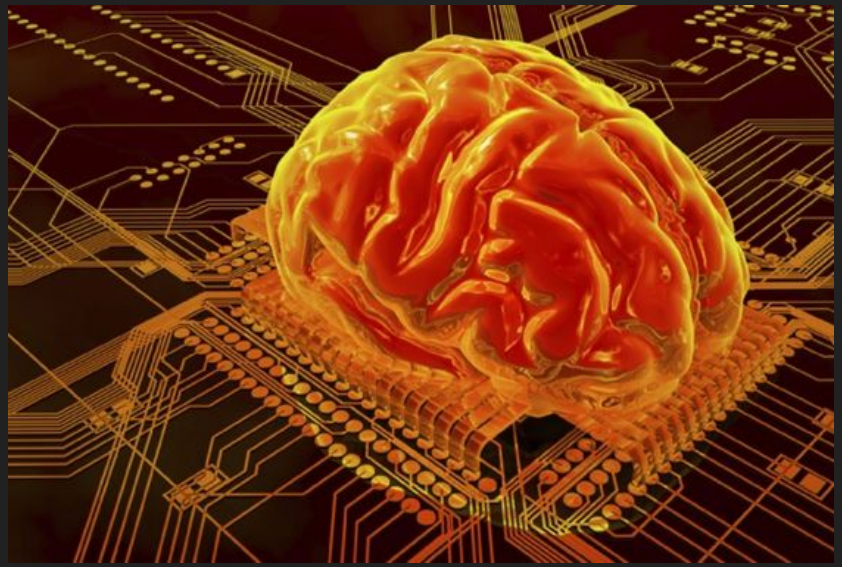


NeuroScience 101

Hector Orozco & Saurabh Shaw

NeuroTech 101

Monthly workshops during the next 6 months that end with a Hackathon

This year:

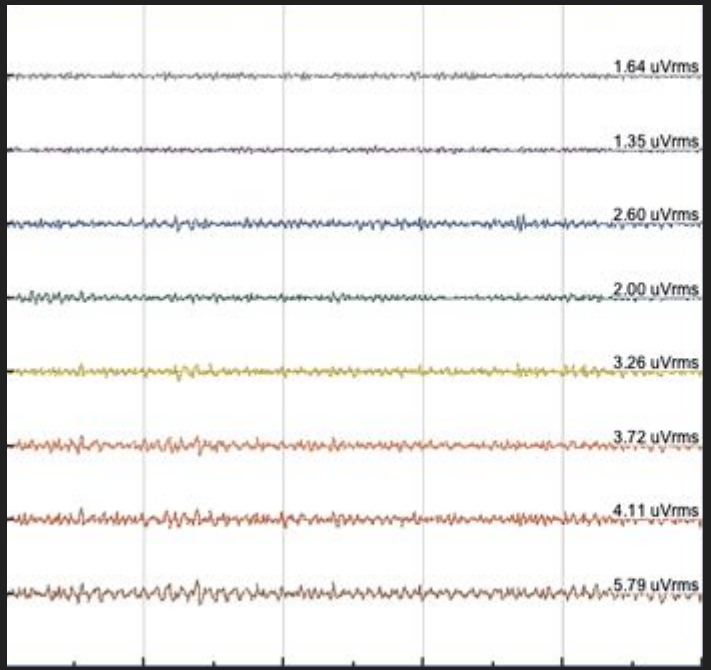
- NeuroDevices 101 (DONE)
- Neuroscience 101 (Today)
- Digital Signal Processing & Feature Extraction I (TBD)

All resources will be available on GitHub!

