

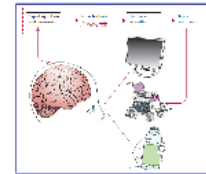
Interfaces cerveau-machine :

« agir par la pensée »

A. Bury
O. Guieu
H. Jouhaud
P. Traynard



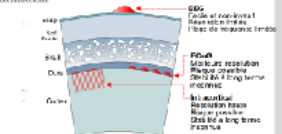
Interfaces cerveau-machine



→ Utilisateur s'adapte au système par l'entraînement.
→ L'algorithme de traduction doit s'adapter à l'utilisateur.

Les signaux utilisés

- Activité électroencéphalographique (EEG) en surface du crâne
- Activité électrocorticographique (ECoG) à la surface corticale
- Activité intracorticale



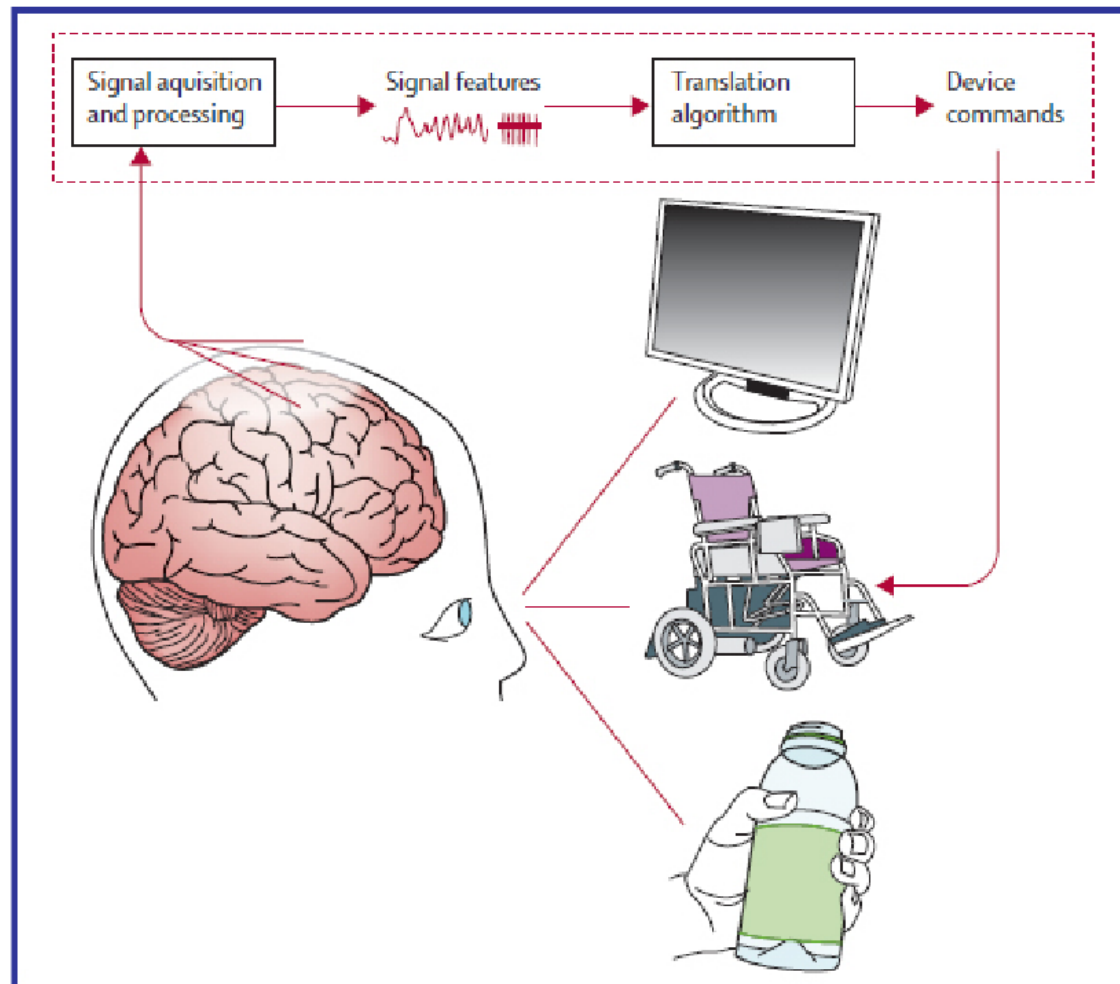
Conclusion

- Une technologie prometteuse mais encore au stade de la recherche
- Utilisation thérapeutique des interfaces cerveau-machine pour la rééducation

Bibliographie

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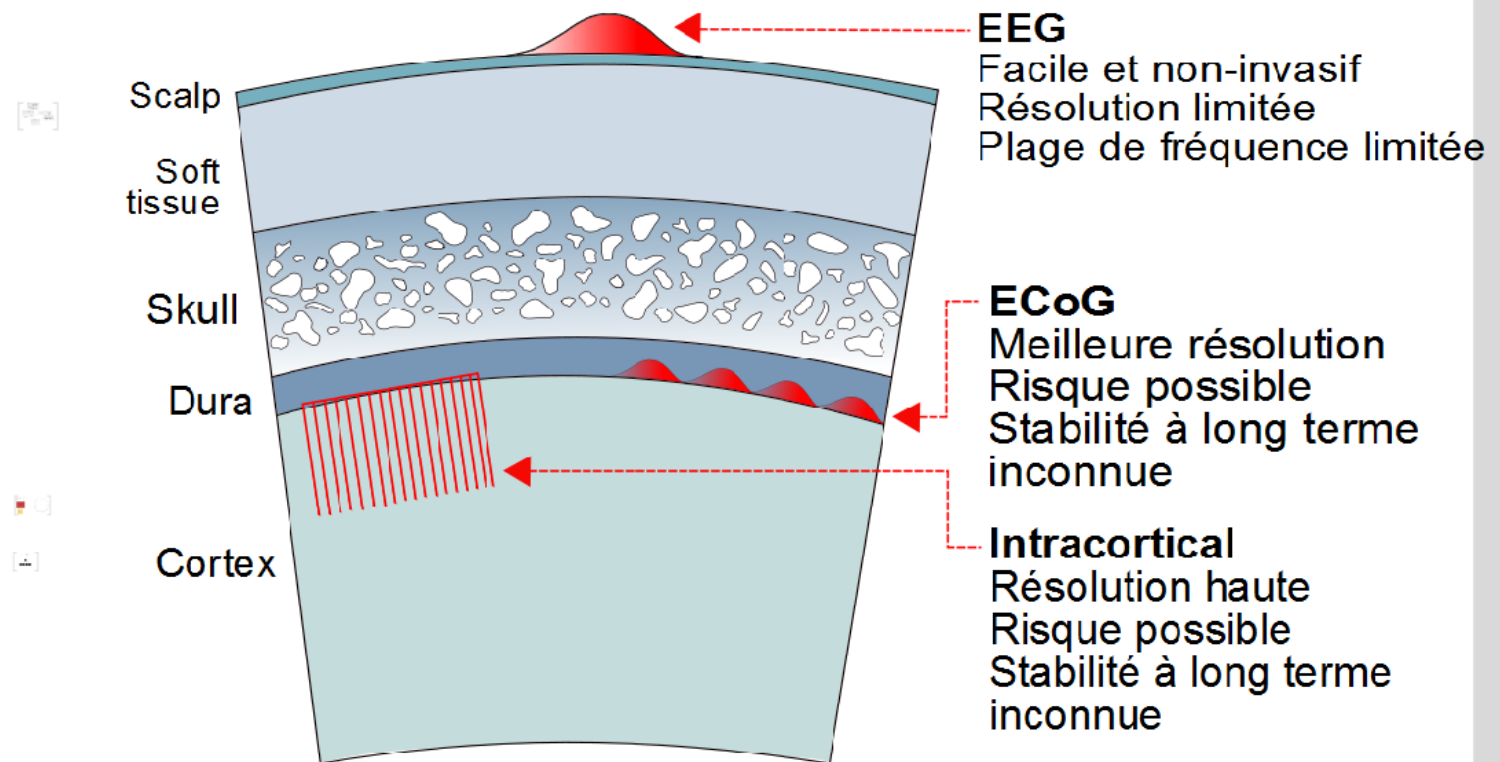
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Introduction



SSVEP : steady-state visual evoked potential

Rapide

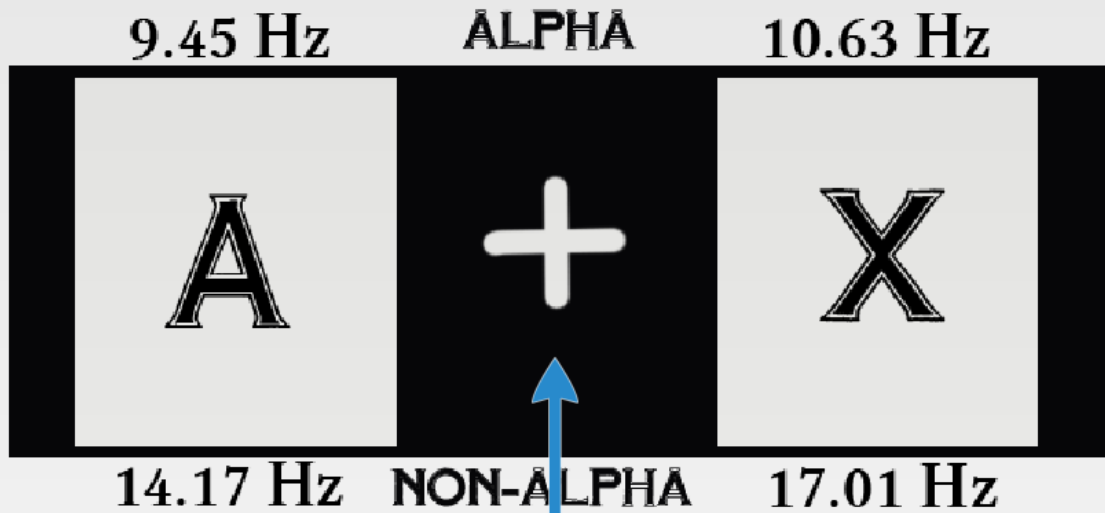
Précis (bon rapport signal / bruit)

Stimulation visuelle à une fréquence f

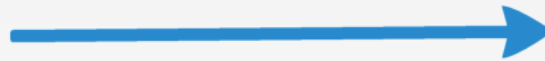


Réponse neuronale de fréquence f (ou $k.f$)

Expérience



Regard fixe / mobile



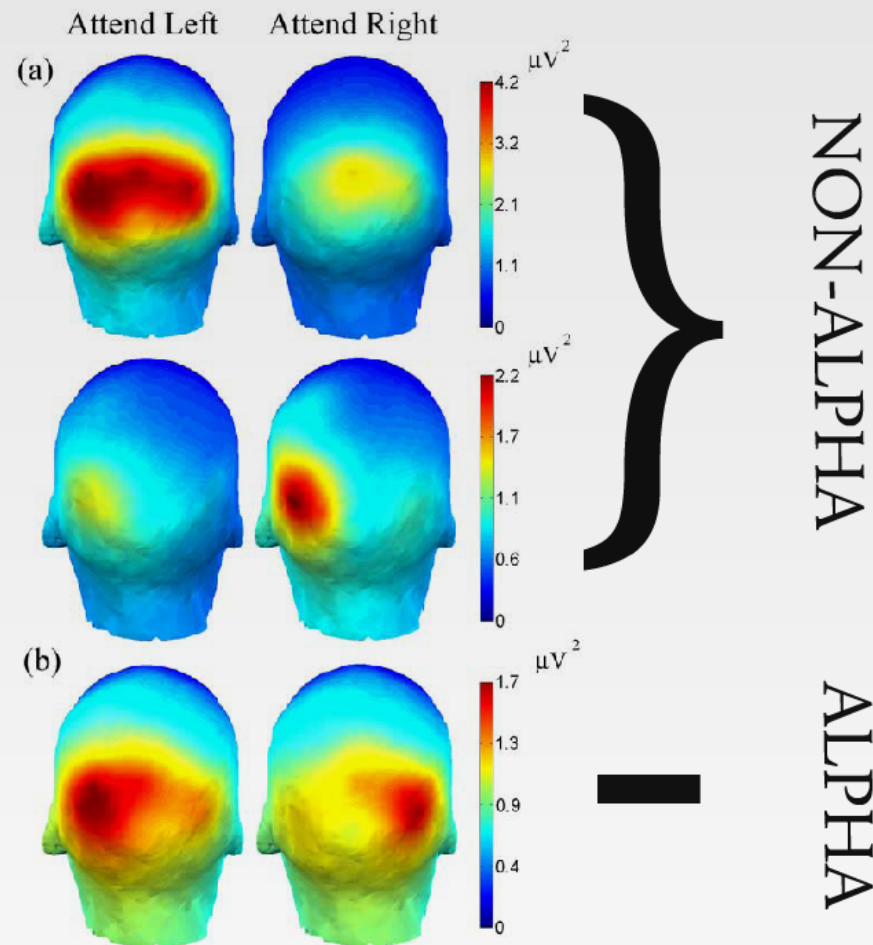
EEG



Fréquence de l'image de gauche

Fréquence de l'image de droite

Activité alpha
(lobe pariéto-occipital)



→ Choix des positions optimales de détection

Données



1/10 : Etalonnage

9/10 : Tests de reconnaissance





Résultats

Précision moyenne

SSVEP uniquement : (regard mobile 95%)

regard fixe 70% (2.1 b/m)

Activité alpha uniquement : 73% (2.6 b/m)

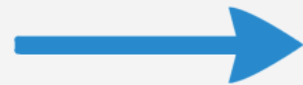
SSVEP + alpha : 79% (4.6 b/m)

Conclusion

Amélioration de la précision en combinant les données

Précision maximale : 79% (combinaison)

