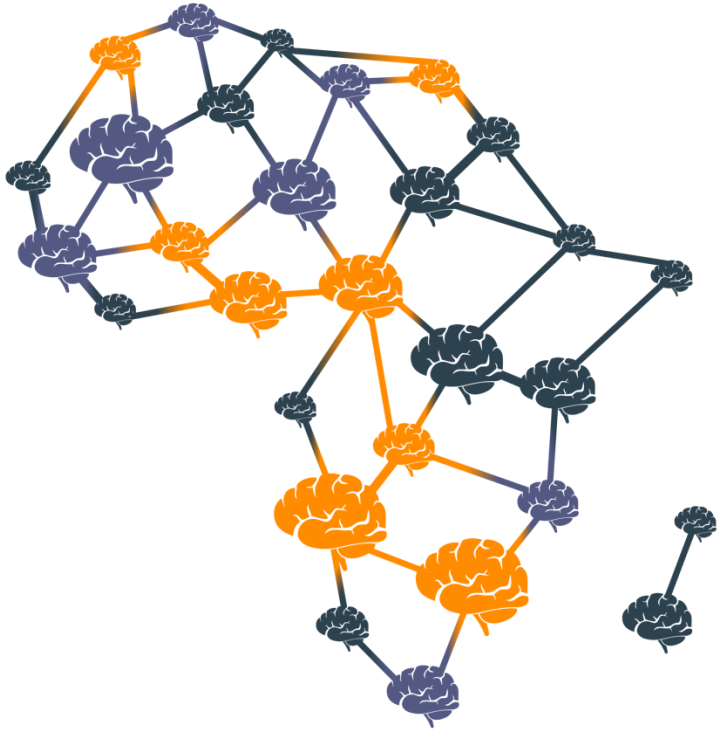
Reflections on EEG research and summary of the workshop

Robert Oostenveld

Mikkel C. Vinding

9-14 June 2025
Port Harcourt, Nigeria



African Brain Data Network

Outline of the workshop

- Lectures
- Hands-on practicals
  - Experimental design (PsychoPy)
  - Recording EEG
  - Data analysis (MATLAB)
- Discussions

01 - Outline of the workshop.pptx
02 - EEG background.pptx
03 - EEG in Africa.pptx
04 - Experimental design, part A.pptx
05 - How does an EEG system work.pptx
06 - Experimental design, part B.pptx
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19 - Where to go from here.pptx
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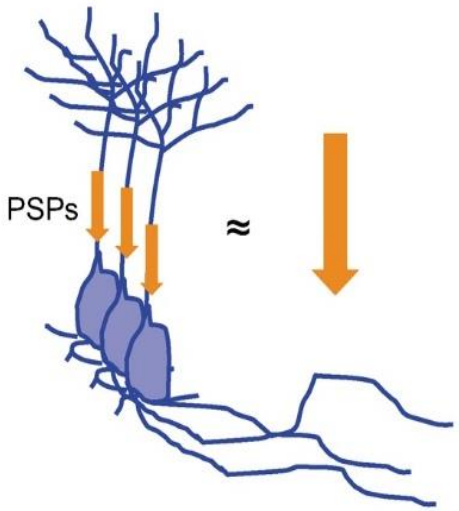
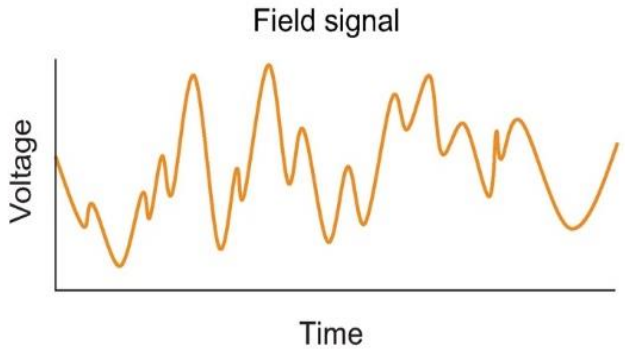
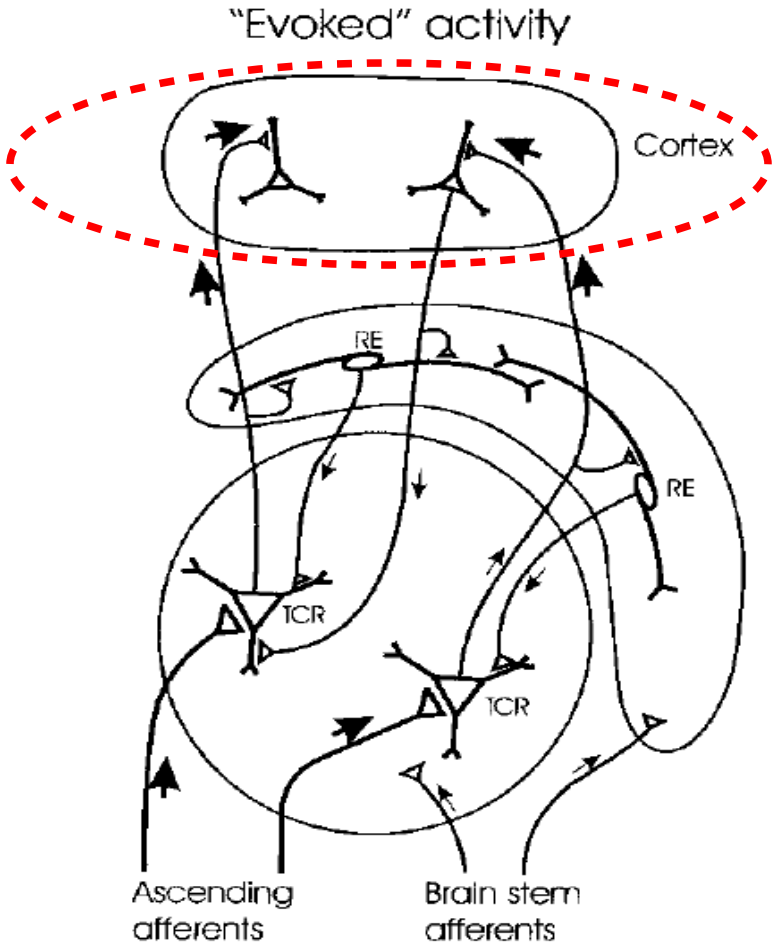
What we measure



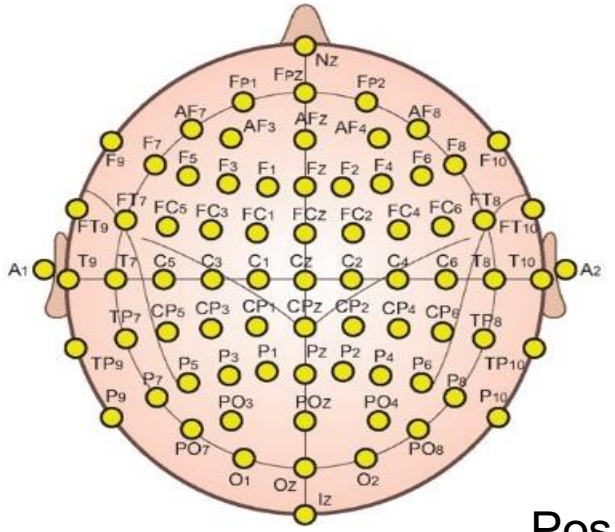


EEG measures the activity of populations of pyramidal neurons in the cortex arising from synchronous firing within a cortical patch.

