

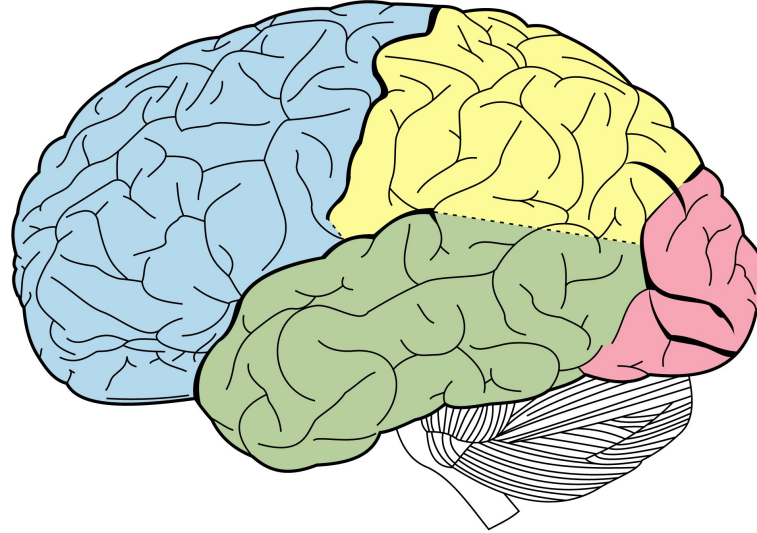
Intro to Brain-Computer Interfaces

Overview

- Brain Structure
 - Lobes
 - Neuron
- Brain Recording
 - Invasive
 - Non-invasive
- What is BCI?
- Applications
- How does it work?
- BCI Types

Frontal

- Logic
- Reasoning
- Motor planning
- Speech initiation



Parietal

- Sensory processing
- Orientation

Temporal

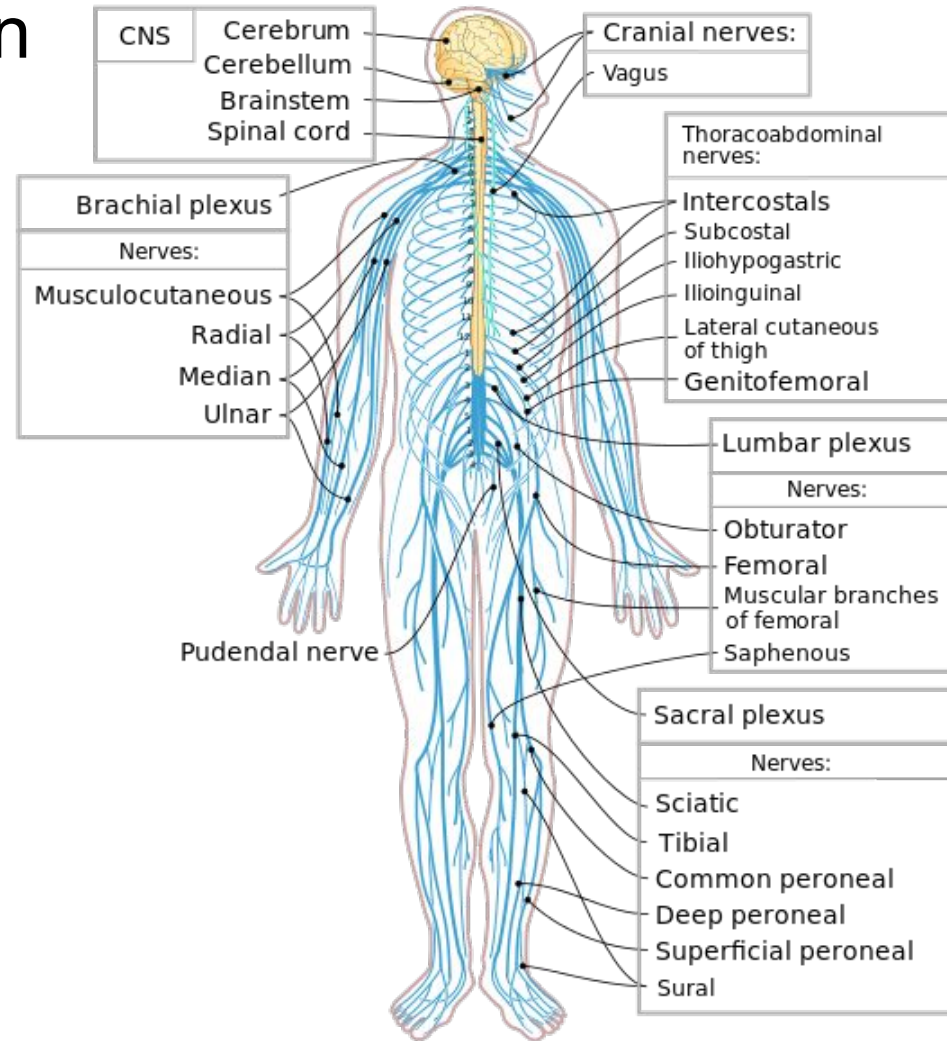
- Memory
- Speech processing

Occipital

- Visual processing

Measuring human cognition

- Central nervous system
 - PET
 - fMRI
 - fNIRS
 - MEG
 - EEG
 - ECoG
- Peripheral nervous system
 - EMG (muscles)
 - ECG (heart)
 - EGG (stomach)
 - EOG (eyes)
 - GSR (sweat)



