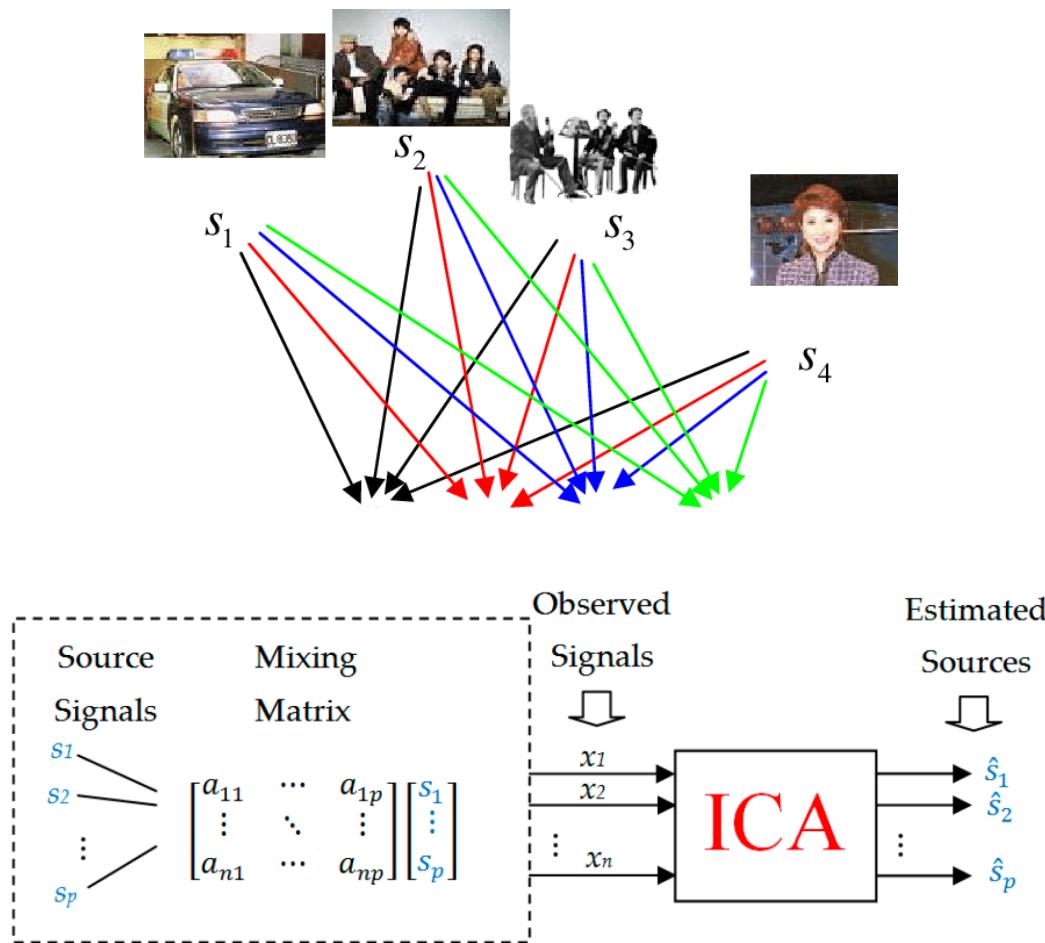


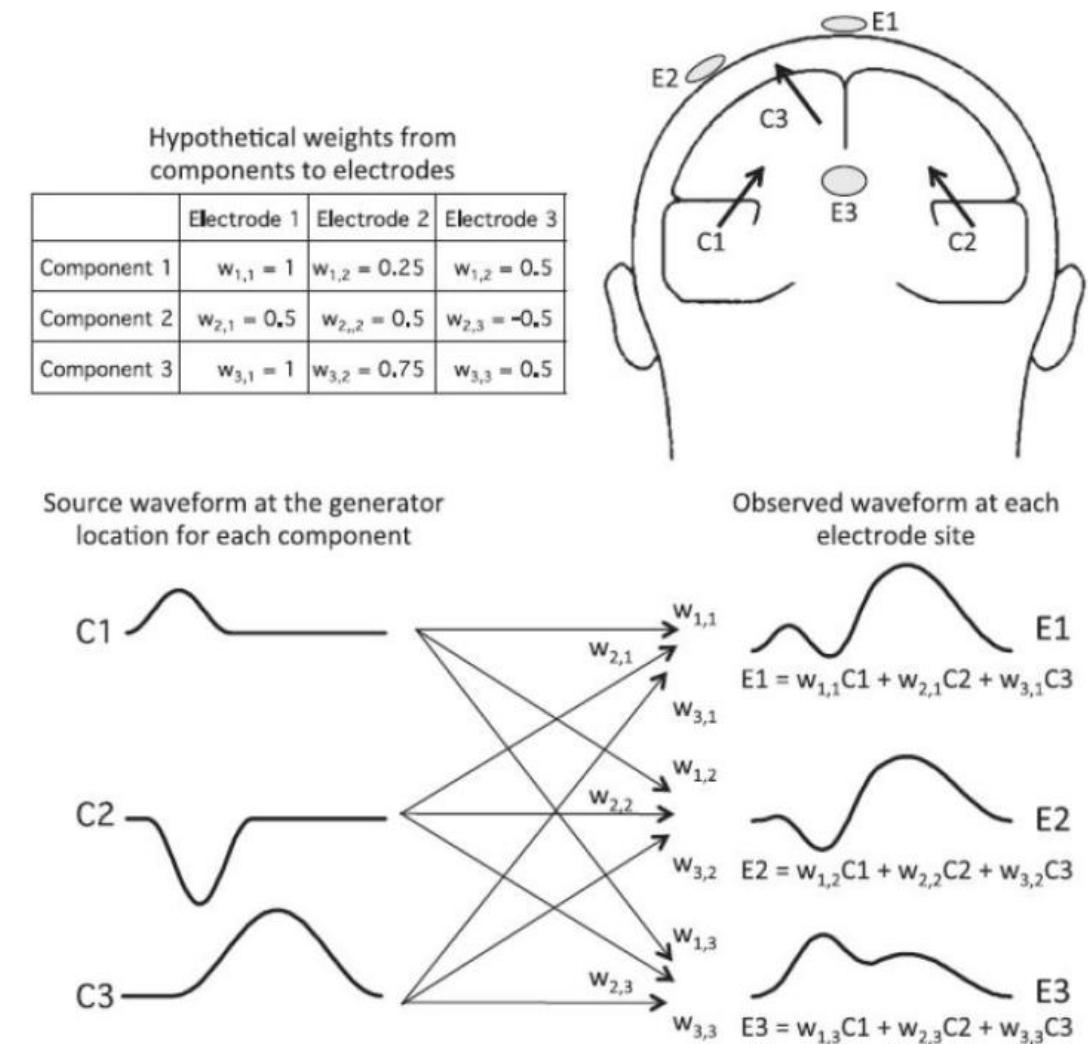
# **EEGLAB and ERPLAB**

Interdisciplinary Schools  
Signal Processing Department  
Parisa Khoorahe

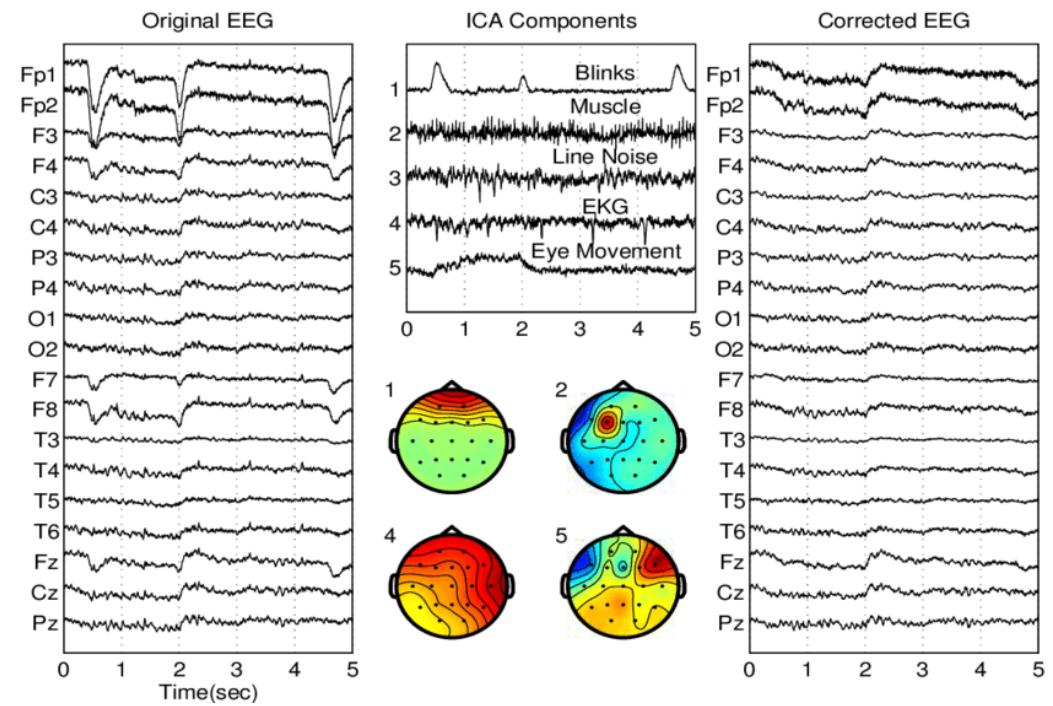
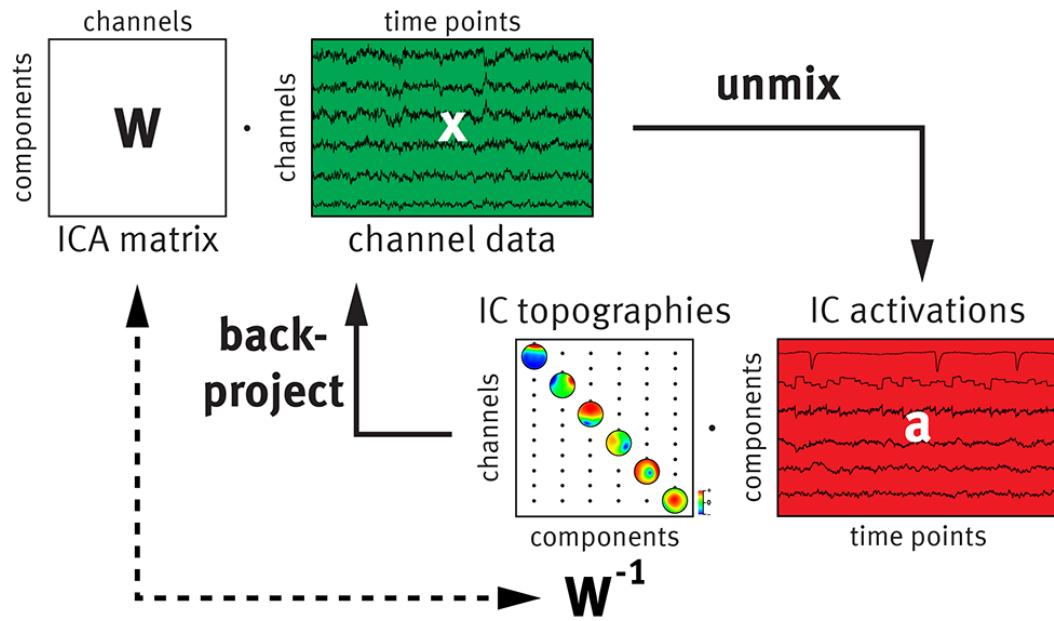
# EEGLAB - ICA



	Electrode 1	Electrode 2	Electrode 3
Component 1	$w_{1,1} = 1$	$w_{1,2} = 0.25$	$w_{1,3} = 0.5$
Component 2	$w_{2,1} = 0.5$	$w_{2,2} = 0.5$	$w_{2,3} = -0.5$
Component 3	$w_{3,1} = 1$	$w_{3,2} = 0.75$	$w_{3,3} = 0.5$



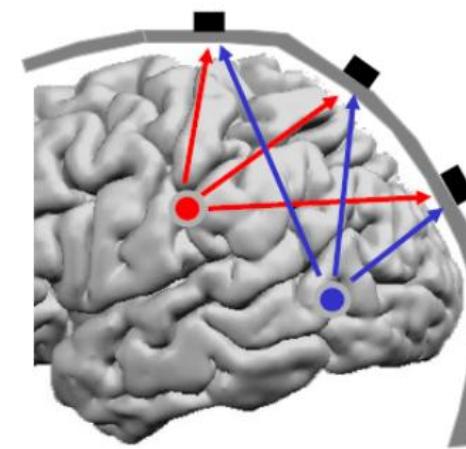
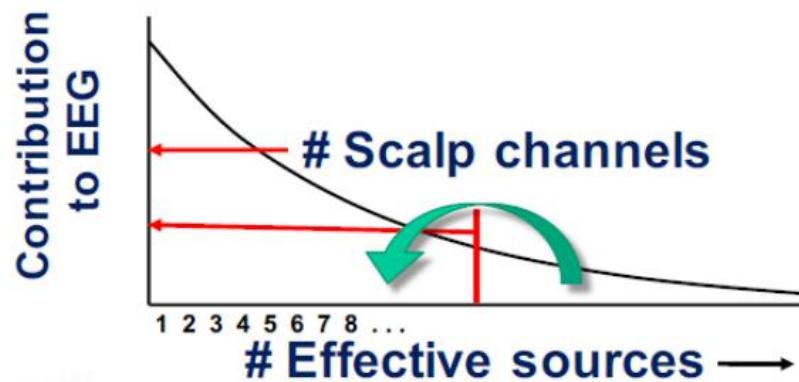
# EEGLAB - ICA



# EEGLAB - ICA

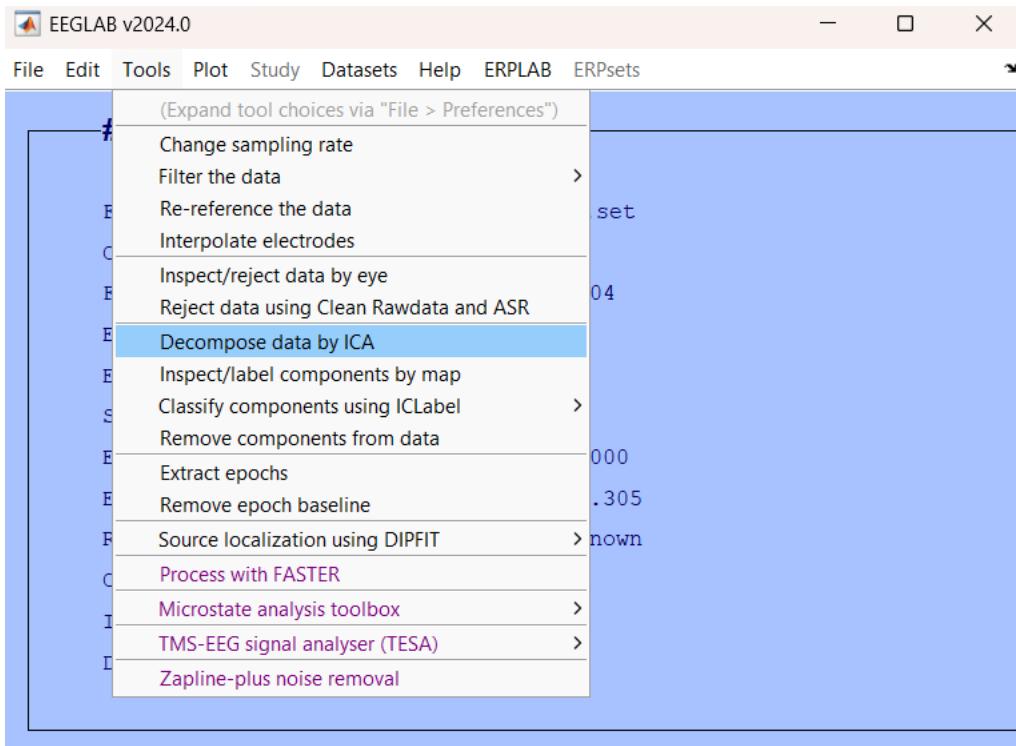
## ICA Assumptions

- Mixing is linear at electrodes ✓
- Propagation delays are negligible ✓
- Component locations are fixed (?)
- Component time courses are independent ?
- # components  $\leq$  # scalp channels ?