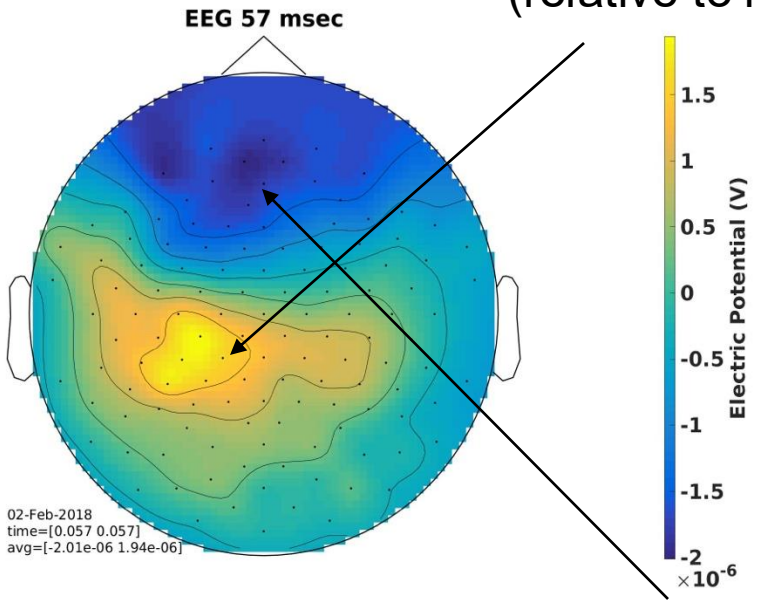


Pfurtscheller & Lopes da Silva (1999)

EEG data

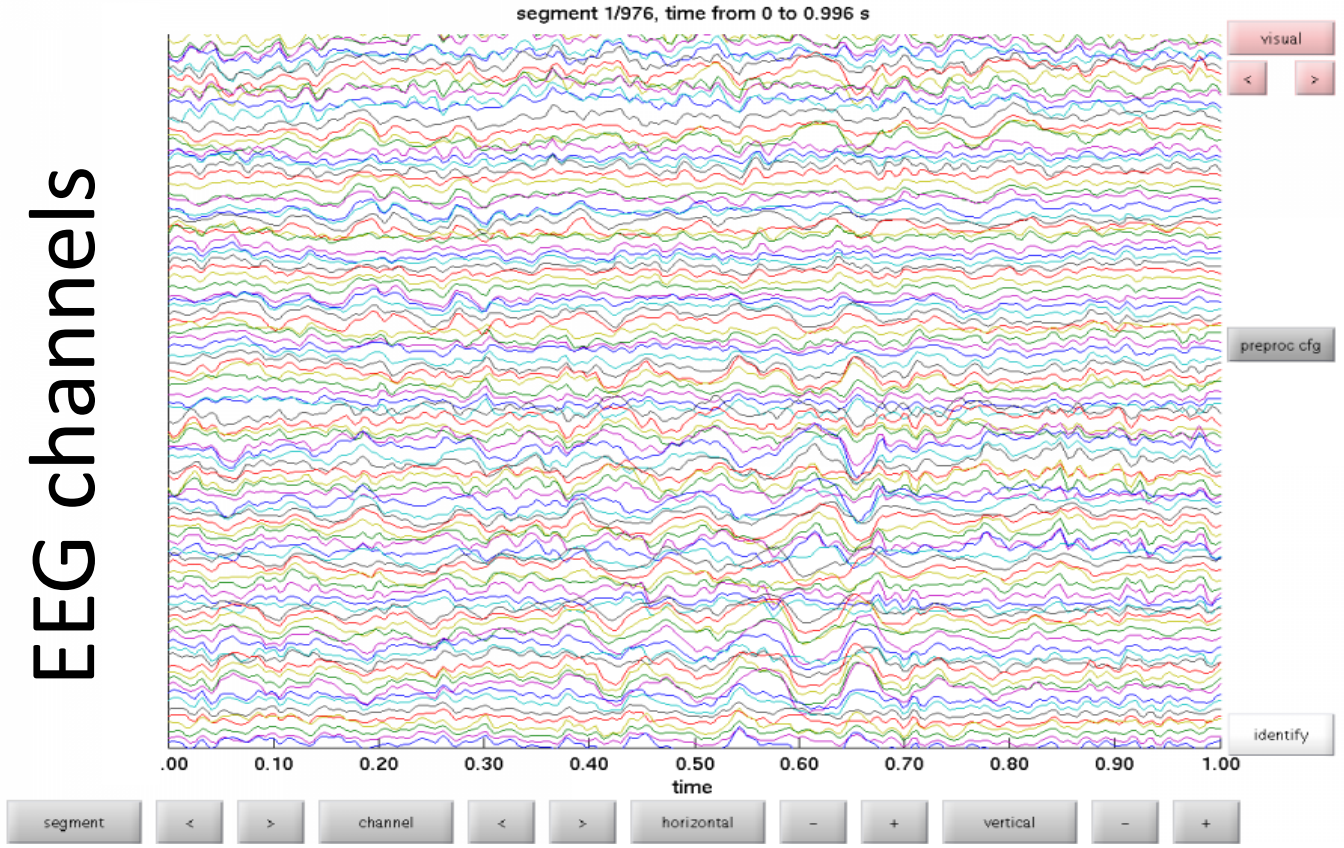


Positive voltage (relative to ref.)



