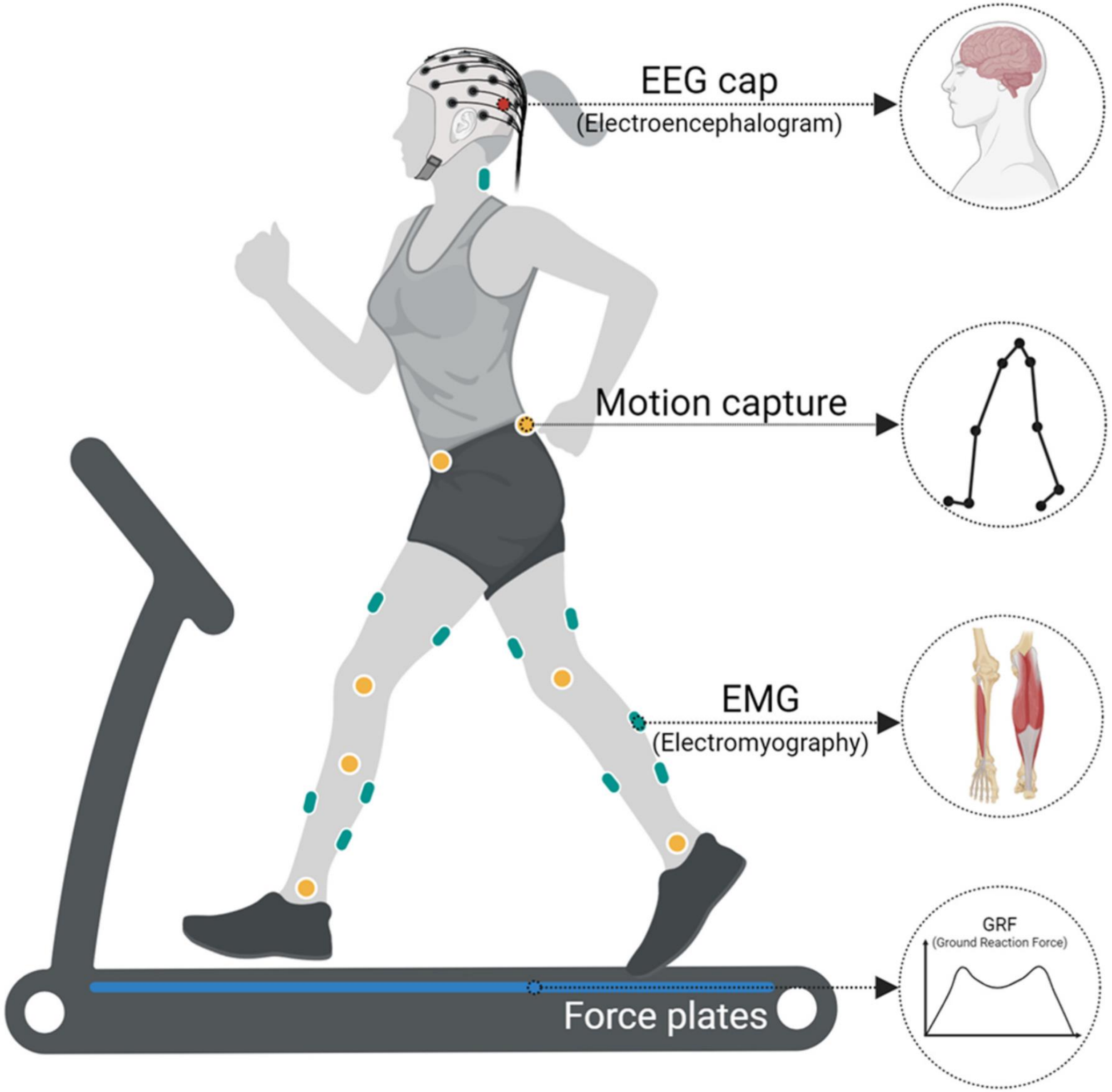
WS#1
EEG und Ganganalyse

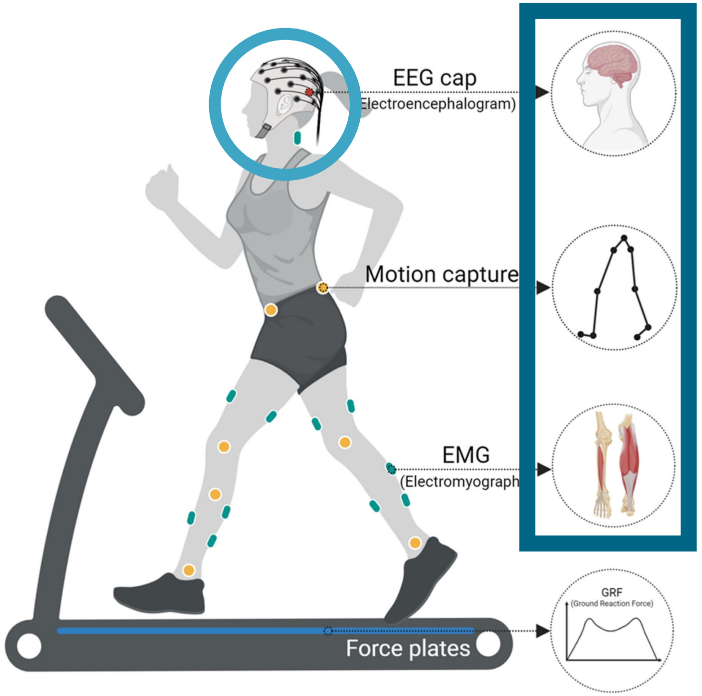
GAMMA Workshop – Kiel 2024

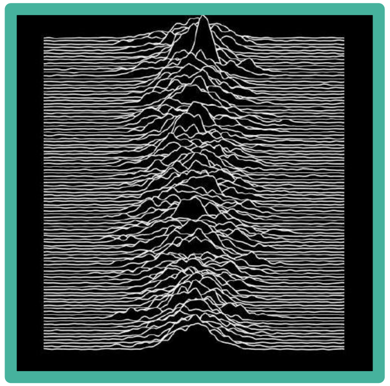
Julius Welzel



Richter ea., Neuroscience & Biobehavioral Reviews, 2024

What to expect today:





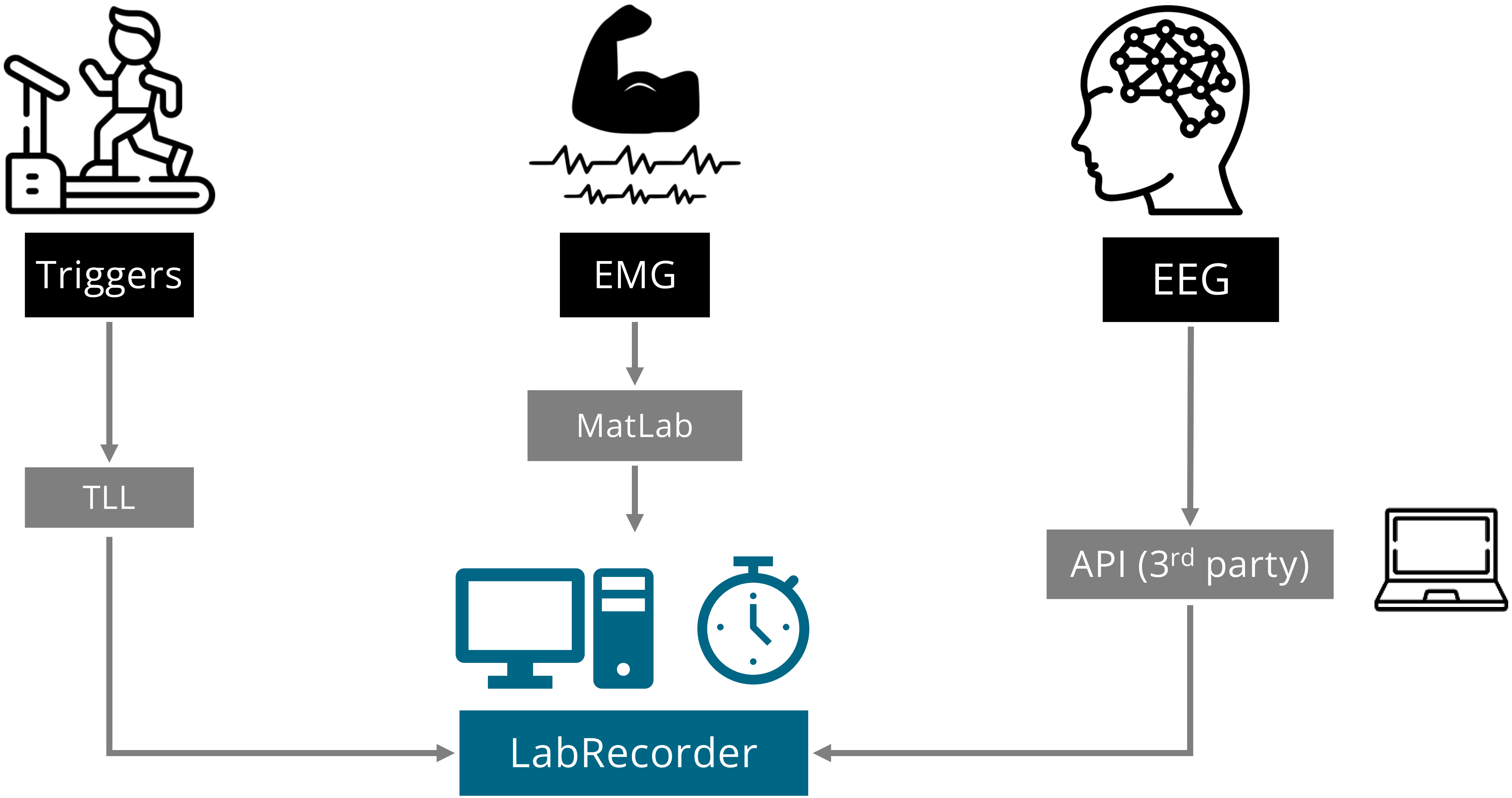
How can I record **EEG, EMG, MoCap, video,** ... in a **synchronized** manner?

