BCI 기술의 현재와 미래

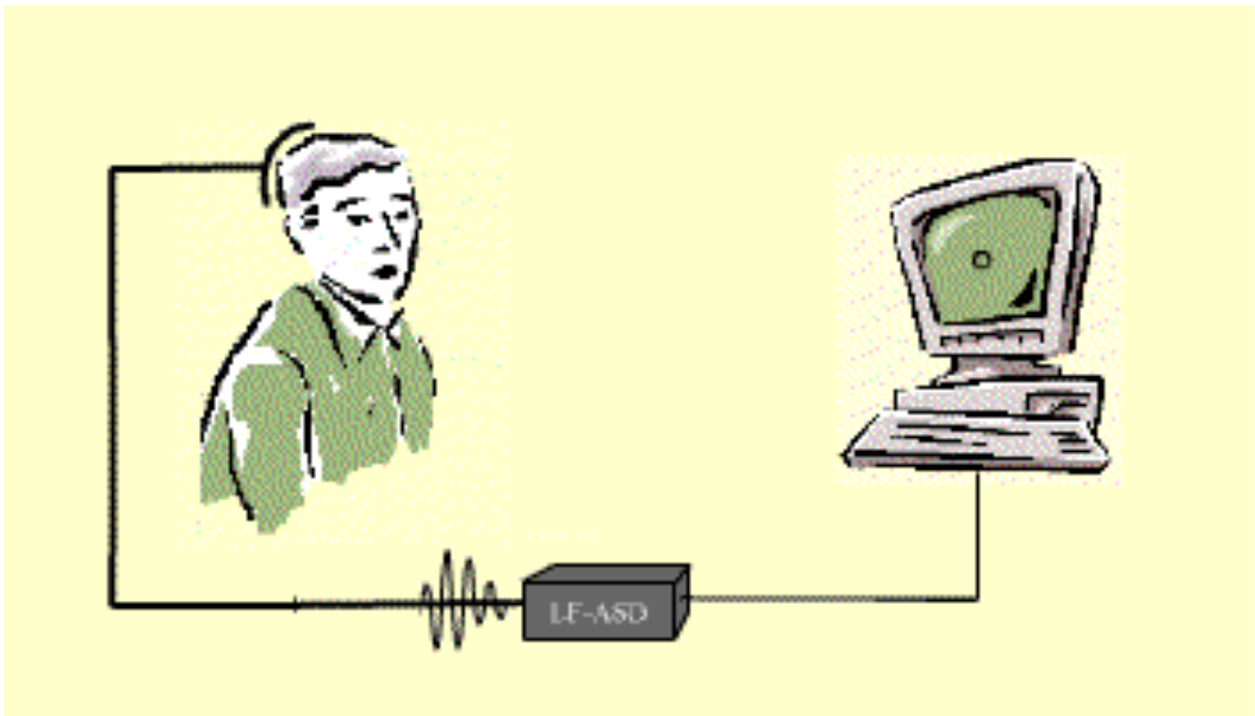
김성필

UNIST 바이오메디컬공학과

뇌와 컴퓨터를 연결해 주는 기술

뇌-컴퓨터 인터페이스

Brain-Computer Interface (BCI)



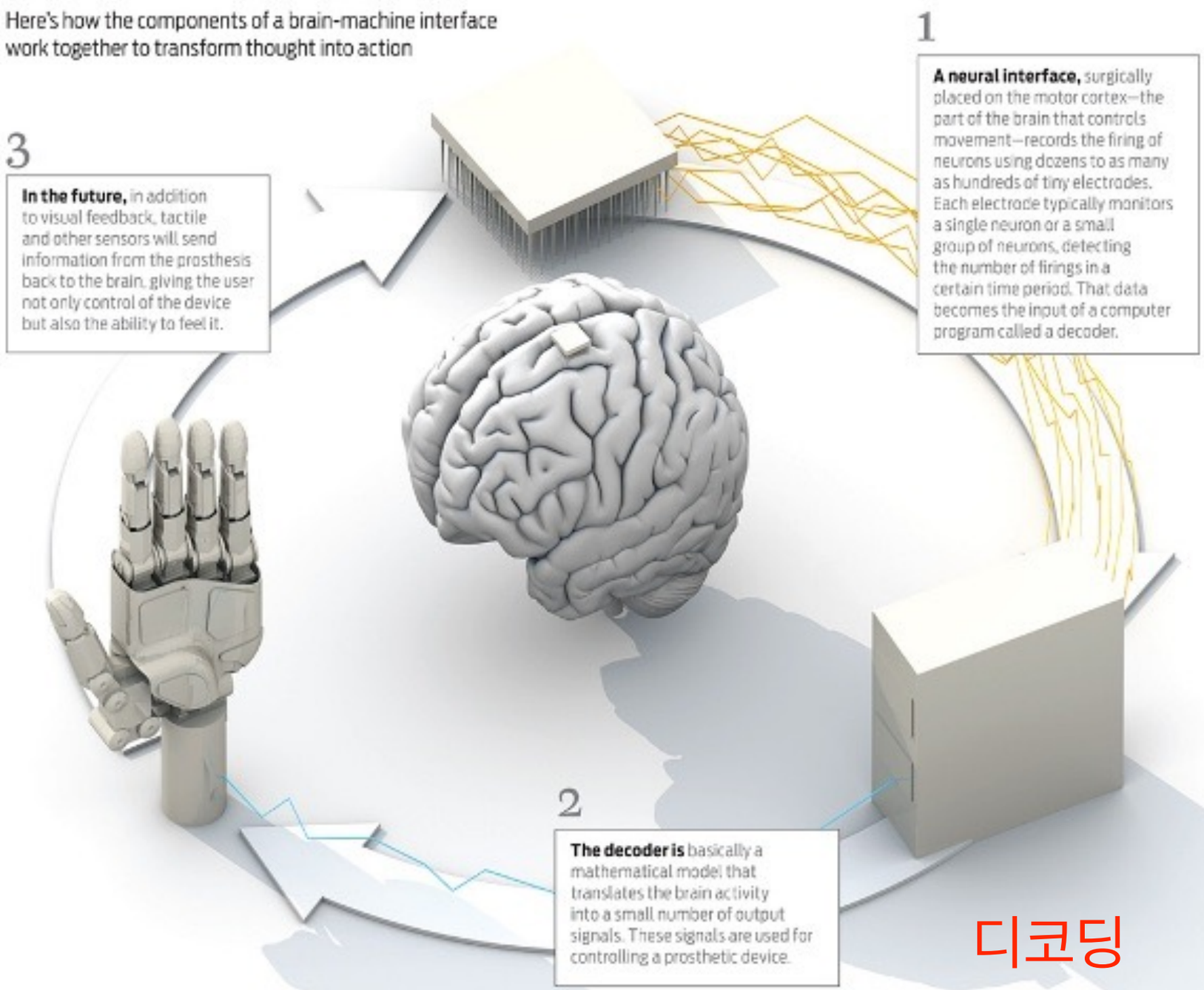
The Diving Bell and the Butterfly

- Jean-Dominique Bauby, France
- Paralyzed by stroke
- Written by blinking the left eye
- It took about 200,000 blinks to write the book

“I decided to stop pitying myself. Other than my eye, two things aren't paralyzed, my imagination and my memory.”

