UNIVERSITÉ DE GENÈVE

Human Neuron Lab

HUG Hôpitaux Universitaires Genève

# Implants cérébraux: bientôt une réalité?

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Neuroclub UNIGE, 12 octobre 2023

# Implants cérébraux: bientôt une réalité?

**Plan**

- L'homme le plus riche du monde
- Pas une (si) mauvaise idée
- Interfaces cerveau-machine
- Un peu plus près des neurones
- Observer le cerveau
- Stimuler le cerveau
- Restaurer les mouvements
- Restaurer la parole
- Restaurer le langage?
- Pourquoi pas déjà maintenant?
- Enjeux éthiques

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# L’homme le plus riche du monde

Hôpitaux Universitaires Genève

the tesla space

Neuralink.com

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# L’homme le plus riche du monde

HUG Hôpitaux Universitaires Genève

the tesla space

# L’homme le plus riche du monde

Pas une (si) mauvaise idée!

# Pas une (si) mauvaise idée

(EEG)

Can these observable electrical brain signals be put to work as carriers of information in man-computer communication or for the purpose of controlling such external apparatus as prosthetic devices or spaceships? Even on the sole basis of the present states of the art of computer science and neurophysiology, one may suggest that such a feat is potentially around the corner.

Vidal, 1973

# Pas une (si) mauvaise idée

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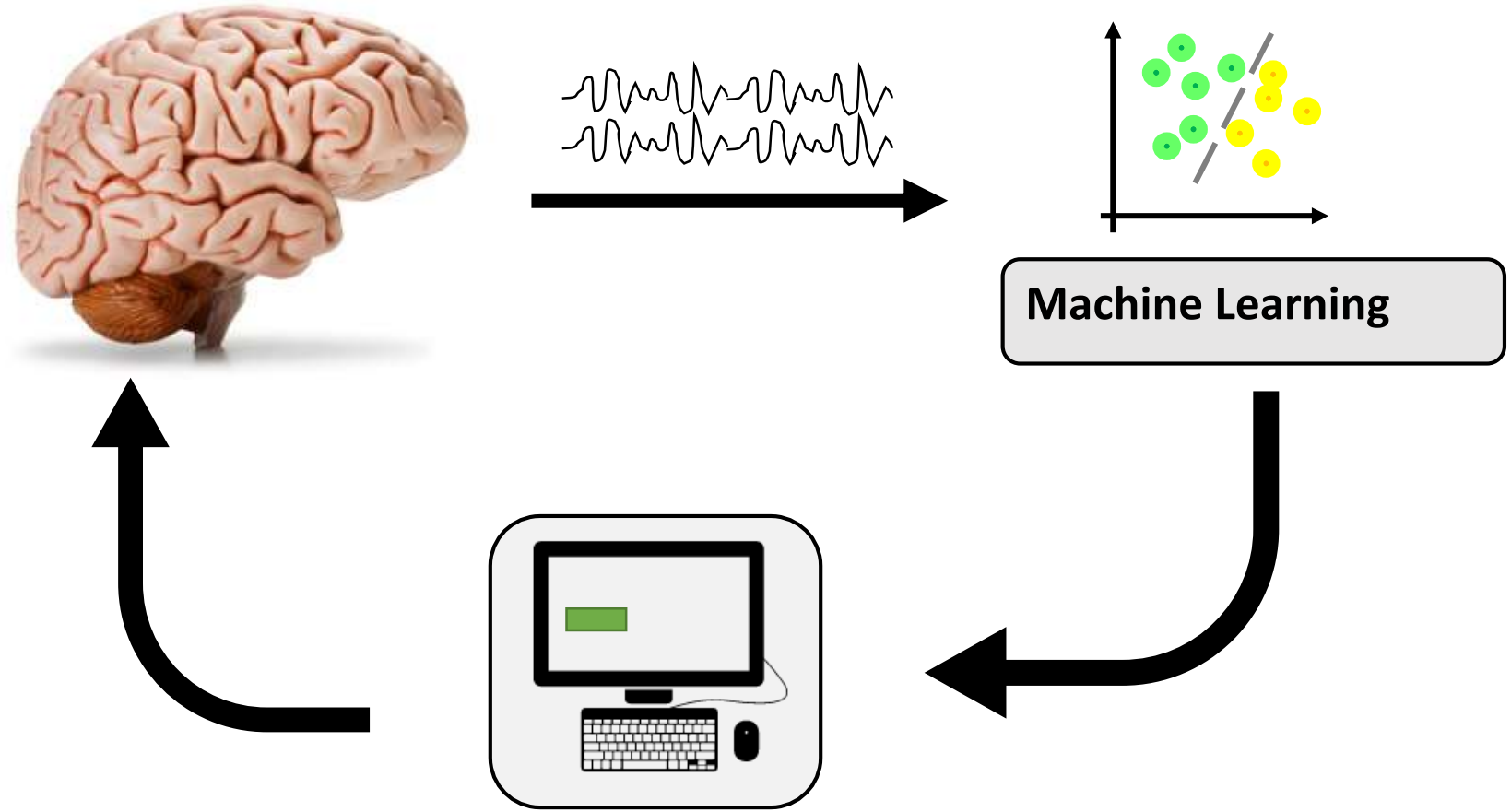
**Restaurer les fonctions du cerveau?**

**Augmenter les capacités du cerveau?**

Vidal, 1973

# Interfaces cerveau-machine

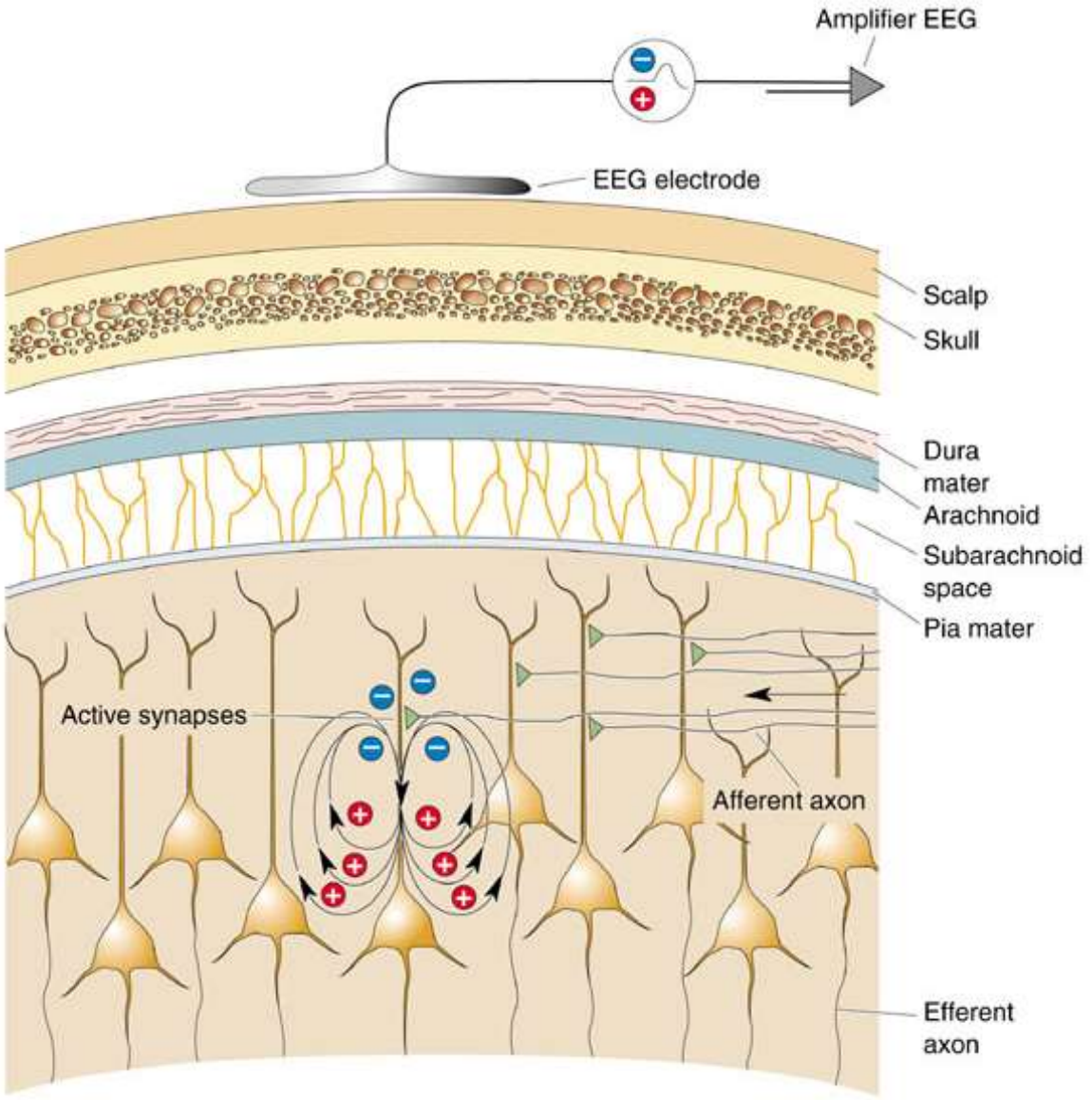



Silvia Marchesotti

# Interfaces cerveau-machine

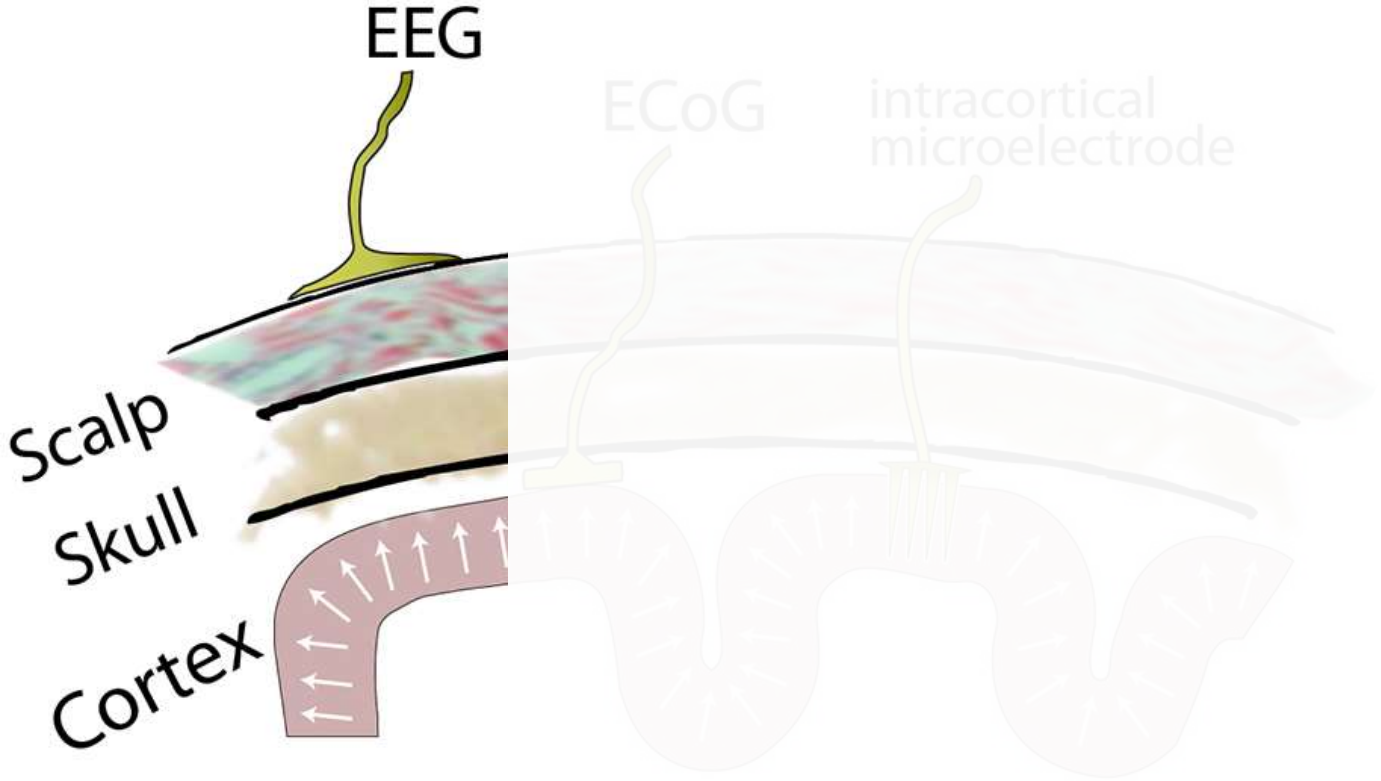
**L'EEG est loin des neurones**

- Résolution spatiale 15-20 mm (dans les meilleures circonstances)
- Relation complexe entre signaux EEG et activité des neurones




Bear et al., Exploring the brain, 2007; Mégevand et al., 2014

# Un peu plus près des neurones




Miller et al., 2020

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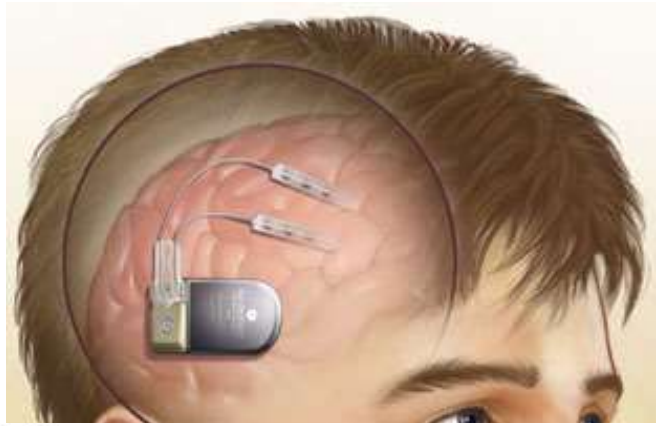