Brain Recording

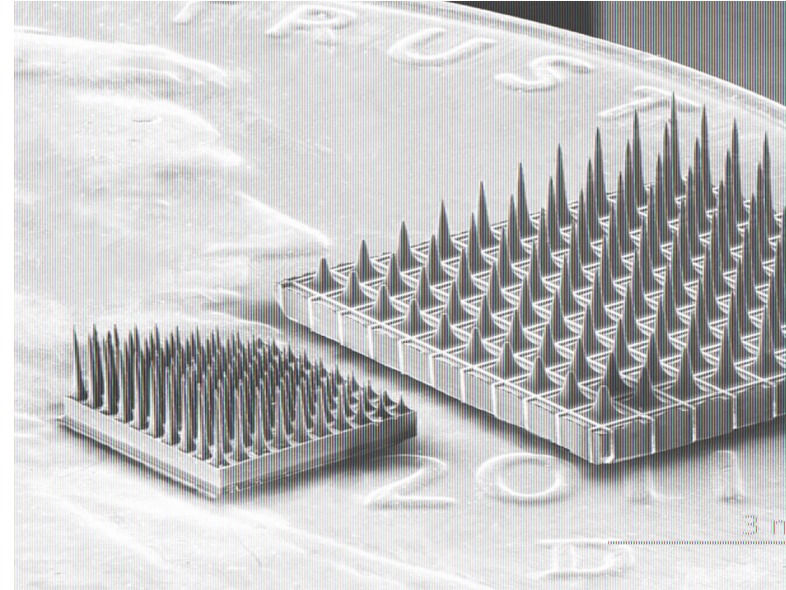
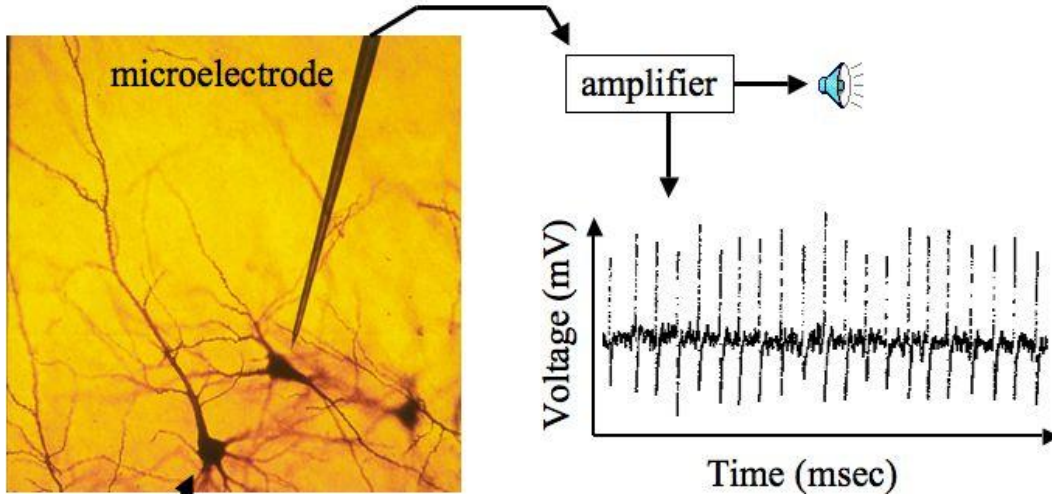
Invasive