How to use **EEG**

How do I interpret my **"mobile" EEG** data?

How can I record **EEG, EMG, MoCap, video, ...** in a **synchronized** manner?

Part 1- How to synchronize recordings



Kothe ea., bioRxiv, 2024

LabStreamingLayer (LSL)

LSL distribution comprises:

- **Core Library**: liblsl and language interfaces (C, C++, Python, Java, MATLAB).
- **Platform**: General-purpose and cross-platform (Windows, Linux, macOS, Android).
- **Architecture**: Supports x86, amd64, and arm.

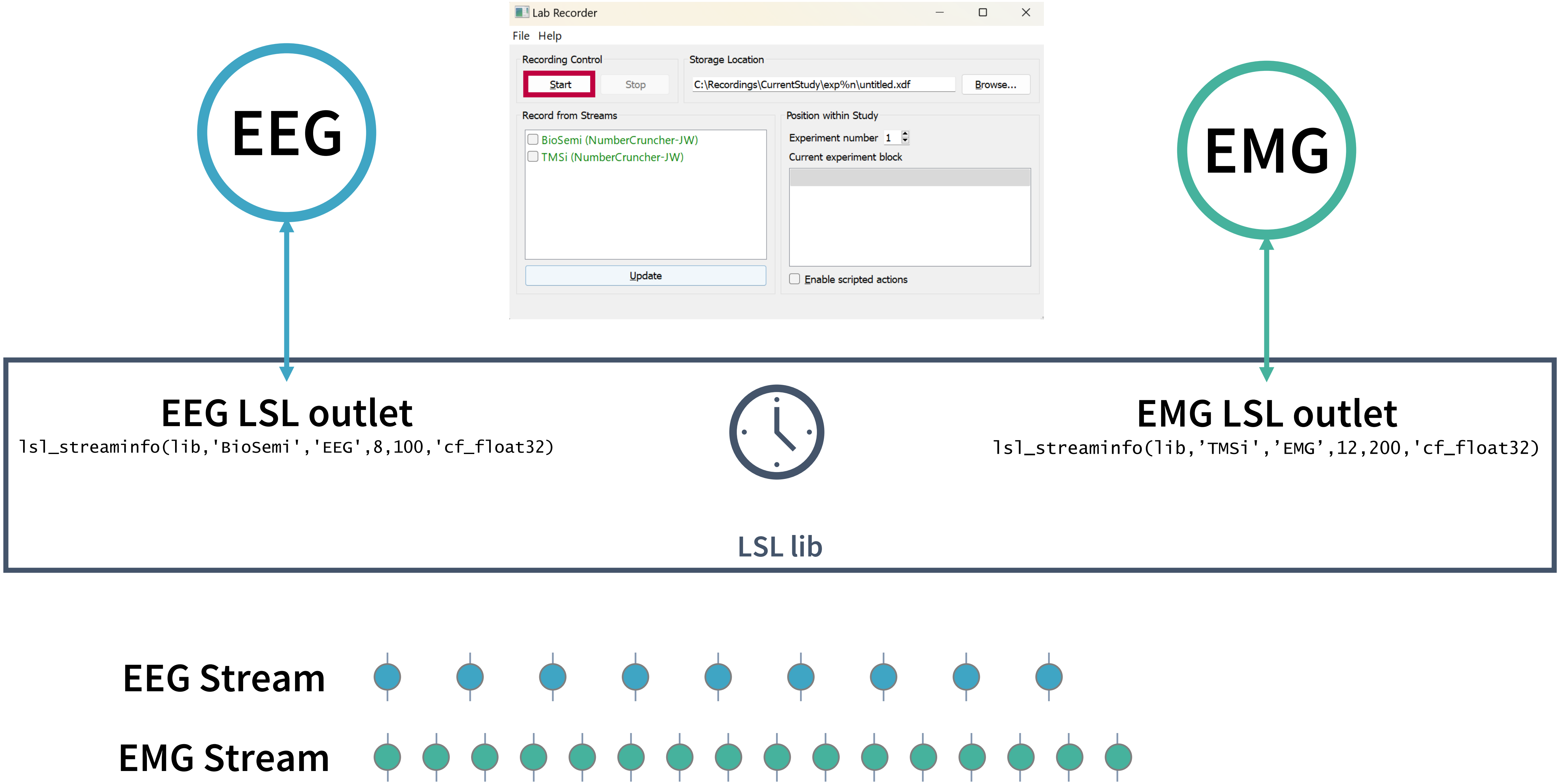
The most common way to use LSL is to use one or more applications to stream data from one or more devices (e.g., EEG and Eye Tracker) over the local network and record the with the LabRecorder.

Steps to use LSL:

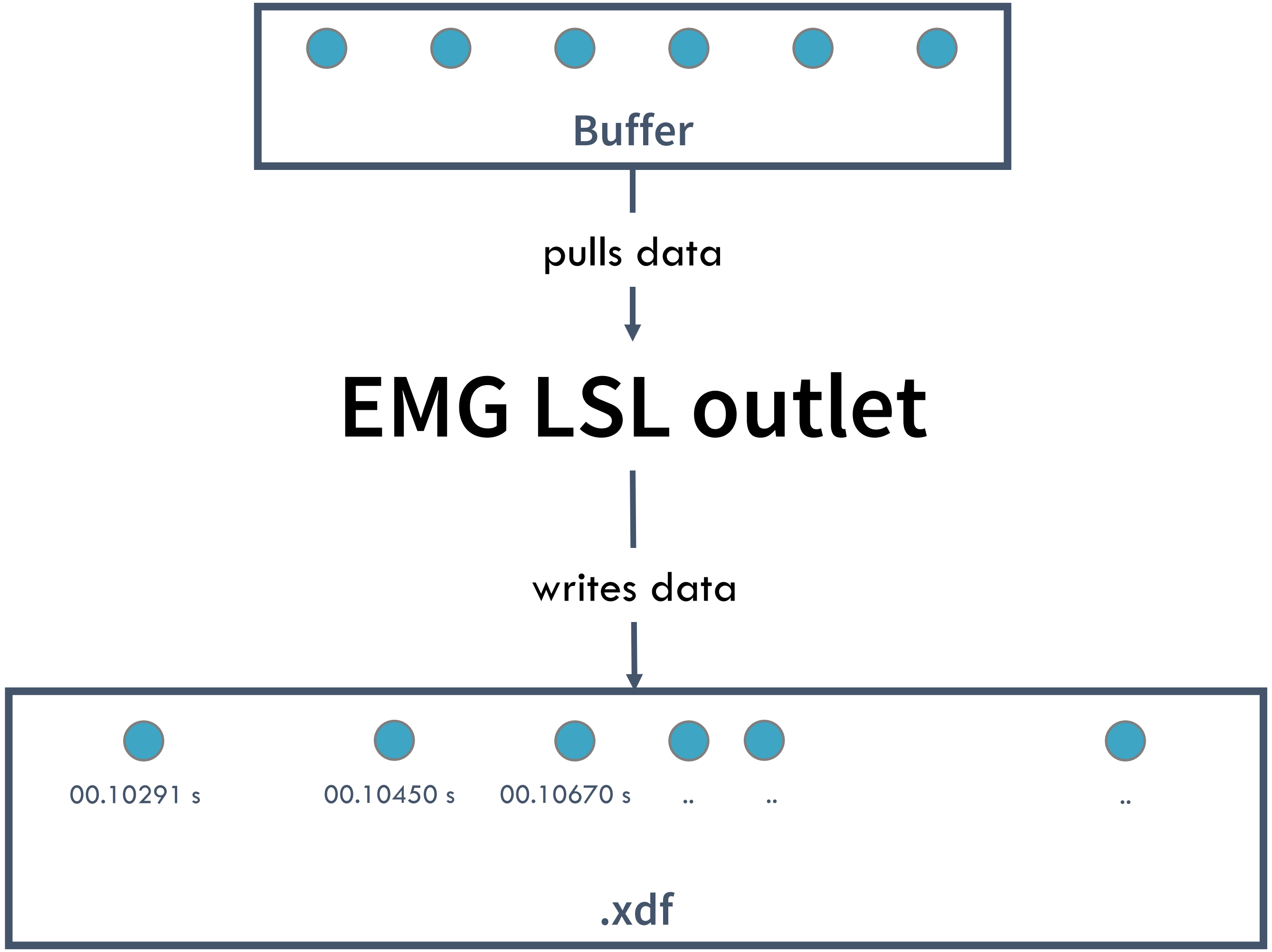
1. Create LSL outlet
2. Fetch data from device
3. Push data to LSL outlet