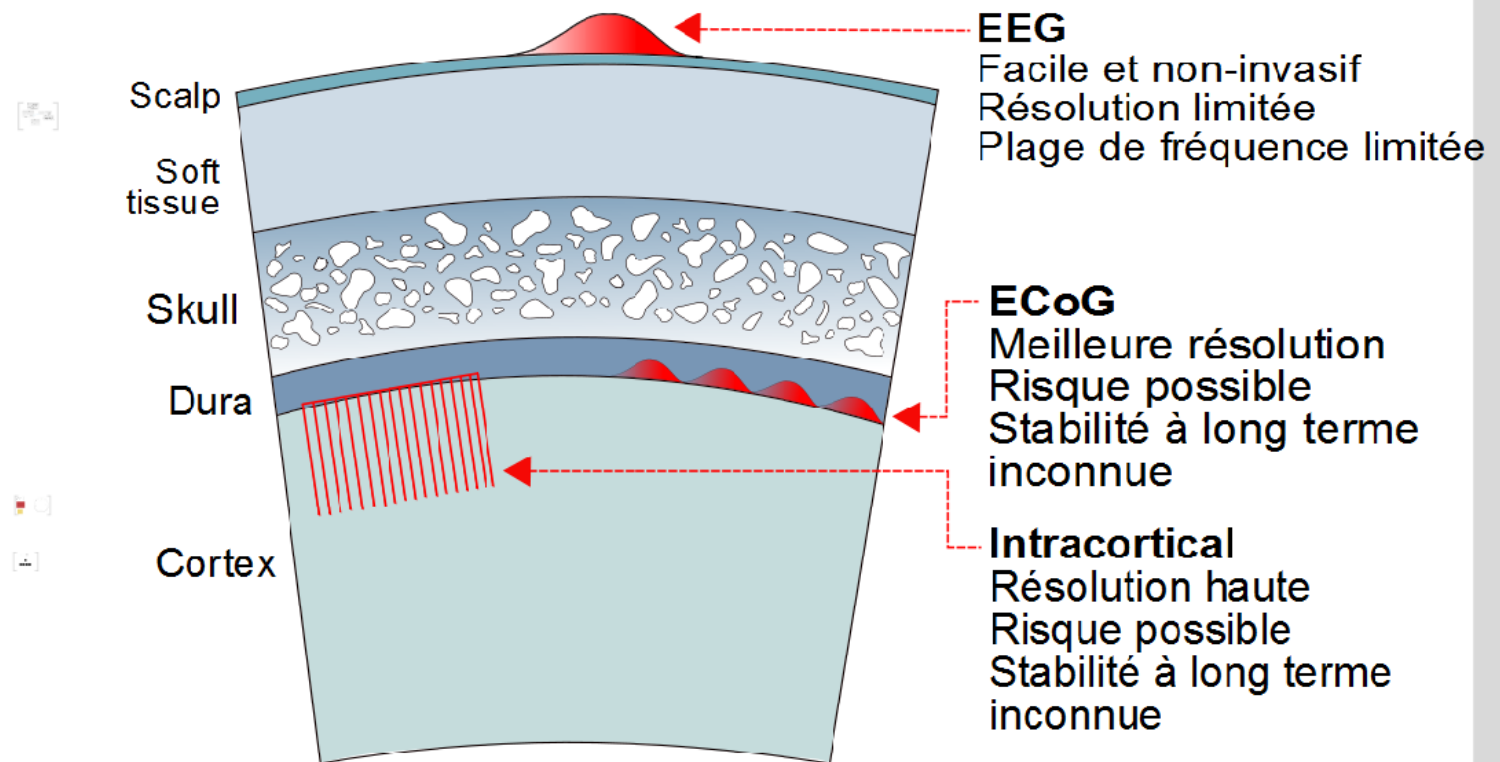
N'utilise pas les nerfs moteurs ou sensoriels



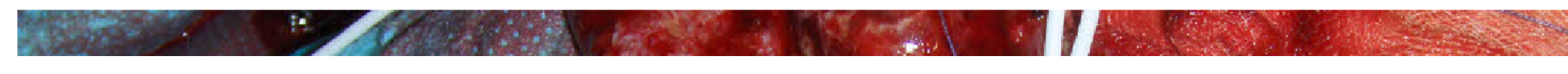
Utilisable avec les handicapés
(Mais besoin de la vue)

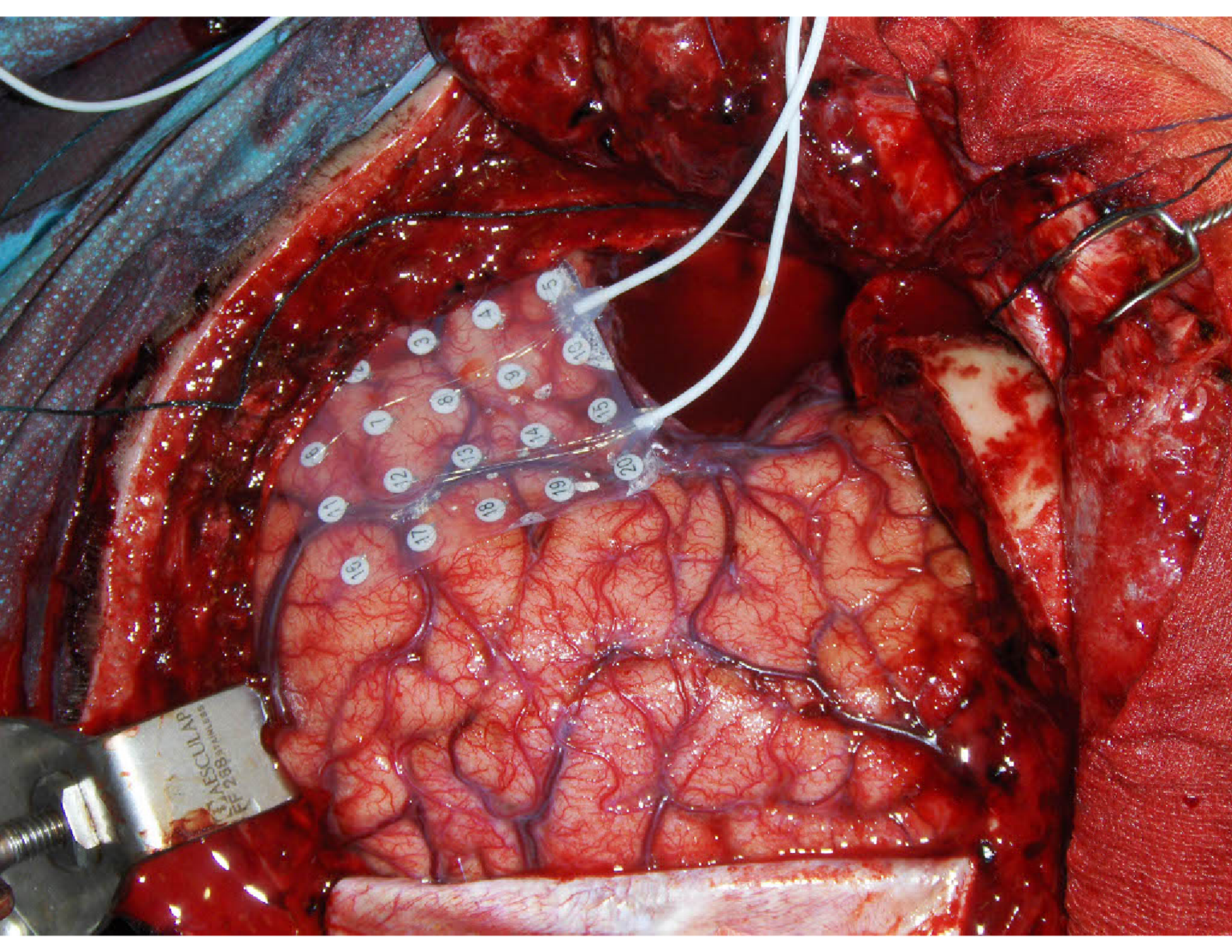
Les signaux utilisés

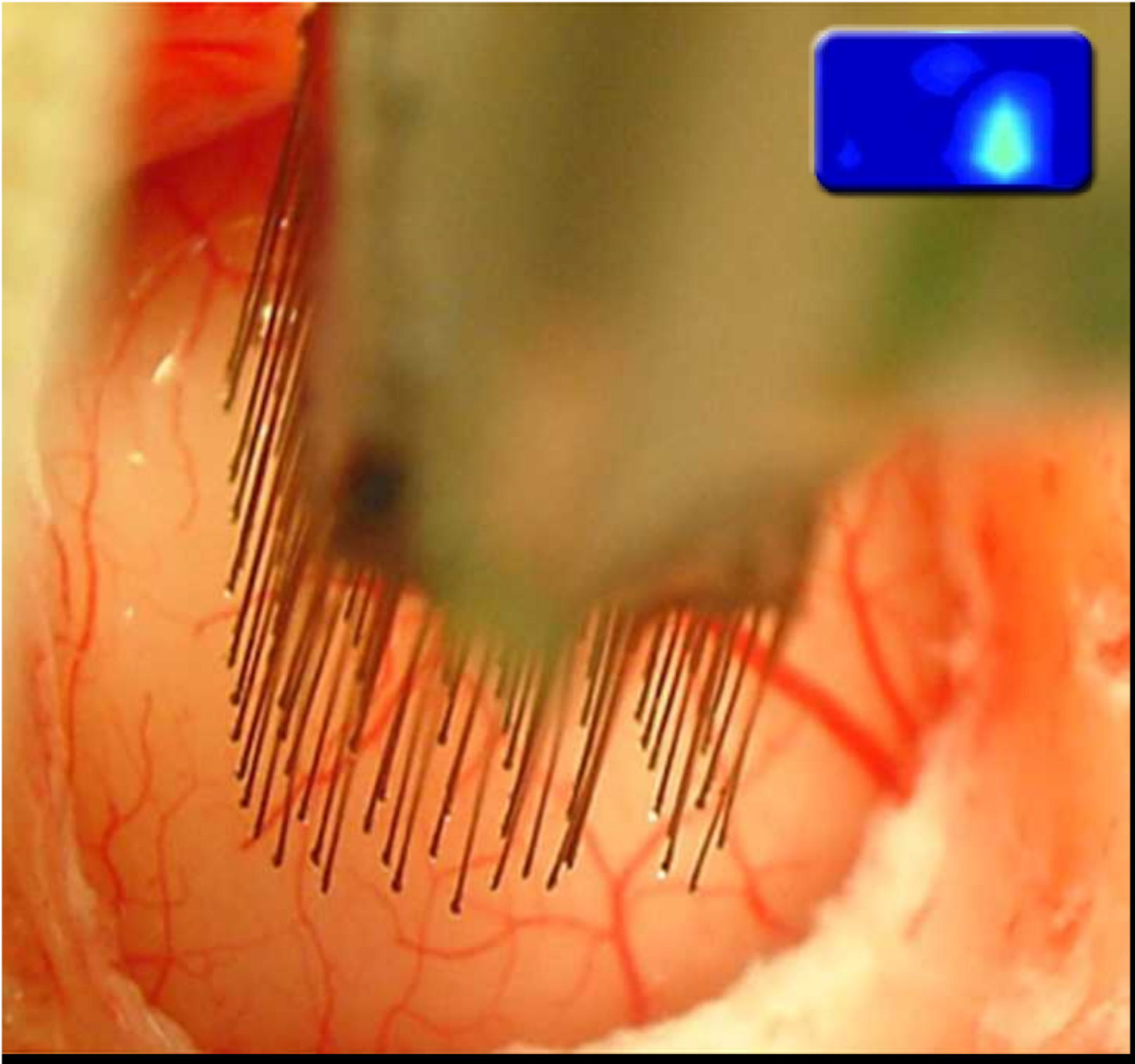
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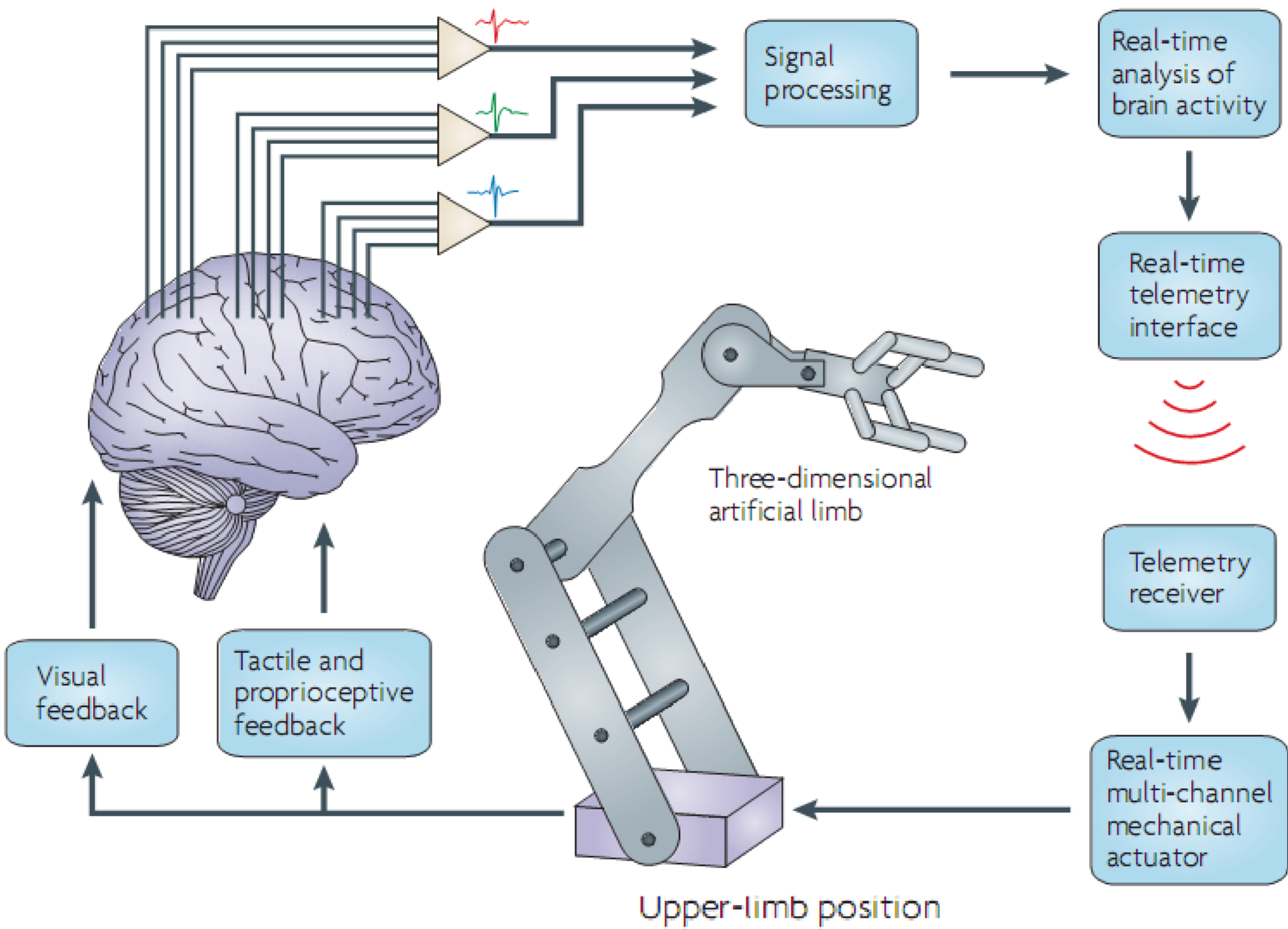