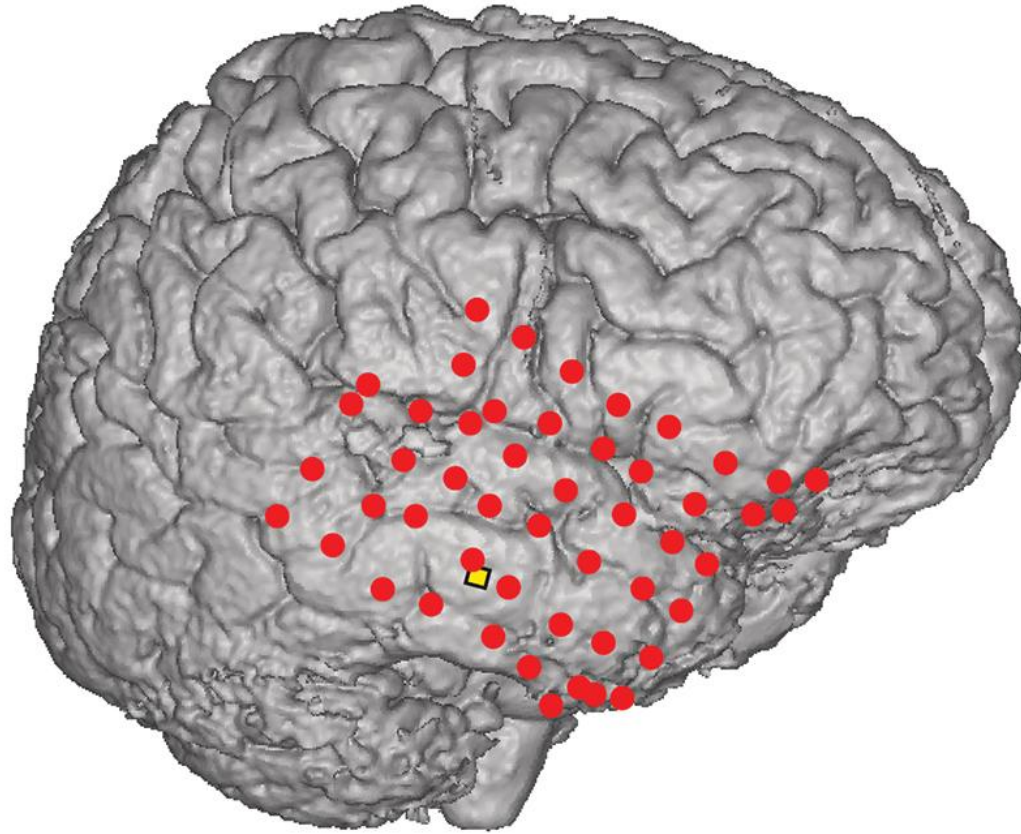
- Requires surgery
- More accurate
- Single-neuron
- Group of neurons

Non-invasive

- No surgery
- Less accurate
- Larger groups of neurons

Invasive - Single cell recording



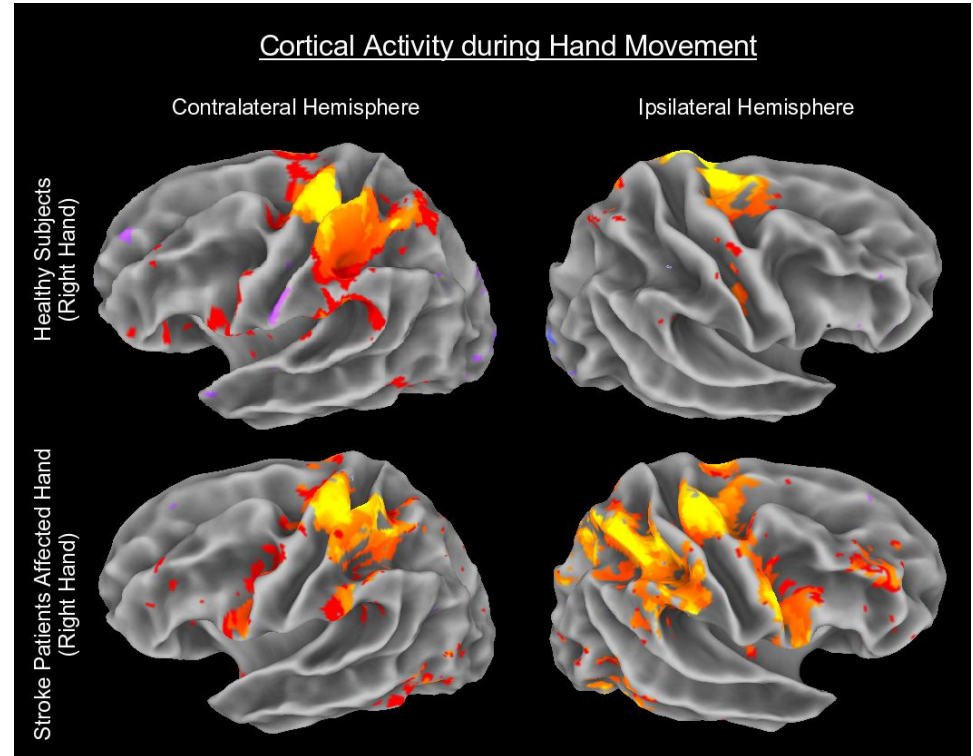


Invasive - Electrocorticography (ECoG)



Noninvasive - Electroencephalography (EEG)

Noninvasive - fMRI



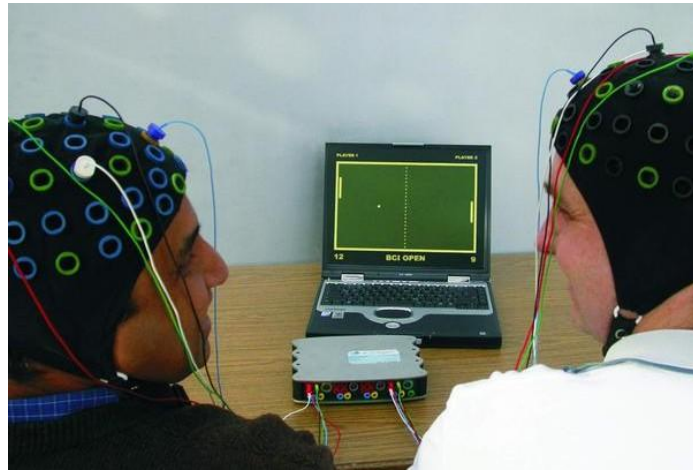
What is BCI?