– Jean-Dominique Bauby

뇌-컴퓨터 연결에 필요한 기본 요소



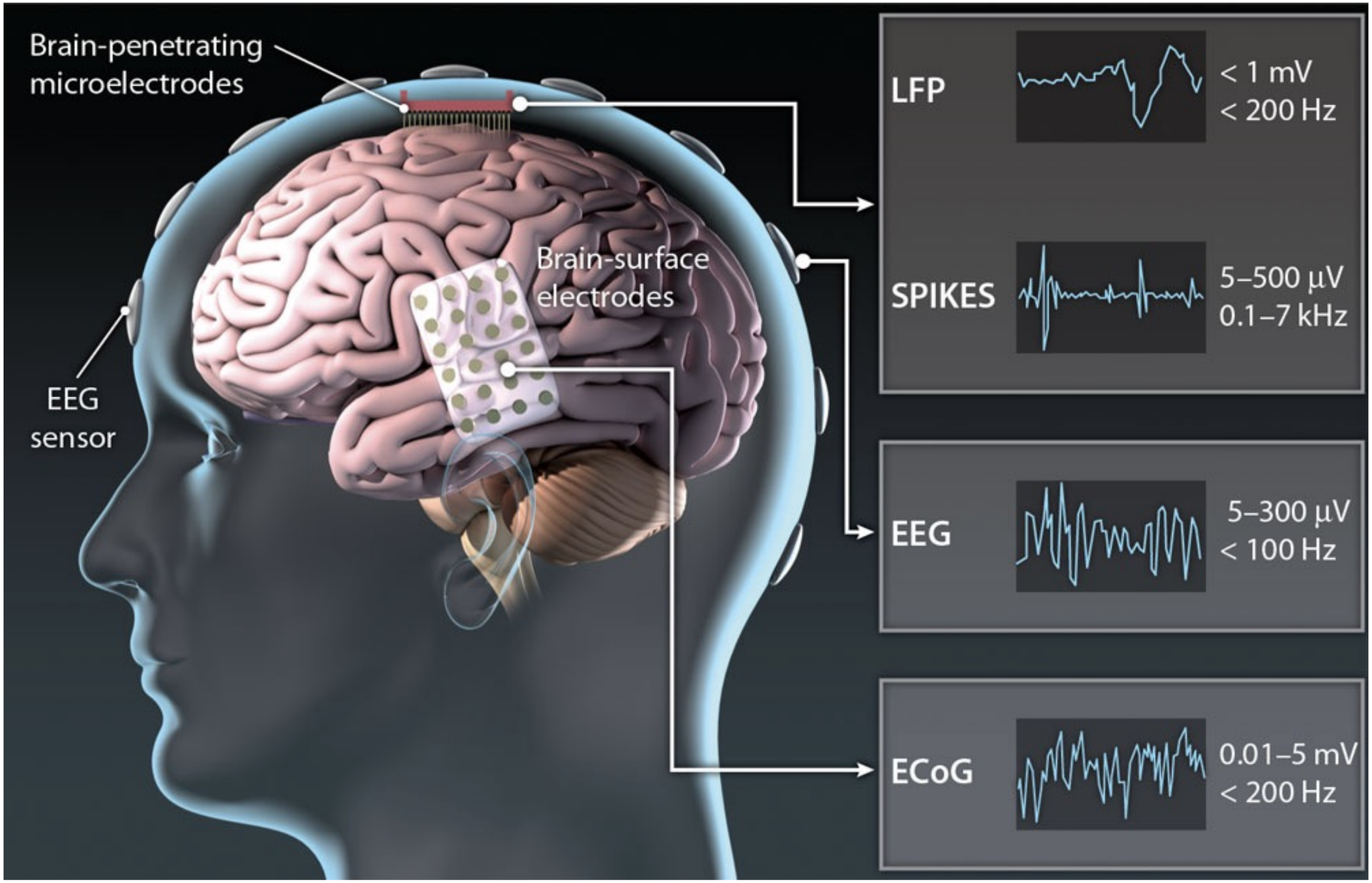
센싱

컨트롤

디코딩

Biosignal Lab,
Univ Patras

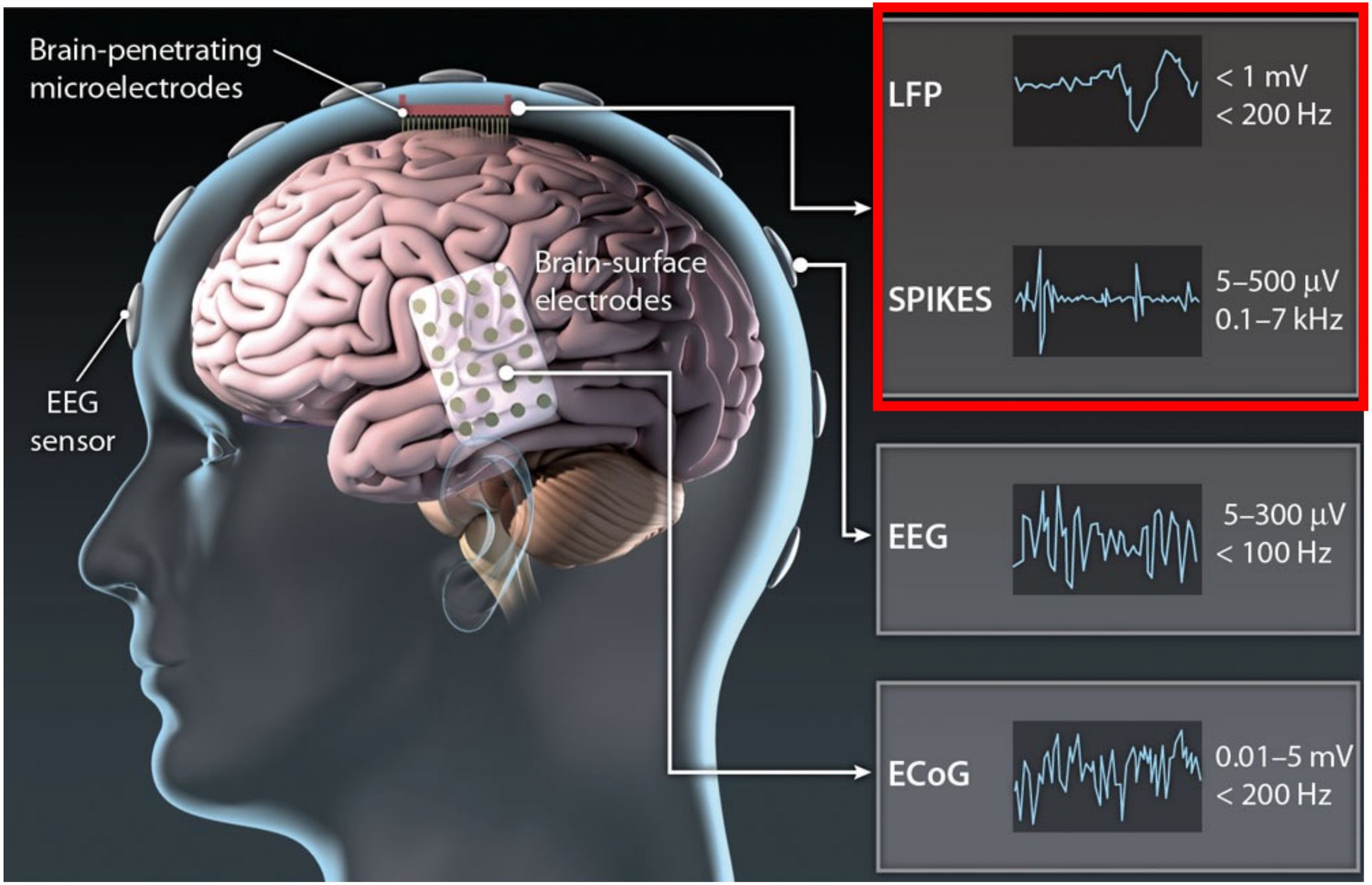
뇌-기계 연결에 필요한 뇌신호



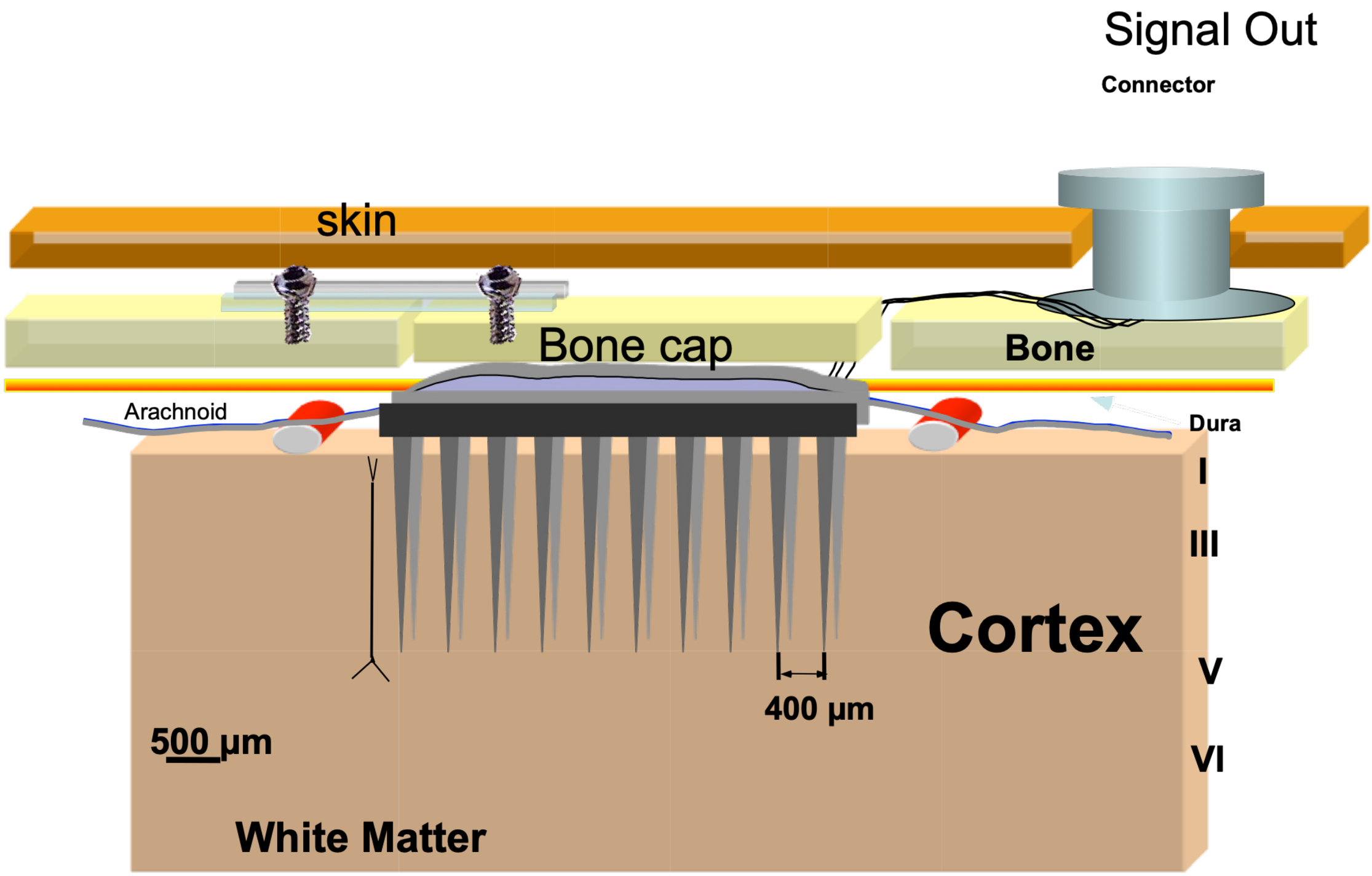
(Thakor, JHU, 2013)

이식형 BCI

뇌-기계 연결에 필요한 뇌신호



(Thakor, JHU, 2013)


Signal Out
Connector
skin
Bone cap
Bone
Arachnoid
Dura
I
III
V
VI
Cortex
400 µm
500 µm
White Matter