# EEGLAB - ICA

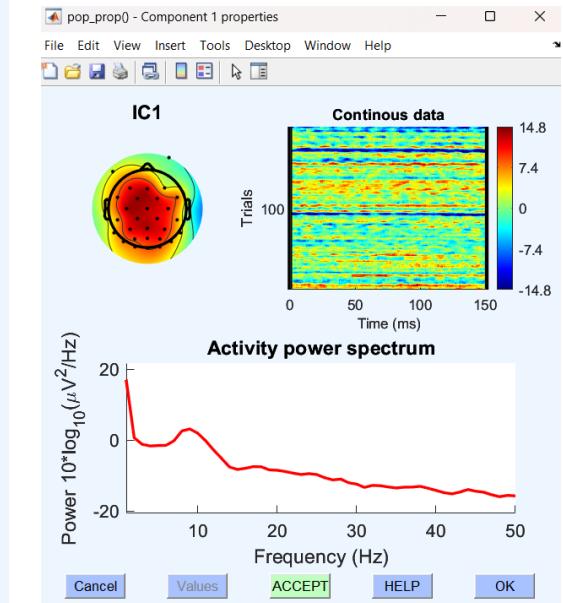
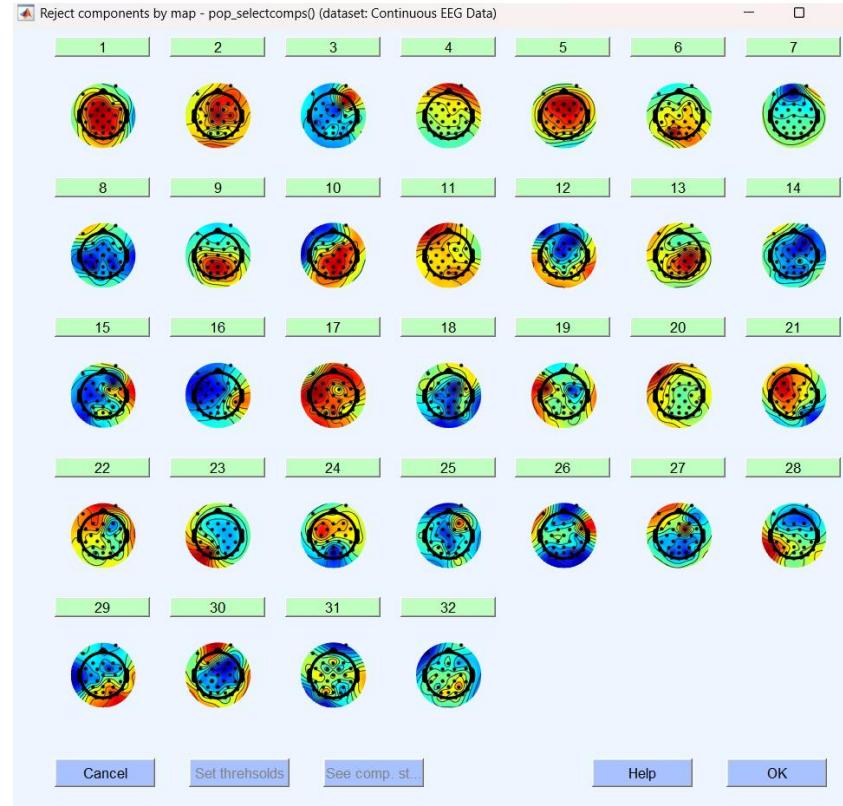
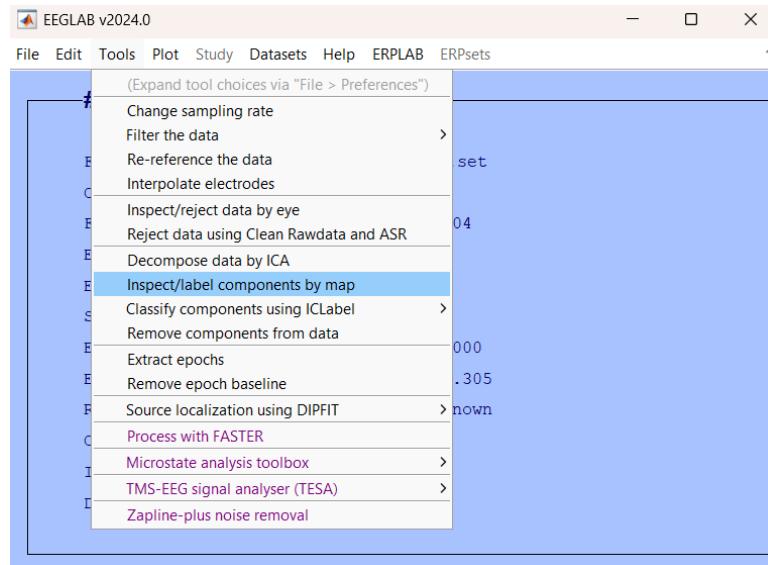
## Run ICA



```
Beginning ICA training ... first training step may be slow ...
step 1 - lrate 0.001000, wchange 15.62852586, angledelta 0.0 deg
step 2 - lrate 0.001000, wchange 0.51124541, angledelta 0.0 deg
step 3 - lrate 0.001000, wchange 0.31433587, angledelta 72.7 deg
step 4 - lrate 0.000980, wchange 0.19431470, angledelta 70.8 deg
step 5 - lrate 0.000960, wchange 0.15787512, angledelta 81.2 deg
step 6 - lrate 0.000941, wchange 0.15995196, angledelta 87.9 deg
step 7 - lrate 0.000922, wchange 0.15739317, angledelta 101.8 deg
step 8 - lrate 0.000904, wchange 0.11756677, angledelta 101.8 deg
step 9 - lrate 0.000886, wchange 0.11609272, angledelta 105.3 deg
step 10 - lrate 0.000868, wchange 0.11734940, angledelta 109.6 deg
...
step 267 - lrate 0.000005, wchange 0.00000250, angledelta 103.3 deg
step 268 - lrate 0.000005, wchange 0.00000129, angledelta 100.3 deg
step 269 - lrate 0.000005, wchange 0.00000140, angledelta 94.3 deg
step 270 - lrate 0.000005, wchange 0.00000168, angledelta 95.7 deg
step 271 - lrate 0.000004, wchange 0.00000121, angledelta 92.1 deg
step 272 - lrate 0.000004, wchange 0.00000143, angledelta 101.5 deg
step 273 - lrate 0.000004, wchange 0.00000120, angledelta 106.8 deg
step 274 - lrate 0.000004, wchange 0.00000109, angledelta 84.3 deg
step 275 - lrate 0.000004, wchange 0.00000113, angledelta 98.9 deg
step 276 - lrate 0.000004, wchange 0.00000089, angledelta 95.3 deg
Sorting components in descending order of mean projected variance ...
Scaling components to RMS microvolt
eeg_checkset: recomputing the ICA activation matrix ...
```

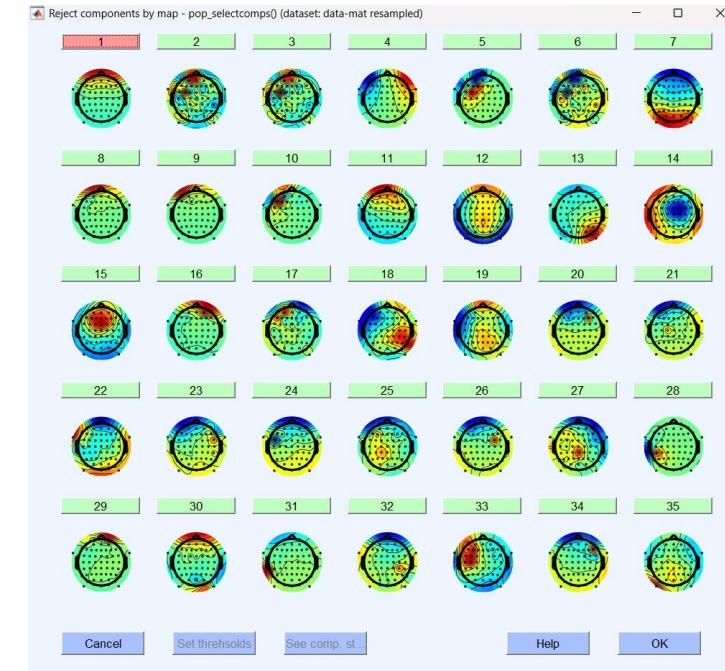
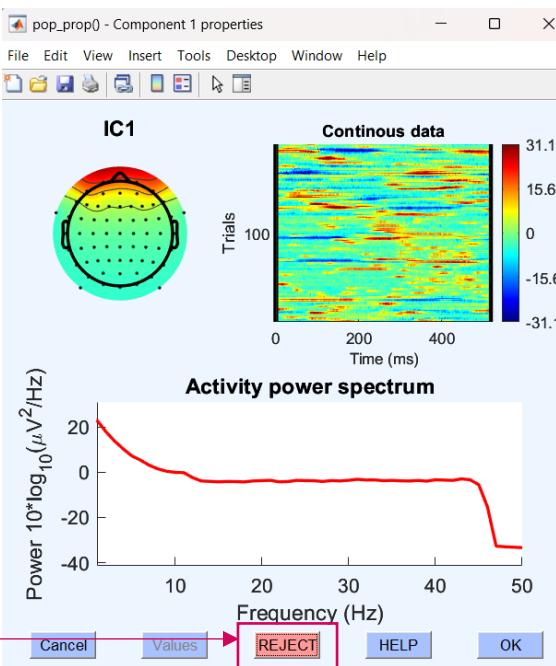
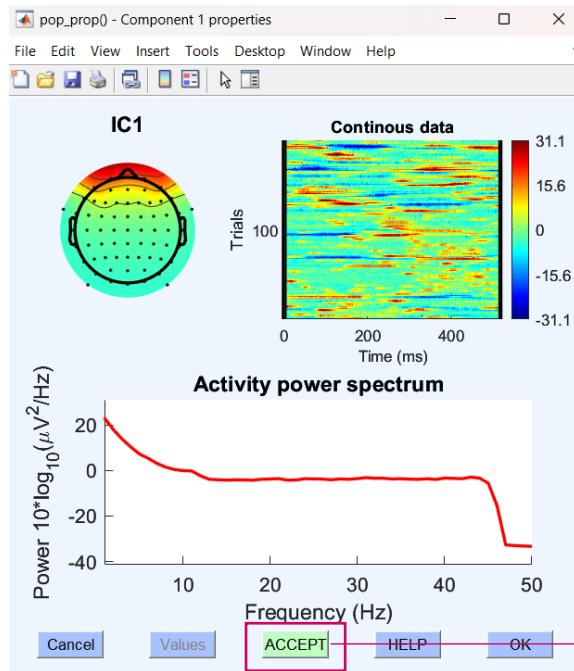
# EEGLAB - ICA

## Inspect/Reject components



# EEGLAB - ICA

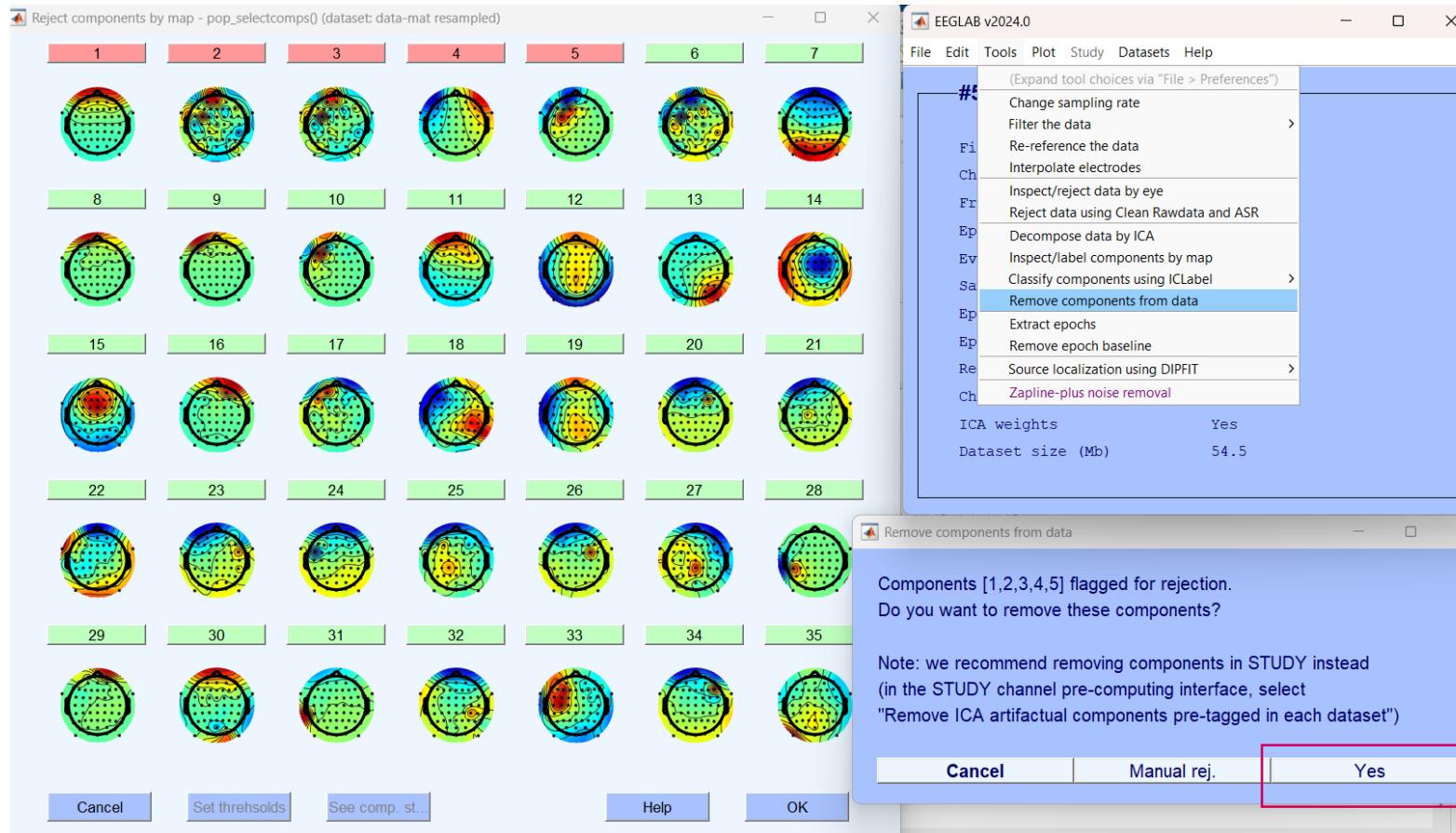
Inspect/Reject components



Click to reject

# EEGLAB - ICA

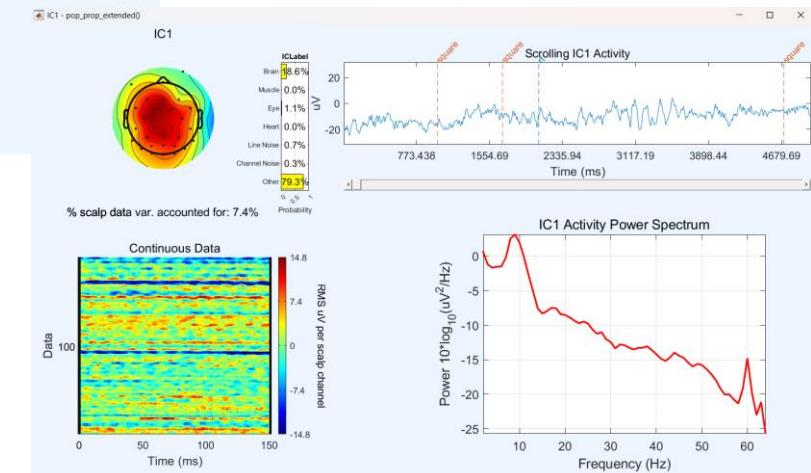
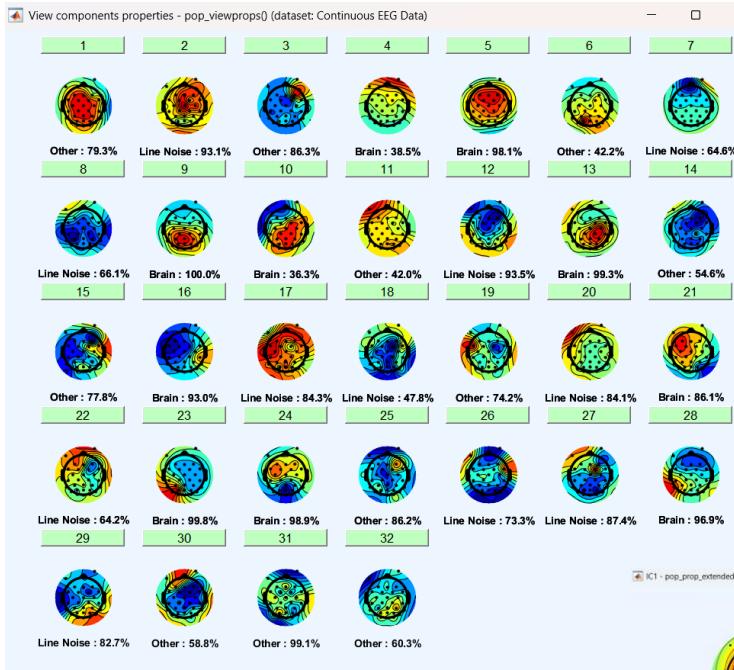
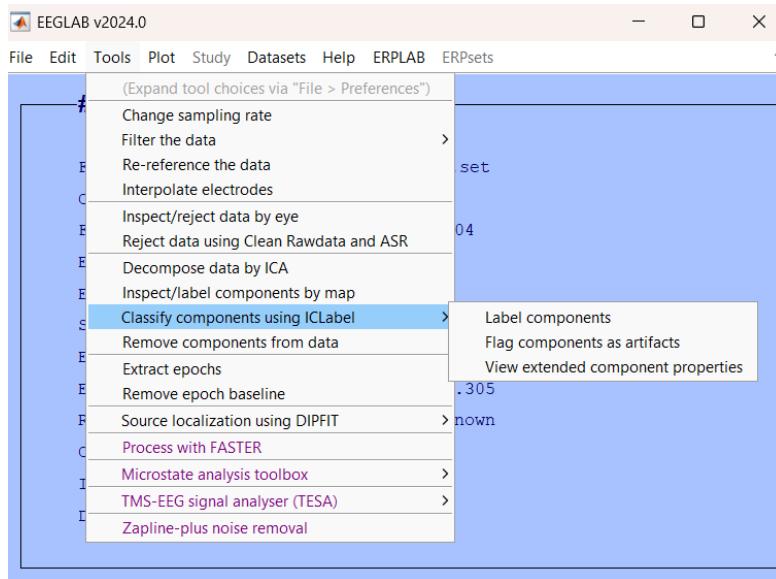
## Inspect/Reject components



