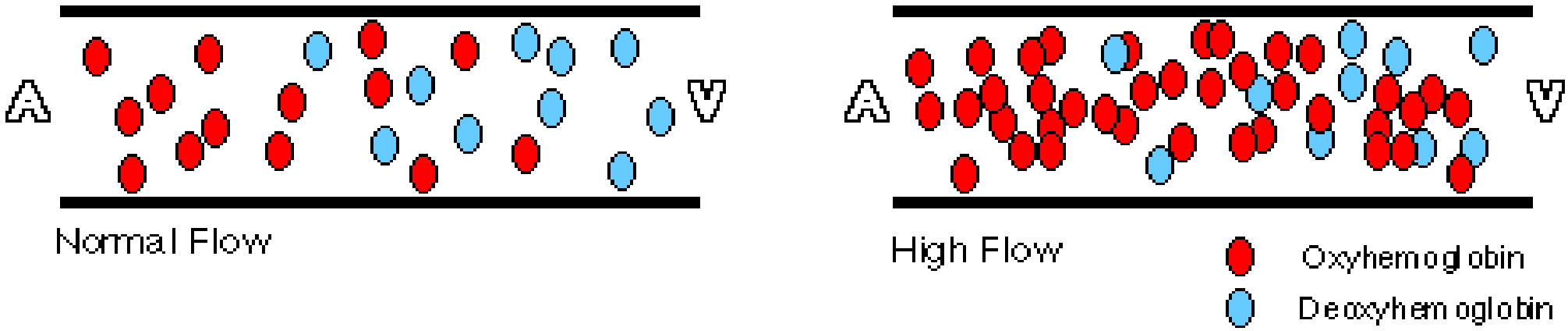
Imagerie par Résonance Magnétique (IRM)

L’aspect physique:

Ce sont les différences de densité d’hydrogène dans les types de tissus différents qui donnent les images anatomiques

Imagerie par Résonance Magnétique fonctionnelle (IRMf)

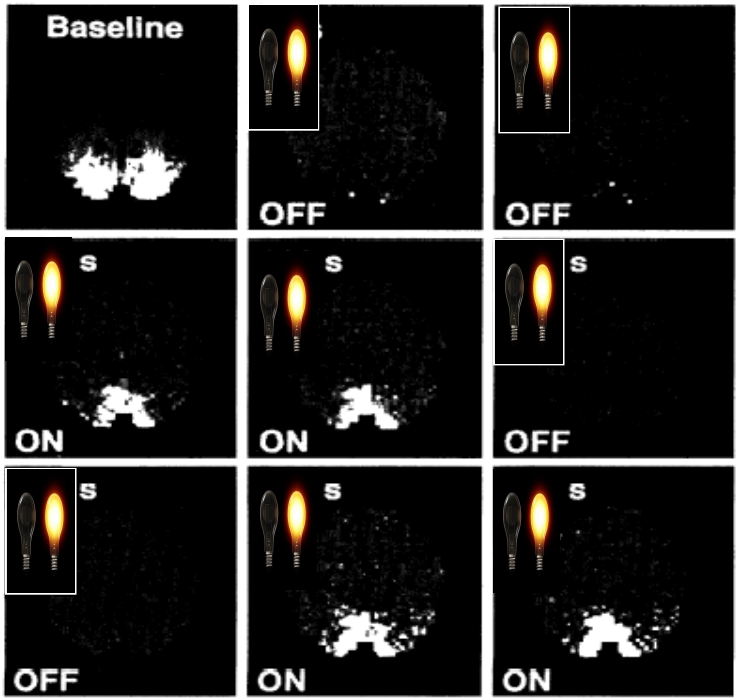
L'aspect physiologique:

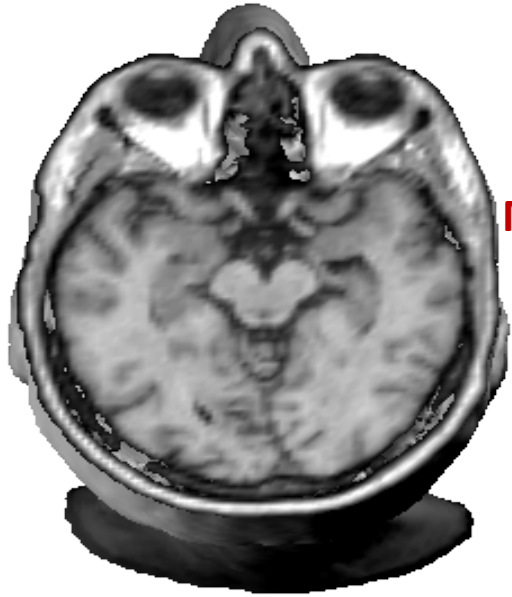


- **Dans le sang il y a de la oxyhémoglobine et de la déoxyhémoglobine.**
- **Elles sont susceptibles d'être magnétisées différemment.**
- **Les niveaux locaux de ces molécules changent avec l'activité cérébrale.**

BOLD (Blood Oxygen Level Dependent) Contrast

Imagerie par Résonance Magnétique fonctionnelle (IRMf)