Walk Again Project

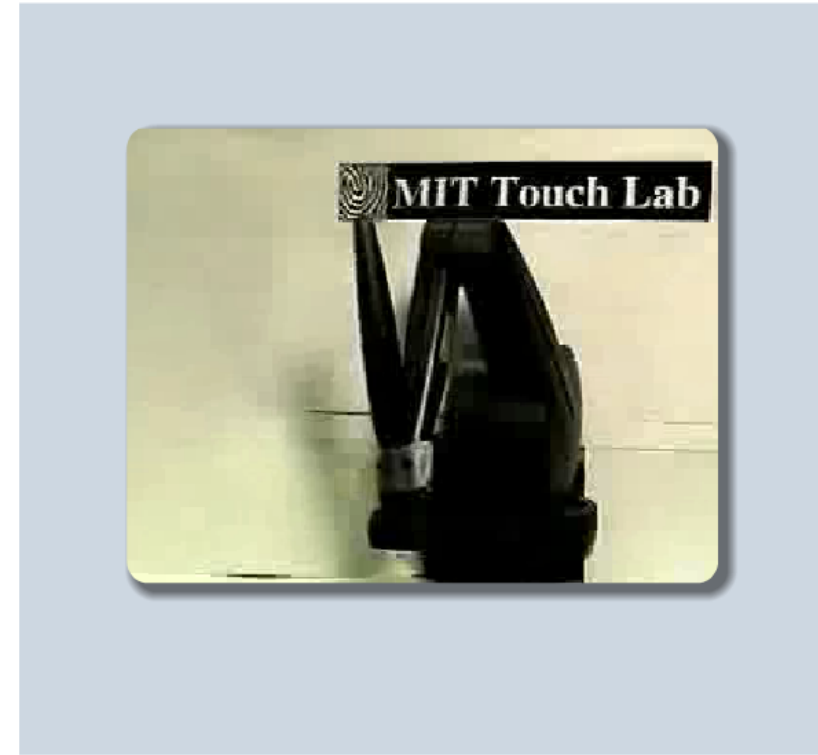
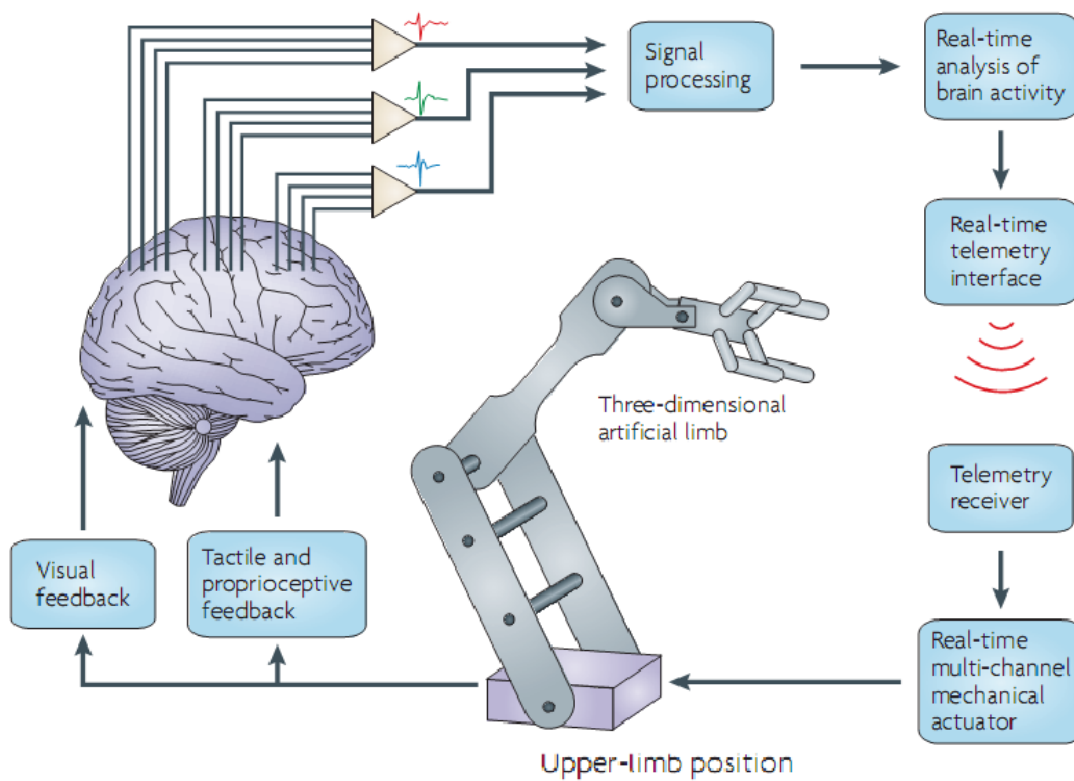




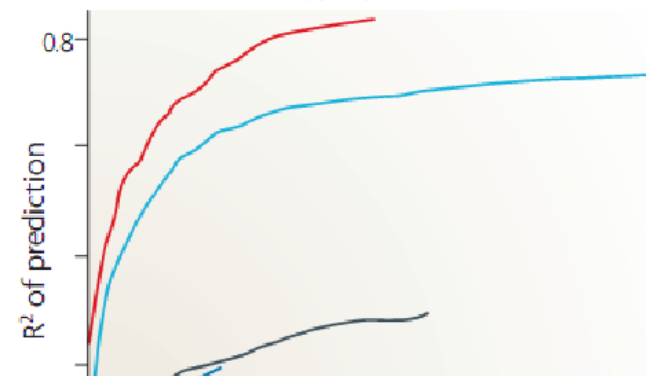
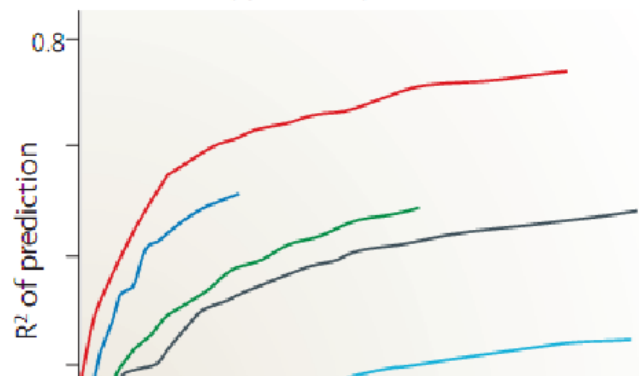


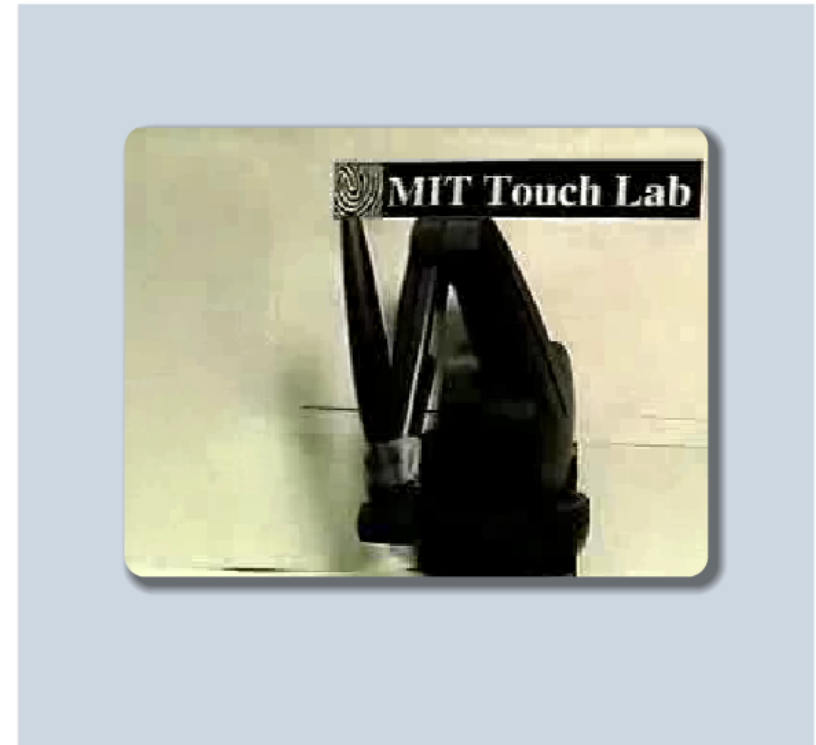
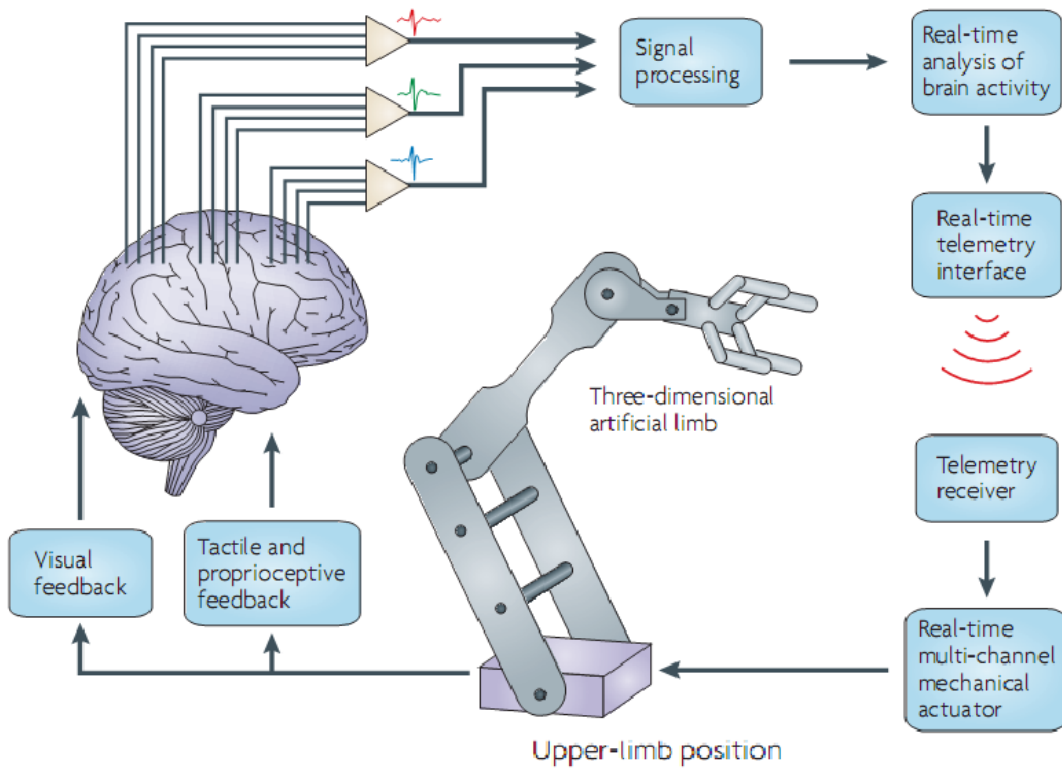


Codage distribué

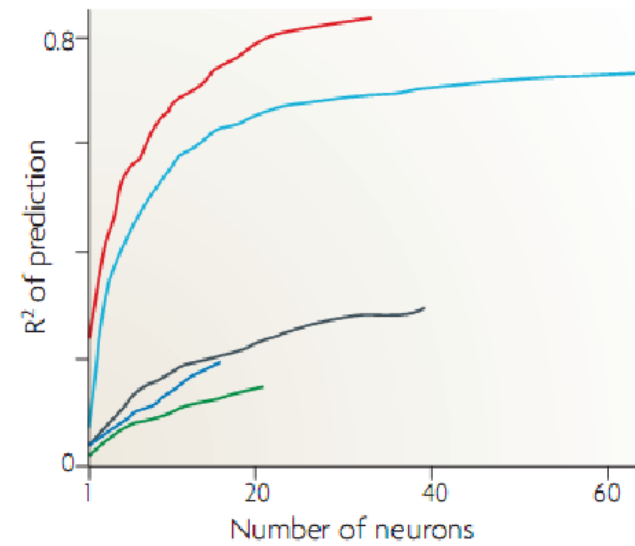
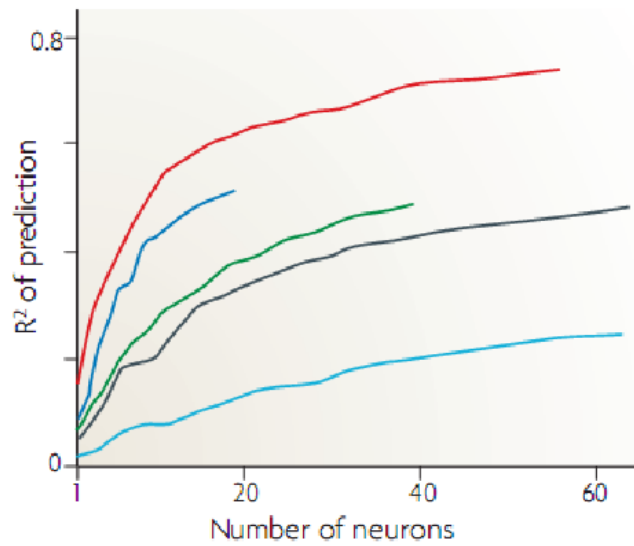


