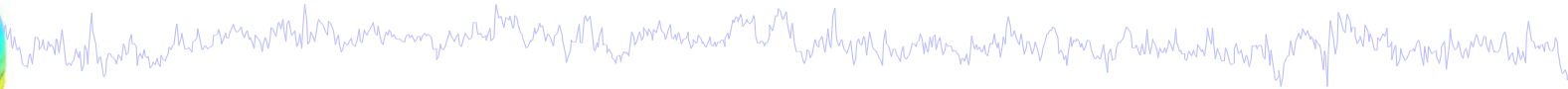


# Artifact rejection and running ICA



## Task 1

Reject noisy data

## Task 2

Run ICA

## Task 3

Plot components

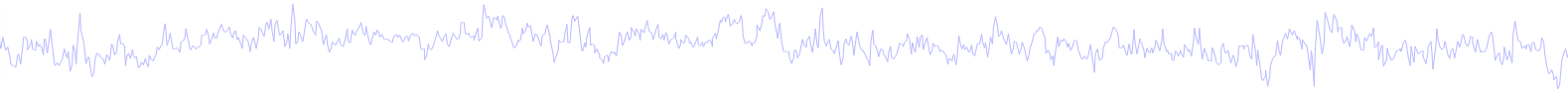
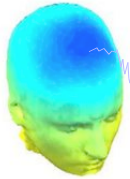
## Task 4

Remove components  
(i.e. back-projection)

## Exercise...



# Independent Component Analysis

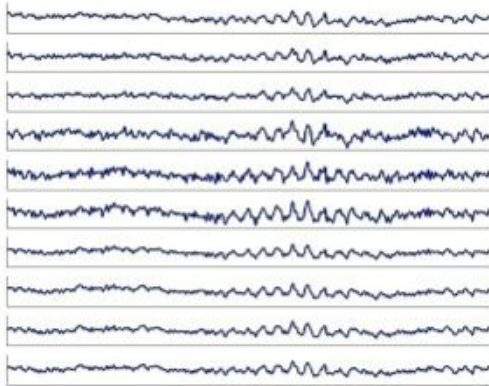


$x = \text{scalp EEG}$

$W = \text{unmixing matrix}$

$u = \text{sources}$

Channels

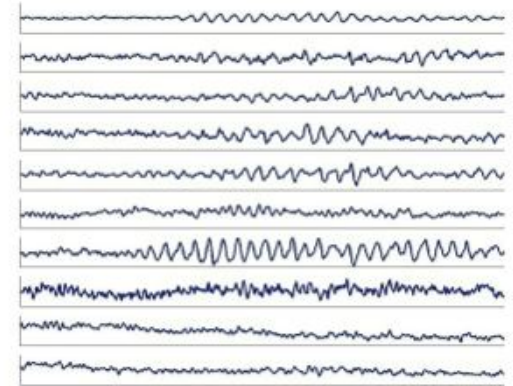


Time

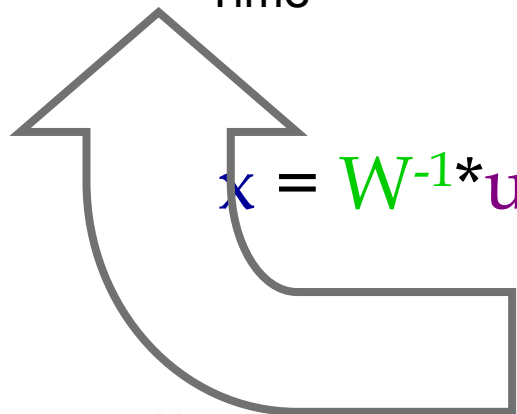
$$W^*x = u$$

ICA

Components

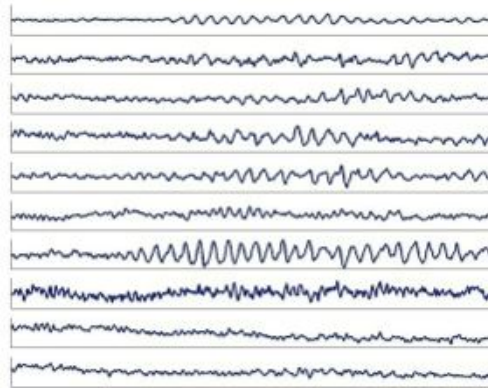


Time



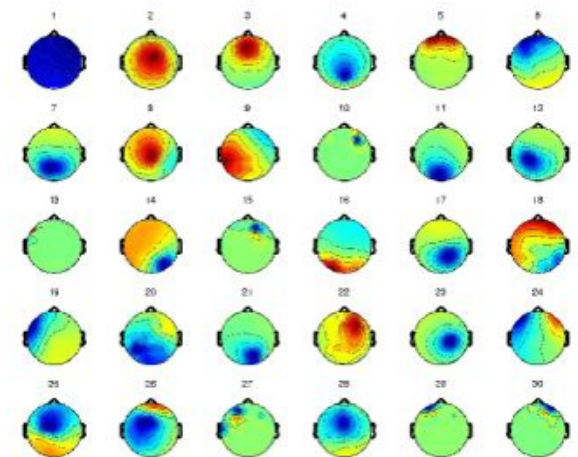
$$x = W^{-1} * u$$

$u = \text{sources}$



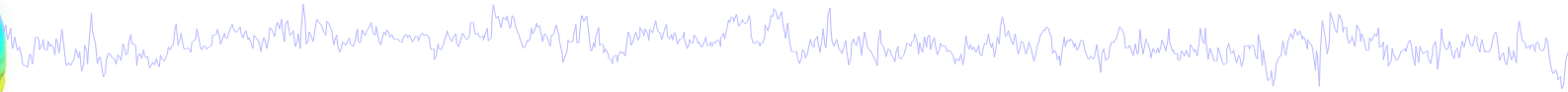
$W^{-1}$  (scalp projections)

\*



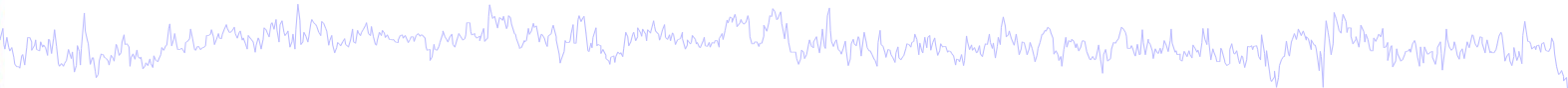
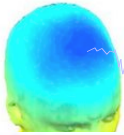
ICA Components

# “Secrets” to a good ICA decomposition



- Garbage in... garbage out (it's not magic)
- Remove large, non-stereotyped artifacts
- Do you have enough data? (based mostly on time, not frames)
- High-pass filter to remove slow drifts (no low-pass filter needed)
- Remove bad channels
- Data must be in double precision (not single)