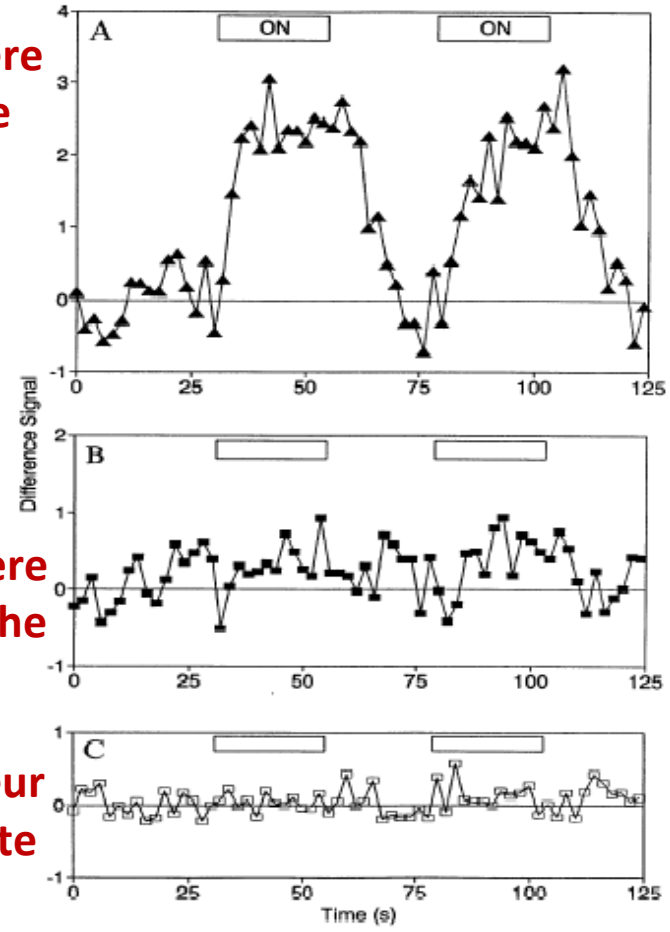




Matière grise

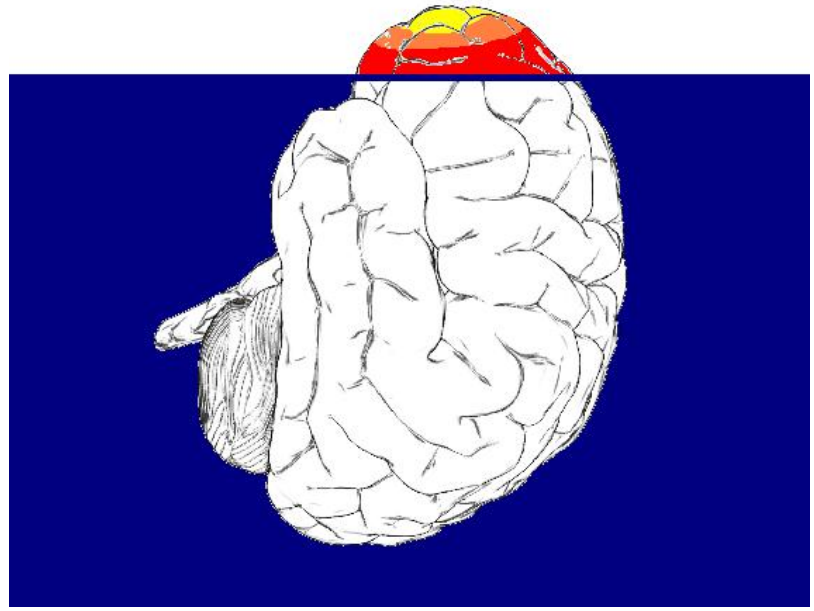
Matière blanche

L'extérieur de la tête



Blamire et al., 1992; Kwong et al., 1992; Ogawa et al., 1992

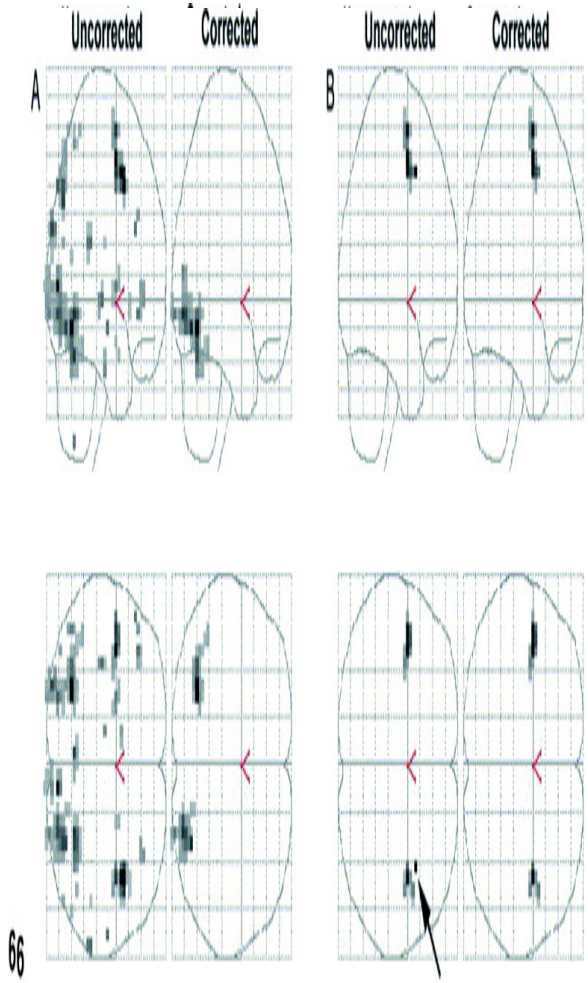
La neuroimagerie et l'enjeu pour l'homme



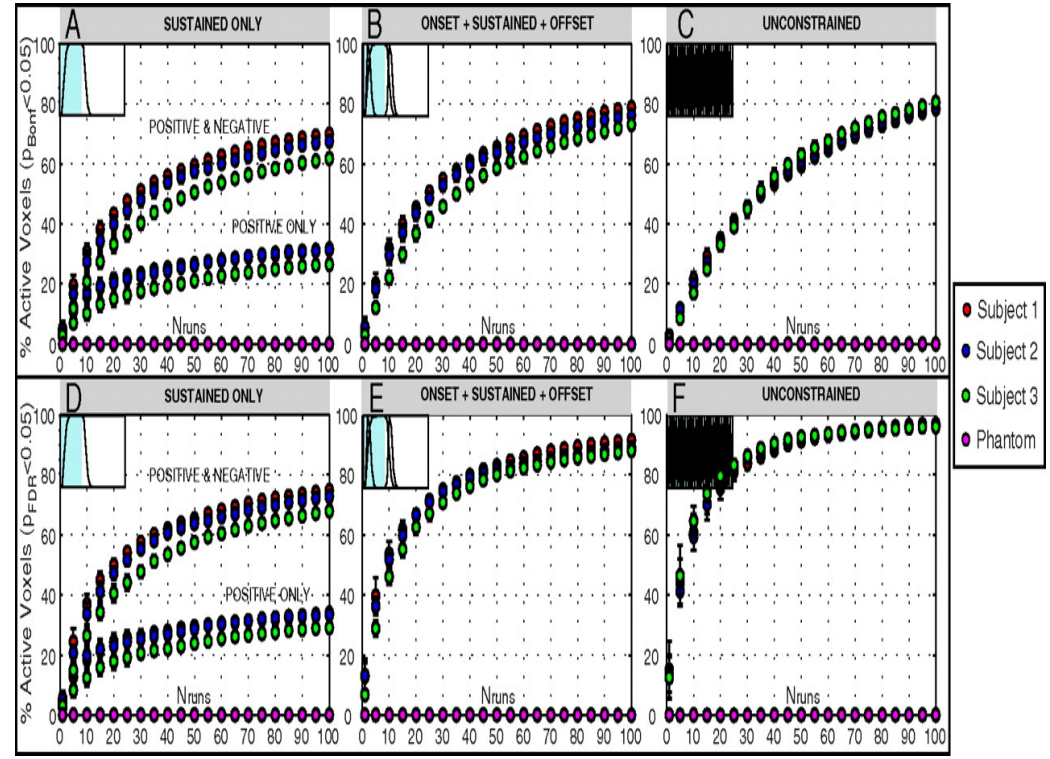
- On risque de penser que la neuroimagerie peut nous donner la vérité complète

Discover Magazine (March 21, 2012)

Imagerie par Résonance Magnétique fonctionnelle (IRMf)



Maldjian et al., (2003) *Neuroimage*



Gonzalez-Castillo et al., (2012) *Proceedings of the National Academy of Sciences USA*