Gripping force



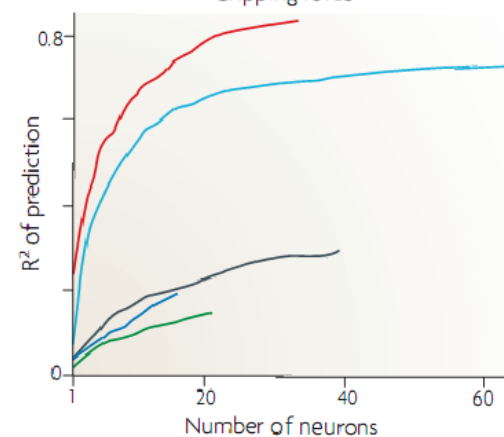
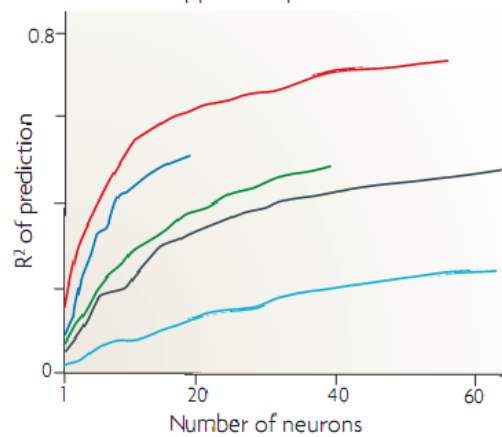
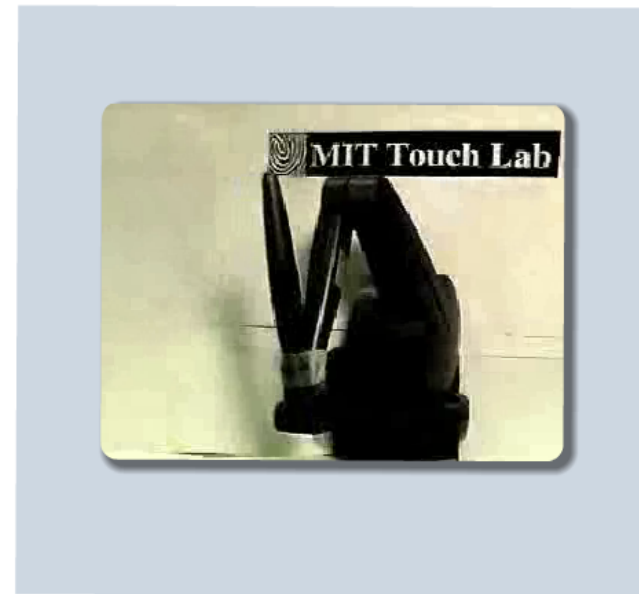
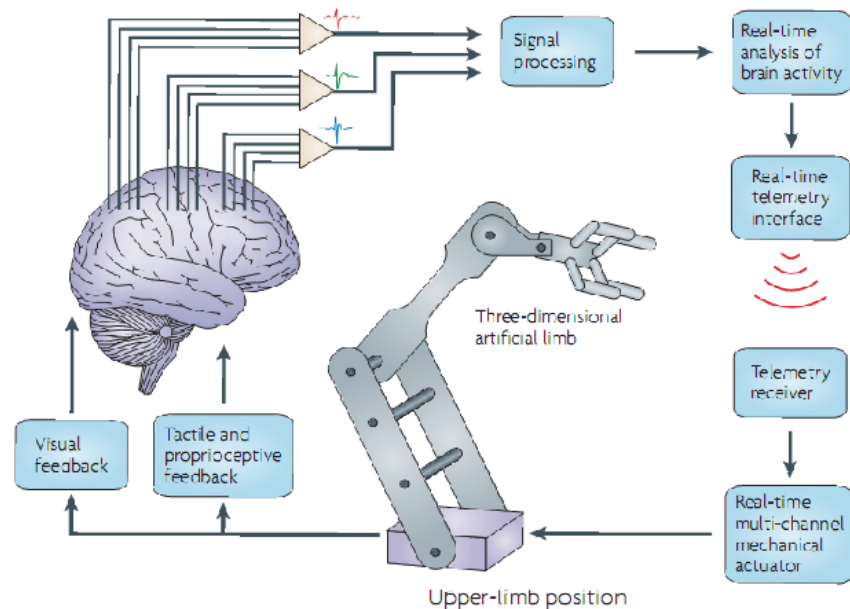


Gripping force



— PMd — M1 — S1 — SMA — PP

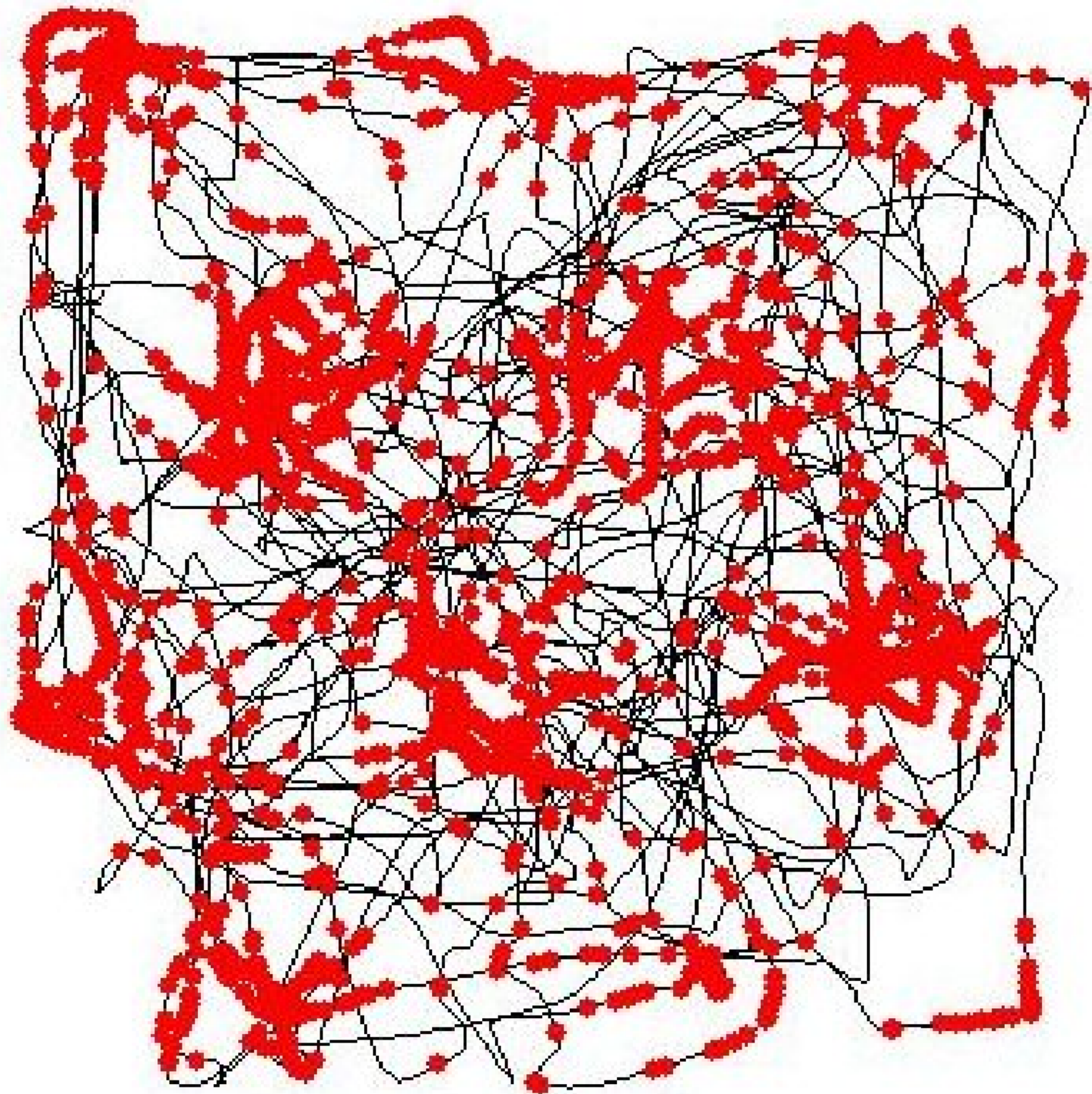
Codage distribué



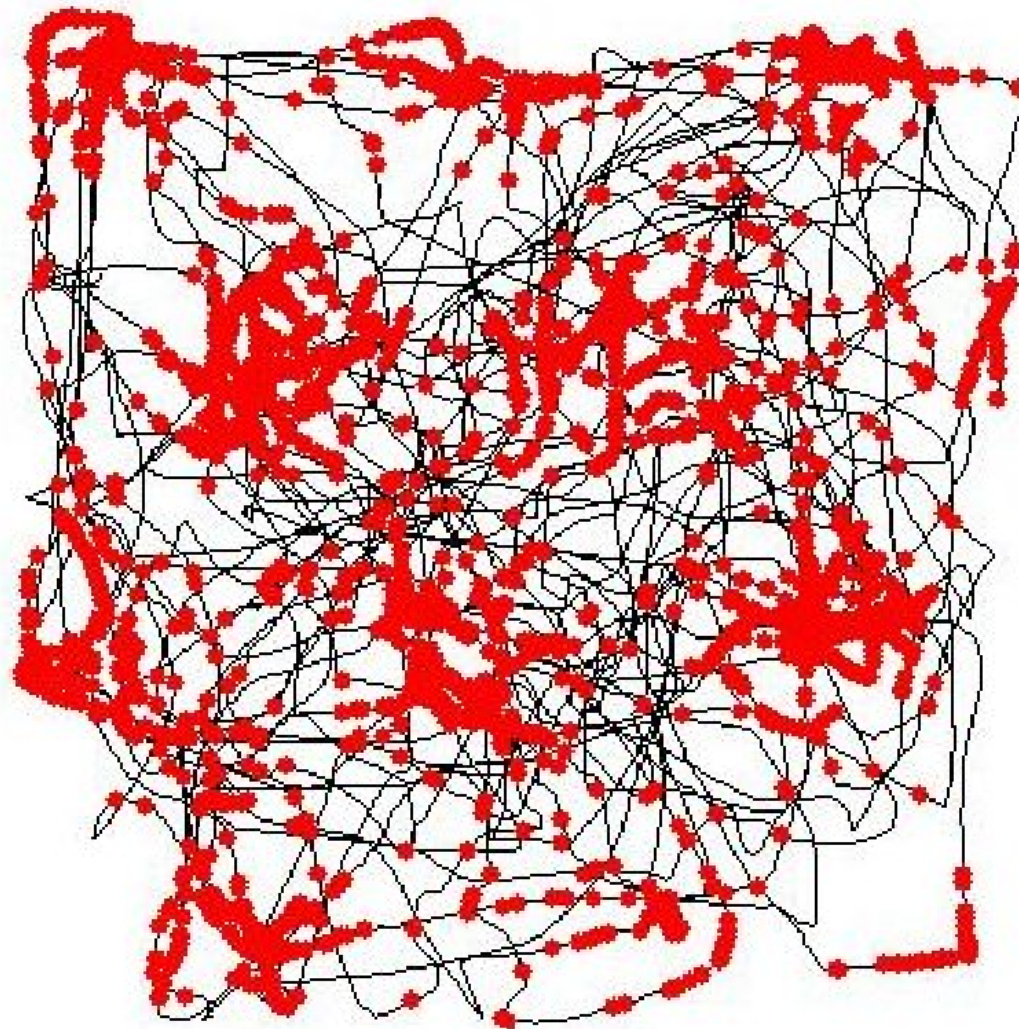
— PMd — M1 — S1 — SMA — PP

Insuffisance du neurone seul

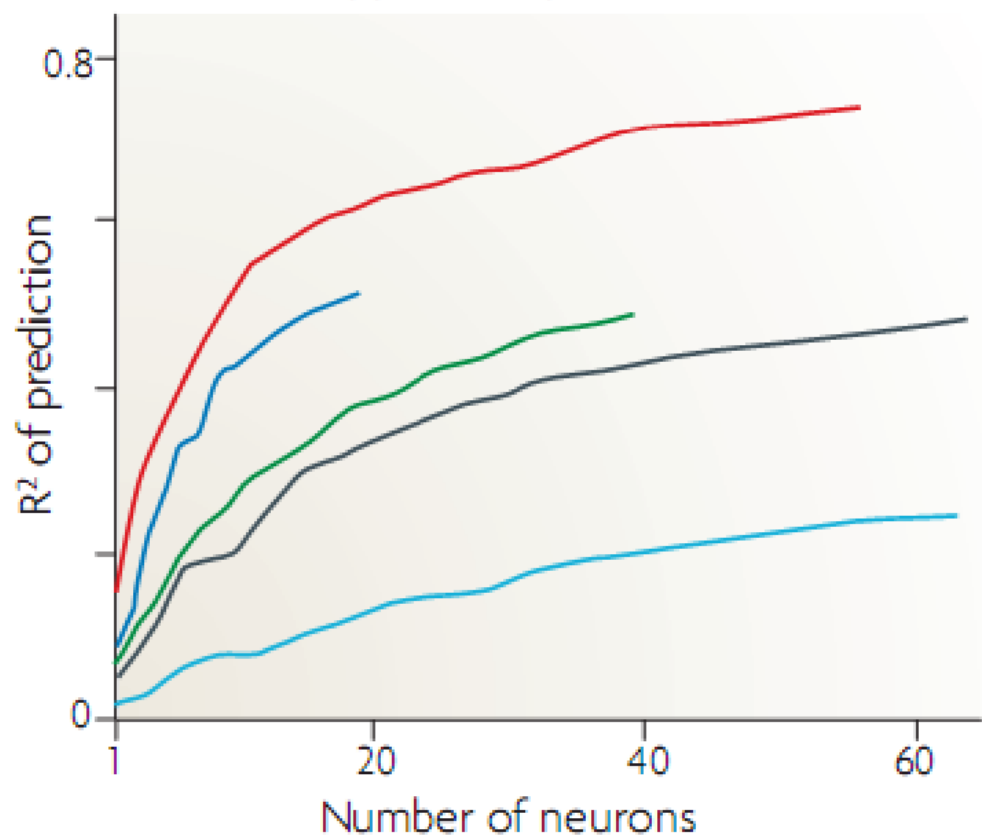
- Information limitée
- Variabilité temporelle importante
- Bruit