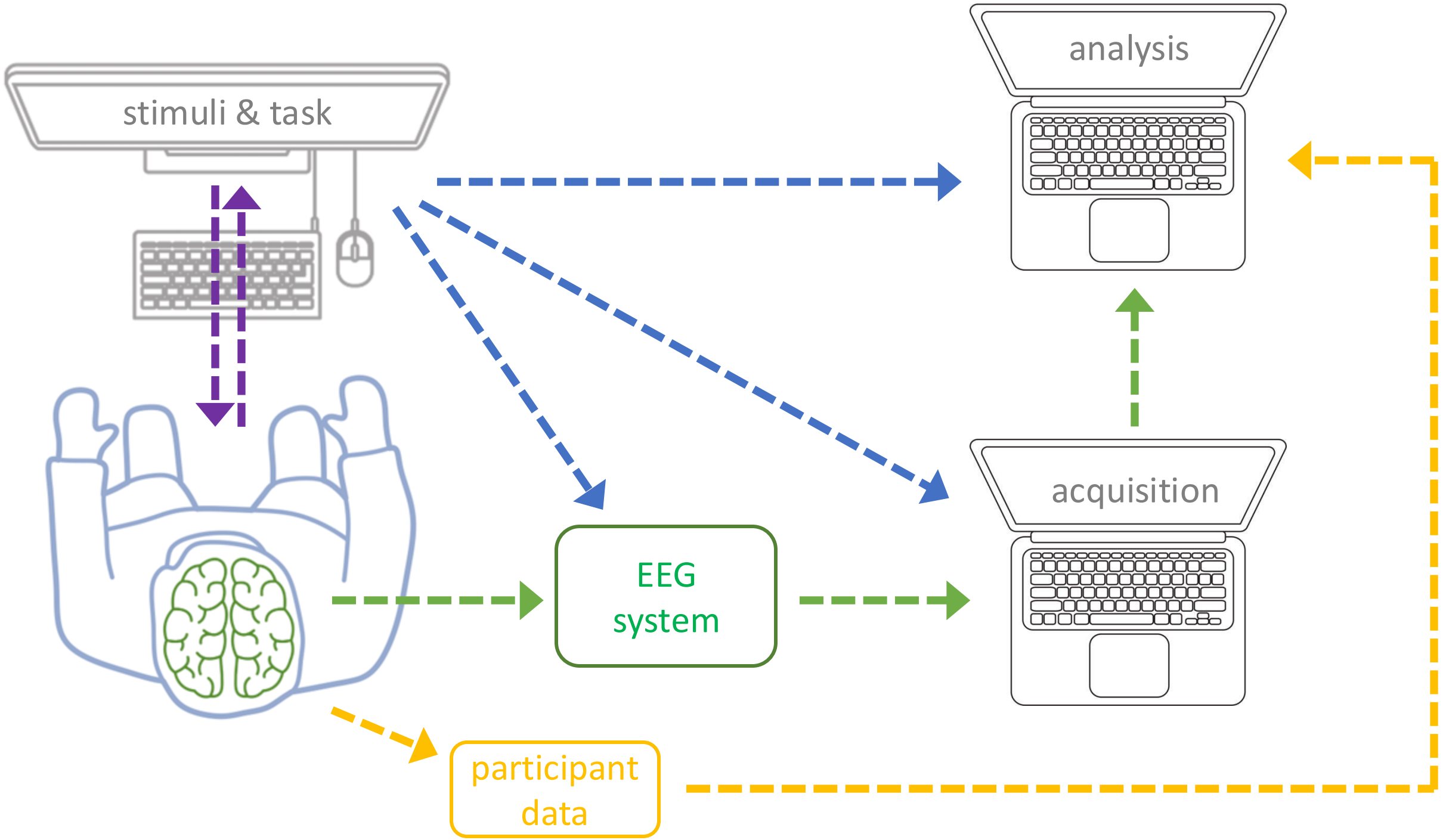
Negative voltage (relative to ref.)

Unit: microvolts (µV)