NeuroScience 101: Objectives

1. Discuss the neural signals commonly used for neurotech projects

2. Understand the neural underpinnings of such signals and how to generate them



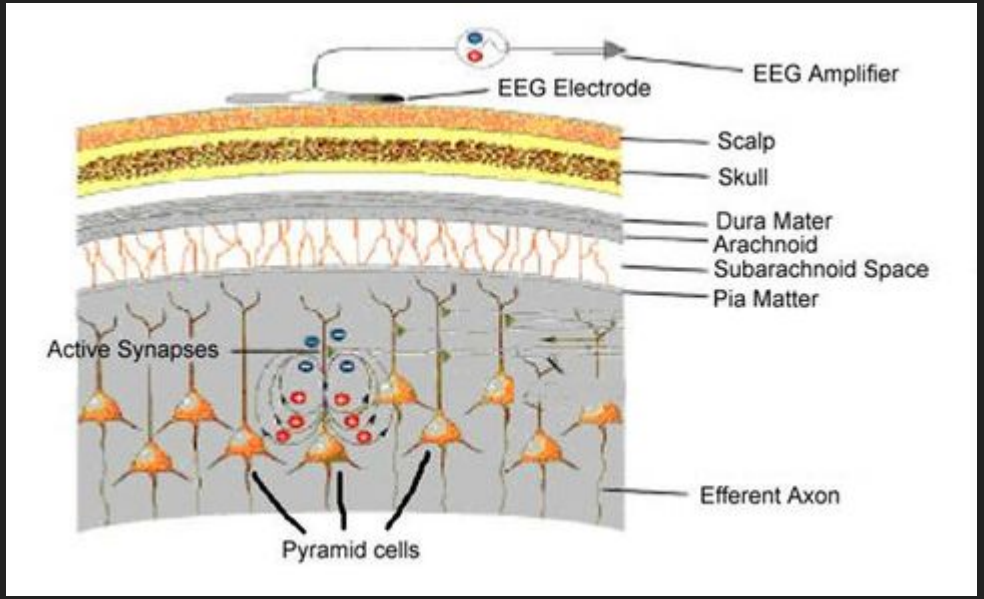
Quick intro: EEG

Underlying neural activity from neural cortex

Volume conduction

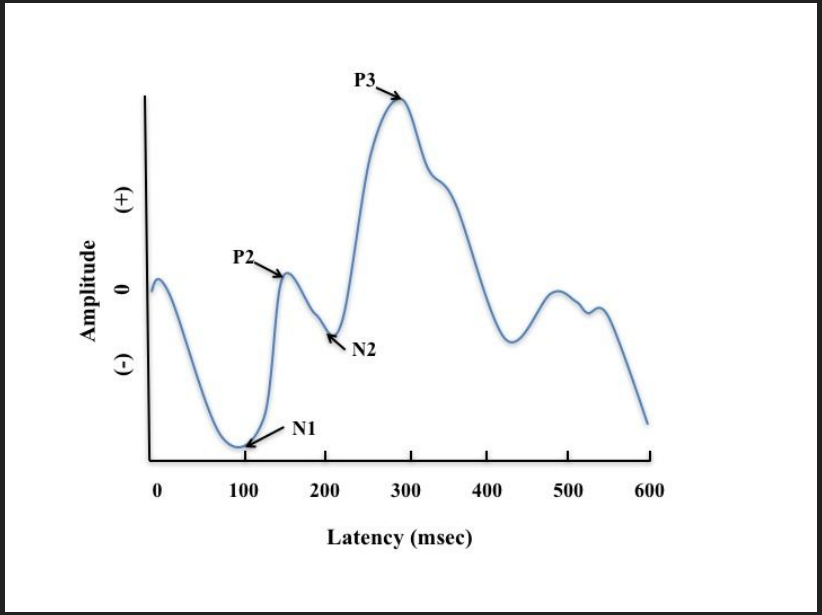
Electrode coverage

External noise

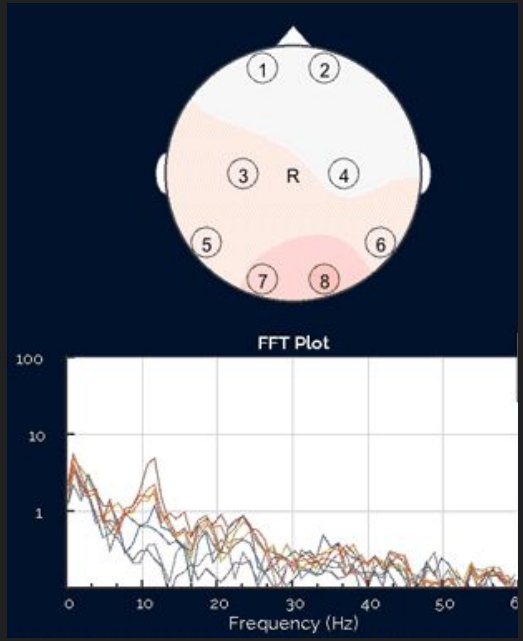


Modes of EEG generation:

Exogenous (ERP based)



Endogenous (abstract features based)