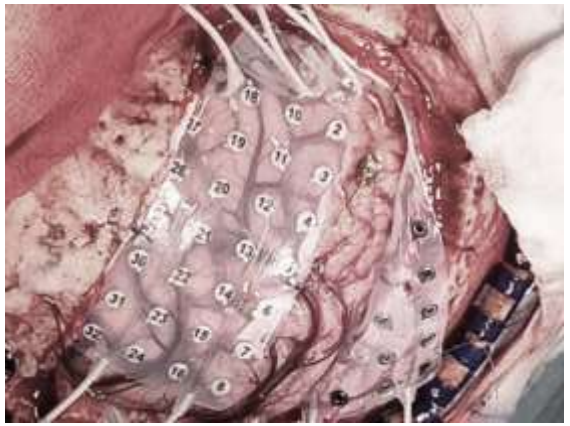

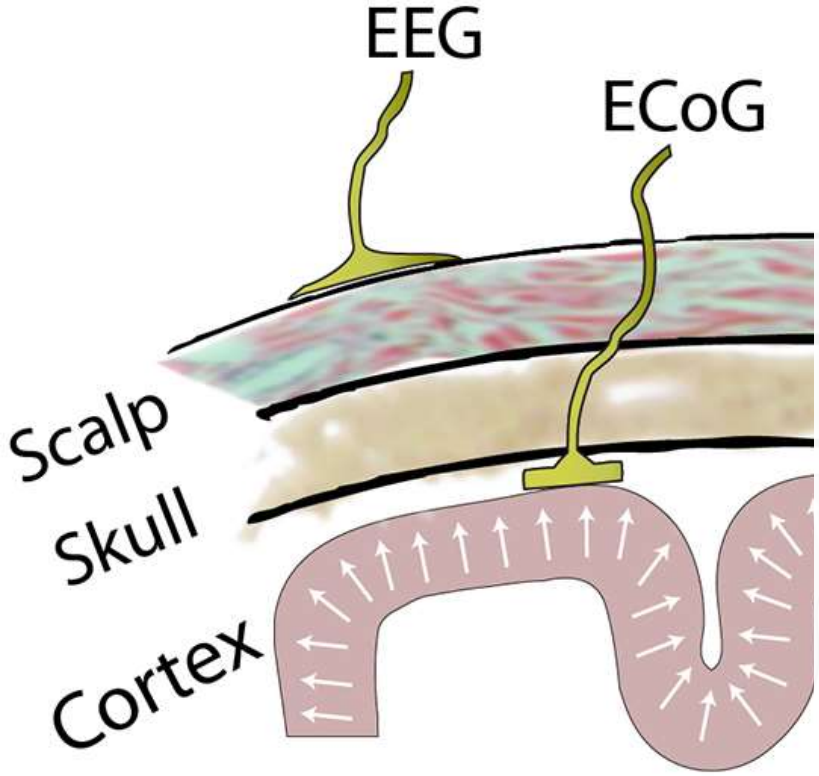




Miller et al., 2020

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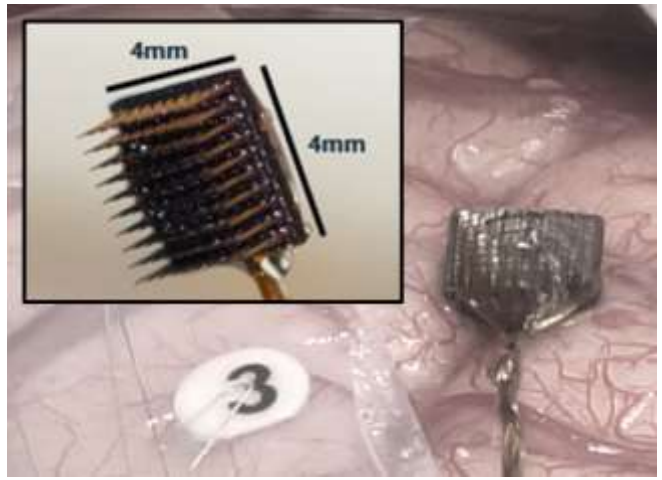
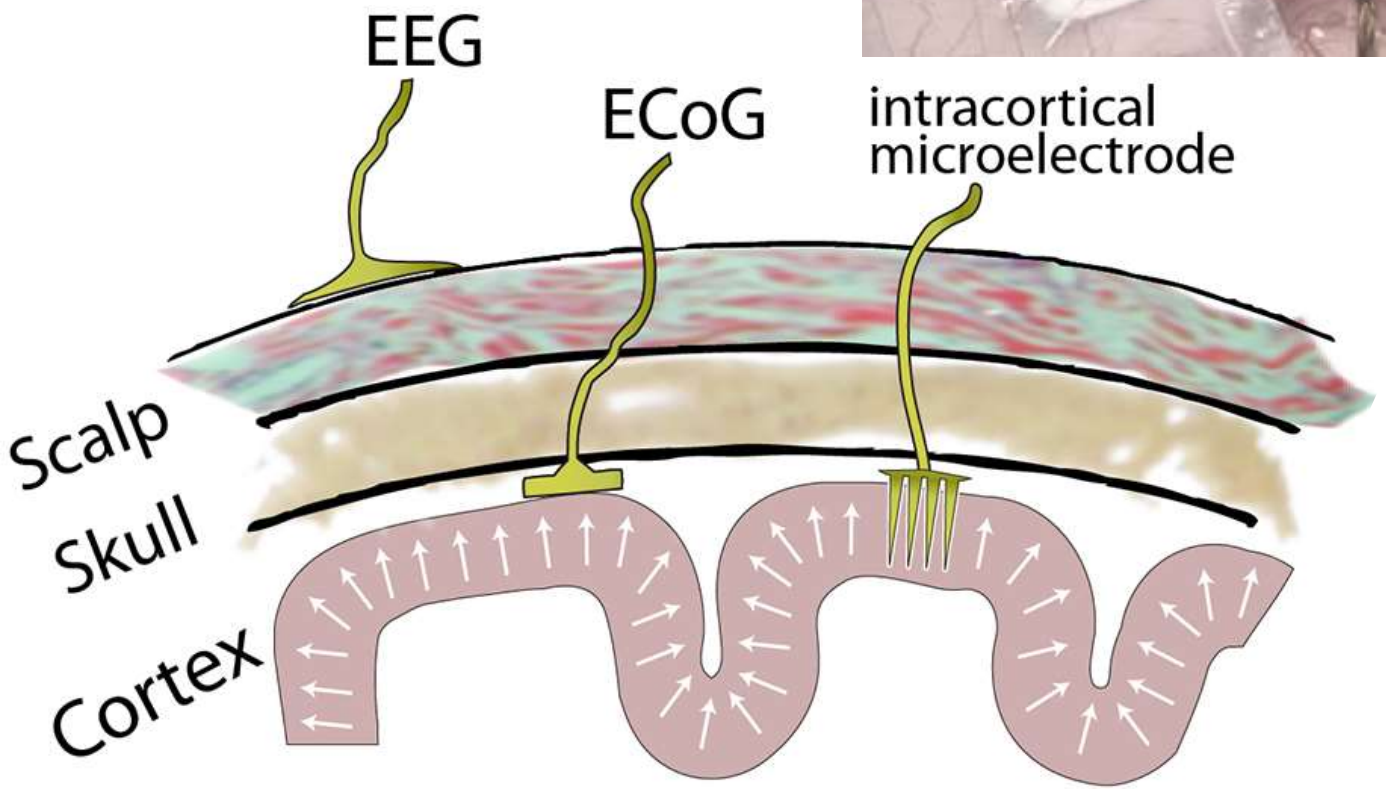
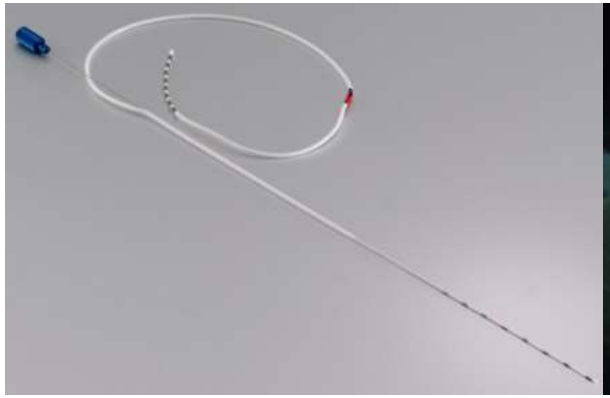


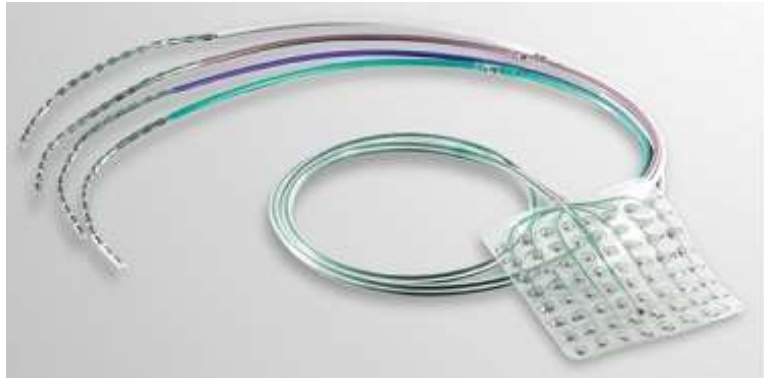
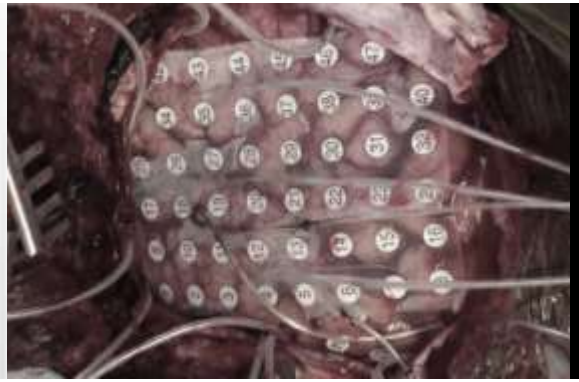
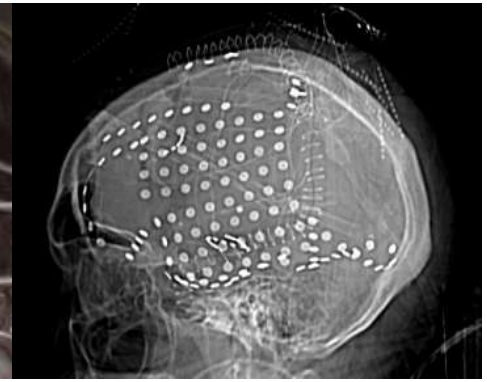