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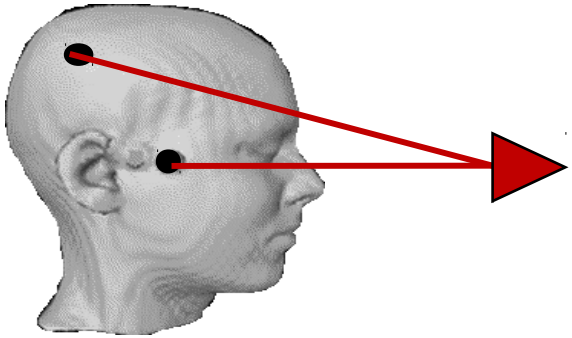
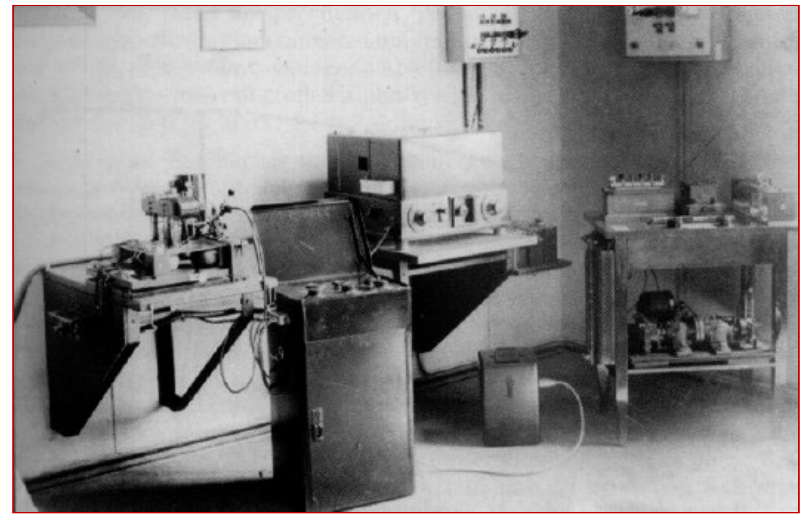
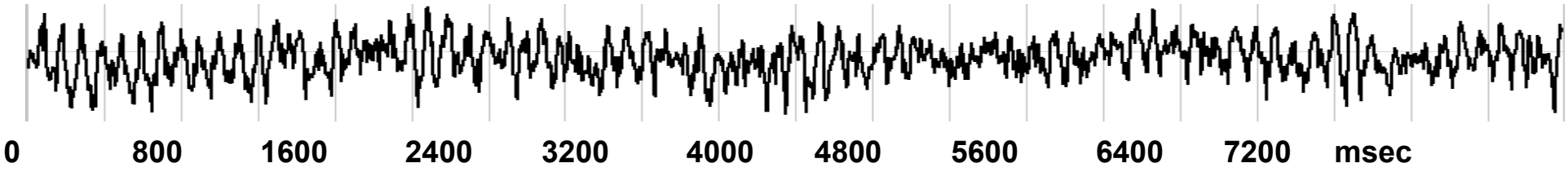


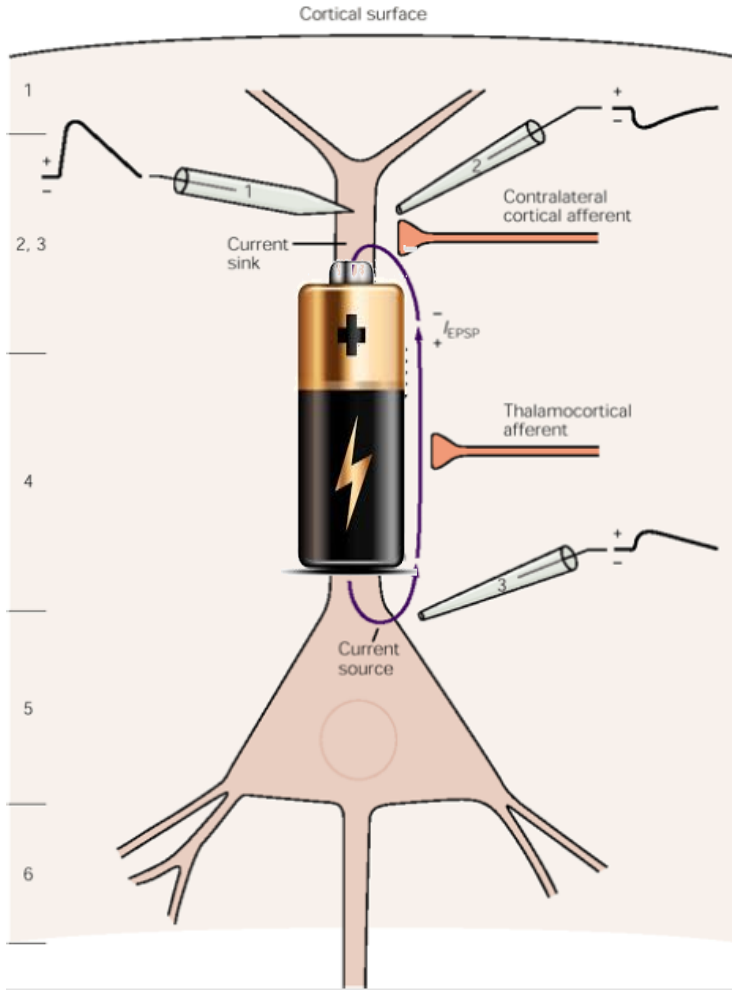


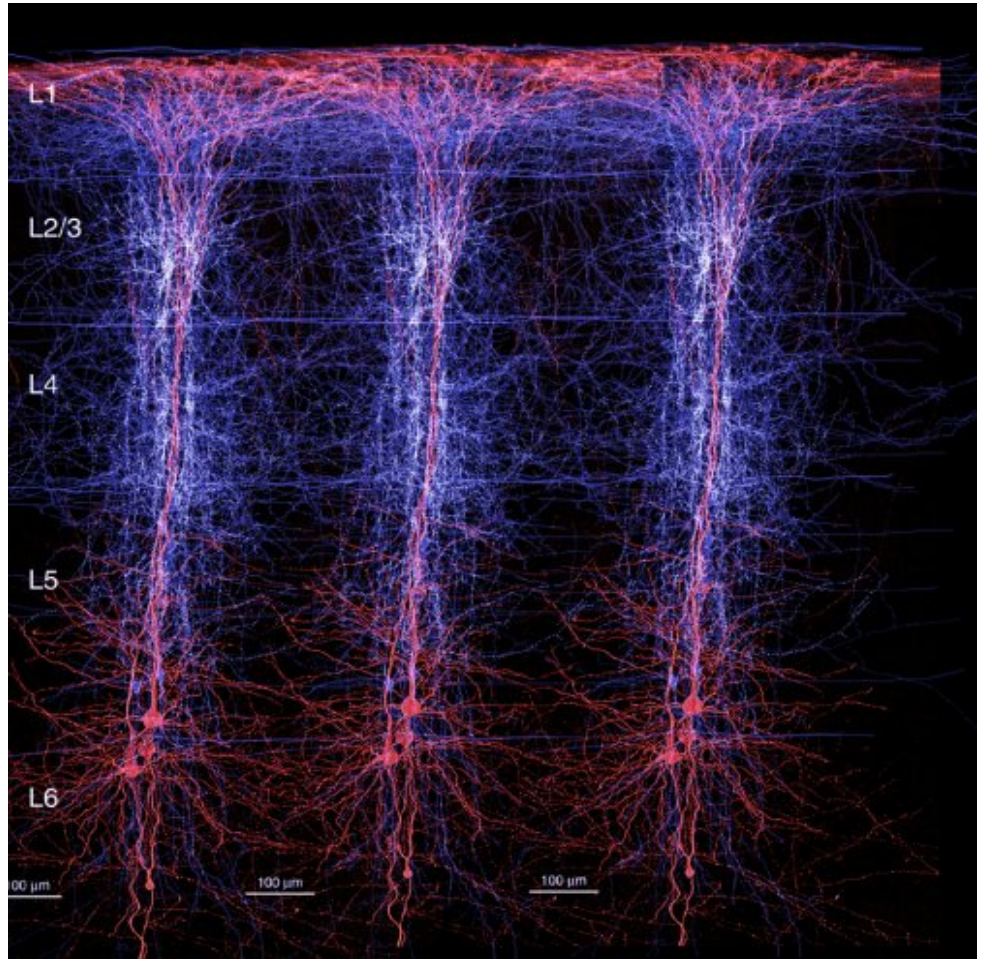
Hans Berger
(1926)



Mesure directe des potentiels post-synaptiques en temps réel

Electroencephalographie (EEG)