Hochberg et al. 2006

Elon Musk launches Neuralink, a venture to merge the human brain with AI

Rockets, cars, and now brain chips

by Nick Statt | @nickstatt | Mar 27, 2017, 4:10pm EDT

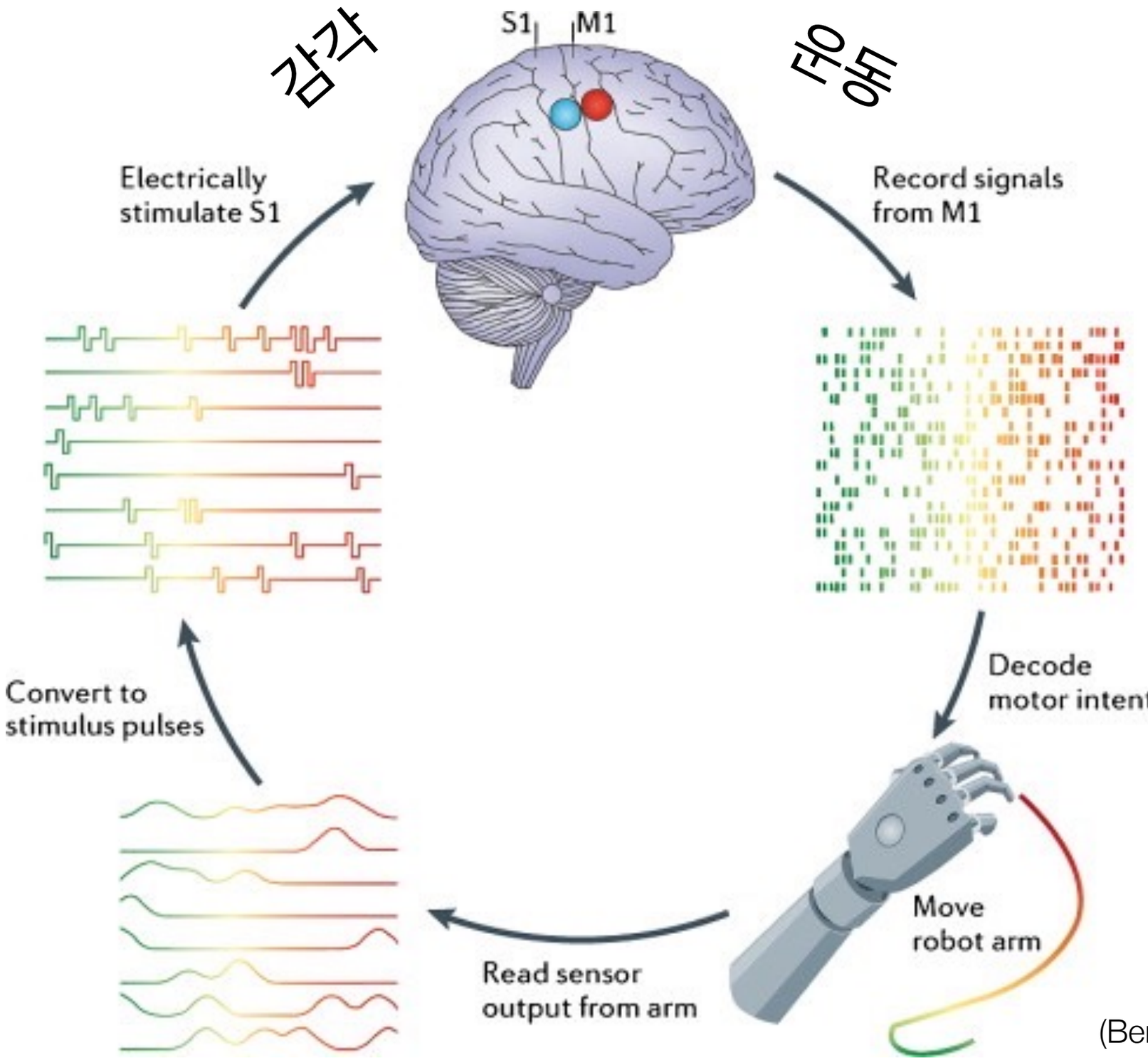
NEURALINK

- 두개골 아래 부위에 삽입하는 동전 크기의 신경 인터페이스 “Link” 발표

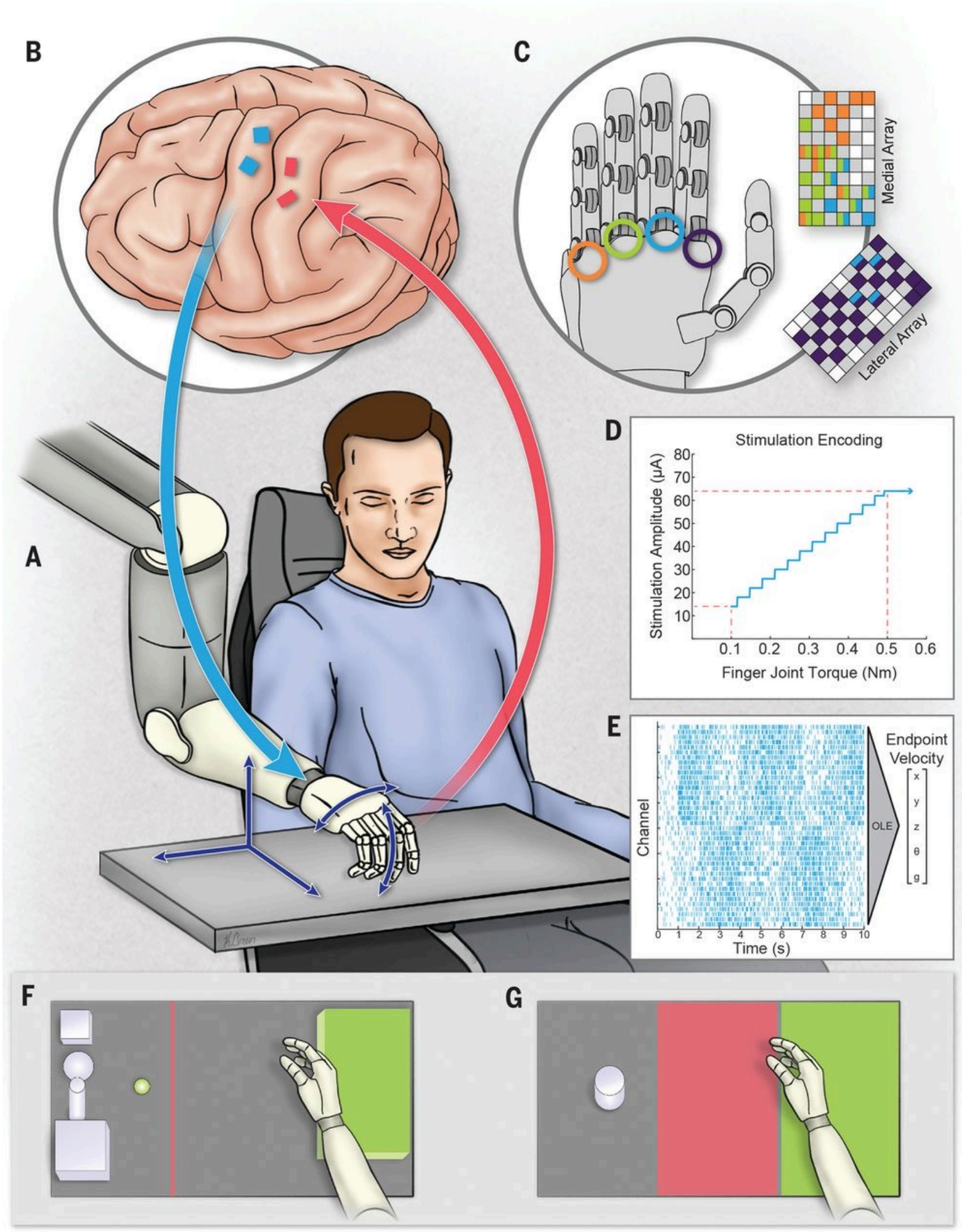
READ & WRITE ON EVERY CHANNEL

Channels	1,024
Battery life	All day
Recharging time	Overnight
Wireless range	5 - 10 meters
Implant size	23 mm x 8 mm
Look	Not externally visible