Miller et al., 2020

# Observer le cerveau

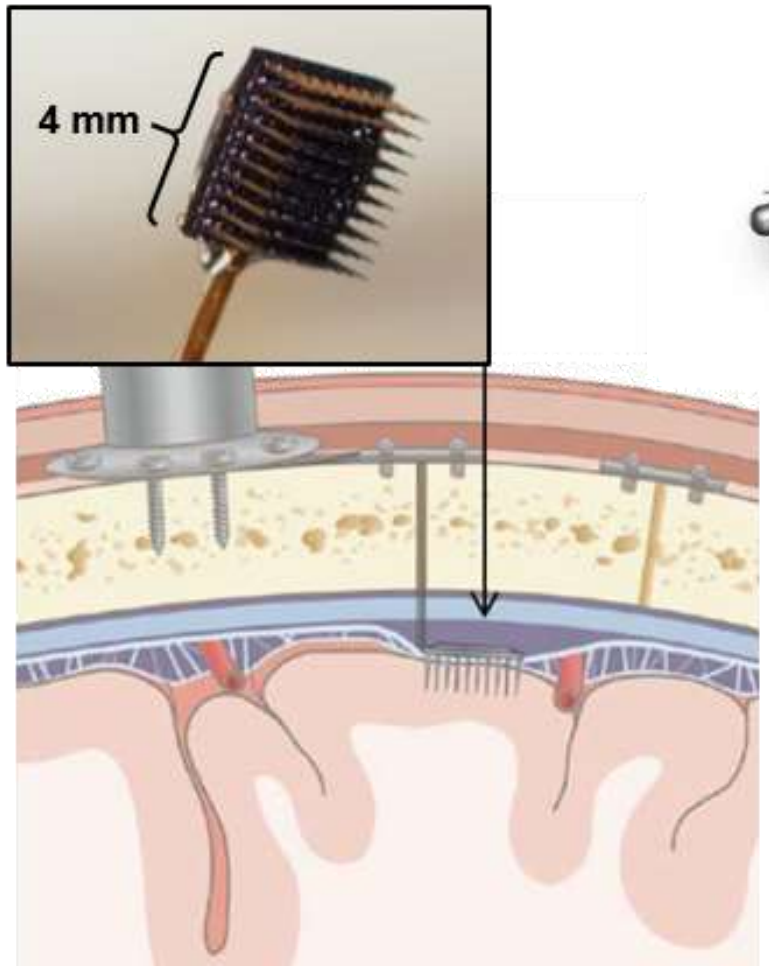
## EEG intracrânien

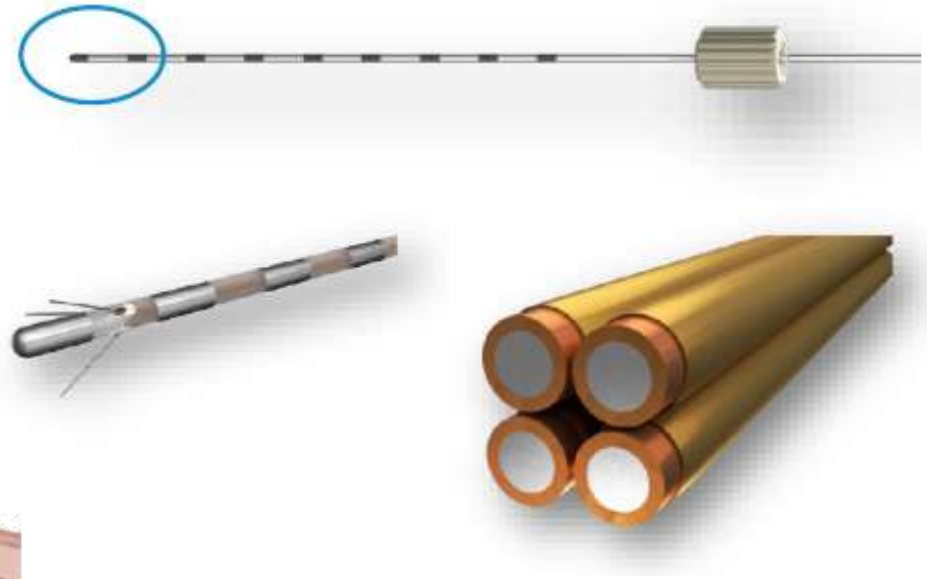


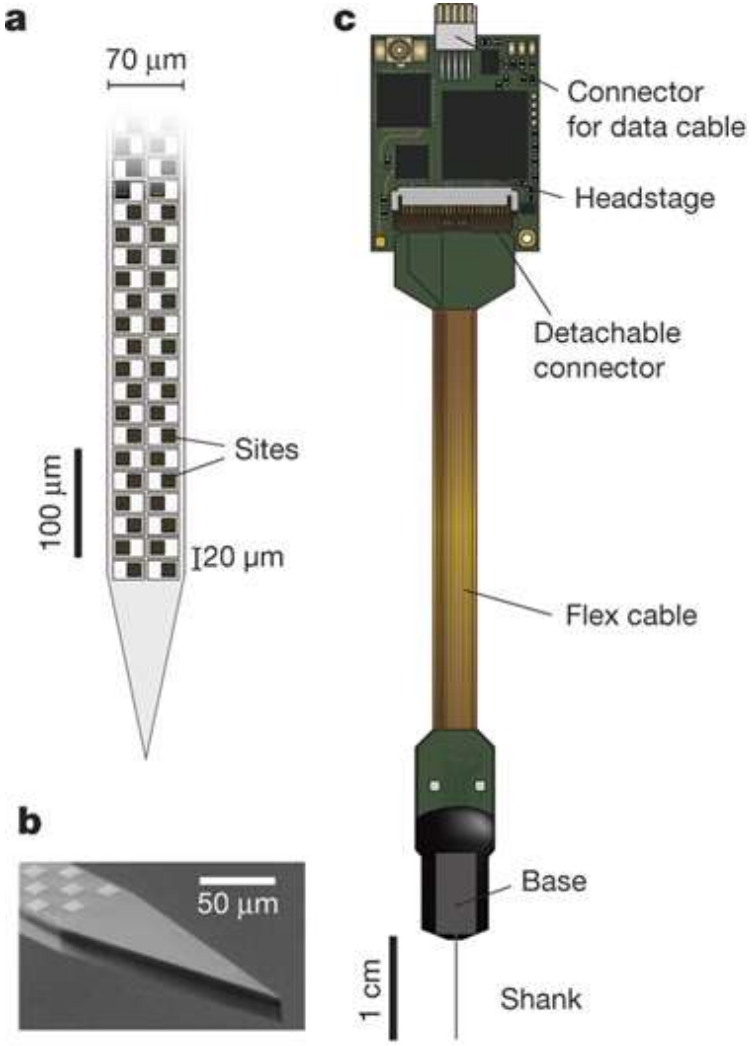





# Observer le cerveau

## Micro-électrodes




Mégevand et al., 2017; Cash and Hochberg, 2015; Paulk et al., 2022

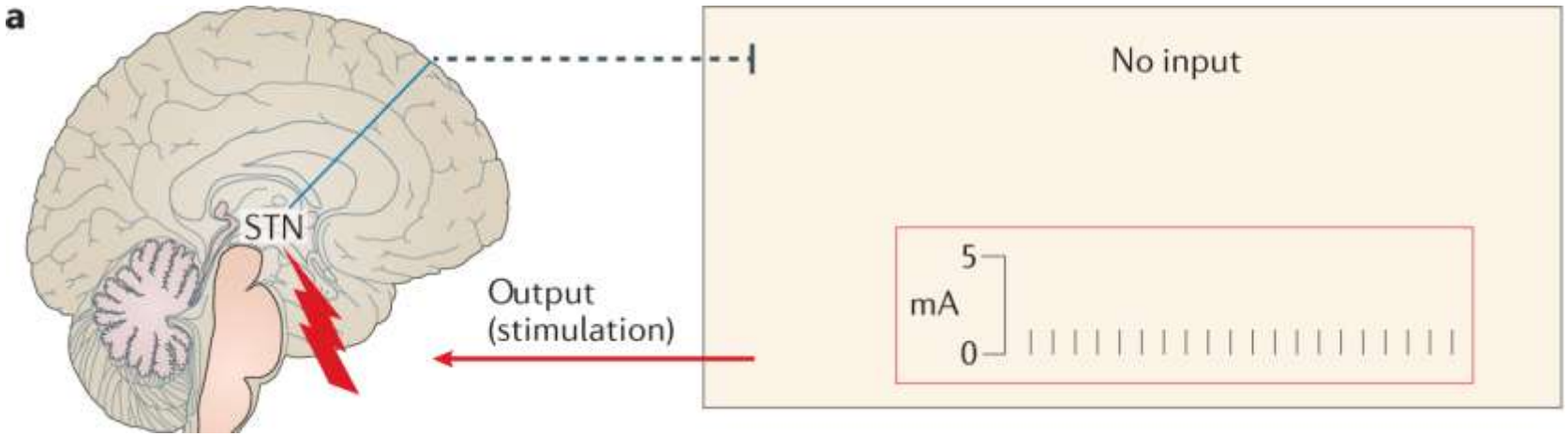
# Observer le cerveau

## Utah array @ UNIGE / HUG


Mégevand et al., 2017

# Stimuler le cerveau

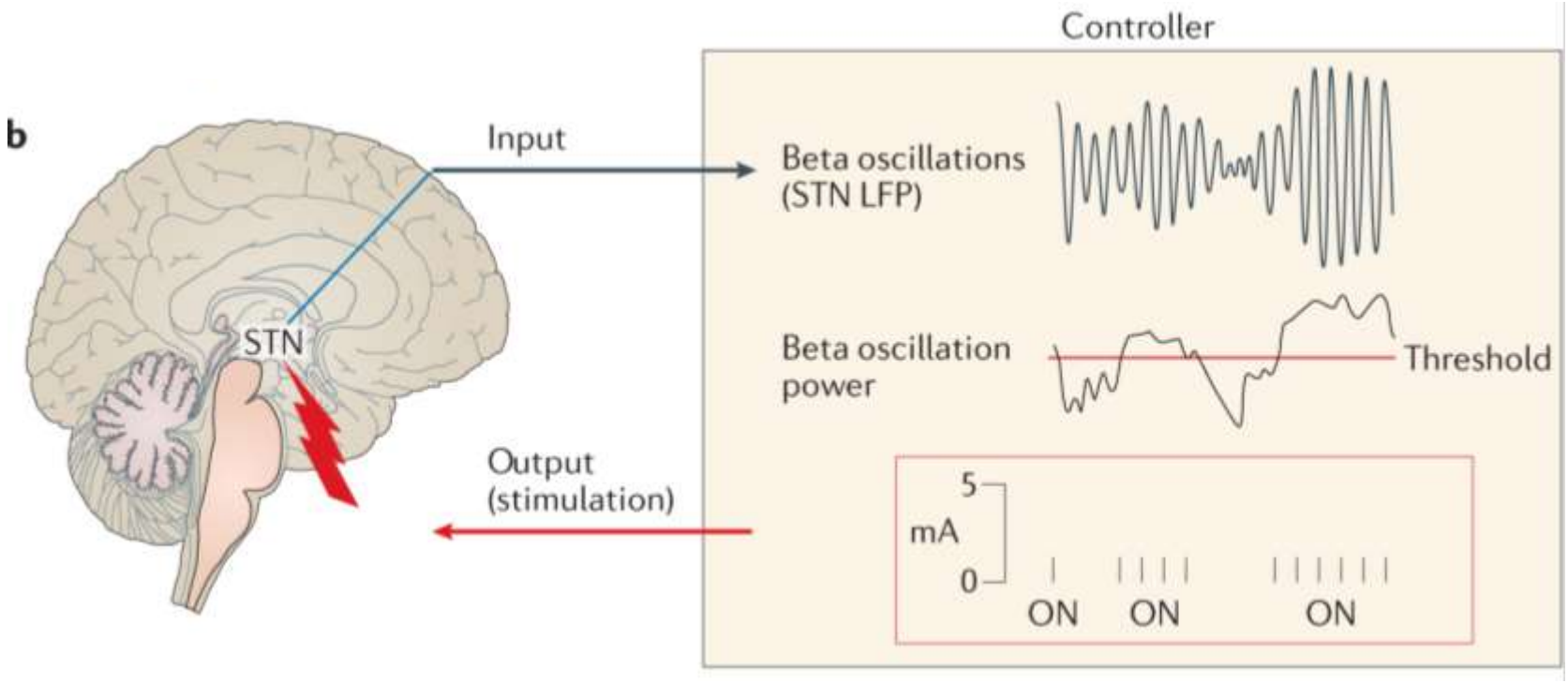
Le présent: amélioration du syndrome parkinsonien




Bouthour et al., 2019

# Stimuler le cerveau

Le futur: DBS "on demand"
(boucle fermée)




Bouthour et al., 2019

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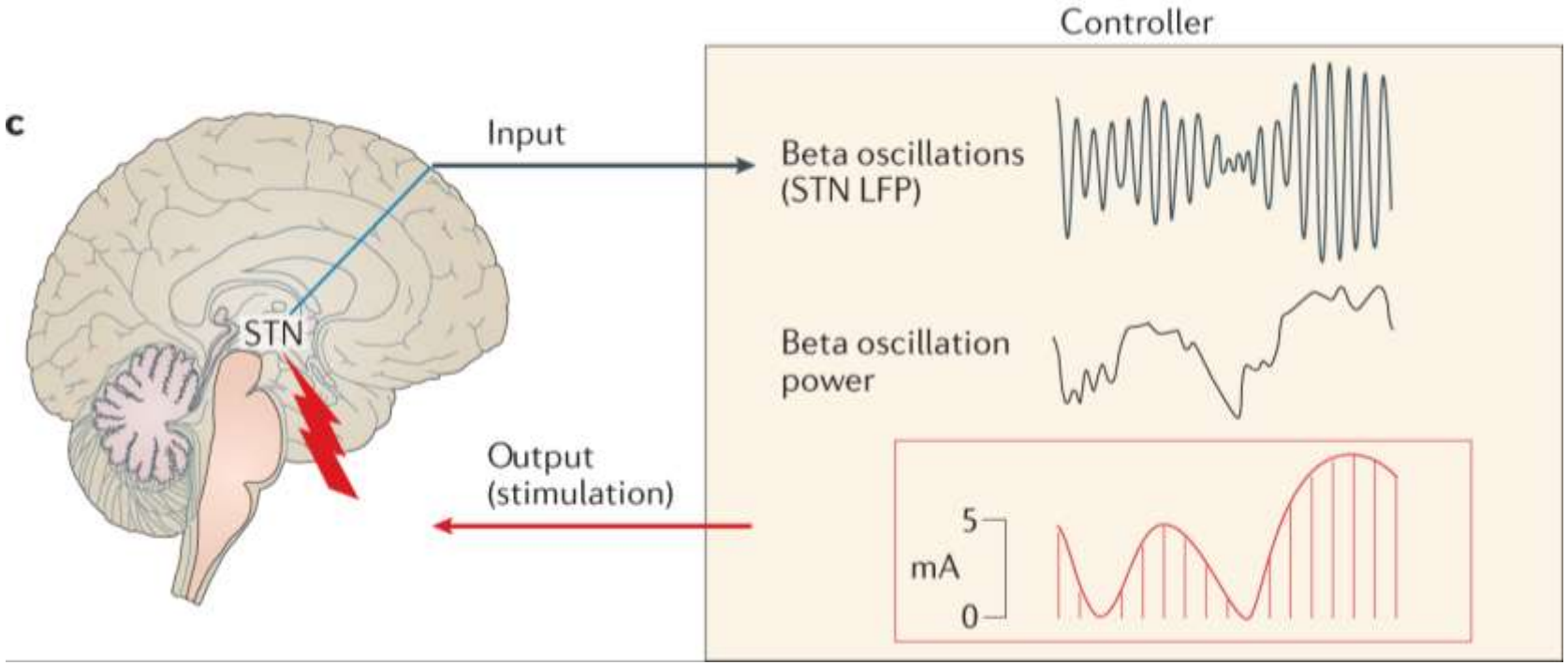
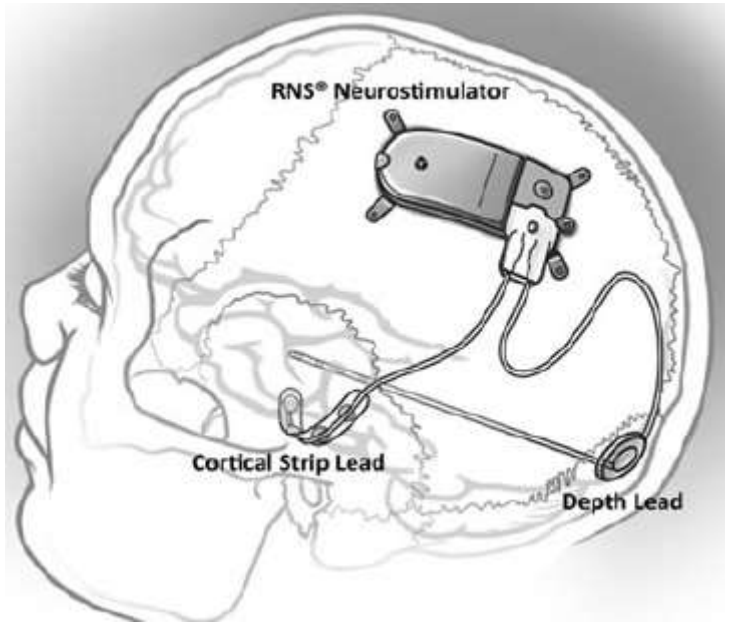
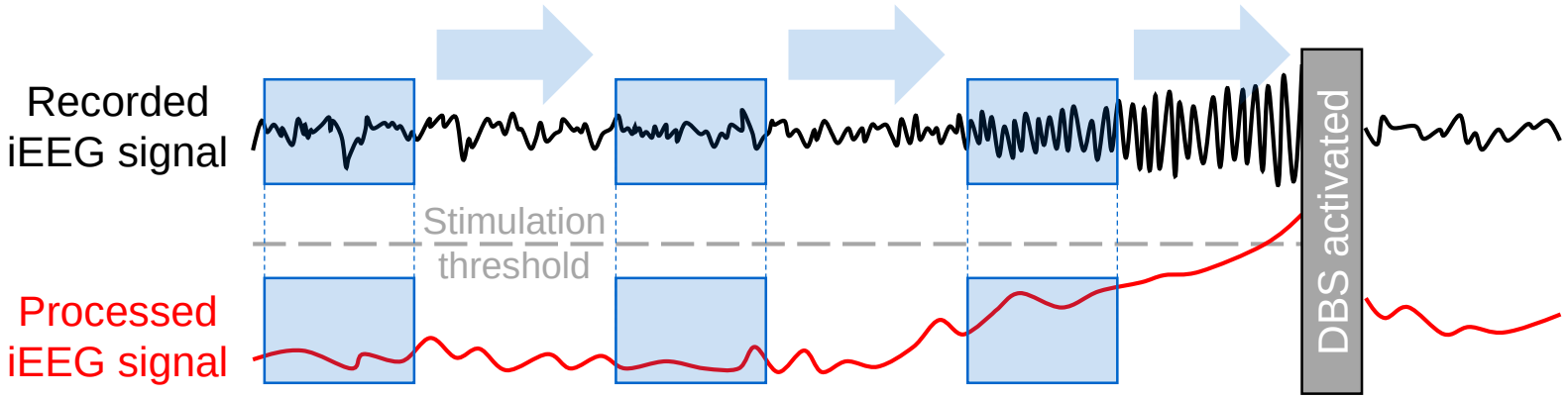