# Runica options



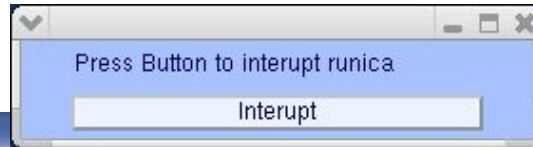
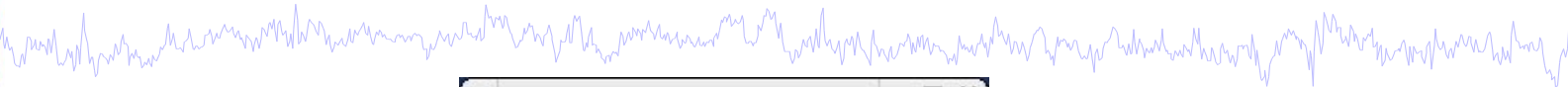
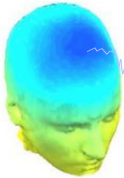
Option	Default	Comments
'extended'	0	1 is recommended to find sub-gaussians
'stop'	1e-7	final weight change → stop
'lrate'	determined from data	too small → too long... too large → wts blow up
'maxsteps'	512	more channels → more steps
'pca'	0 or EEG.nbchan	Decompose only a principal data subspace

Other algorithms:  
binica, amica, sobi, acsobi





# Runica progress...



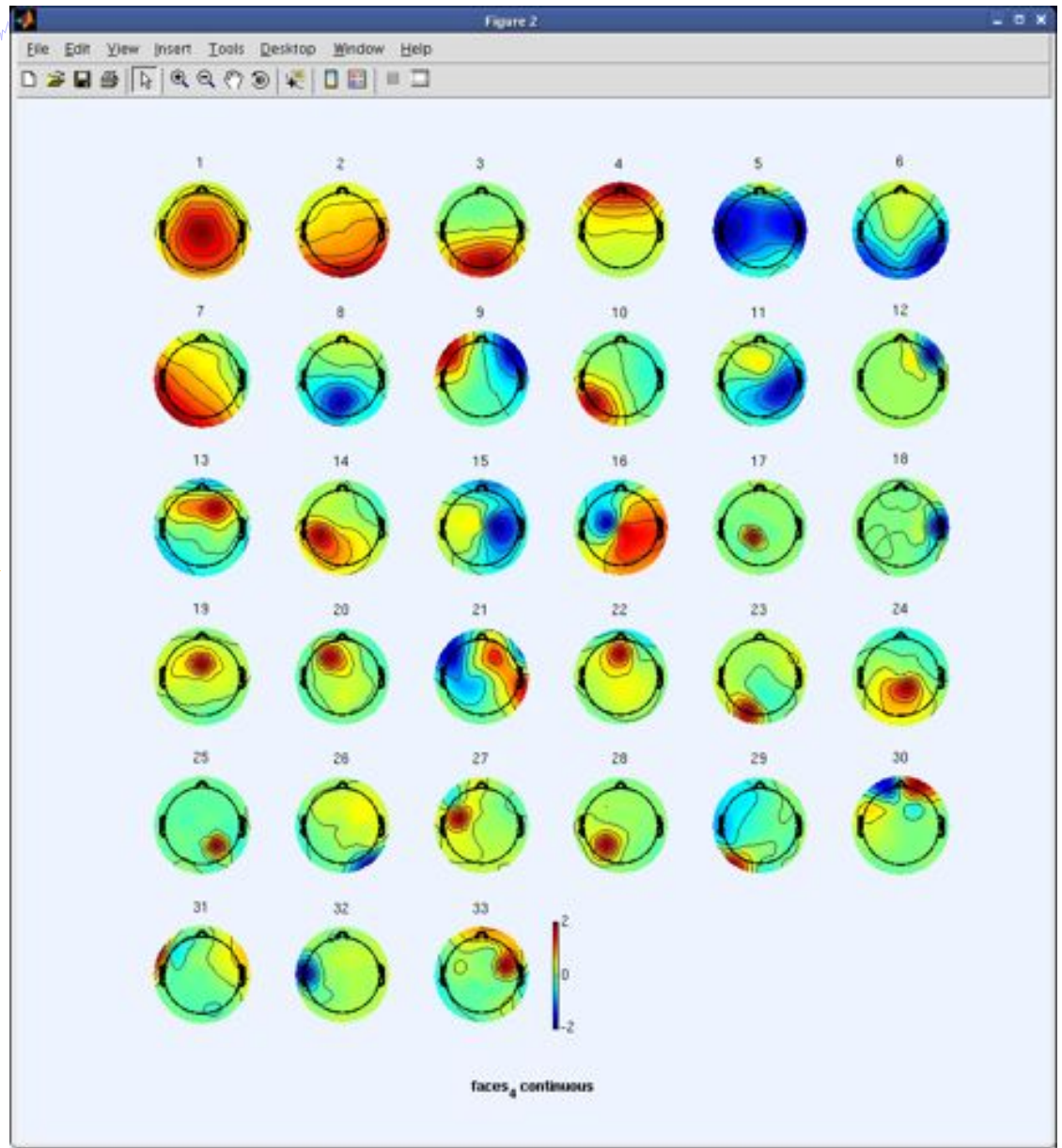
```
cash
Input data size [33,133175] = 33 channels, 133175 frames/finding 33 ICA components using extended ICA.
Kurtosis will be calculated initially every 1 blocks using 9000 data points.
Decomposing 122 frames per ICA weight ((1089)/2 = 133175 weights. Initial learning rate will be 0.001, block size
Learning rate will be multiplied by 0.98 whenever angledelta >= 90 deg.
More than 32 channels: default stopping weight change 1E-7
Training will end when wchange < 1e-07 or after 512 steps.
Online bias adjustment will be used.
Removing mean of each channel ...
Final training data range: -171.806 to 179.034
Computing the sphering matrix...
Starting weights are the identity matrix ...
Sphering the data ...
Beginning ICA training ... first training step may be slow ...
step 1 - lrate 0.001000, wchange 16.97951324, angledelta 0.0 deg
step 2 - lrate 0.001000, wchange 0.26700495, angledelta 0.0 deg
step 3 - lrate 0.001000, wchange 0.79098323, angledelta 104.0 deg
step 4 - lrate 0.000990, wchange 0.66700021, angledelta 147.2 deg
step 5 - lrate 0.000960, wchange 0.63849071, angledelta 146.5 deg
step 6 - lrate 0.000941, wchange 0.73967995, angledelta 150.7 deg
step 7 - lrate 0.000922, wchange 0.75727229, angledelta 151.6 deg
step 8 - lrate 0.000904, wchange 0.74051387, angledelta 137.9 deg
step 9 - lrate 0.000886, wchange 0.74536137, angledelta 156.0 deg
step 10 - lrate 0.000868, wchange 0.72101402, angledelta 141.7 deg
step 11 - lrate 0.000851, wchange 0.14630114, angledelta 102.5 deg
step 12 - lrate 0.000834, wchange 0.11822100, angledelta 114.3 deg
step 13 - lrate 0.000817, wchange 0.79992966, angledelta 101.5 deg
step 14 - lrate 0.000801, wchange 0.26735750, angledelta 109.1 deg
step 15 - lrate 0.000785, wchange 0.12125291, angledelta 94.2 deg
step 16 - lrate 0.000769, wchange 0.10285606, angledelta 110.7 deg
step 17 - lrate 0.000754, wchange 0.09770499, angledelta 118.6 deg
step 18 - lrate 0.000739, wchange 0.09544428, angledelta 117.1 deg
```

```
cash
step 241 - lrate 0.000002, wchange 0.00000082, angledelta 101.5 deg
step 242 - lrate 0.000001, wchange 0.00000061, angledelta 96.1 deg
step 243 - lrate 0.000001, wchange 0.00000057, angledelta 97.5 deg
step 244 - lrate 0.000001, wchange 0.00000054, angledelta 93.7 deg
step 245 - lrate 0.000001, wchange 0.00000055, angledelta 100.3 deg
step 246 - lrate 0.000001, wchange 0.00000047, angledelta 96.3 deg
step 247 - lrate 0.000001, wchange 0.00000046, angledelta 91.3 deg
step 248 - lrate 0.000001, wchange 0.00000045, angledelta 101.5 deg
step 249 - lrate 0.000001, wchange 0.00000041, angledelta 103.1 deg
step 250 - lrate 0.000001, wchange 0.00000036, angledelta 95.5 deg
step 251 - lrate 0.000001, wchange 0.00000033, angledelta 92.1 deg
step 252 - lrate 0.000001, wchange 0.00000029, angledelta 97.4 deg
step 253 - lrate 0.000001, wchange 0.00000030, angledelta 95.8 deg
step 254 - lrate 0.000001, wchange 0.00000025, angledelta 94.2 deg
step 255 - lrate 0.000001, wchange 0.00000023, angledelta 97.6 deg
step 256 - lrate 0.000001, wchange 0.00000023, angledelta 97.1 deg
step 257 - lrate 0.000001, wchange 0.00000021, angledelta 92.0 deg
step 258 - lrate 0.000001, wchange 0.00000020, angledelta 93.1 deg
step 259 - lrate 0.000001, wchange 0.00000013, angledelta 95.0 deg
step 260 - lrate 0.000001, wchange 0.00000015, angledelta 98.3 deg
step 261 - lrate 0.000001, wchange 0.00000014, angledelta 93.0 deg
step 262 - lrate 0.000001, wchange 0.00000014, angledelta 94.3 deg
step 263 - lrate 0.000001, wchange 0.00000013, angledelta 95.4 deg
step 264 - lrate 0.000001, wchange 0.00000012, angledelta 94.1 deg
step 265 - lrate 0.000001, wchange 0.00000011, angledelta 96.1 deg
step 266 - lrate 0.000001, wchange 0.00000010, angledelta 94.8 deg
step 267 - lrate 0.000001, wchange 0.00000010, angledelta 94.5 deg
step 268 - lrate 0.000001, wchange 0.00000010, angledelta 97.7 deg
step 269 - lrate 0.000001, wchange 0.00000008, angledelta 95.1 deg
Sorting components in descending order of mean projected variance ...
Permuting the activation wave forms ...
>>
>>
```