양방향 뇌-기계 인터페이스

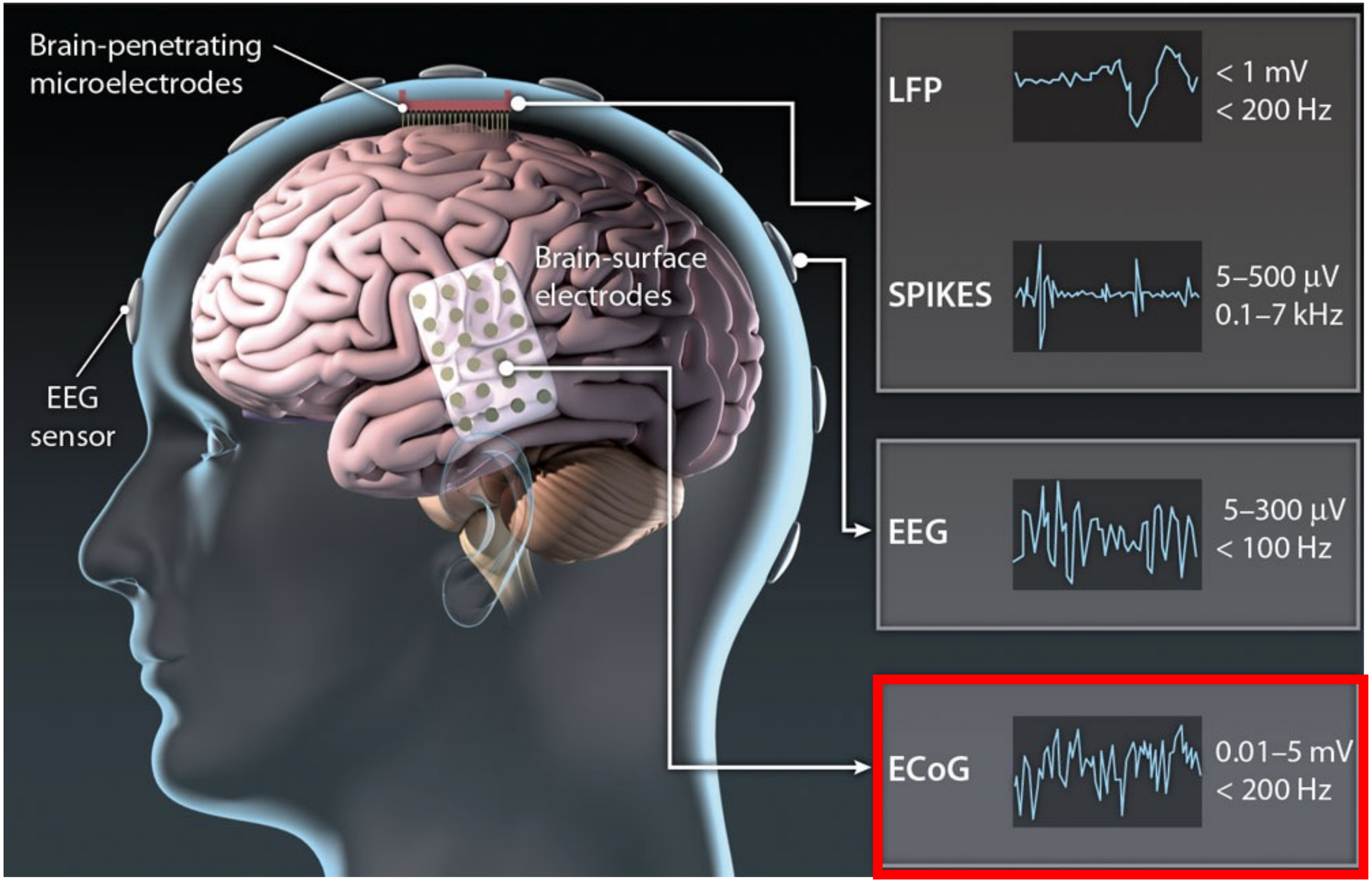


(Bensmia and Miller, 2014)



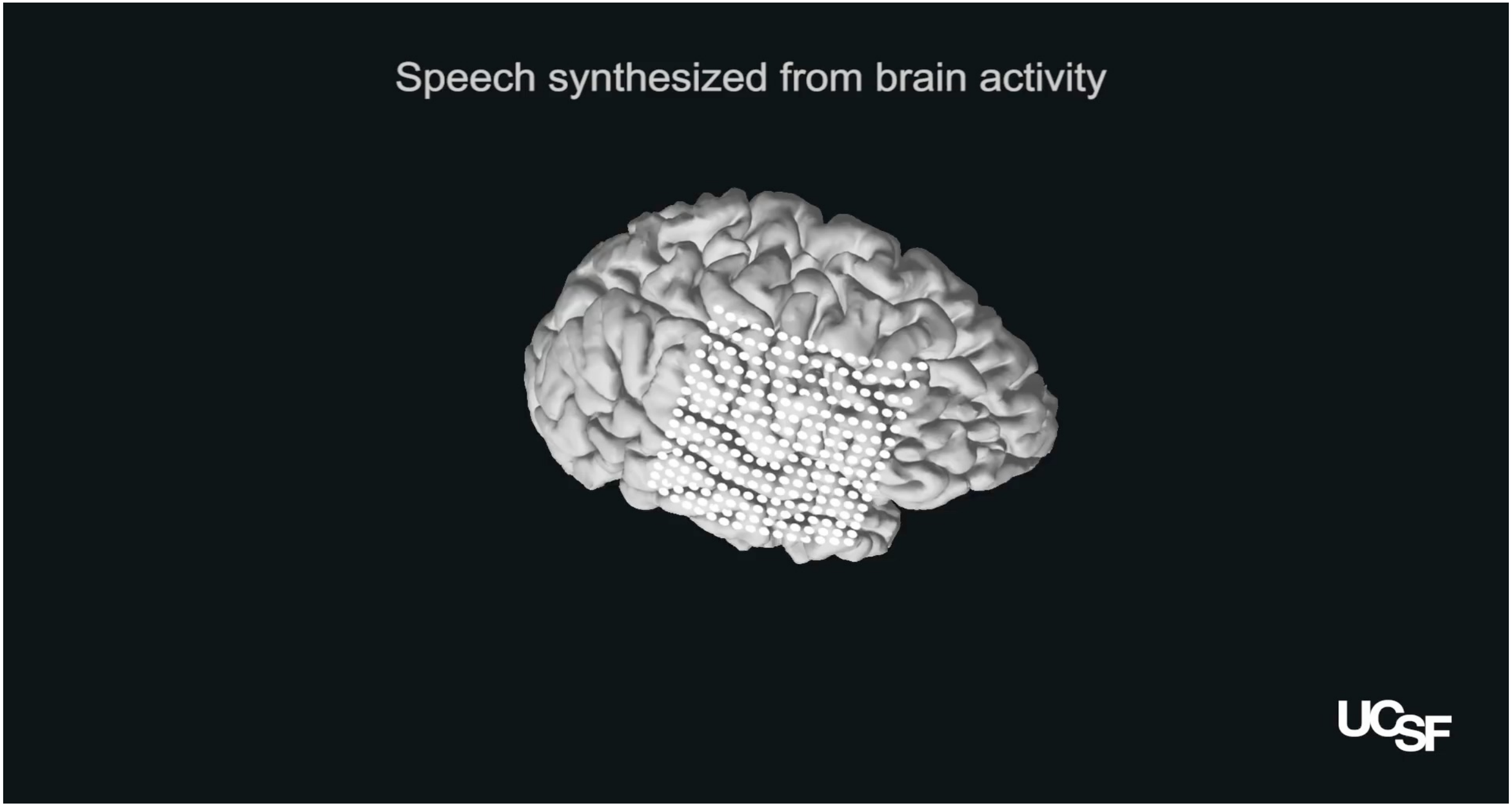
(Flesher *et al.*, 2021)

뇌-기계 연결에 필요한 뇌신호



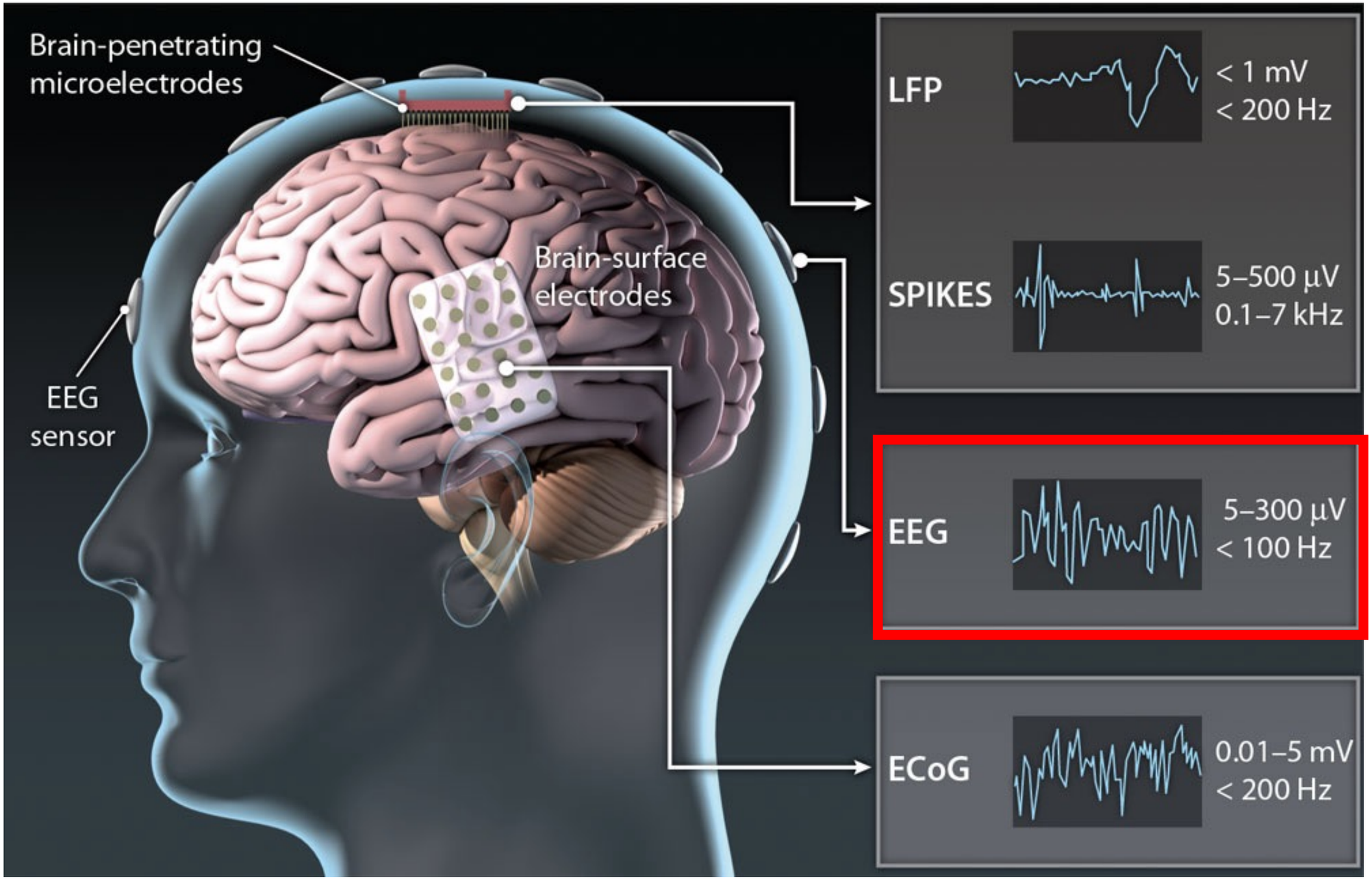
(Thakor, JHU, 2013)