Brain-Computer Interface

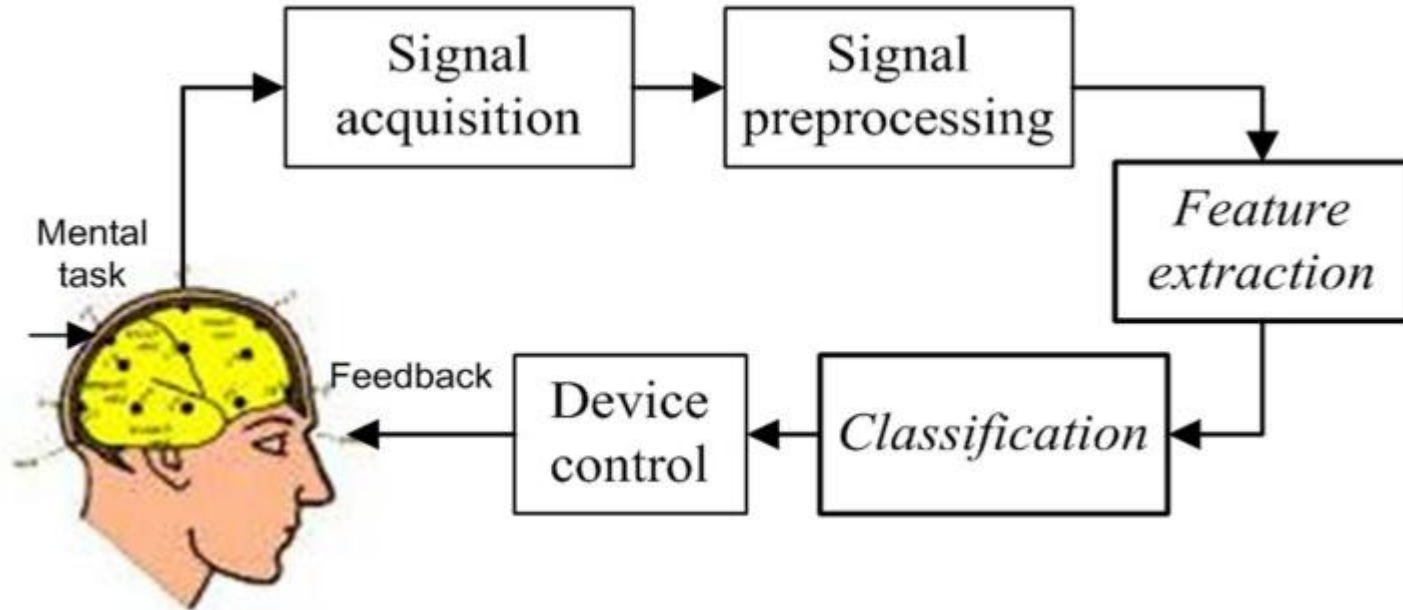
“Direct communication pathway between the brain and an external device” (Wikipedia)



Applications



How does it work?