EEG signals

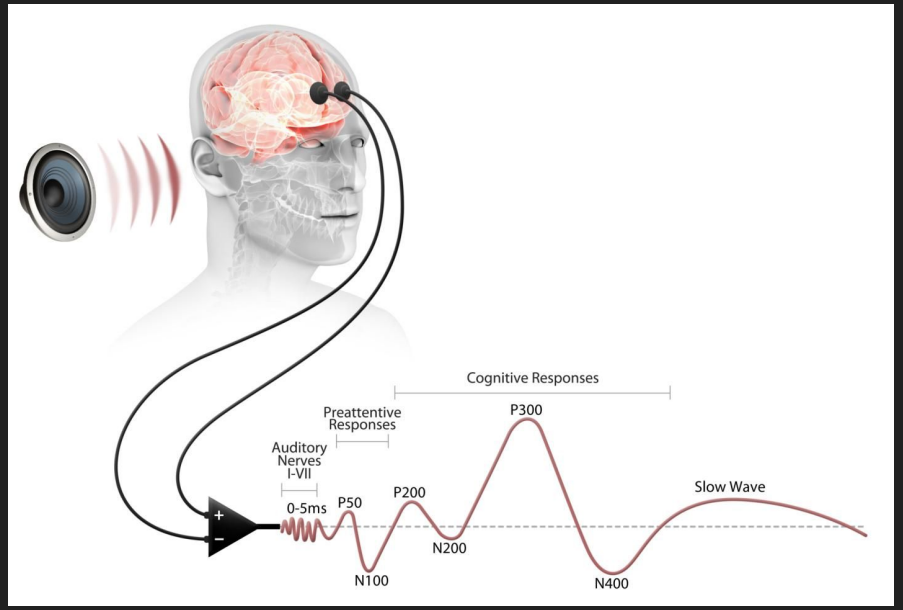
Signal	Physiological phenomena	Number of choices	Training	Information transfer rate
VEP	Brain signal modulations in the visual cortex	High	No	60–100 bits/min
SCP	Slow voltages shift in the brain signals	Low (2 or 4, very difficult)	Yes	5–12 bits/min
P300	Positive peaks due to infrequent stimulus	High	No	20–25 bits/min
Sensorimotor rhythms	Modulations in sensorimotor rhythms synchronized to motor activities	Low (2, 3, 4, 5)	Yes	3–35 bits/min

Exogenous EEG based devices

Rely on stimulus based EEG responses

User trains to associate the elicited EEG response with a control signal

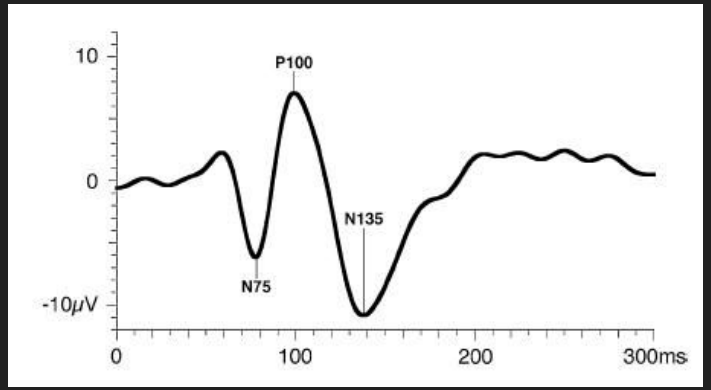
Majority of applications



Visual Evoked Potential (VEP)

Stimulus: Flashing lights or lights moving across the visual field.

Activity in Occipital lobe



Flashes < 2 Hz - Transient VEP

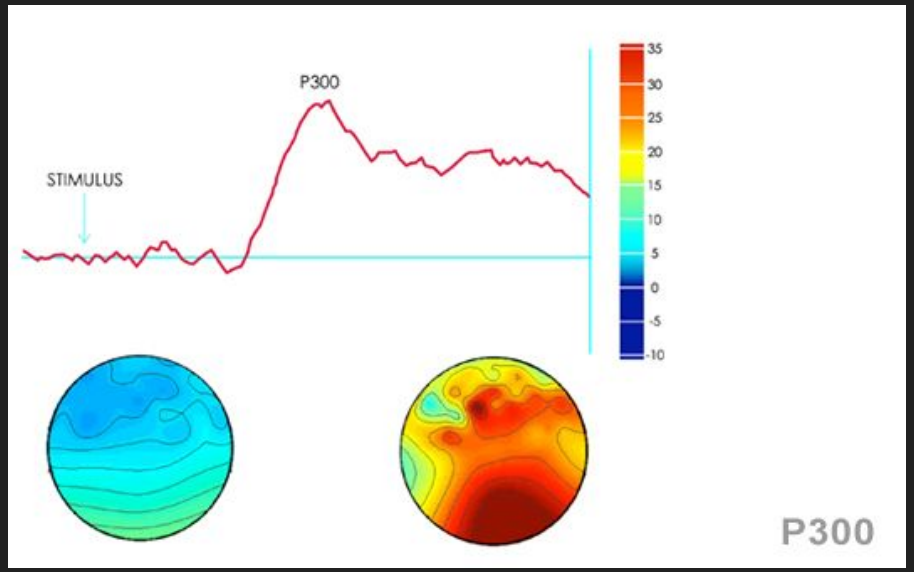
Flashes > 6 Hz - Steady State VEP

P300

Stimulus: Oddball

Multiple regions

The magnitude of P300 shows the level of surprise



Endogenous EEG based devices

Rely on user generated potentials (without external stimulus)