Bouthour et al., 2019

# Stimuler le cerveau

Le présent: détection et inter-ruption des crises épileptiques

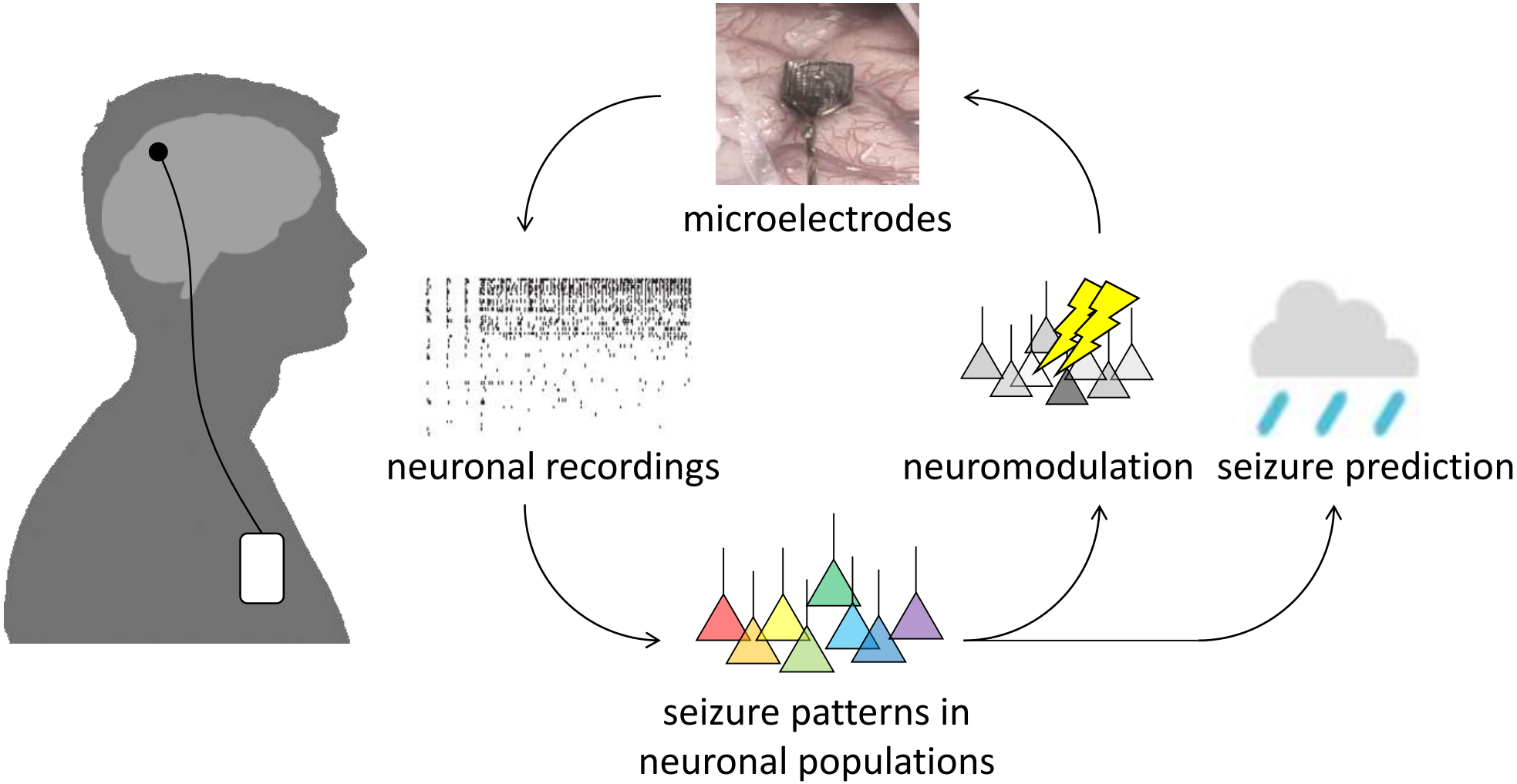


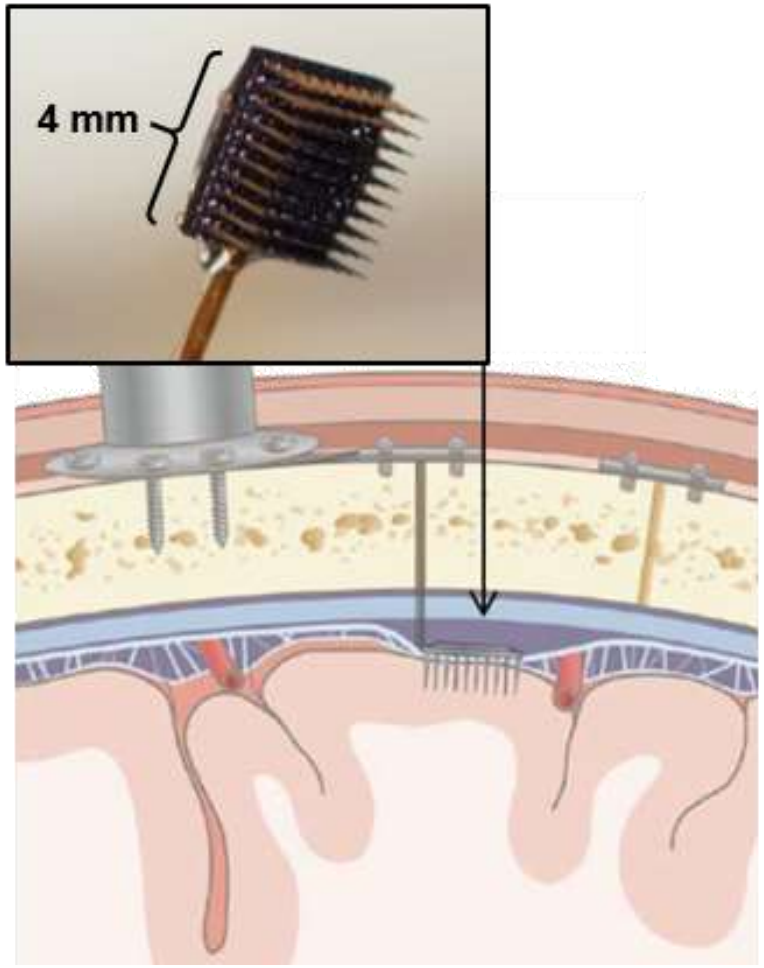

Bouthour et al., 2019; Neuropace.com

# Stimuler le cerveau

## Le futur?

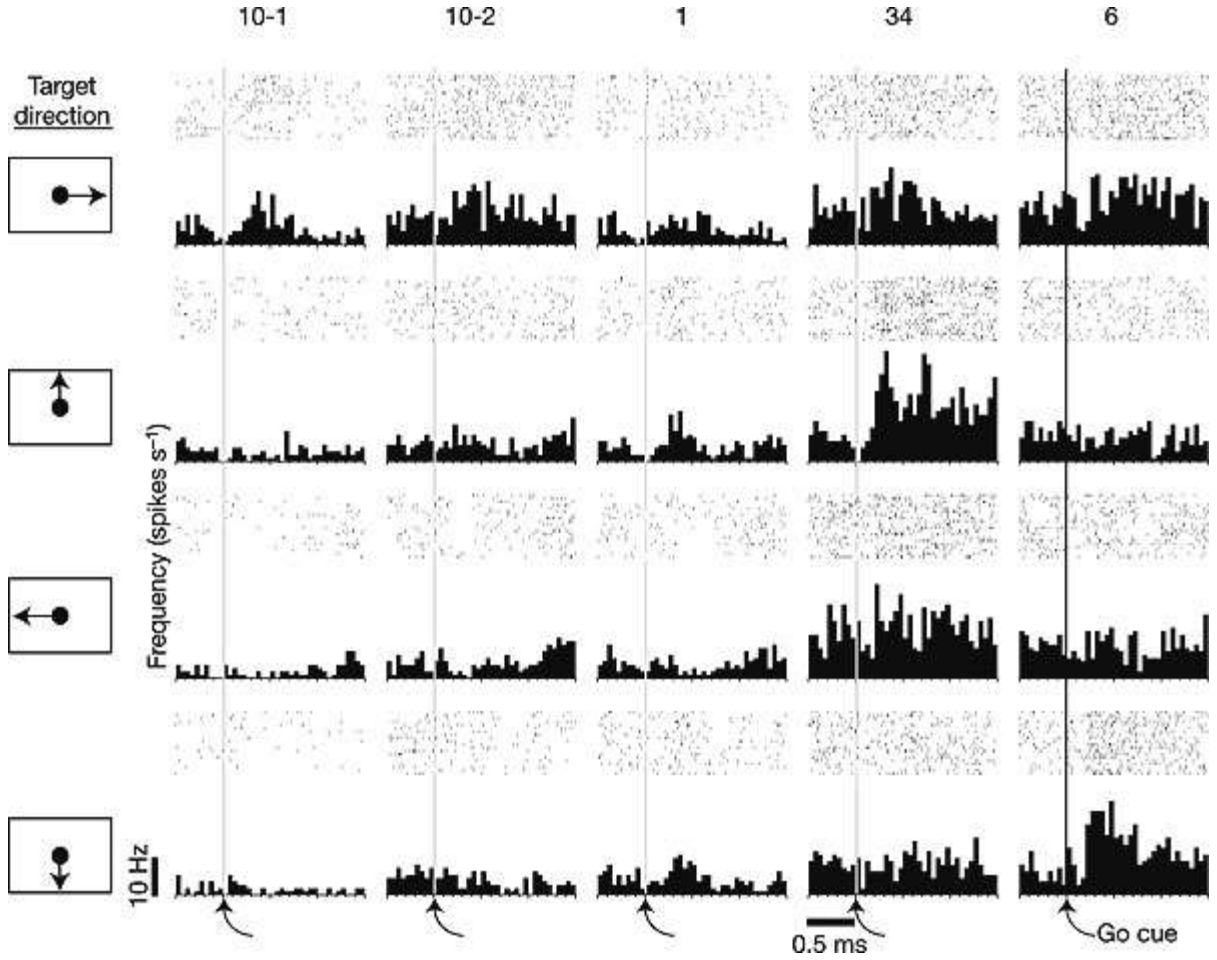


# Restaurer les mouvements

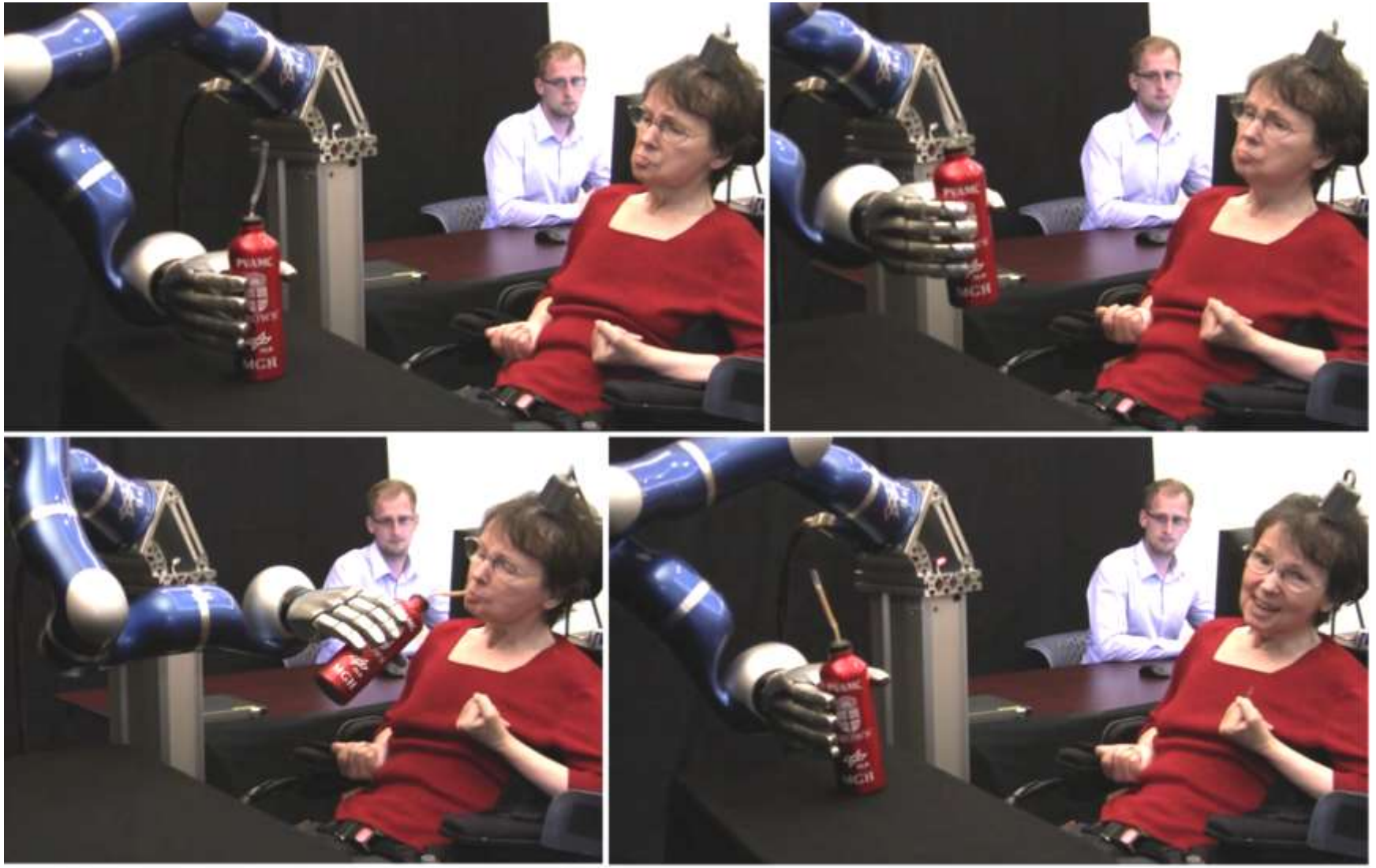

Hochberg et al., 2006; Mégevand et al., 2017

# Restaurer les mouvements

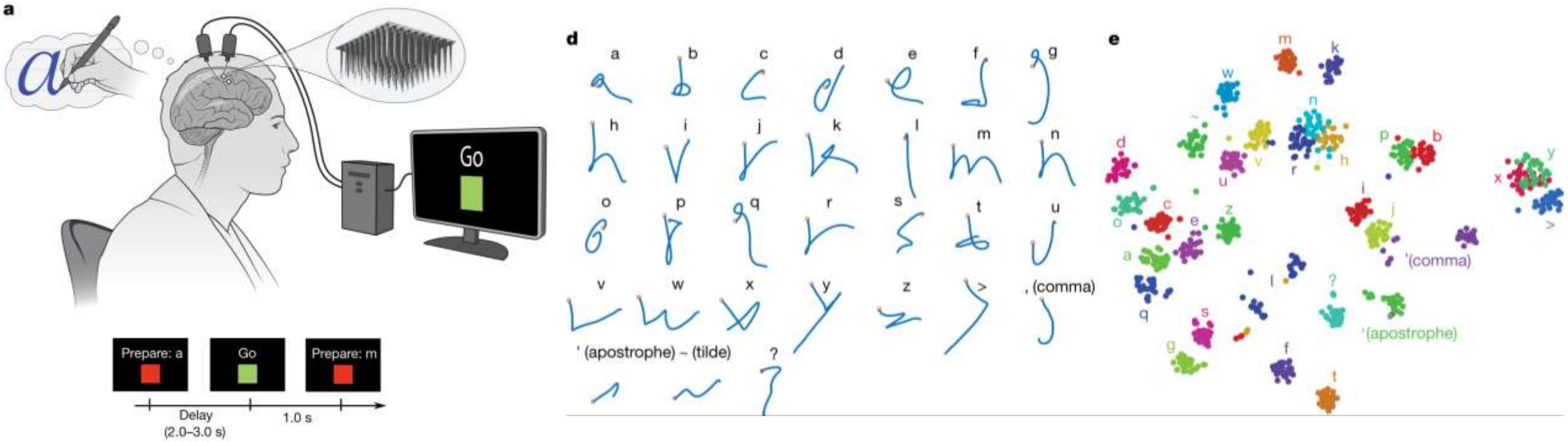

Hochberg et al., 2006

# Restaurer les mouvements



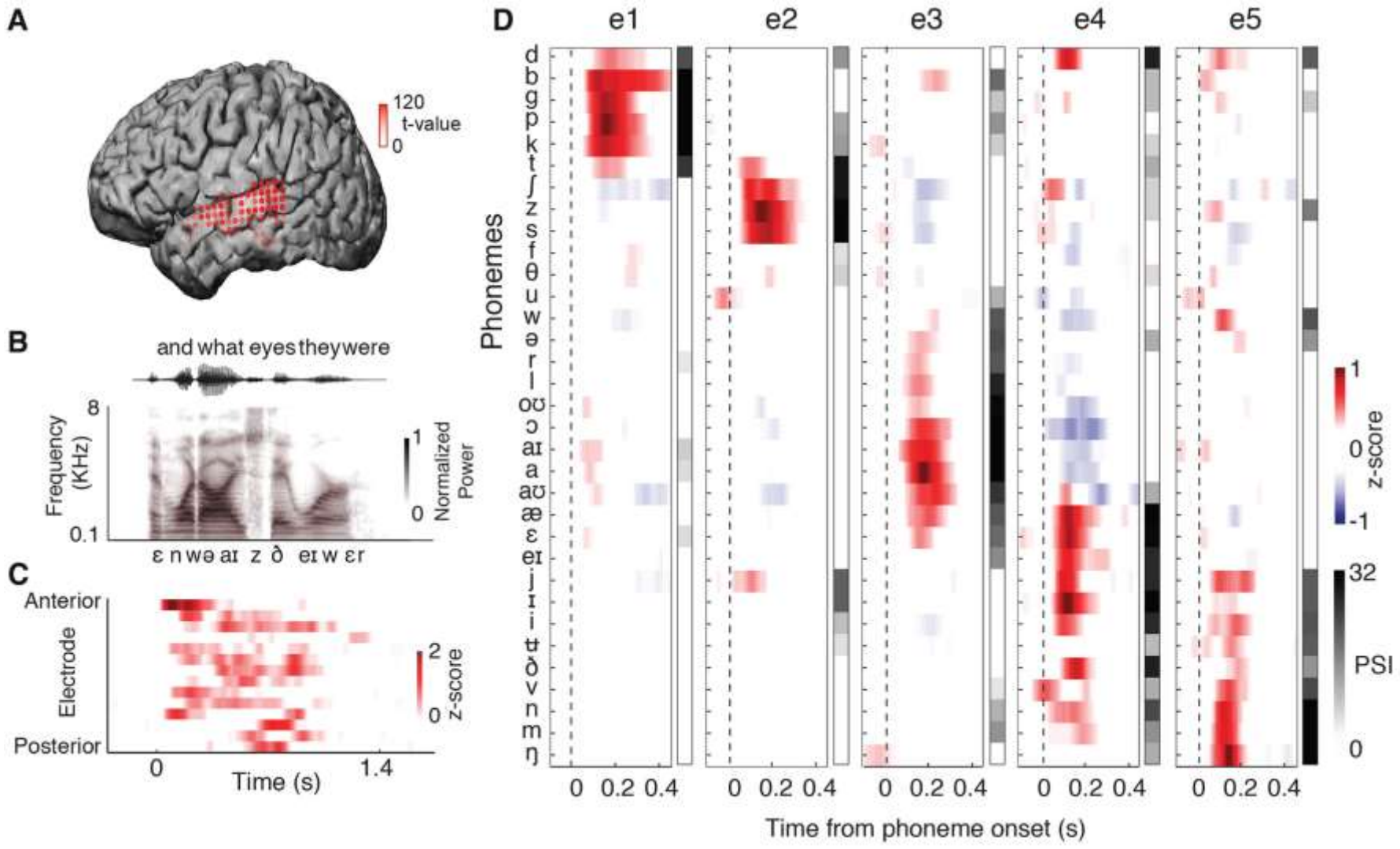