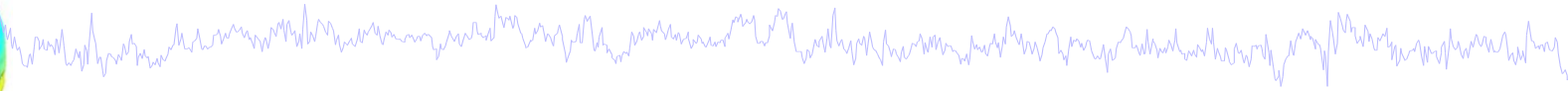
# ICA weights in EEG structure

```
Terminal
File Edit View Terminal Tabs Help
>> EEG
EEG =

    setname: "faces_4_continuous"
    filename: "faces_4.set"
    filepath: "/home/julia/workshop04/"
    subject: ""
    group: ""
    condition: ""
    session: {}
    comments: [13x48 char]
    nbchan: 33
    trials: 1
    pnts: 133175
    srates: 250
    xmin: 0
    xmax: 532.6960
    times: {}
    data: [33x133175 single]
    icaact: [33x133175 single]
    icawinv: [33x33 double]
    icasphere: [33x33 double]
    icaweights: [33x33 double]
    icananswim: [1x33 double]
    chanlocs: [1x33 struct]
    urchanlocs: {}
    chaninfo: [1x1 struct]
        ref: "common"
    event: [1x731 struct]
    urevent: [1x731 struct]
    eventdescription: [1 1]
    epoch: {}
    epochdescription: {}
    reject: [1x1 struct]
    state: [1x1 struct]
    specdata: {}
    specicaact: {}
    splinefile: ""
    icasplinefile: ""
    dipfit: [1x1 struct]
    history: [1x1633 char]
    saved: "no"
    etc: {}
```