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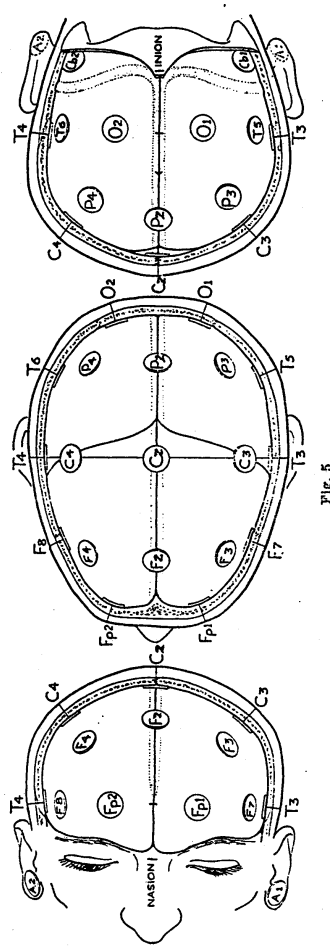

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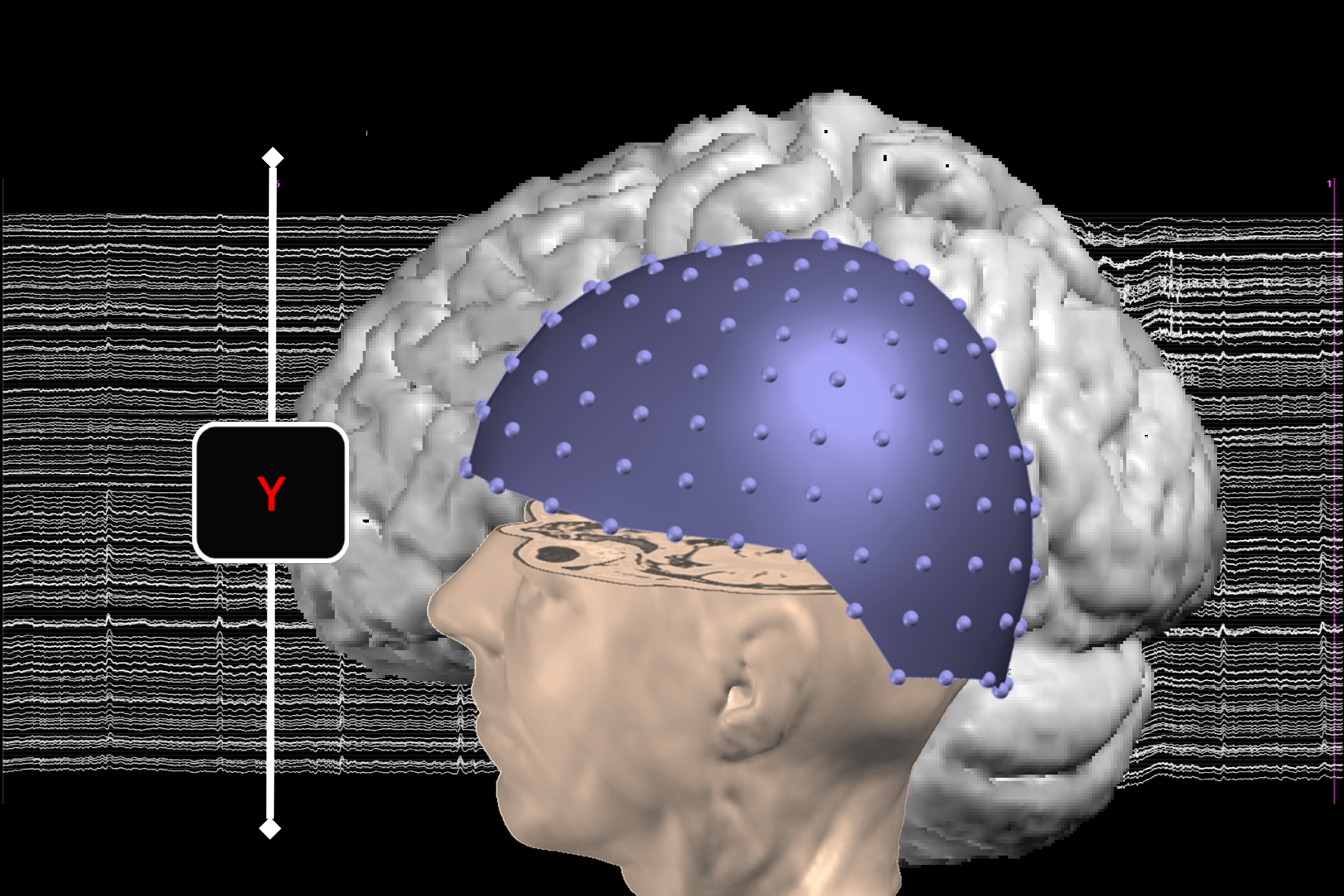
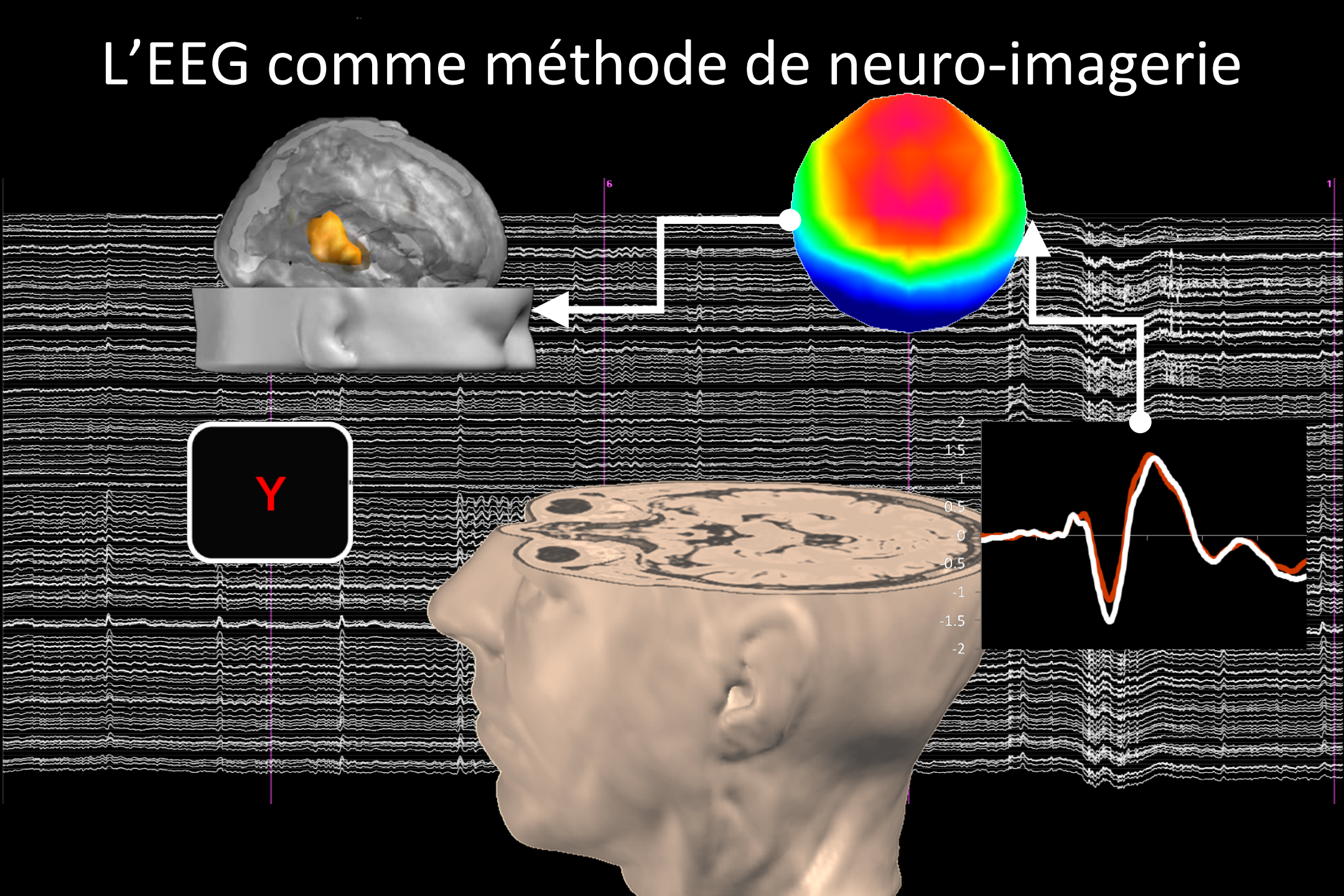
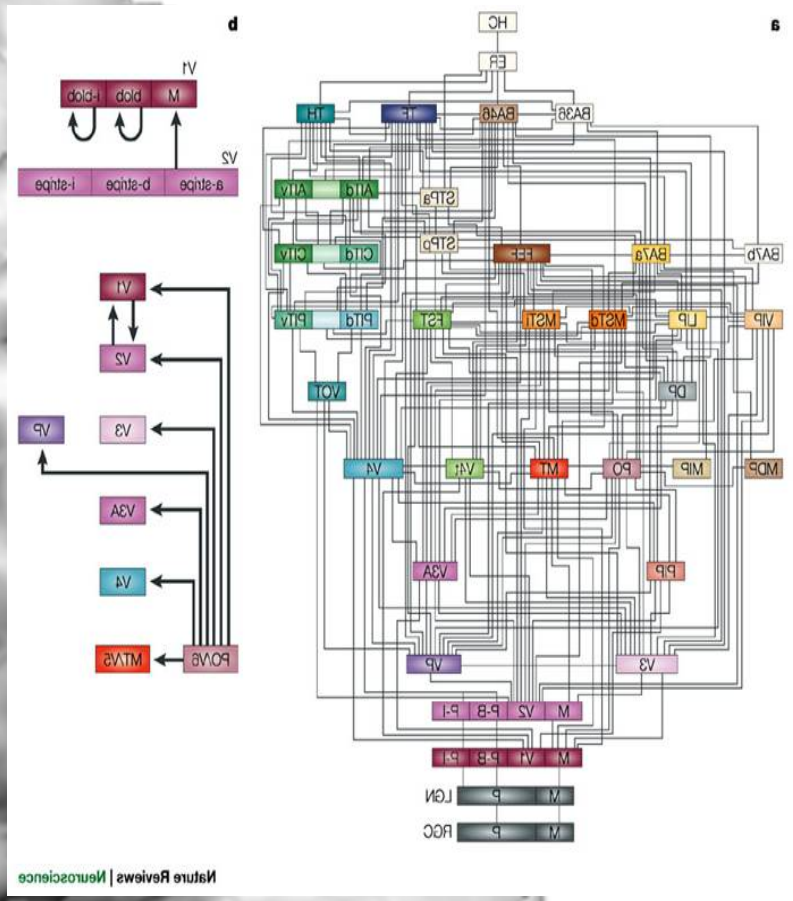
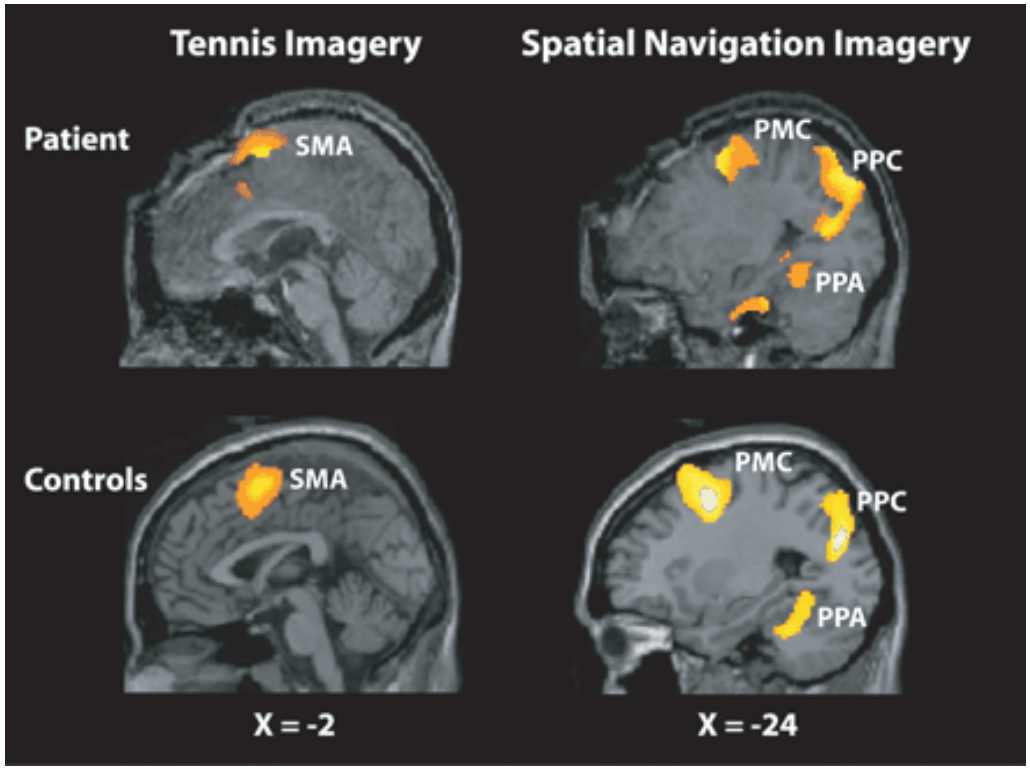