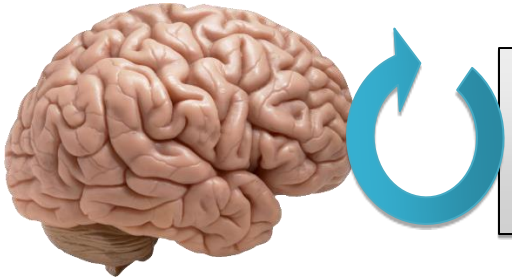


EEG channels

Time


stimuli & task
analysis
acquisition
EEG
system
participant
data

Cognitive theories and measured brain activity



Cognition

Brain process

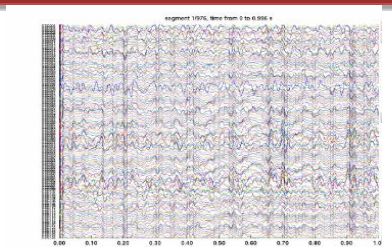
Measurement method

Recorded signal

Cognitive theory

Cognitive task

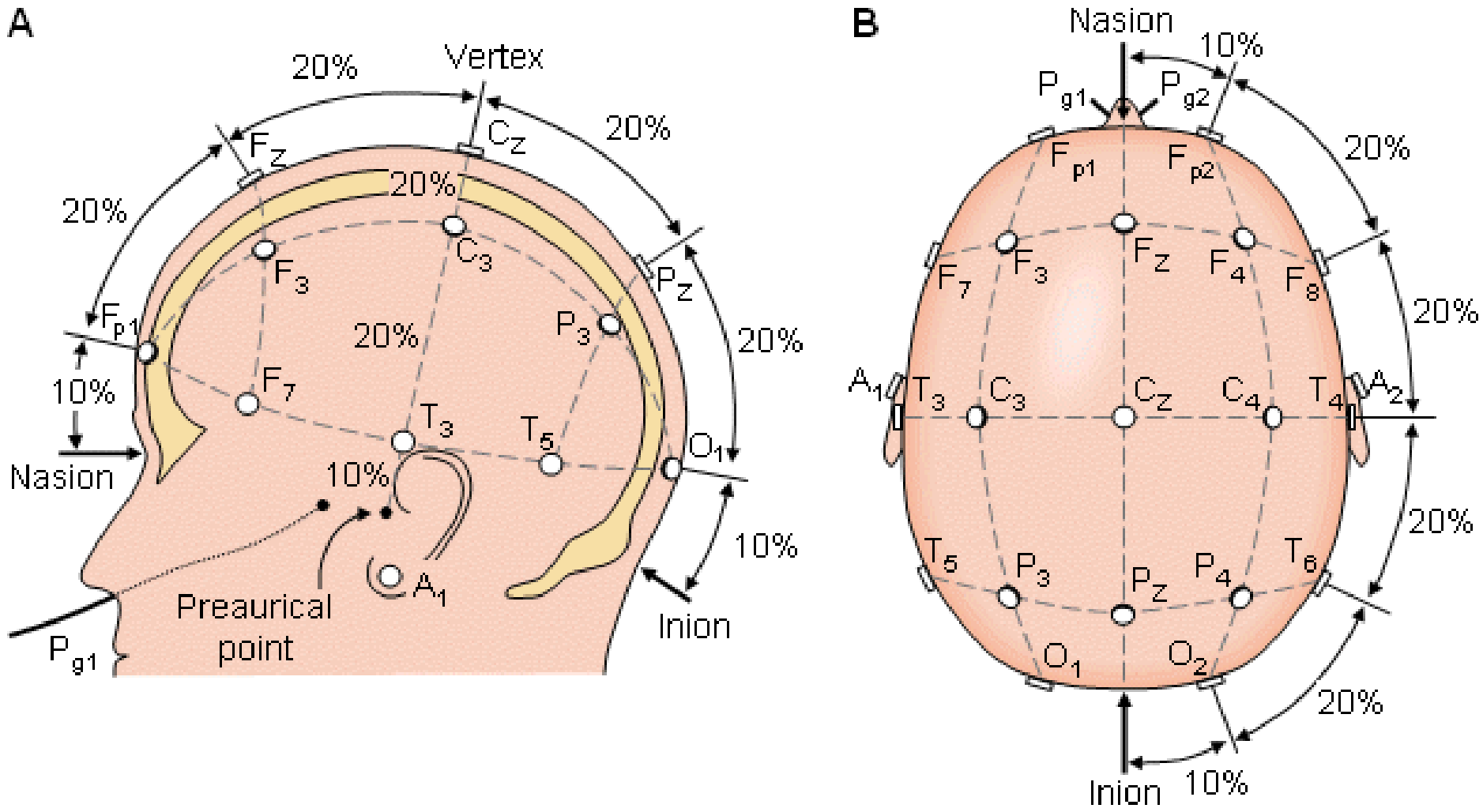
Observed behaviour



Correlation?

RT, performance, etc.

The 10-20 electrode placement system



African hair is different from Caucasian/European hair

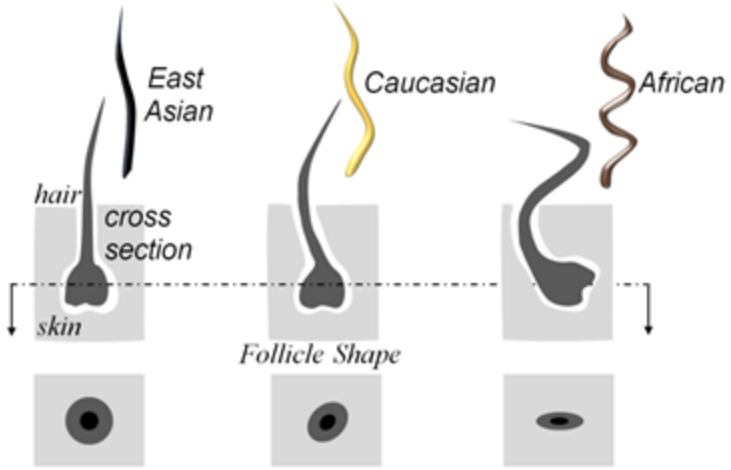


Fig. 1: People of different ethnic origin have varying hair types that originate from different follicle sizes and shapes. People of African descent have particularly coarse and curly hair [8].

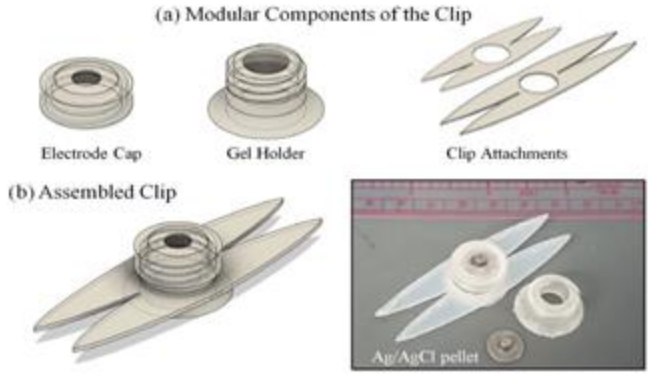


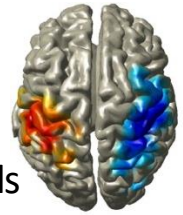
Fig. 3: Components of the *Sevo* electrode prototype. (a) CAD drawings of the modular components of the electrode and (b) CAD drawing of the assembled clip shown alongside a photograph of the 3D printed prototype

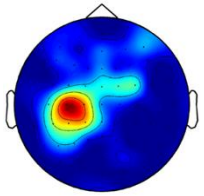
Fig. 4: Our experimental protocol setup: The right half of each participant's hair was braided, while the left half remained unbraided. Every labeled point bore a gold cup electrode, while the braided points bore a *Sevo* electrode as well. *(left)* Schematic diagram of electrode placements; *(right)* Photograph of *Sevo* electrodes placed on a braided participant.

Etienne et al. (2020). *Novel Electrodes for Reliable EEG Recordings on Coarse and Curly Hair*. https://doi.org/10.1101/2020.02.26.965202

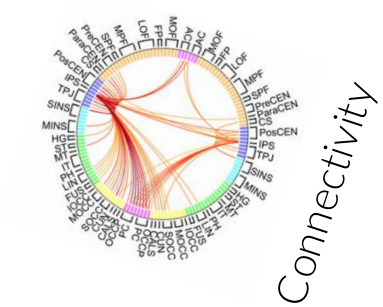
Possibilities in EEG analysis

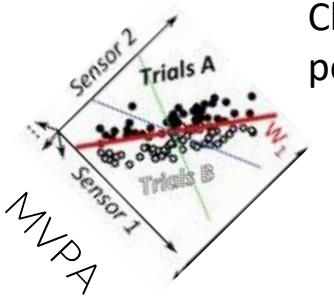
Location:
Signals from different locations



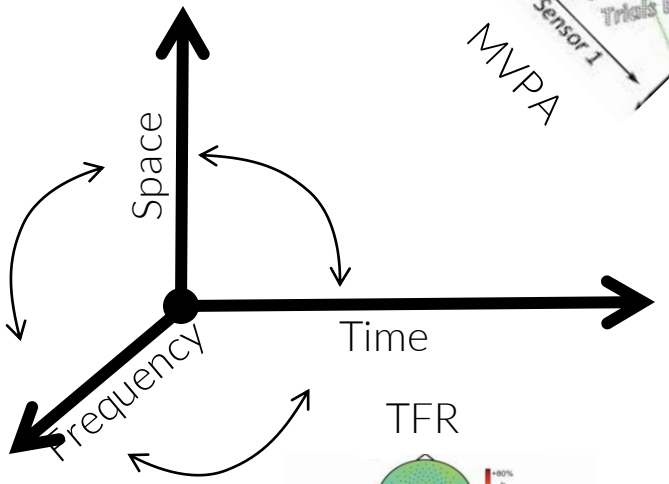


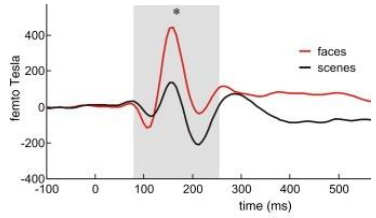
Connectivity:
Relationship between signals from different locations