# Artifact rejection and running ICA



## Task 1

Reject noisy data

## Task 2

Run ICA

## Task 3

Plot components

## Task 4

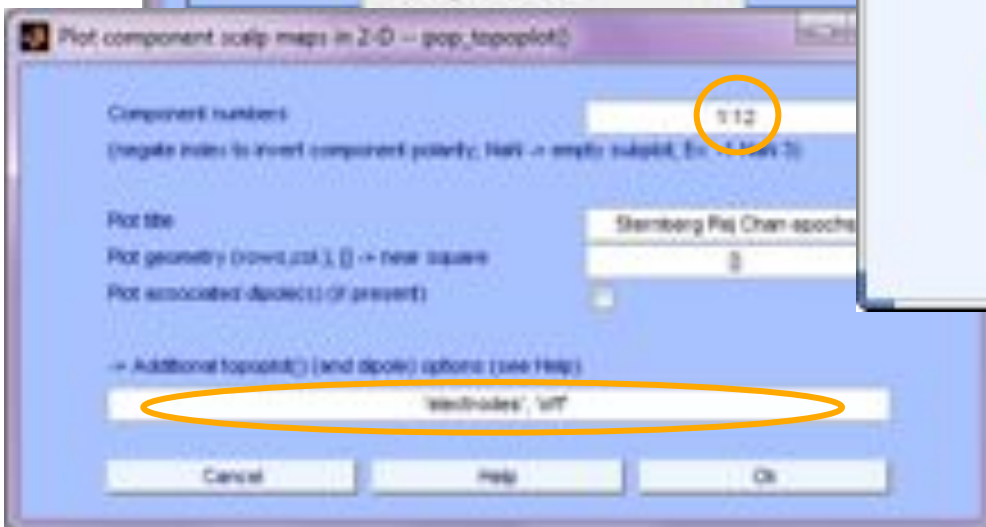
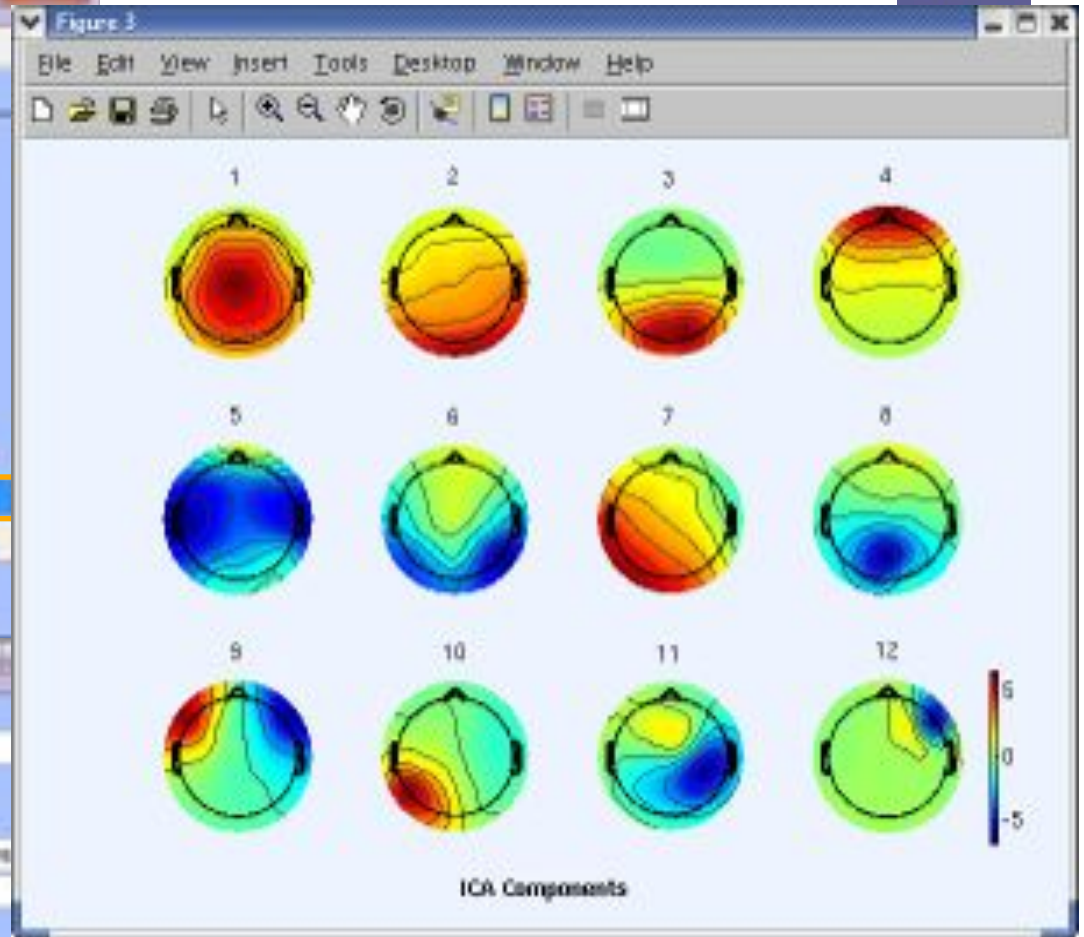
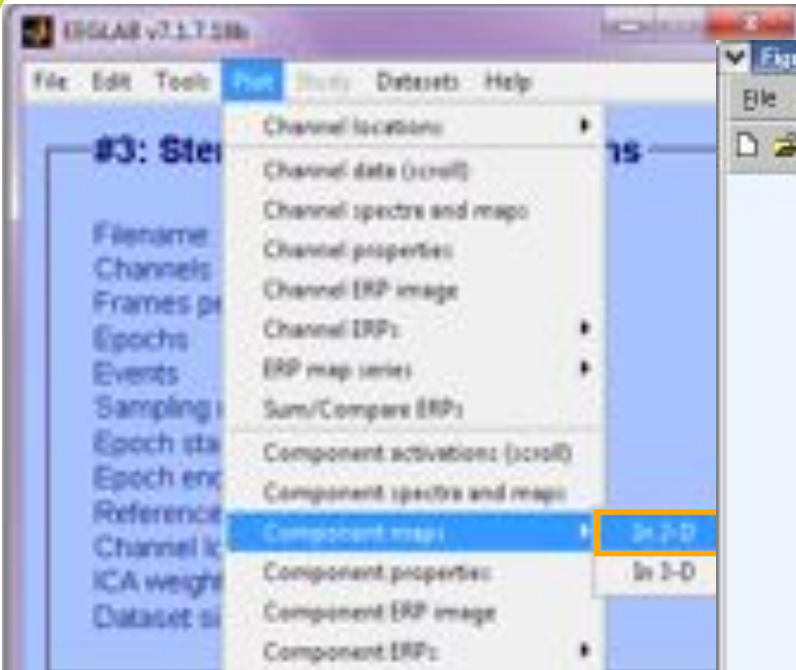
Remove components  
(i.e. back-projection)