Y

L’EEG comme méthode de neuro-imagerie

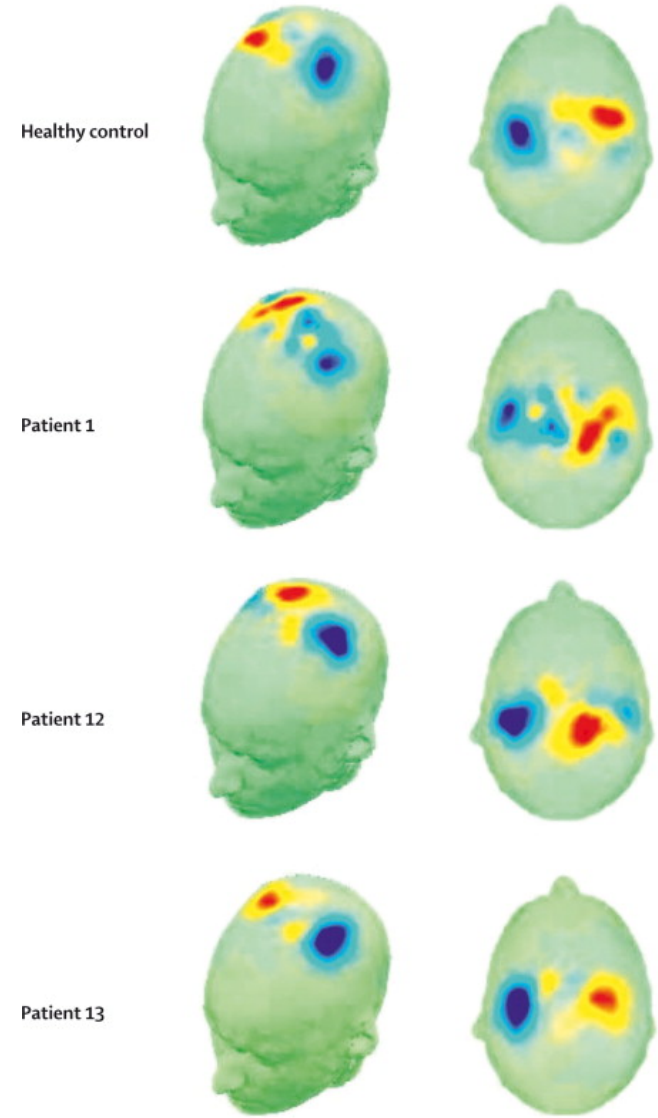


Qui parle à qui? Quand? Pour dire quoi?