Hochberg et al., 2012

# Restaurer les mouvements



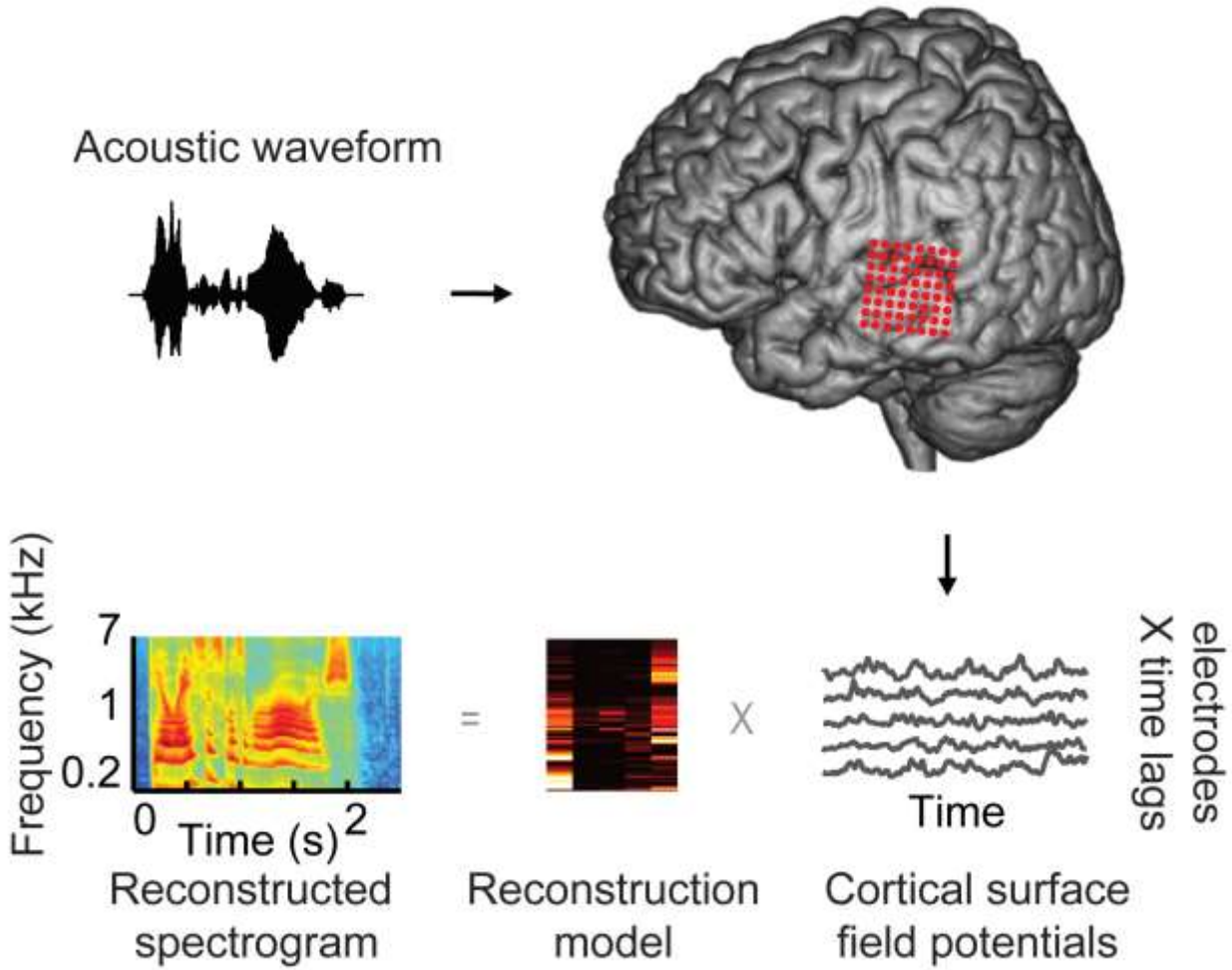

Willett et al., 2021

# Restaurer la parole



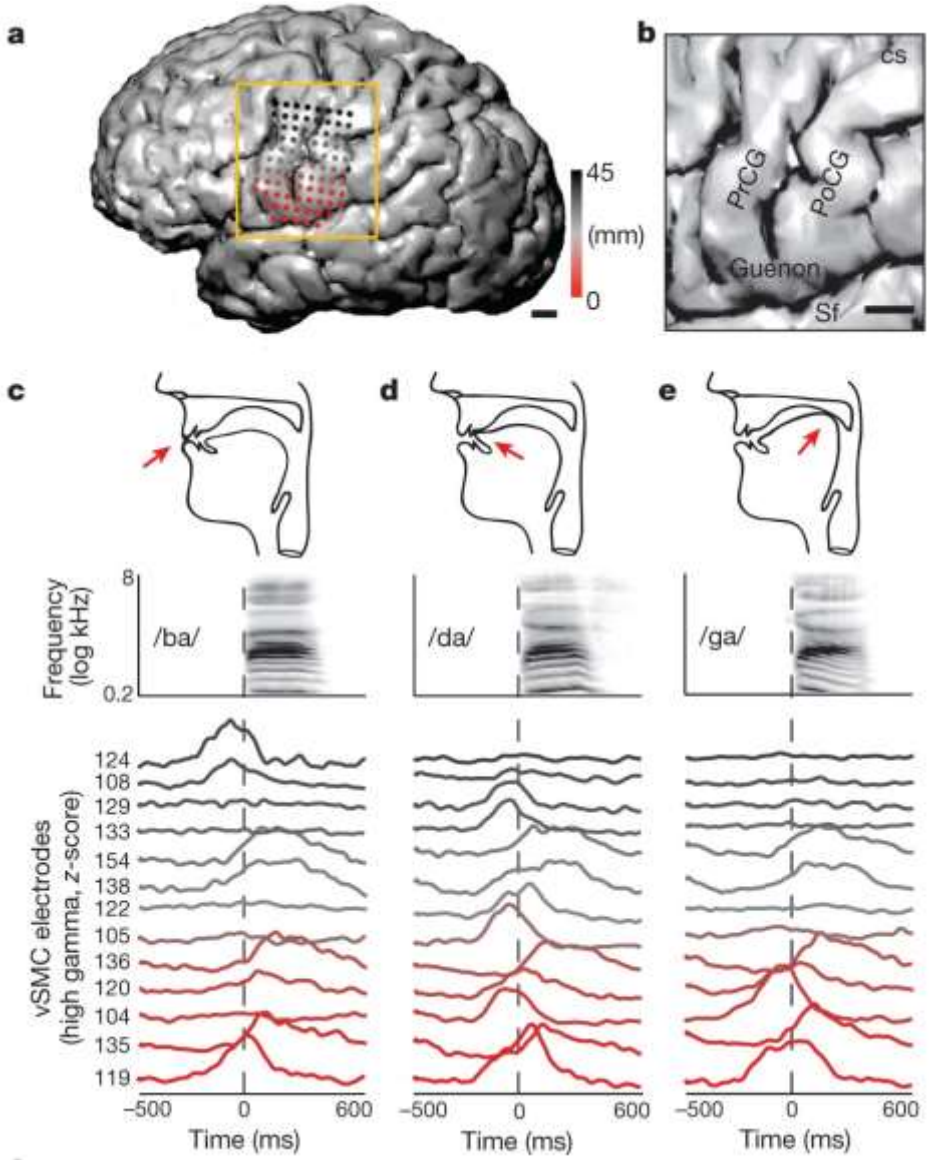

Mesgarani et al., 2014

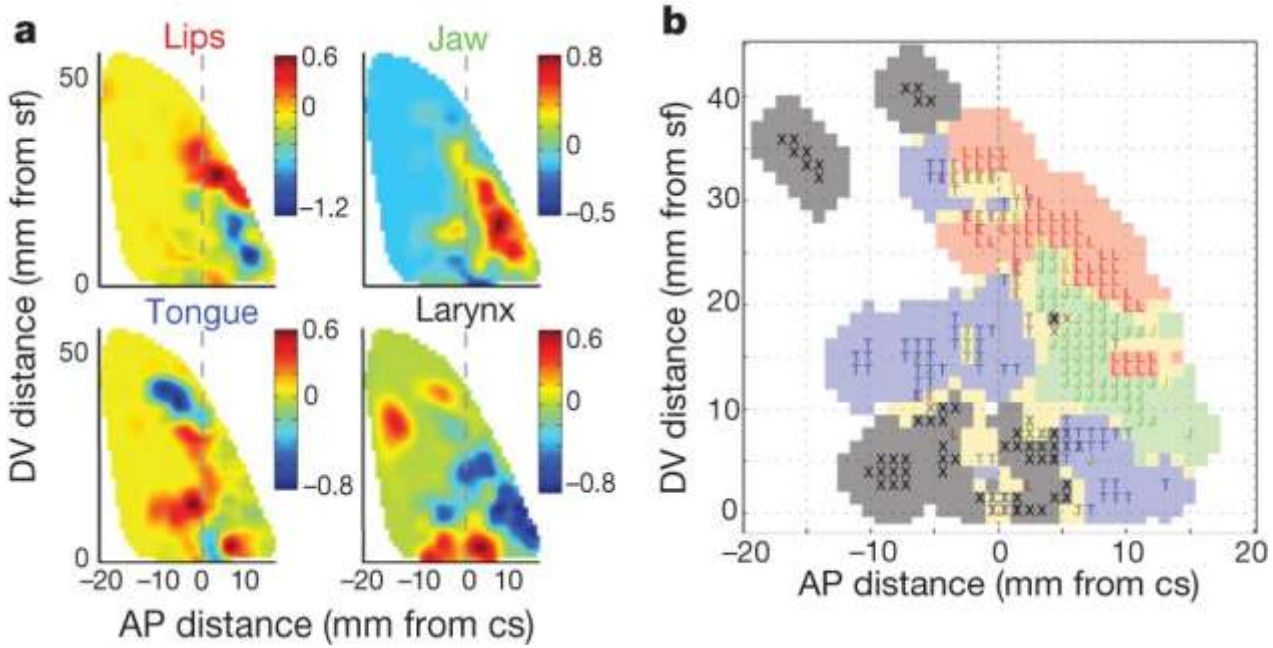
# Restaurer la parole




Pasley et al., 2012

# Restaurer la parole




Bouchard et al., 2013

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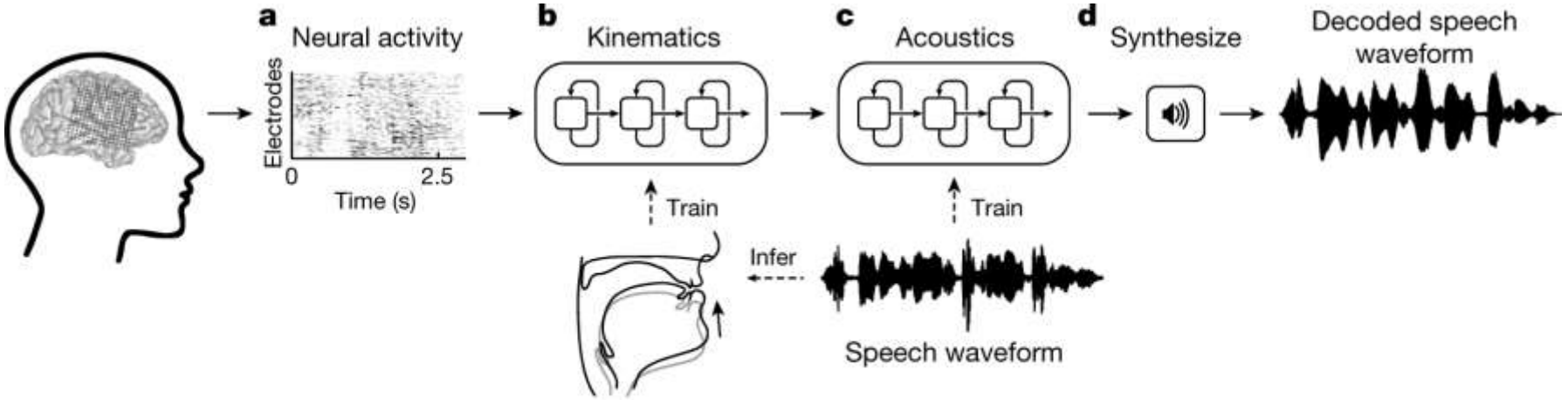
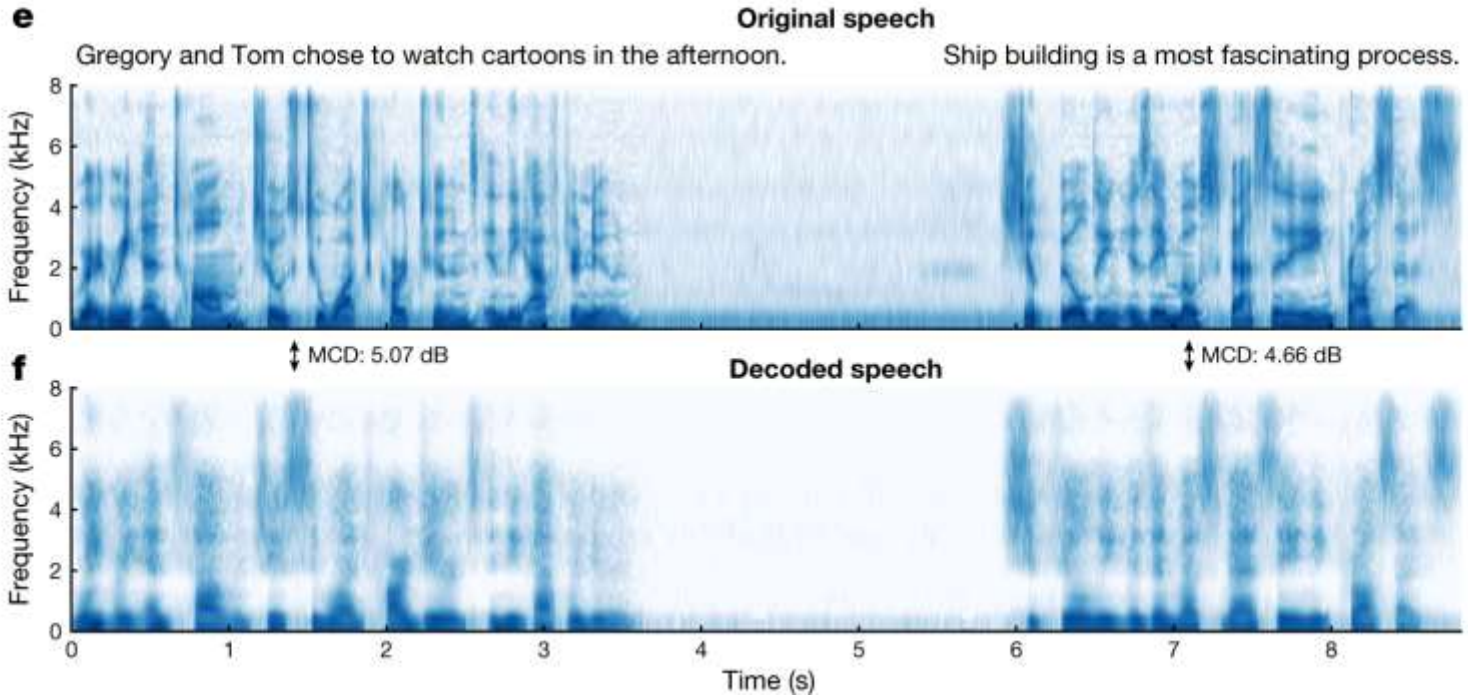
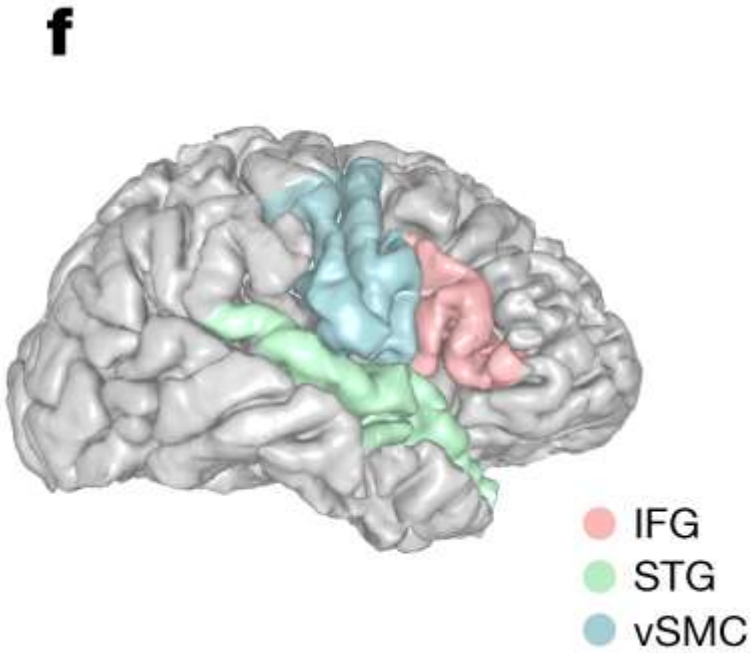
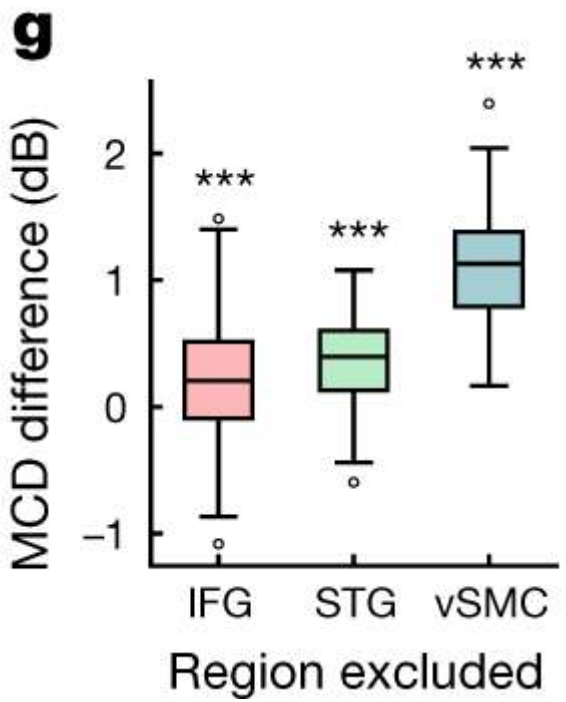