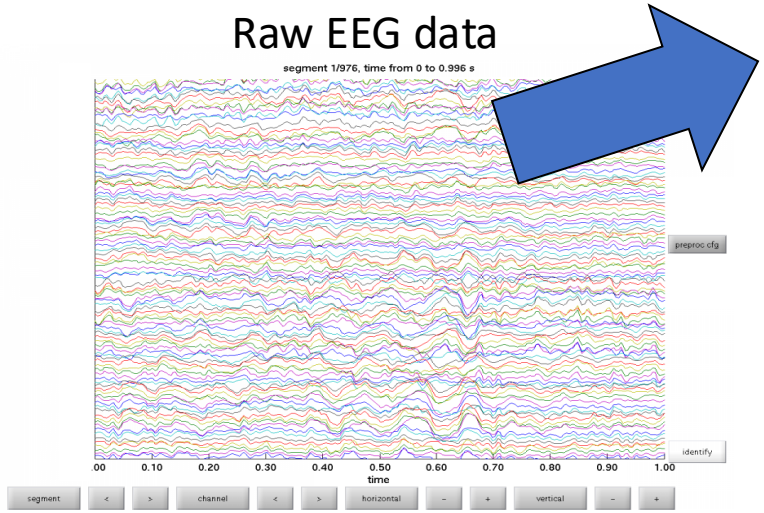
MVPA:
Classification/spatial filter per sensor and time point

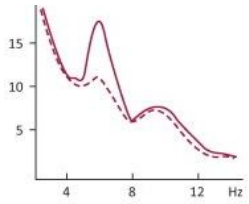




Evoked responses :
Time- and phase-locked
= Amplitude per time point

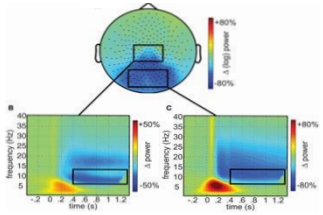
Raw EEG data





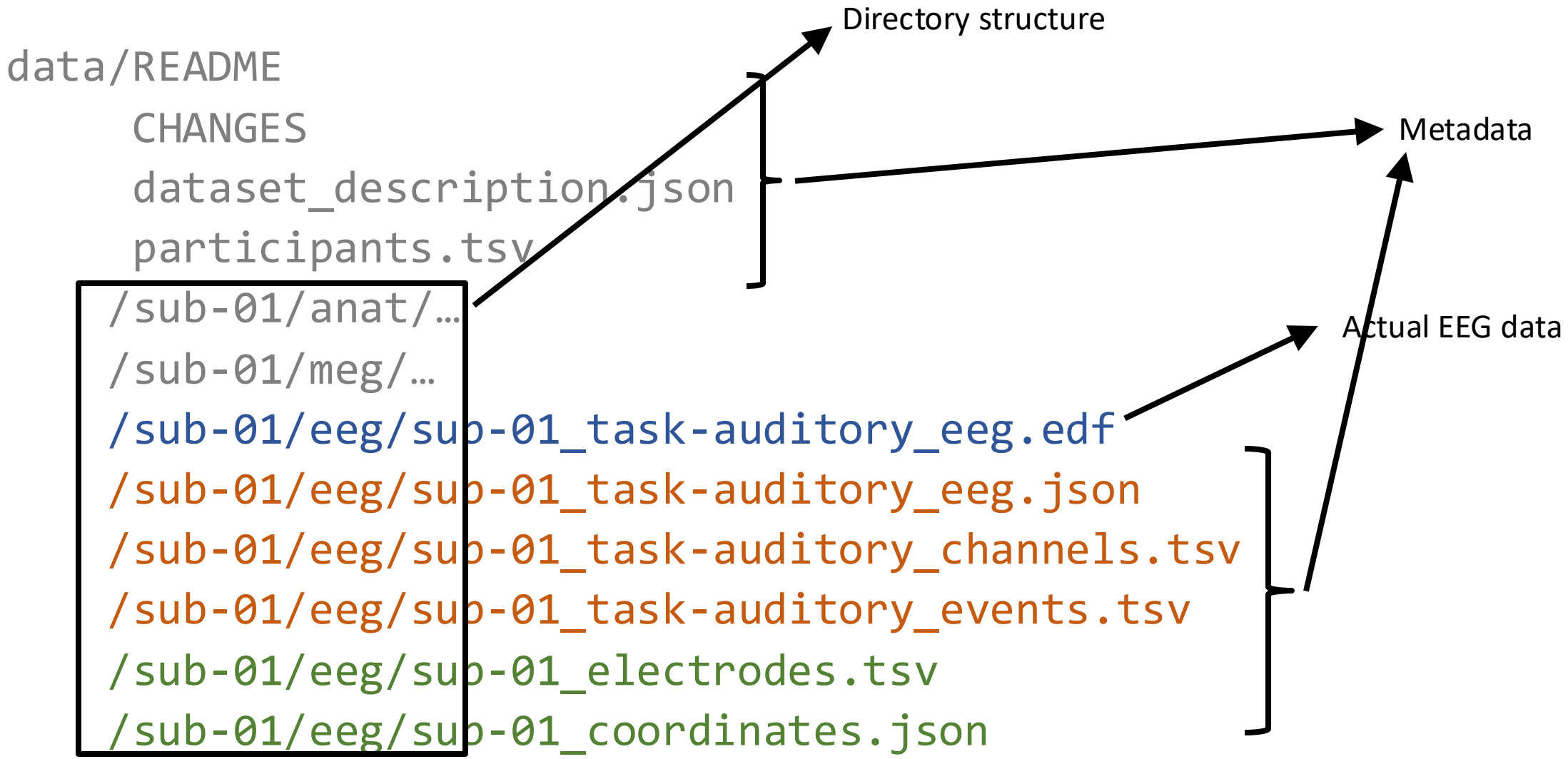
Frequency responses :
Frequency-specific
= Power per frequency band

TFR



Time-frequency responses :
Time and frequency-specific
= Power per frequency band over time