Remove components  
that were flagged

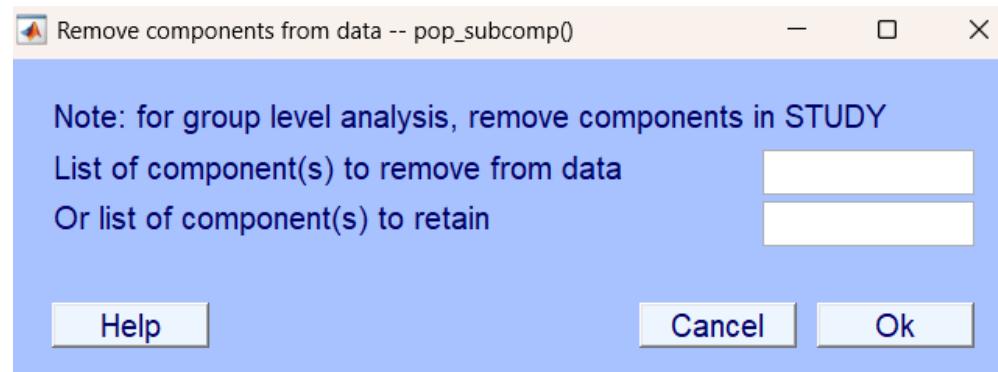
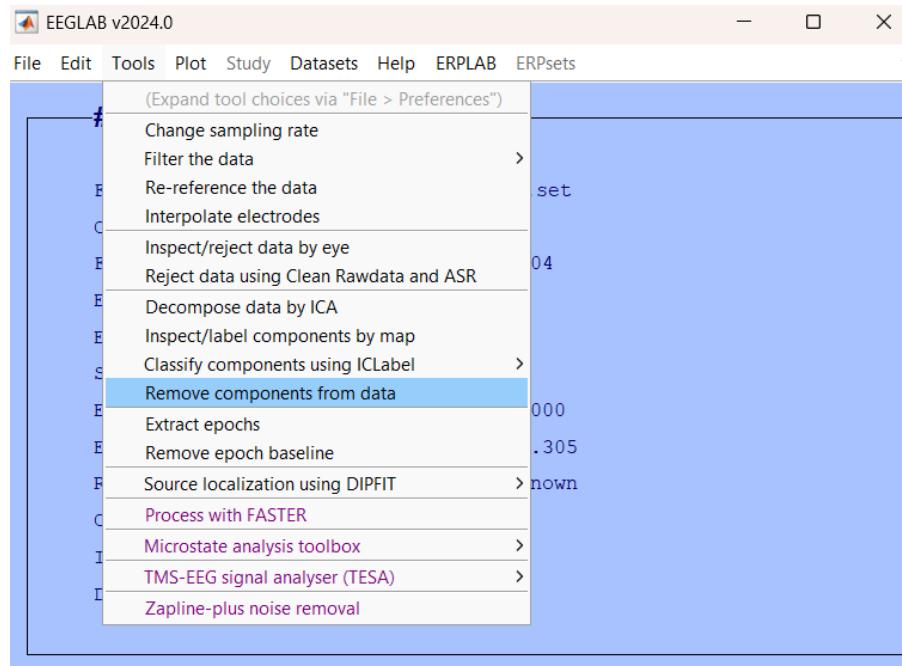
# EEGLAB - ICA

Classify components using ICLabel



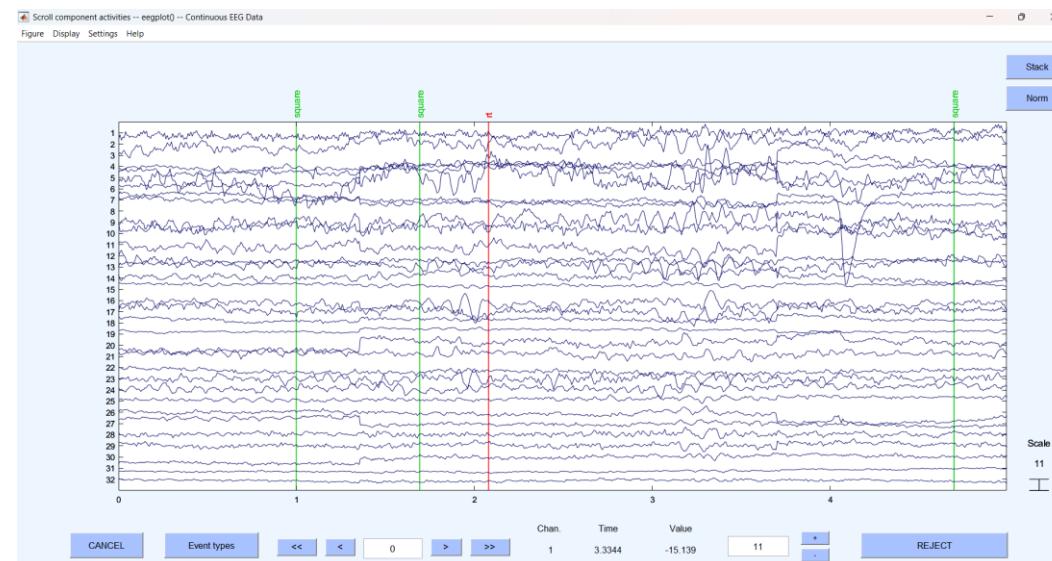
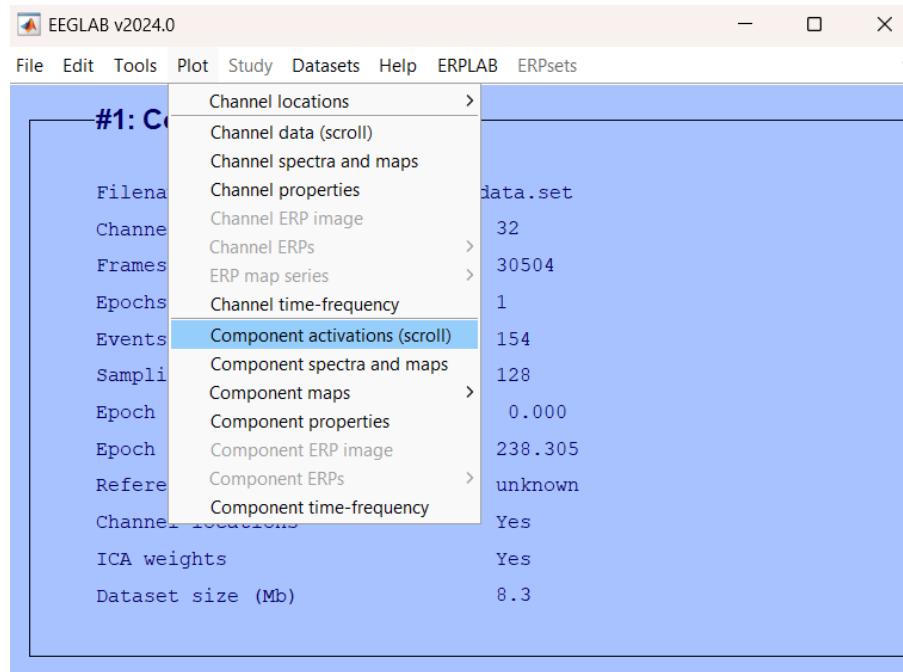
# EEGLAB - ICA

## Remove components



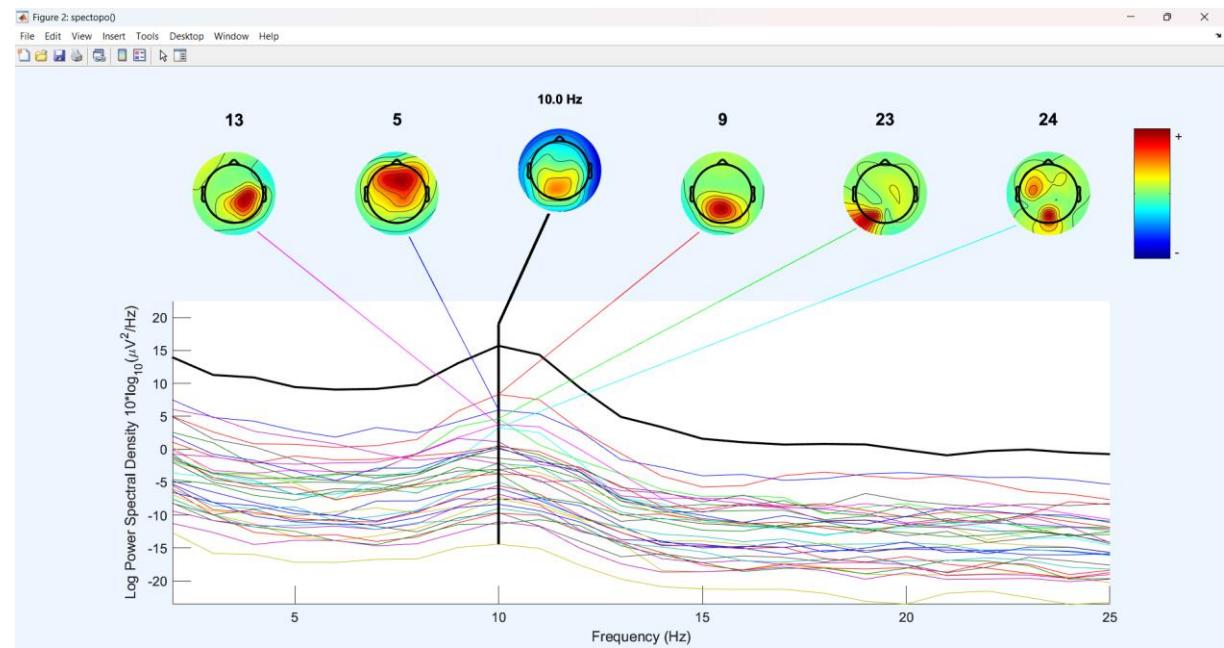
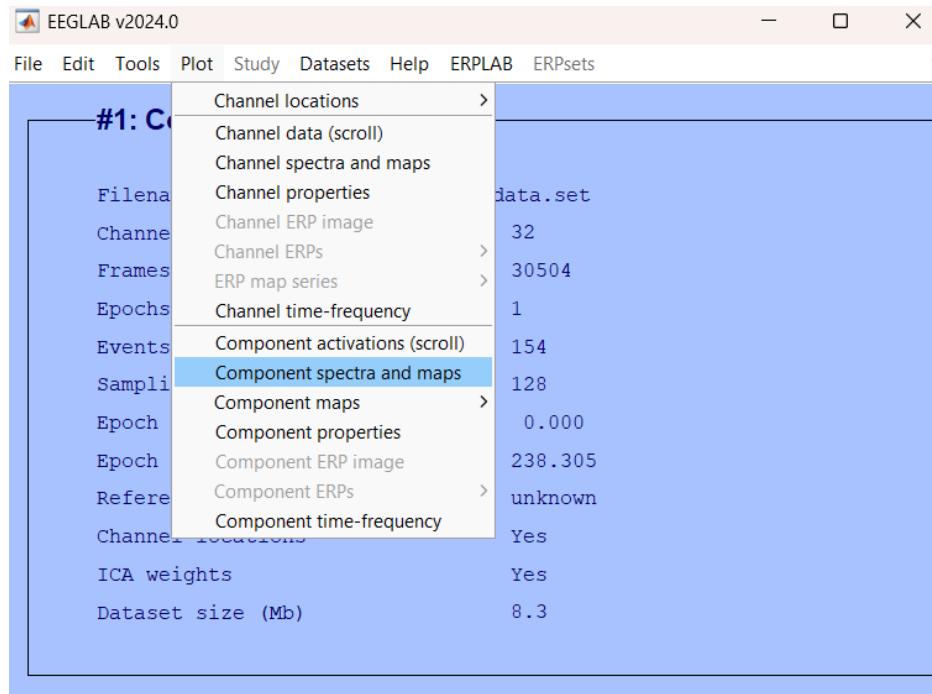
# EEGLAB - ICA

Components activations (scroll)



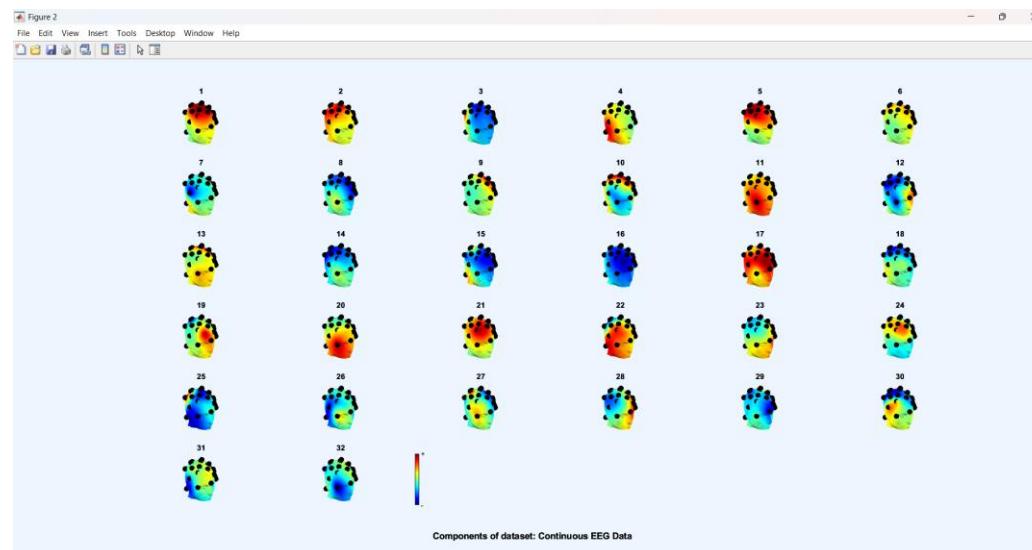
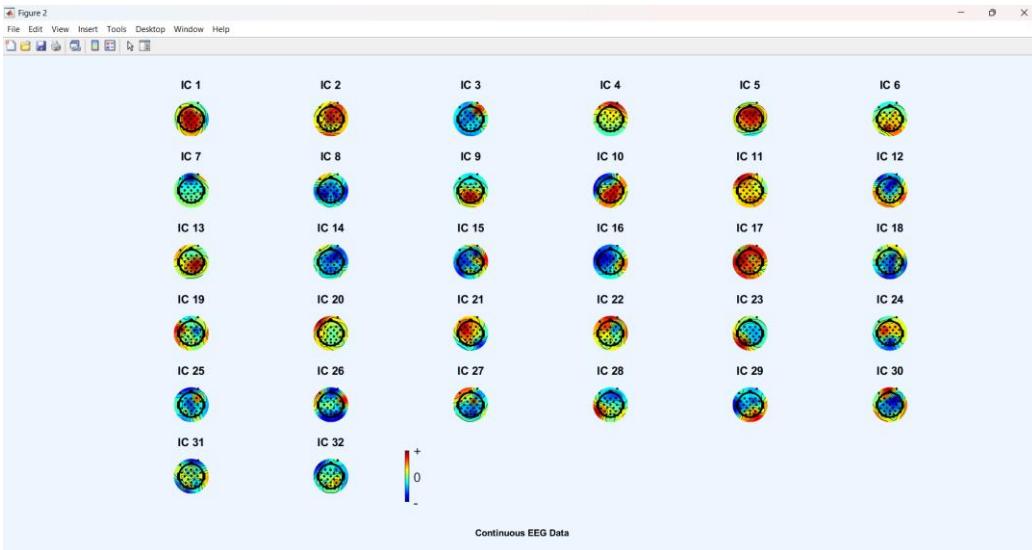
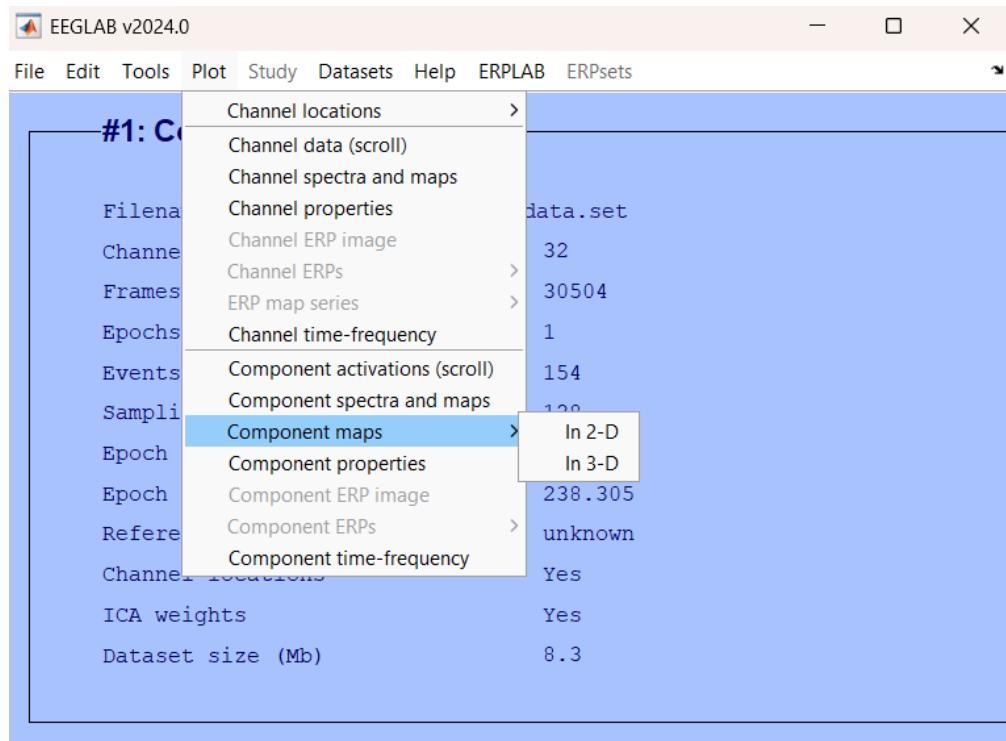
# EEGLAB - ICA