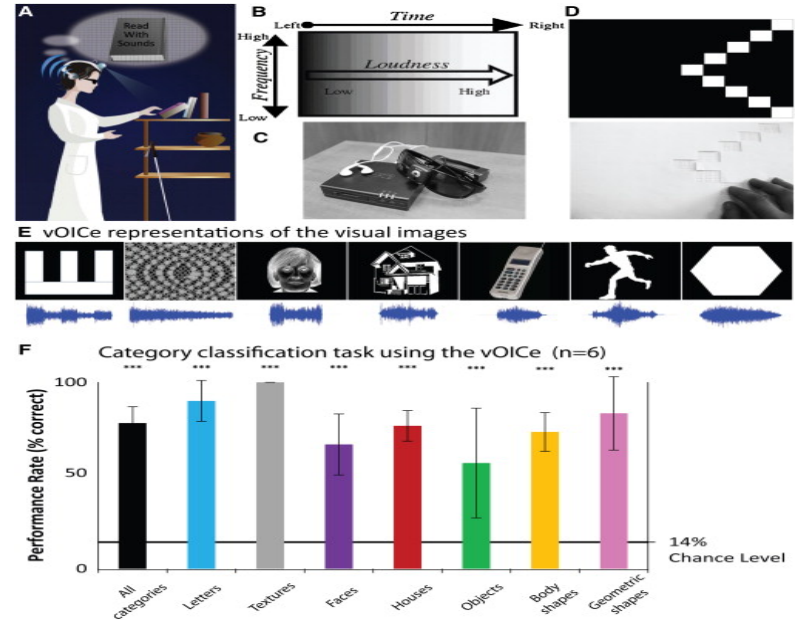


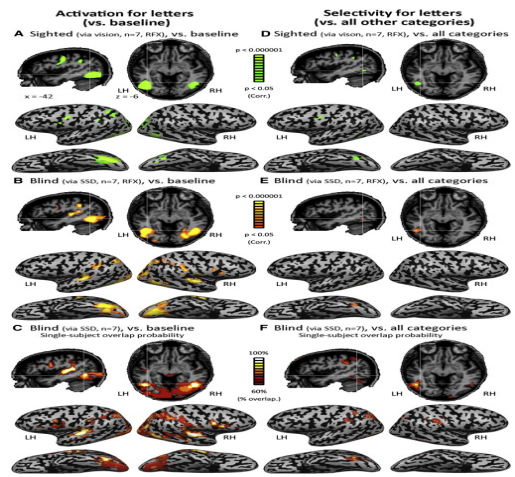
Owen et al.(2006) ***Science***

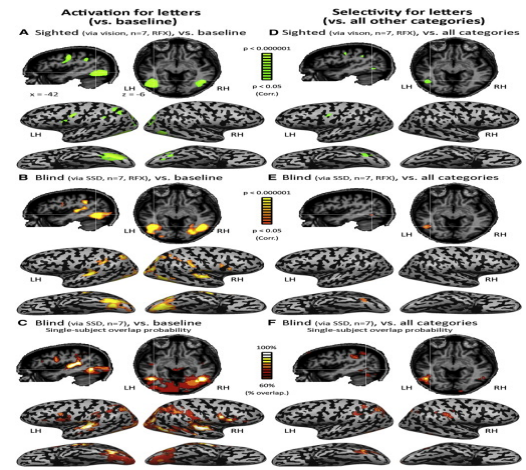


Cruse et al. (2011) ***The Lancet***

Prof. Jose Millan, EPFL



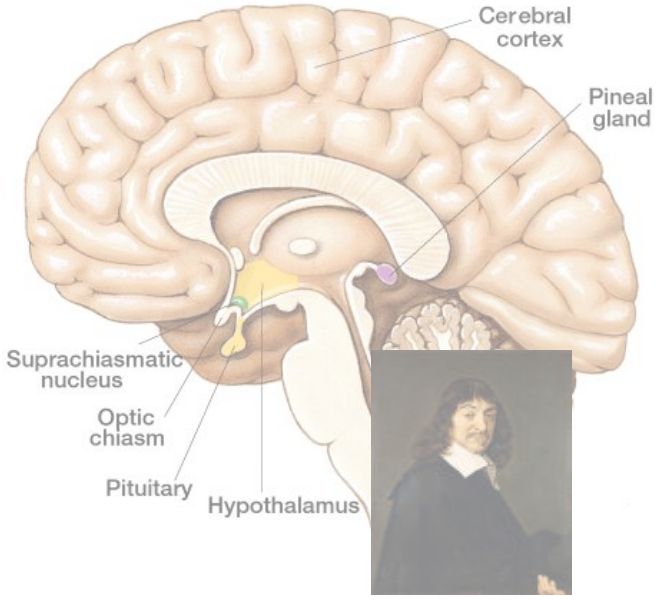




Striem-.Amit et al. (2012) *Neuron*

La neuroimagerie et l'enjeu pour l'homme

- On risque de penser que la neuroimagerie peut localiser tous les fonctions, et que chaque fonction peut être localiser



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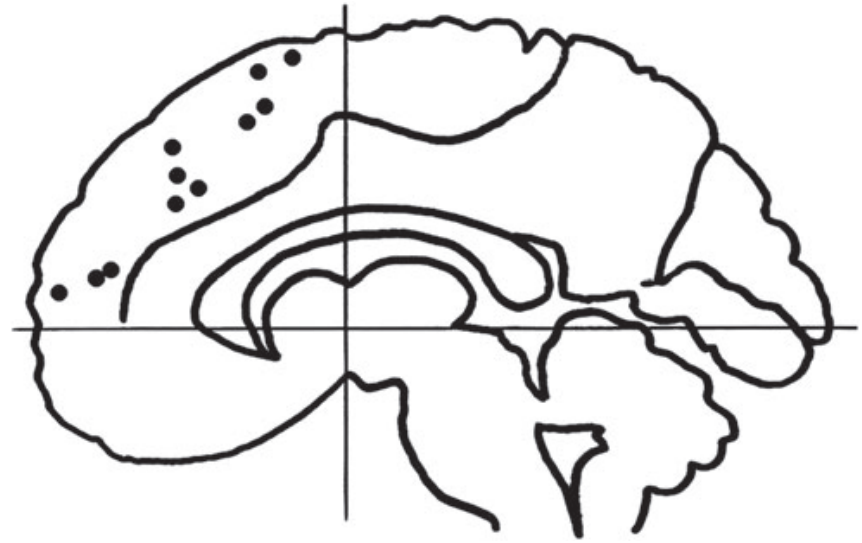
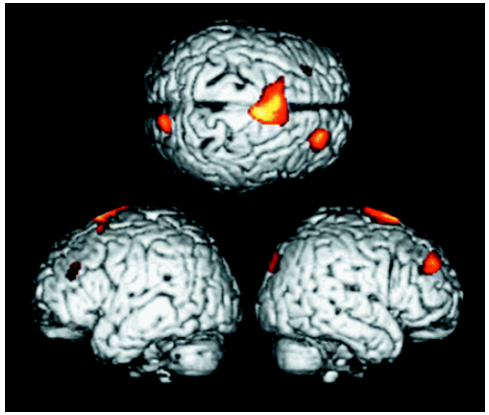
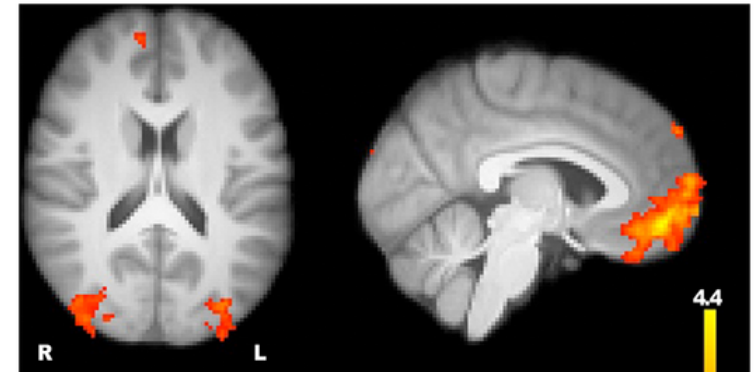