언어 복원 인터페이스



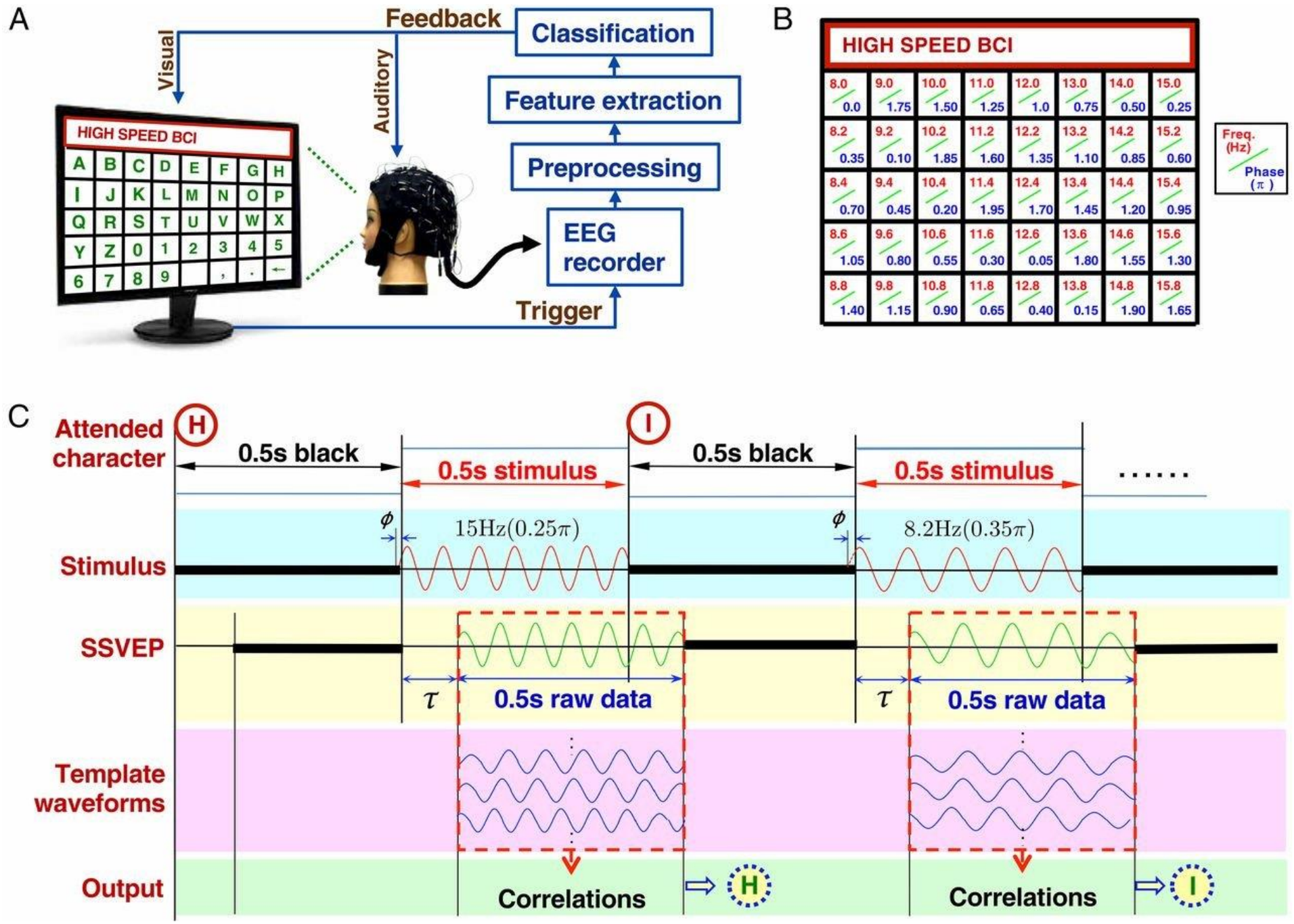
비이식형 BCI

뇌-기계 연결에 필요한 뇌신호



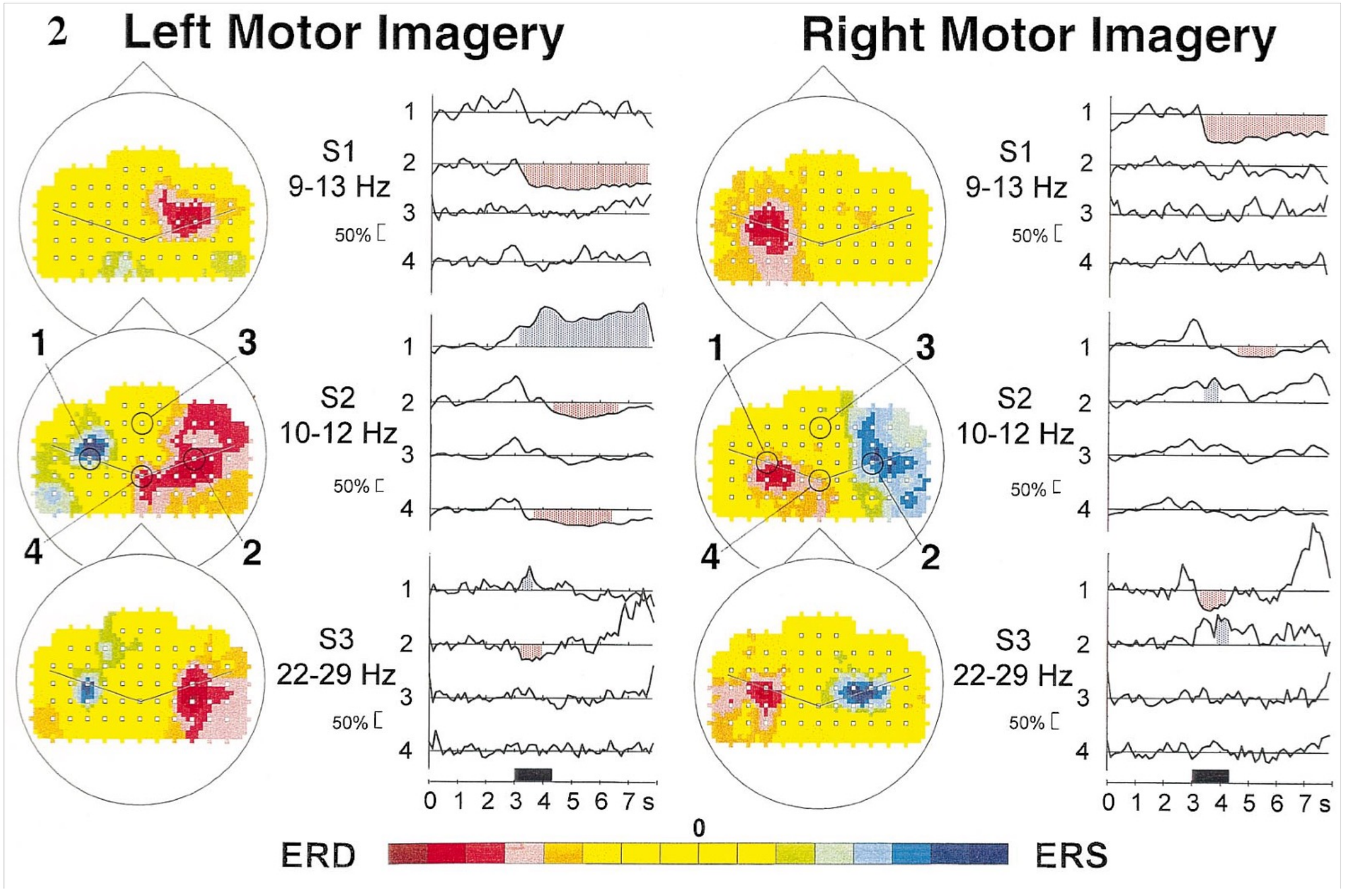
(Thakor, JHU, 2013)