Components spectra and maps



# EEGLAB - ICA

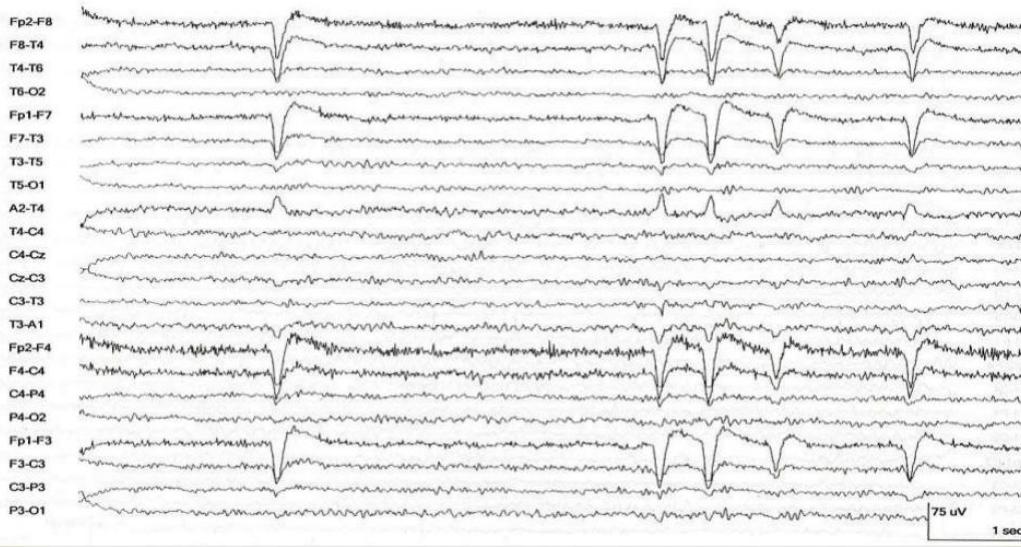
## Components maps



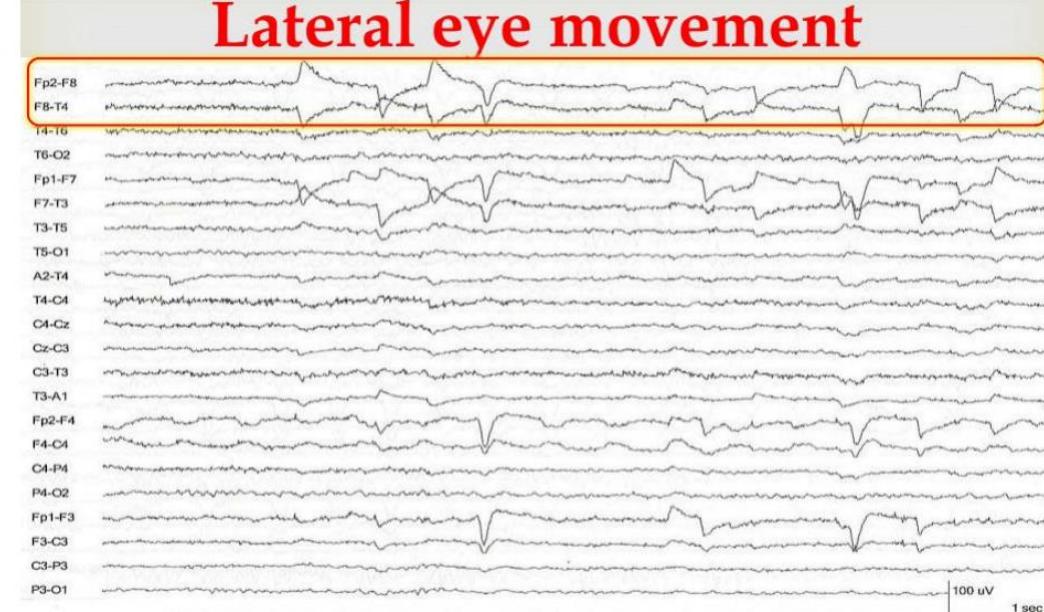
# EEGLAB - ICA

## Artifacts

Blink artifact



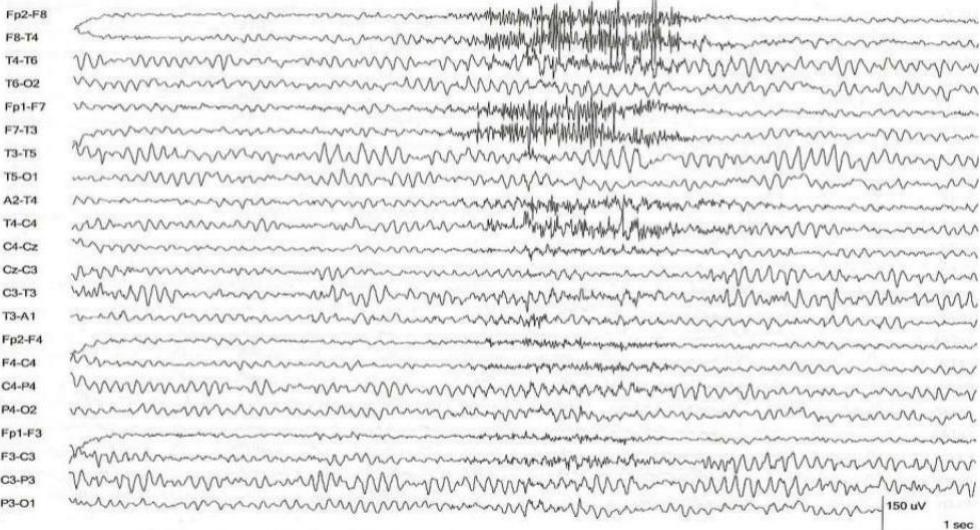
Lateral eye movement



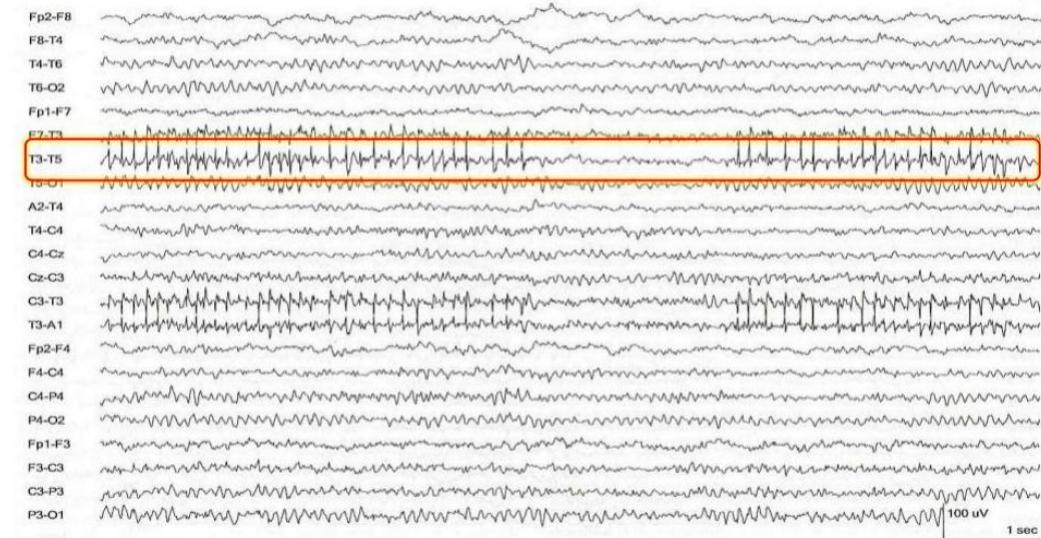
# EEGLAB - ICA

## Artifacts

### Muscle artifact



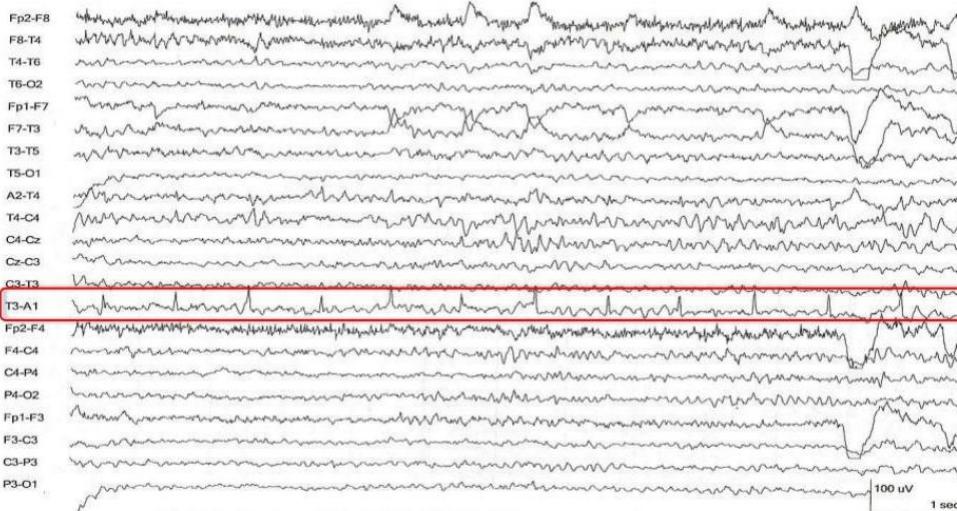
### EMG artifact



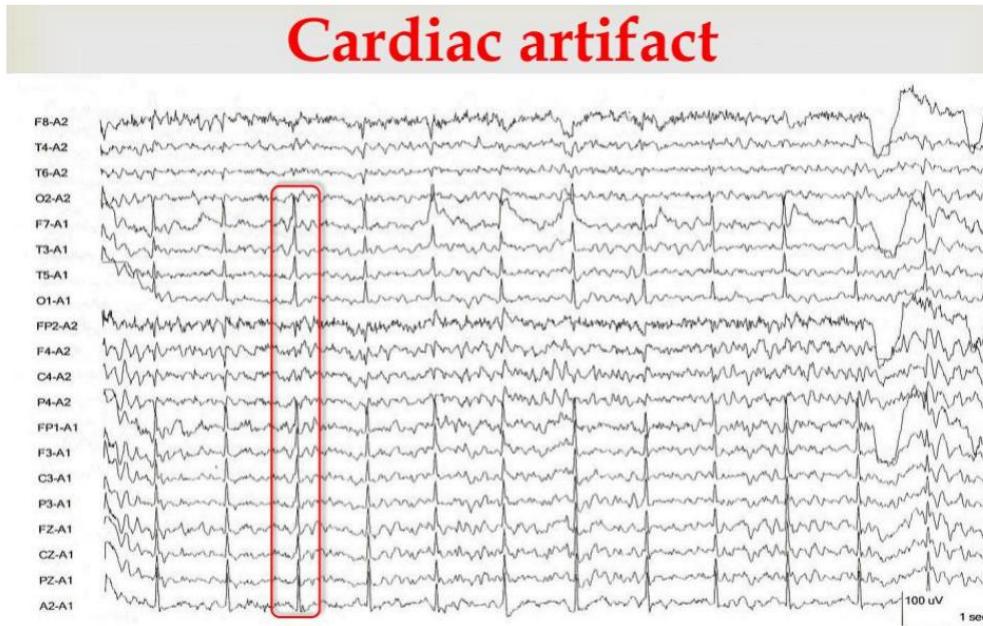
# EEGLAB - ICA

## Artifacts

Cardiac artifact

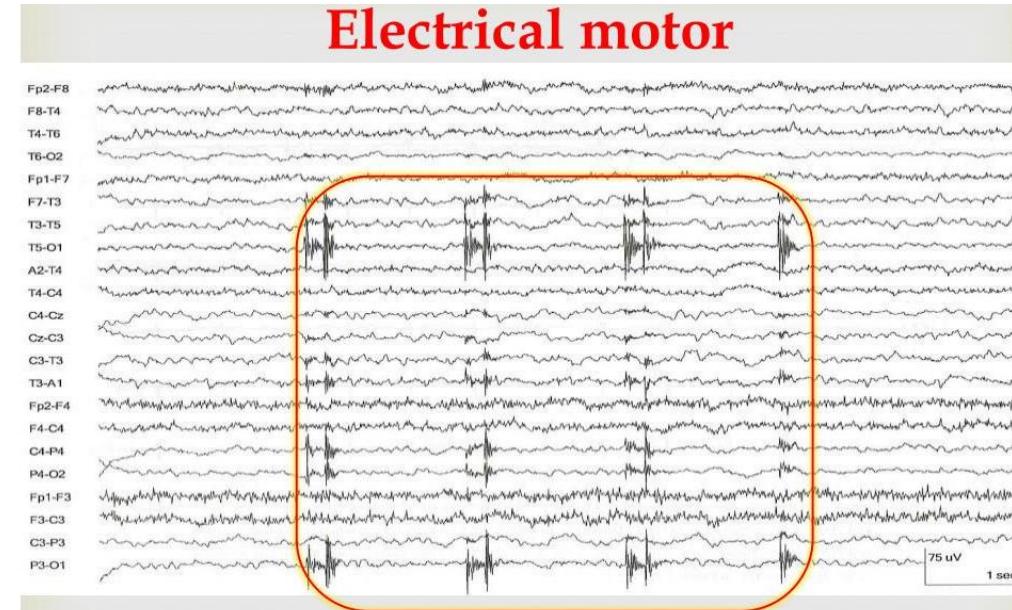
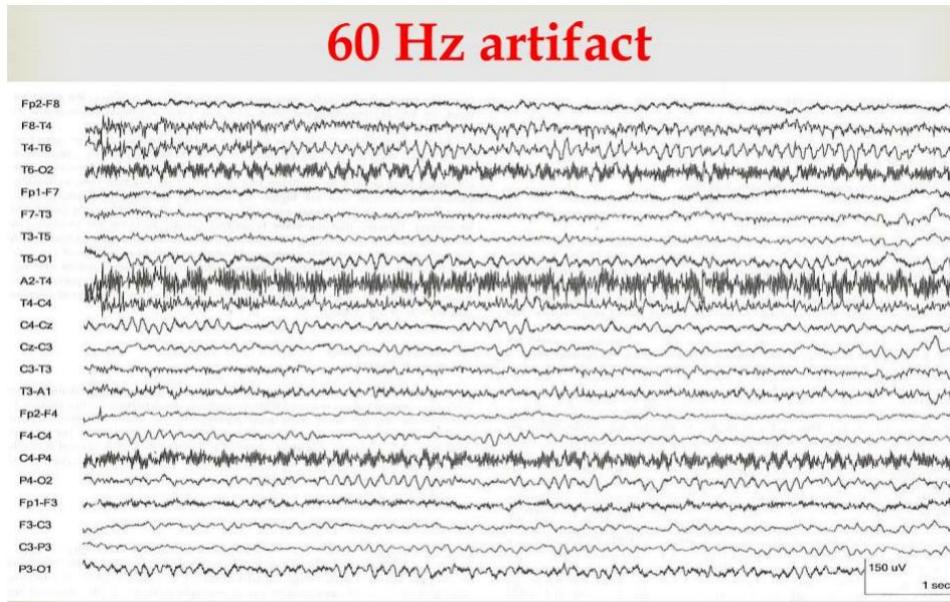