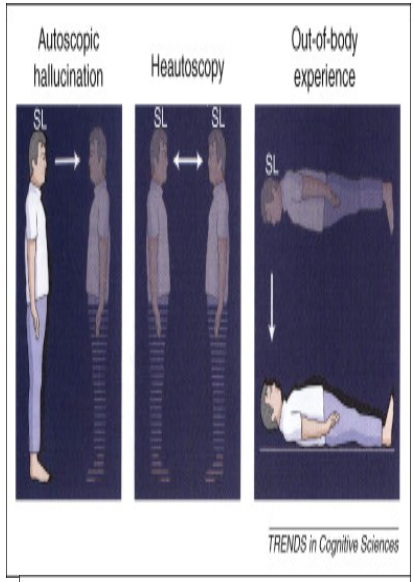
Seitz & Angel (2012) *Rev. Neurosci*



Azari et al. (2001) *Eur. J,. Neurosci*



Harris et al. (2012) *PLOS One*



Brain technologies raise unprecedented ethical challenges

SIR — We share Jens Clausen's opinion, expressed in his Commentary 'Man, machine and in between' (*Nature* **457,** 1080–1081; 2009), that brain–machine interfaces promise many benefits and should be pursued. However, we do not agree that these technologies pose similar ethical challenges to those already addressed. Some consequences may be unprecedented.

Imagine if insights from the field of cortical prosthetics in human and non-human primates were combined with research on bodily self-consciousness in of conscious experience. Such consequences differ from those outlined by Clausen for deep brain stimulation and treatment with psychoactive drugs.

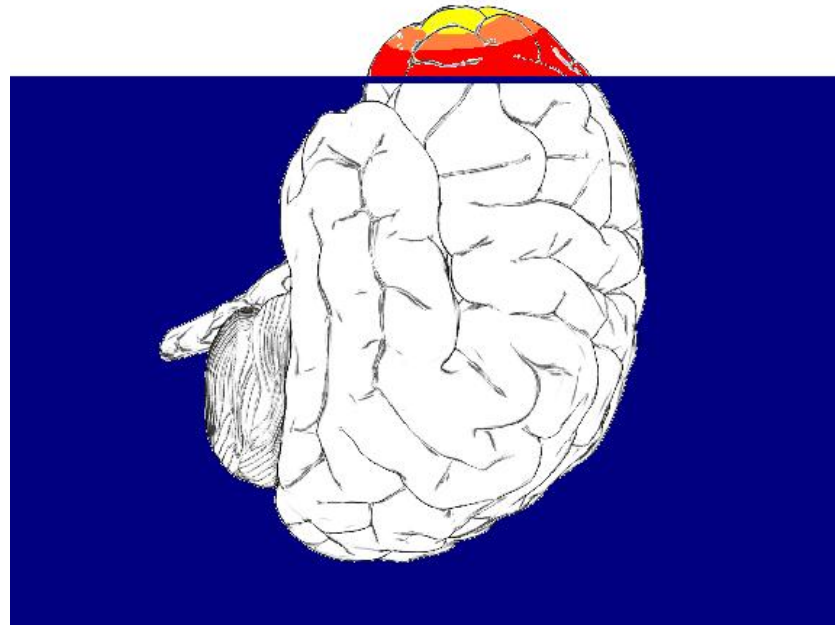
New links between cognitive neuroscience, engineering, brain–machine interfacing and medicine could lead to a generation of technologies that may not just blur the limits of human and machine, but fundamentally alter an individual's sense of self. We should welcome the machine to the brain, but should proceed with caution, given that such an addition could change the criteria for self and identity.

Olaf Blanke, Jane E. Aspell Laboratory of Cognitive Neuroscience, Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland
e-mail: olaf.blanke@epfl.ch

Blanke & Metzinger (2009) ***Trends in Cognitive Sciences***

La neuroimagerie et l'enjeu pour l'homme

- Comme chrétiens on cherche la vérité.
- Comme scientifiques on interprète les données.
- La neuroimagerie est-il la vérité complète?



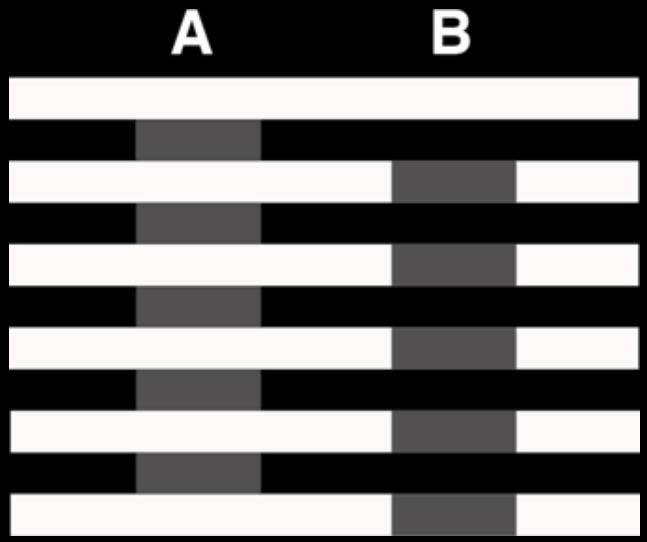
Discover Magazine (March 21, 2012)

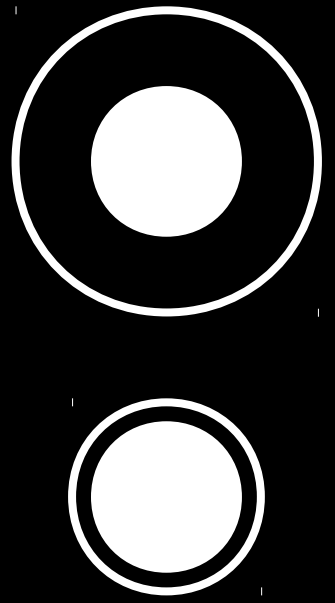
"Whilst *part* of what we perceive comes through our senses from the object before us, *another part* (and it may be the larger part) always comes out of our own mind."