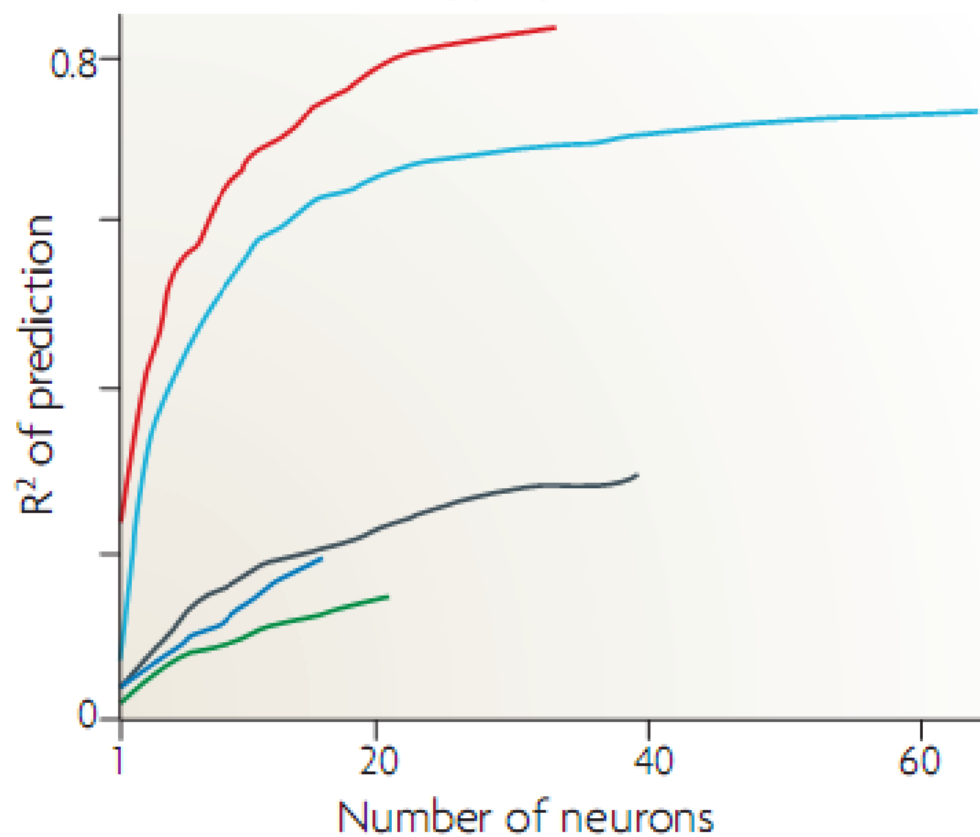
Multi-tâche



Upper-limb position

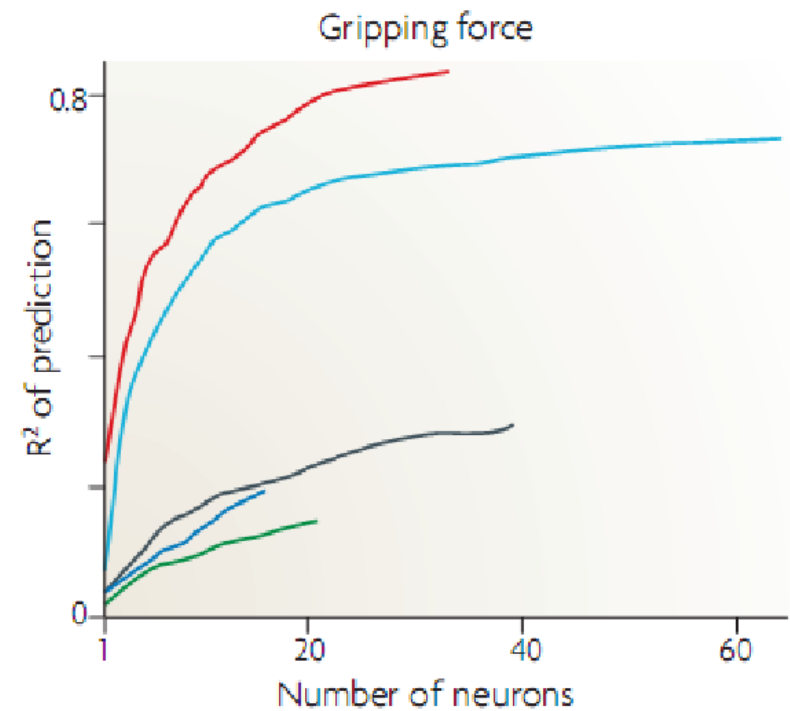
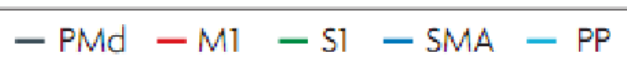
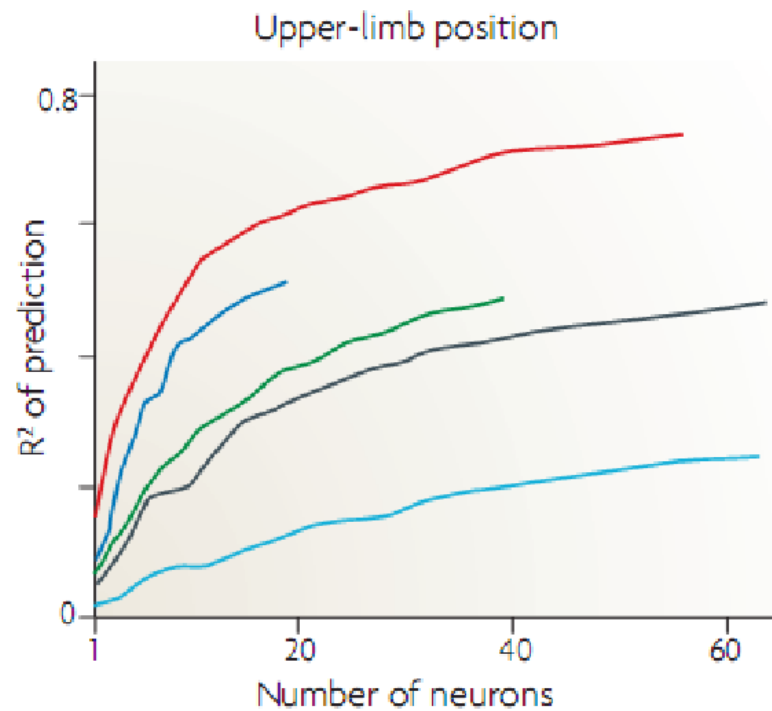


Gripping force



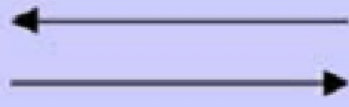
— PMd — M1 — S1 — SMA — PP

Effet de masse

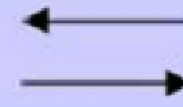


Degeometricescence

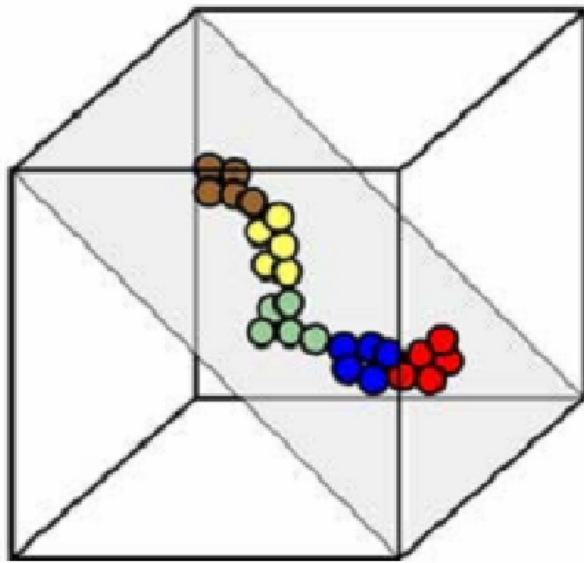
Sounds
Odors



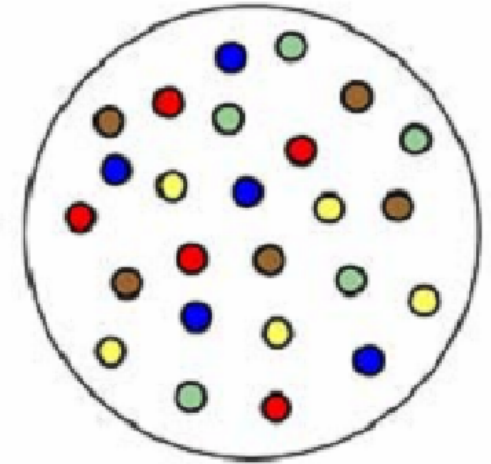
RA
Antennal lobe



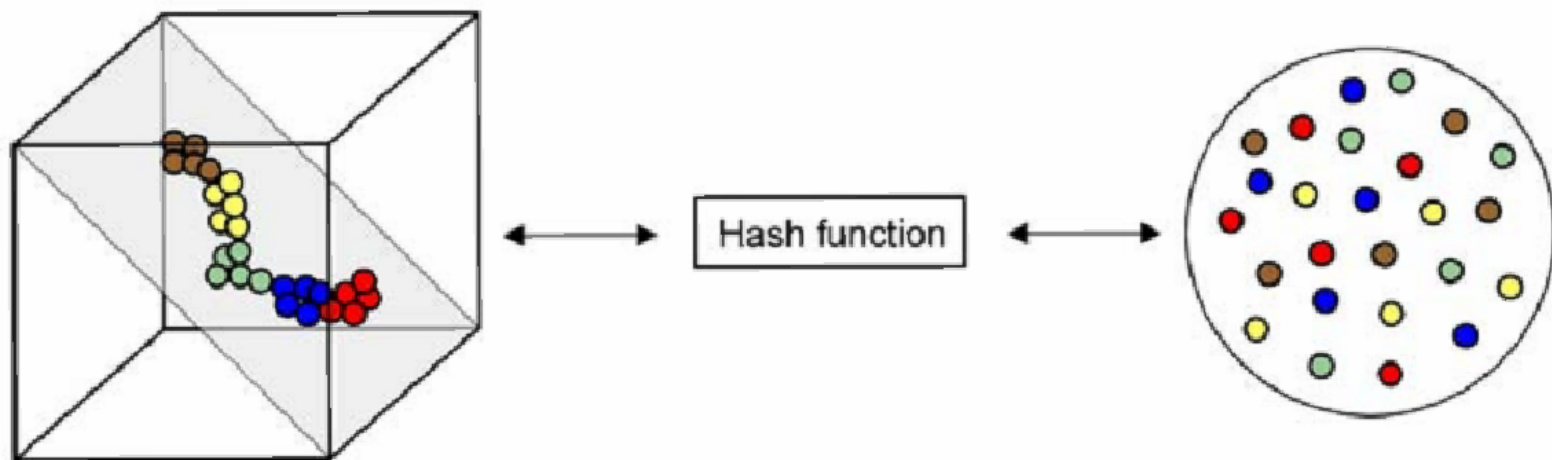
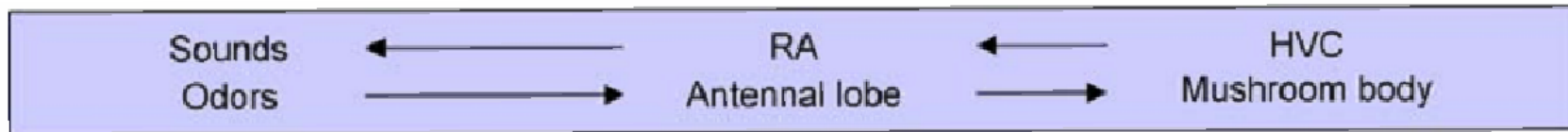
HVC
Mushroom body




