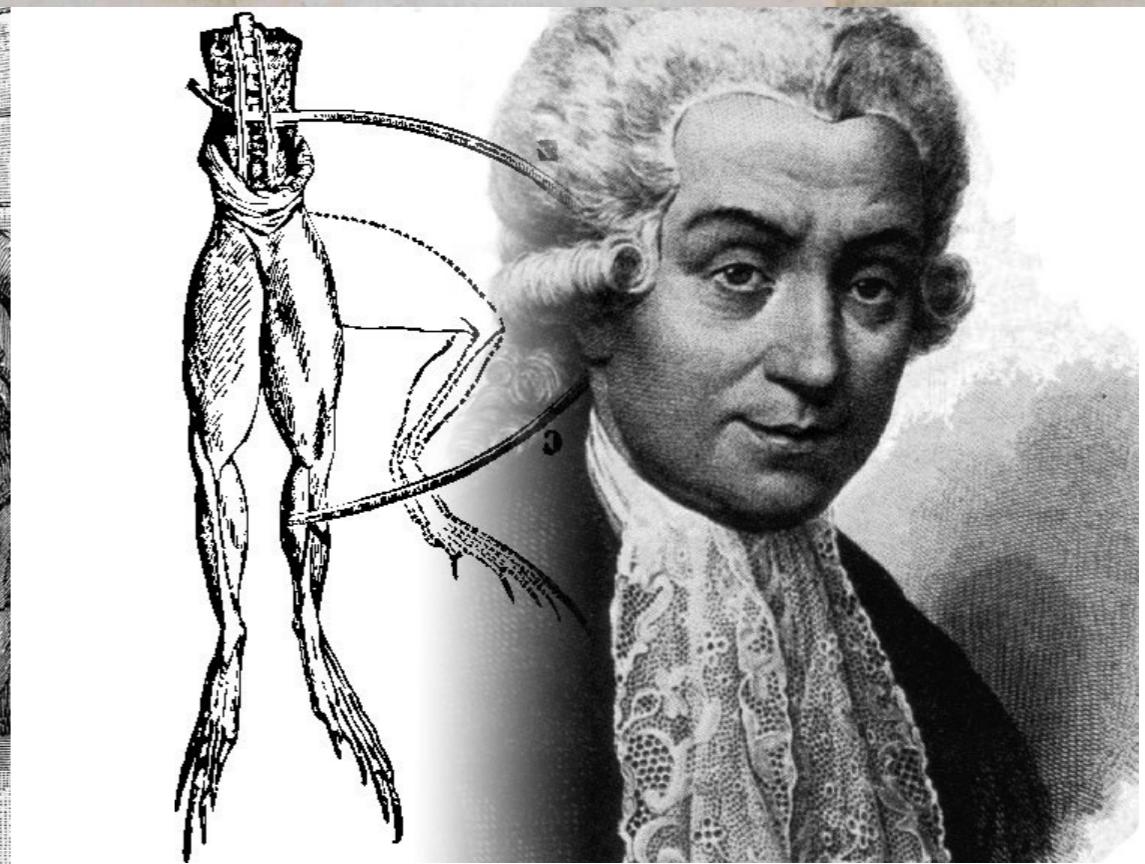
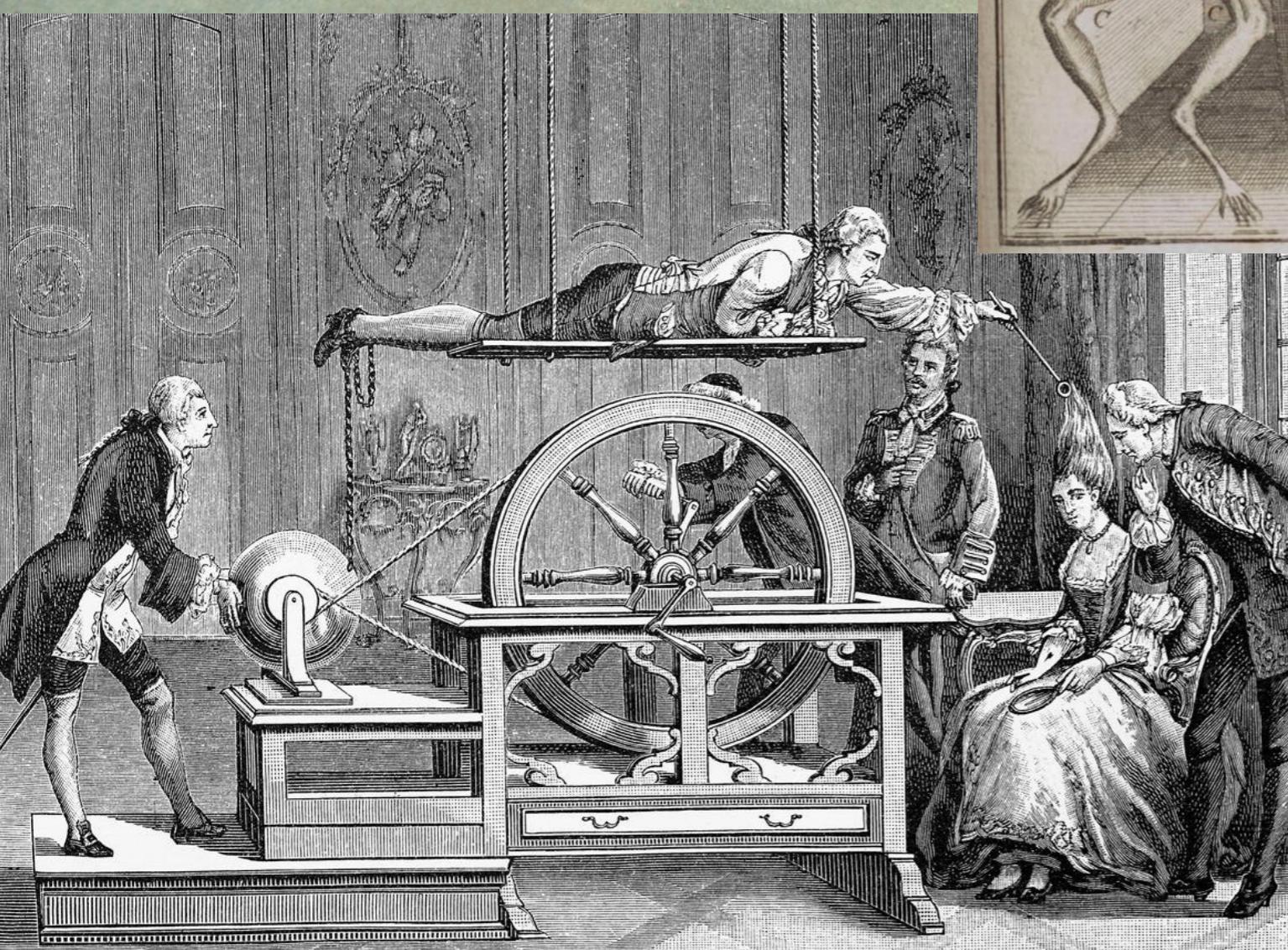
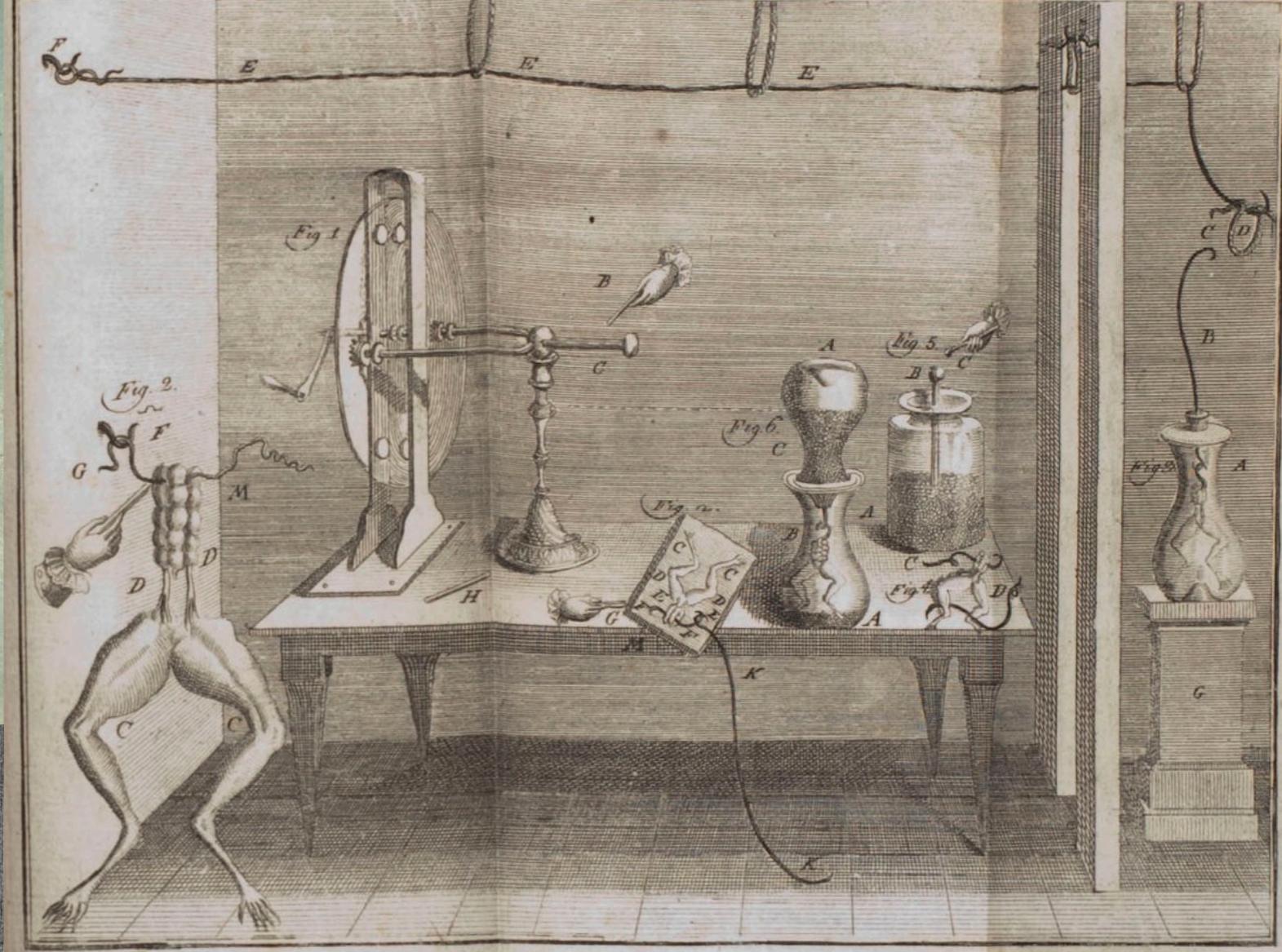
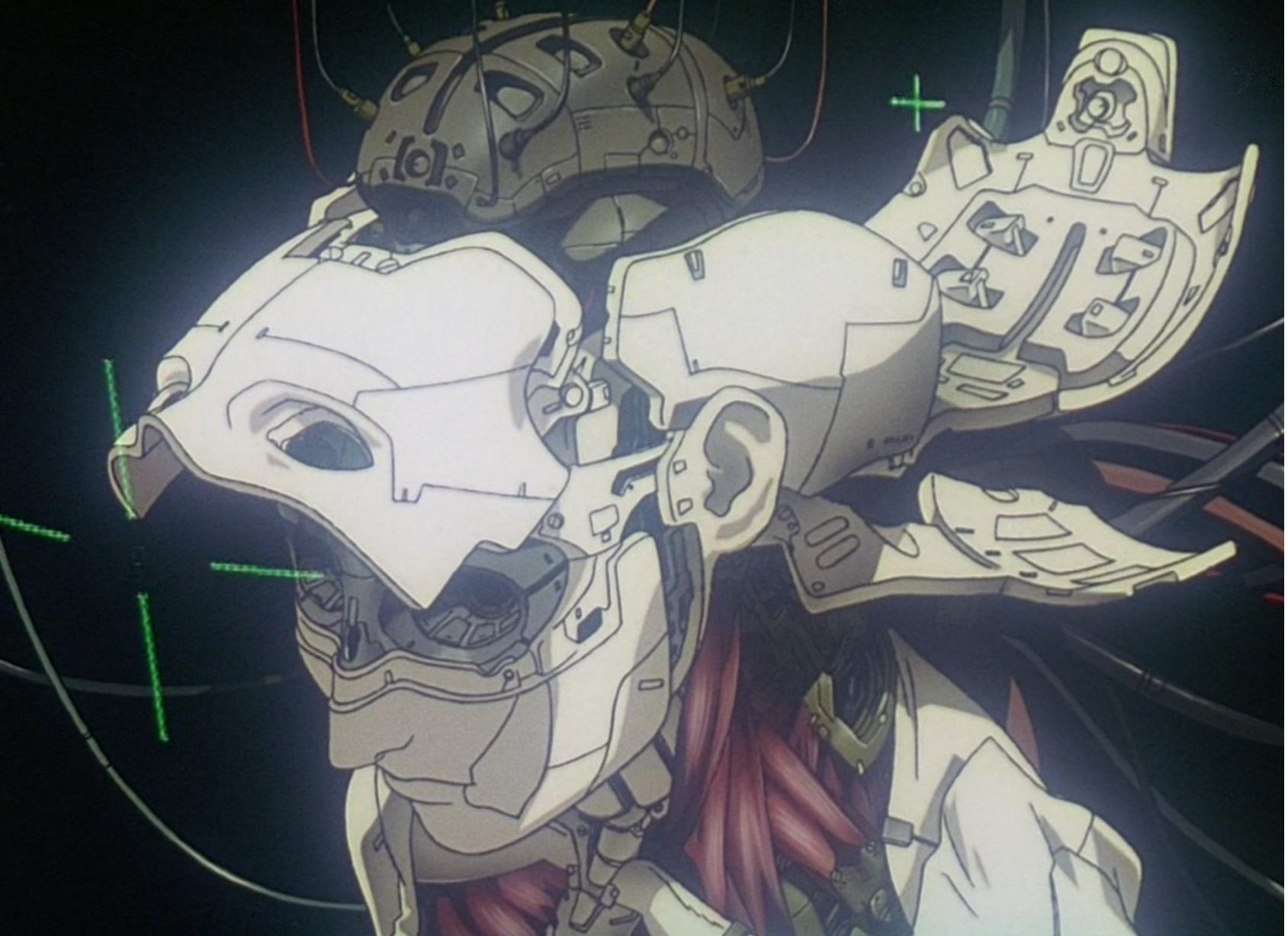


Interfaz máquina - sistema nervioso: teoría básica y herramientas





Estructura del taller

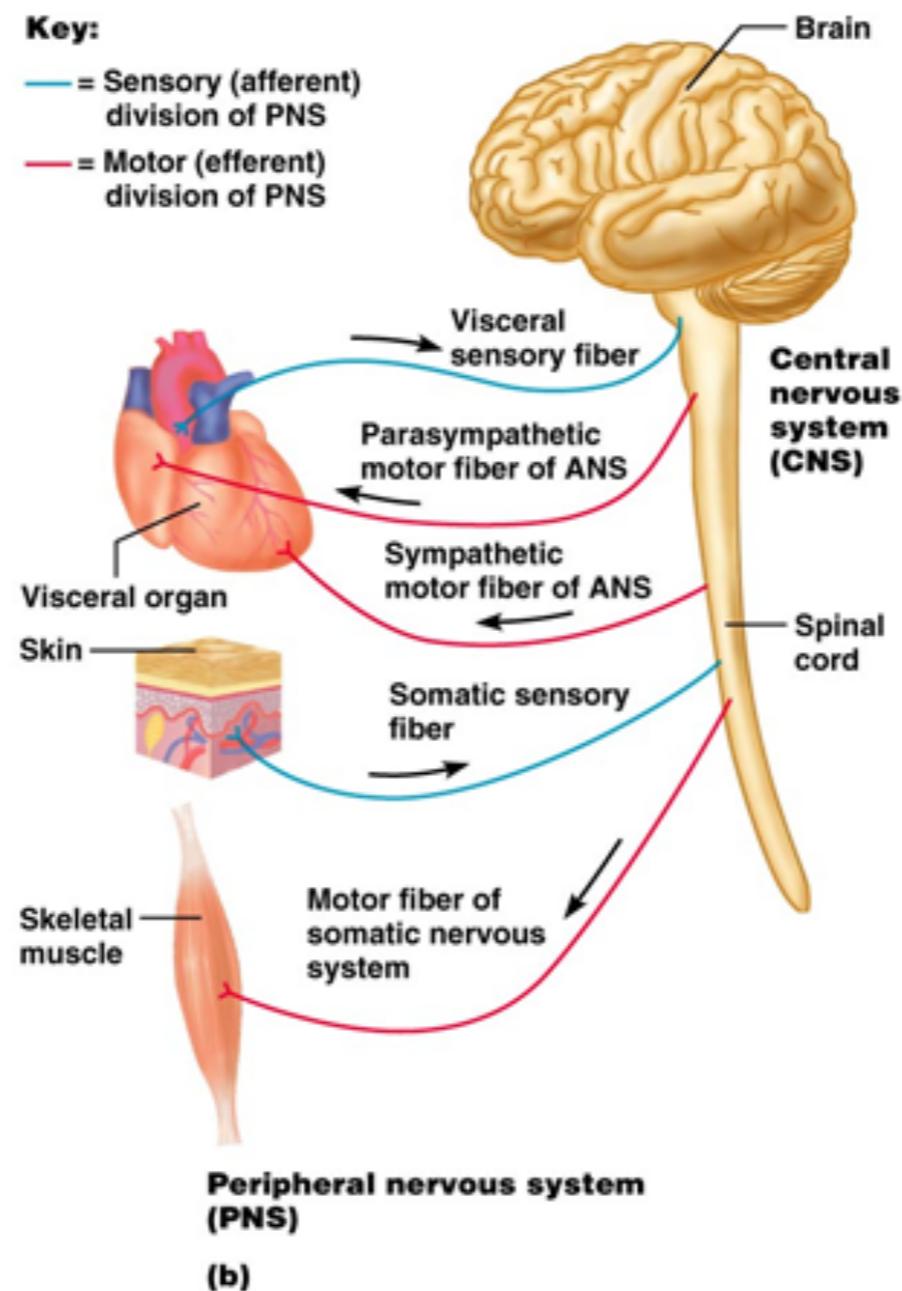
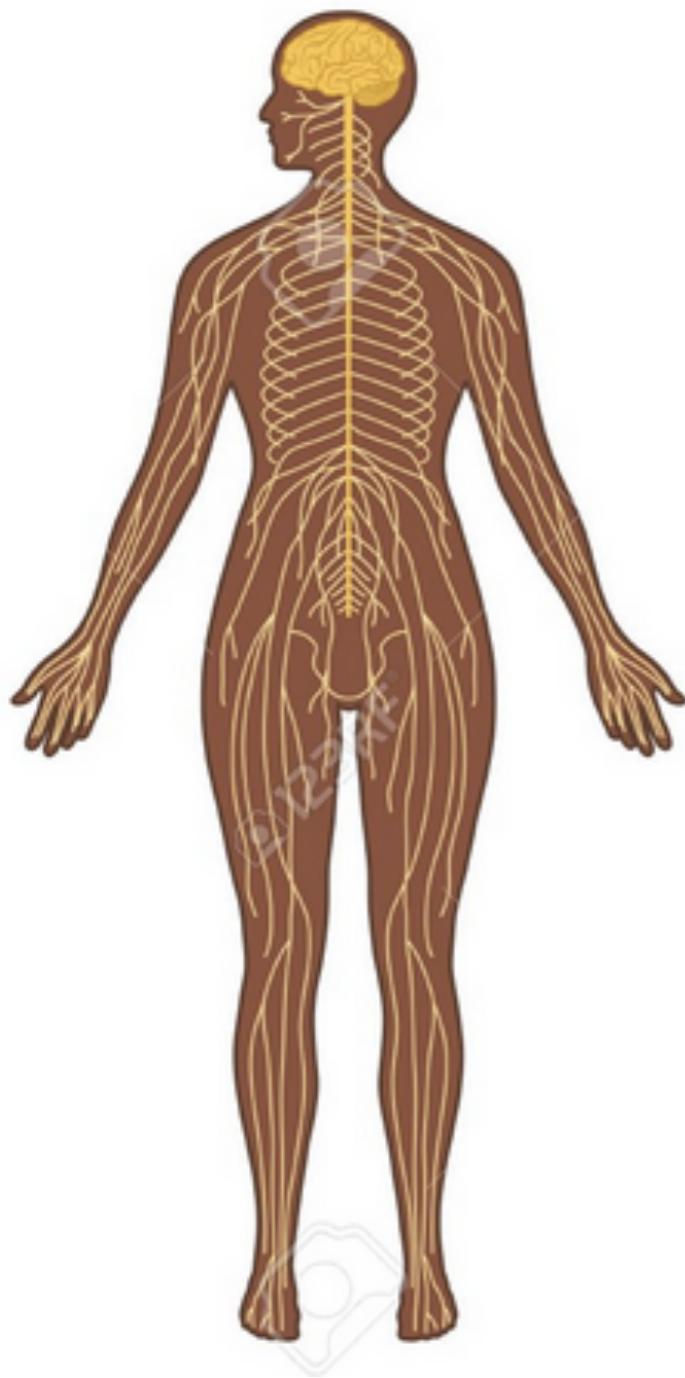
- Primeras ideas
- Cómo se generan las señales del sistema nervioso / Qué información llevan
- Qué herramientas utilizamos para medirlas
- Cómo analizamos las señales qué medimos para usarlas en el arte
- Proyecto en grupo