Example Matlab Code

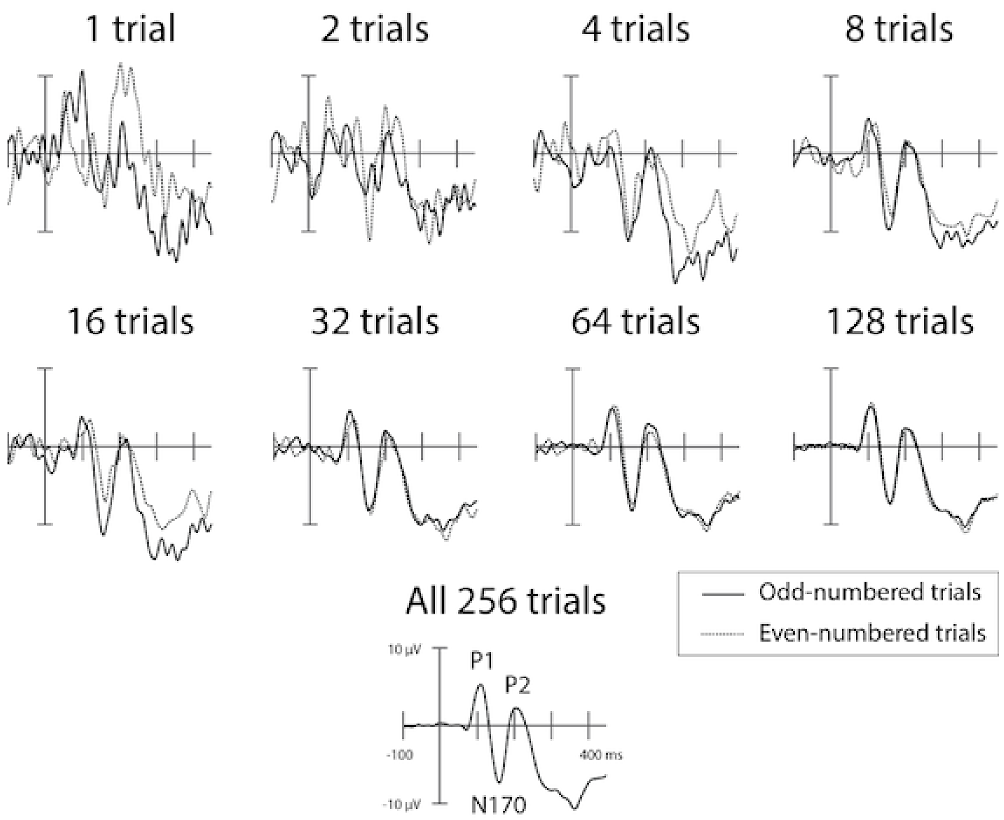
```matlab
%% instantiate the library
disp('Loading library...');
lib = lsl_loadlib();

% make a new stream outlet
disp('Creating a new streaminfo...');
info = lsl_streaminfo(lib,'DelSys','EMG',8,100,'cf_float32'); % 8 channels, 100 Hz, float32

% initiate DelSys Trigno wireless EMG SDK

DelsysInput = tcpip(HOST_IP,50041); % HOST_IP is the IP address of the computer running the Delsys SDK, 50041
DelsysInput.InputBufferSize = 6400; % Buffer size for the input stream

disp('Opening an outlet...');
outlet = lsl_outlet(info);

% send data into the outlet, sample by sample
disp('Now transmitting data...');
while true
    % get data from device
    tmp_data = fread(DelsysInput,bytesReady); % read data from device (8 channel EMG)

    % push data to LSL outlet
    outlet.push_sample(tmp_data); % push data to LSL outlet
end
```

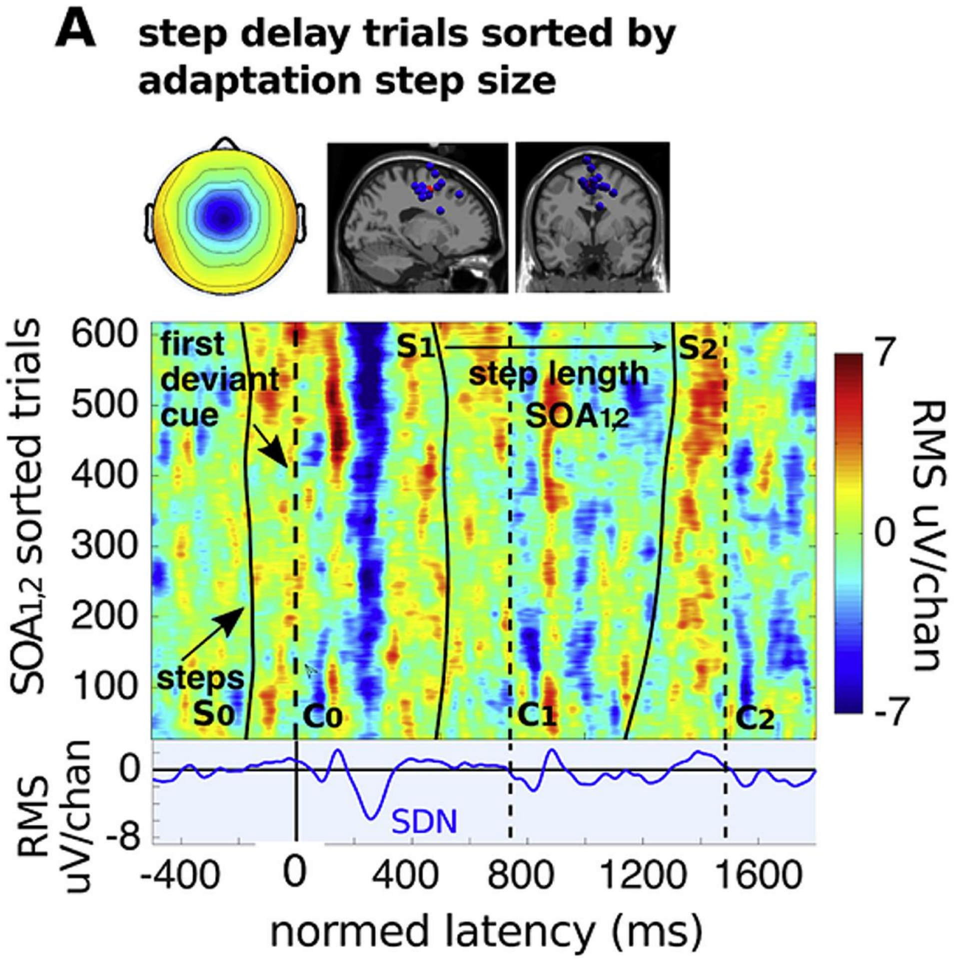

Lab Recorder
File Help
Recording Control
Start
Stop
Storage Location
C:\Recordings\CurrentStudy\exp%n\untitled.xdf
Browse...
Record from Streams
BioSemi (NumberCruncher-JW)
TMSi (NumberCruncher-JW)
Update
Position within Study
Experiment number 1
Current experiment block
Enable scripted actions
EEG
EMG
EEG LSL outlet
lsl_streaminfo(lib,'BioSemi','EEG',8,100,'cf_float32)
EMG LSL outlet
lsl_streaminfo(lib,'TMSi','EMG',12,200,'cf_float32)
LSL lib
EEG Stream
EMG Stream

EMG


Buffer
pulls data
EMG LSL outlet
writes data
00.10291 s
00.10450 s
00.10670 s
..
..
..
.xdf

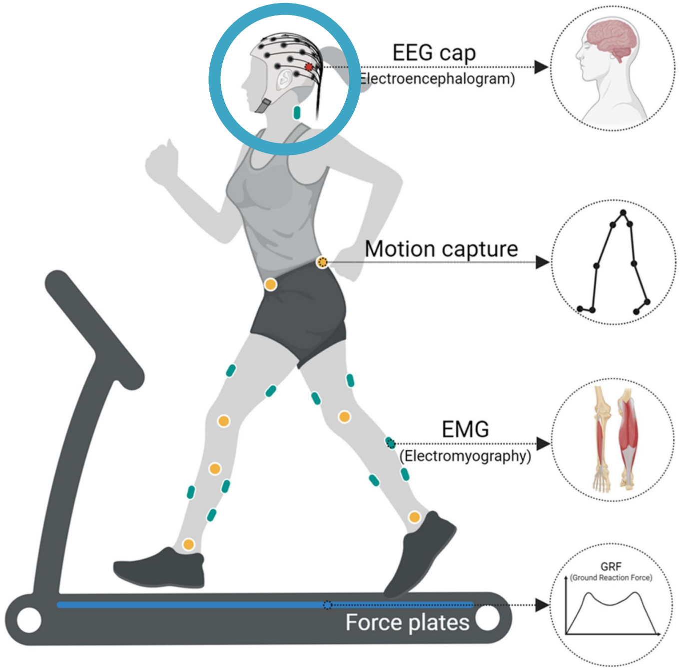
Why is subsecond presicion important?





Wagner ea., Neuroimage, 2019

What to expect today:



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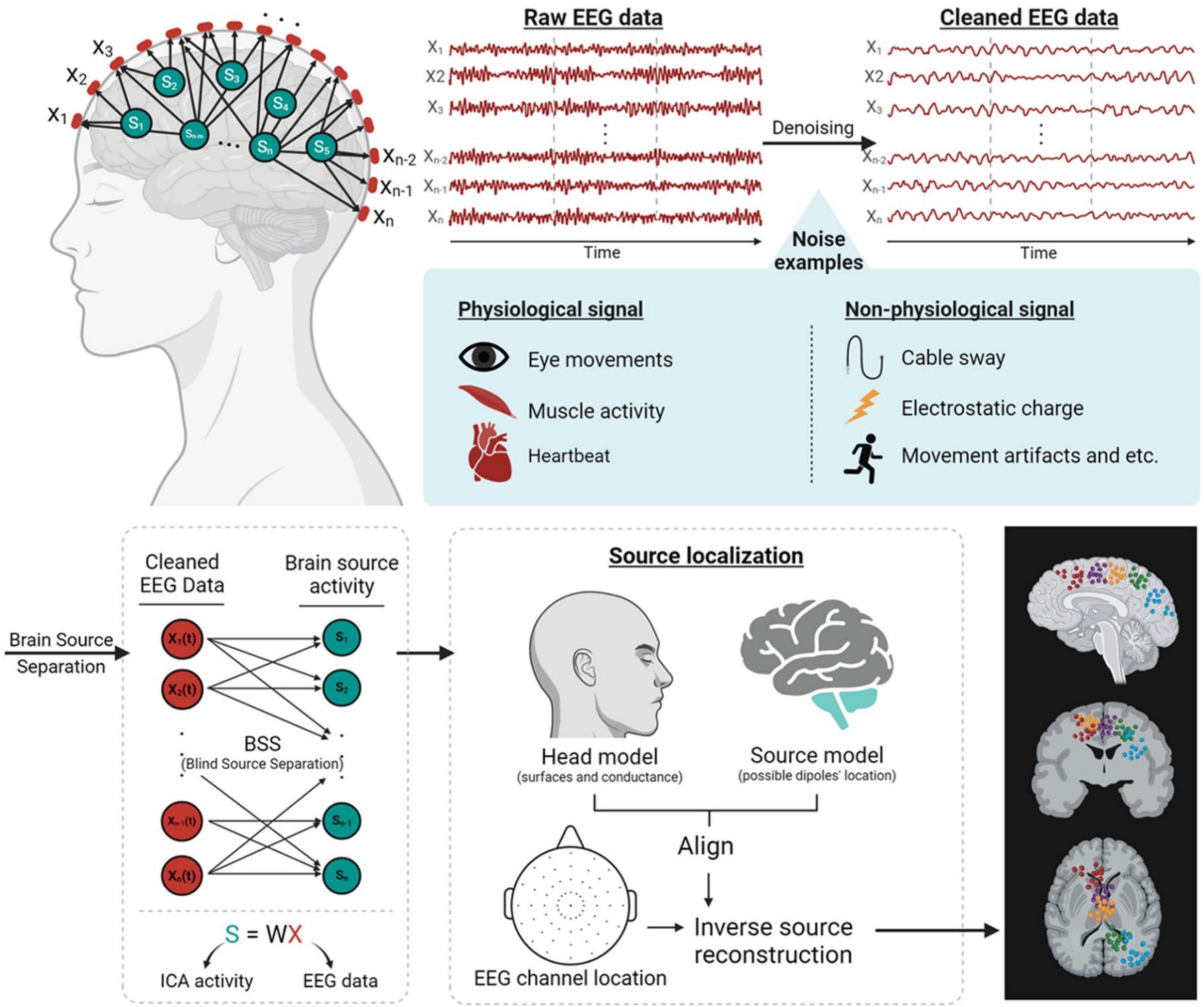
How to use
EEG