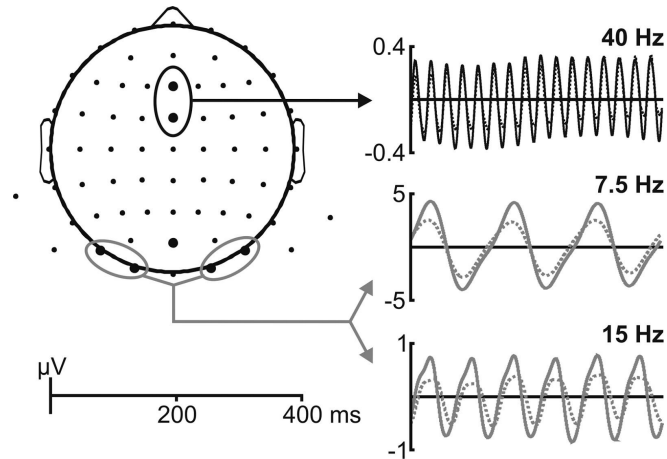


BCI Types

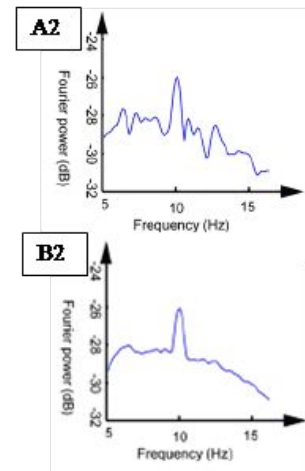
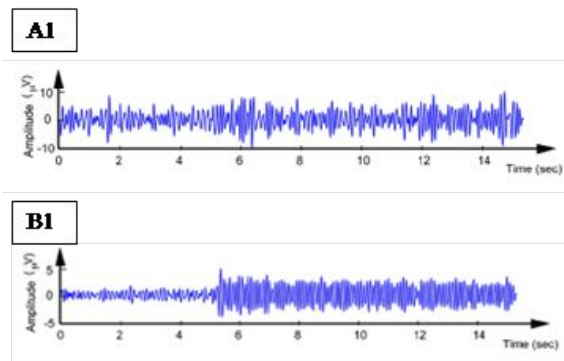
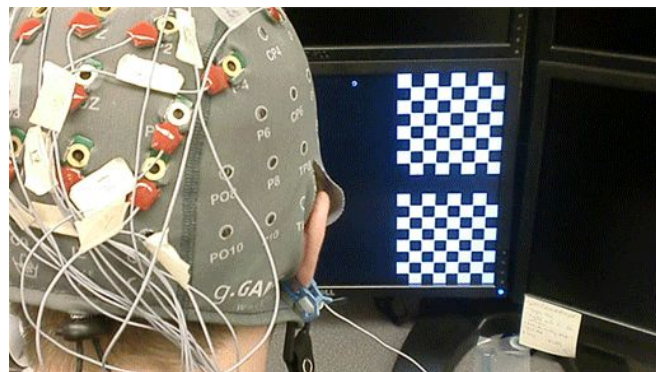
- **SSVEP**
- Frequency-based BCI
- Event related potentials
- Motor imagery
- Slow cortical potentials
- Neurofeedback

SSVEP

Steady State Visually Evoked Potentials



— attend auditory — attend visual
..... ignore auditory ignore visual

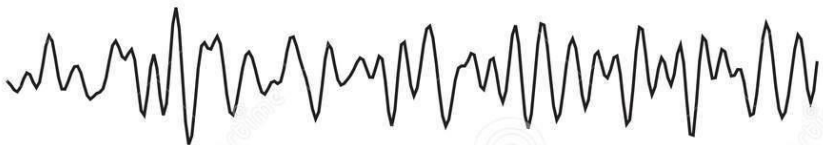


Frequency-Based

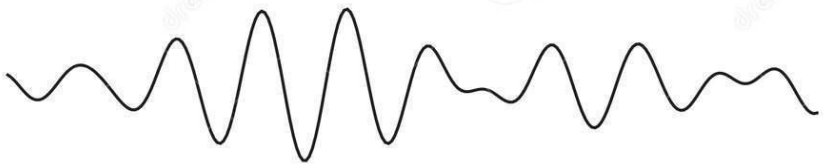
GAMMA
31 - 100 Hz



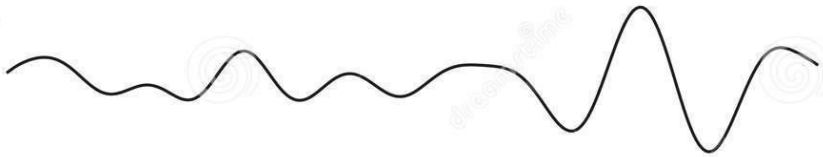
BETA
16 - 30 Hz



ALPHA
8 - 15 Hz



THETA
4 - 7 Hz



DELTA
0.1 - 3 Hz



0.0 0.2 0.4 0.6 0.8 1.0

Insight
Peak focus
Expanded
consciousness

Alertness
Concentration
Cognition

Relaxation
Visualization
Creativity

Meditation
Intuition
Memory

Detached
awareness
Healing
Sleep

(Seconds)

NeuroSky[®]