Cardiac artifact



# EEGLAB - ICA

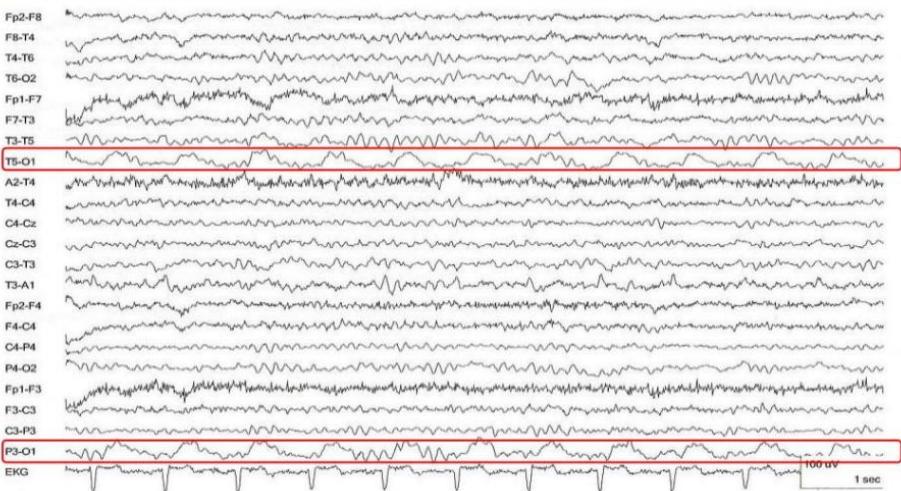
## Artifacts



# EEGLAB - ICA

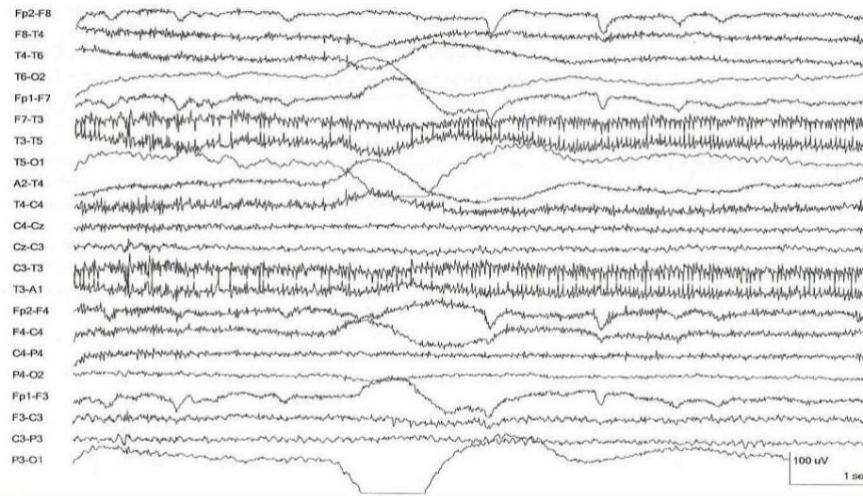
## Artifacts

### Pulse artifact

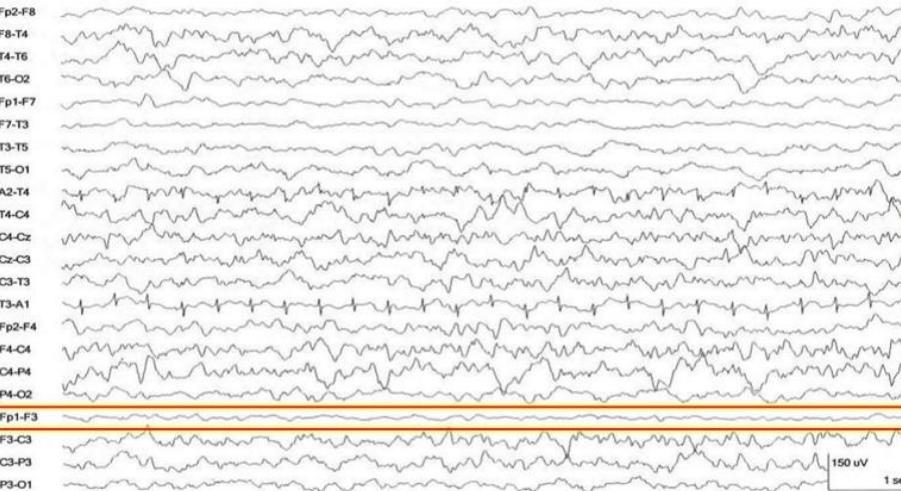


Focal slow waves at the left occiput follow each heart beat, as indicated in the ECG channel. The slow waves are artifact due to electrode movement and were eliminated by repositioning the O1 electrode

### Lead movement

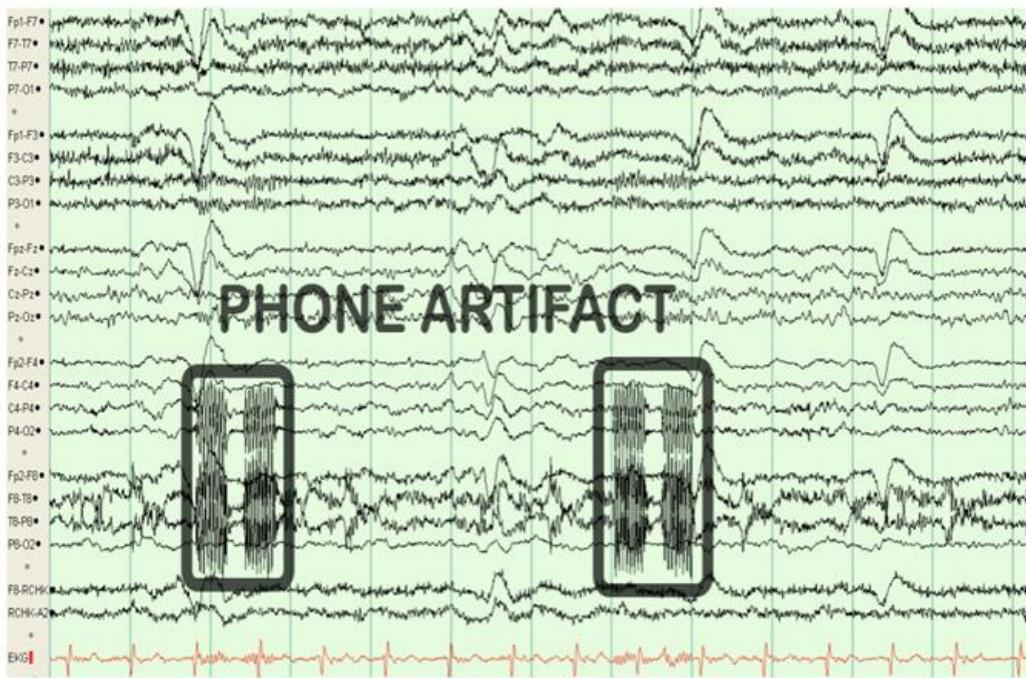


### Salt bridge artifact



# EEGLAB - ICA

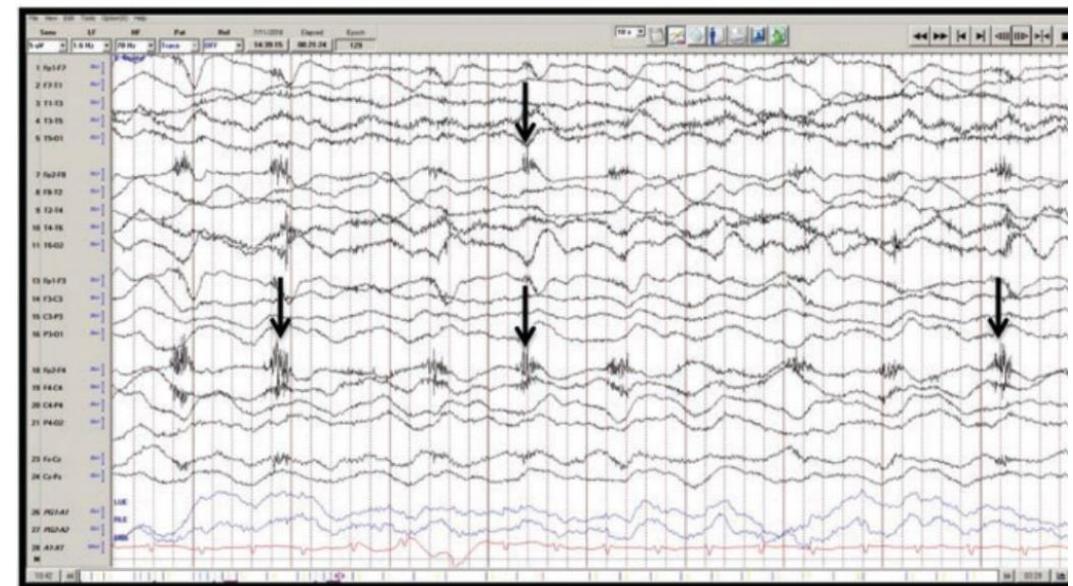
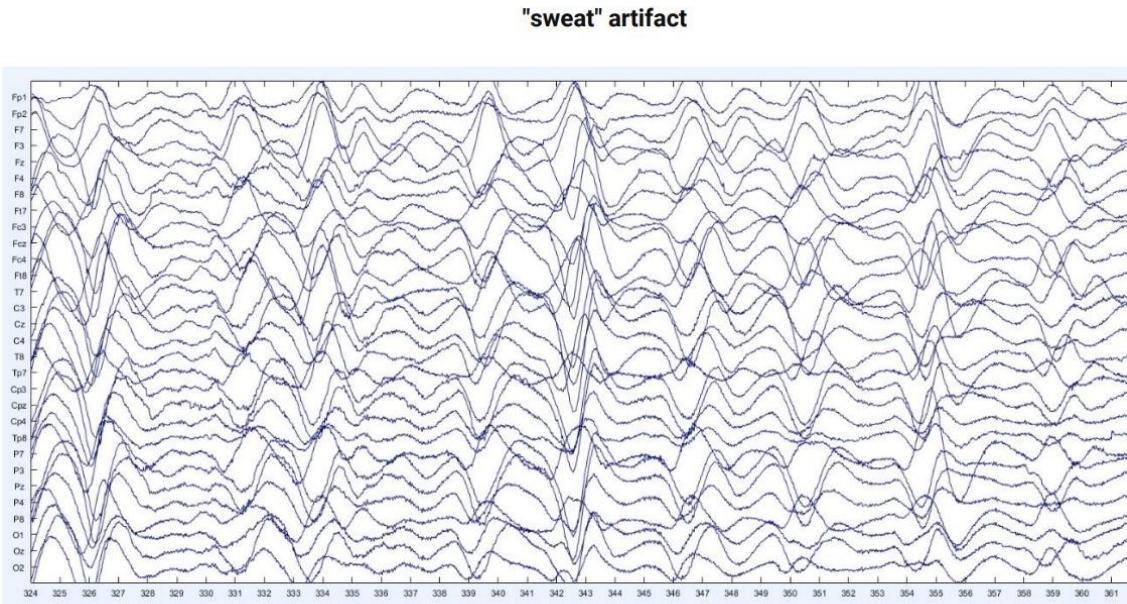
## Artifacts



**Fig. 8.7** Artifact created by laptop being plugged in for charging. It resolves with unplugging the laptop

# EEGLAB - ICA

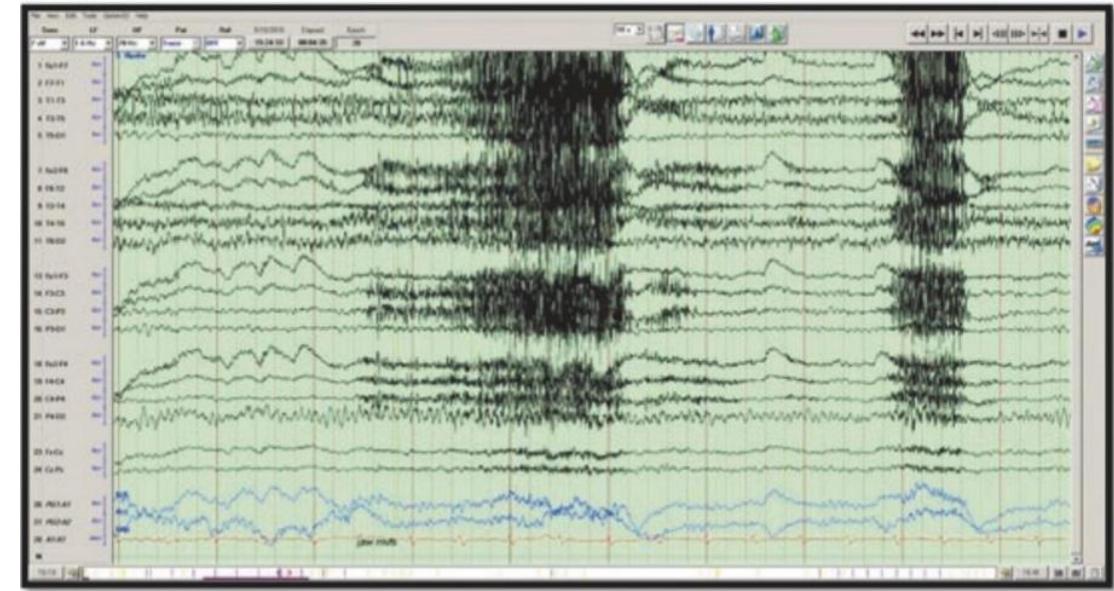
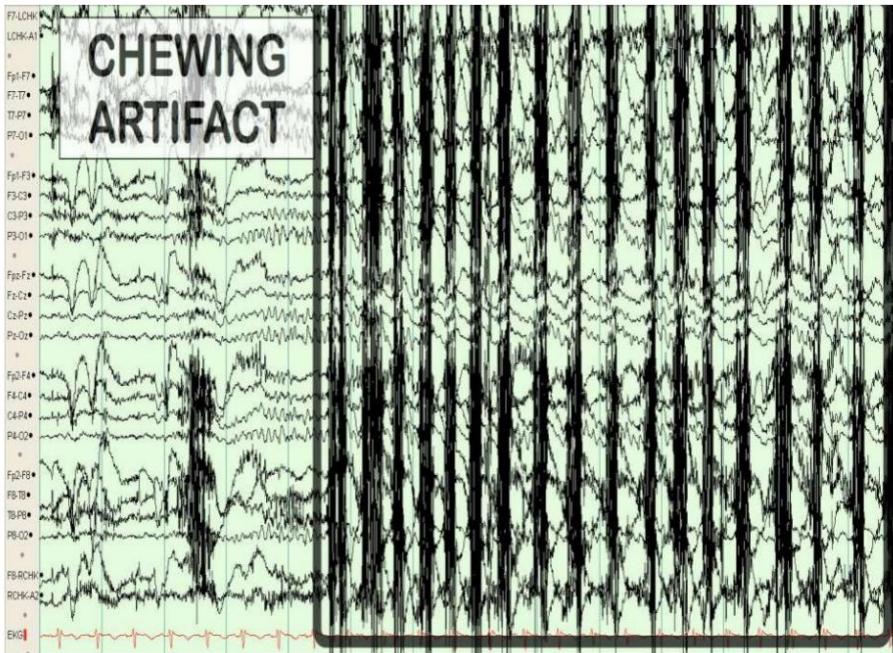
## Artifacts



**Fig. 8.22** EEG tracing showing repetitive sniffling artifact (black arrows)

# EEGLAB - ICA

Artifacts



EEG tracing showing jaw movement followed by swallowing artifact

# EEGLAB - ICA

## ICLabel Tutorial: EEG Independent Component Labeling

[Overview](#)

[Why Help Us?](#)

[How To Label](#)

[Telling Components Apart](#)

[Practice Labeling](#)

[Leave A Comment](#)

[Label EEG Components](#)

[Profile](#)

### Overview

Welcome to ICLabel. The goals of this website are (1) to help EEG researchers who use independent component analysis (ICA) to distinguish independent components (ICs) as brain or non-brain sources and (2) to collect a large number of crowd-sourced IC labels. Users who go through the tutorial material and then volunteer to label new ICs based on their presented properties are contributing to the development of an accurate automated classifier that will be soon be released as an EEGLAB plug-in and integrated into basic EEGLAB functions. A version that operates in real-time will be integrated into the [Real-time EEG Source-mapping Toolbox](#) (REST). For more information, see [Why Help Us?](#).