User trains to reliably generate potentials

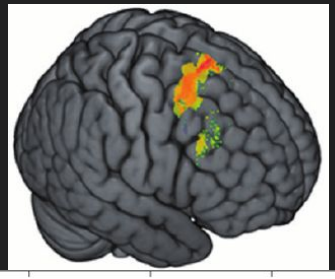
Applications are limited

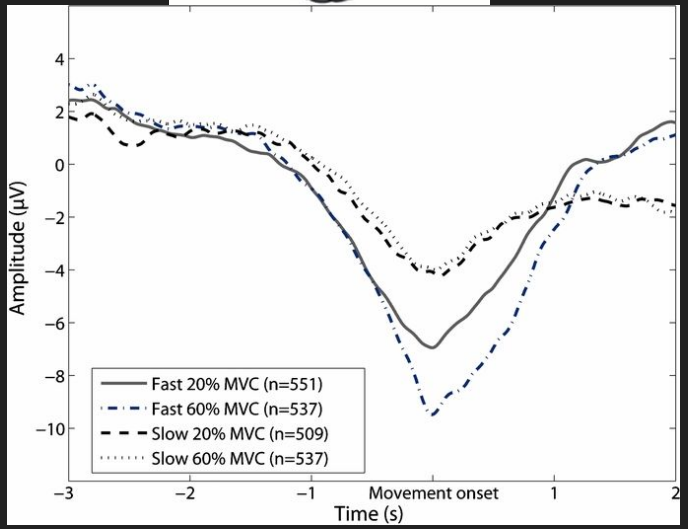
Slow Cortical Potentials (SCP)

Stimulus: Movement Related

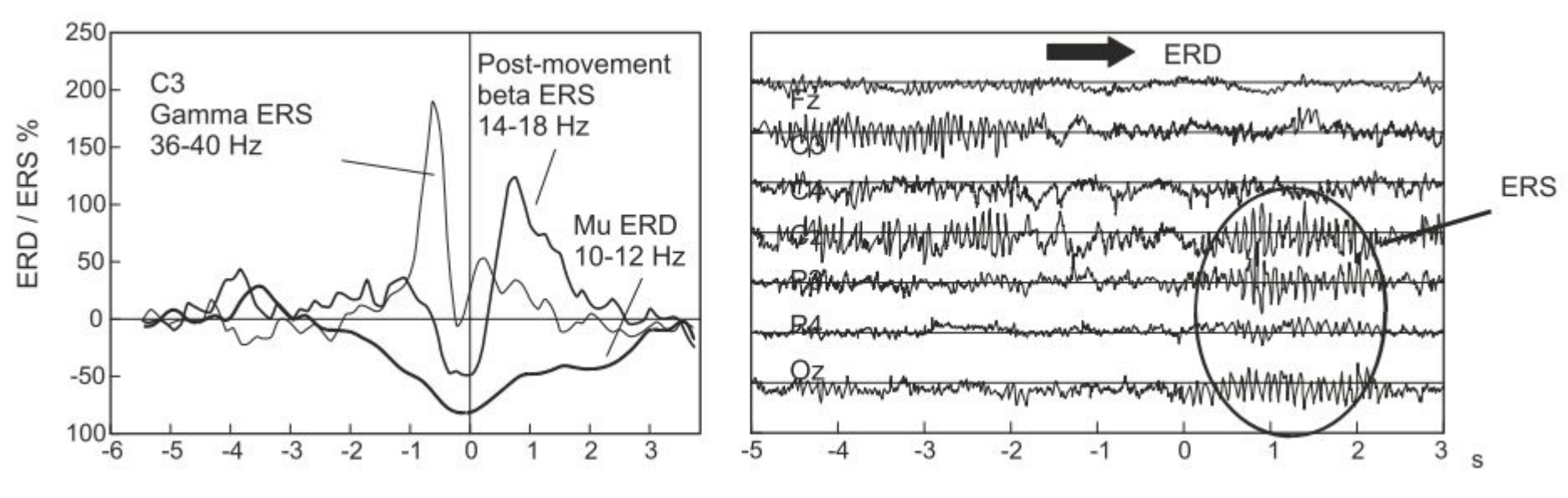
Activity in Supplementary Motor Cortex

One important subtype - Movement Related Cortical Potential (MRCP)