## Exercise...



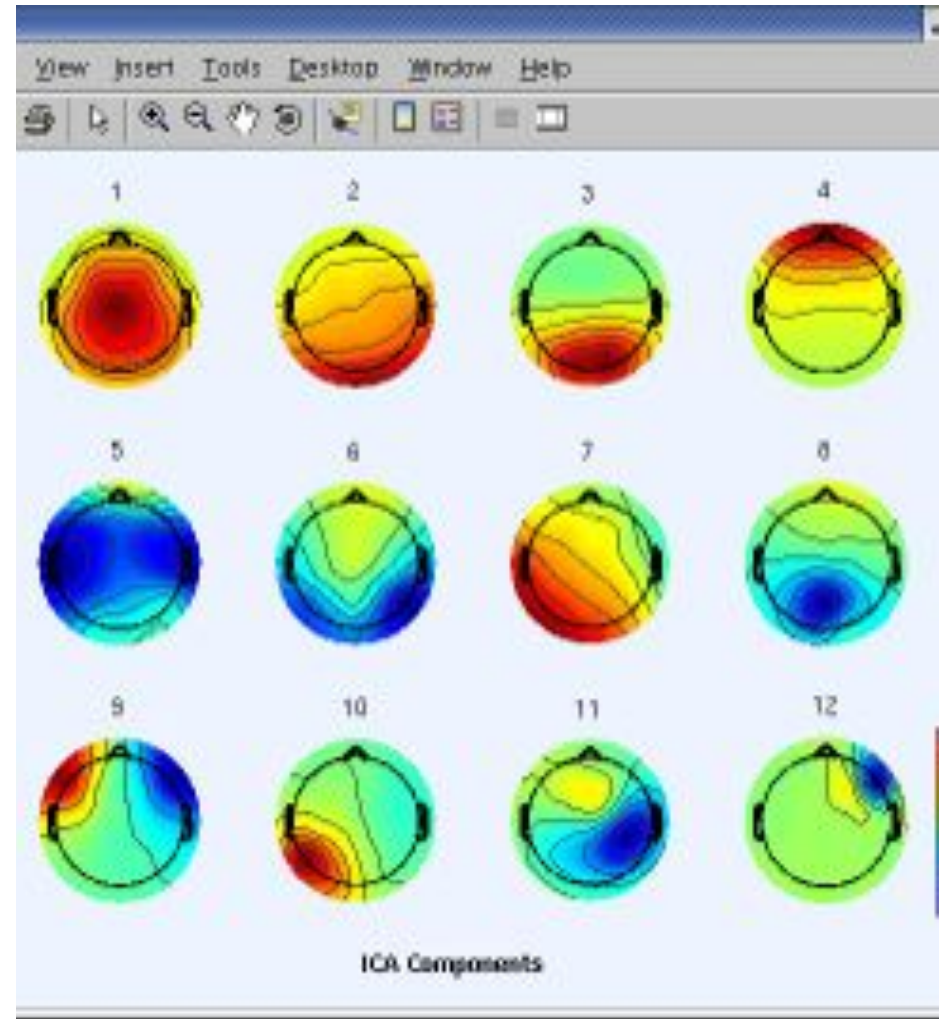
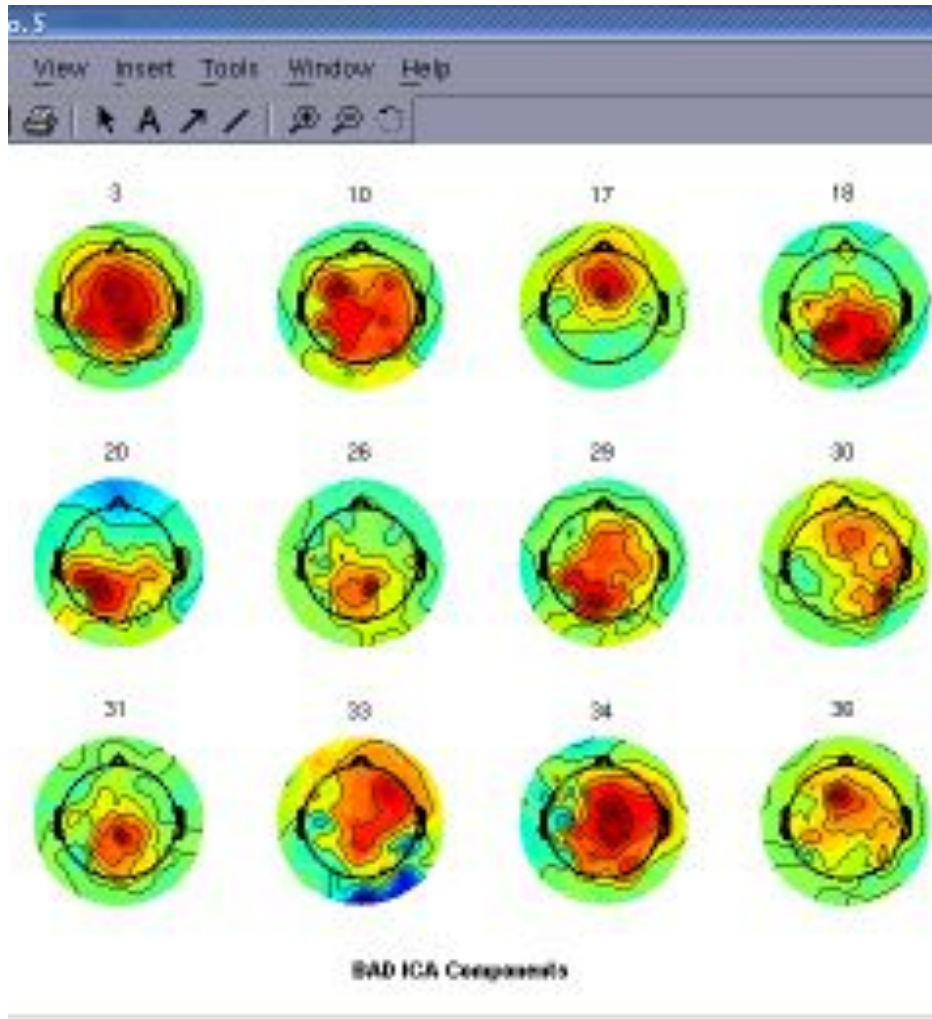