Richter ea., Neuroscience & Biobehavioral Reviews, 2024


CP5
P5
PO7
PO3
TP7
P7
FT7

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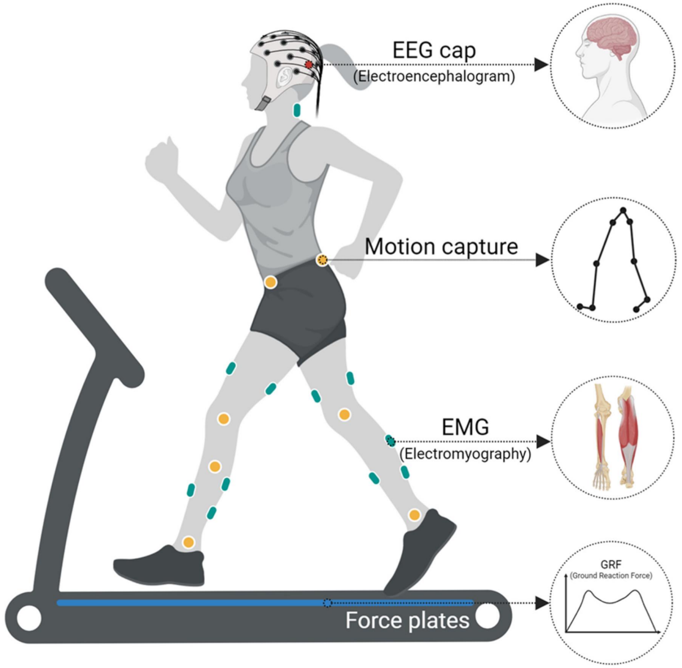

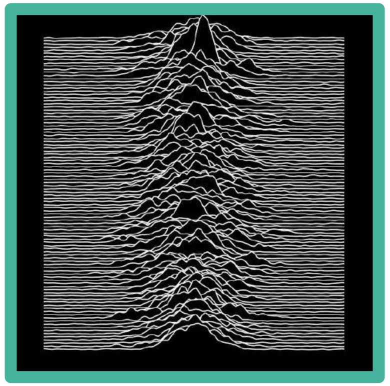

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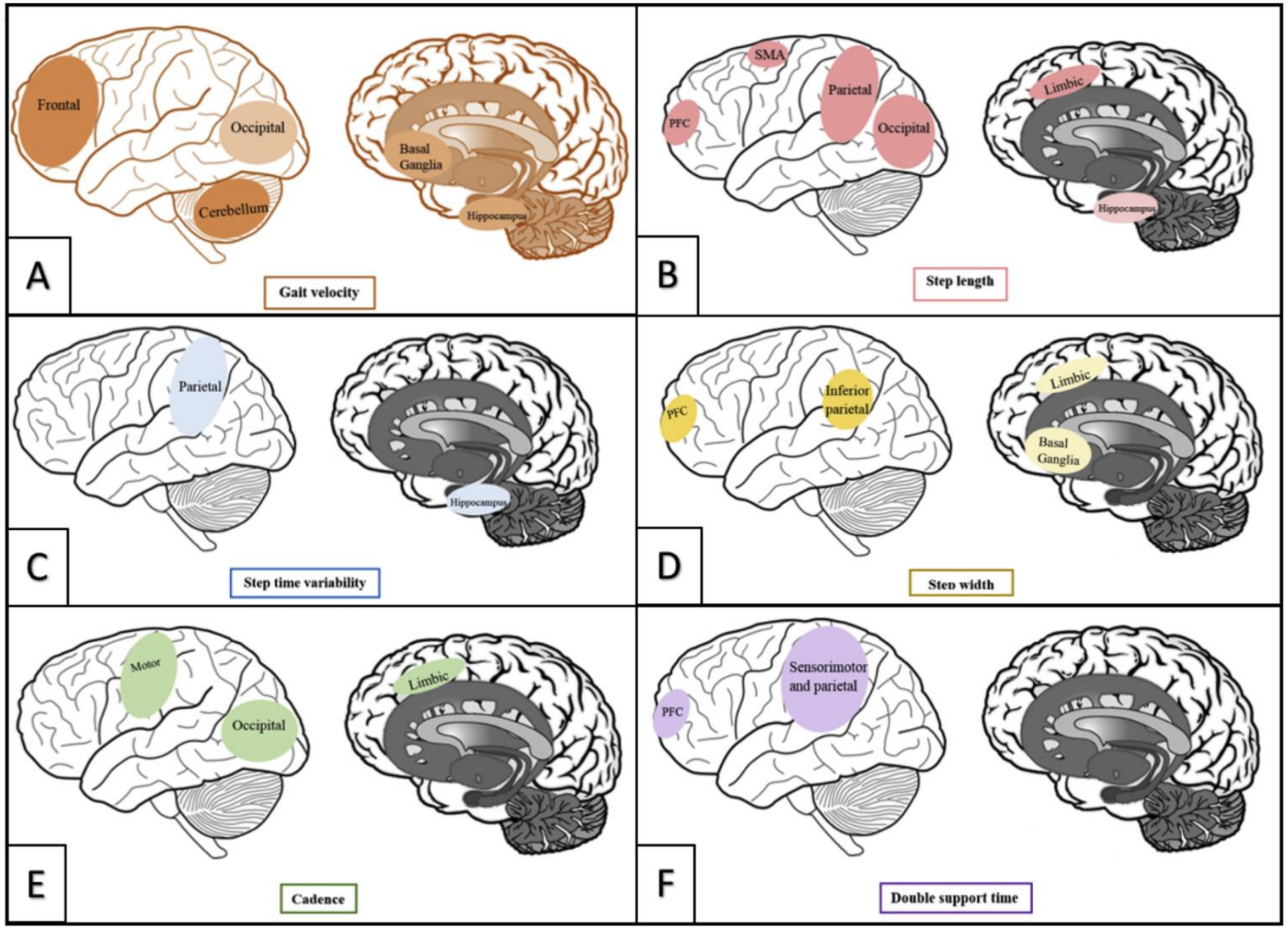
How do I interpret my **“mobile”** **EEG** data?

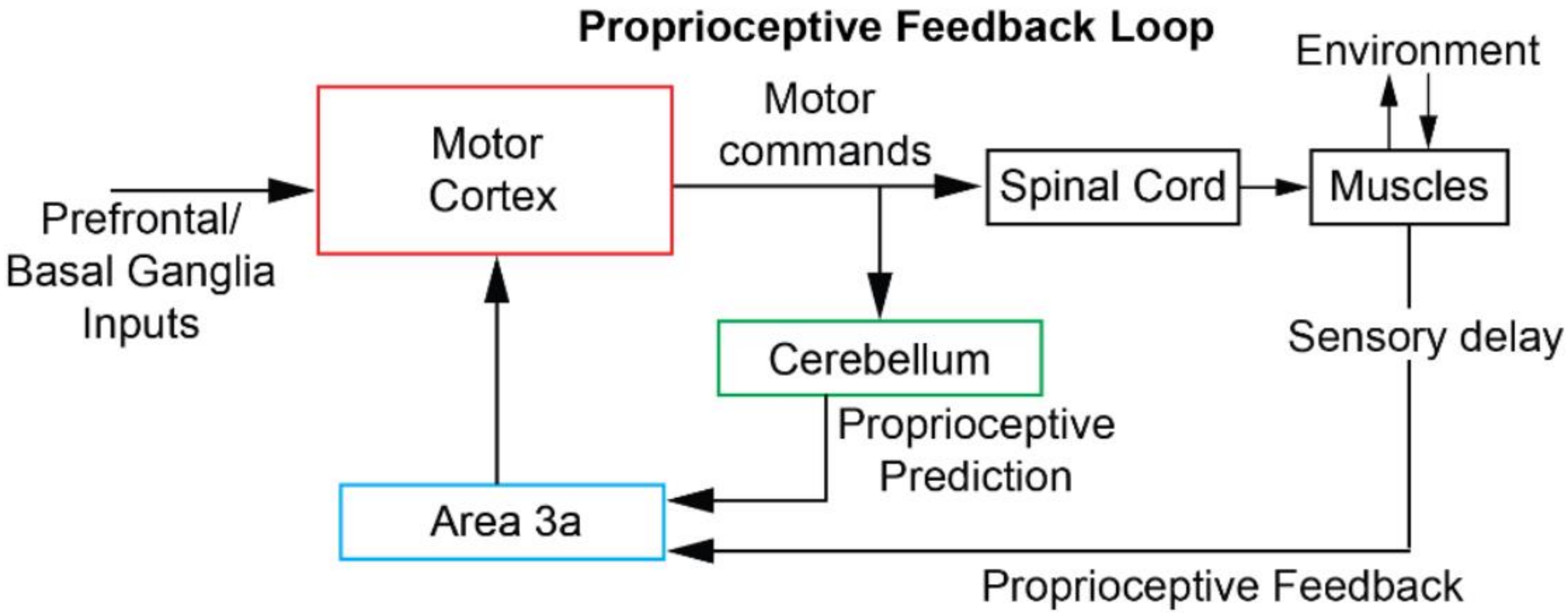
Why is EEG so interesting?