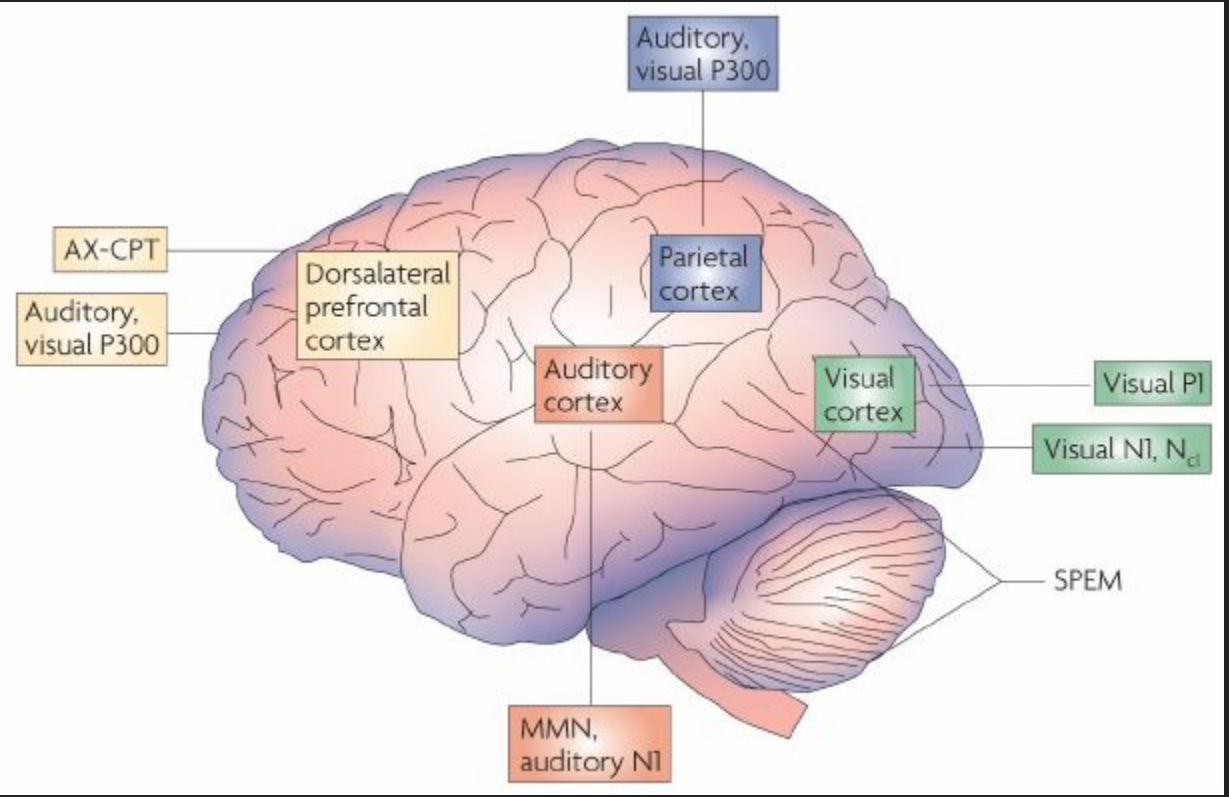




Sensorimotor Rythms



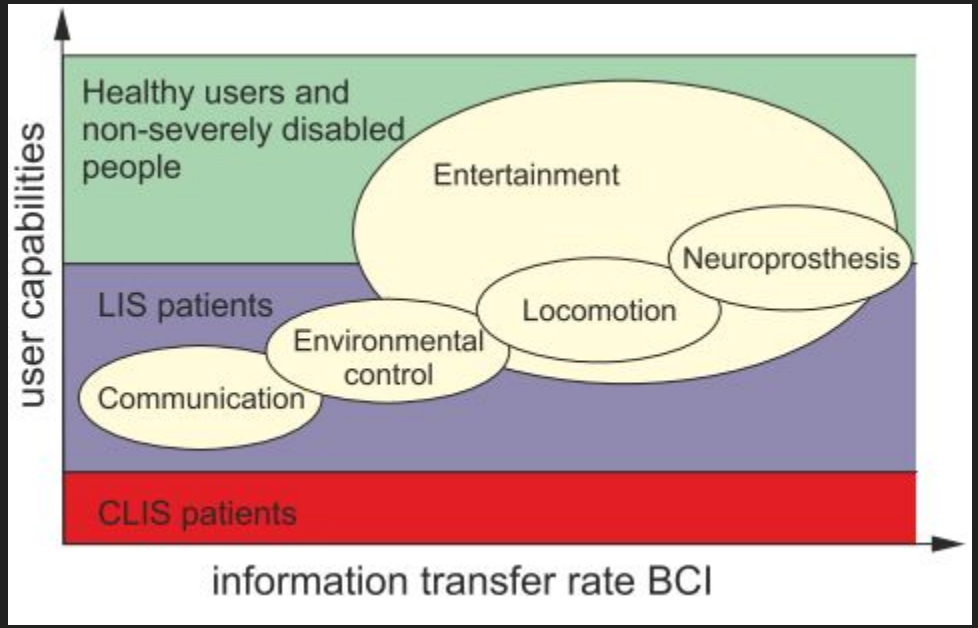
Where are these located?