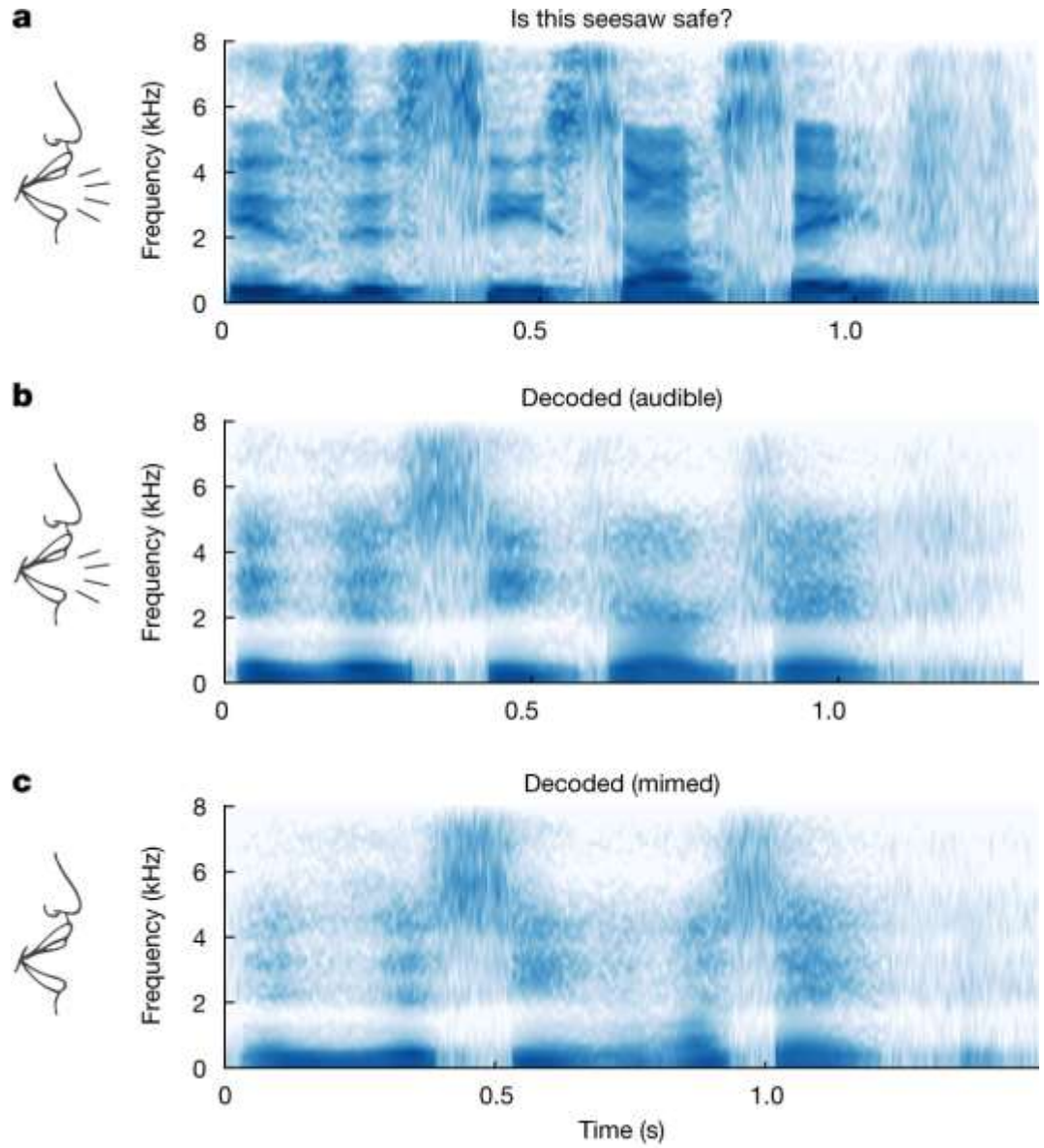




Arumanchipalli et al., 2019

# Restaurer la parole




Arumanchipalli et al., 2019

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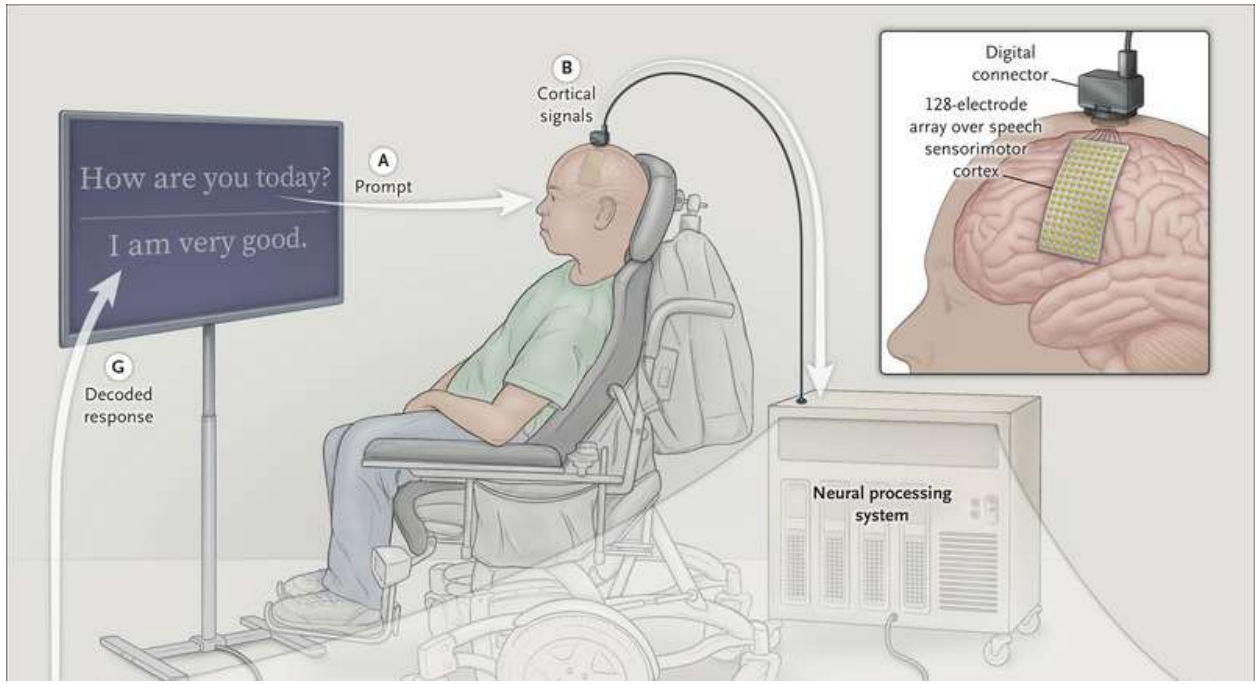
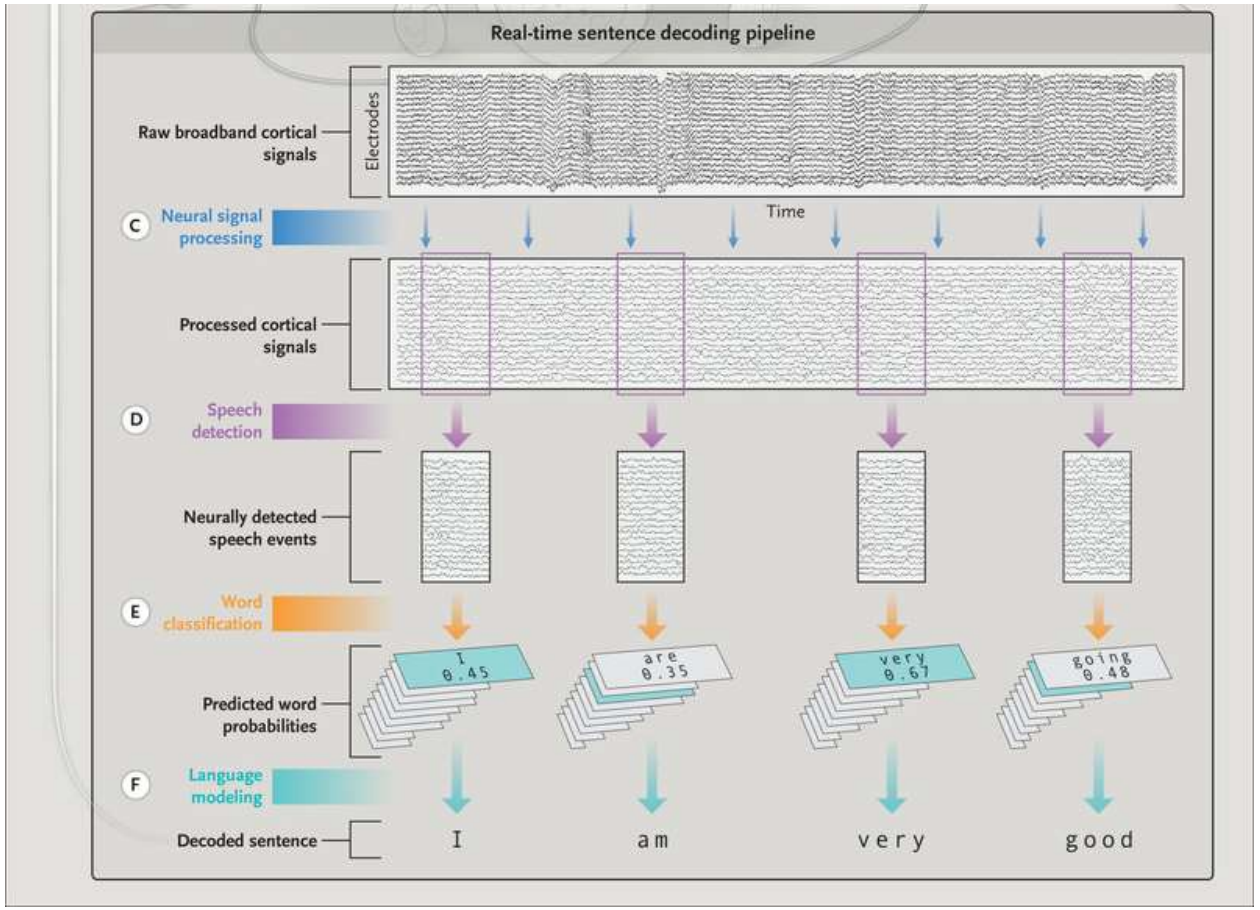
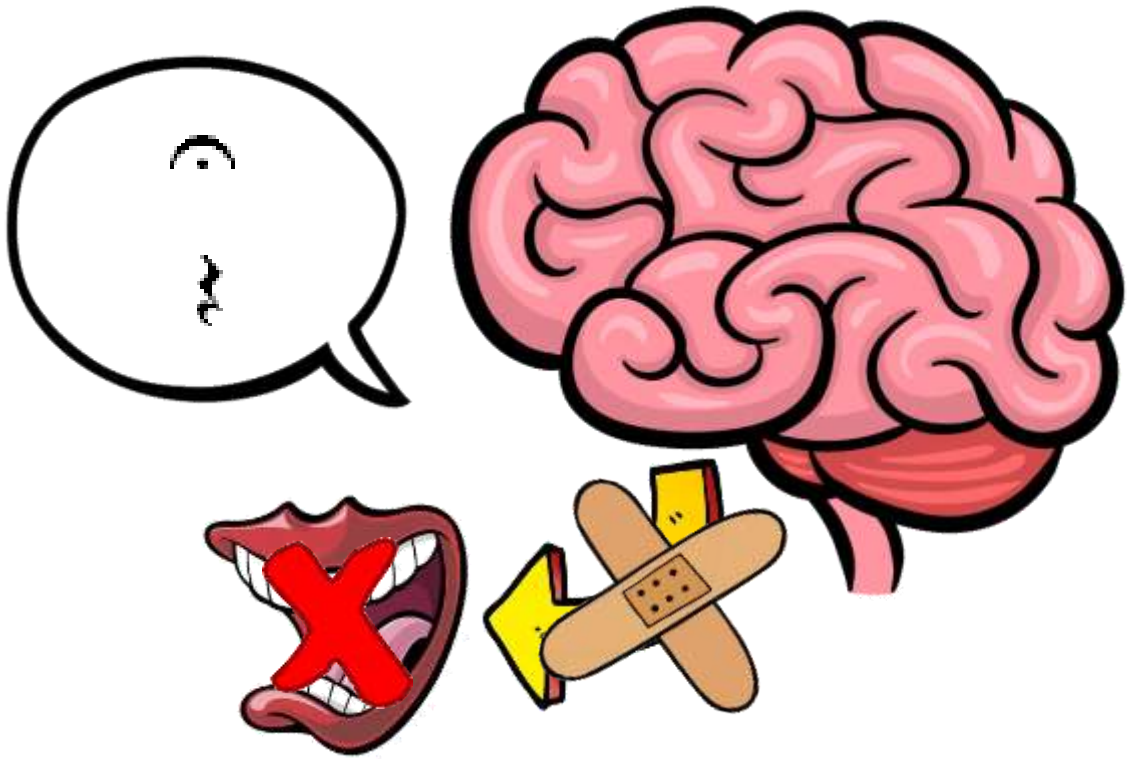



Moses et al., 2021

# Restaurer le langage?



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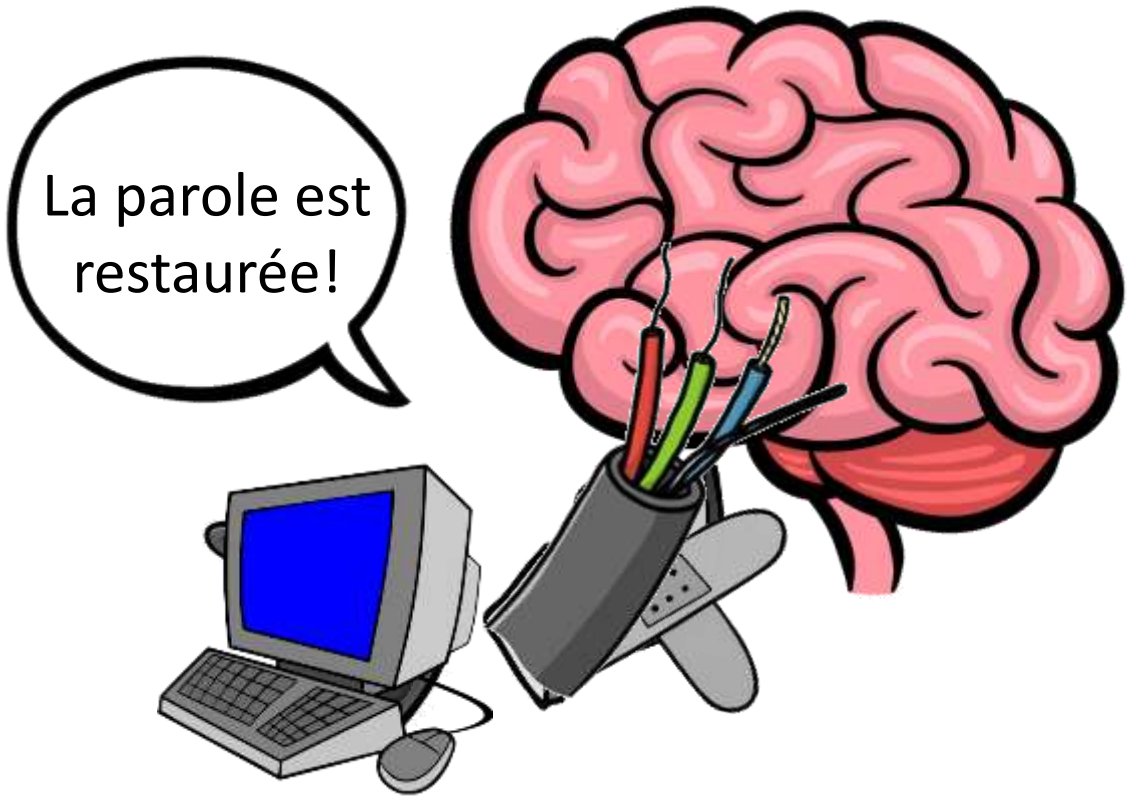

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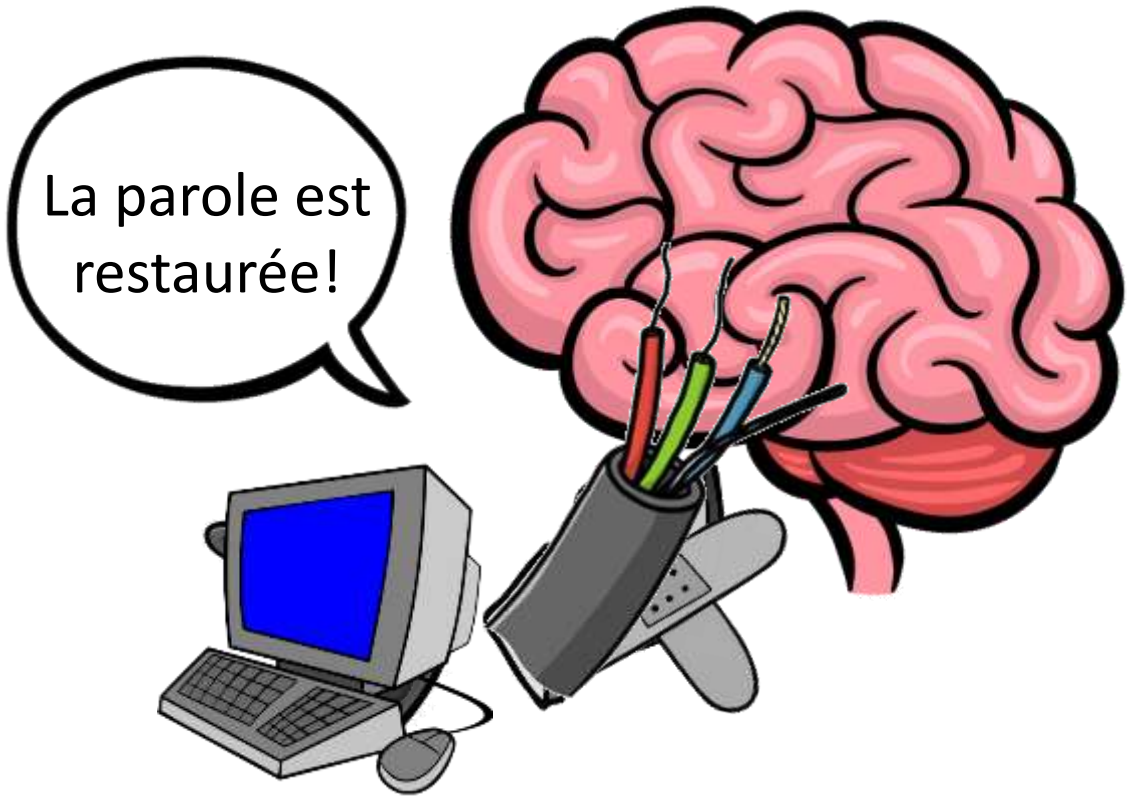