Interfaz maquina - sistema nervioso

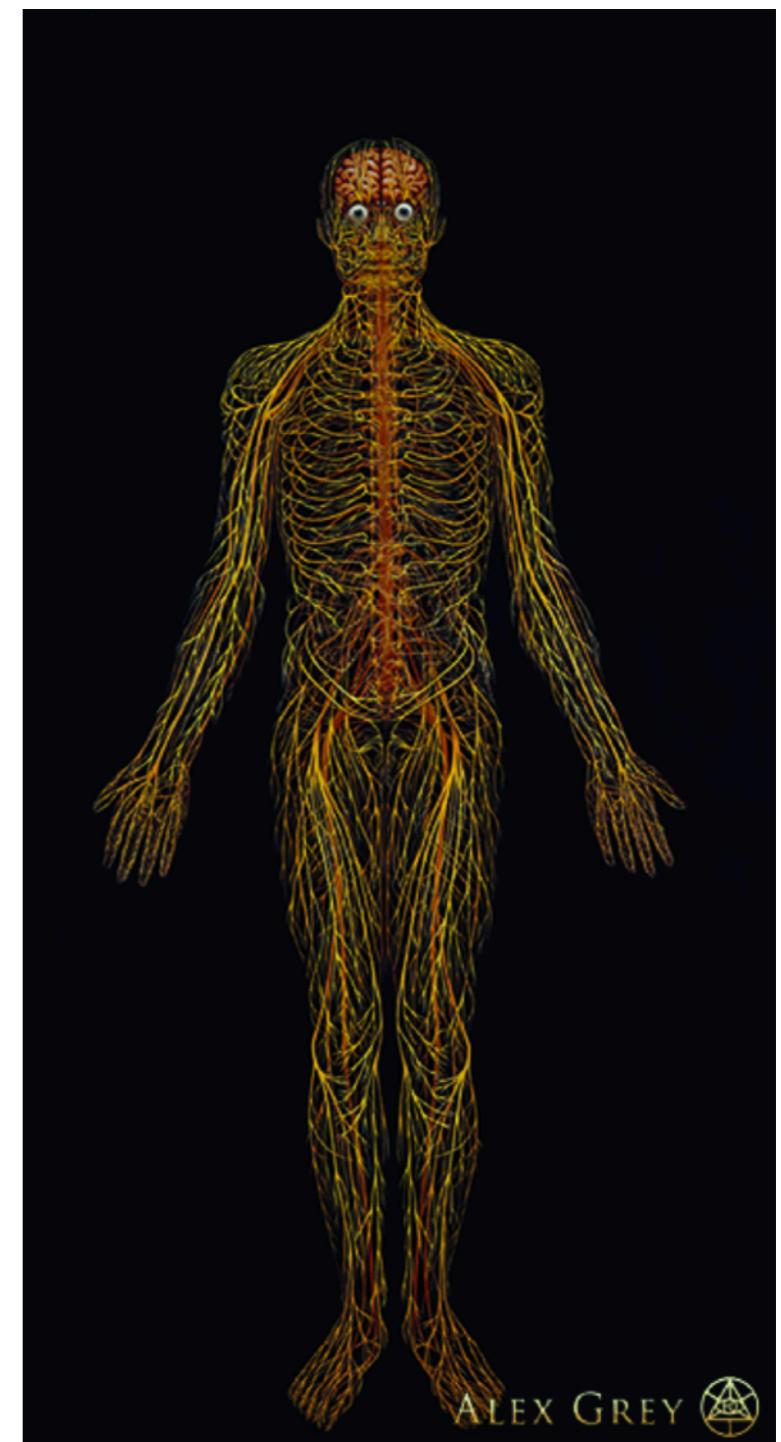
- Interfaz: permite a dos sistemas comunicarse o establecer una conexión.



¿Qué es el sistema nervioso?



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ALEX GREY

¿Cómo captar las señales del sistema nervioso?

BRAIN INTERFACING
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Electrodes placed on a subject's scalp

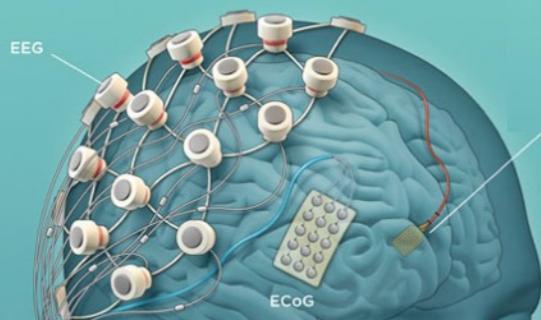
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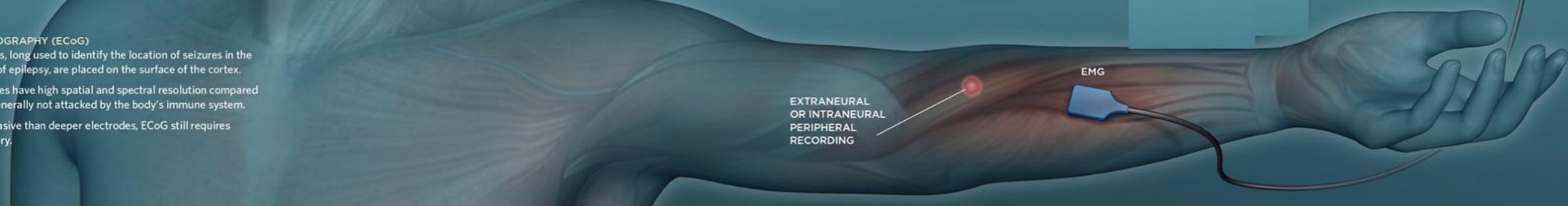


ELECTROMYOGRAPHY (EMG)
Monitoring the electrical signature generated by muscle contractions can provide yet another source signal for neuroprosthetic devices.



EXTRANEURAL OR INTRANEURAL PERIPHERAL RECORDING

EMG



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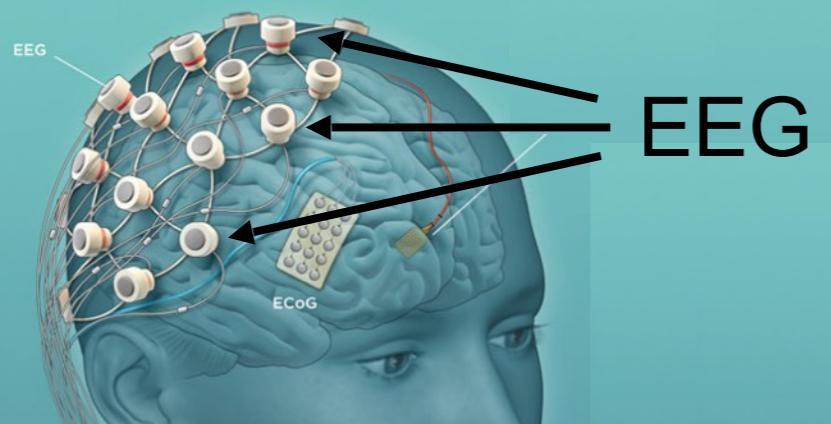
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EMG

EXTRANEURAL
OR INTRANEURAL
PERIPHERAL
RECORDING

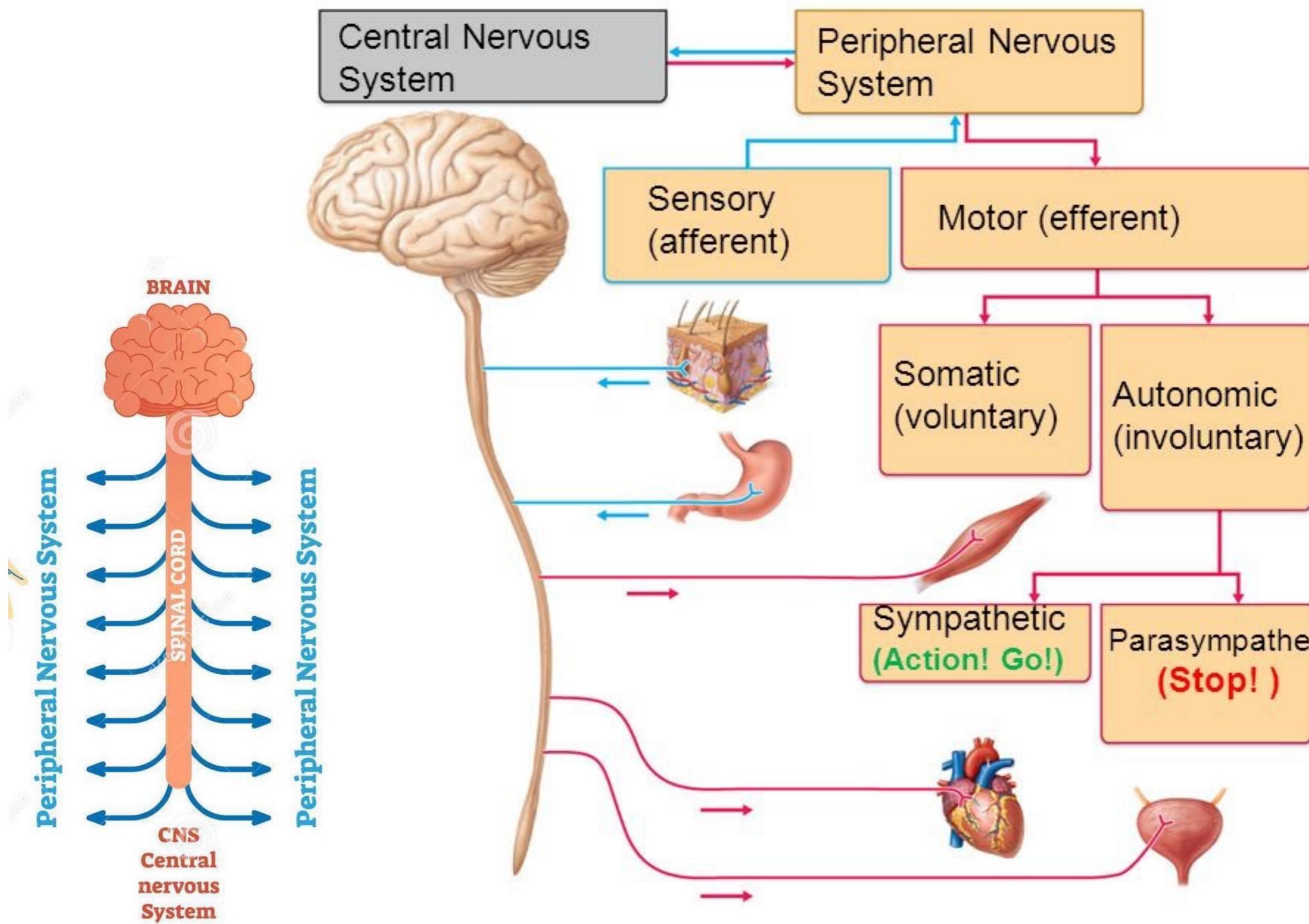


¿Cómo se puede usar en el arte?

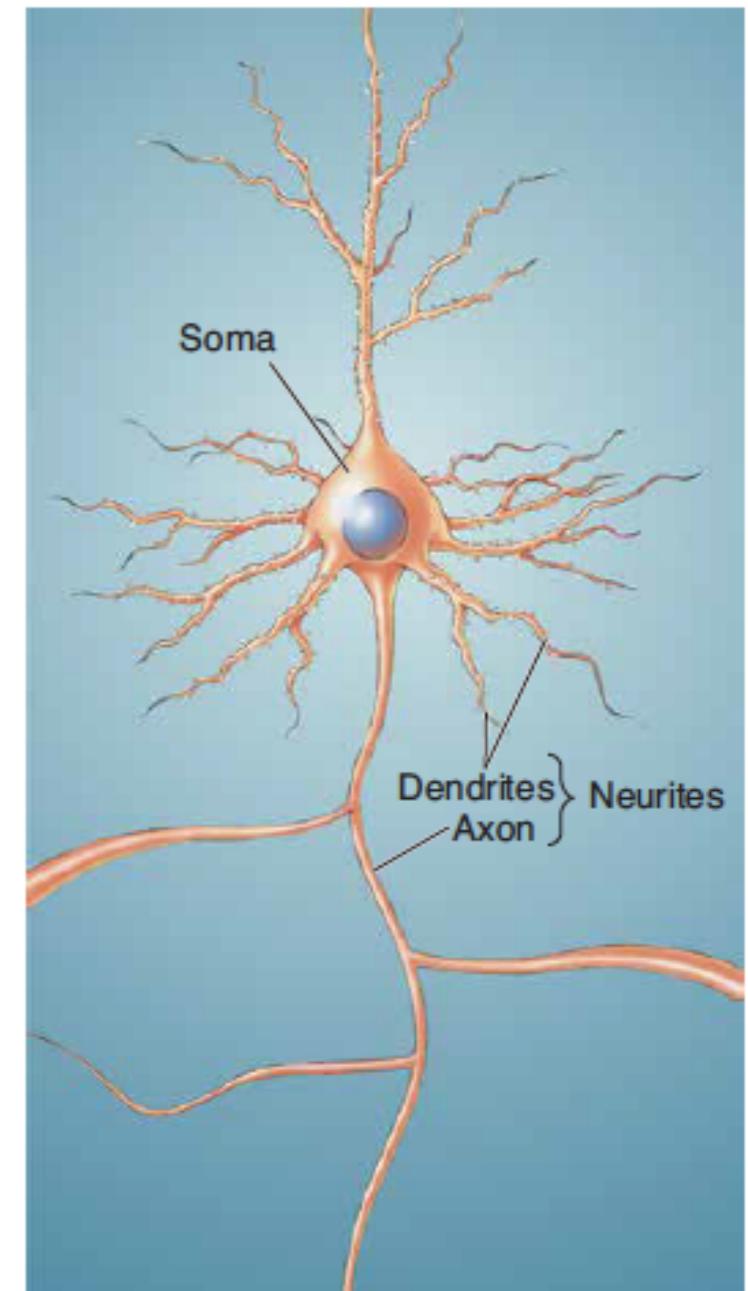


- <https://bichosproxemicos.blogspot.com/2019/03/señales-biometricas-y-arte.html>

División del sistema nervioso

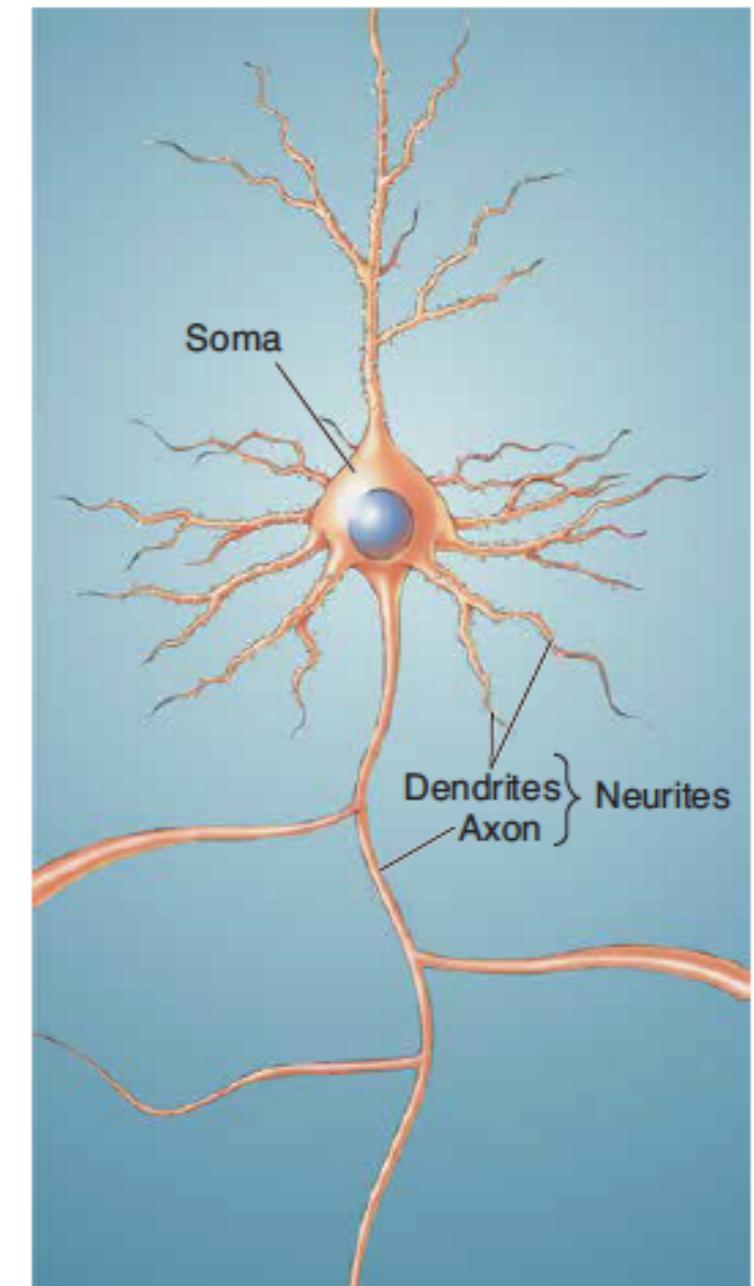
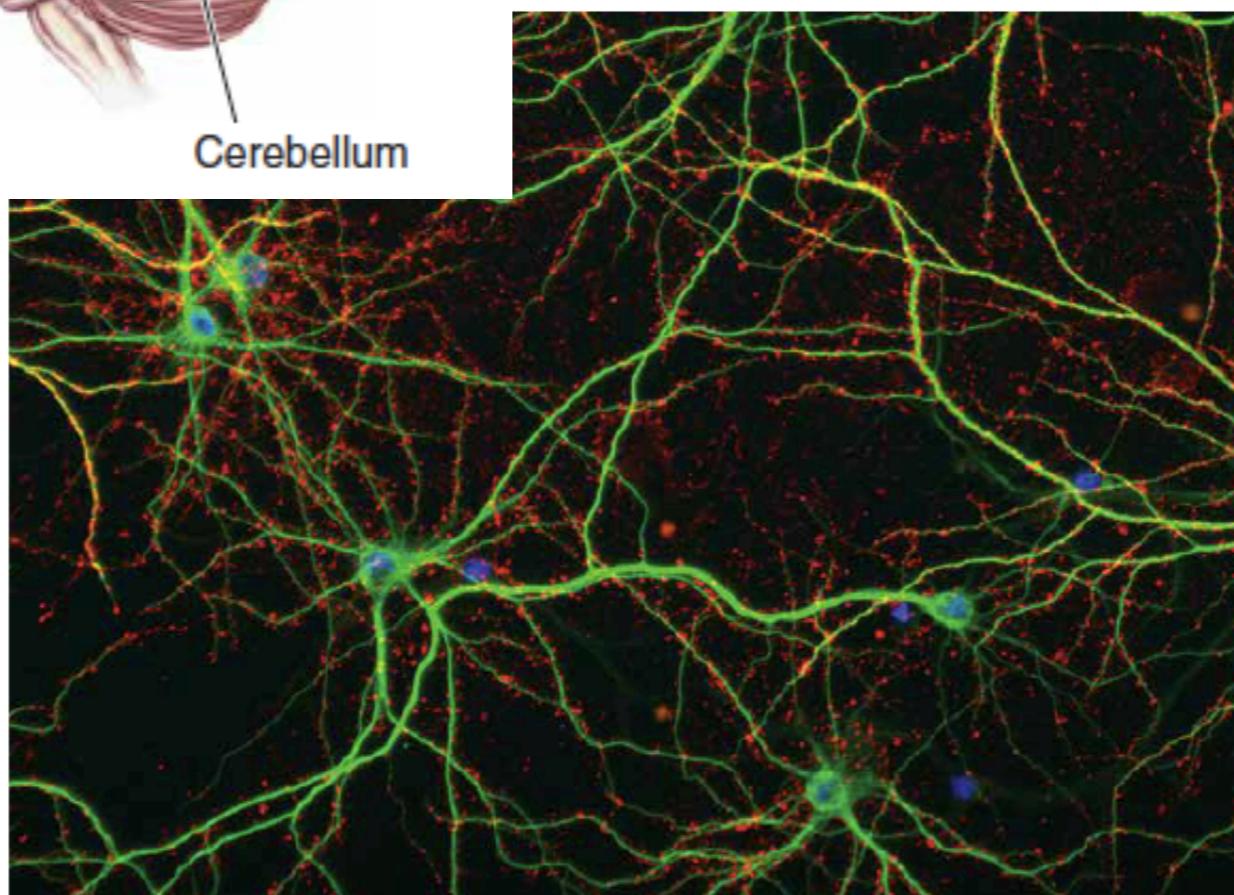
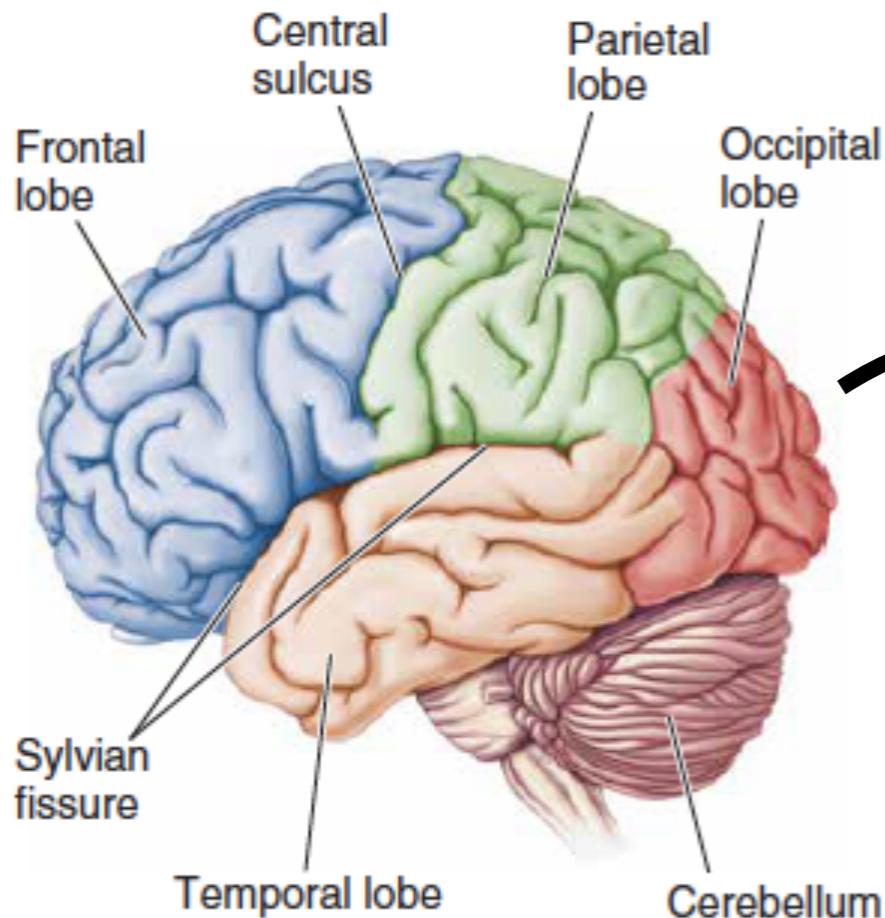


Redes de neuronas



▲ FIGURE 2.4
The basic parts of a neuron.