Hash function



Principe de Dégénérescence



Modulated with hand and robot

-1  1.5
Normalized rate

Lag = -400 ms

Instant velocity measurement

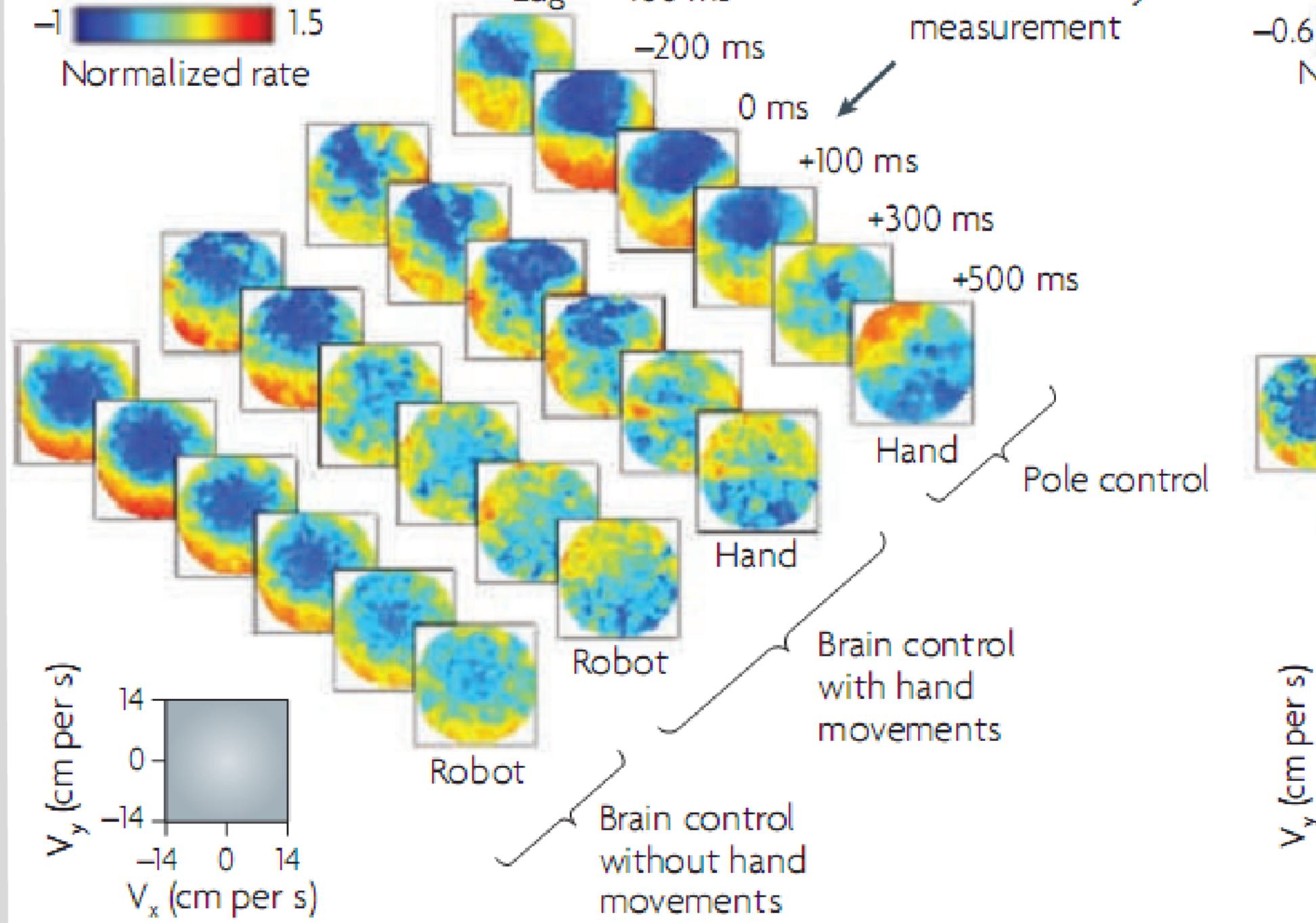
-200 ms

0 ms

+100 ms

+300 ms

+500 ms



Hand

Pole control

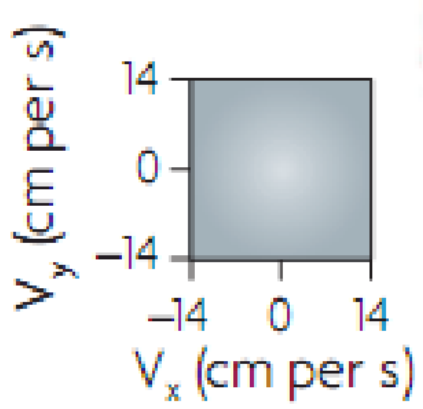
Hand

Robot

Brain control with hand movements

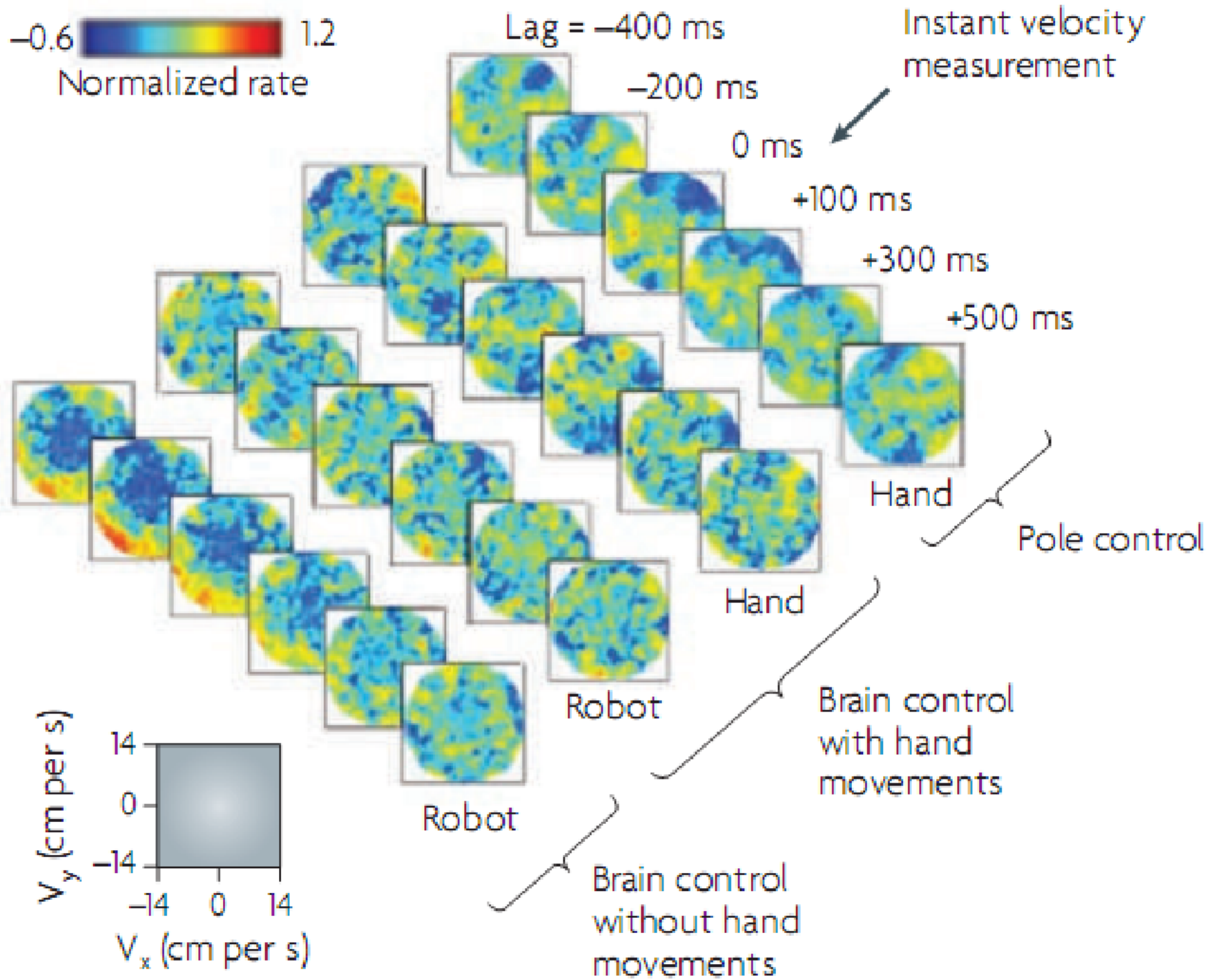
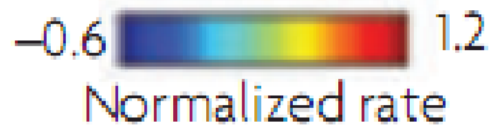
Robot

Brain control without hand movements

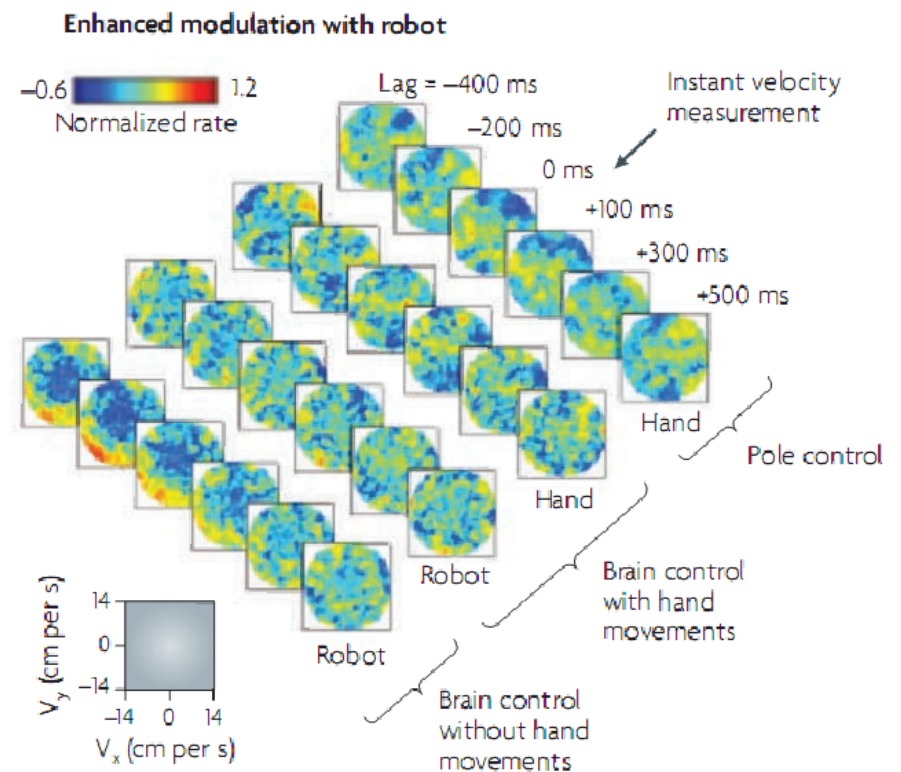
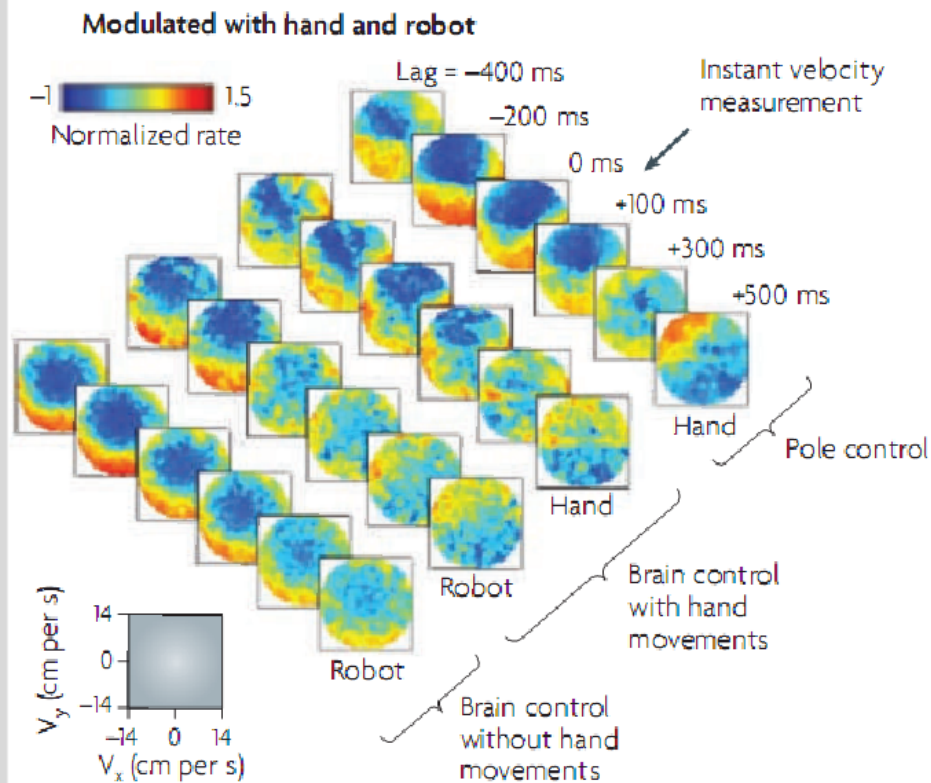


V_y (cm per s)

Enhanced modulation with robot



Plasticité



Conservation de la décharge

Le nombre total de décharges d'un ensemble de neurones corticaux est conservé durant l'apprentissage

Contexte

Différentes réponses
neuronaux selon que les
stimulis soient

- passifs
- actifs



Contexte
Différentes réponses neuronales selon que les stimuli soient
• passifs
• actifs

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• Information limitée
• Variabilité temporelle importante
• Bruit

Multi-tâche

Effet de masse

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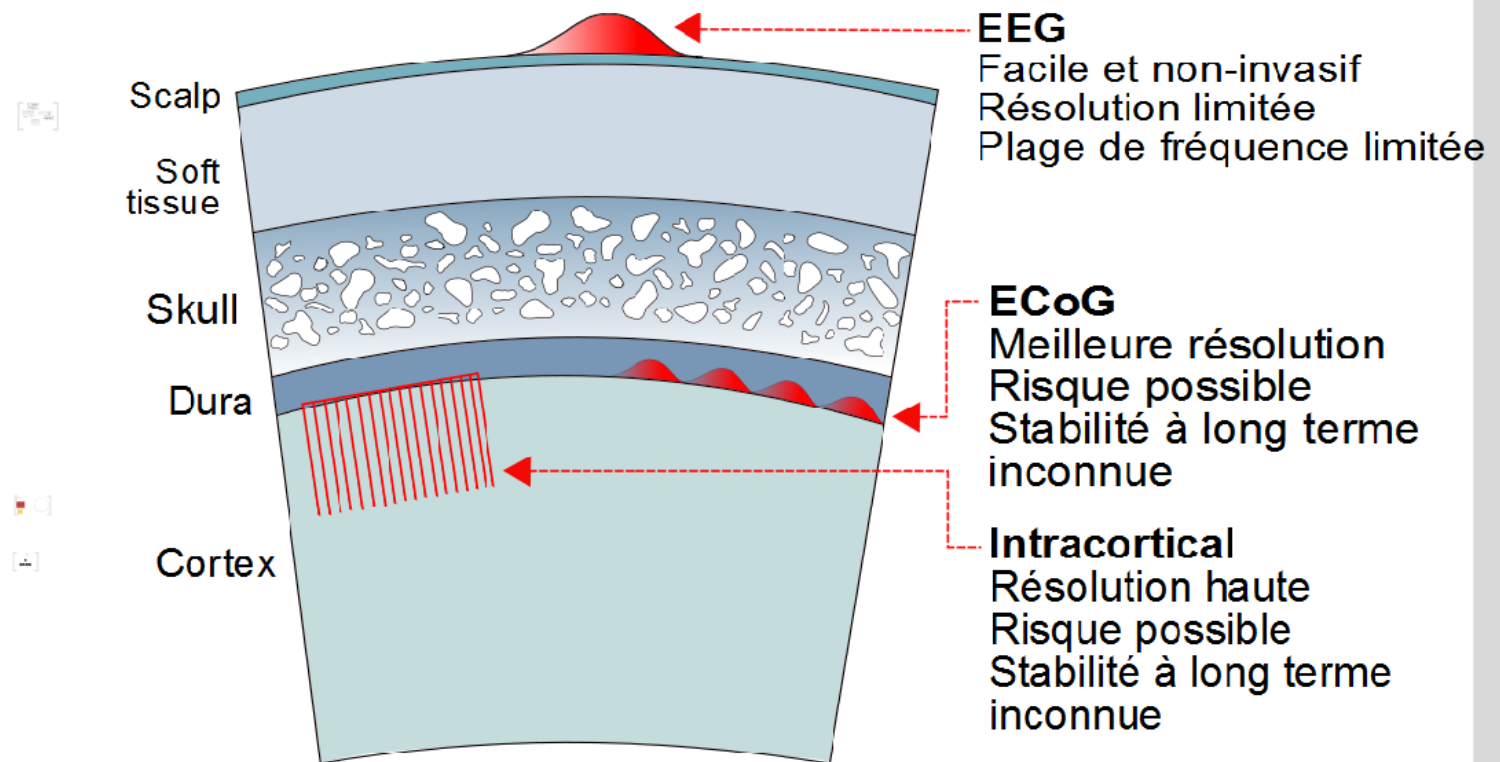
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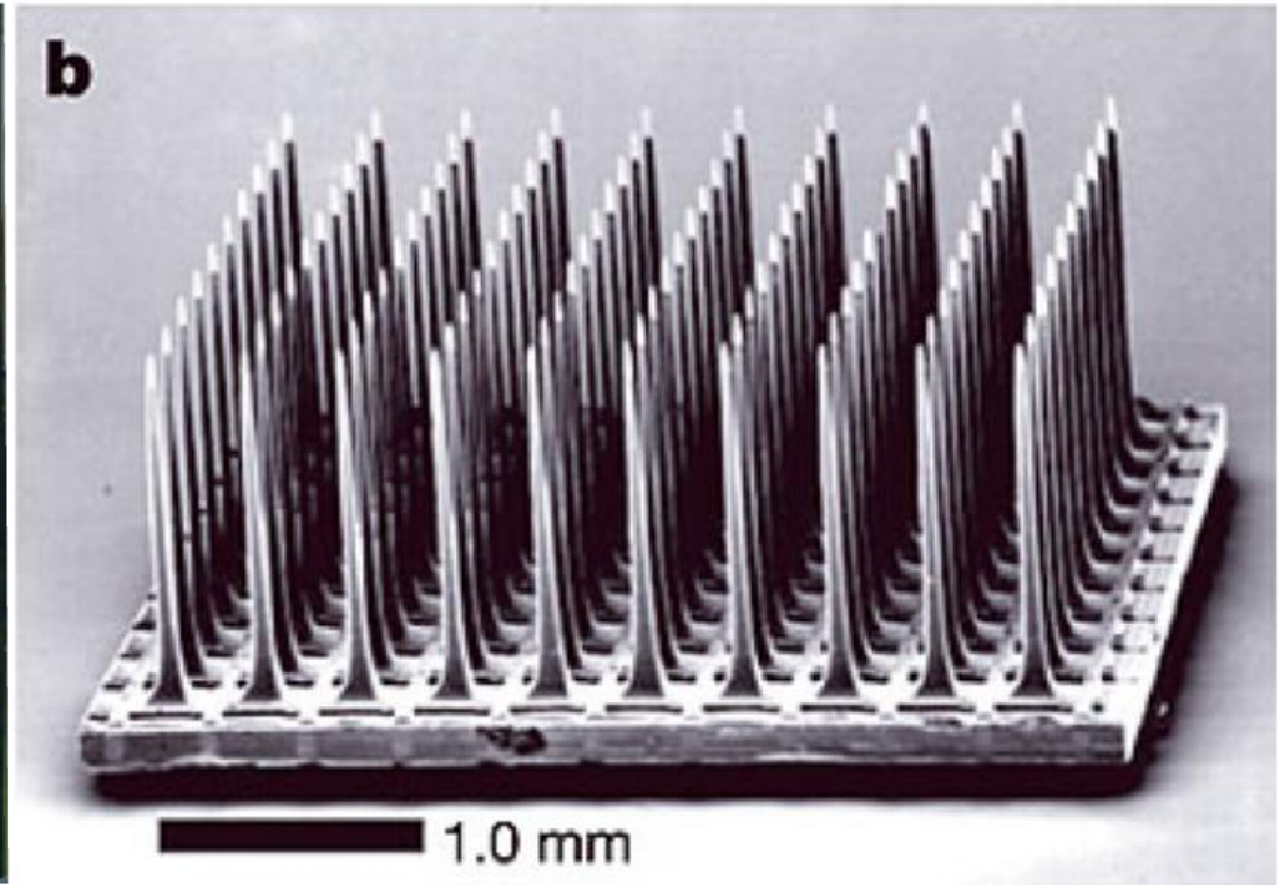
Utilisation de l'activité neuronale persistante chez les personnes tétraplégiques