# Plot ICA scalp maps

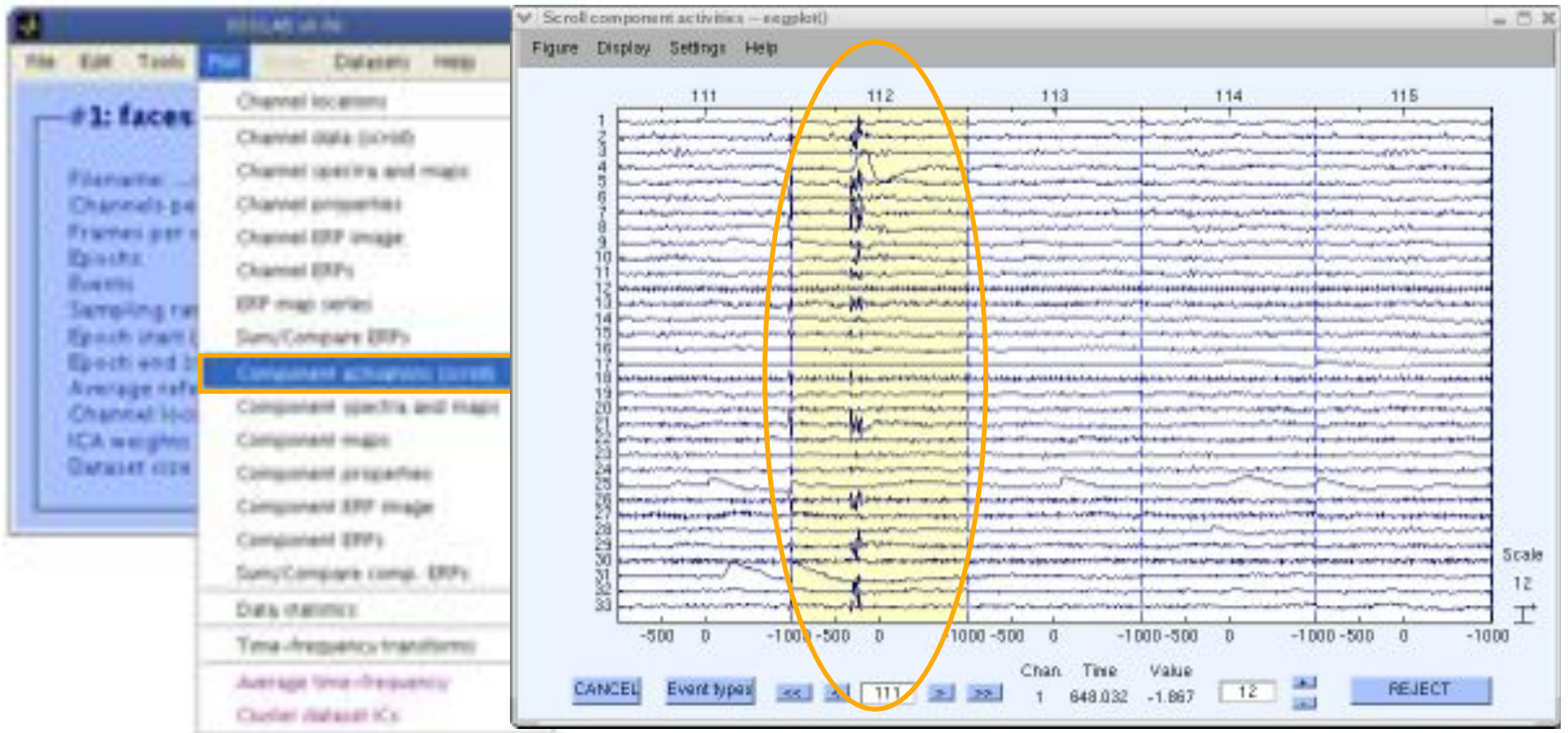
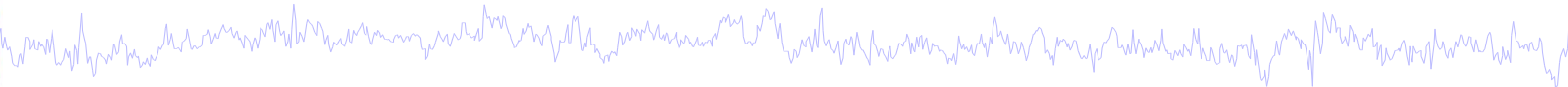
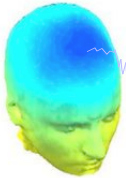




# Compare 'good' and 'bad' scalp maps



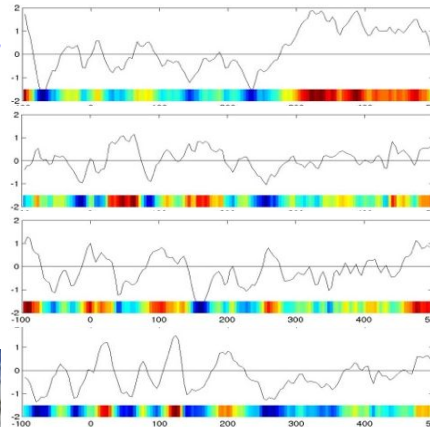
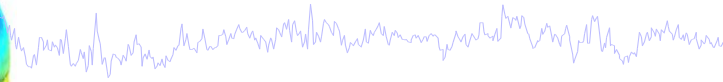
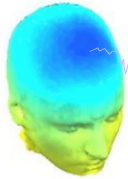
# Scroll component activities



**Time periods that are not independent across ICs should be removed and ICA run again for better decomposition**



# Plot ICA component properties



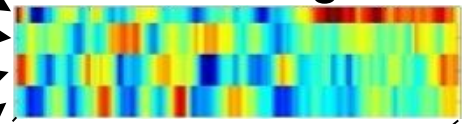
Trial 1

Trial 2

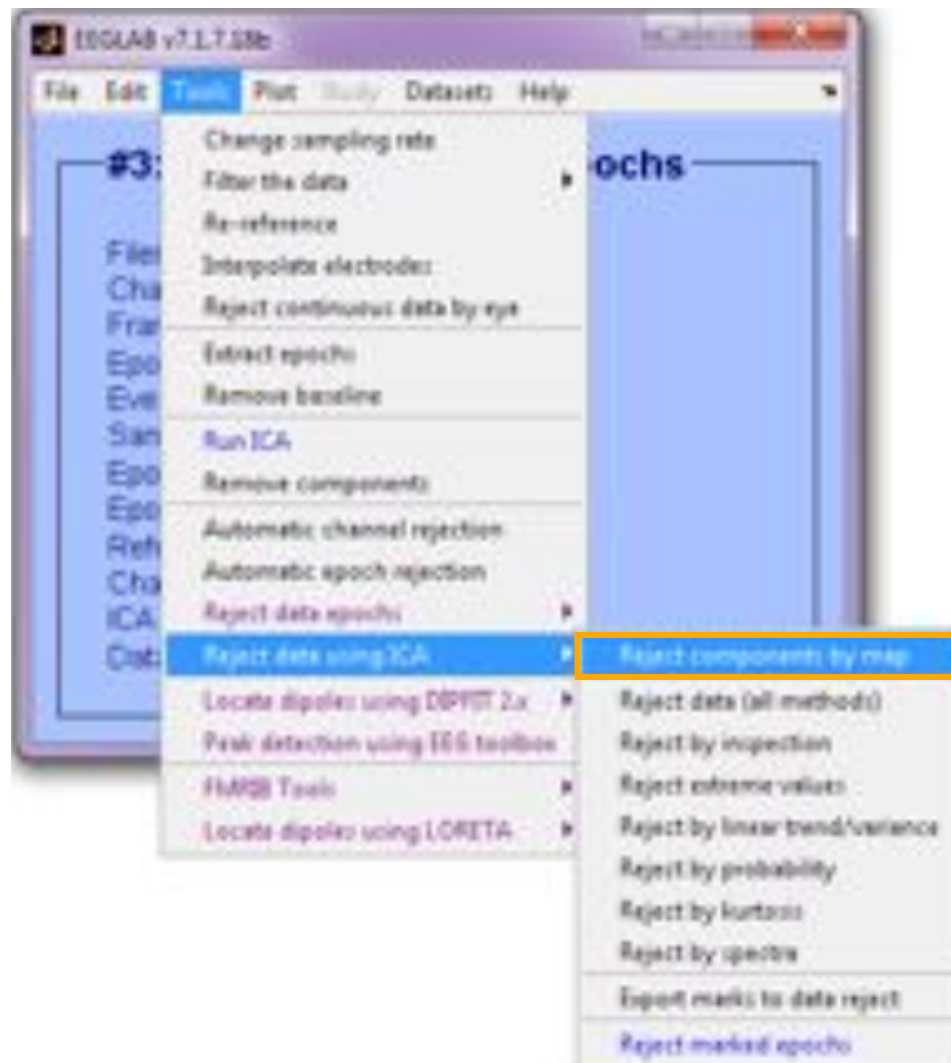
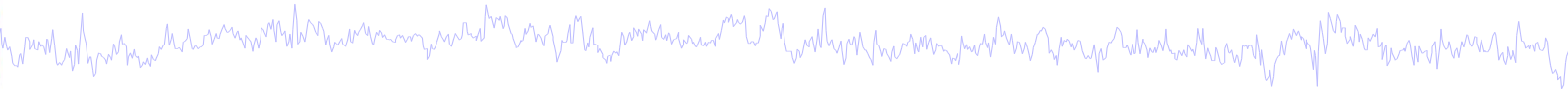
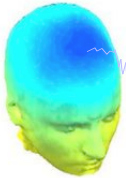
Trial 3