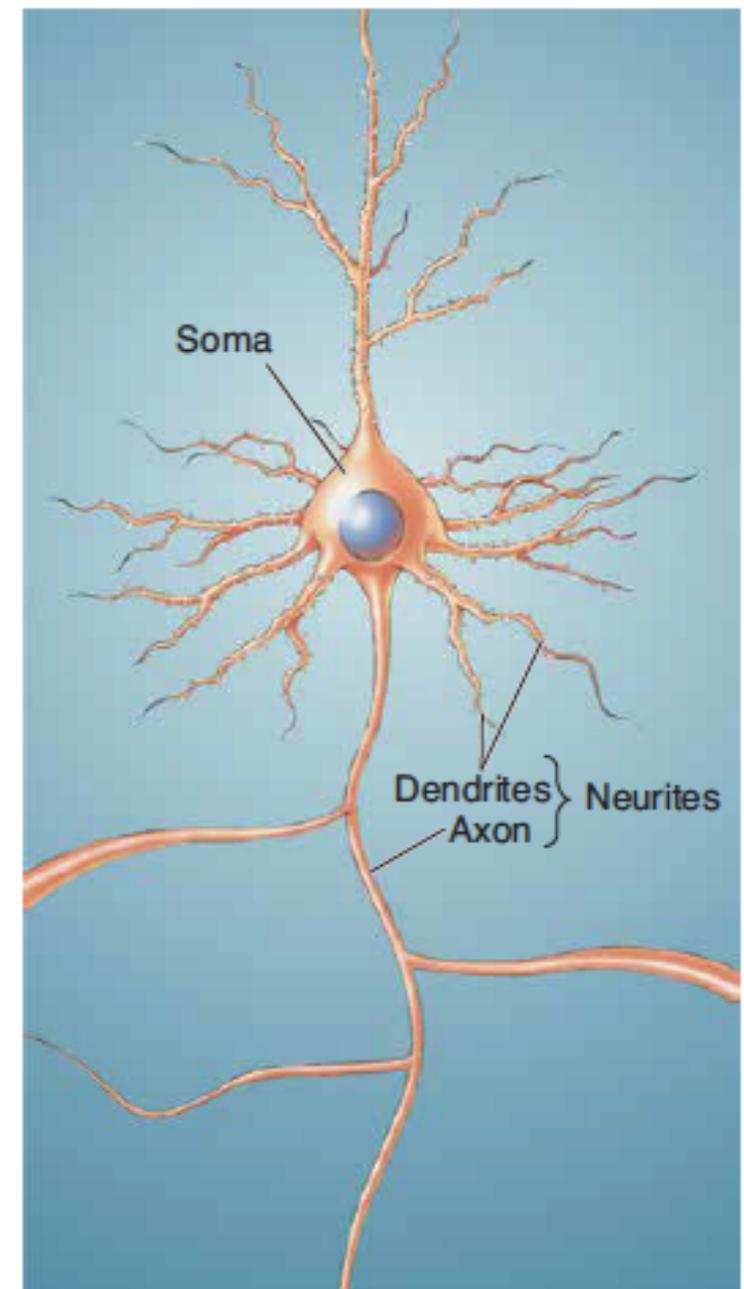
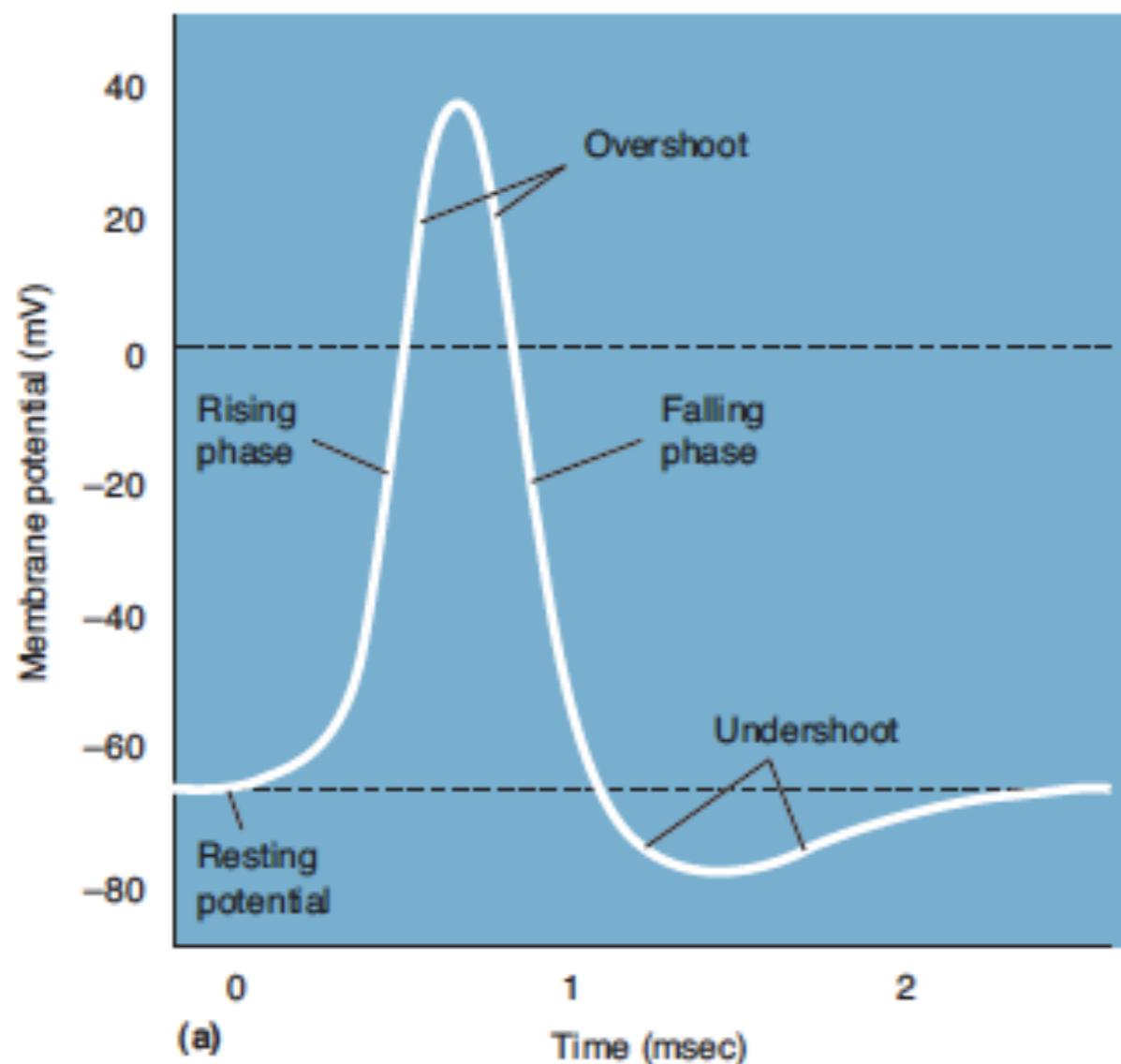
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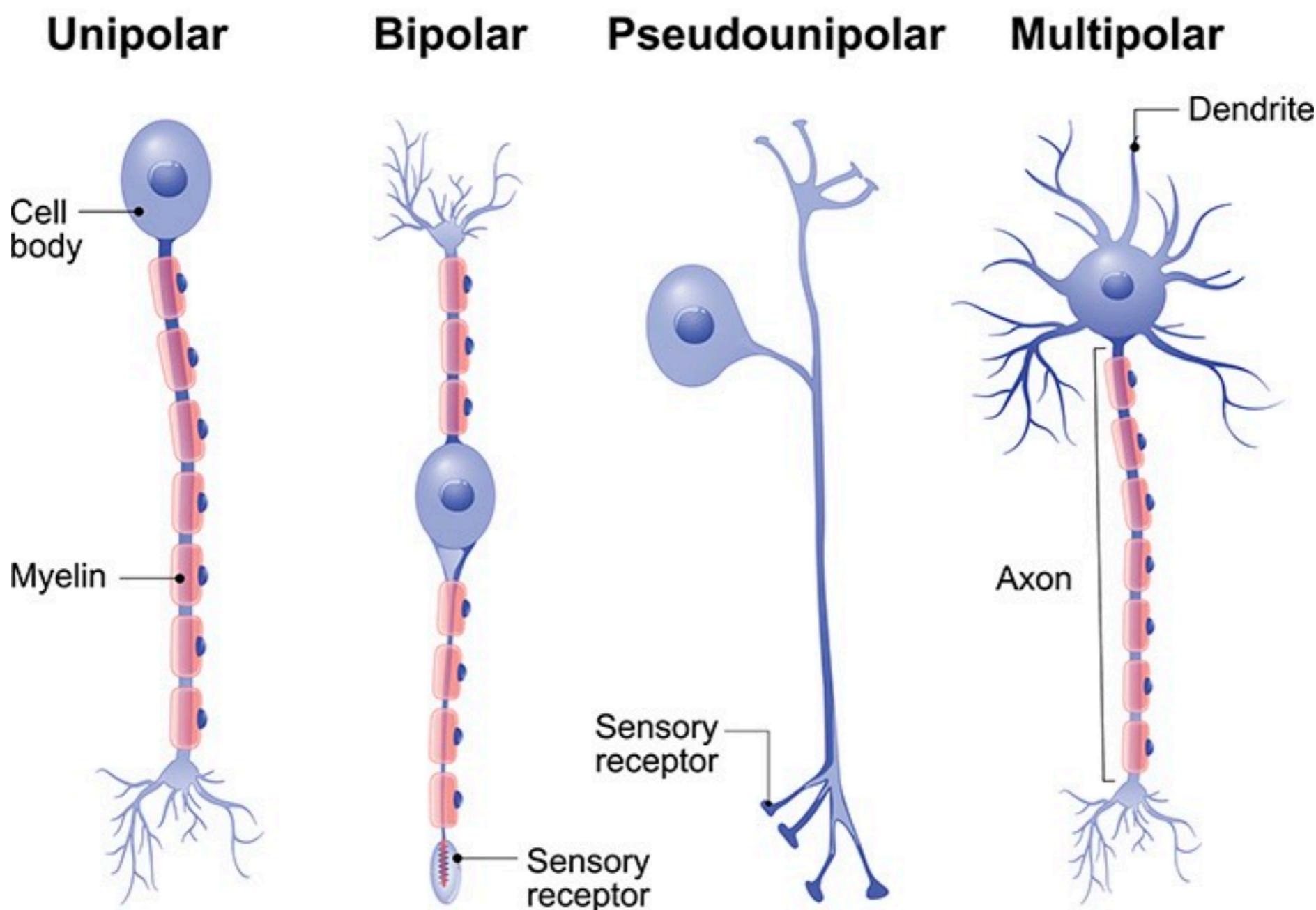
Las neuronas

- Transmisión de señales: Acción potential
- Corriente eléctrica: flujo de iones

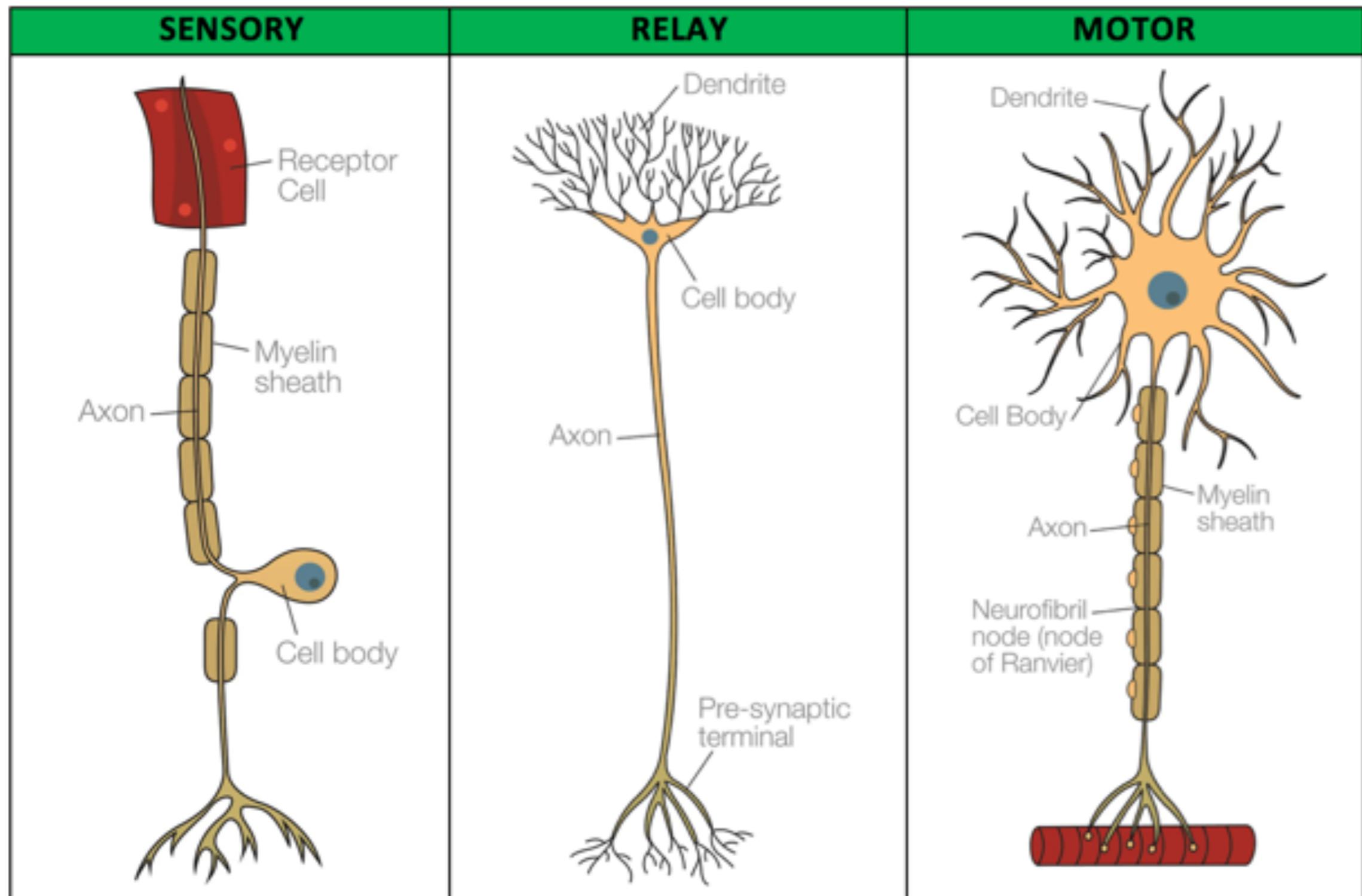


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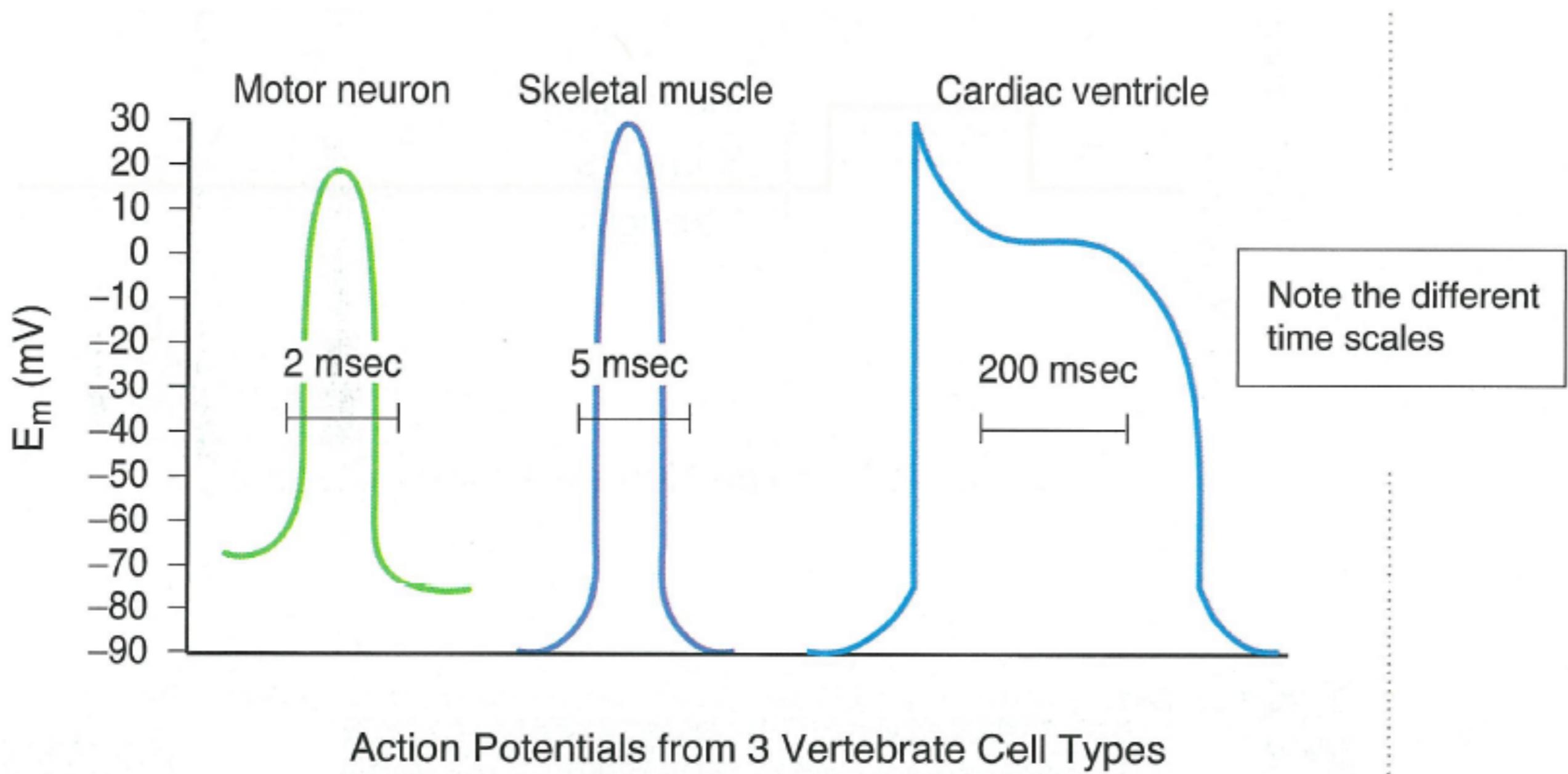
Tipos de neuronas