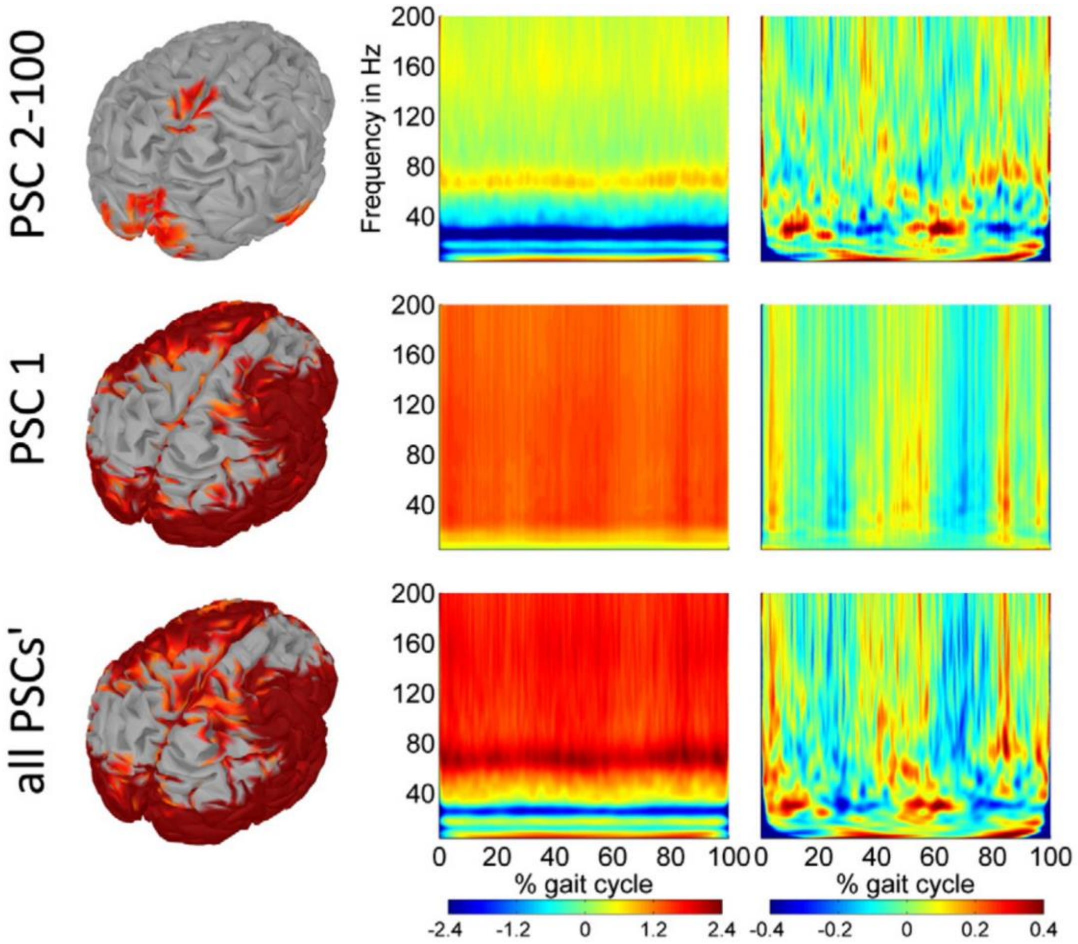
Wilson ea., Neuroscience and Biobehavioral Reviews, 2019

Dynamical Feedback Control: Motor Cortex as an Optimal Feedback Controller Based on Neural Dynamics |Versteeg ea., bioarXiv, 2022

- M1 as main feedback controller in motor control



What about artifacts?



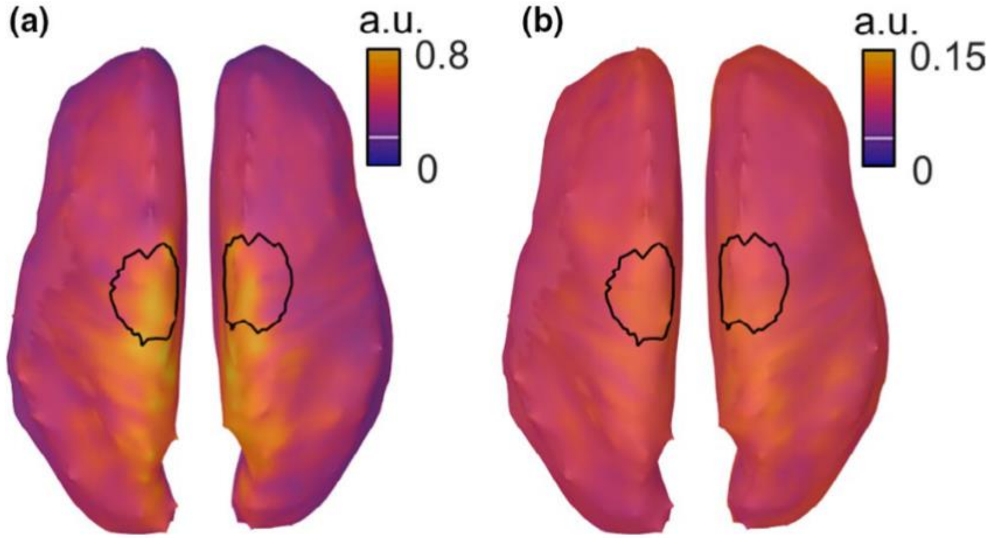
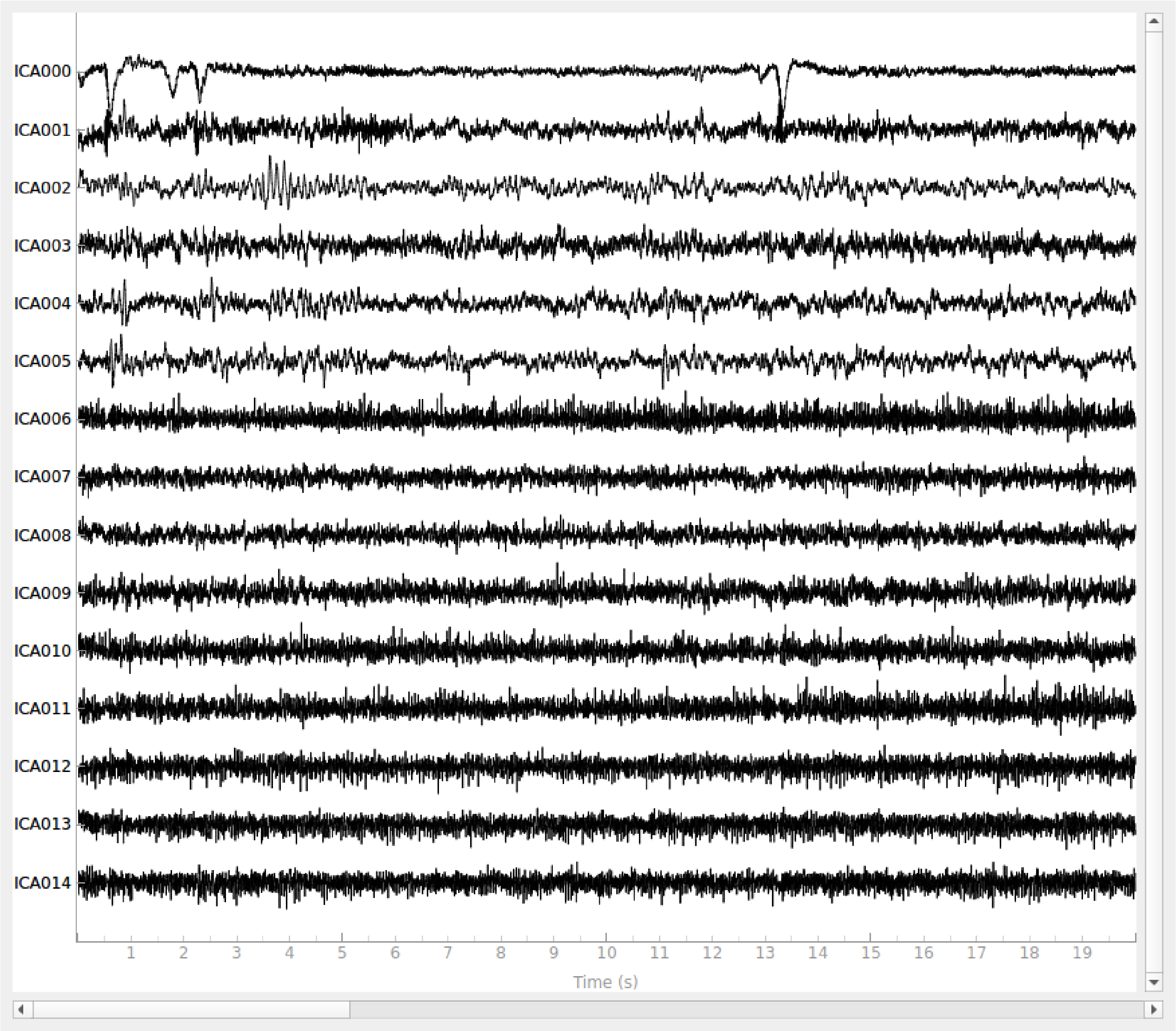