BIDS for MRI, MEG, EEG



EEG preprocessing

Visual inspection

Bad channel detection

Filtering

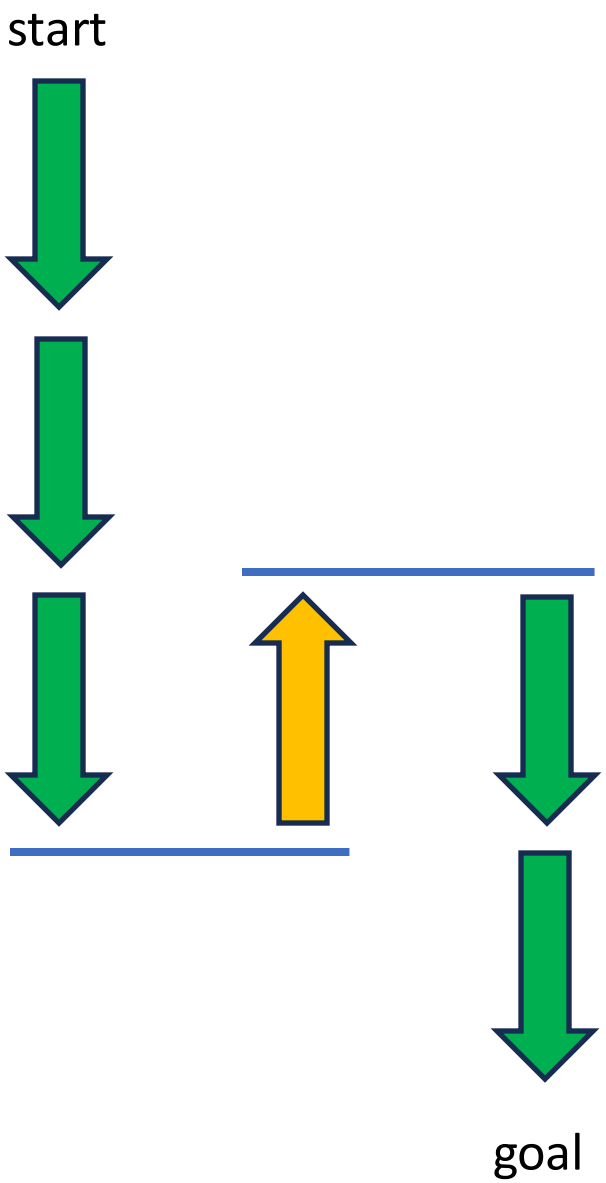
Re-referencing

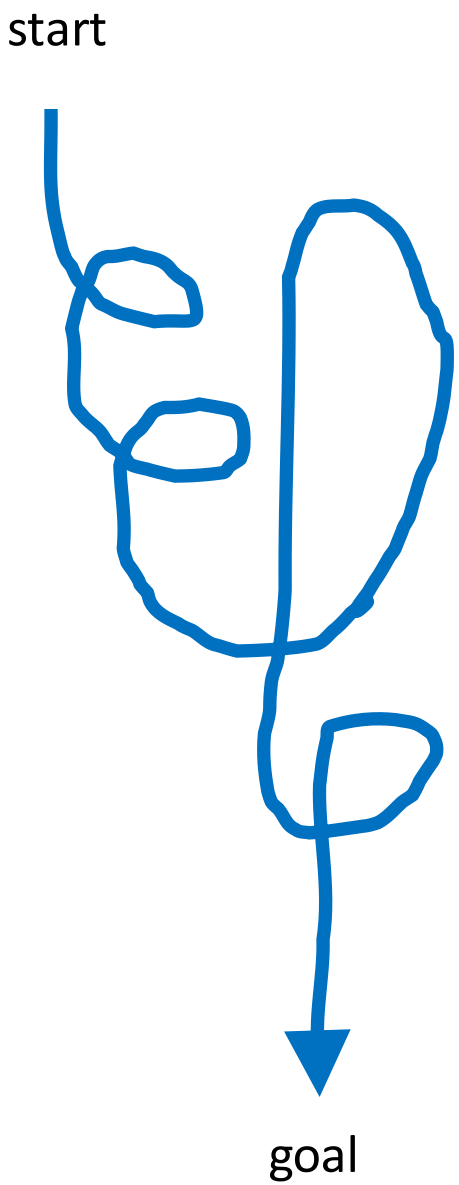
Independent component analysis

Segmenting

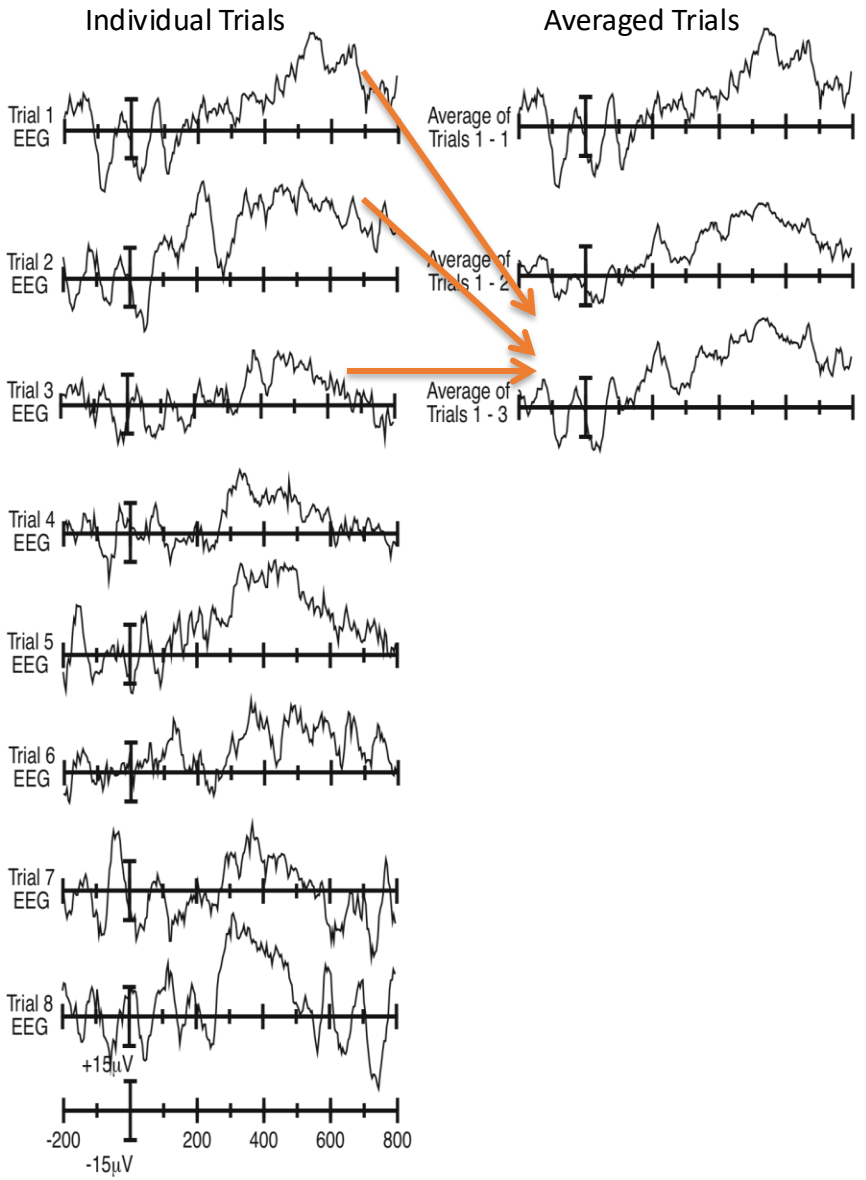
Confounds

Go through multiple iterations of EEG preprocessing

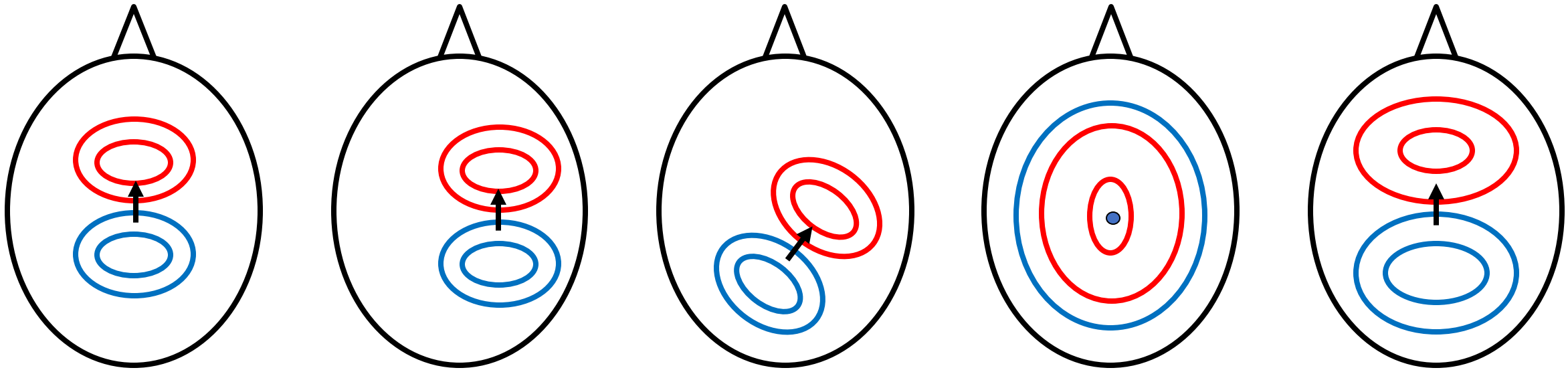




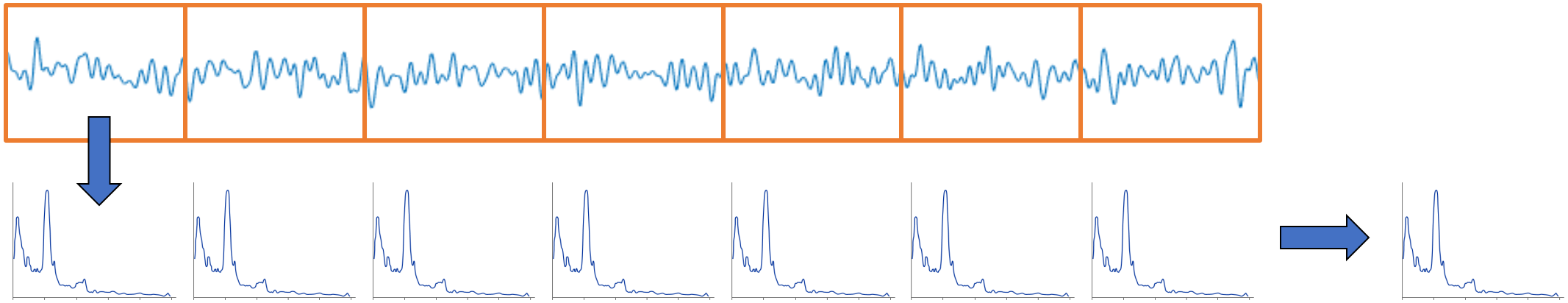
Event-Related Potential
ERP



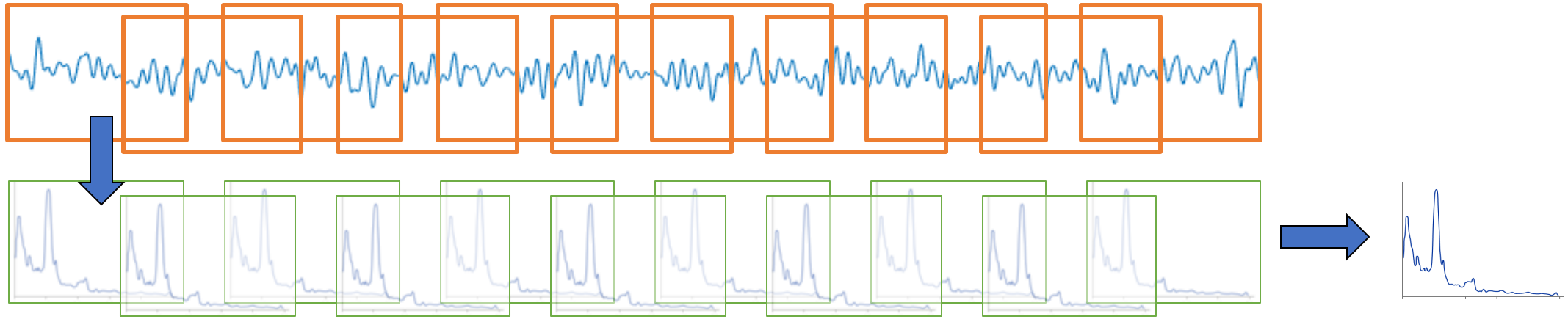
Forward models and ERP topograpies



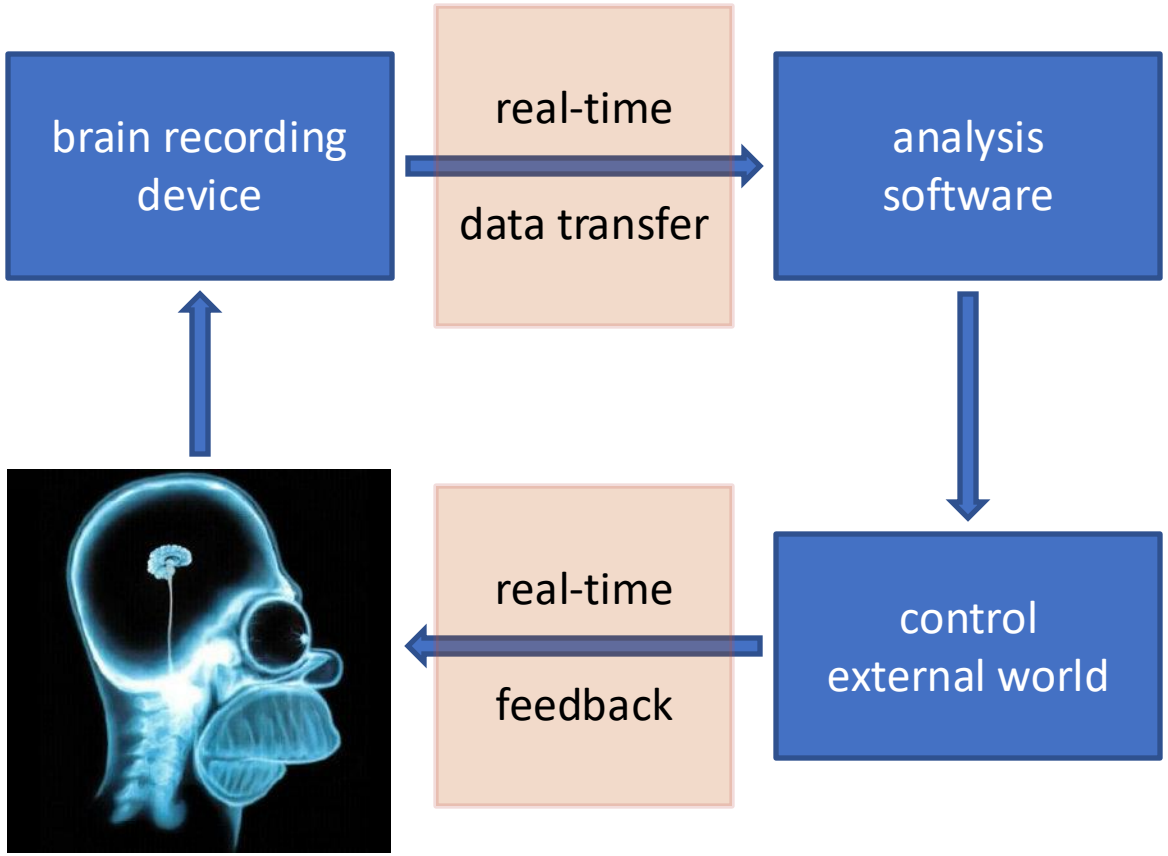
Segment, FFT, average



Segment with some overlap



Streaming data in closed-loop systems



Handle the incoming data, do artifact detection, processing, translating to control signal … a pure real-time streaming protocol is hard to work with