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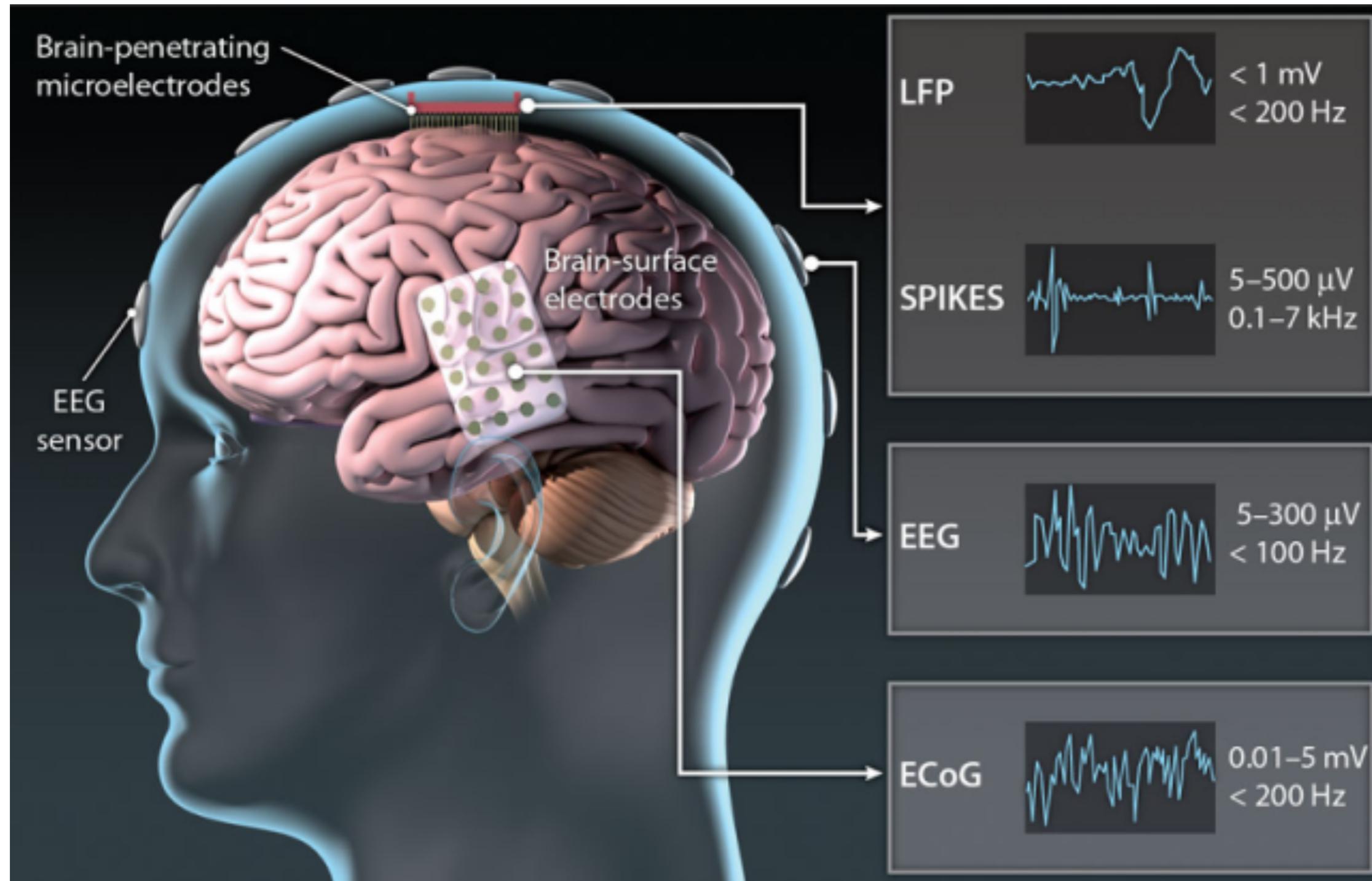
Tipos de señales



Práctica 1

- Arduino básico
- <https://bichosproxemicos.blogspot.com/2016/06/arduino.html>
- <https://bichosproxemicos.blogspot.com/2016/12/el-inicio-del-arduino-una-vez-mas.html>
- Practica conexiones básicas: <https://bichosproxemicos.blogspot.com/2015/11/conexiones-basicas.html>
- Practica Theremin: <https://bichosproxemicos.blogspot.com/2015/11/theremin11111.html> Simulación de redes de neuronas con Arduino
- Descargar la biblioteca de Arduino Neural Library <https://github.com/gunthercox/ArduinoNeuronLibrary>

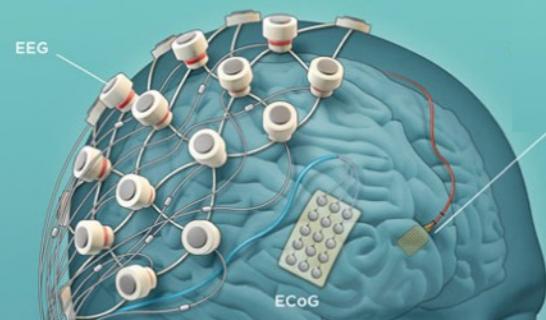
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EXTRANEURAL OR INTRANEURAL PERIPHERAL RECORDING

EMG

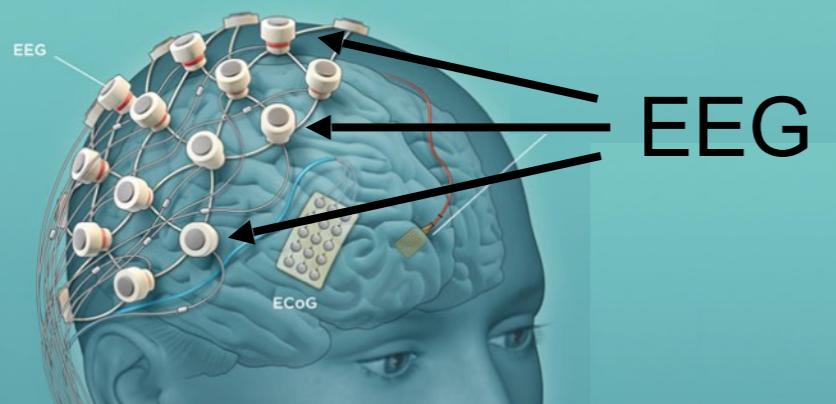


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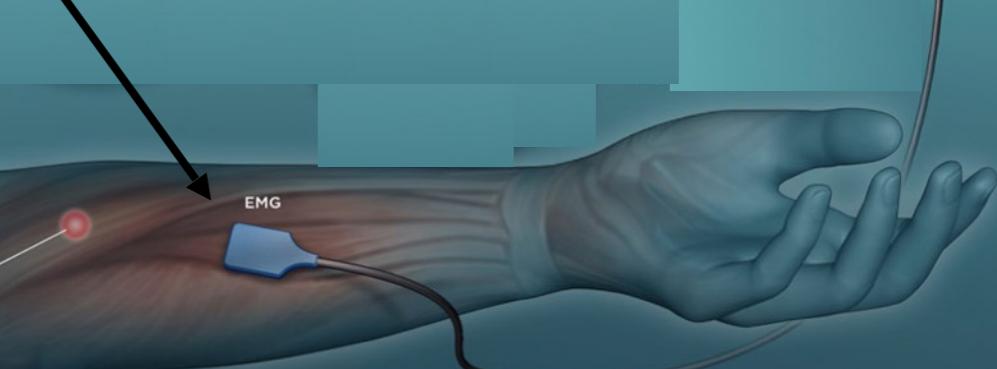
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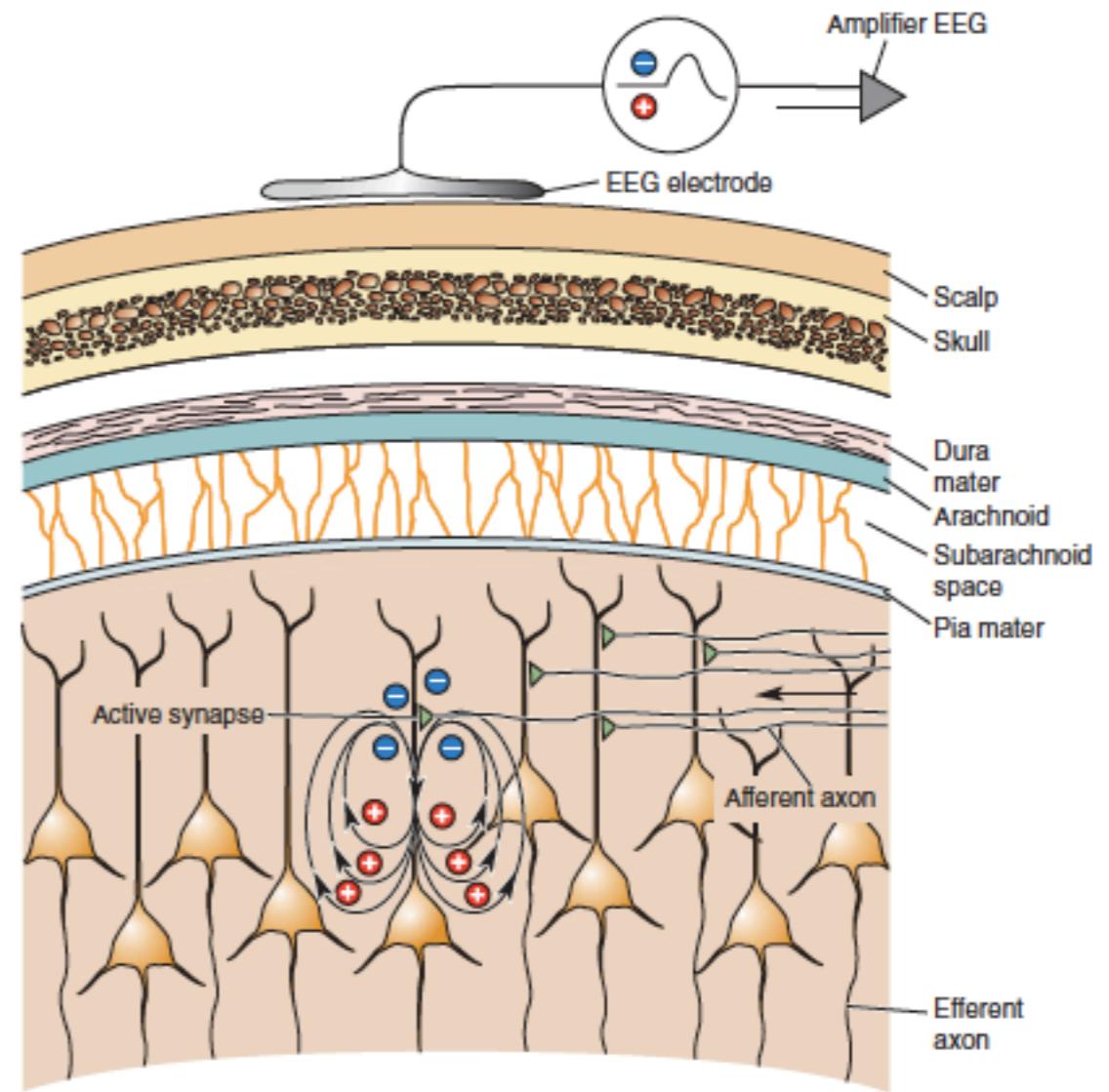
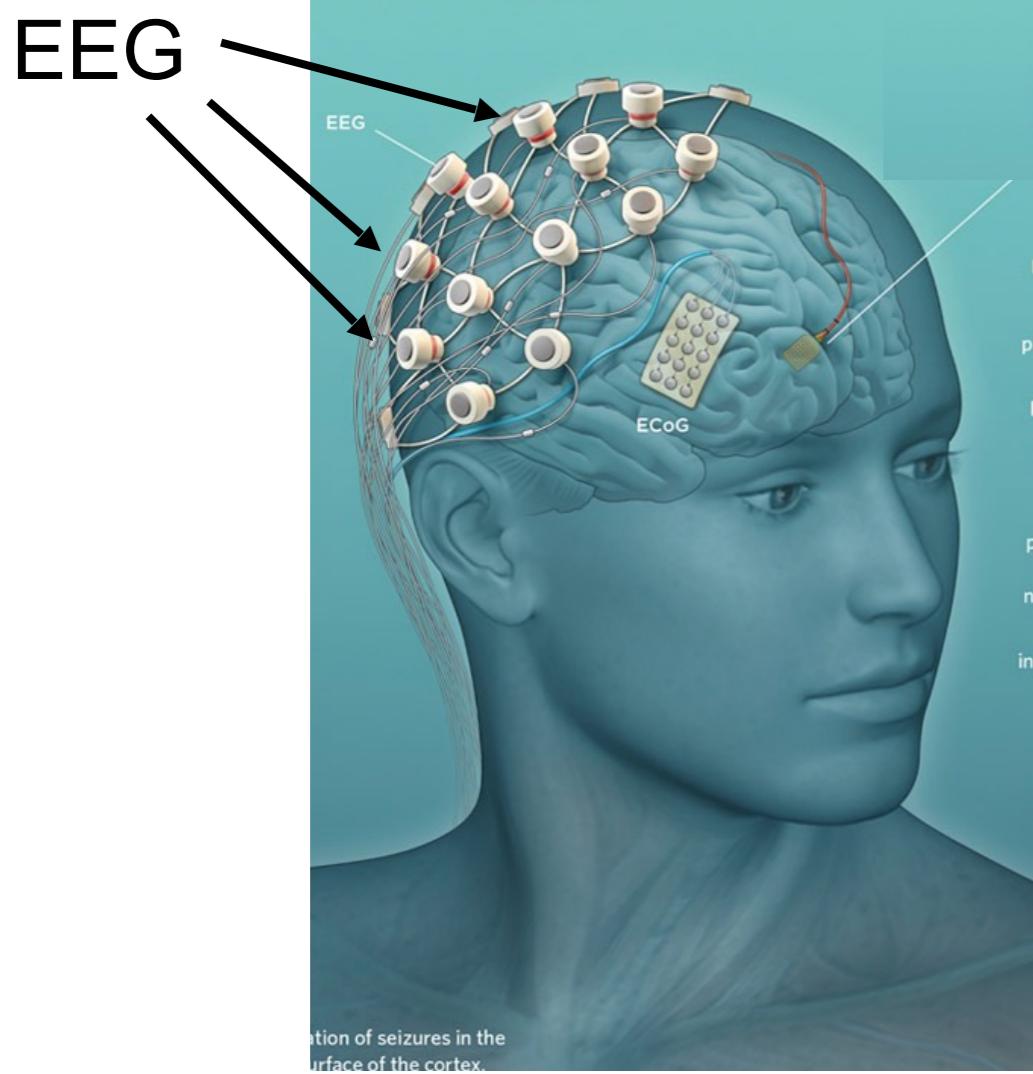
EXTRANEURAL OR INTRANEURAL PERIPHERAL RECORDING



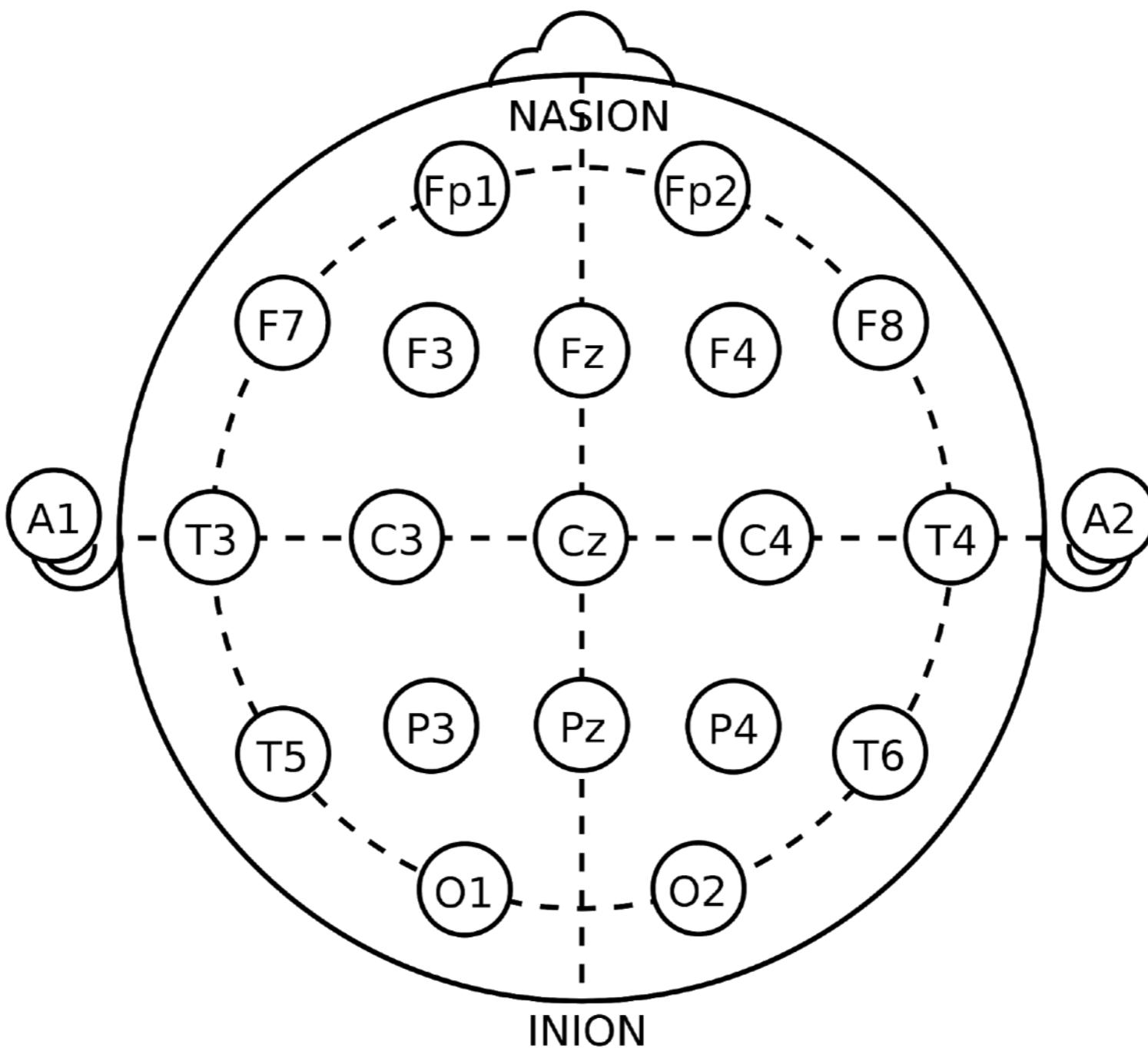
EMG

EEG: ¿Qué medimos?

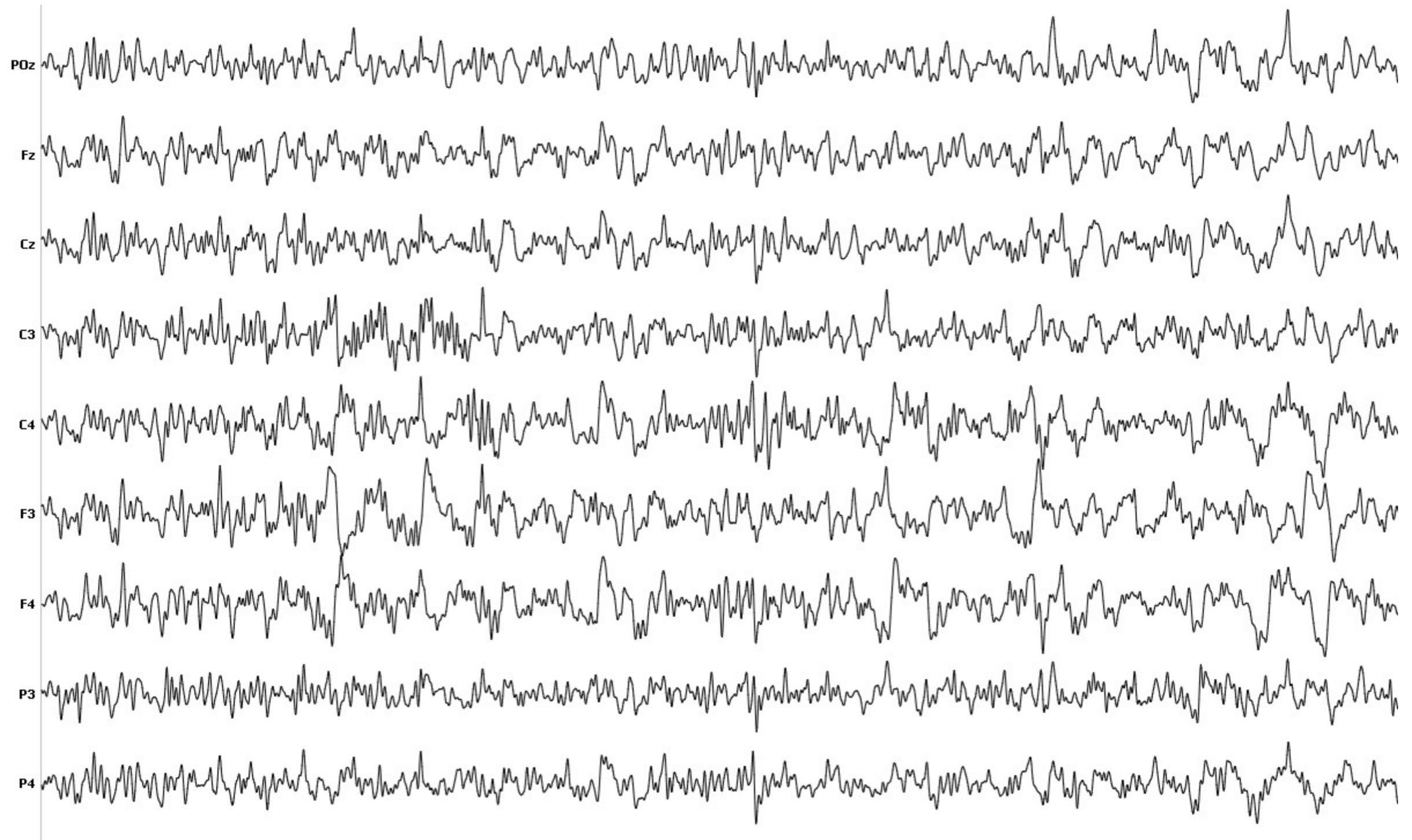
- Suma de la actividad de las neuronas cercanas al electrodo