- Nature et variations de cette activité neuronale
- Expériences pratique
- Voies pour le futur

nature et variations de cette activité neuronale

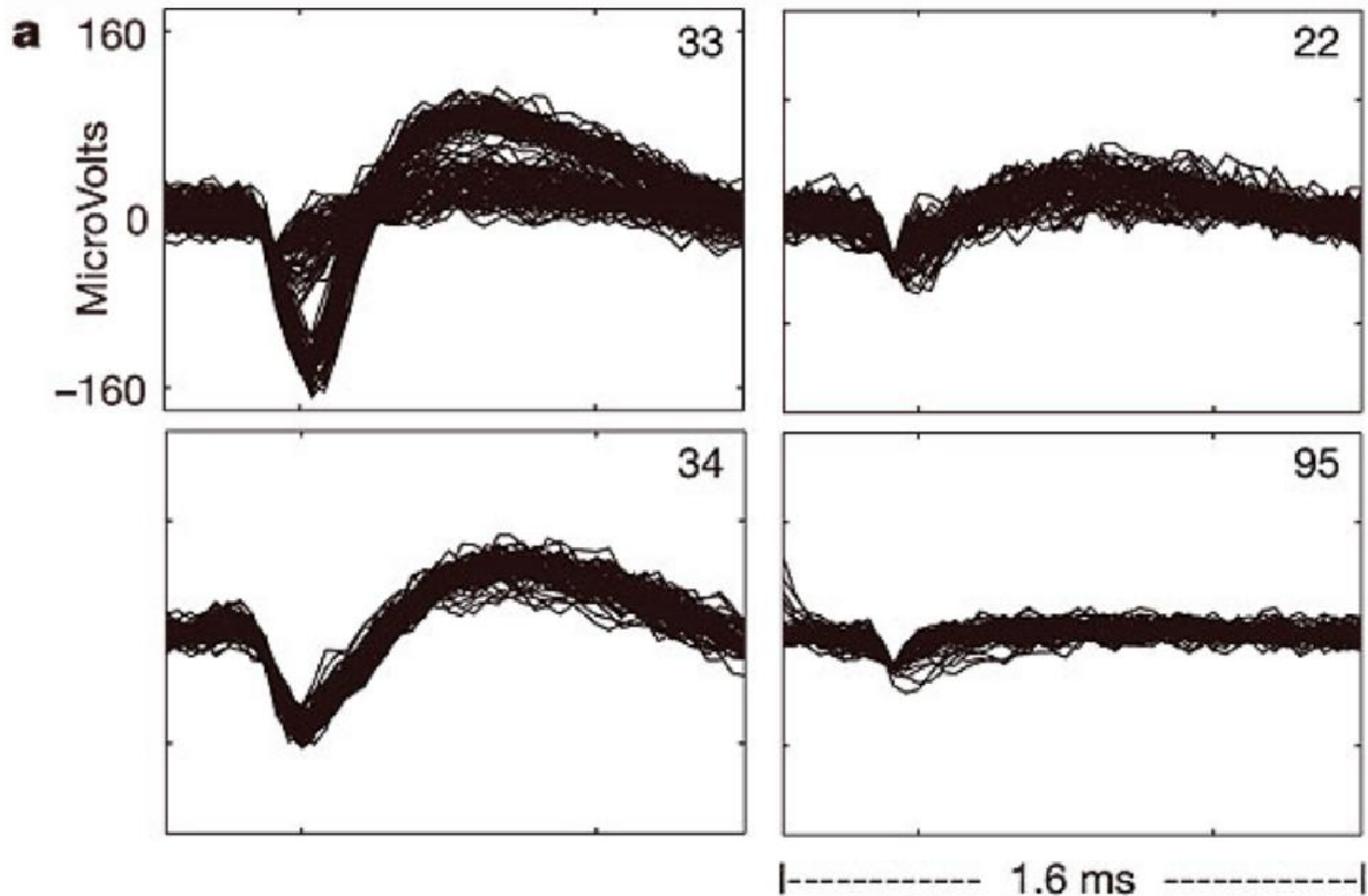


implantation d'électrodes



nature et variations de cette activité neuronale

→ mesure de l'activité

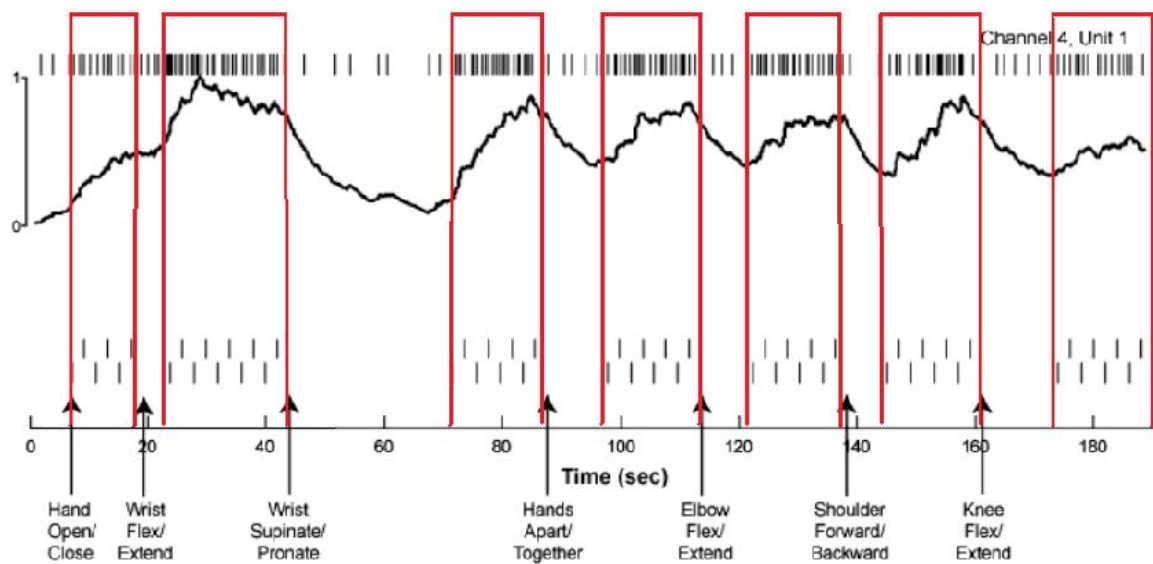


réponse par électrode

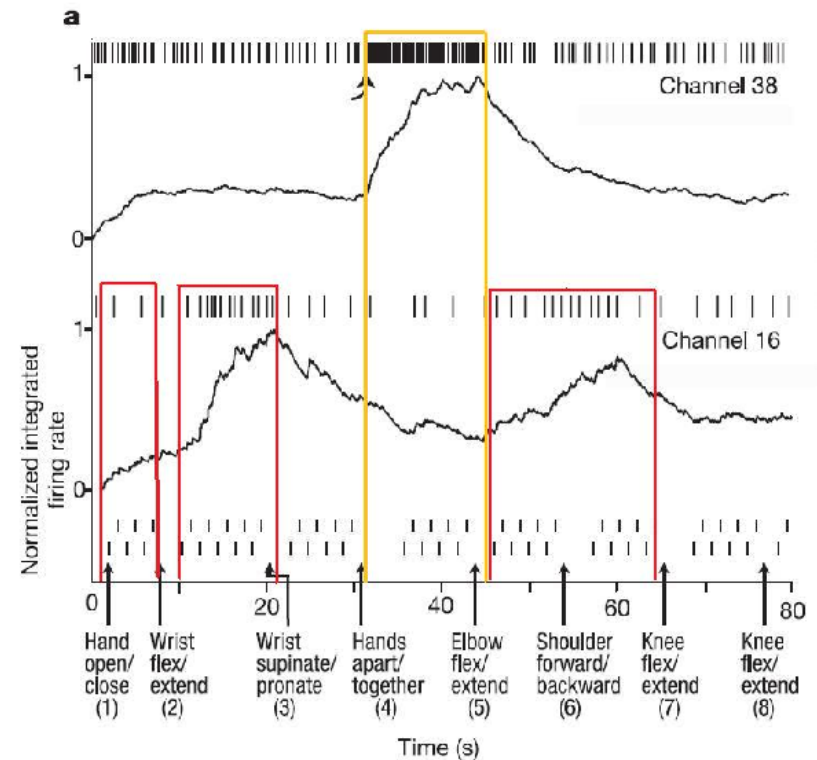
nature et variations de cette activité neuronale



variations de l'activité



réponse non spécifique



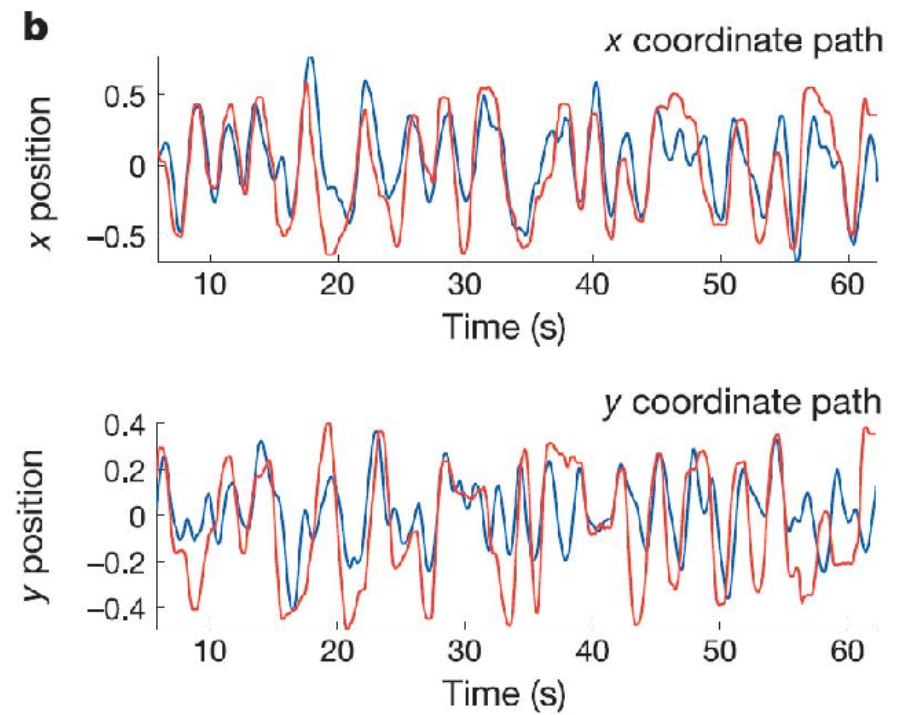
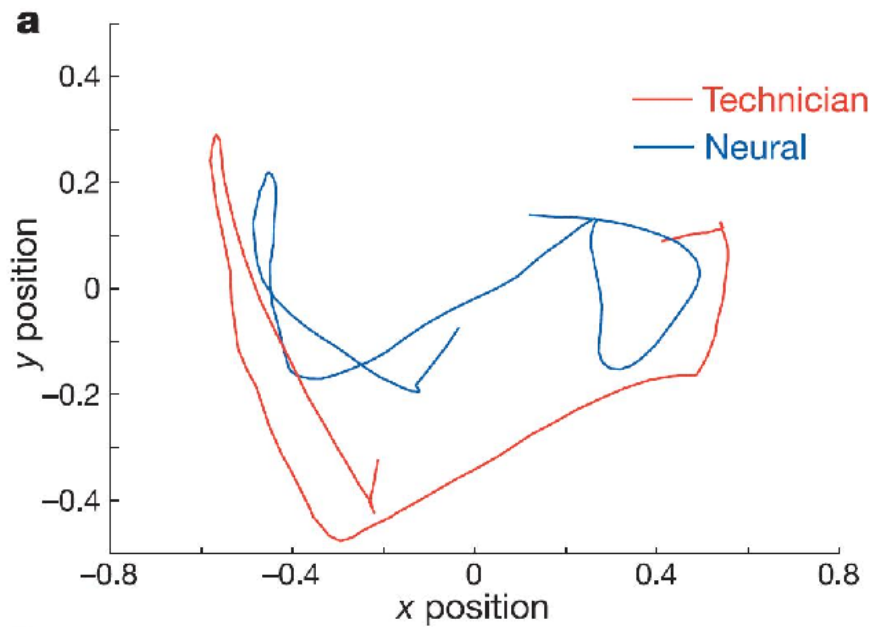
réponse spécifique