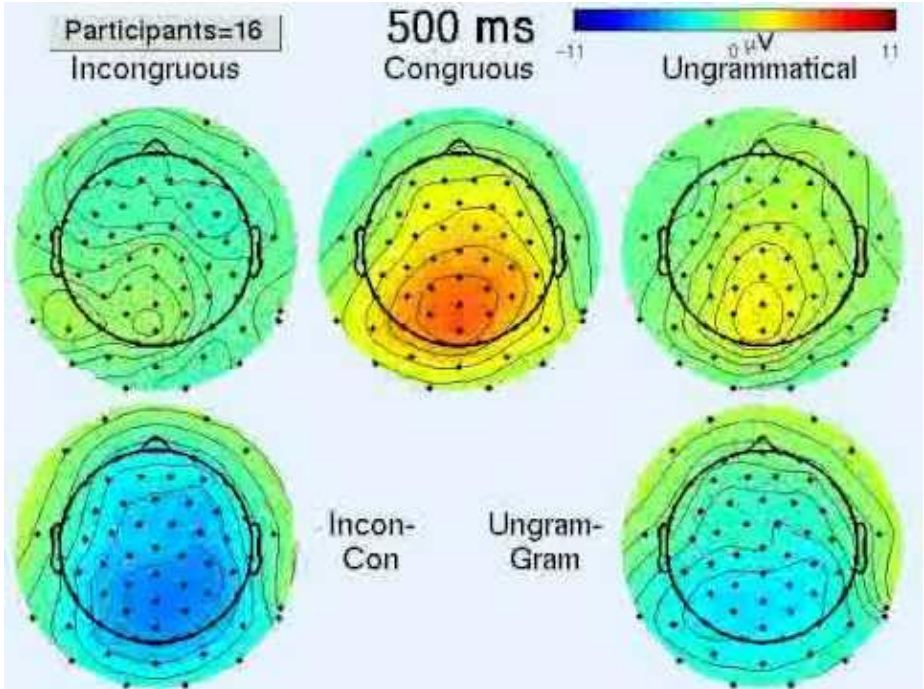
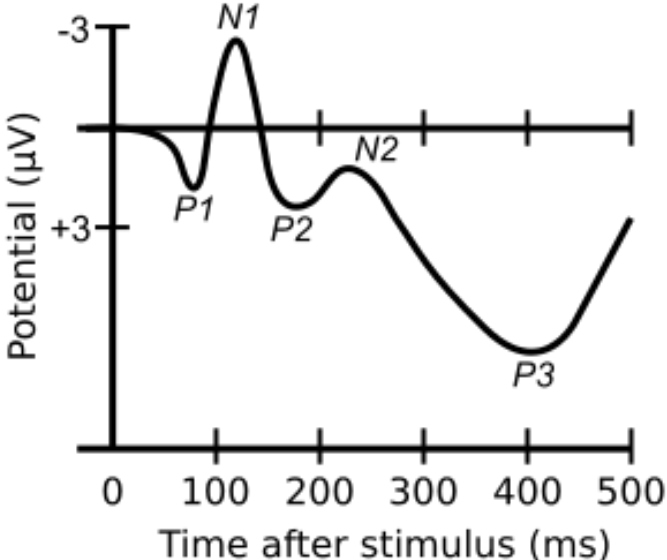
Body and Mind. Quantified.

EMOTIV

muse[™]

the brain sensing headband

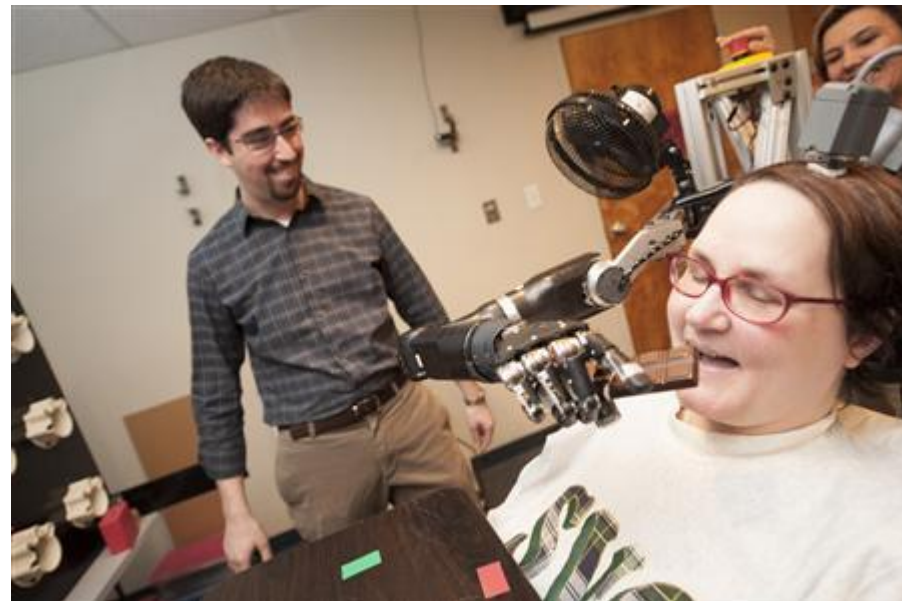
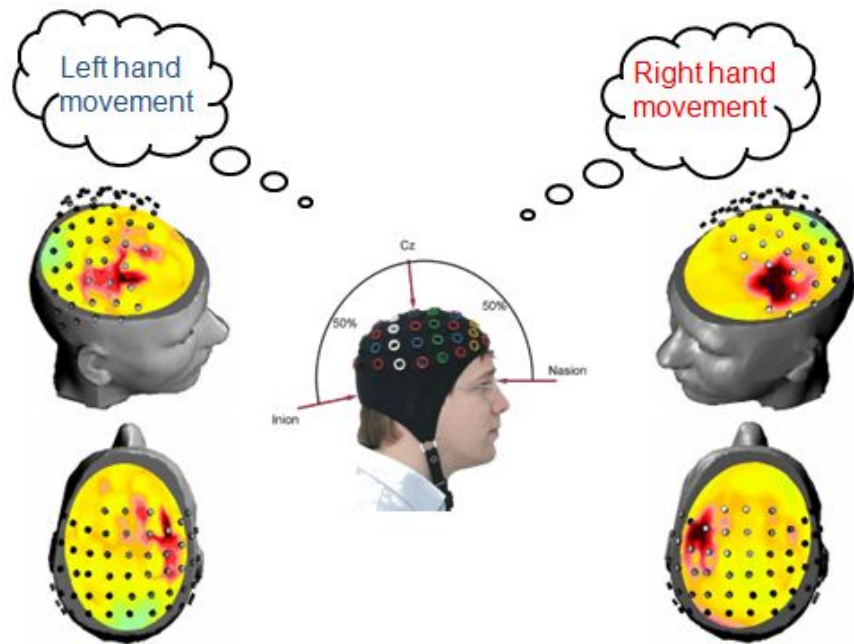
Event Related Potentials (ERP)