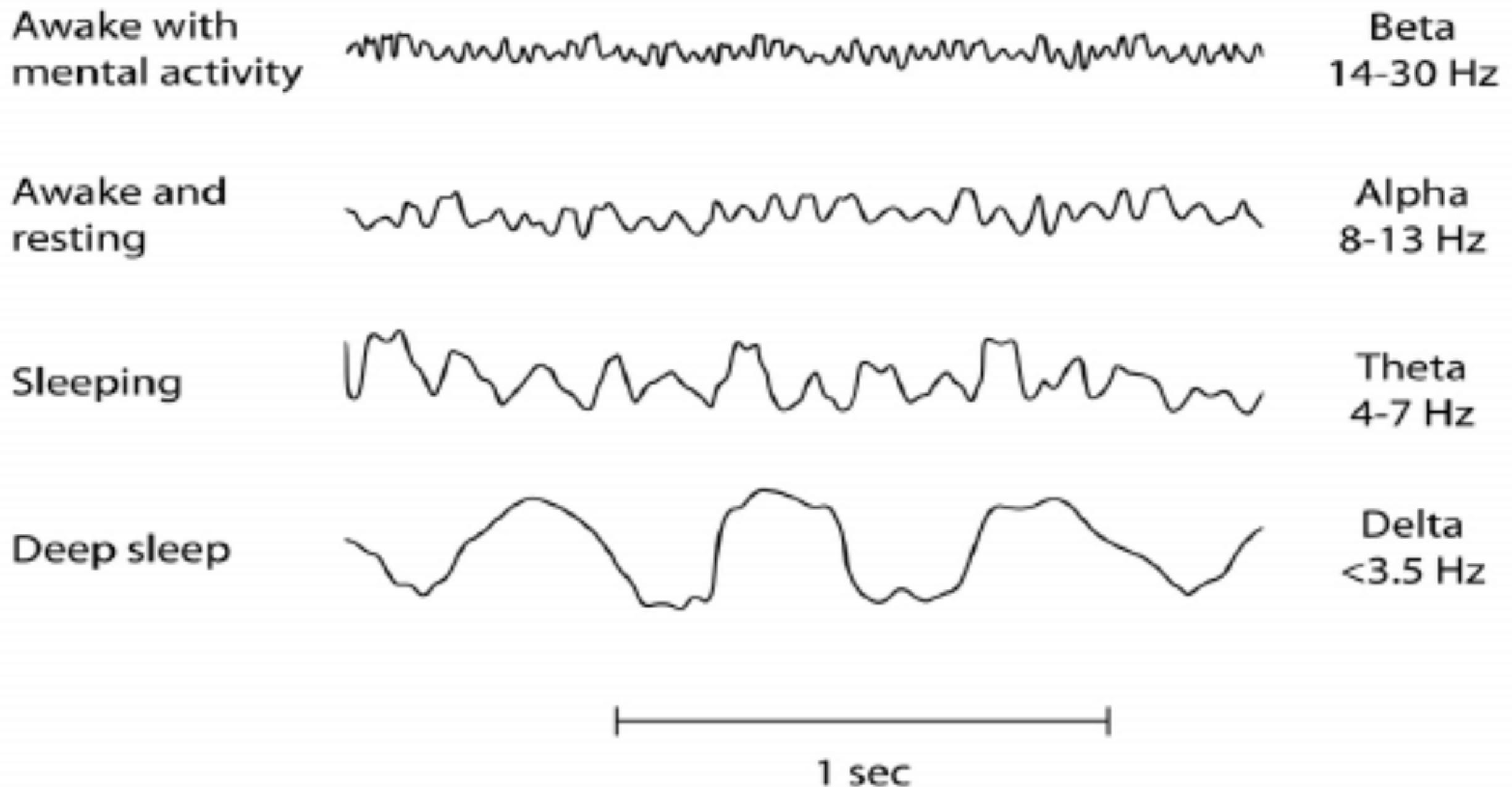
Colocación de los electrodos



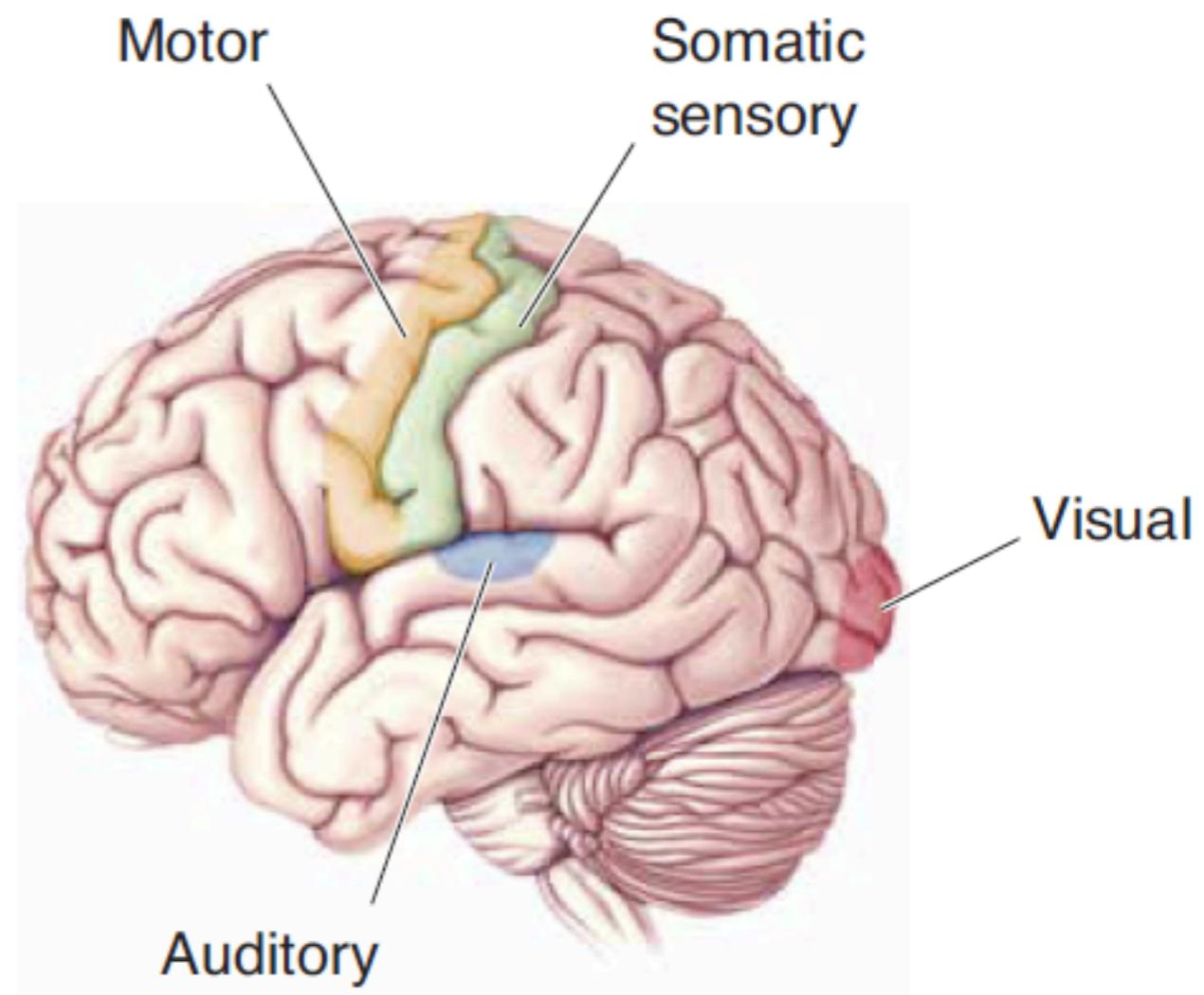
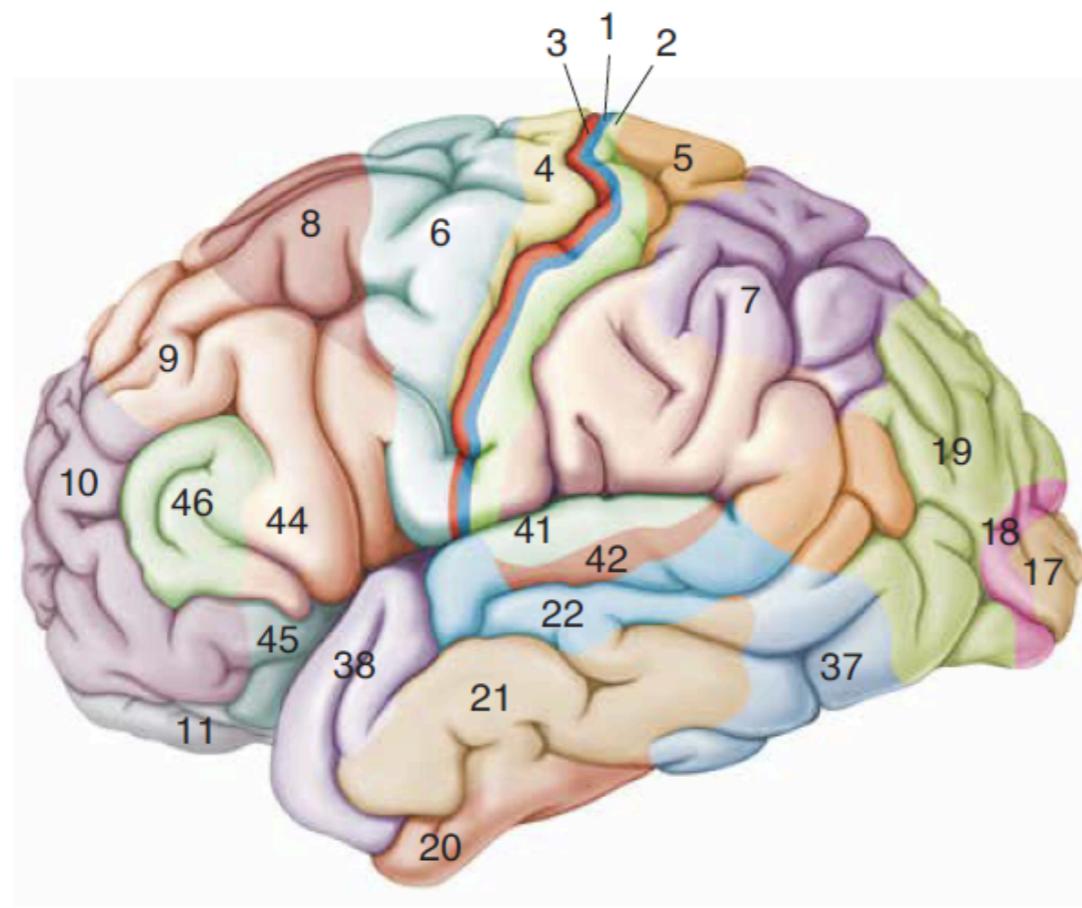
EEG: ¿Qué obtenemos?



¿Qué podemos utilizar?: Oscilaciones neurales

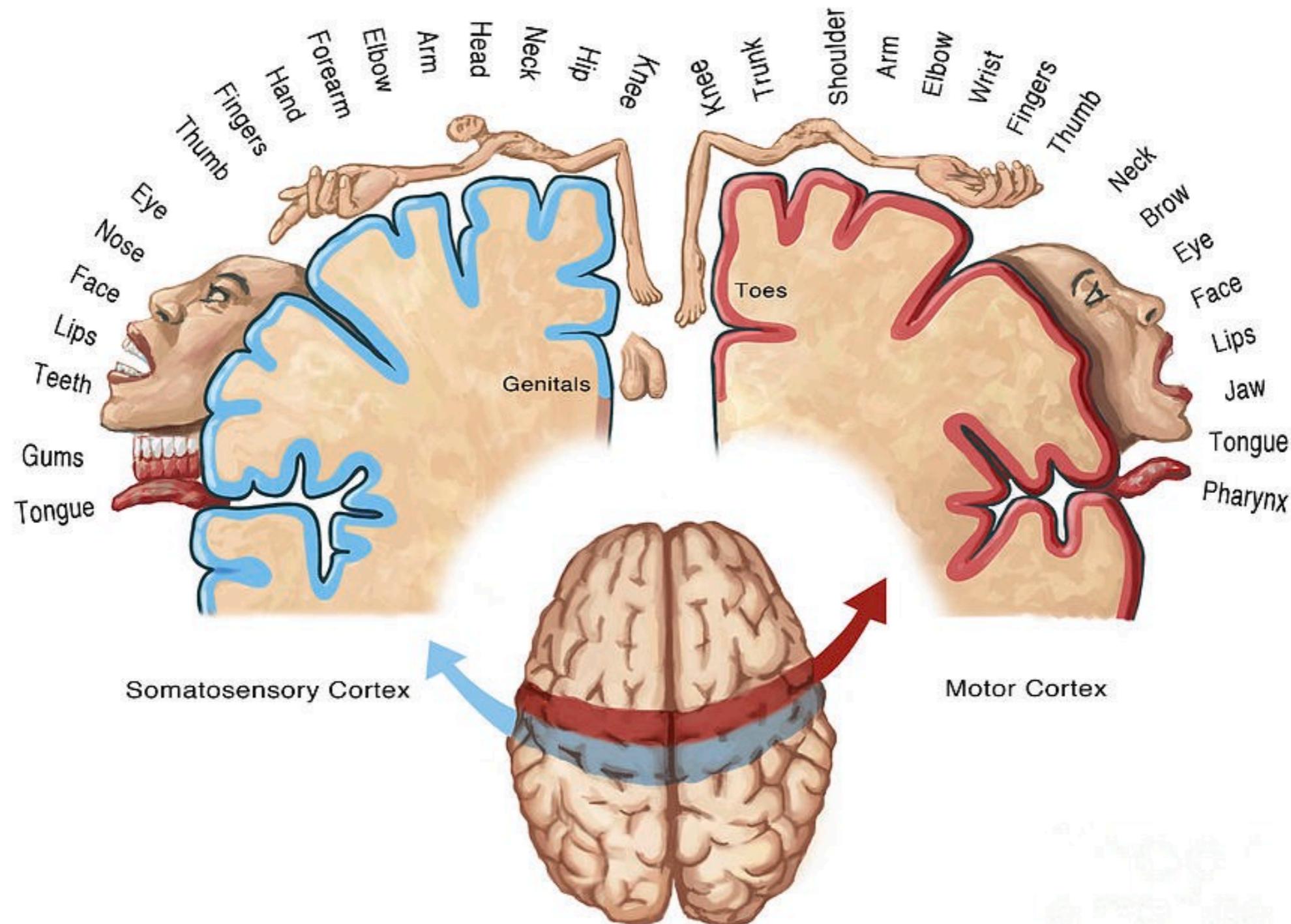


¿Qué podemos utilizar?: Localización de los electrodos



▲ FIGURE 7.28
Brodmann's cytoarchitectural map of the human cerebral cortex.

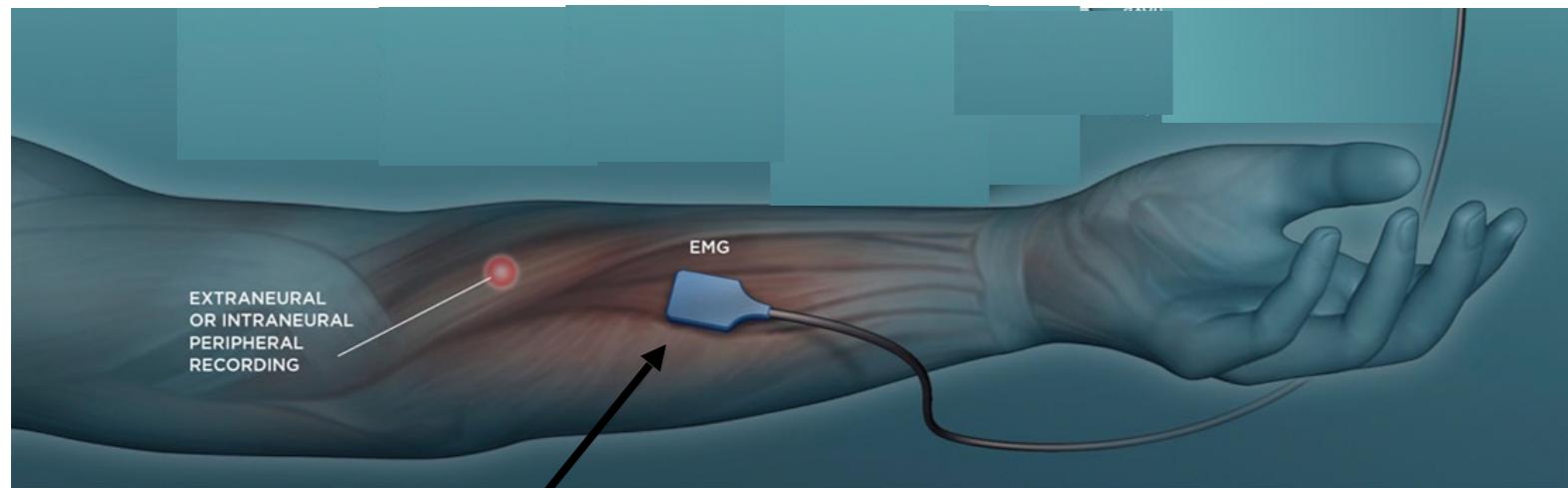
¿Qué podemos utilizar?: Localización de los electrodos



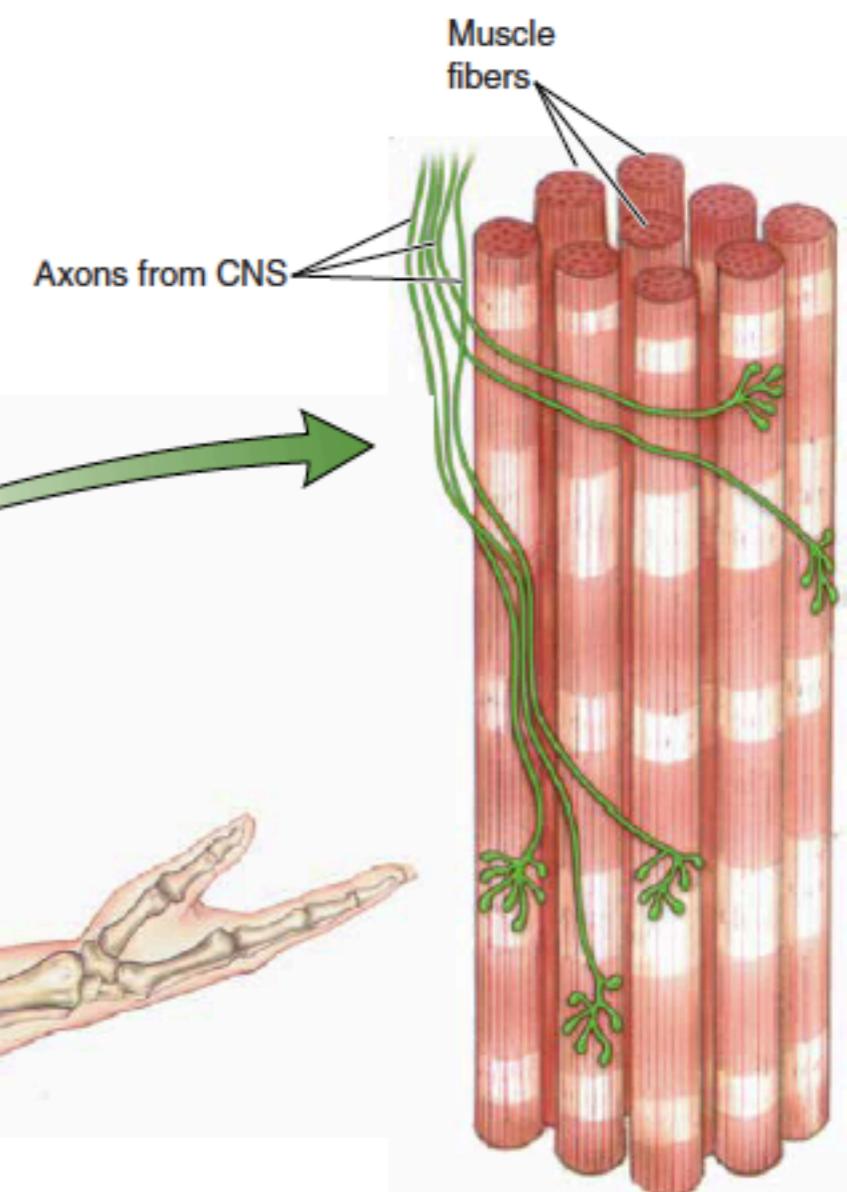
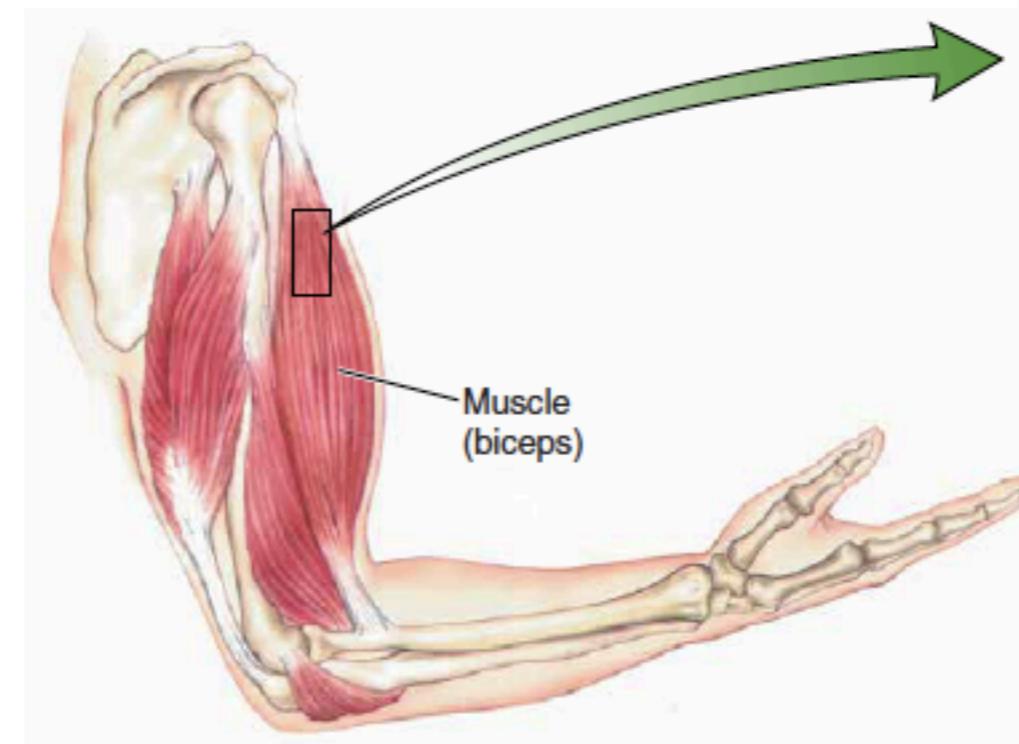
EEG: Limitaciones