Trial 4

ERP Image

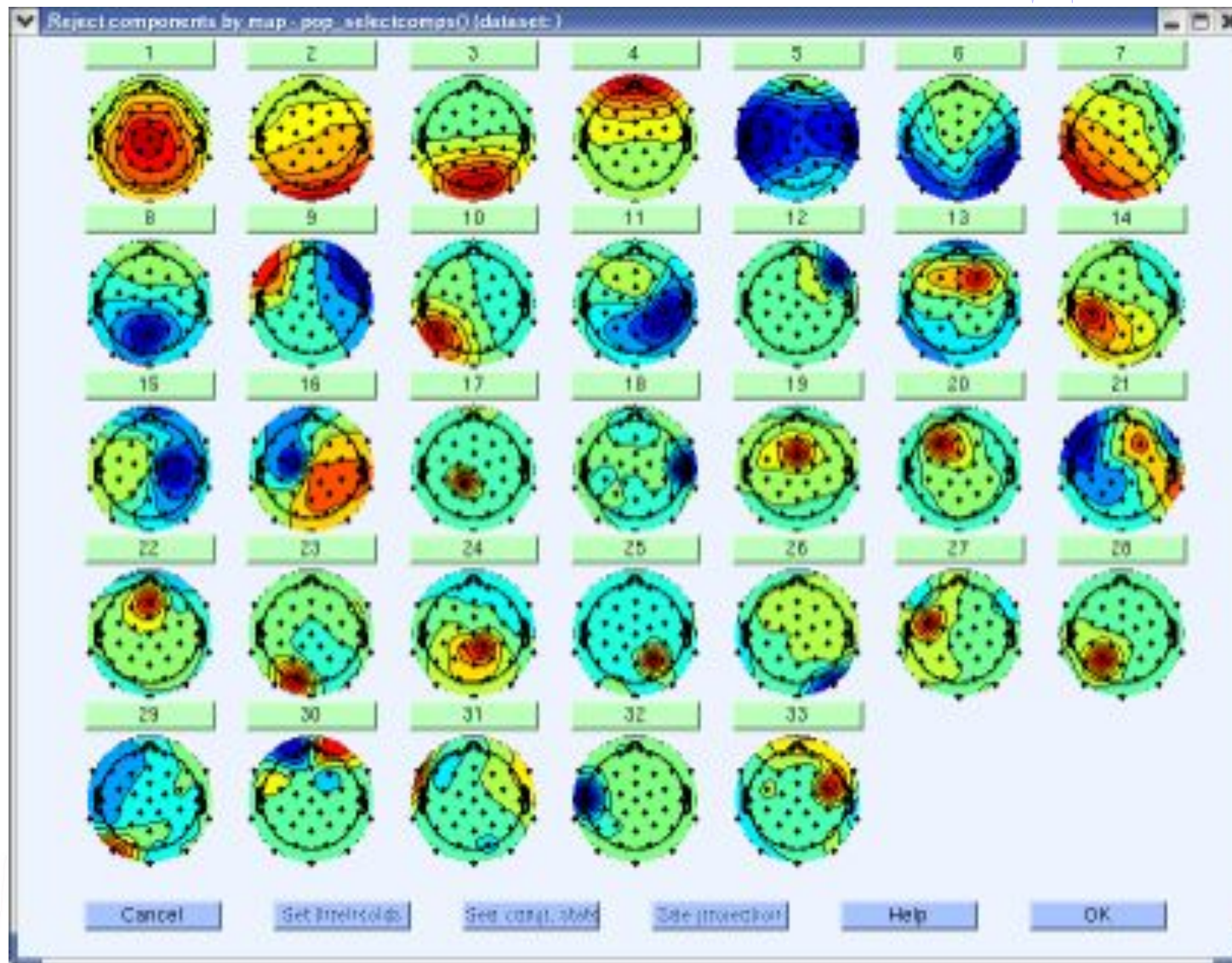
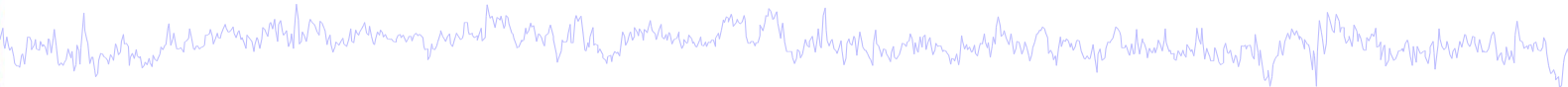
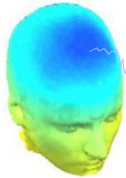