For information on how the ICLabel project implements crowd sourcing, see [this technical paper](#).

-Luca Pion-Tonachini

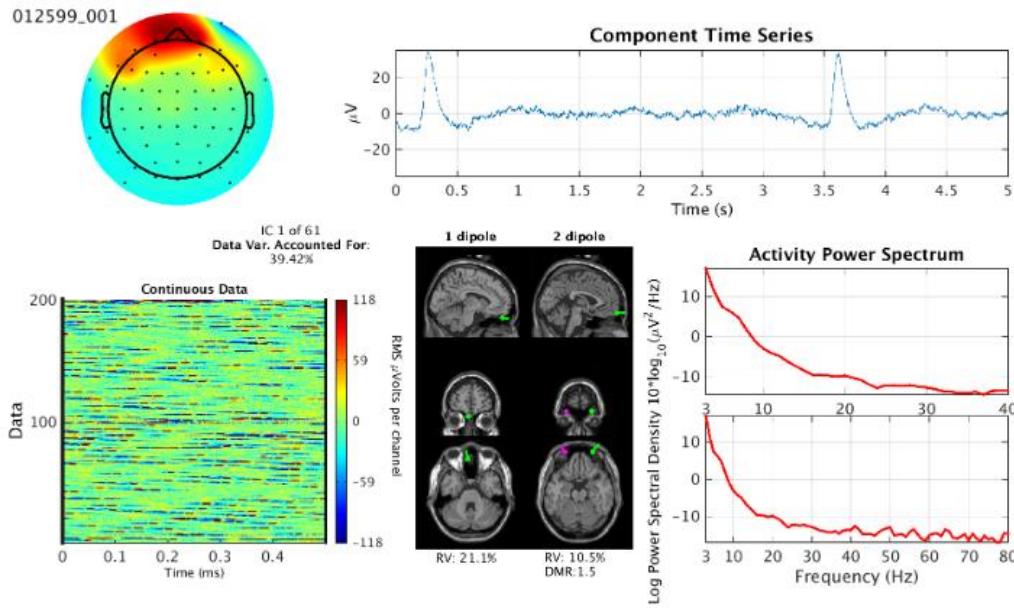
Swartz Center for Computational Neuroscience  
and Department of Electrical and Computer Engineering  
University of California, San Diego

### How to use this site

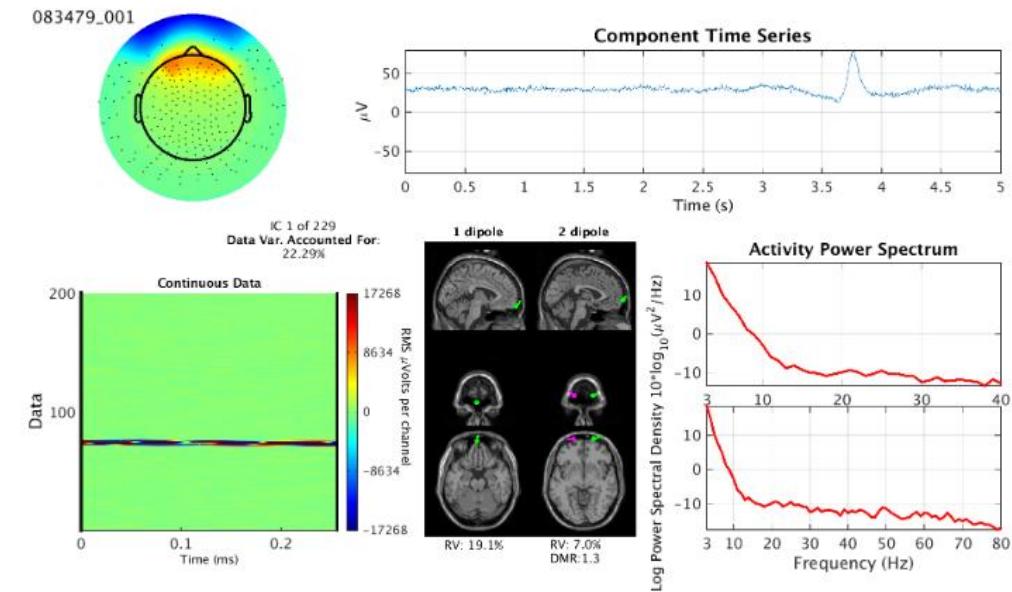
1. [Register](#) or [Log In](#).
2. If you're not experienced at labeling components, see [Telling Components Apart](#) and then [Practice Labeling](#) (with feedback).
3. If you don't know how to enter component labels on this website, see [How To Label](#). It is essential that you understand these instructions before you begin.  
4. Click [Label EEG Components](#) and study the presented set of component properties.

<https://labeling.ucsd.edu/tutorial>

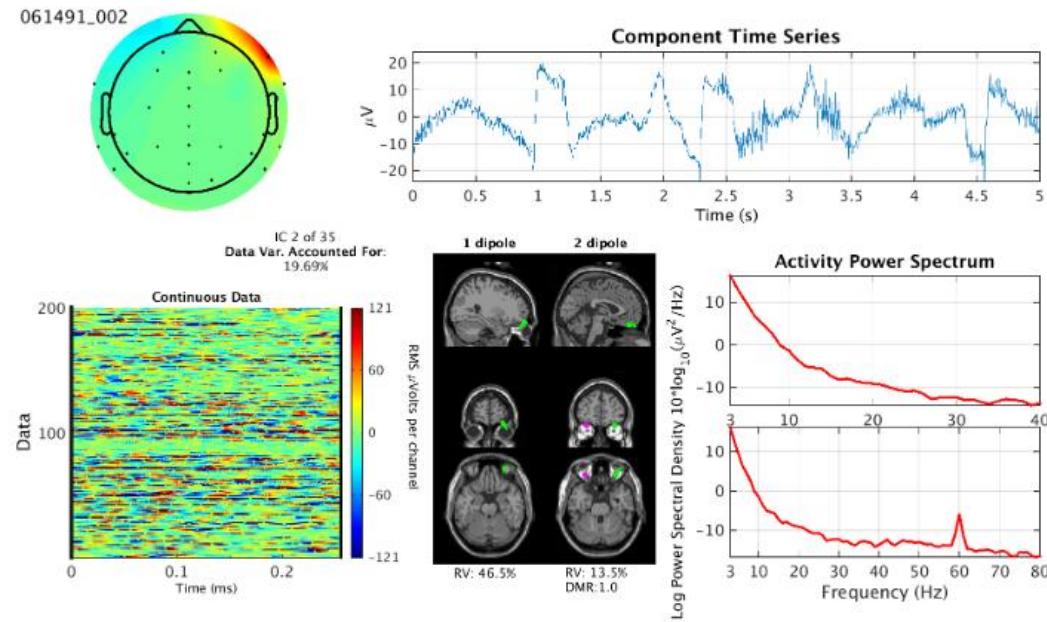
# EEGLAB - ICA



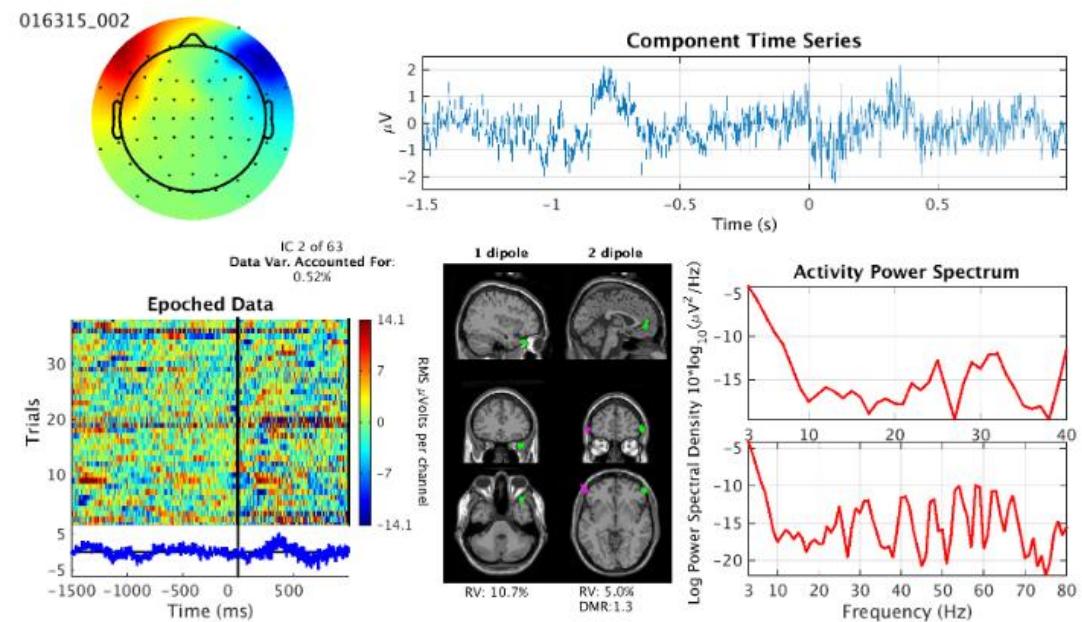
## Eye Component



# EEGLAB - ICA

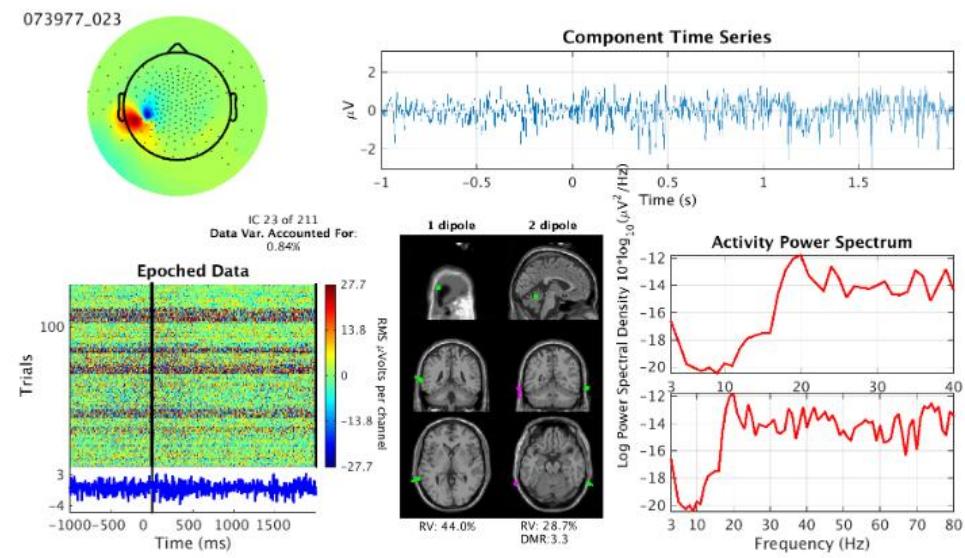
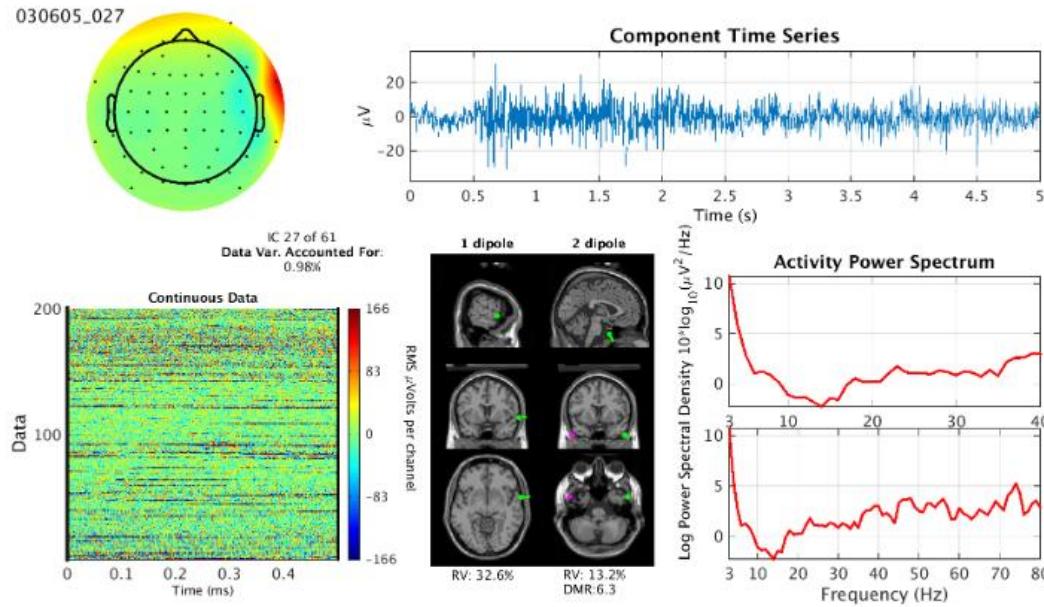