시각적 깜빡임에 반응하는 뇌파



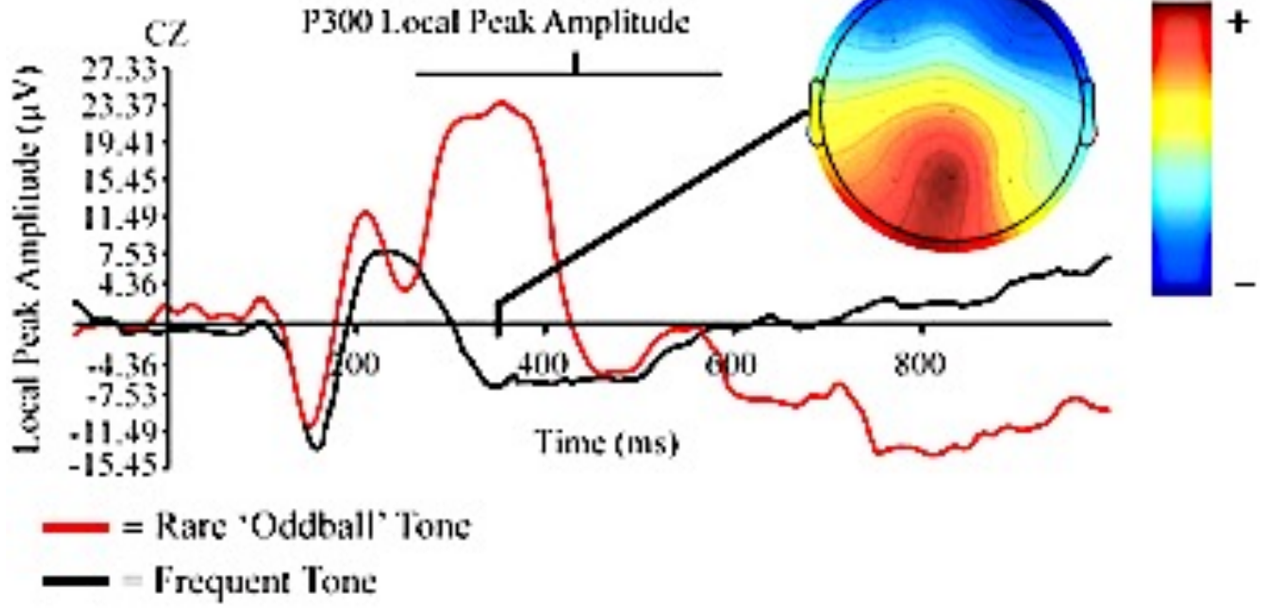
Chen et al., 2015

운동 상상에 따라 달라지는 뇌파

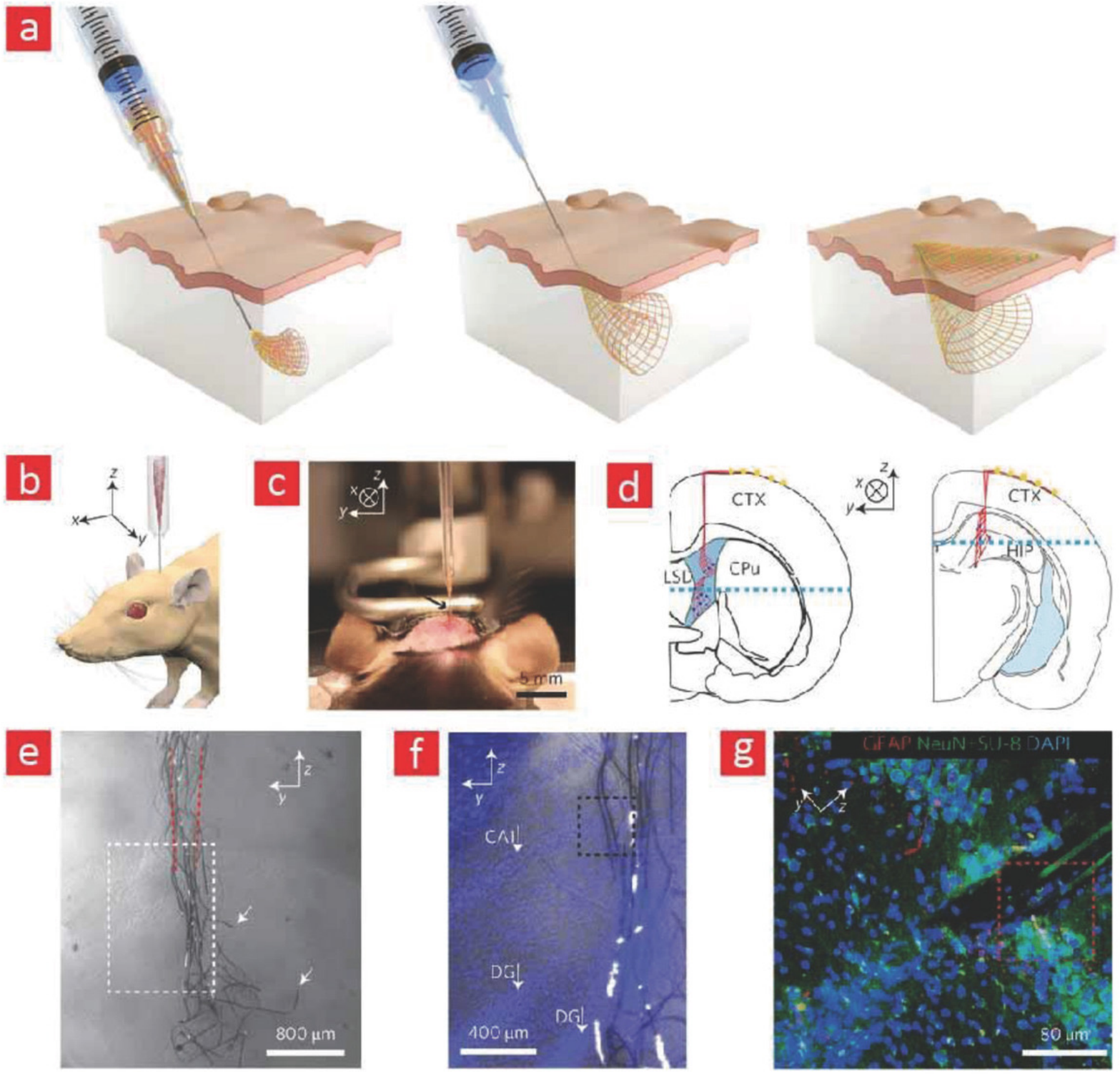


Pfurtscheller and Neuper, 1997

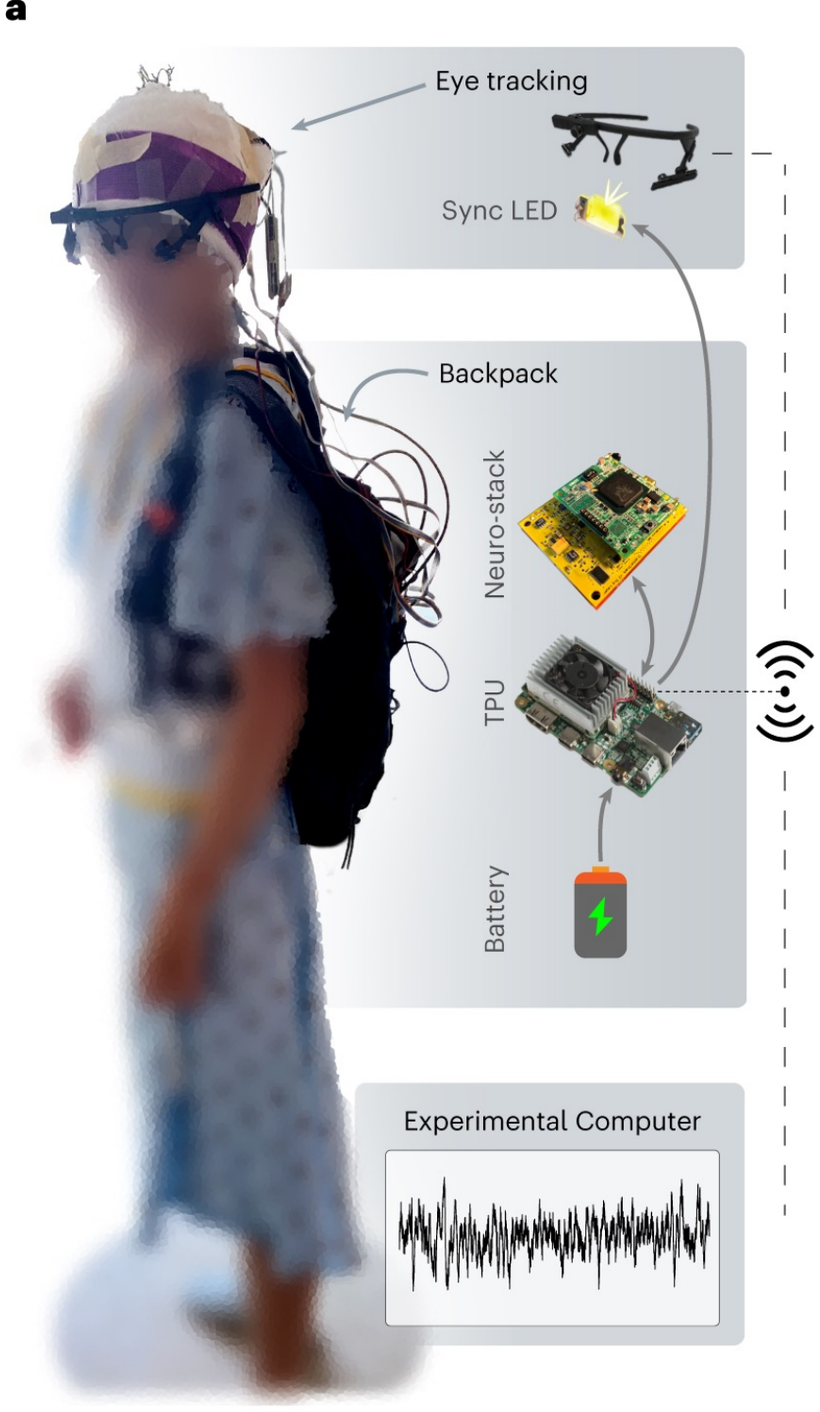
집중하는 대상에 따라 반응하는 뇌파

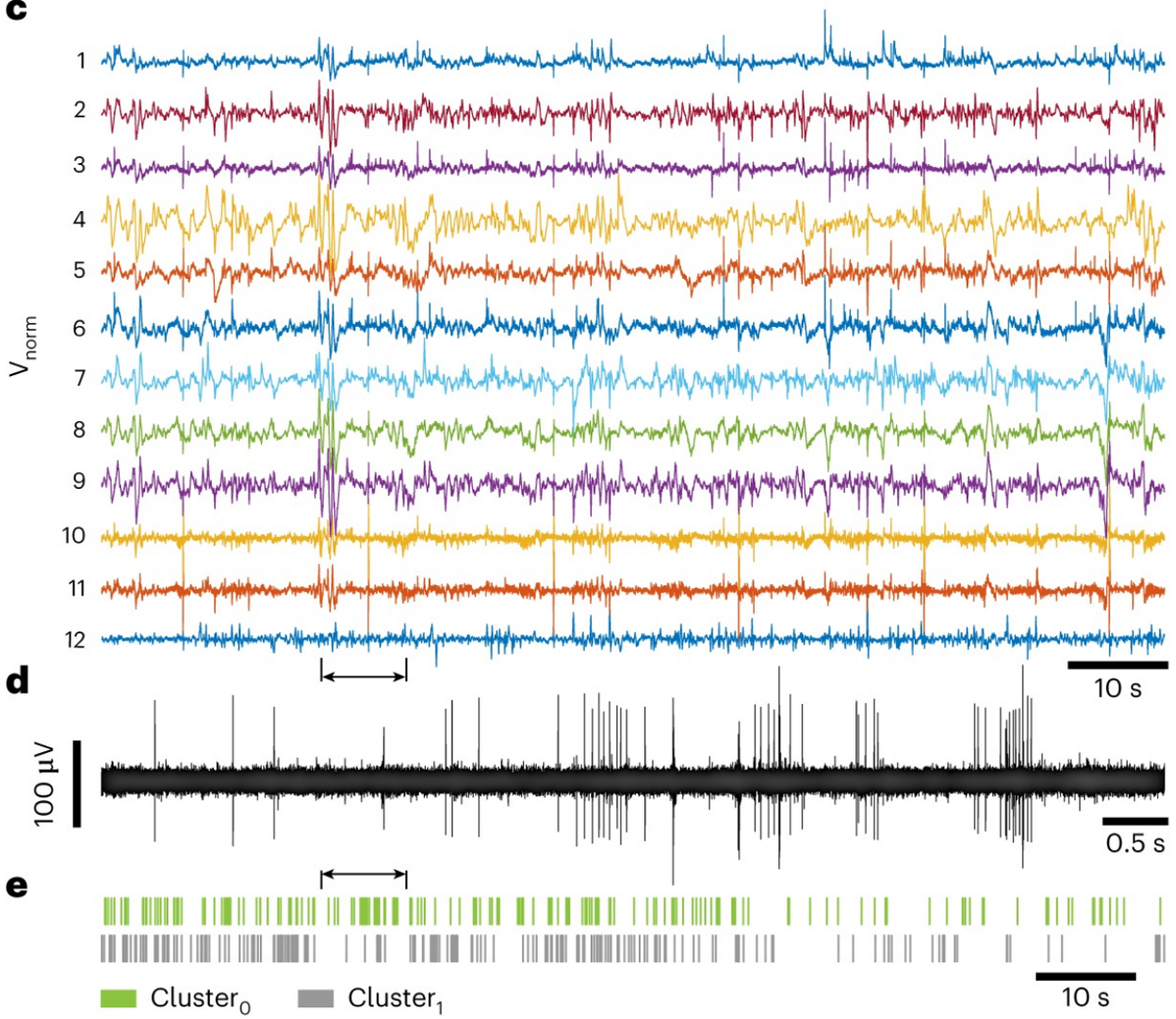