FIGURE 11 Grand mean source estimation of the gait ERP before (a) and after (b) artifact attenuation displayed on the default cortex used by Brainstorm. Borders of the region of interest are contoured

Seeber ea., Neuroimage, 2015; Jacobsen ea., European Journal of Neuroscience, 2020

Remove artifacts (ICA)



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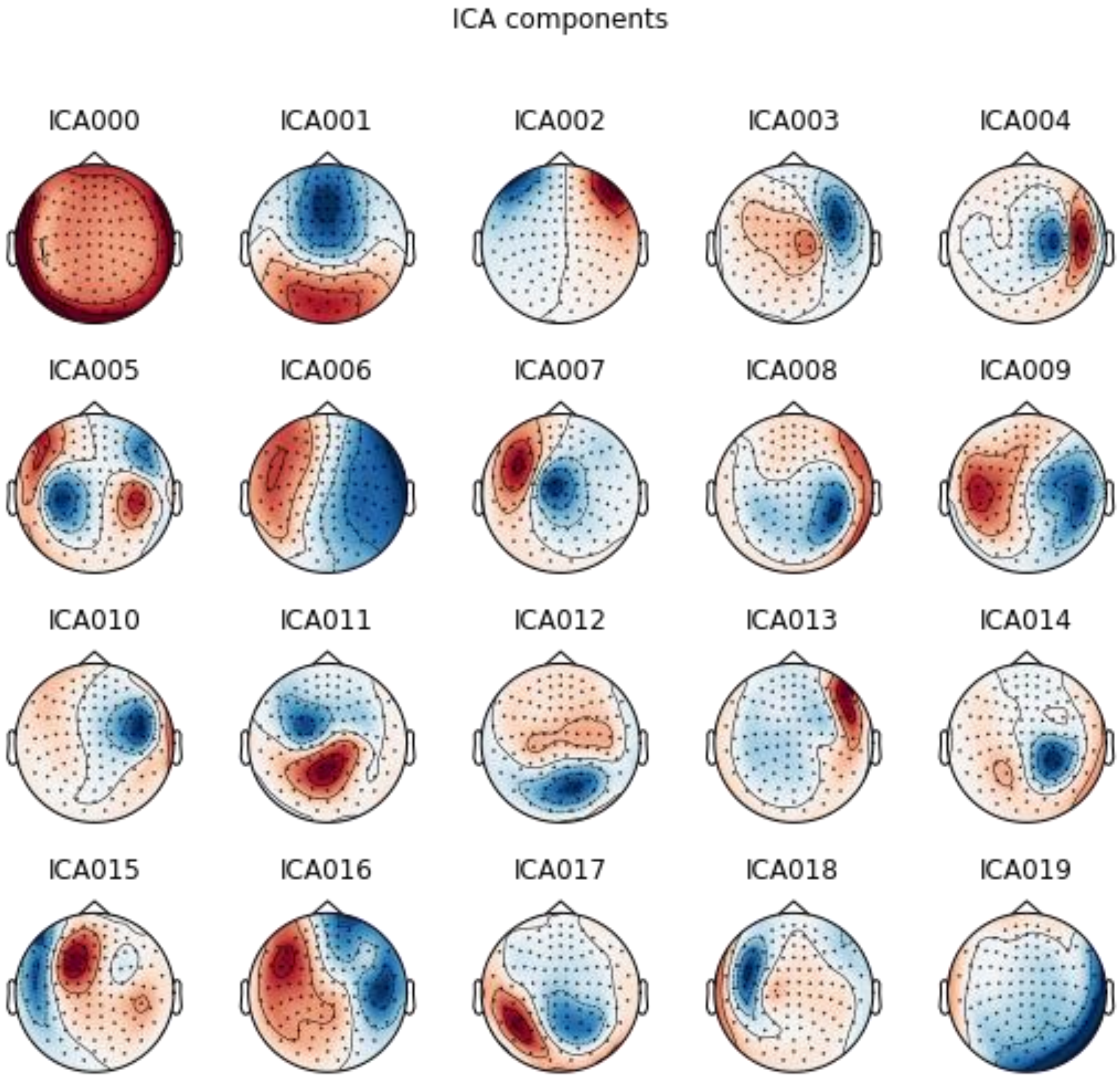

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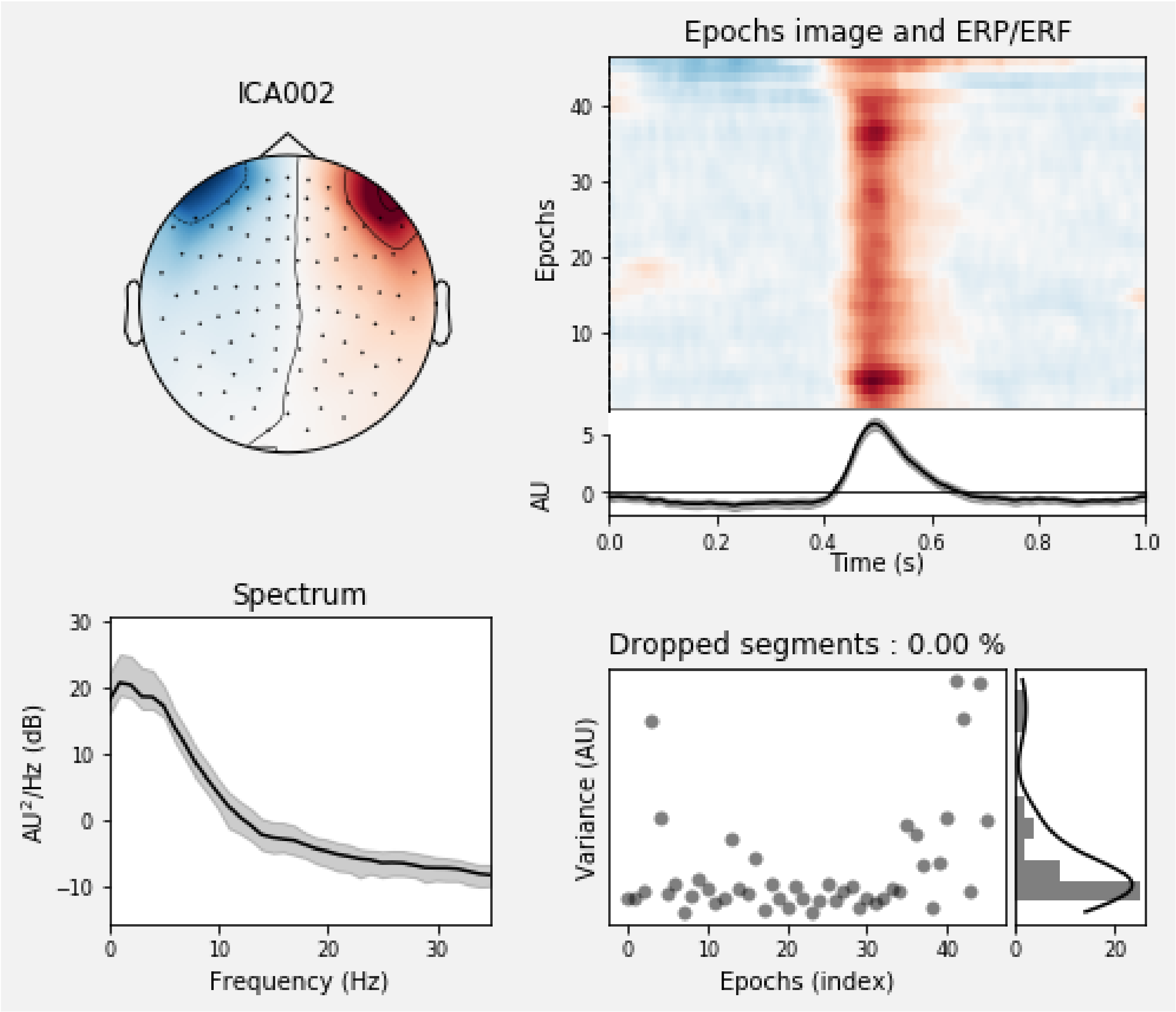