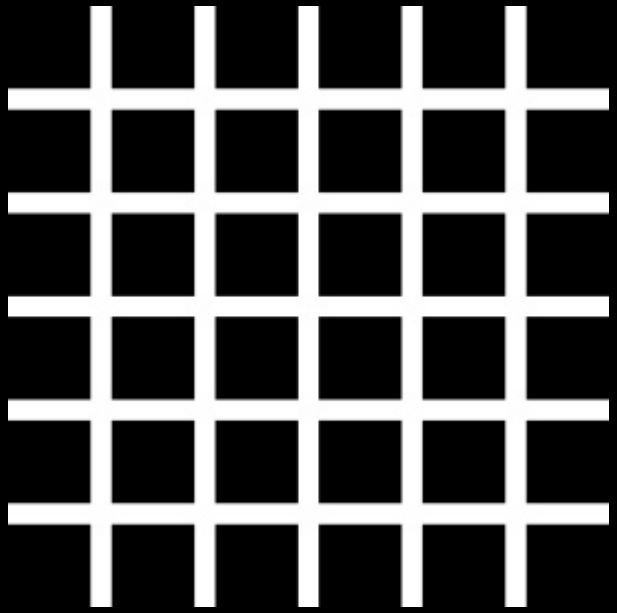
William James

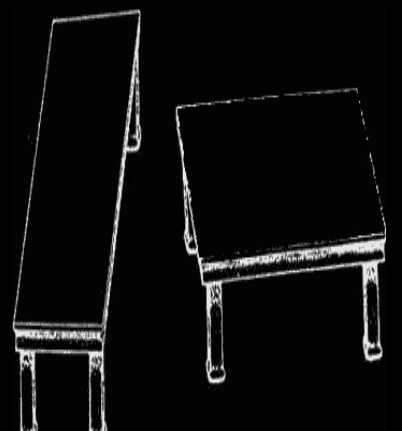
1890, *Principles of Psychology*

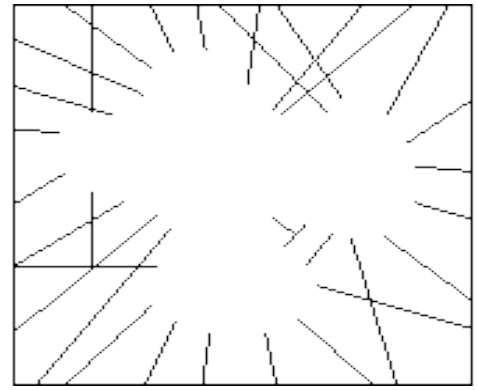
La vision n’est pas égale à la perception

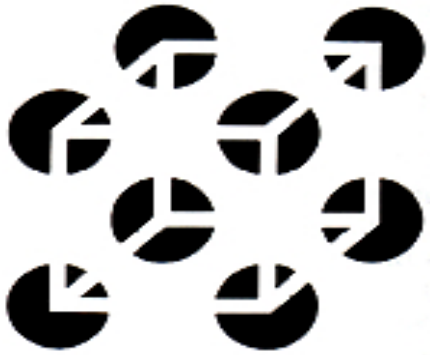


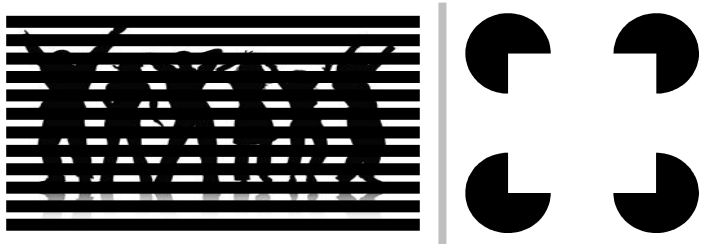


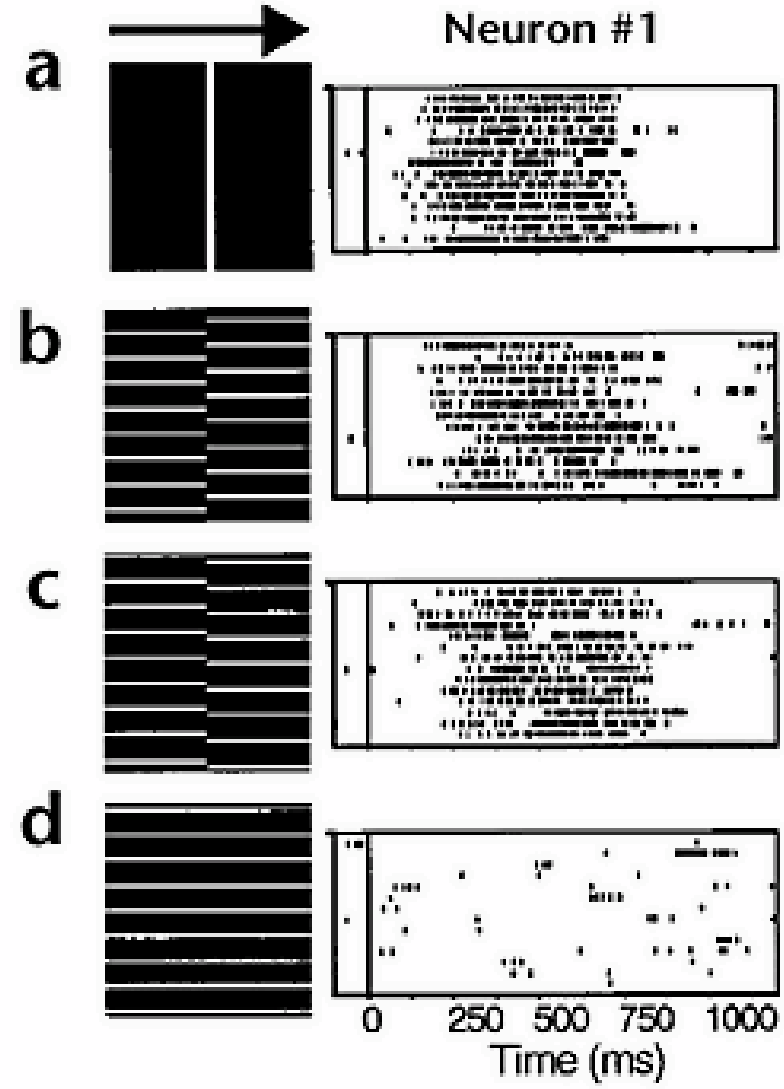











Neuron #1
a
b
c
d
0
250
500
750
1000
Time (ms)

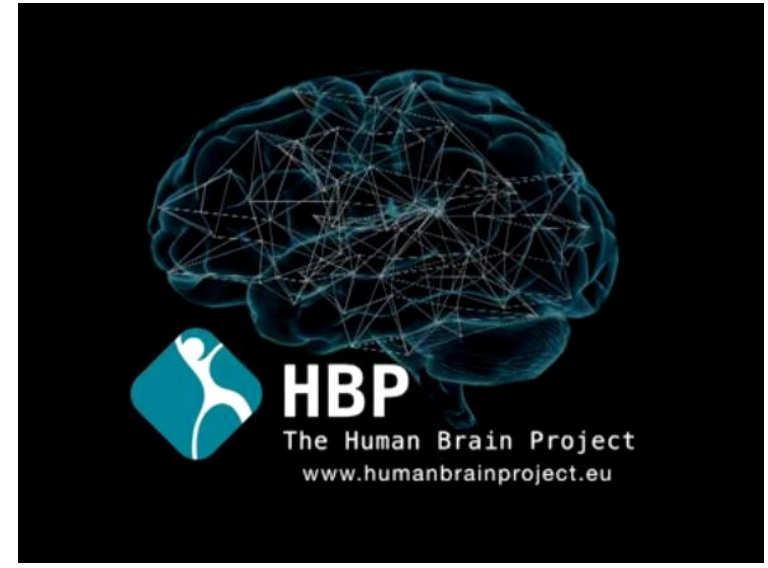
La neuroimagerie et l'enjeu pour l'homme

- Le danger est que les scientifiques ses survendent
- La presse cherche les sujets qui sont facile à vendre

Discover Magazine **(March 21, 2012)**

NEURO|NSIGHT

mountainview learning
teaching brain science to business



NO LIE MRI

neurosense
LEADERS IN APPLIED NEUROSCIENCE