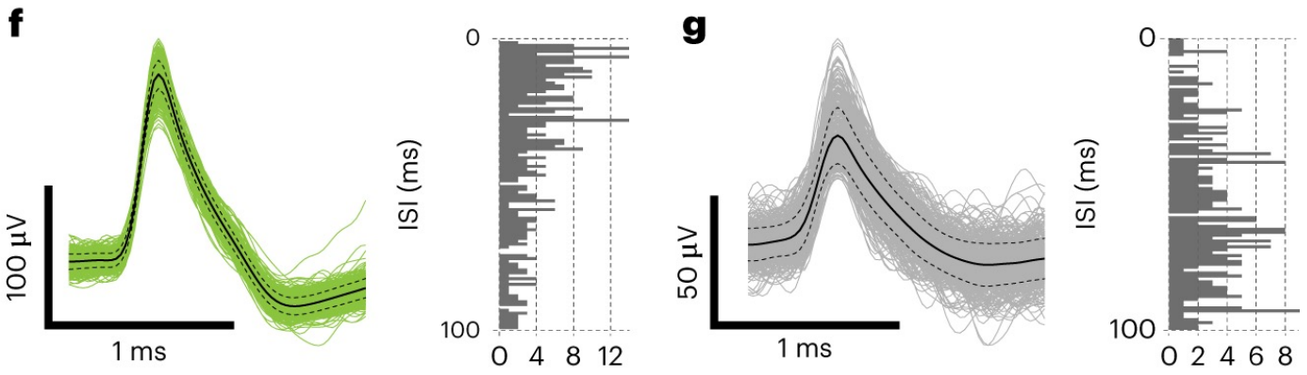
BCI Outlook

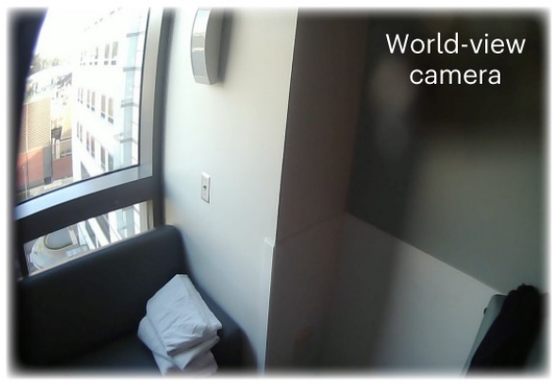


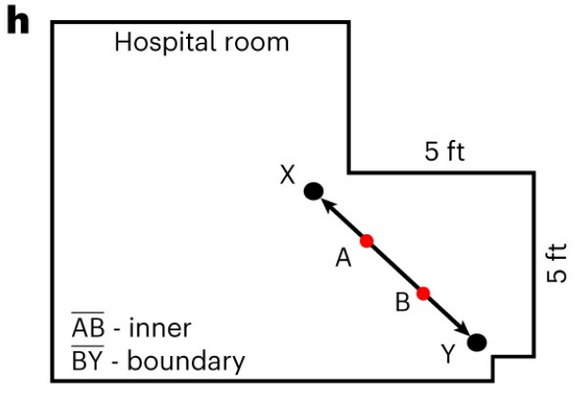
(Mehrali et al., 2018)

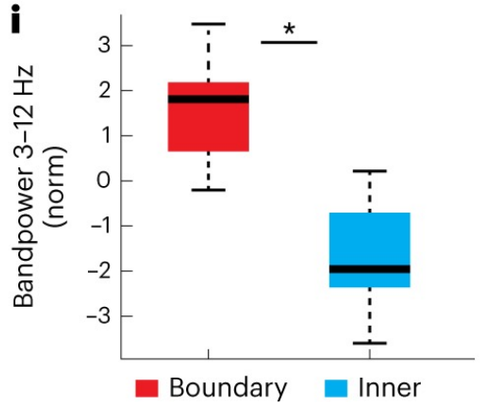








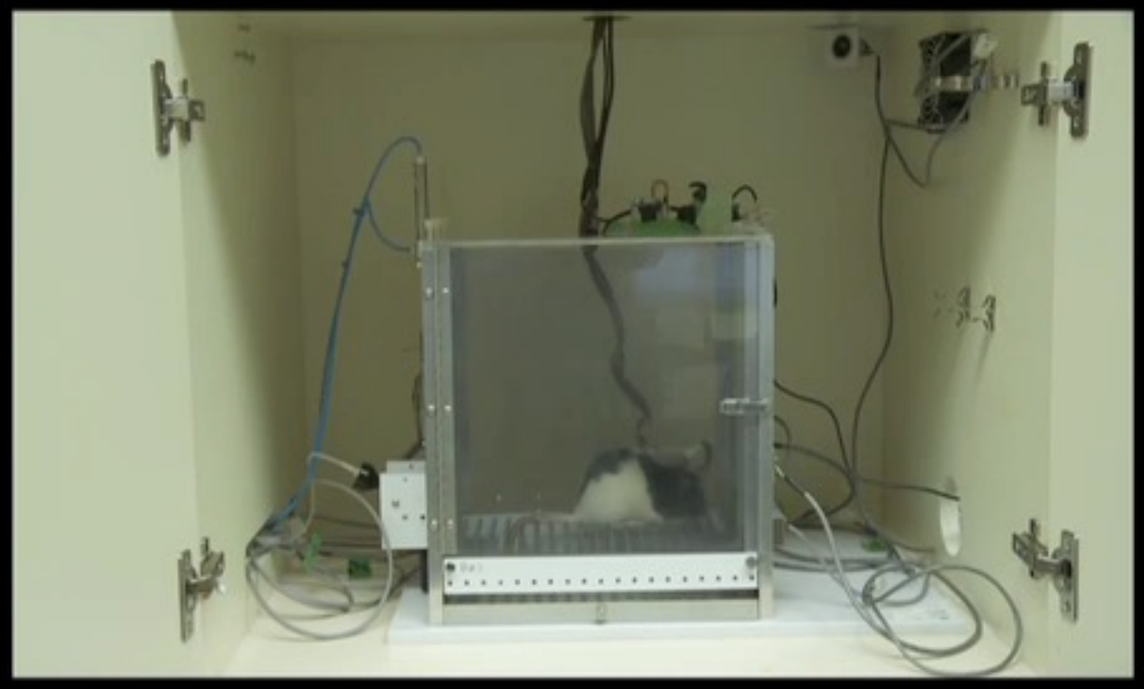




(Topalovic et al., 2023)