Build your own EEG communities

Purpose

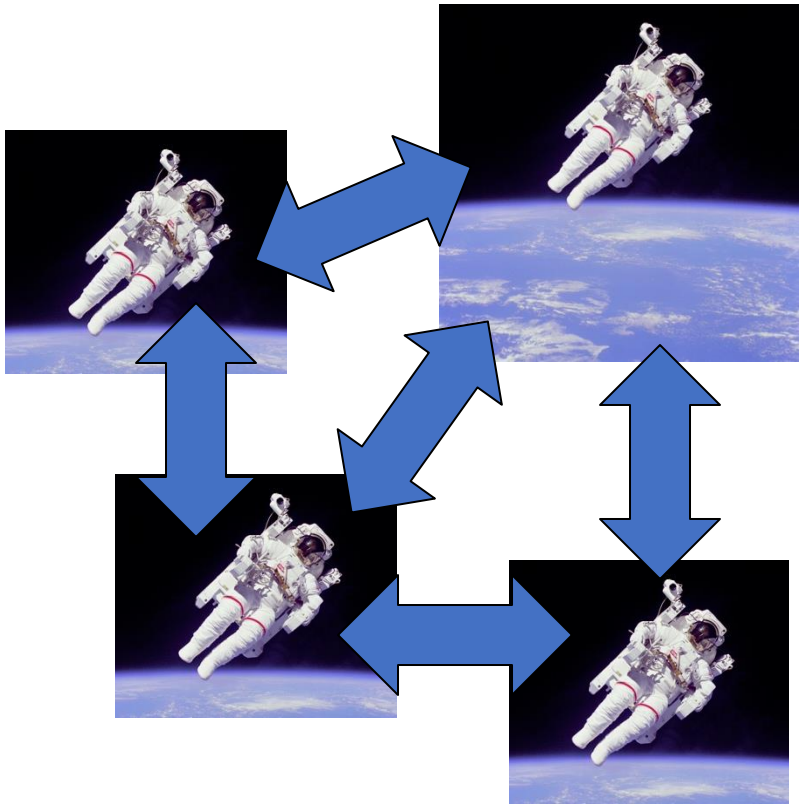
- Peer-to-peer learning: *more minds = more brainpower*

What?

- Arrange a series of meetings
- Agree on format
- Formal or informal meeting:
  - Research presentation of completed EEG project
  - Presentation of new projects -> get feedback
  - Present ongoing studies, analyses, “bring your data to work”, etc.

Who?

- Stay in contact with other workshop attendees
- Engage your local EEG researchers
- Reach out



How?

- Agree on a meeting structure (semi-regular meetings, online/in person, etc.)
- Assign a chair (or rotating chairs) to keep track of who, what, when, and where

Afterwards