- En la mayoría de los casos no sabemos qué significan las señales
- Solo se captan señales sincronizadas
- Separación entre el electrodo y el cerebro

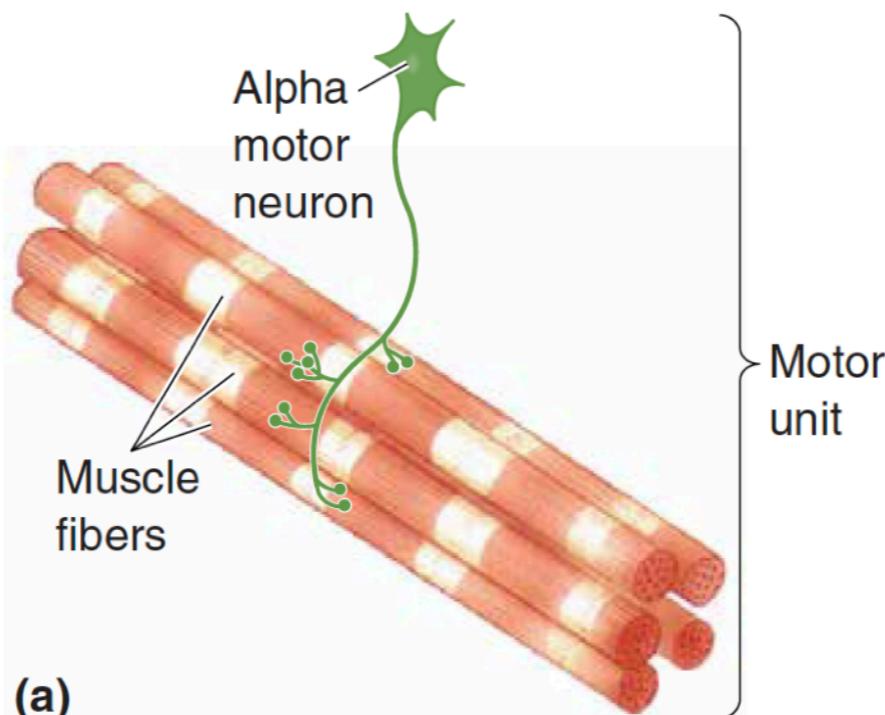
EMG: ¿Qué medimos?



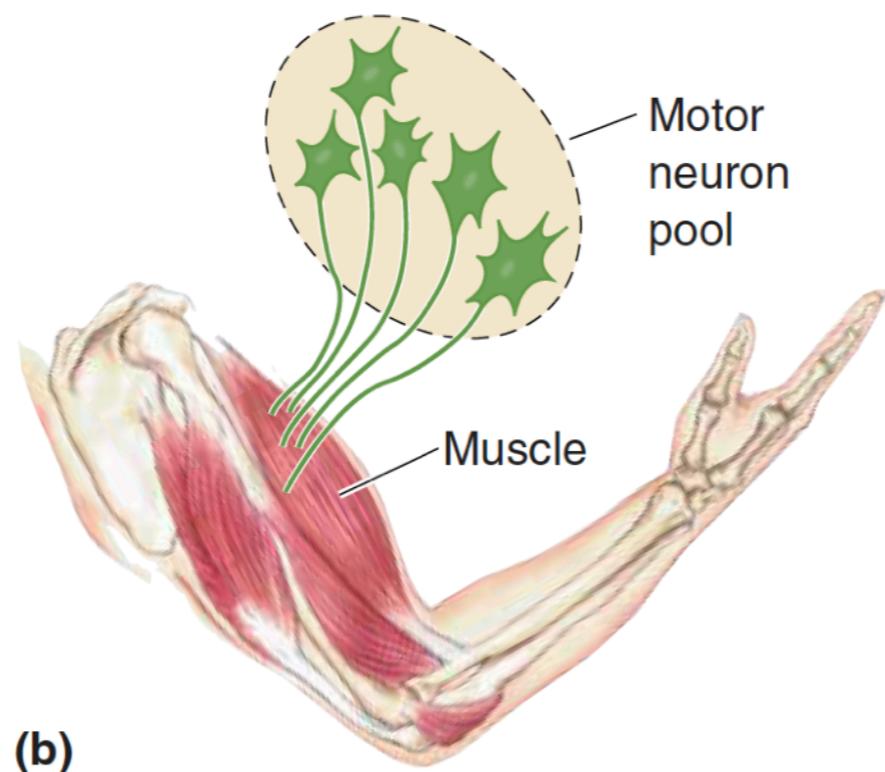
EMG



Unidad motora

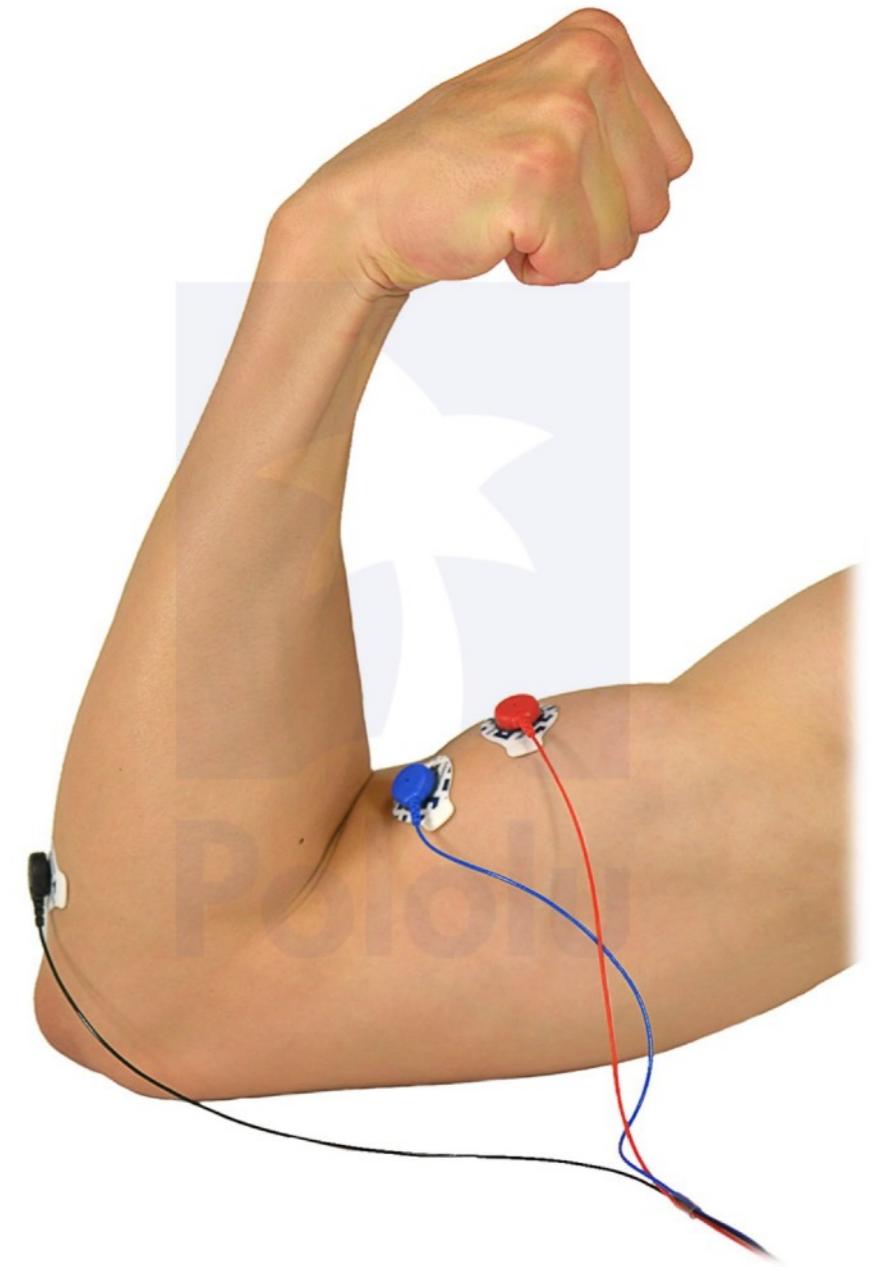
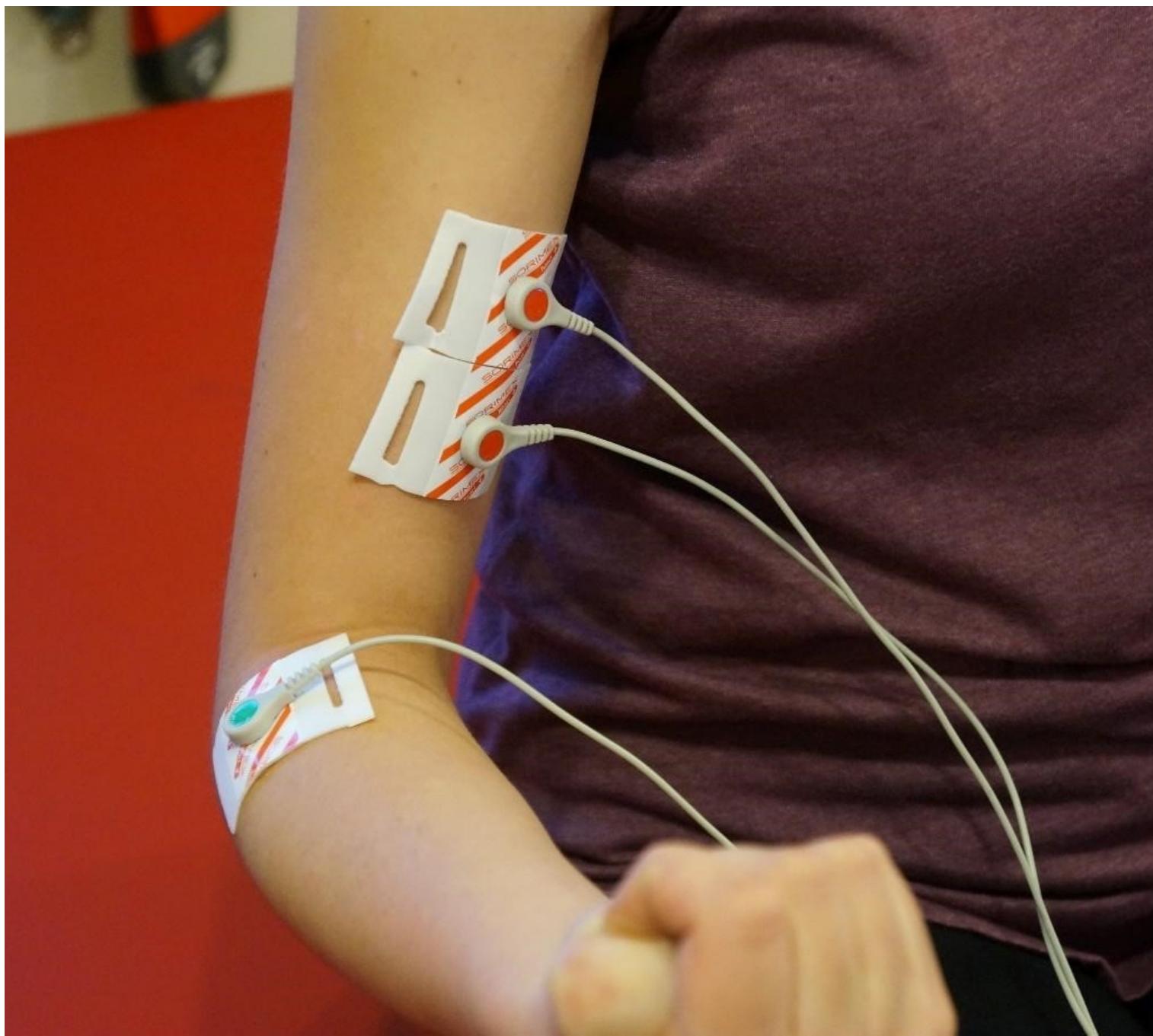


(a)

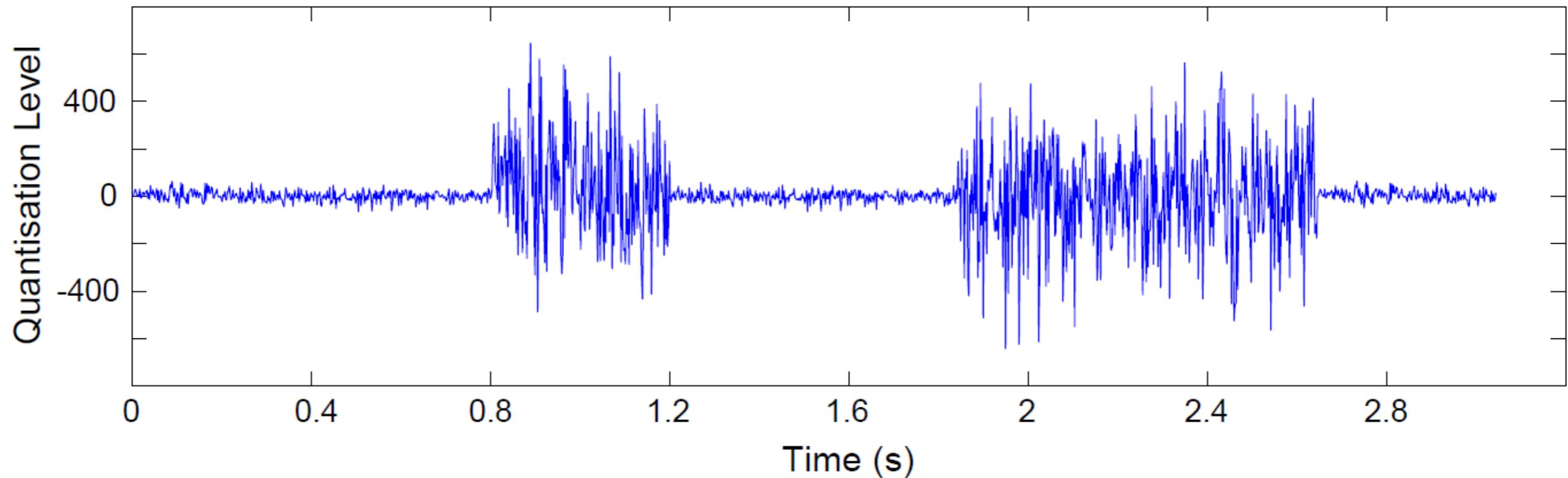


(b)

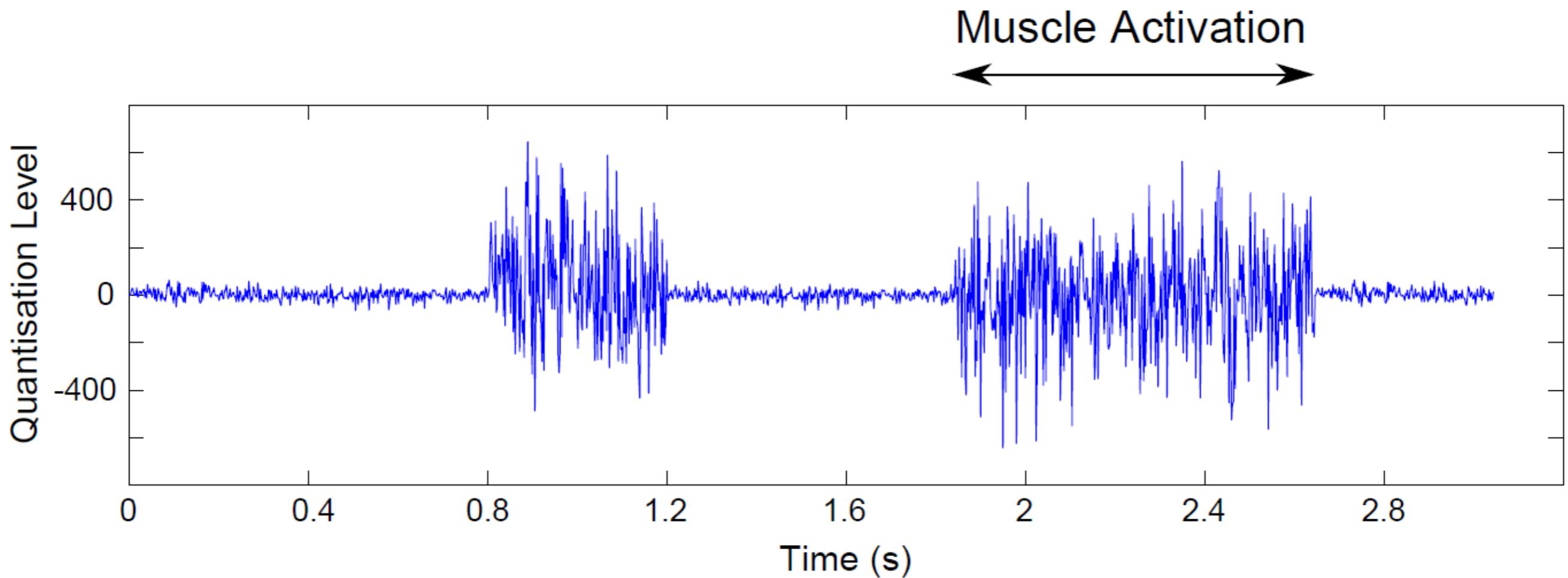
Colocación de los electrodos



EMG: ¿Qué obtenemos?