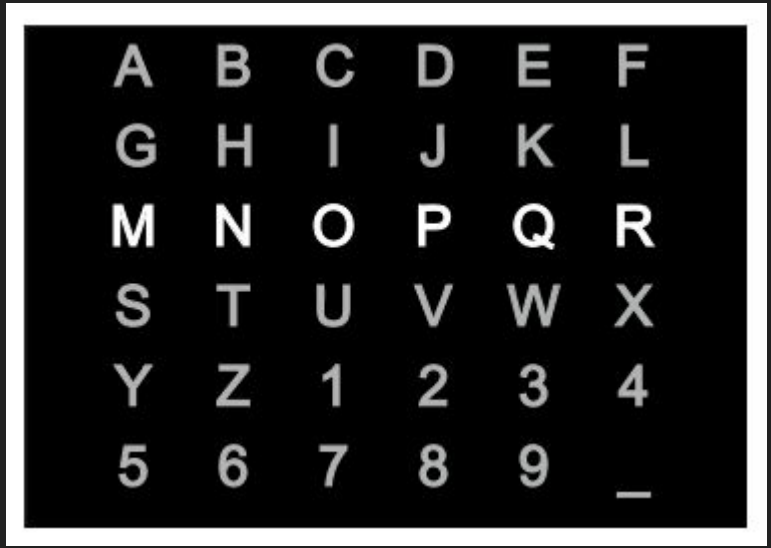
Exogenous vs Endogenous?

Approach	Brain signals	Advantages	Disadvantages
Exogenous BCI	– SSVEP – P300	– Minimal training – Control signal set-up easily and quickly – High bit rate (60 bits/min) – Only one EEG channel required	– Permanent attention to external stimuli – May cause tiredness in some users
Endogenous BCI	– SCPs – Sensorimotor rhythms	– Independent of any stimulation – Can be operated at free will – Useful for users with sensory organs affected – Suitable for cursor control applications	– Very time-consuming training (months or weeks) – Not all users are able to obtain control – Multichannel EEG recordings required for good performance – Lower bit rate (20–30 bits/min)

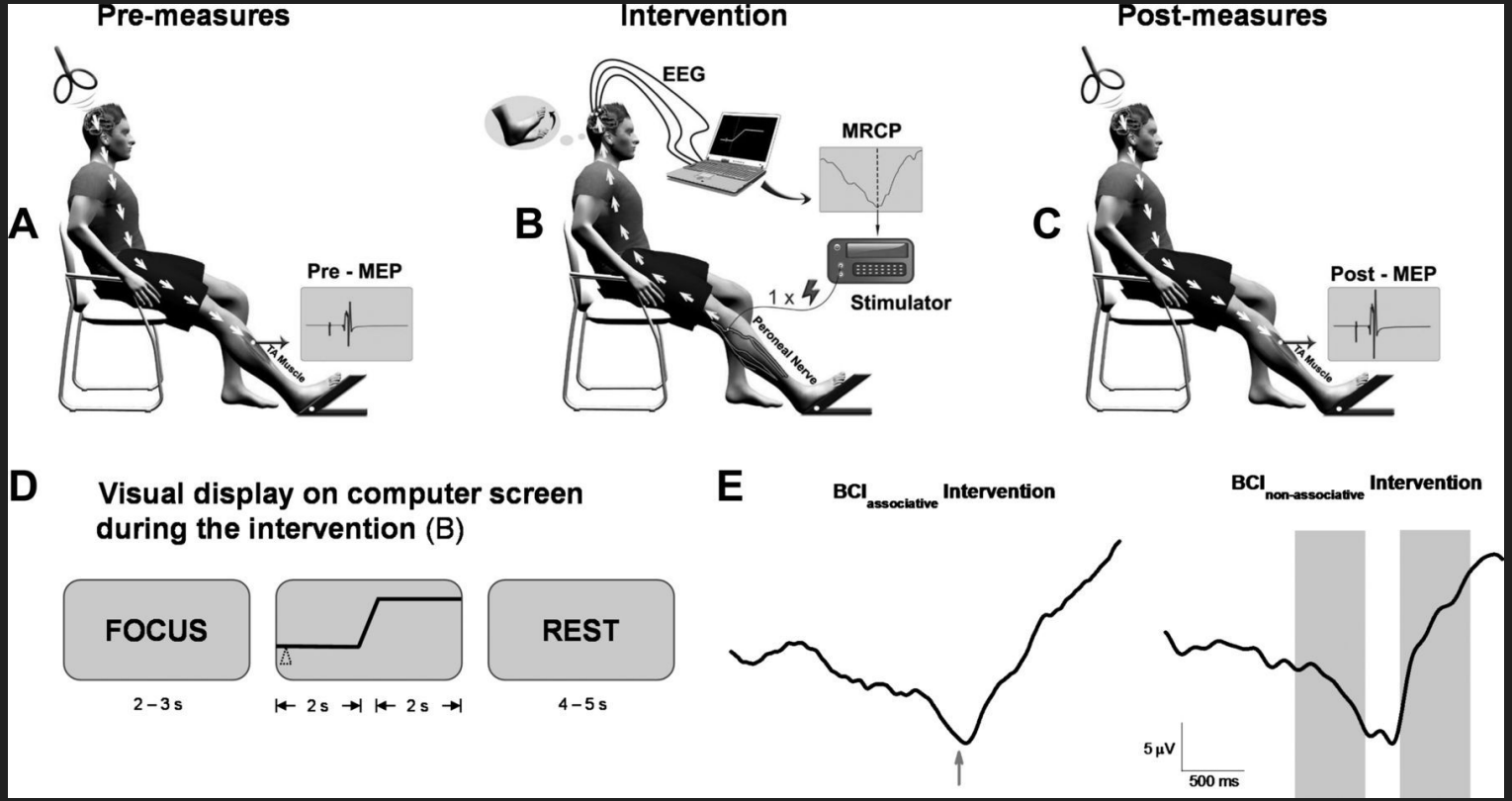
What type of BCI to make?