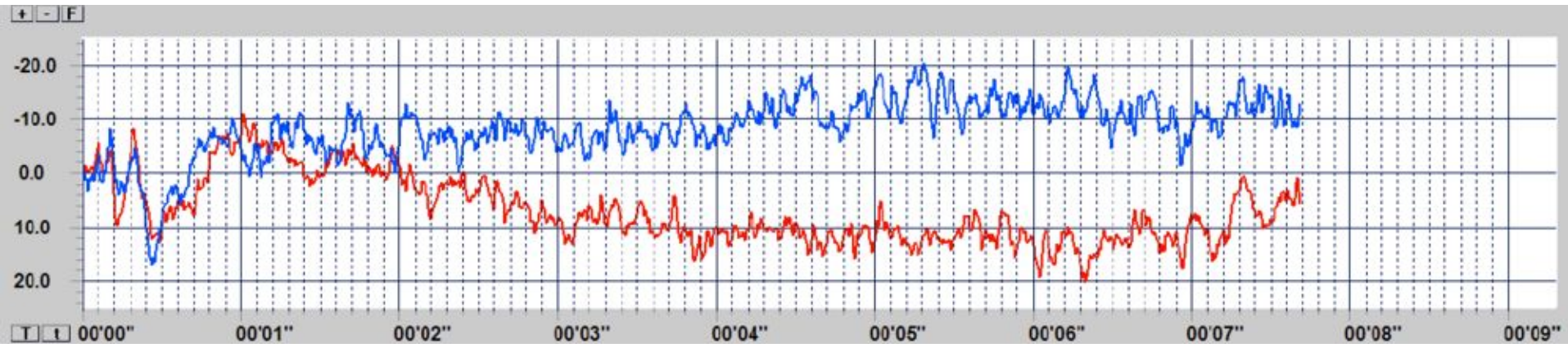
SEND

A	B	C	D	E	F
G	H	I	J	K	L
M	N	O	P	Q	R
S	T	U	V	W	X
Y	Z	1	2	3	4
5	6	7	8	9	_

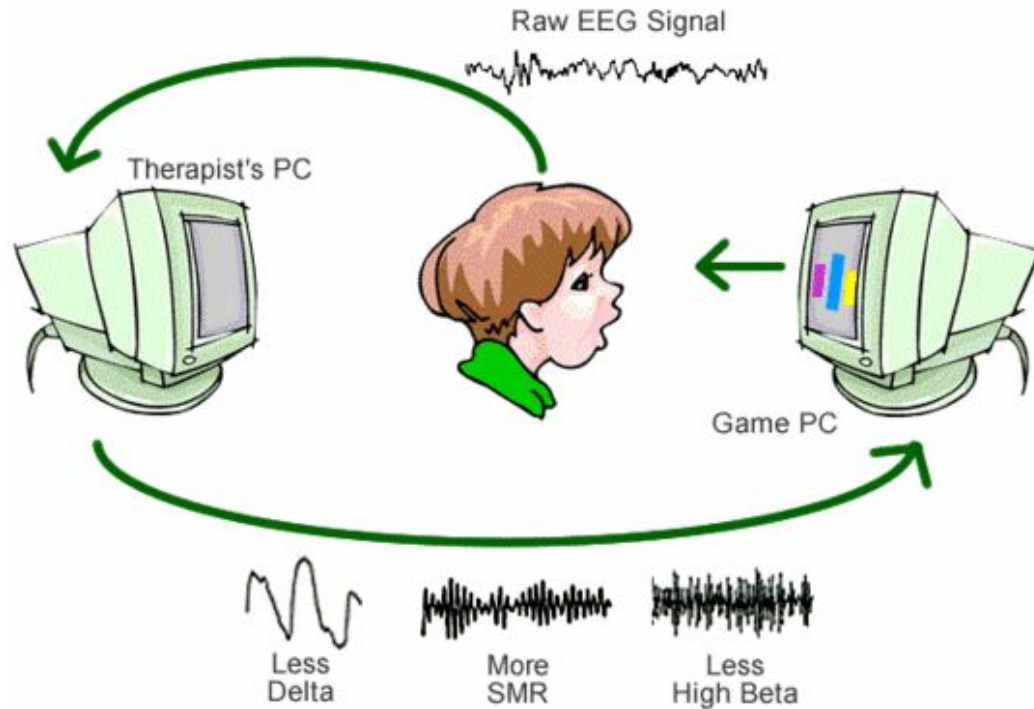
Motor Imagery