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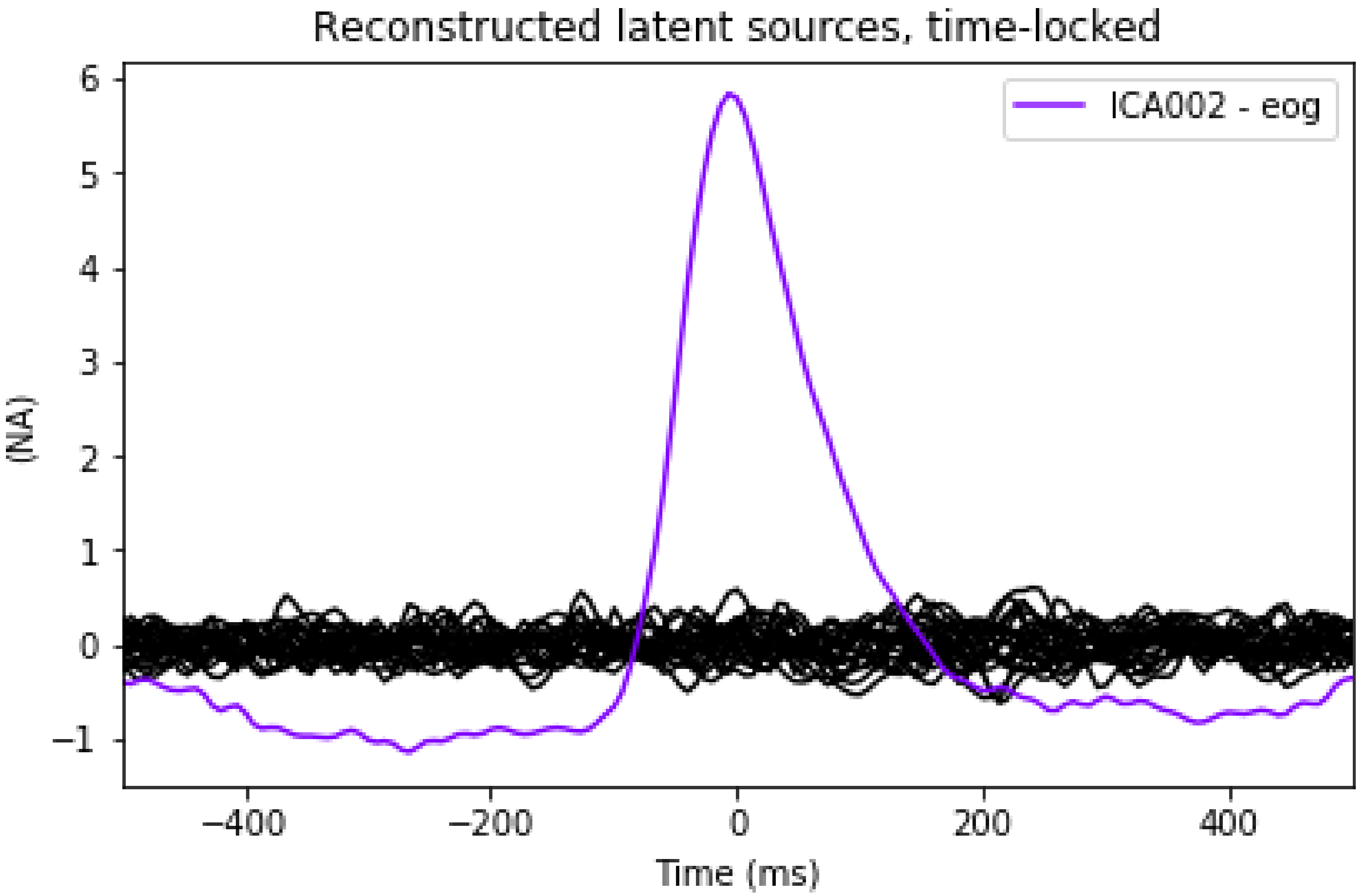

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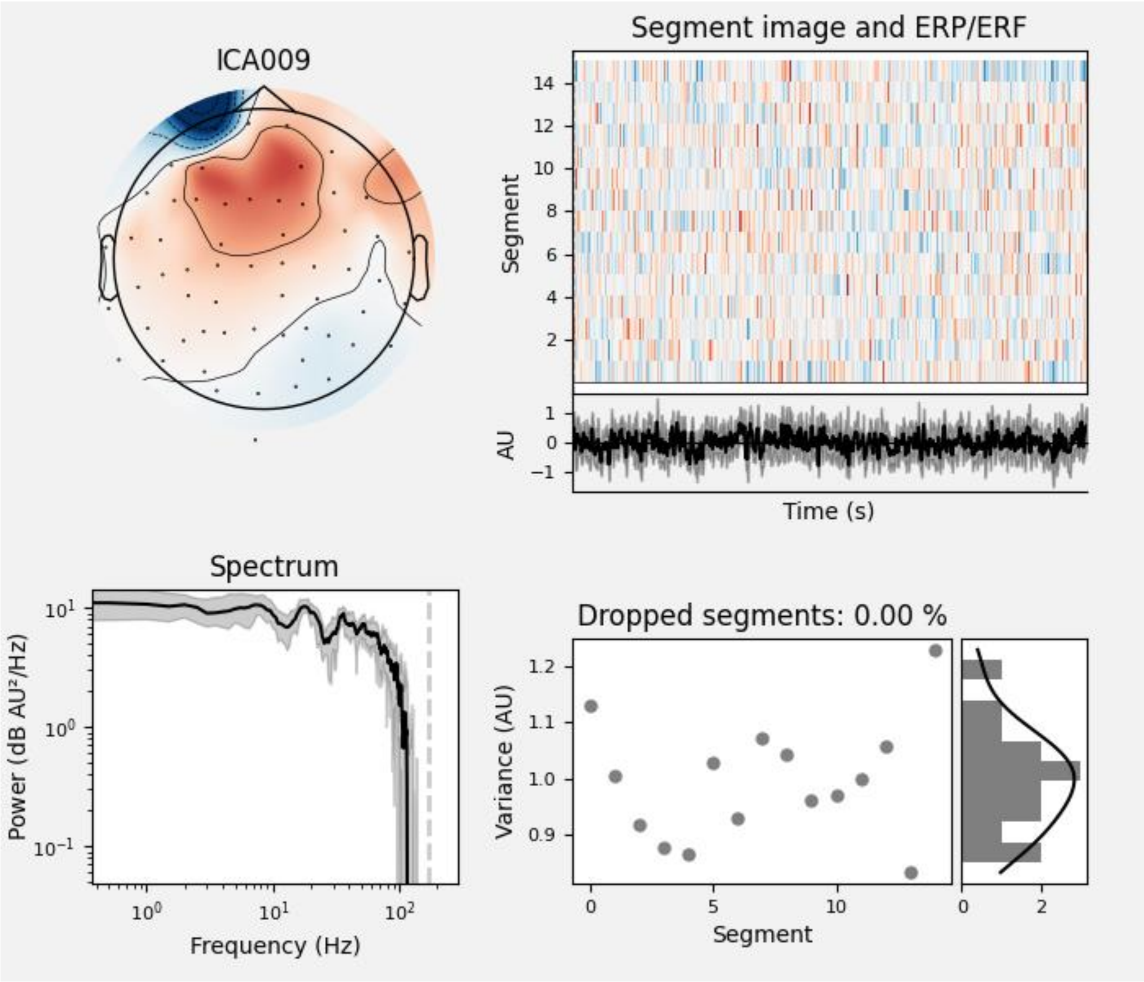
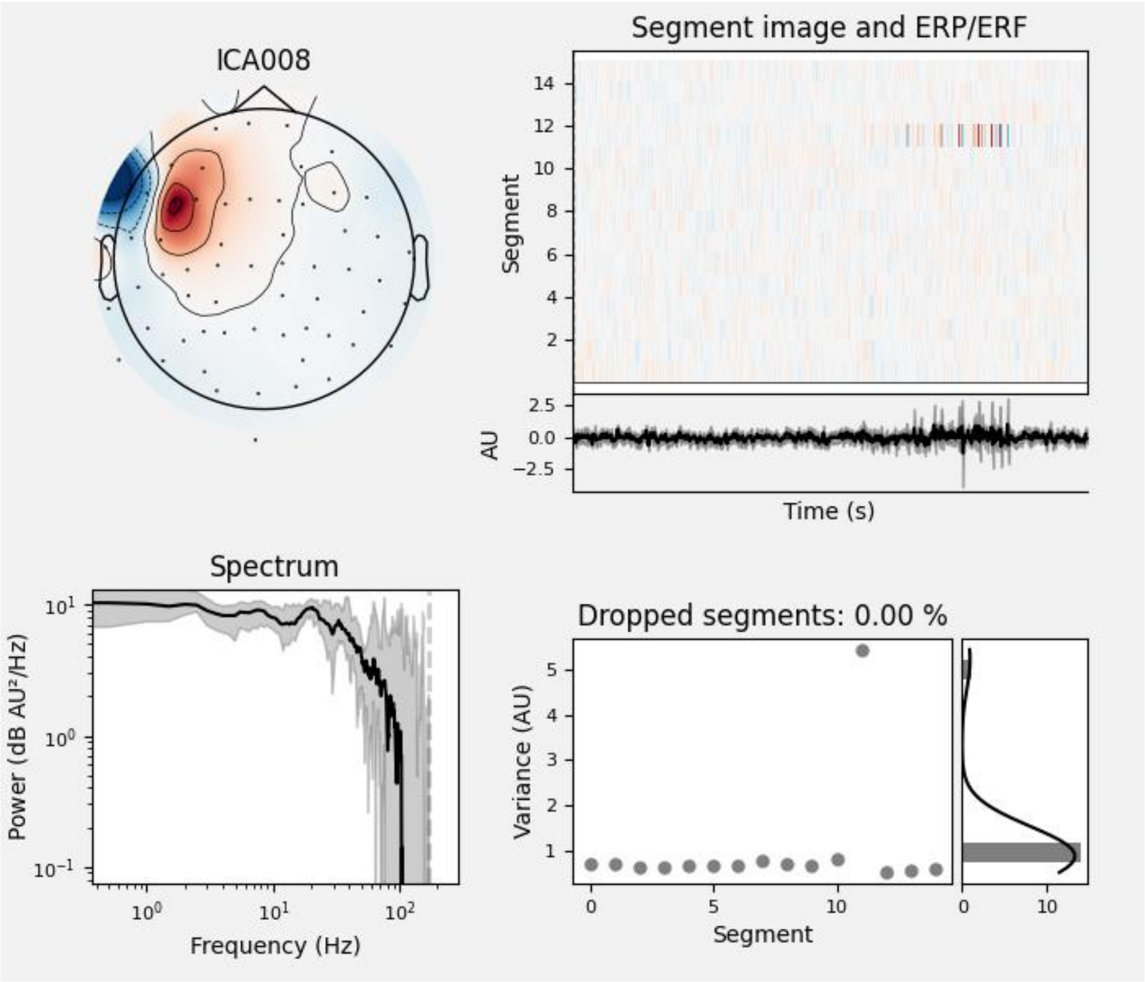
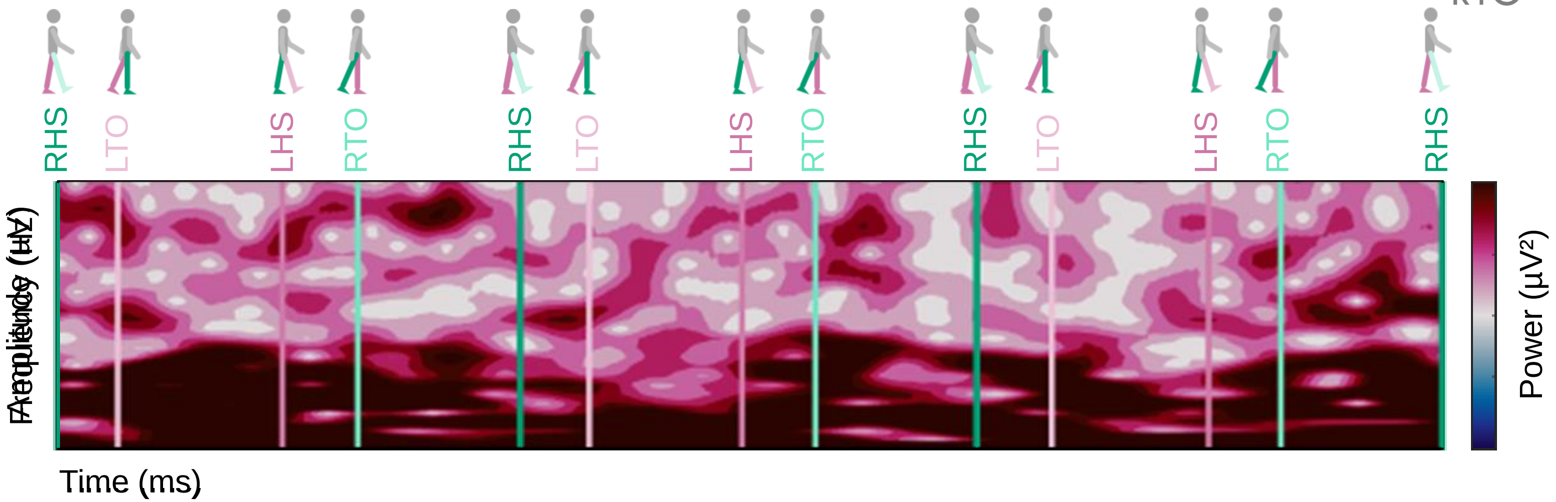