## Eye Component

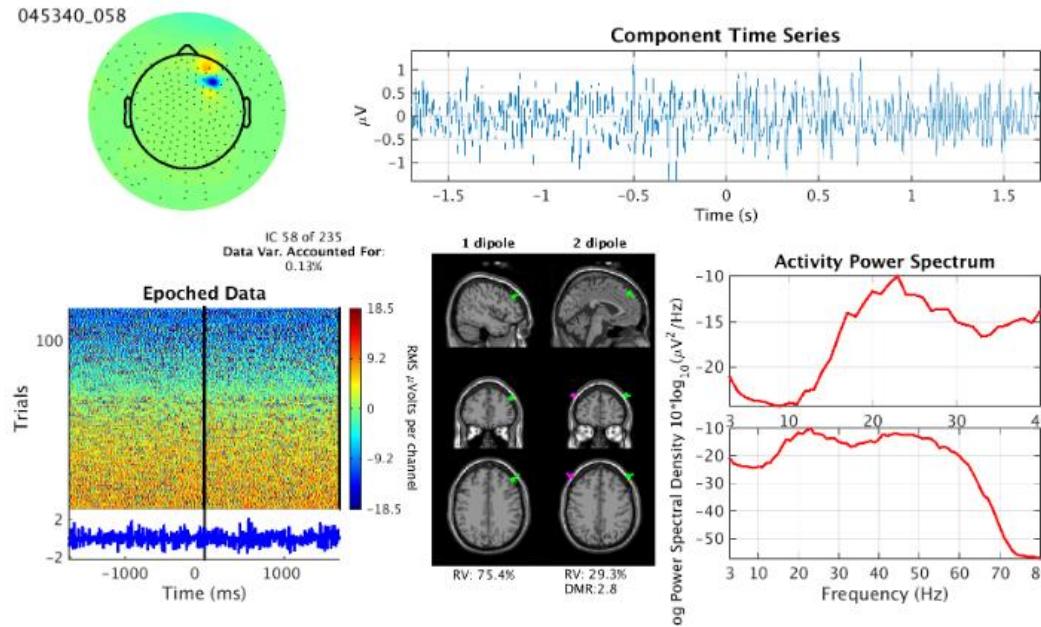


# EEGLAB - ICA

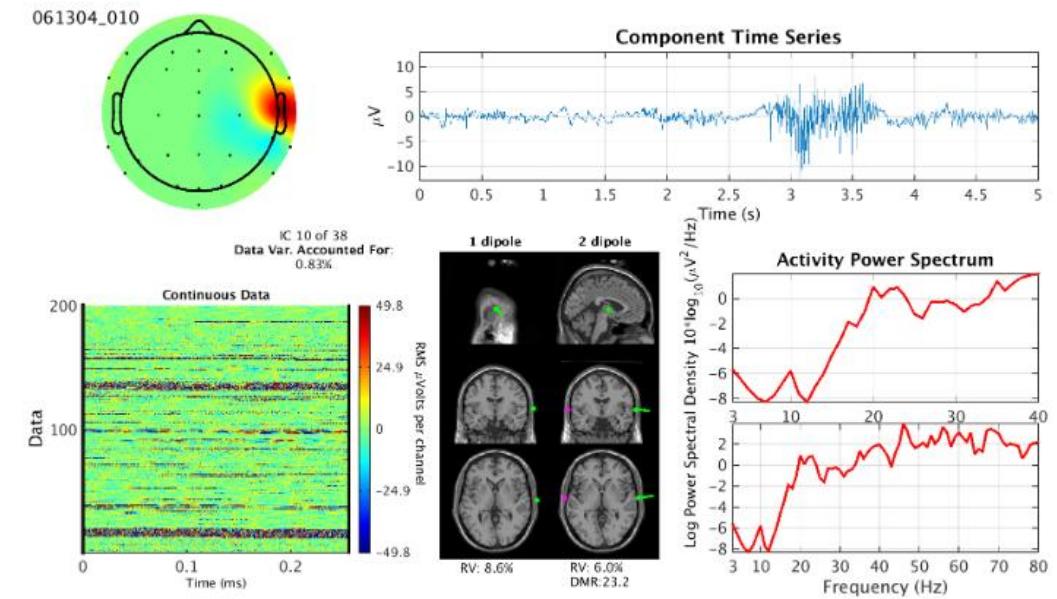
## Muscle Component



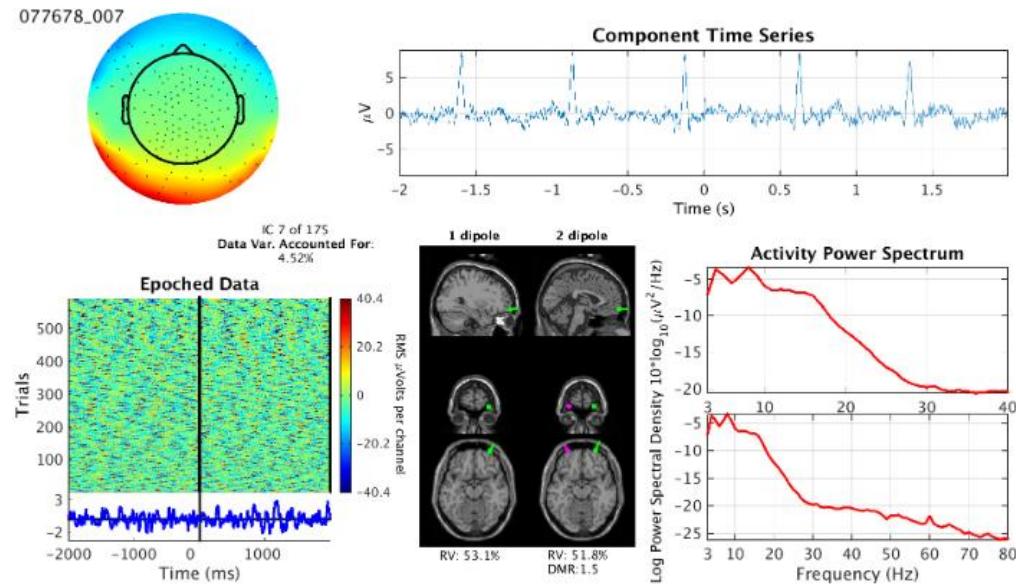
# EEGLAB - ICA



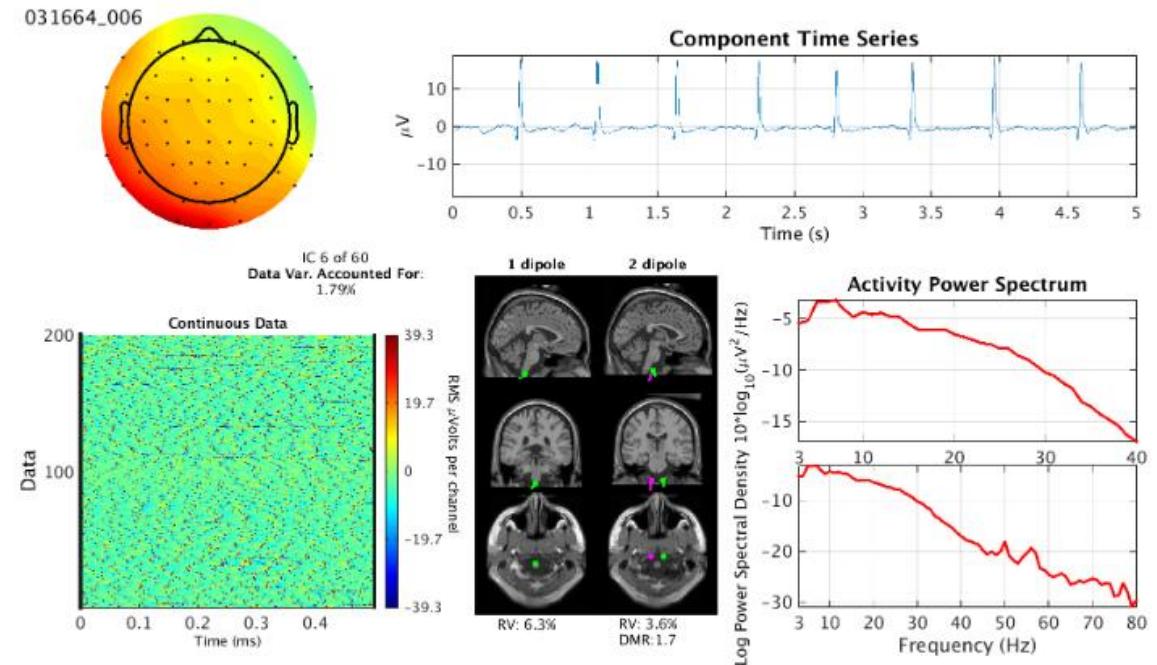
## Muscle Component



# EEGLAB - ICA

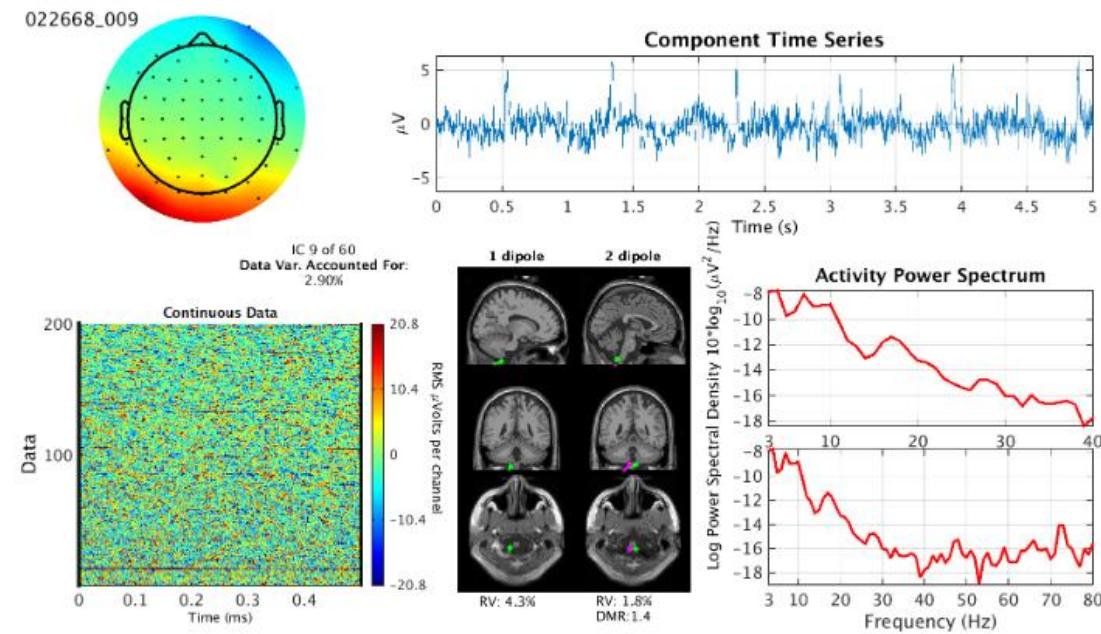


## Heart Component



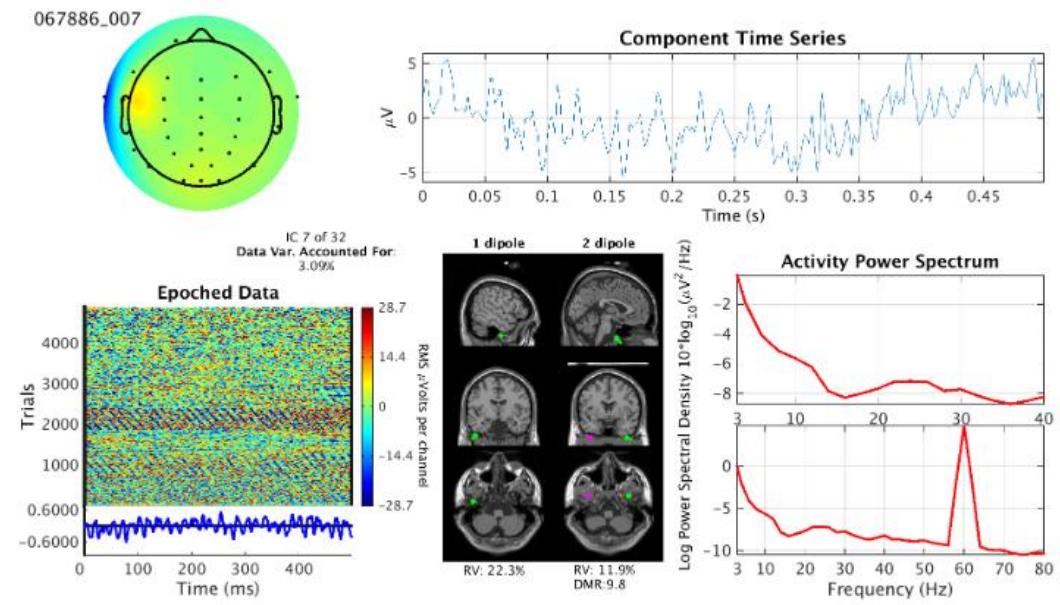
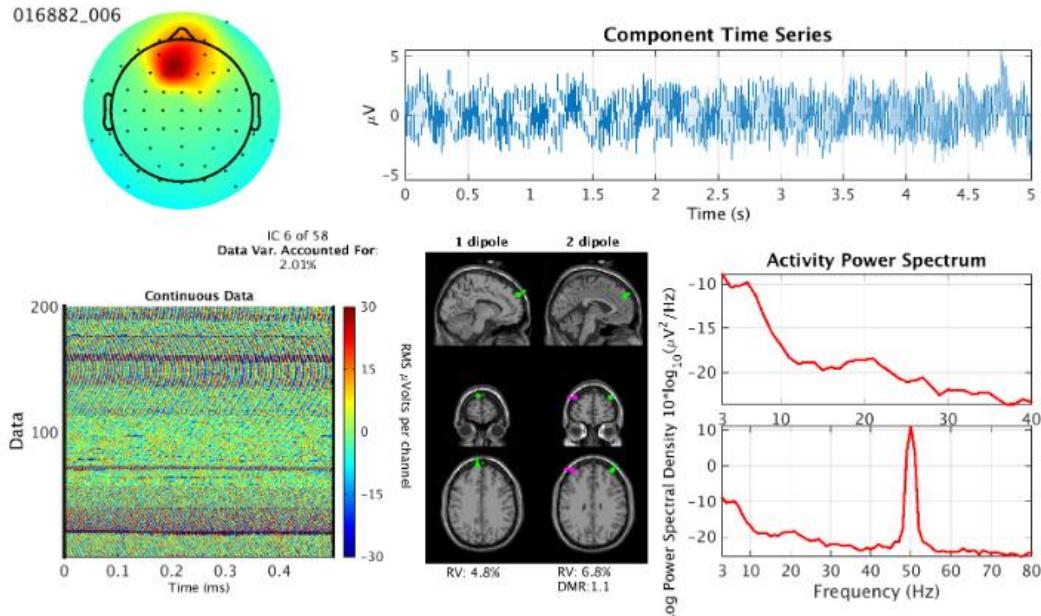
# EEGLAB - ICA