Brain-to-Brain Interface in Rats

Encoder Setup

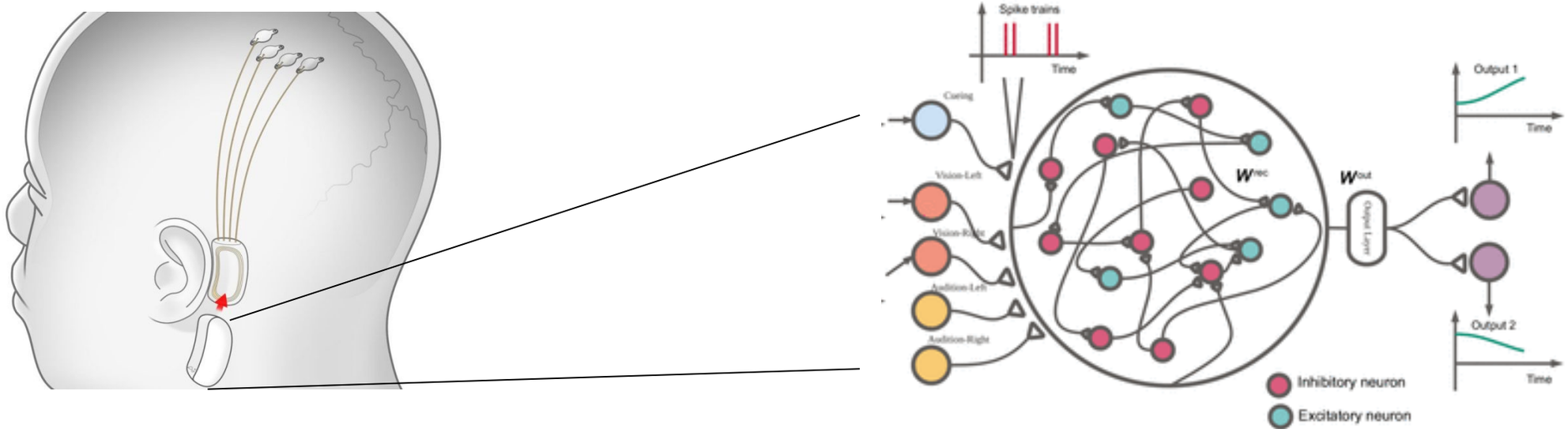


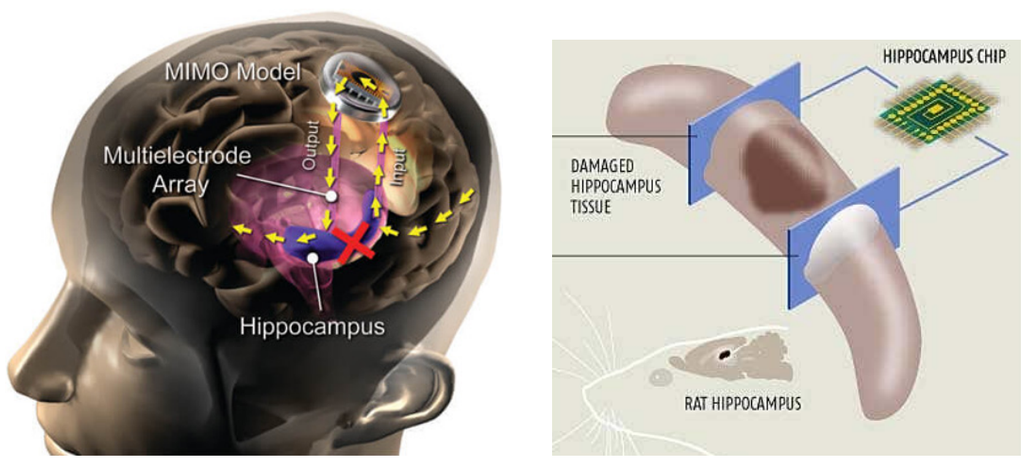
Decoder Setup

(Pais-Vieria et al., 2013)

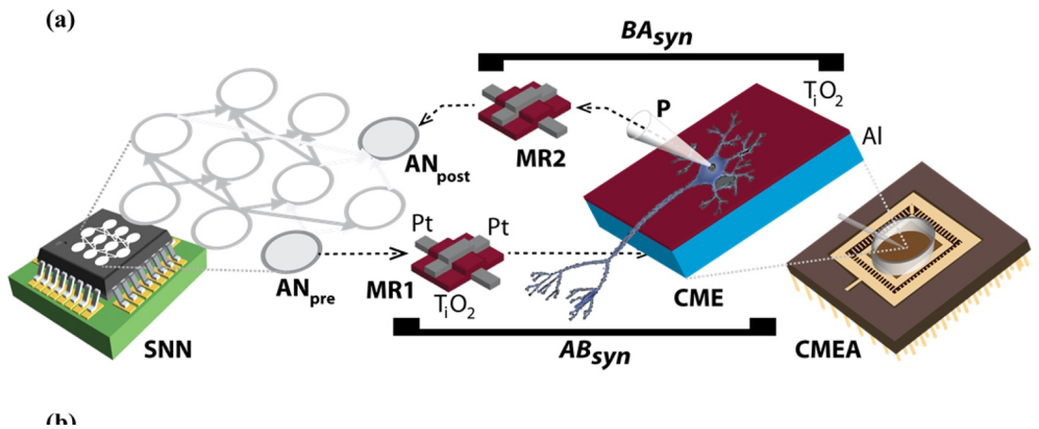
뇌-인공지능 인터페이스 (Brain-AI Interface)

자연신경망 ⟷ 인터페이스 ⟷ 인공신경망





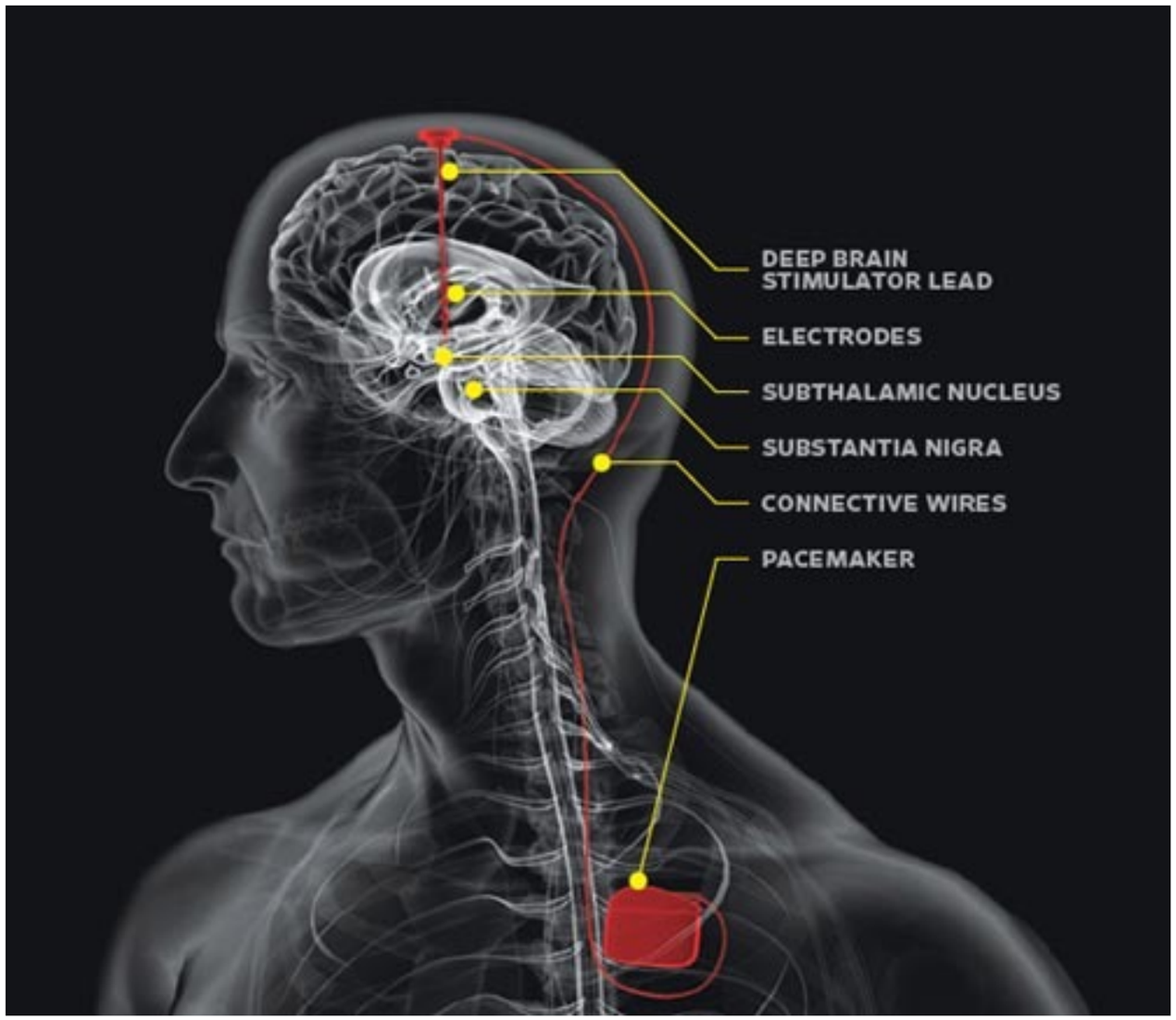
(Hampson et al., 2018)



(Serb et al., 2020)

심부뇌자극 기술: Deep Brain Stimulation (DBS)

파킨슨씨 병 등 다양한 뇌질환 치료를 위한 기술



Source:
J. Illes, UCB @ Dana Org.

(UAB News)