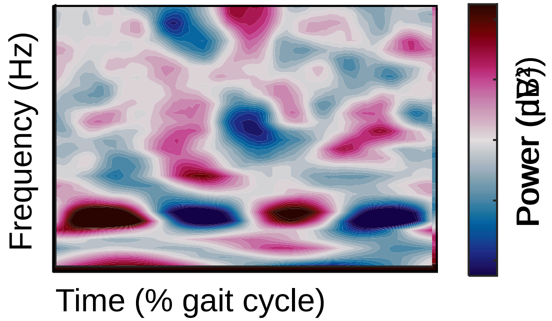


How to assess neural correlates of gait

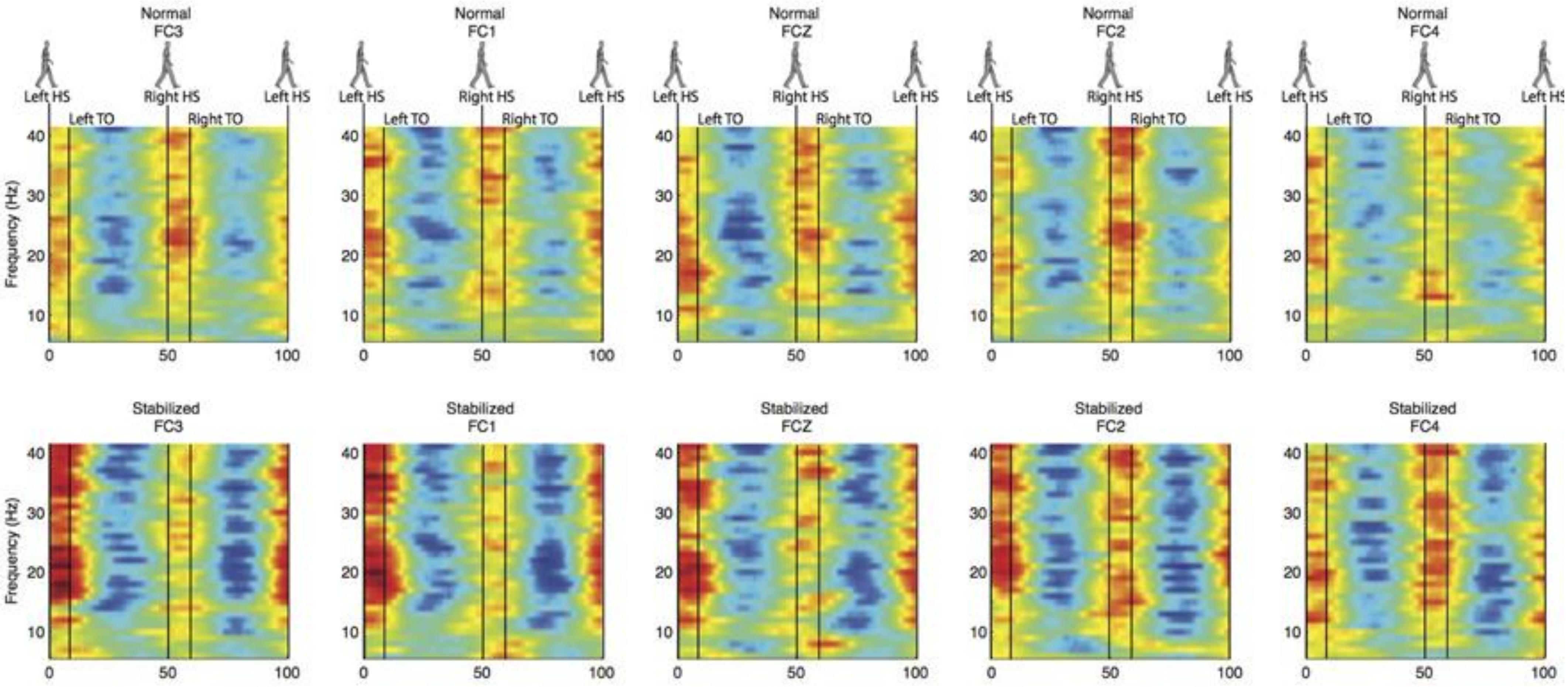
Gait events

LHS left heel strike
LTO left toe-off
RHS right heel strike
RTO right toe-off





EEG & walking



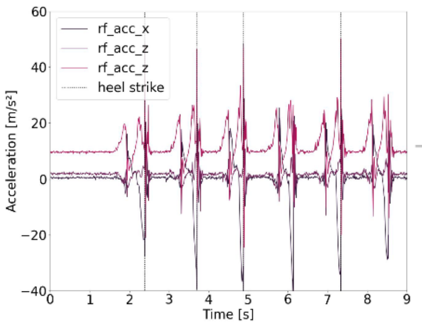
Bruijn ea., Frontiers of Hum. Neurosci., 2015

Organise your data

BIDS
BRAIN IMAGING DATA STRUCTURE

0,26345511	0,092292015	0,008668652	0,930514317	0,690193606	0,809881135
0,694520294	0,191824943	0,843726573	0,397571025	0,88542996	0,895276224
0,076633595	0,258720111	0,547534792	0,282283781	0,27890791	0,232620594
0,577995093	0,045616941	0,04903375	0,940889749	0,153318421	0,668360752
0,054555716	0,791513927	0,587116733	0,466957774	0,975446368	0,048053341
0,966026984	0,196283834	0,711044406	0,338944328	0,719445195	0,438488392
0,98417512	0,507944361	0,1180168	0,796692478	0,175376468	0,488659533
0,98839607	0,155737146	0,800206213	0,633481382	0,752698206	0,852943441
...	...	...	...	...	...

```
README
dataset_description.json
participants.tsv
participants.json
sub-001
  └ motion
      sub-001[_ses-01]_task-<label>_tracksys-<label>_motion.tsv
      sub-001[_ses-01]_task-<label>_tracksys-<label>_motion.json
      sub-001[_ses-01]_task-<label>_tracksys-<label>_events.tsv
      sub-001[_ses-01]_task-<label>_tracksys-<label>_events.json
      sub-001[_ses-01]_task-<label>_tracksys-<label>_channels.tsv
sub-002
  └ motion
      sub-002[_ses-01]_task-<label>_tracksys-<label>_motion.tsv
      ...
```




```
{
  "SamplingFrequency": 60,
  "SamplingFrequencyEffective": 60.19,
  "TaskName": "BIDS Motion fictive example",
  "TrackingSystemName": "imu1",
  "TaskDescription": "walking and talking",
  "MotionChannelCount": 6,
  „SubjectArtefactDescription": "n/a",
  "TrackedPointsCount" : 2,
  "ACCELChannelCount": 3,
  „GYROChannelCount": 3,
  "Manufacturer": "BWSensing",
  "ManufacturersModelName": "BW-imu600",
}
```


onset	duration	trial_type
2.45	0.1	heel_strike
3.81	0.1	heel_strike
4.95	0.1	heel_strike
6.11	0.1	heel_strike
7.24	0.1	heel_strike

name	component	type	tracked_point	units	placement
imu1_rf_acc_x	x	ACCEL	rf	m/s^2	right_foot
imu1_rf_acc_y	y	ACCEL	rf	m/s^2	right _foot
imu1_rf_acc_z	z	ACCEL	rf	m/ s^2	right _foot
imu1_rf_gyro_x	x	GYRO	rf	rad/s	right _foot
imu1_rf_gyro_y	y	GYRO	rf	rad/s	right _foot
imu1_rf_gyro_z	z	GYRO	rf	rad/s	right _foot

Jeung ea., Scientific Data, 2024

Thank you for listening

☺