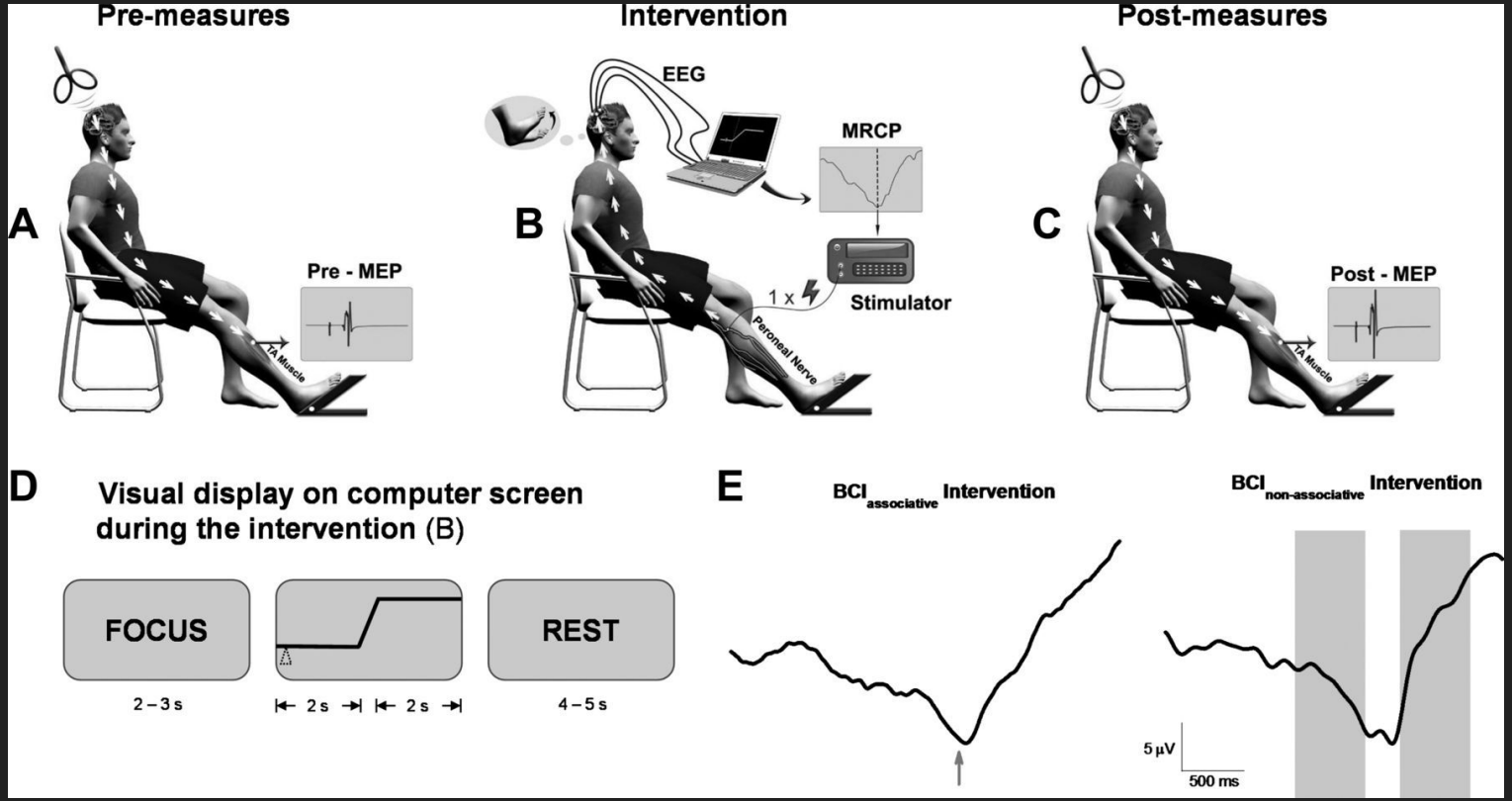
P300 Speller



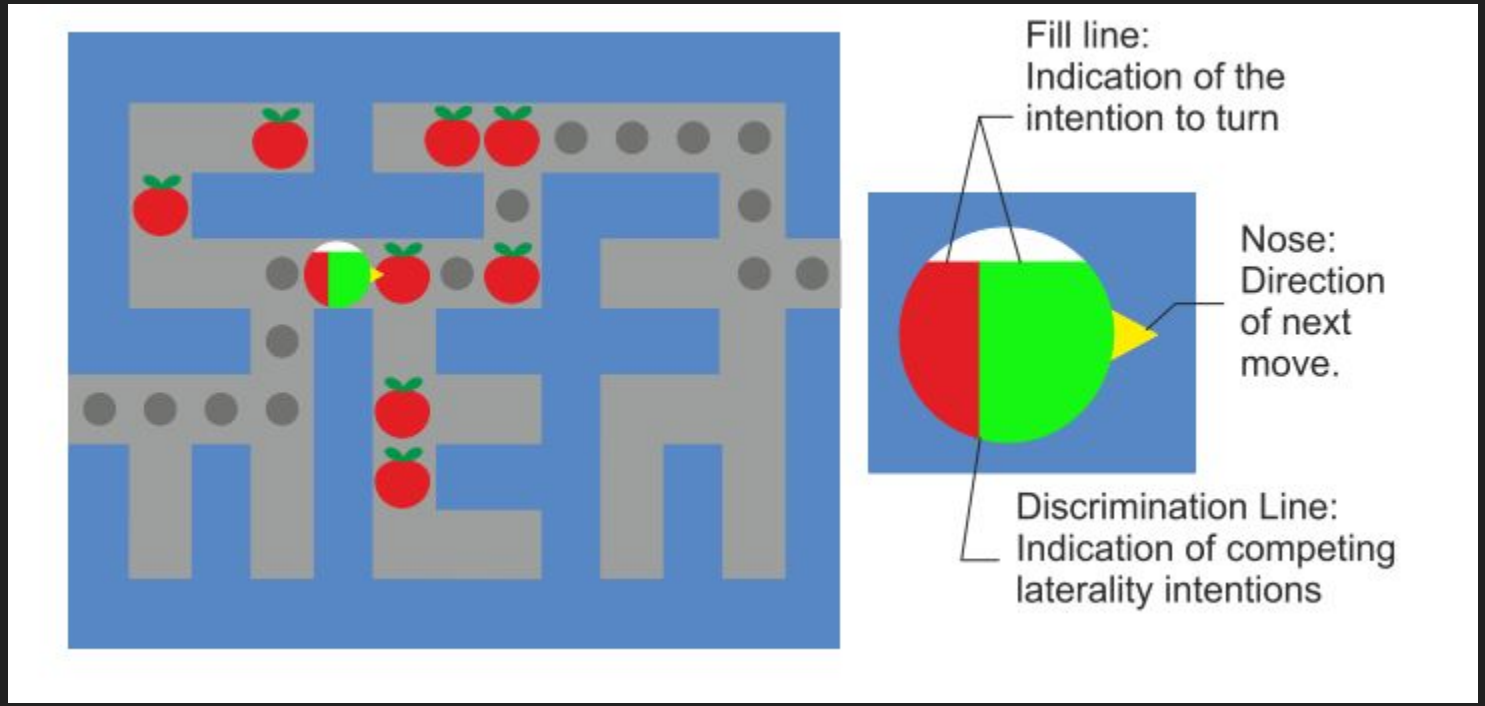
MRCP Trainer



MRCP Trainer



Open ended features - Entertainment BCI



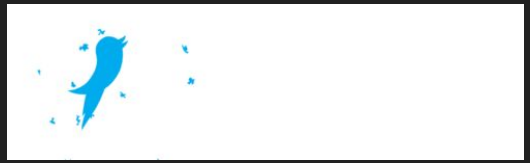
NeuroTechHa - Join the conversation!

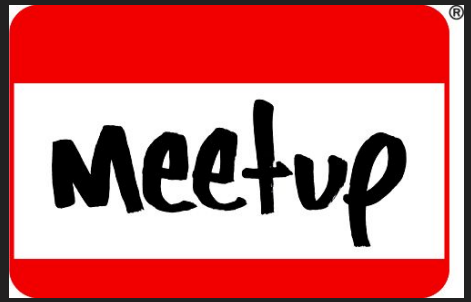
NeuroTechX's Slack, _hamilton channel

Twitter: @NeuroTechHa

Meetup: NeuroTechHa

Facebook: NeuroTechHa





Questions/Feedback?

Thanks!