¿Qué podemos utilizar?: Contracción muscular

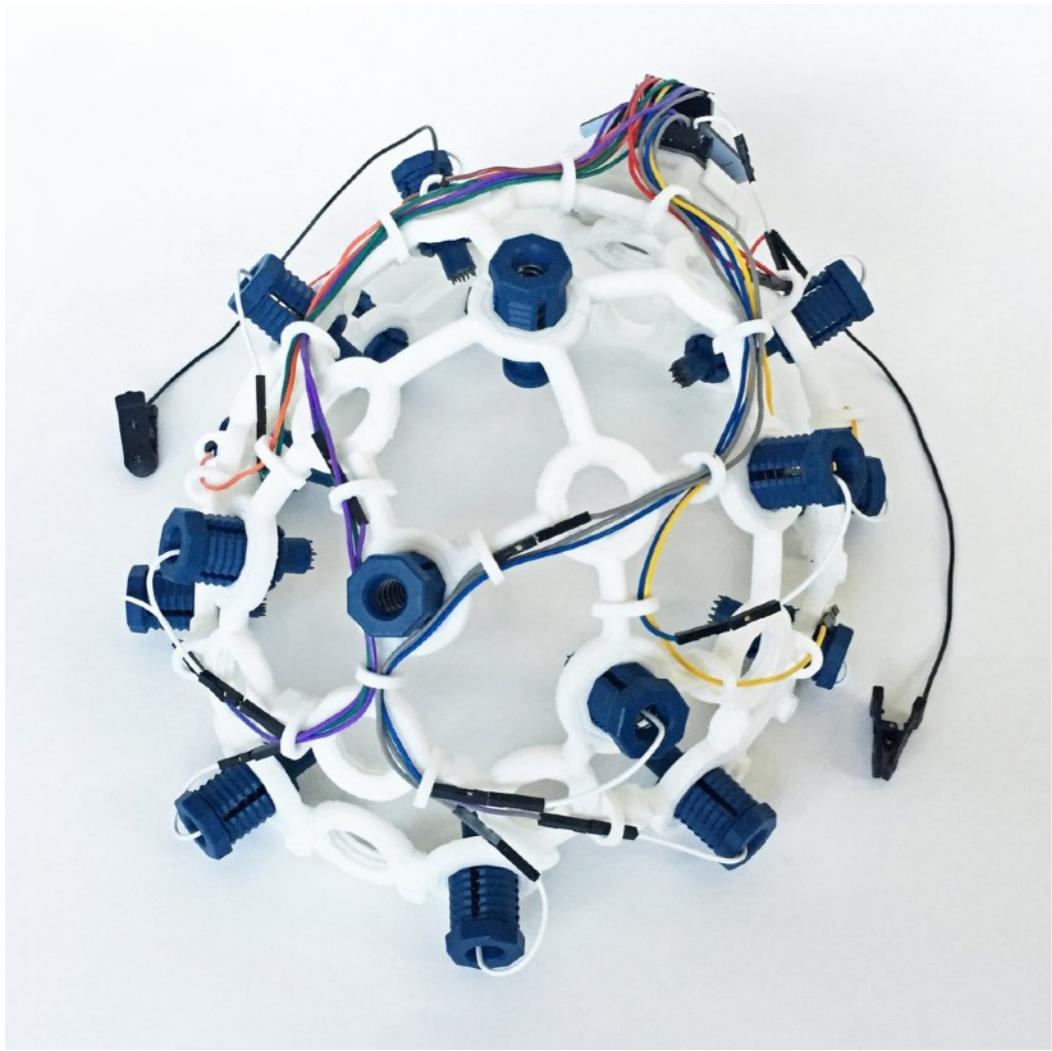


EMG: Limitaciones

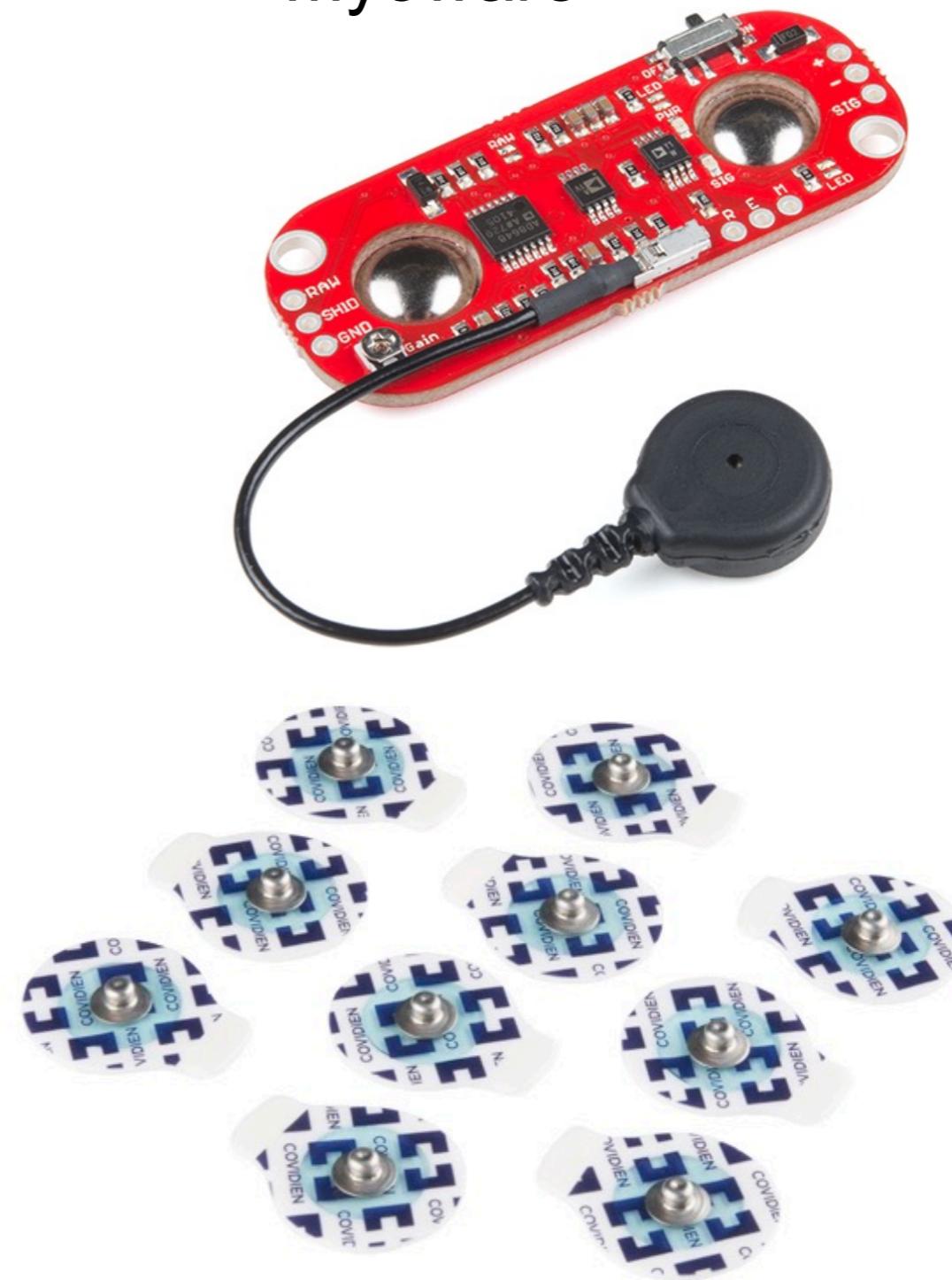
- Solo podemos medir músculos superficiales
- No se puede distinguir actividad de músculos cercanos
- Separación entre el electrodo y el músculo (piel, grasa)

Dispositivos comerciales

OpenBCI

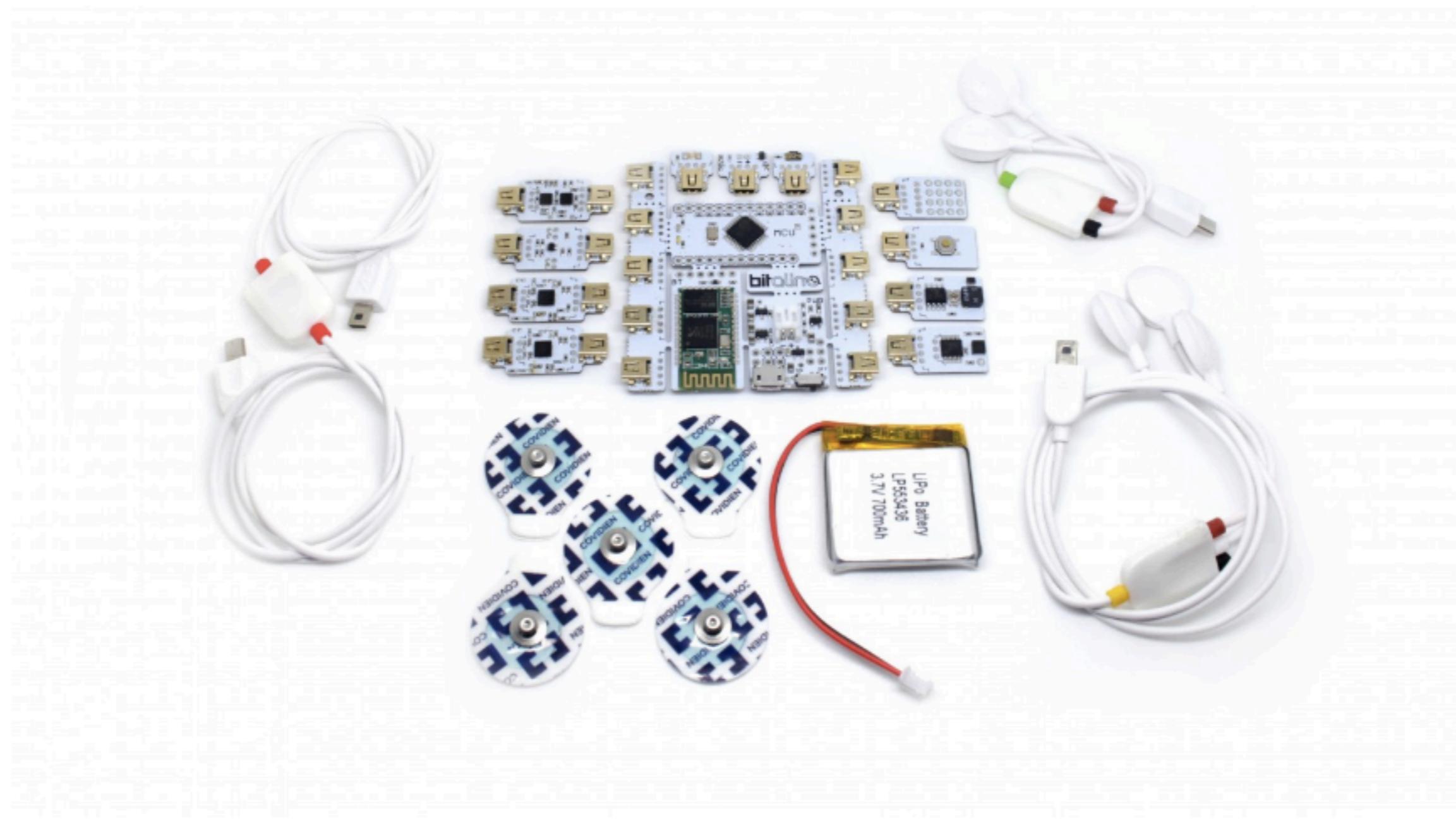


Myoware



Dispositivos comerciales

Bitalino





Consideraciones de seguridad



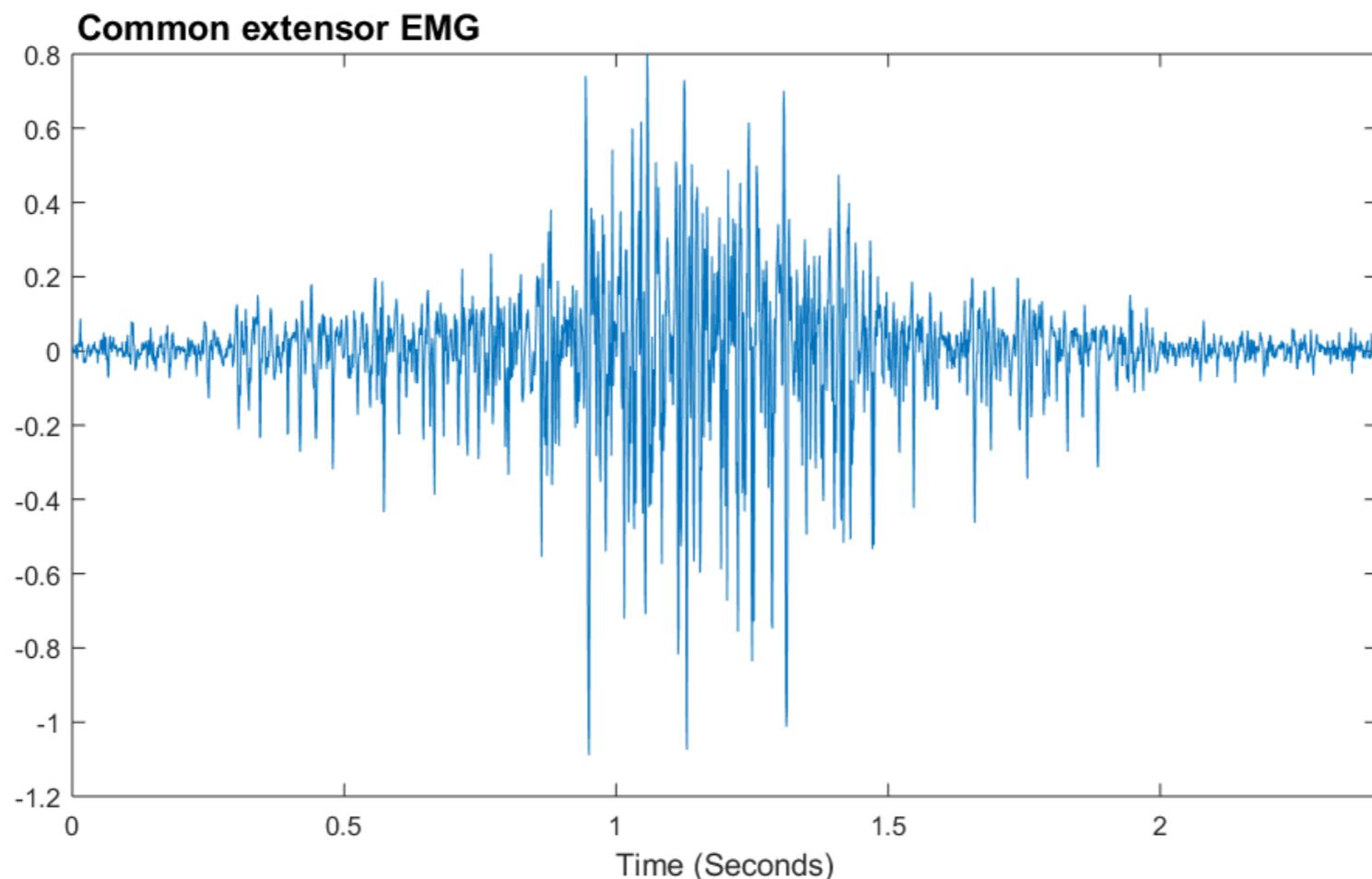
- **Aislamiento del circuito de electrodos del ordenador.** Si la transmisión de datos es a través de un USB utilizar **opto-aislamiento**. En este caso, alimentar el ordenador exclusivamente con baterías (que no esté conectado a la corriente). Otra opción sería utilizar **Bluetooth**.
- Alimentar el microcontrolador con baterías
- No conectar nunca los electrodos al cuerpo mientras el microcontrolador está conectado al ordenador (durante la fase de programación y carga del software)
- No tocar otros dispositivos electrónicos mientras se llevan electrodos en el cuerpo.

Práctica 2

- Colocación de electrodos EMG
- Circuito Arduino-Myoware con USB o bluetooth: <https://cdn.sparkfun.com/assets/a/3/a/f/a/AT-04-001.pdf>
- Vincular con otros programas:
 - Max, Processing, SuperCollider, etc.
 - Observar la señal en distintos músculos

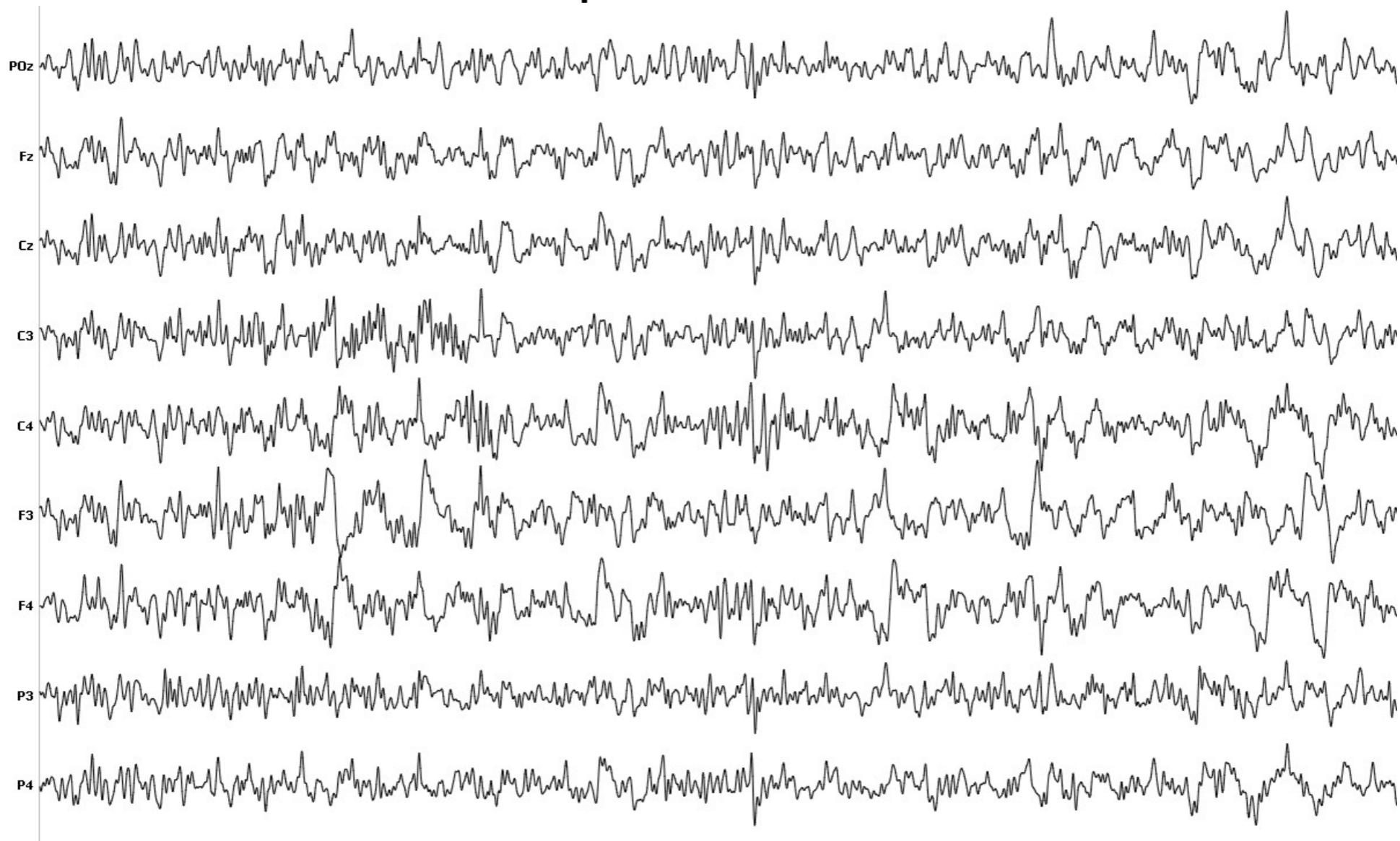
¿Cuál es el objetivo de obtener y procesar la señal?

- Queremos extraer valores que podamos utilizar como actuadores/parámetros en nuestro proyecto artístico



Ejemplo 1: EEG

- Queremos que los colores de unas luces cambien con el estado mental de una persona conectada a un EEG