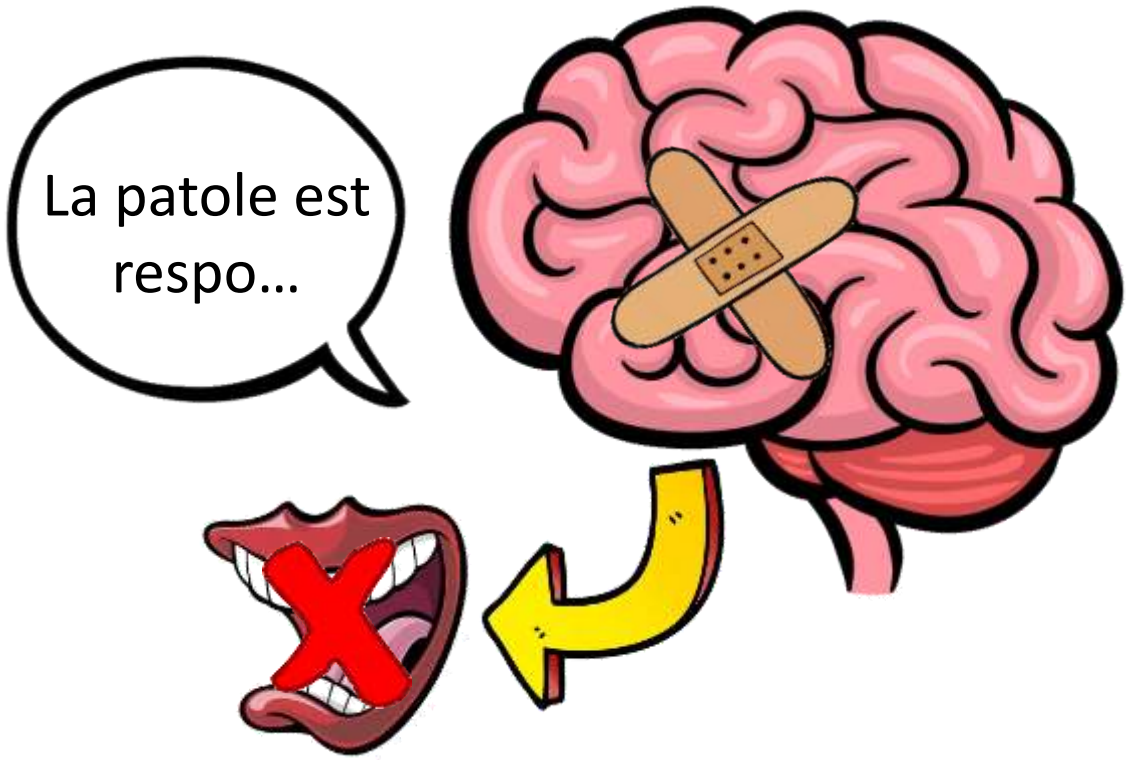

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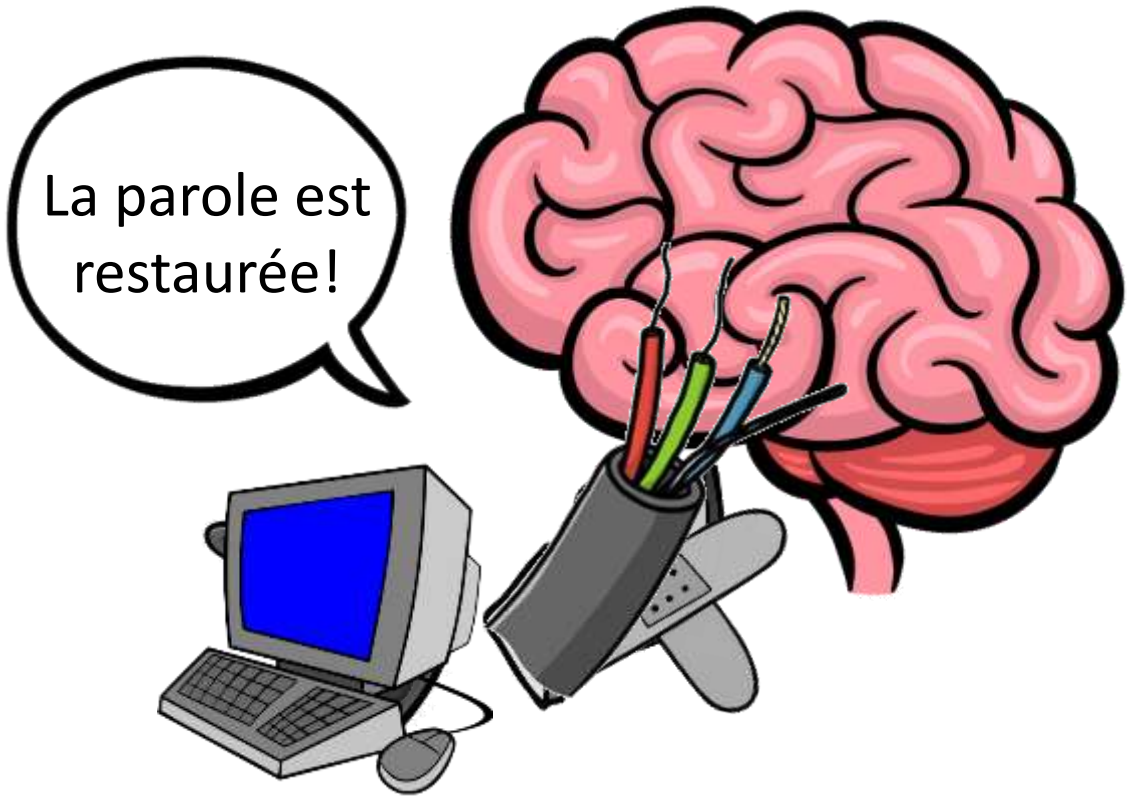


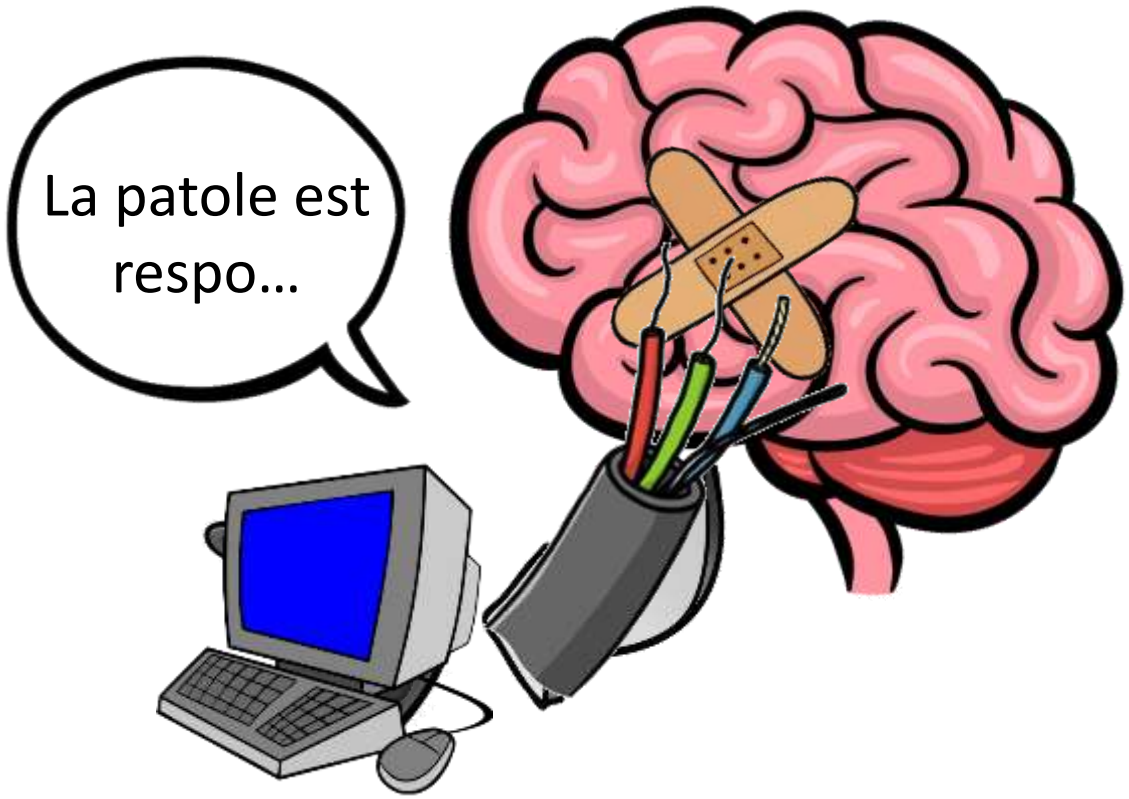

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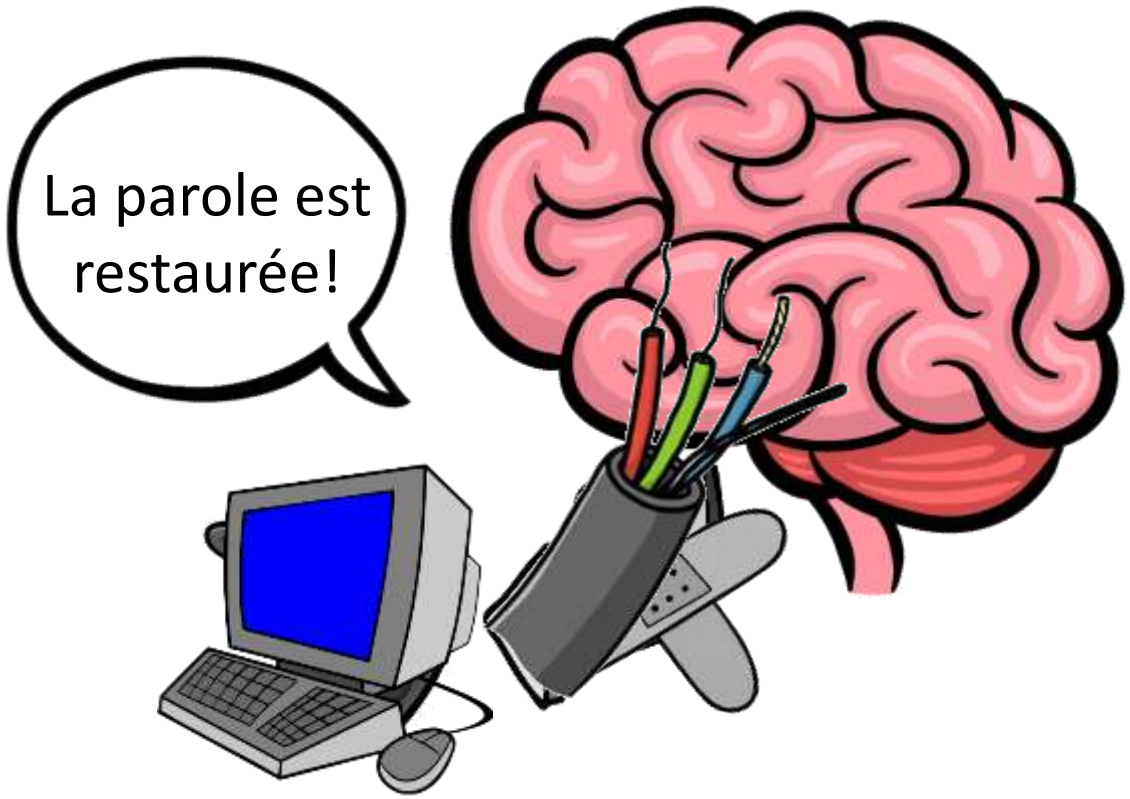
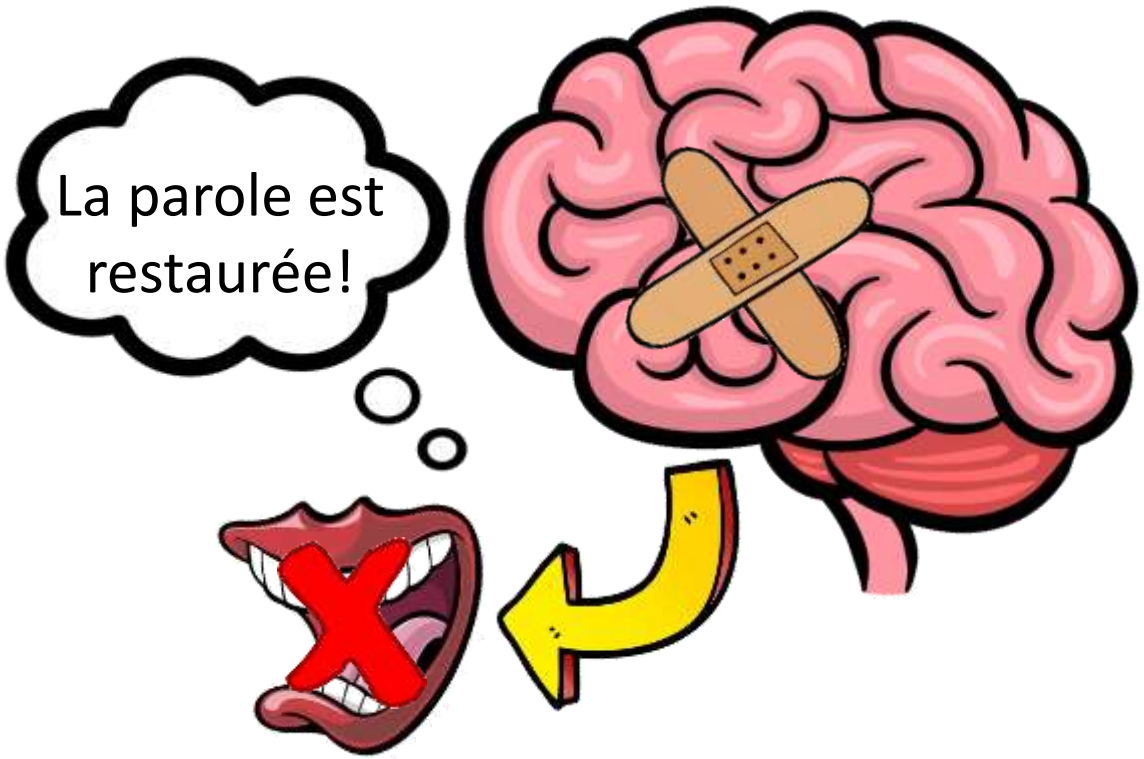
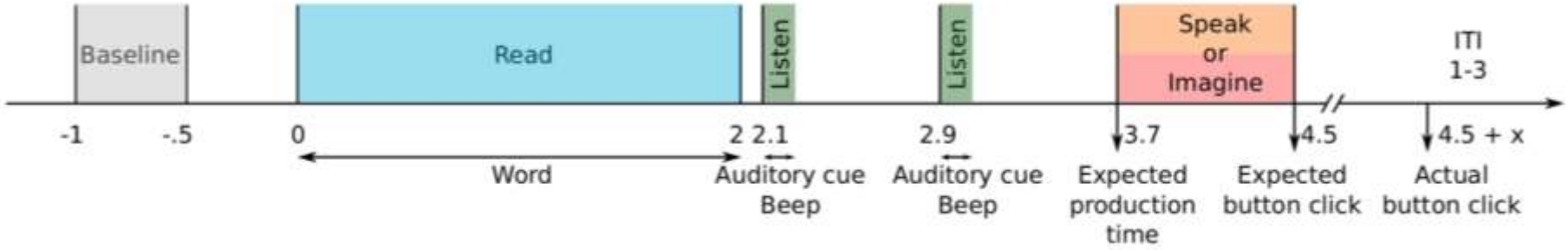
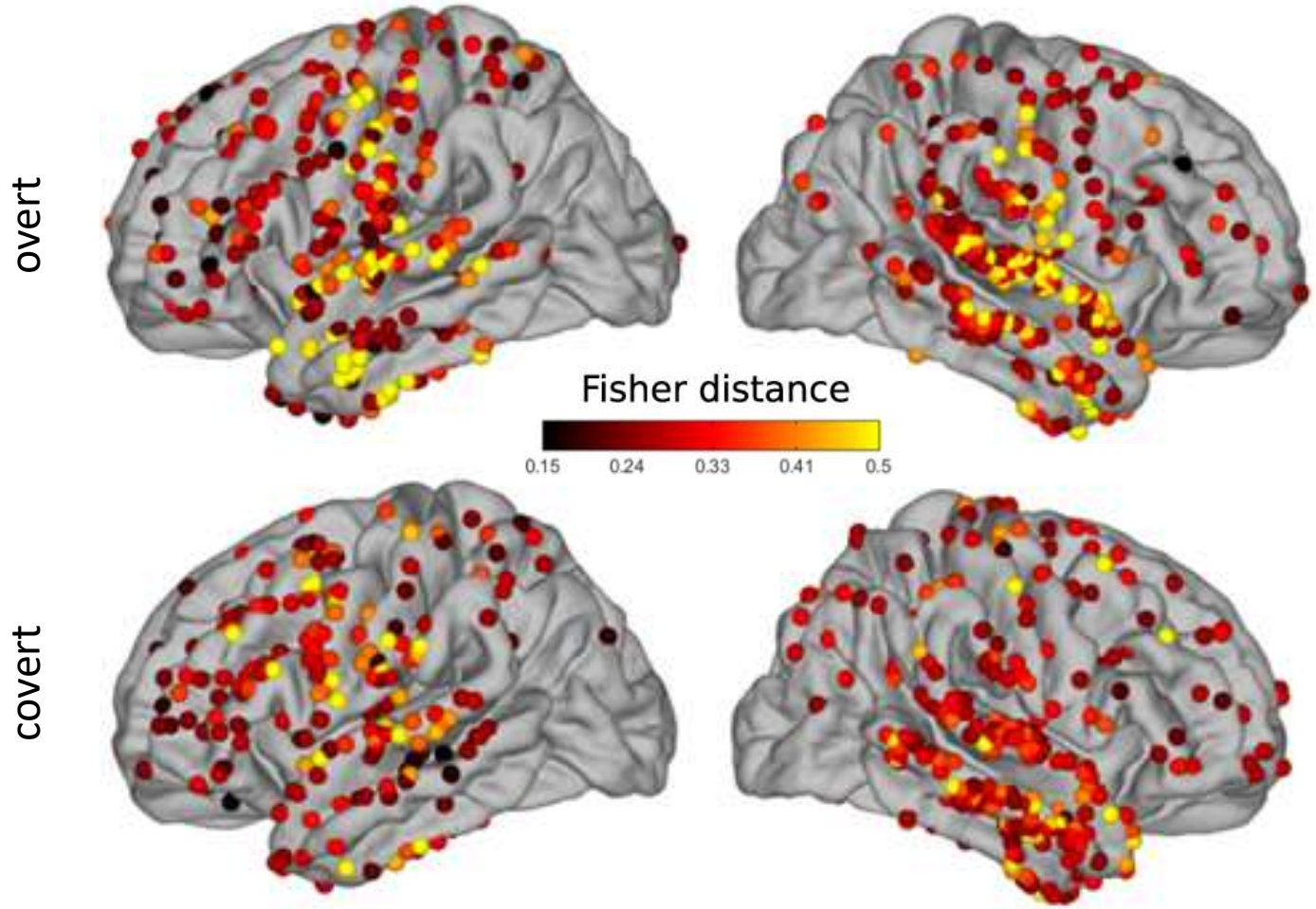