The ABDN EEG workshop webpage will remain online, including links to the exercises and including links to the presentation slides and video recordings.

https://www.fieldtriptoolbox.org/workshop/nigeria2025/

You can review this yourself, and share it with your students and colleagues.

Reading material:

https://www.fieldtriptoolbox.org/workshop/nigeria2025/#reading-material

https://www.fieldtriptoolbox.org/references_papers/

Discussion

Consider the EEG experiment design,the task, the recording, and analysis.

Discuss in your group where *you* want to go and what you still need.

Identify questions that Robert and Mikkel can still answer at this moment.

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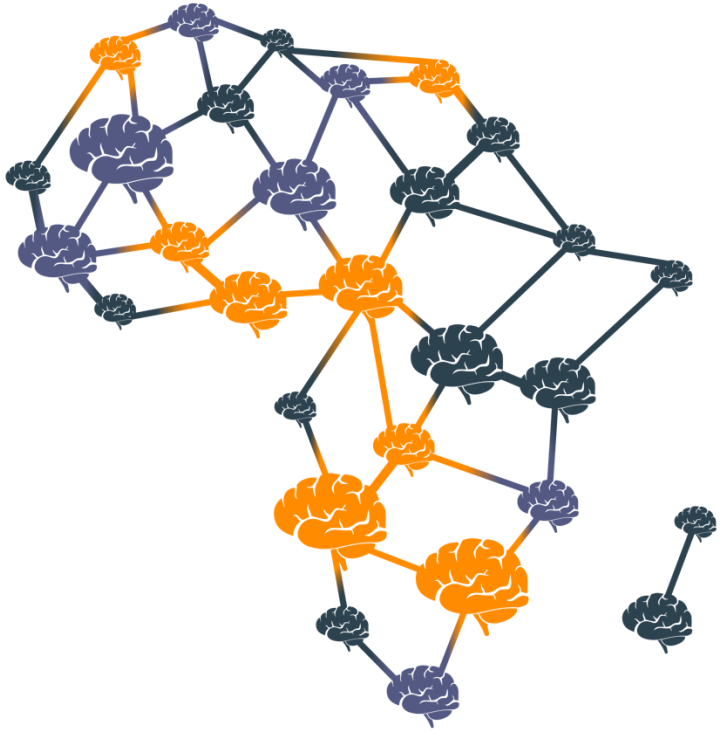

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