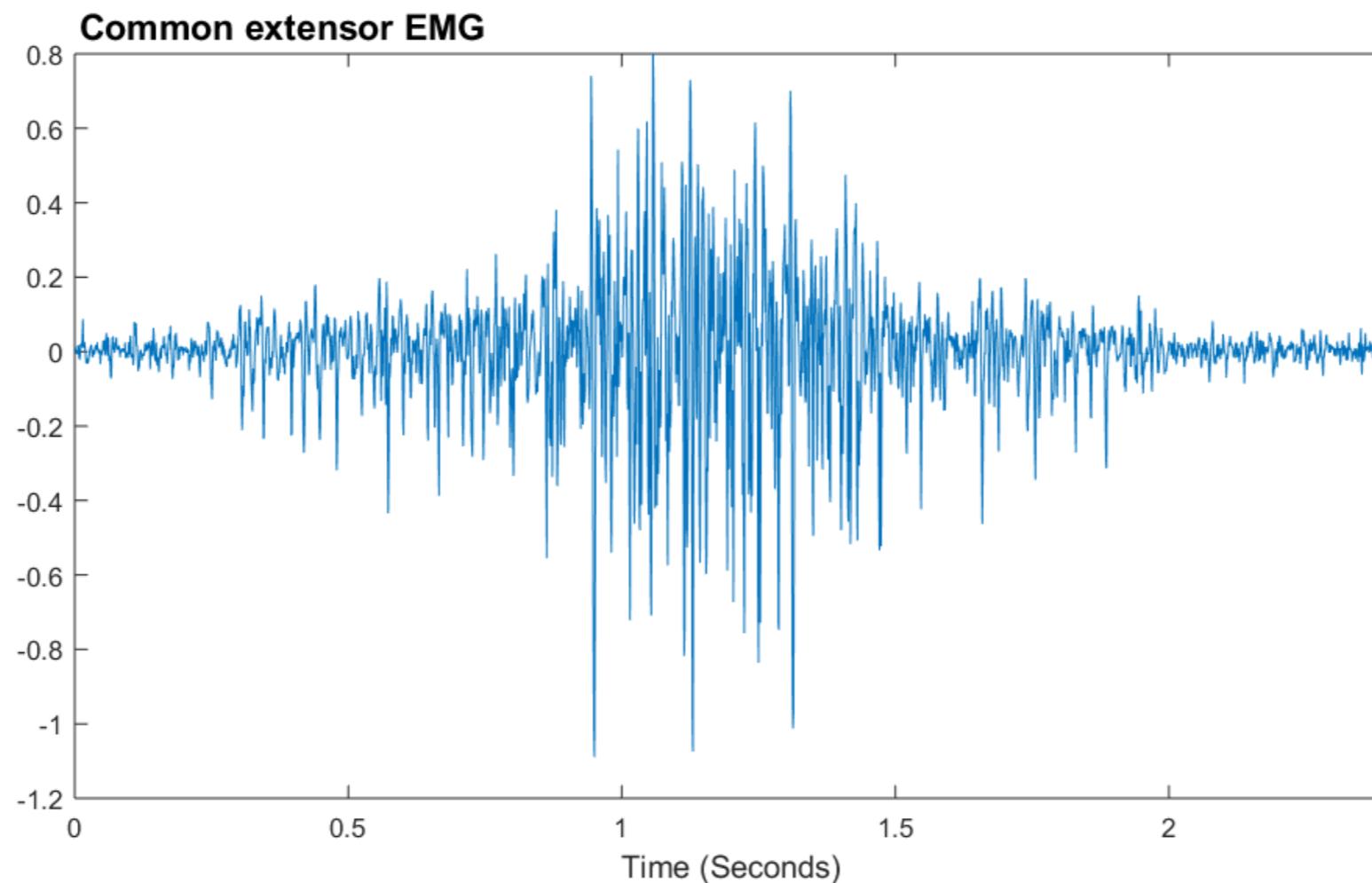
La transformada de Fourier



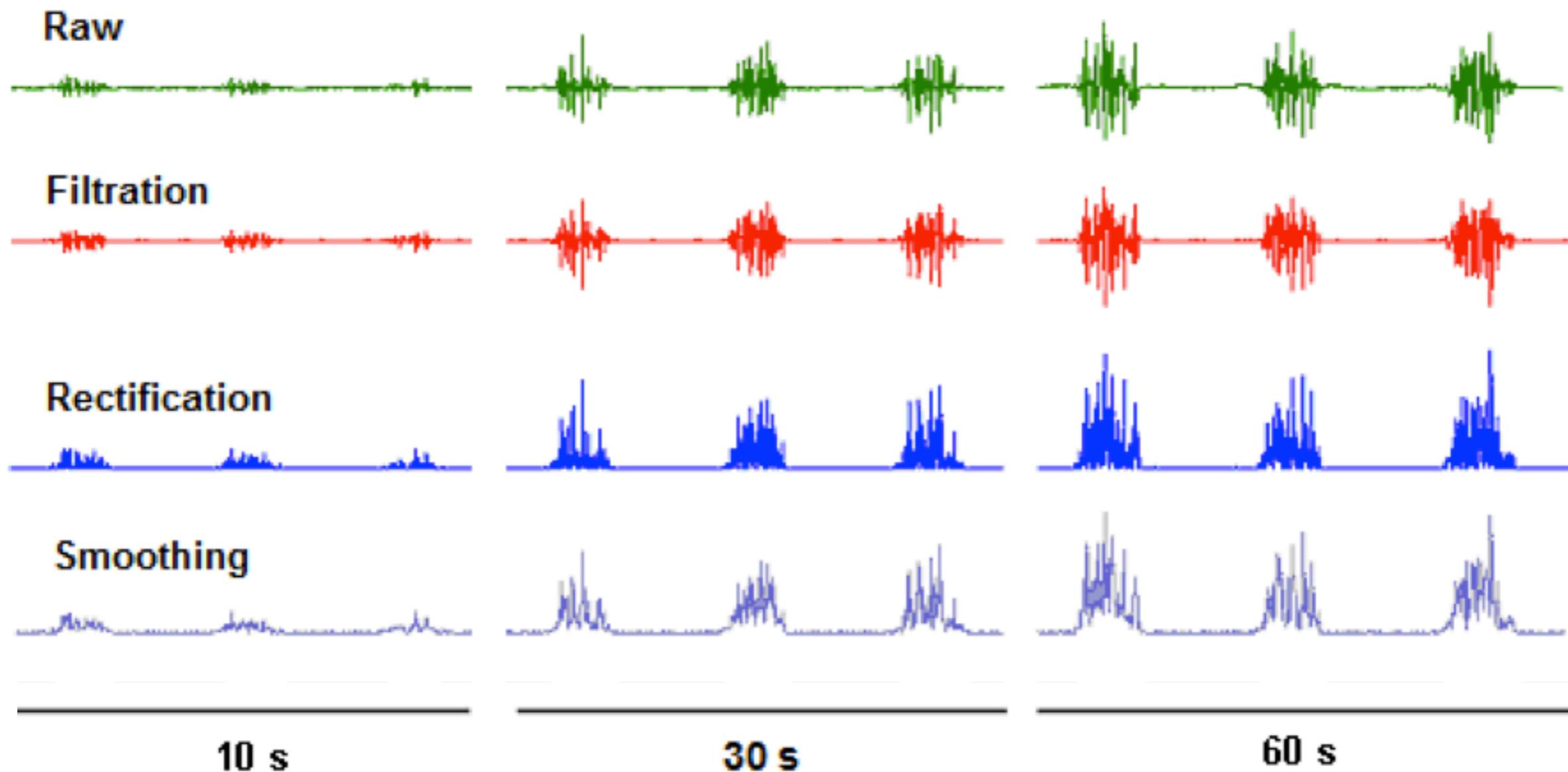
[Source: <https://www.norwegiancreations.com/2017/08/what-is-fft-and-how-can-you-implement-it-on-an-arduino/>]

Ejemplo 2: EMG

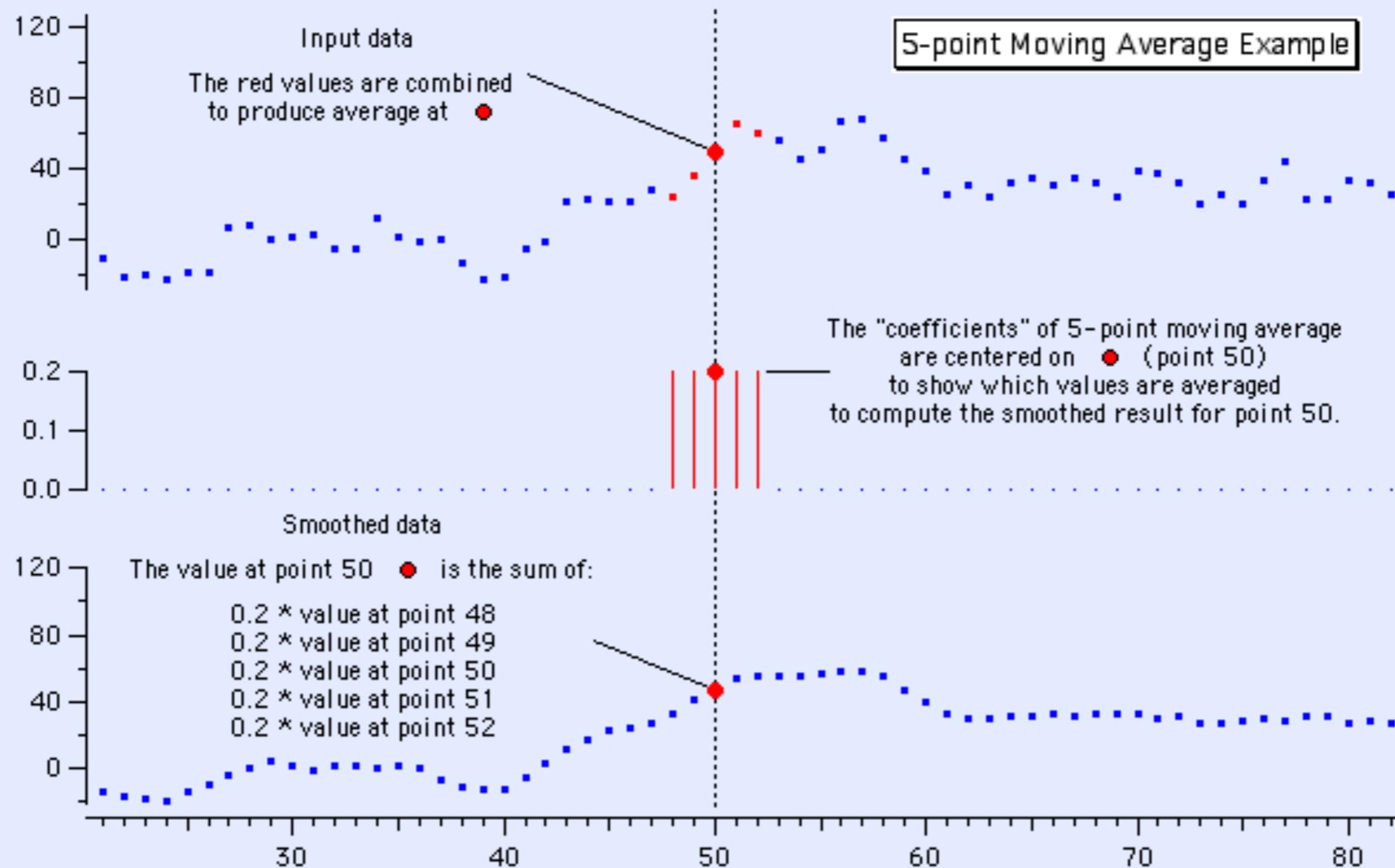
- Queremos que una luz permanezca encendida cuando la persona con un EMG conectado al biceps contraiga el músculo



Aplicando distintas transformaciones

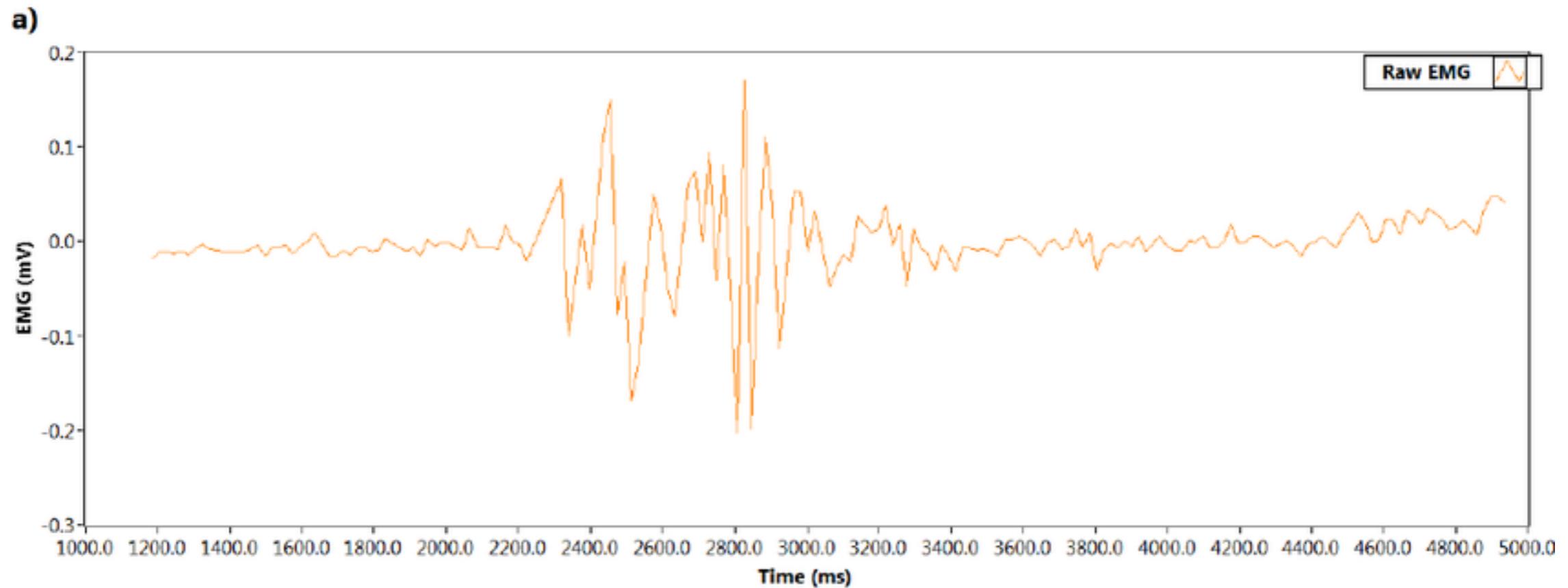


Smoothing: media móvil



[Source: <https://www.wavemetrics.com/products/igorpro/dataanalysis/signalprocessing/smoothing>]

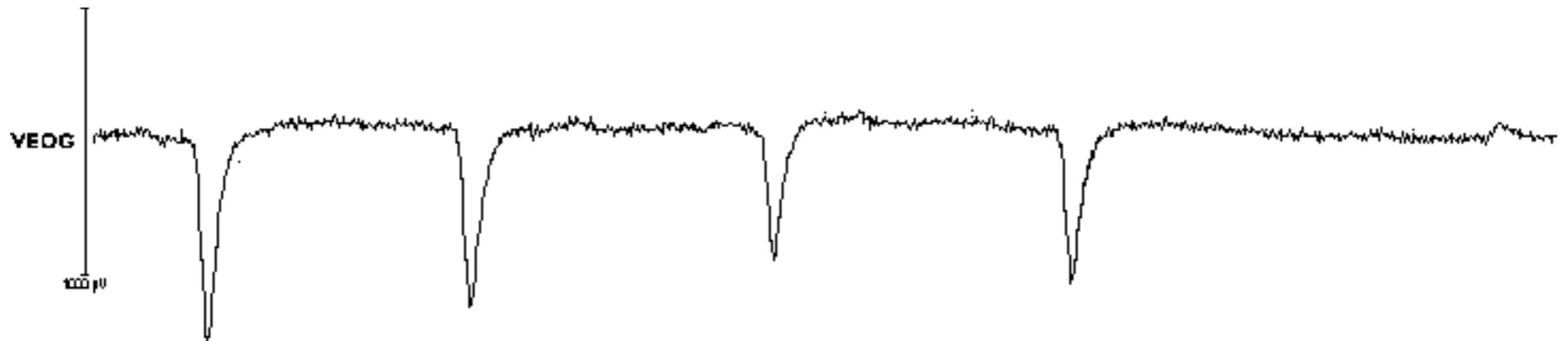
Problemas: Ruido



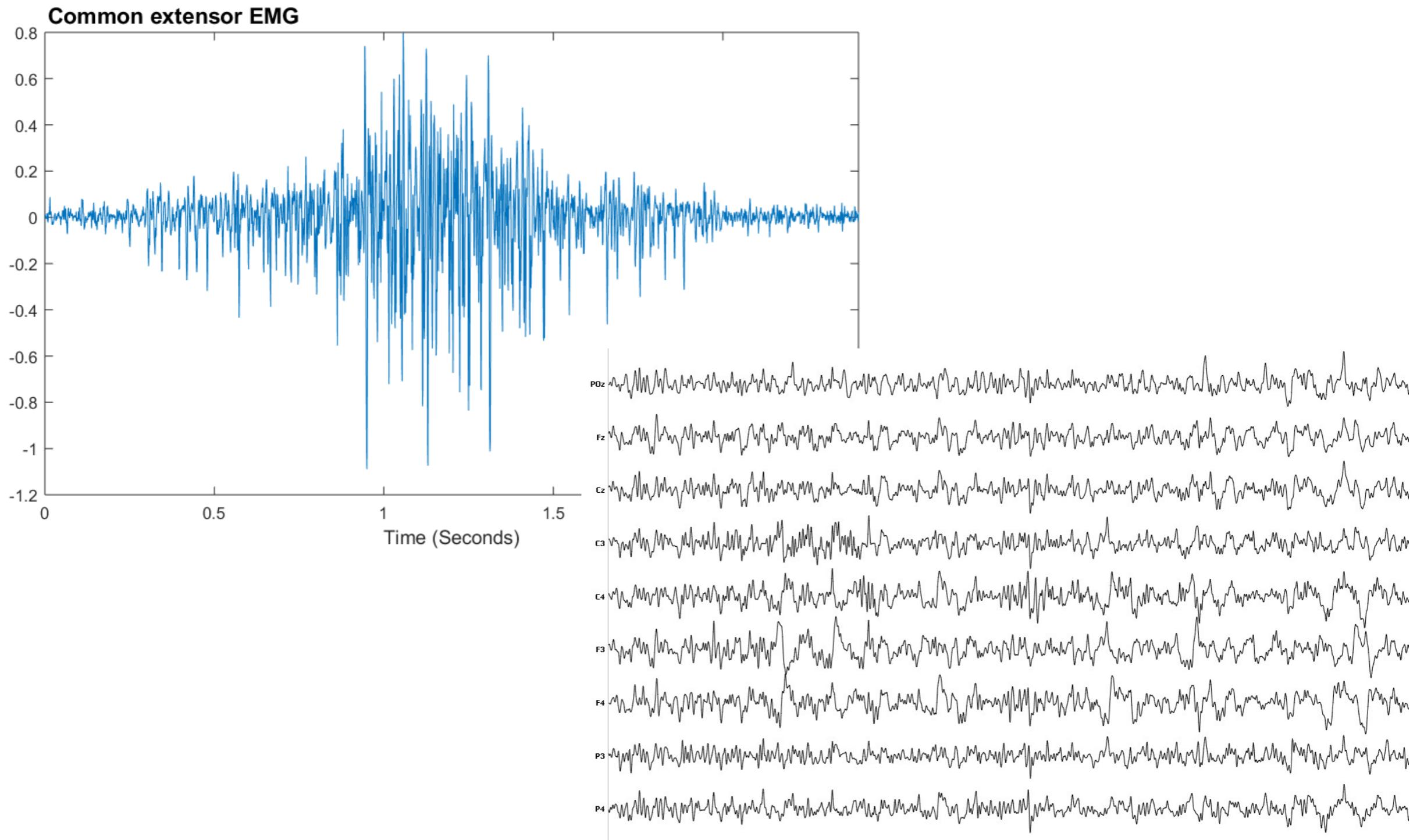
- Señal = actividad del sistema nervioso debajo del electrodo + **RUIDO**
- **Antes de extraer la información**, necesitamos **preprocesar las señales** para eliminar el ruido

Fuentes de Ruido

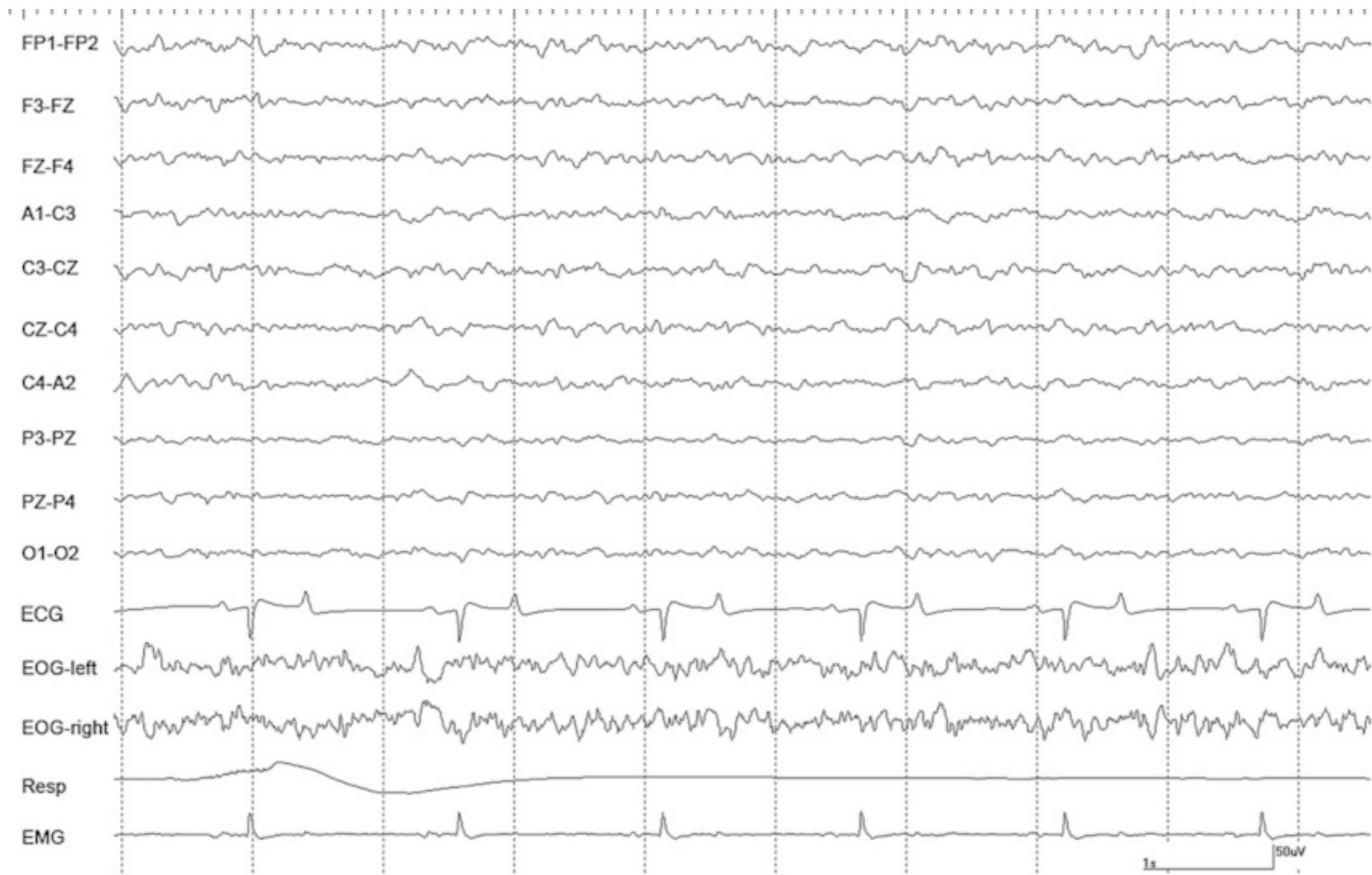
- Ruido propio del electrodo
- Artefactos de movimiento
- Ruido electromagnético
- Crosstalk



Problemas: Procesado en tiempo real



Solución: Epoching



Práctica 3: Procesado de señales

- Ver diferencia entre señal Raw y procesada de Myoware
- Circuitos básicos (encender un LED o led RGB, servo, etc)
- Calcular FFT en Arduino

Contracción del músculo