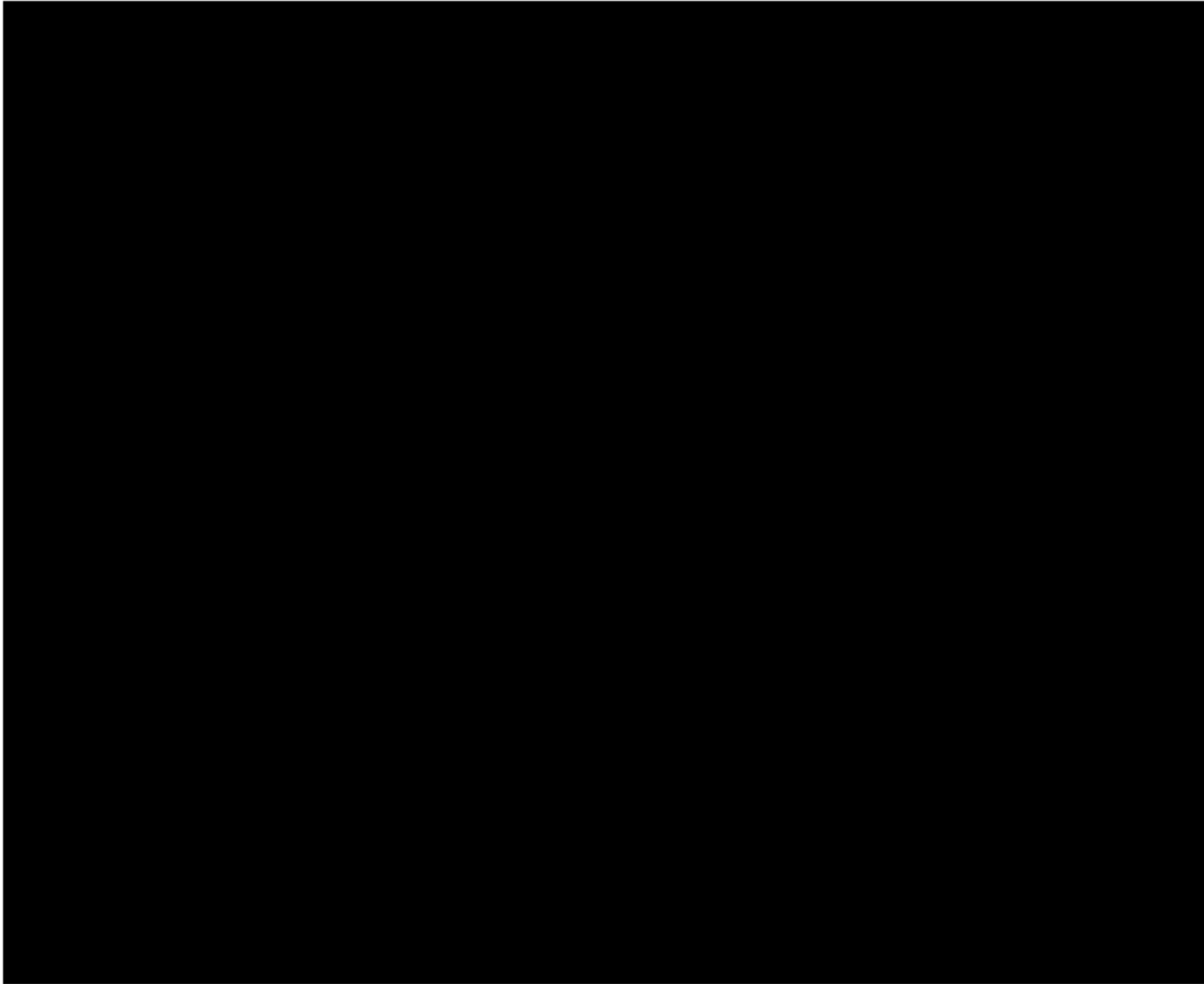
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Expériences pratiques

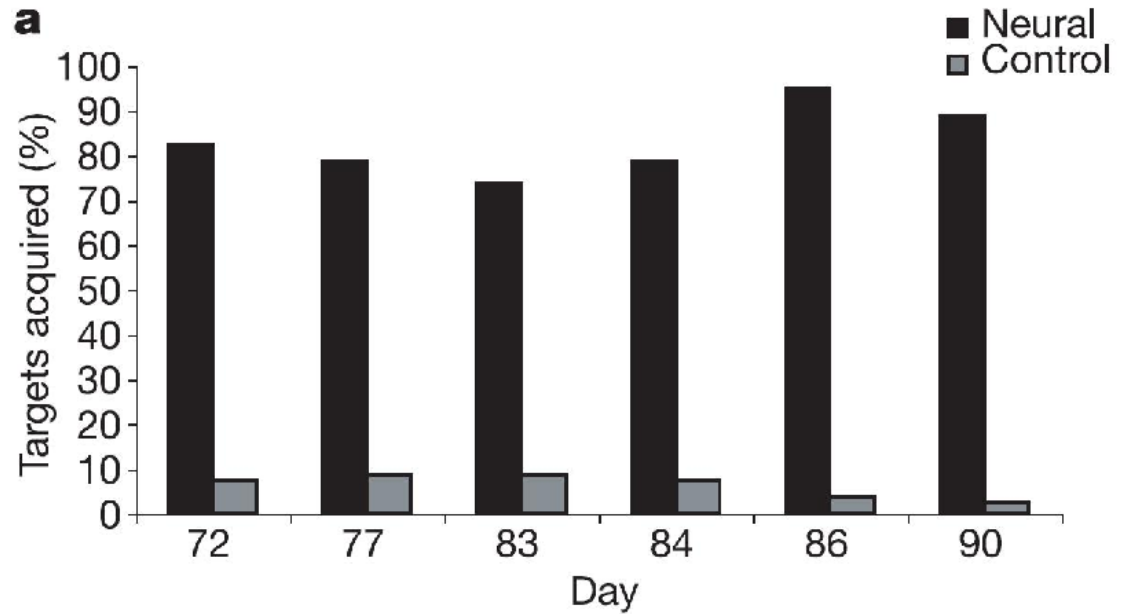
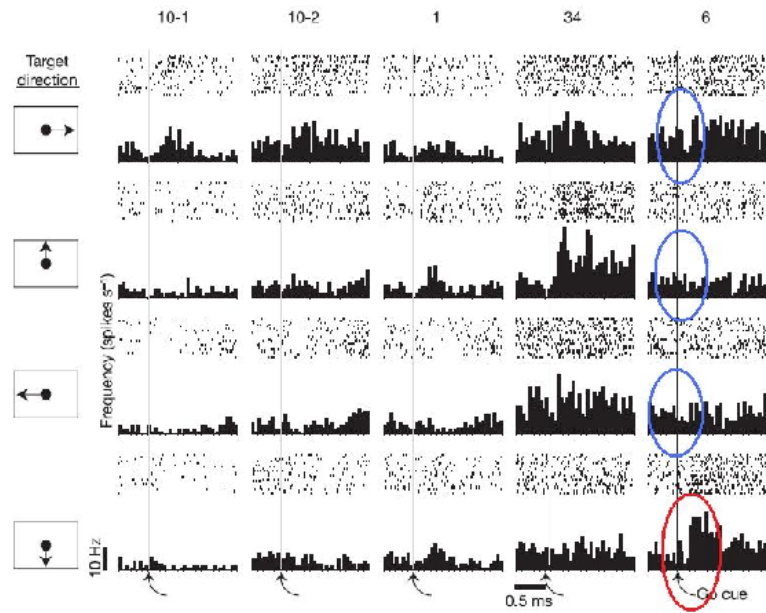
➔ mise à profit de la construction du filtre





Expériences pratiques

➔ "Center-out task"

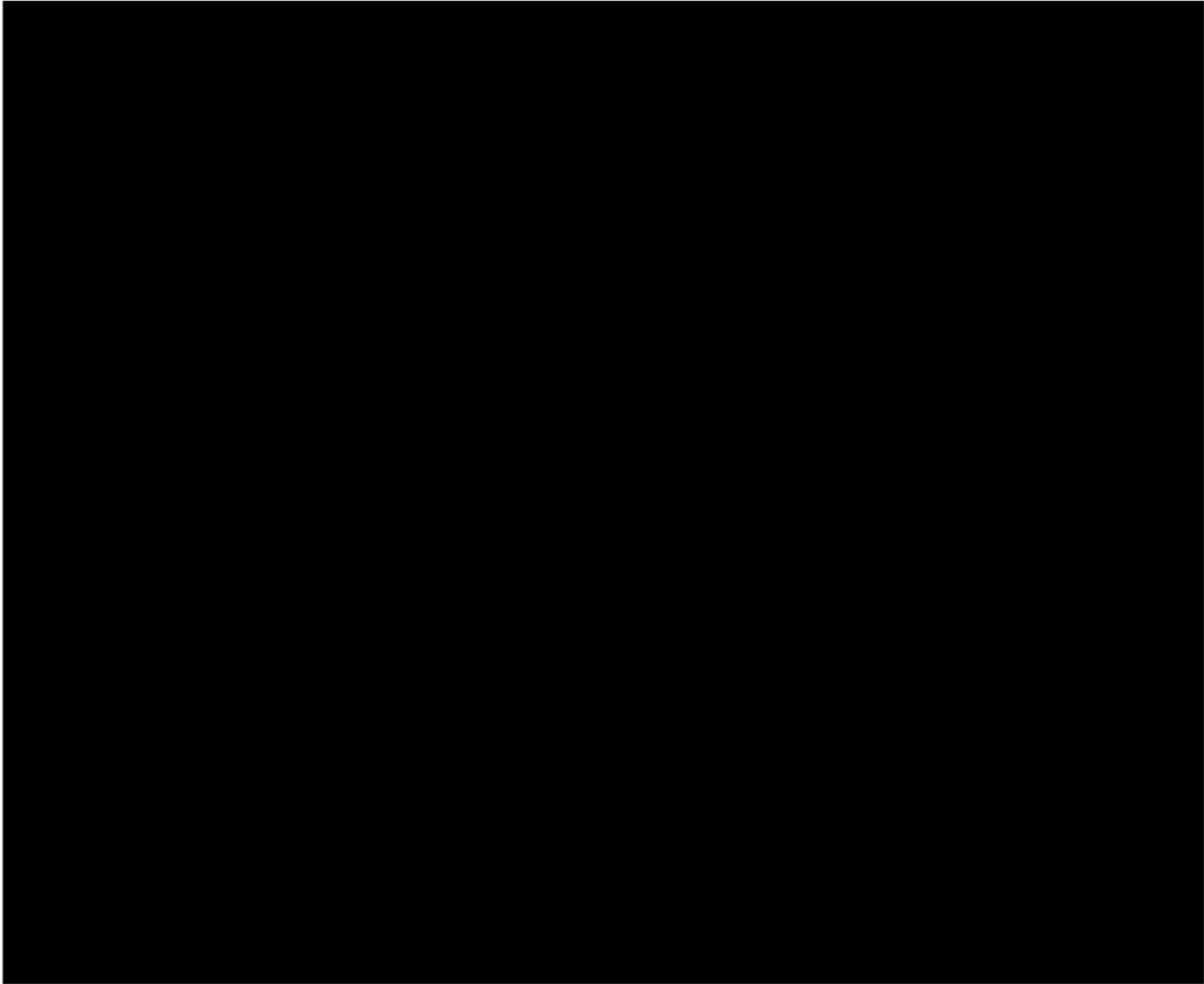


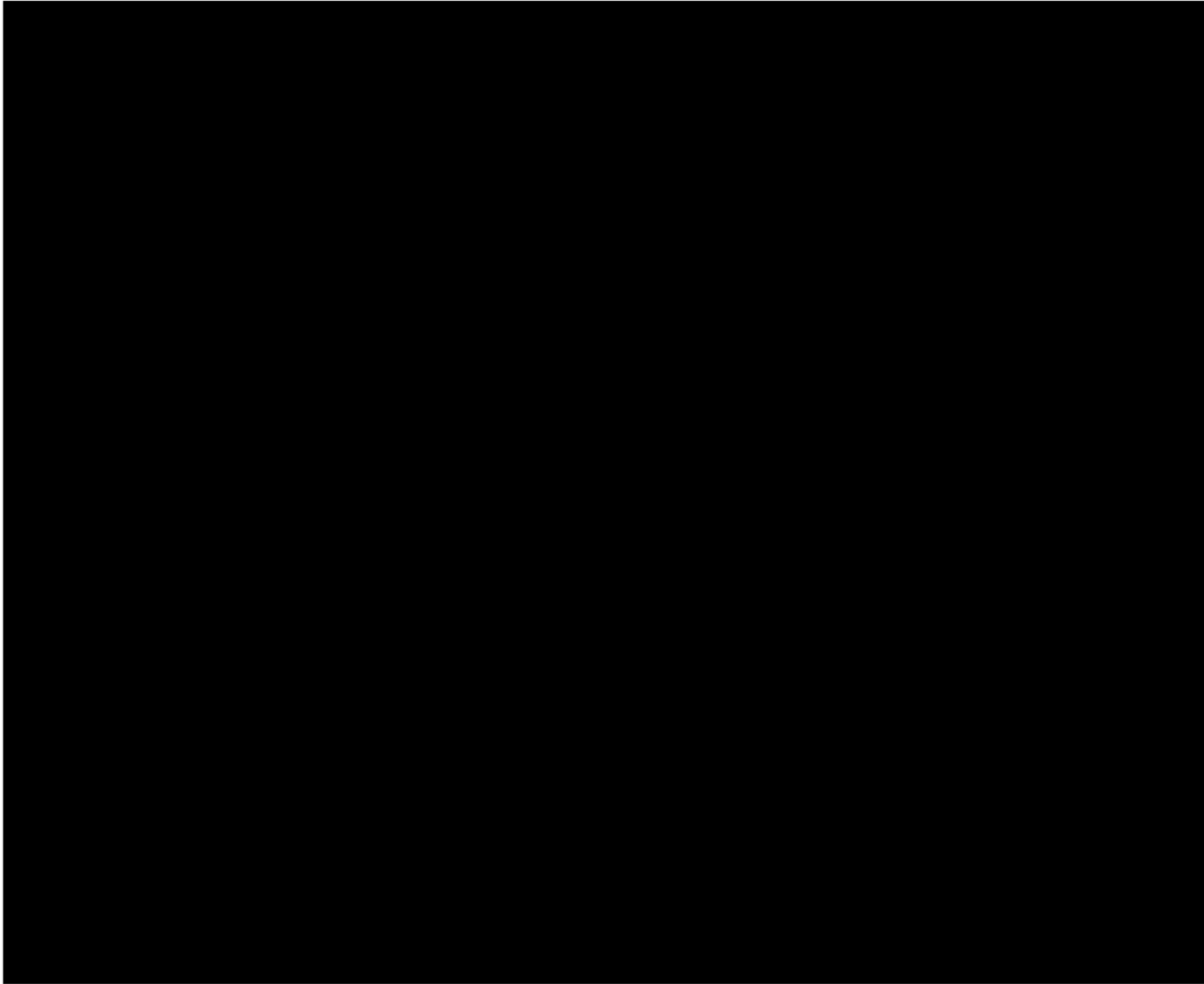
Utilisation de l'activité neuronale persistante chez les personnes tétraplégiques

- Nature et variations de cette activité neuronale
- Expériences pratiques
- Voies pour le futur









Conclusion

- Une technologie prometteuse mais encore au stade de la recherche



- Utilisation thérapeutique des interfaces cerveaux-machines pour la rééducation

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- J. J. Foxe, G. V. Simpson, and S. P. Ahlfors, "Parieto-occipital 10 Hz activity reflects anticipatory state of visual attention mechanisms".

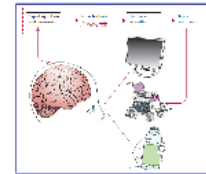
Interfaces cerveau-machine :

« agir par la pensée »

A. Bury
O. Guieu
H. Jouhaud
P. Traynard



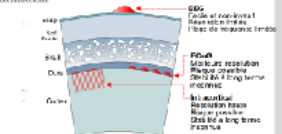
Interfaces cerveau-machine



→ Utilisateur s'adapte au système par l'entraînement.
→ L'algorithme de traduction doit s'adapter à l'utilisateur.

Les signaux utilisés

- Activité électroencéphalographique (EEG) en surface du crâne
- Activité électrocorticographique (ECoG) à la surface corticale
- Activité intracorticale



Conclusion

- Une technologie prometteuse mais encore au stade de la recherche
- Utilisation thérapeutique des interfaces cerveau-machine pour la rééducation

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