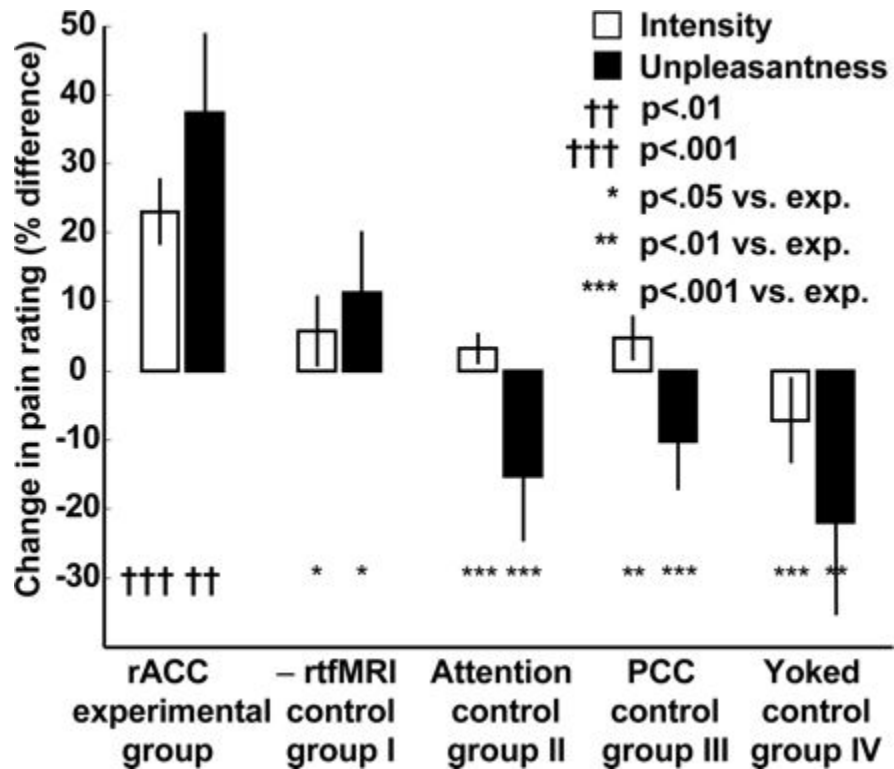
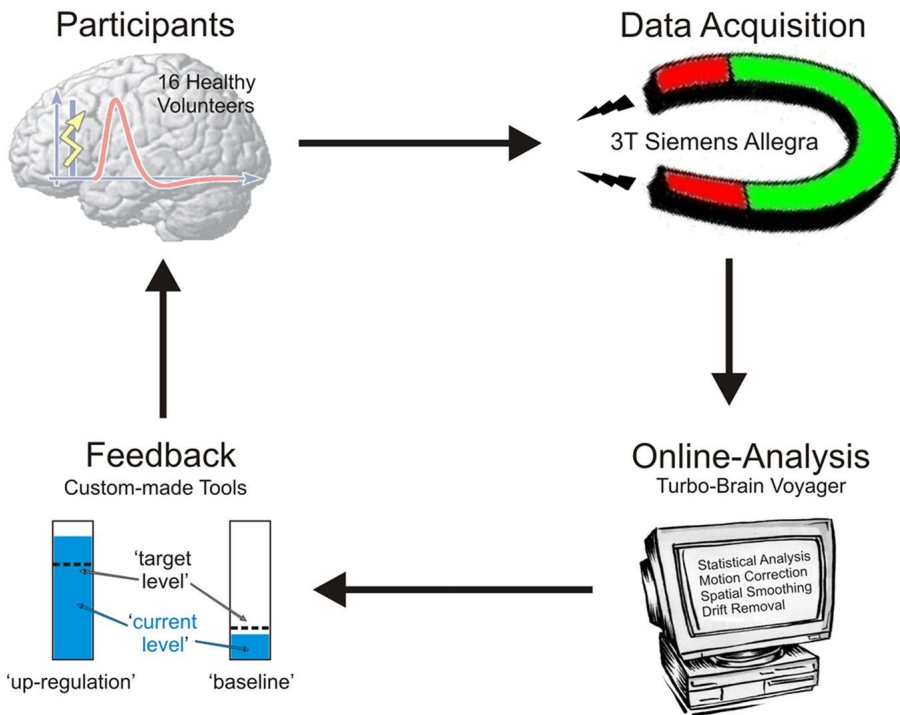
Slow Cortical Potentials (SCP)



EEG Neurofeedback



fMRI Neurofeedback



Break