Fama et al., 2017

# Restaurer le langage?

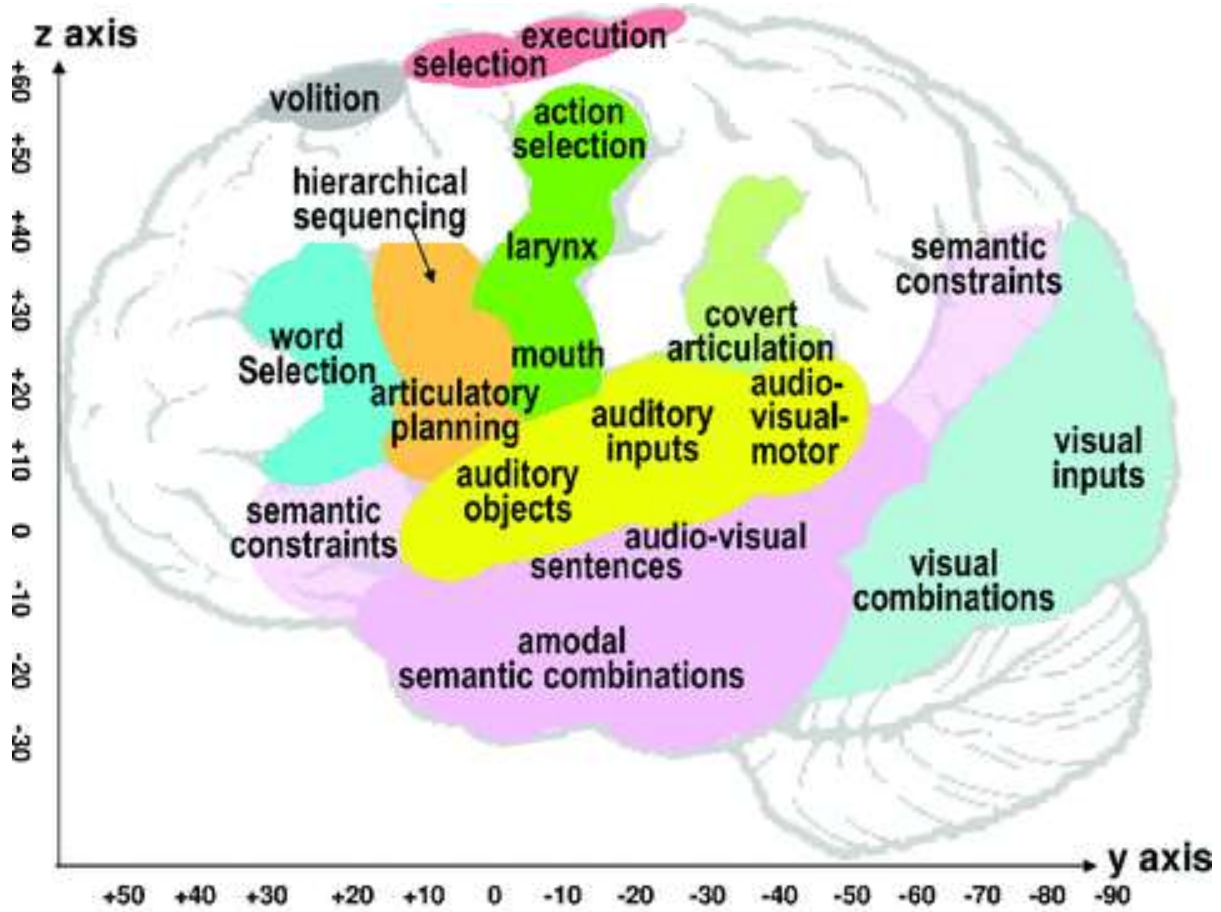



Proix et al., 2022

# Pourquoi pas déjà maintenant?

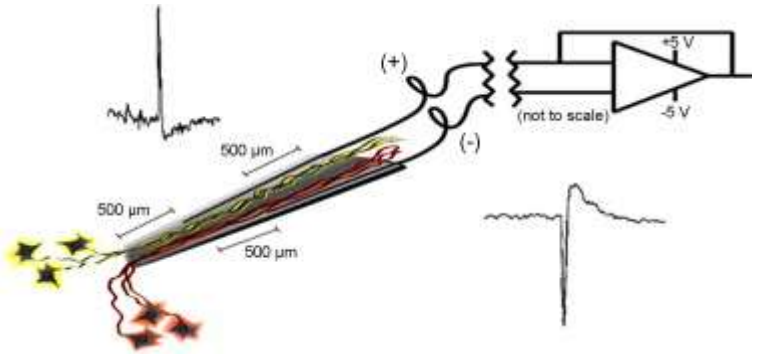
**C’est compliqué!**

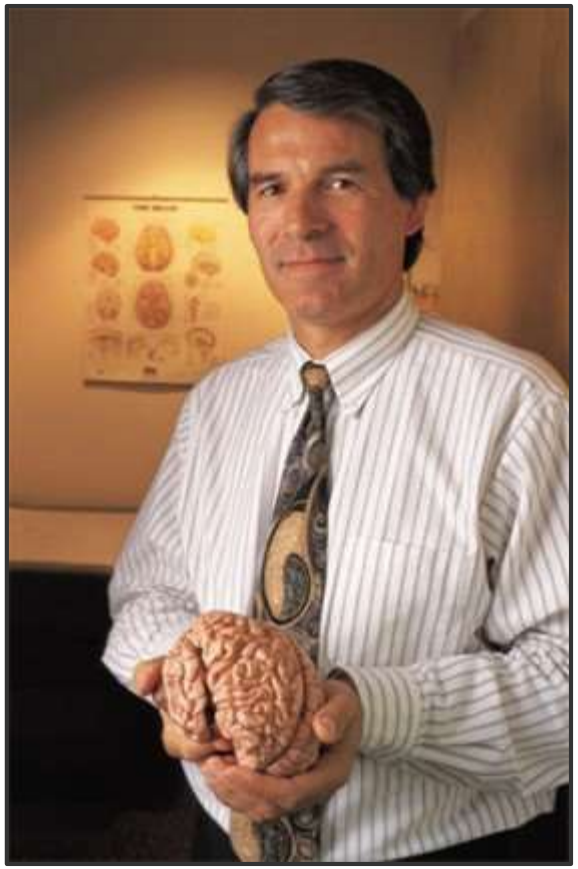


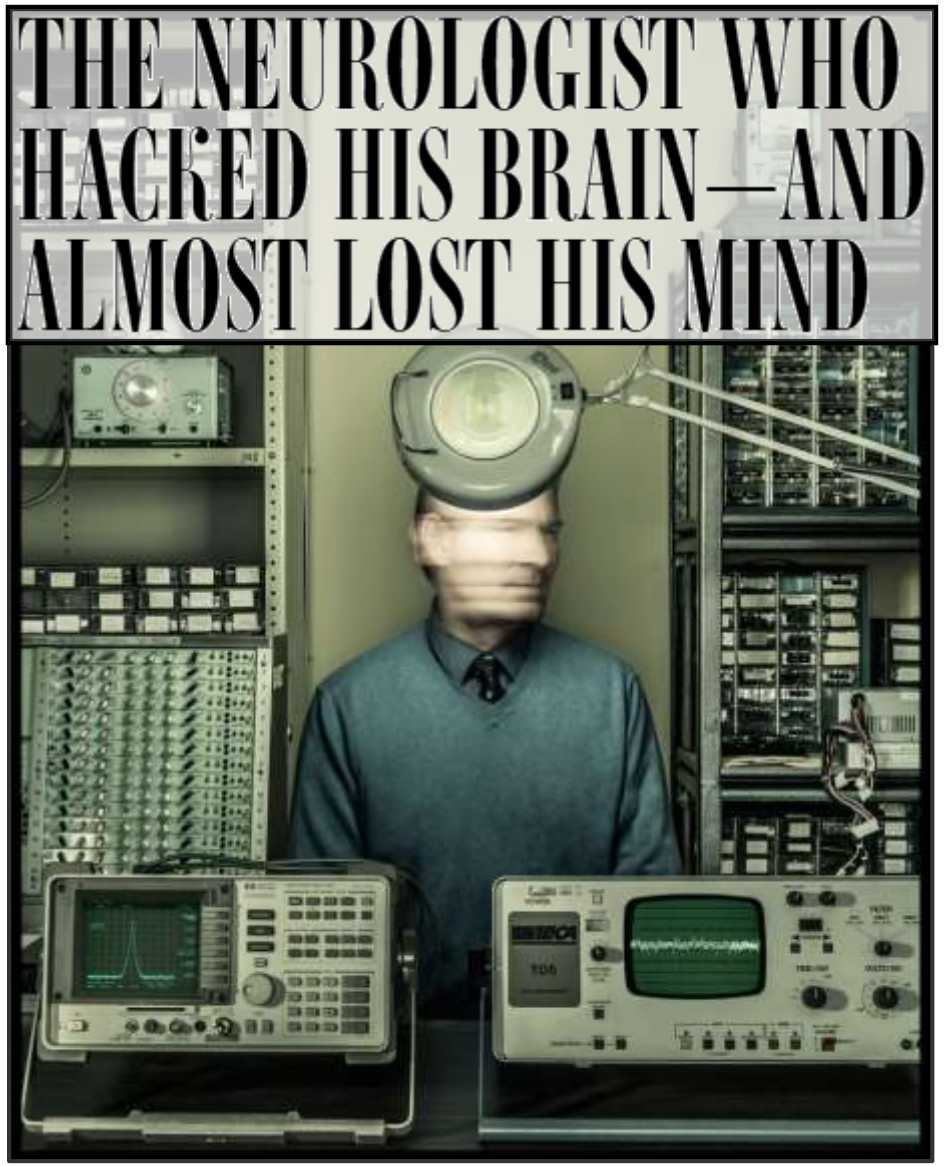

Price, 2010

# Pourquoi pas déjà maintenant?

**C’est risqué!**



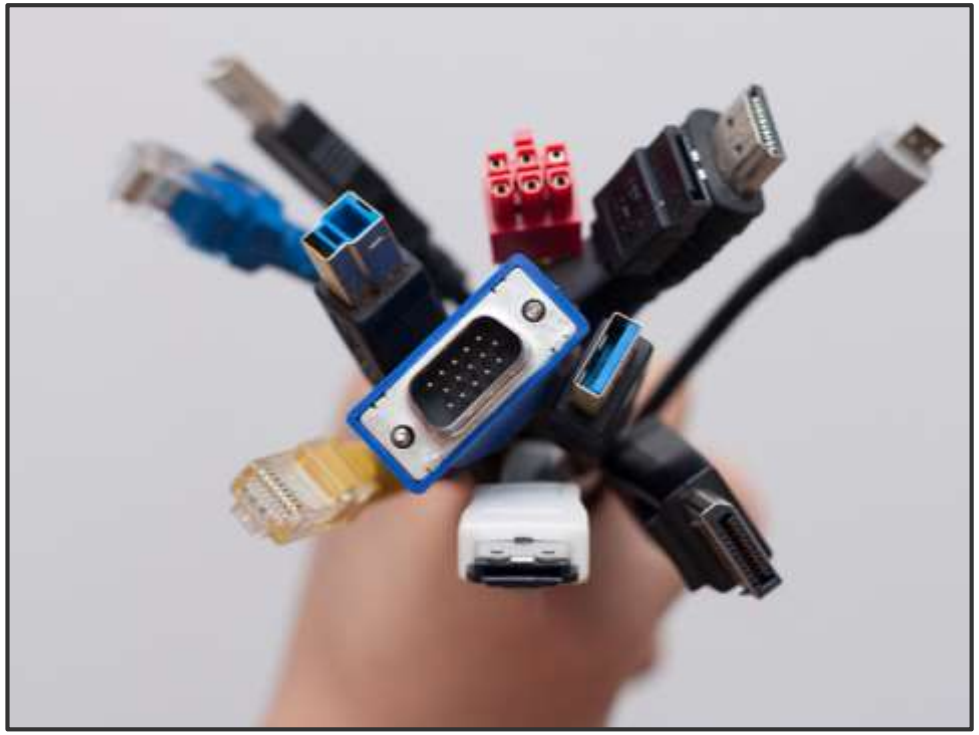






Bartels et al., 2008; MIT Technology Review, 2015; Wired, 2016

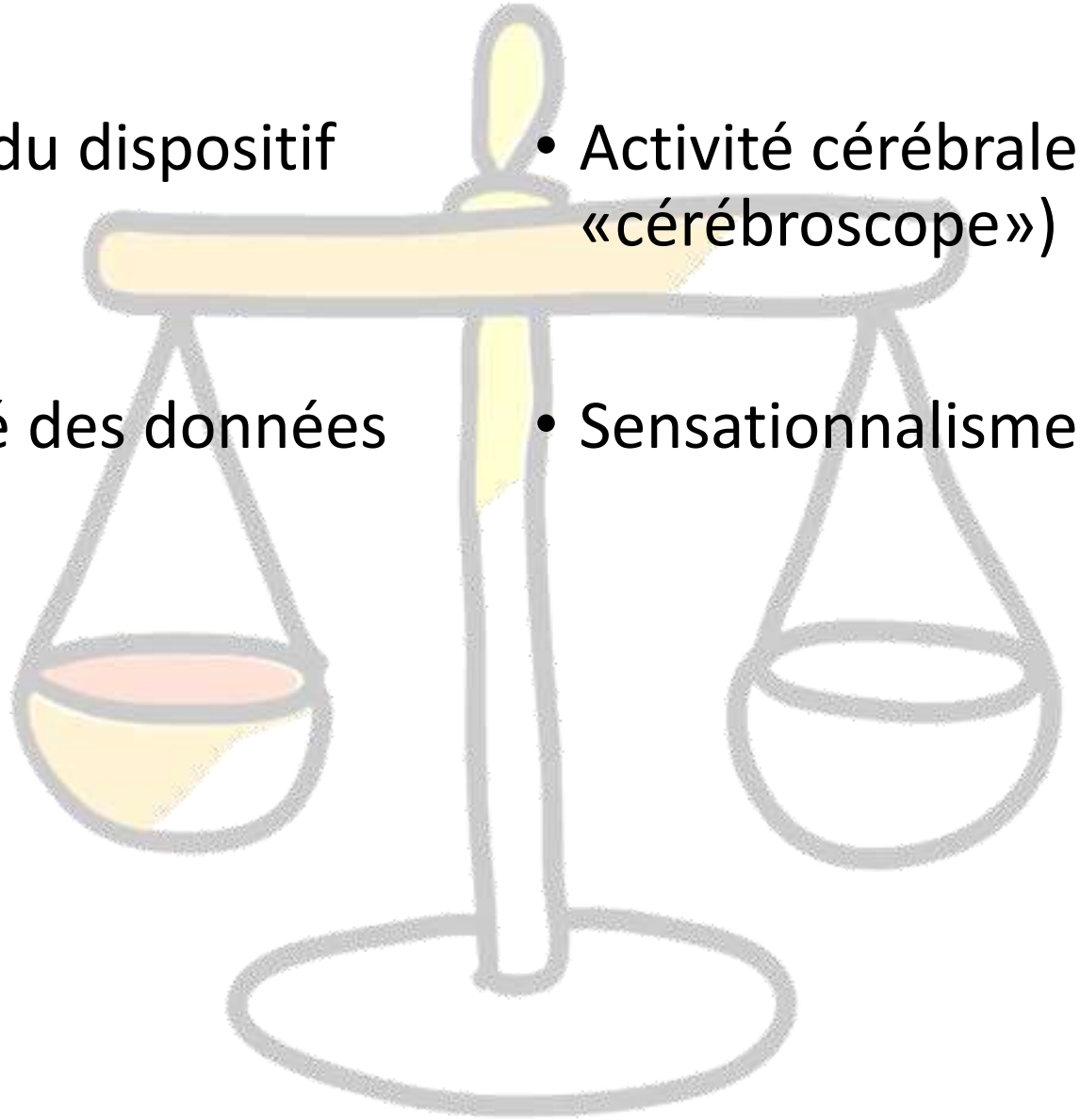
# Pourquoi pas déjà maintenant?

## Le maillon faible



# Enjeux éthiques

- Contrôle et fiabilité du dispositif
- Sécurité et propriété des données
- Activité cérébrale et identité (le «cérébroscope»)
- Sensationnalisme et faux espoirs



Rainey et al., 2019, 2020

# Merci de votre attention!

Silvia Marchesotti
Timothée Proix
Luc Arnal
Anne-Lise Giraud

Jonathan Monney
Lora Fanda
Fiorenzo Artoni


Laurent Spinelli
Serge Vulliémoz
Margitta Seeck

Shahan Momjian

Questions, commentaires: pierre.megevand@unige.ch @labneuron

Illustration: Backyardbrains.com