## Heart Component

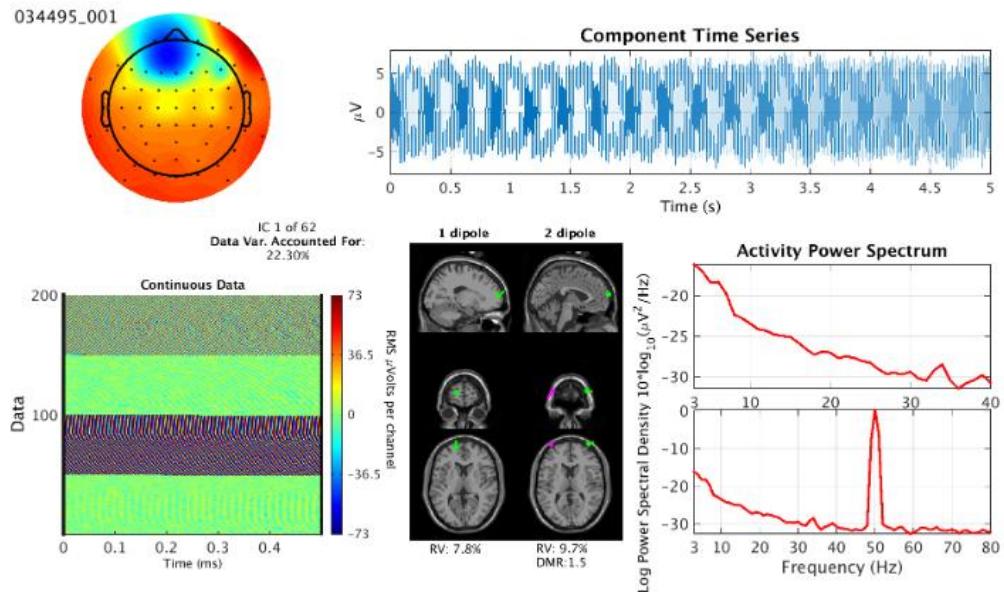


# EEGLAB - ICA

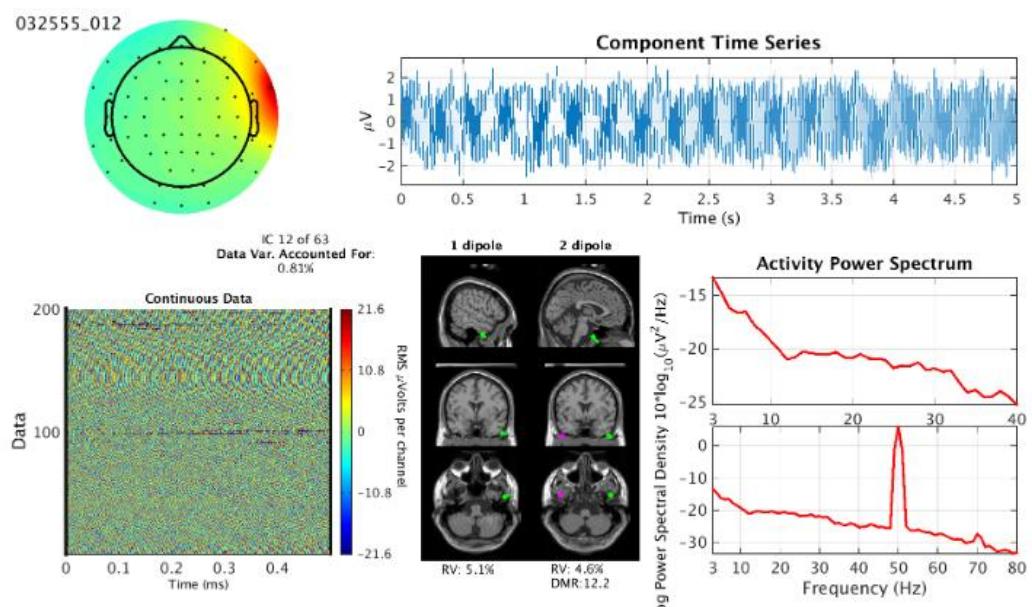
## Line Noise



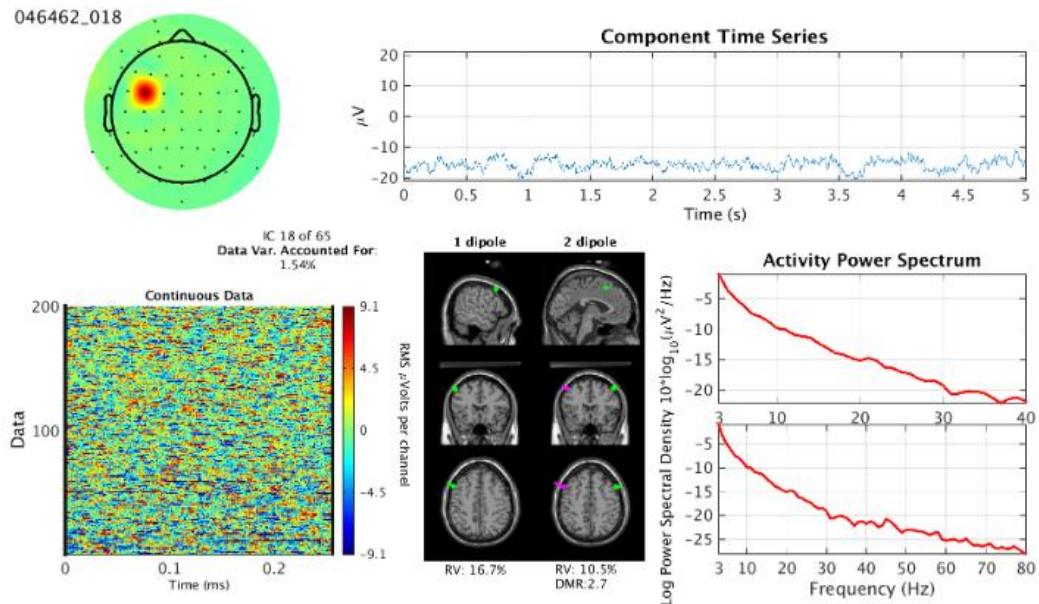
# EEGLAB - ICA



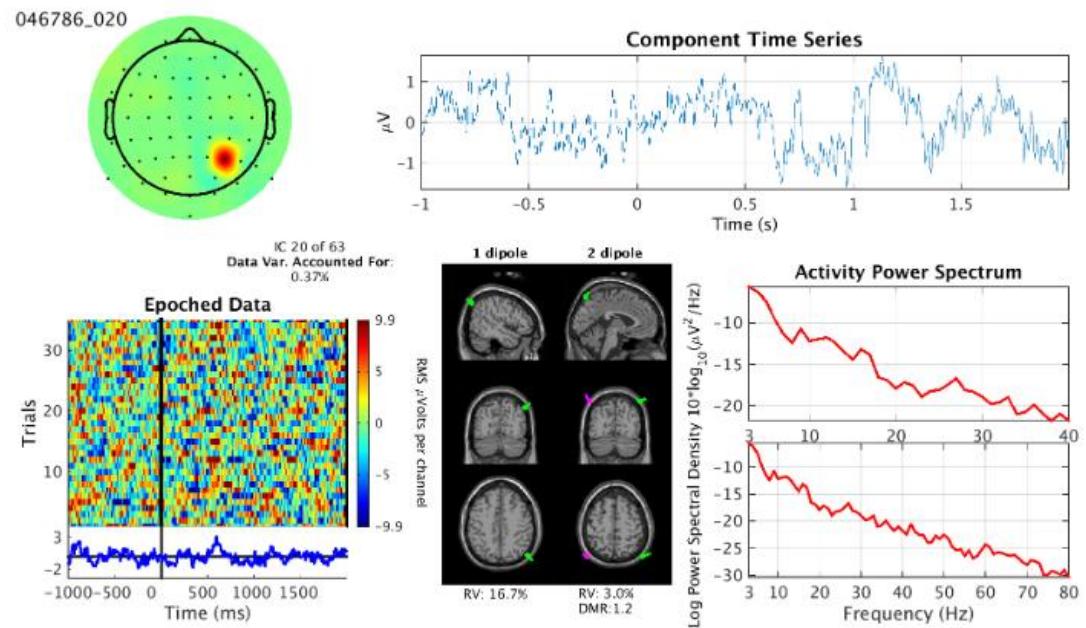
## Line Noise



# EEGLAB - ICA

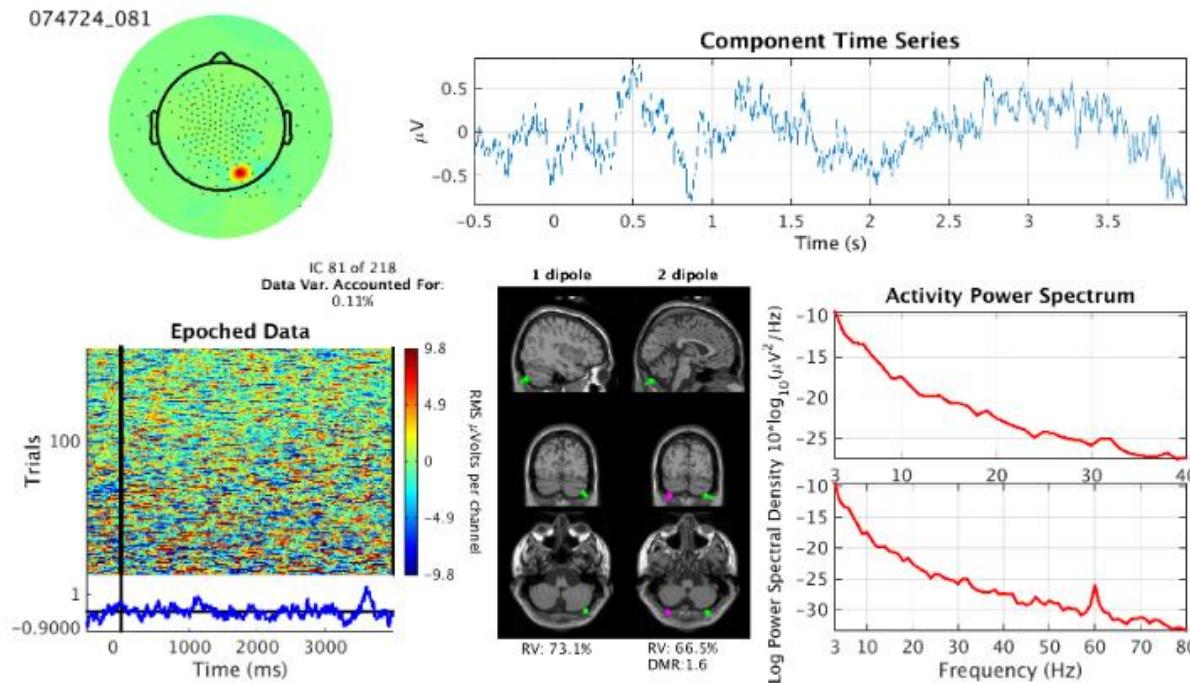


## Channel Noise



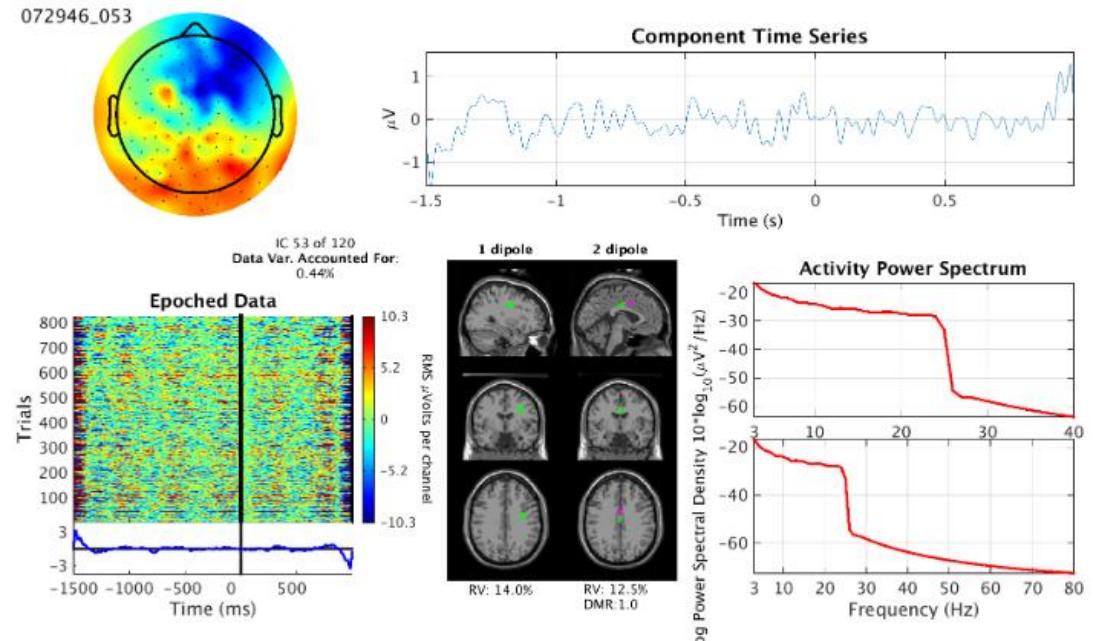
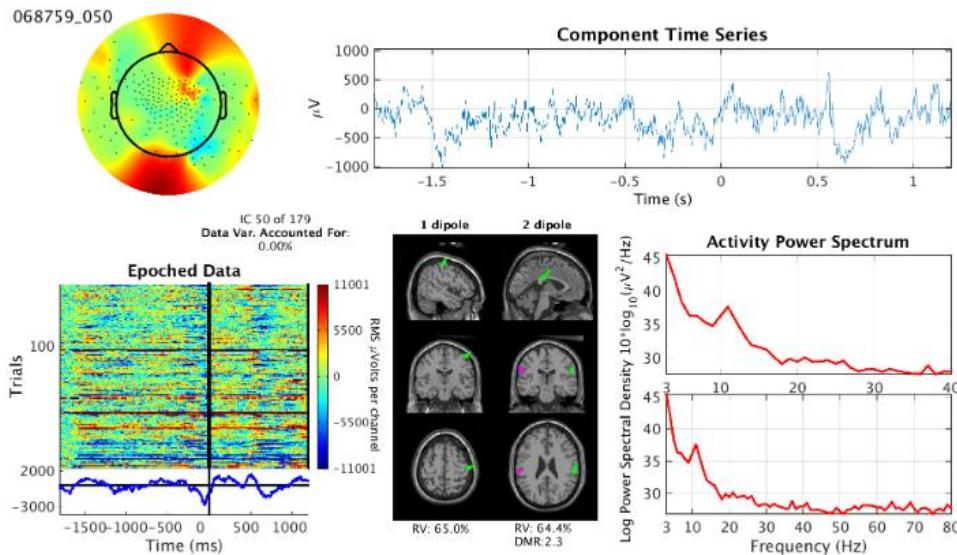
# EEGLAB - ICA

## Channel Noise



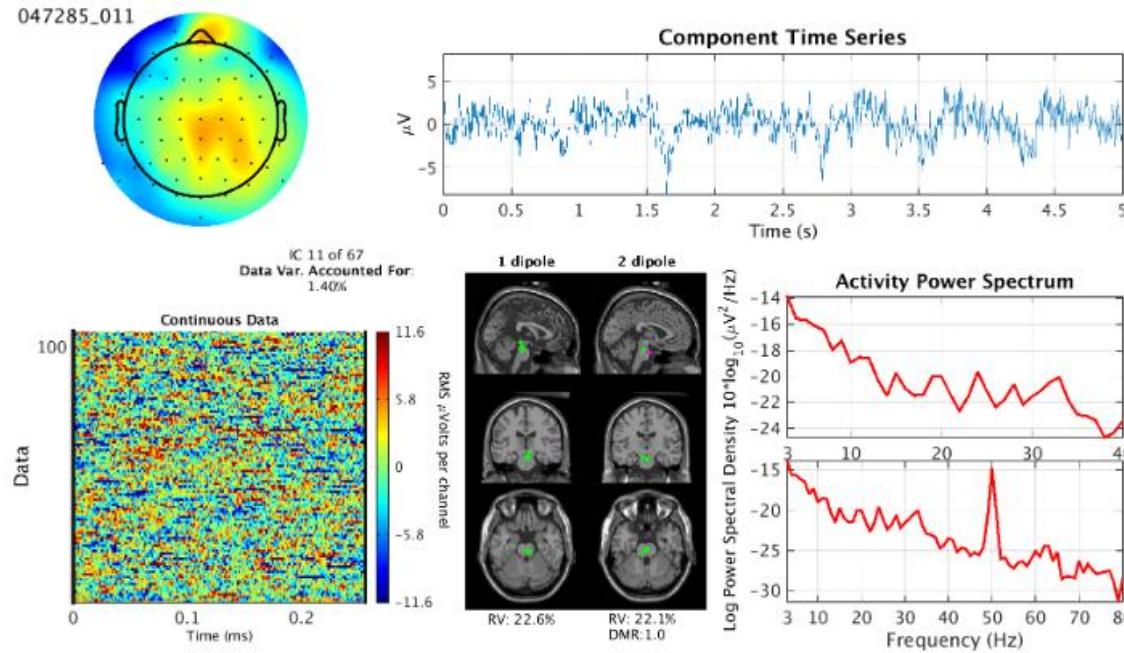
# EEGLAB - ICA

## Other



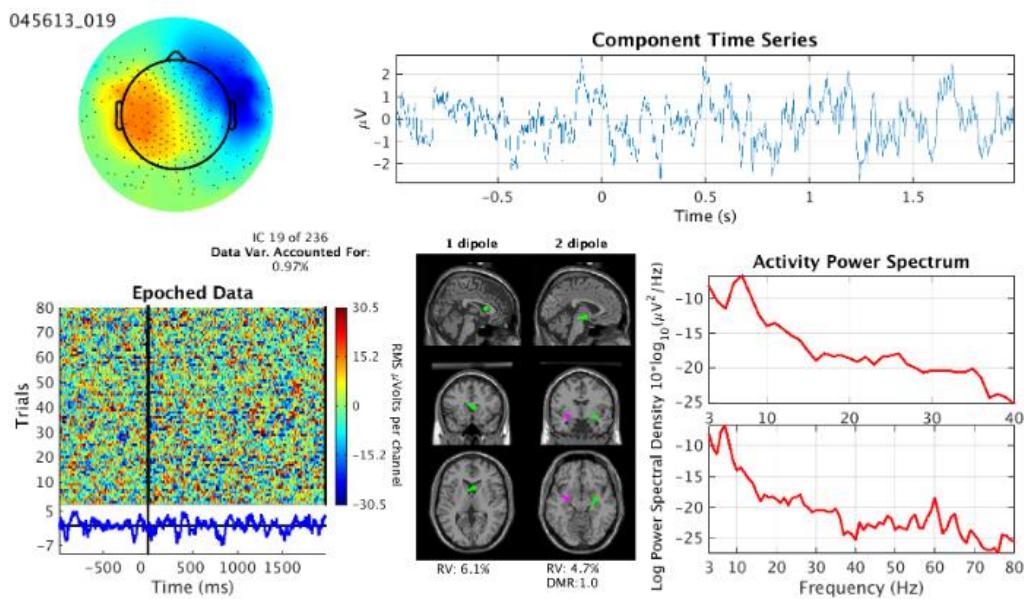
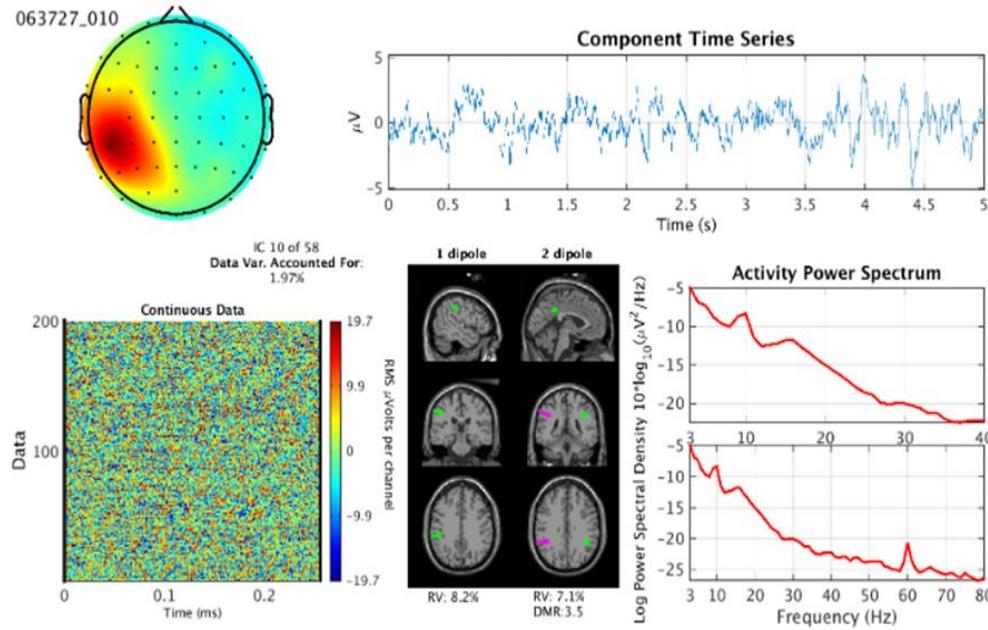
# EEGLAB - ICA

## Other



# EEGLAB - ICA

## Brain Component



# EEGLAB - ICA

## Brain Component