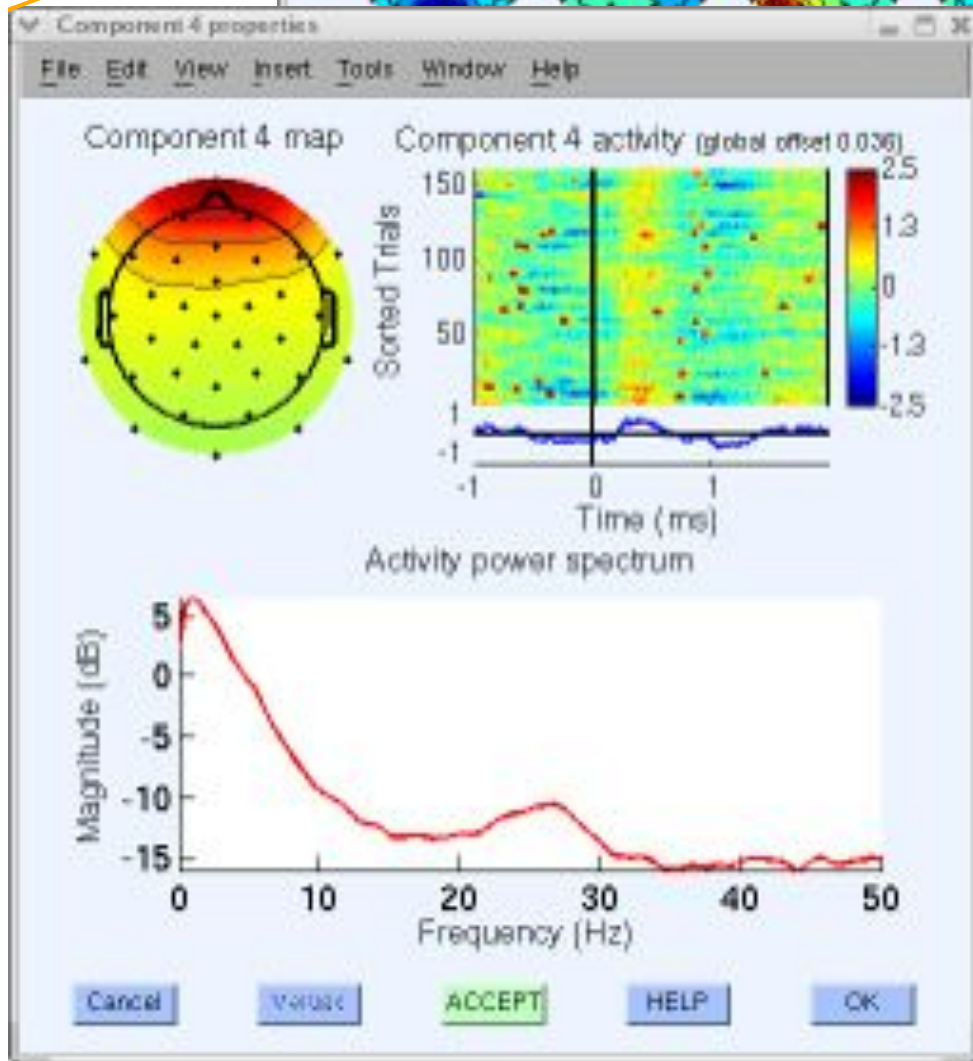
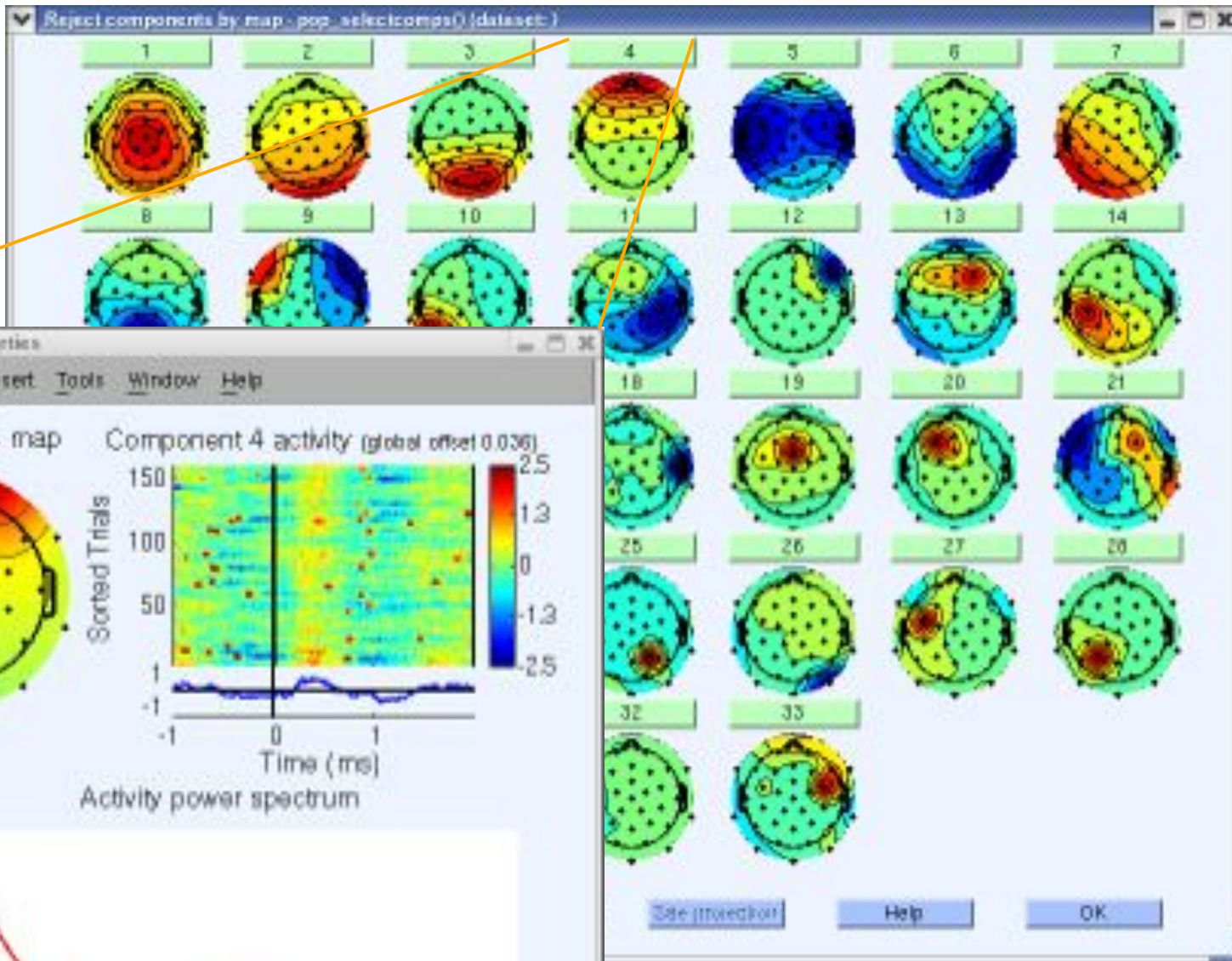
# Reviewing component properties





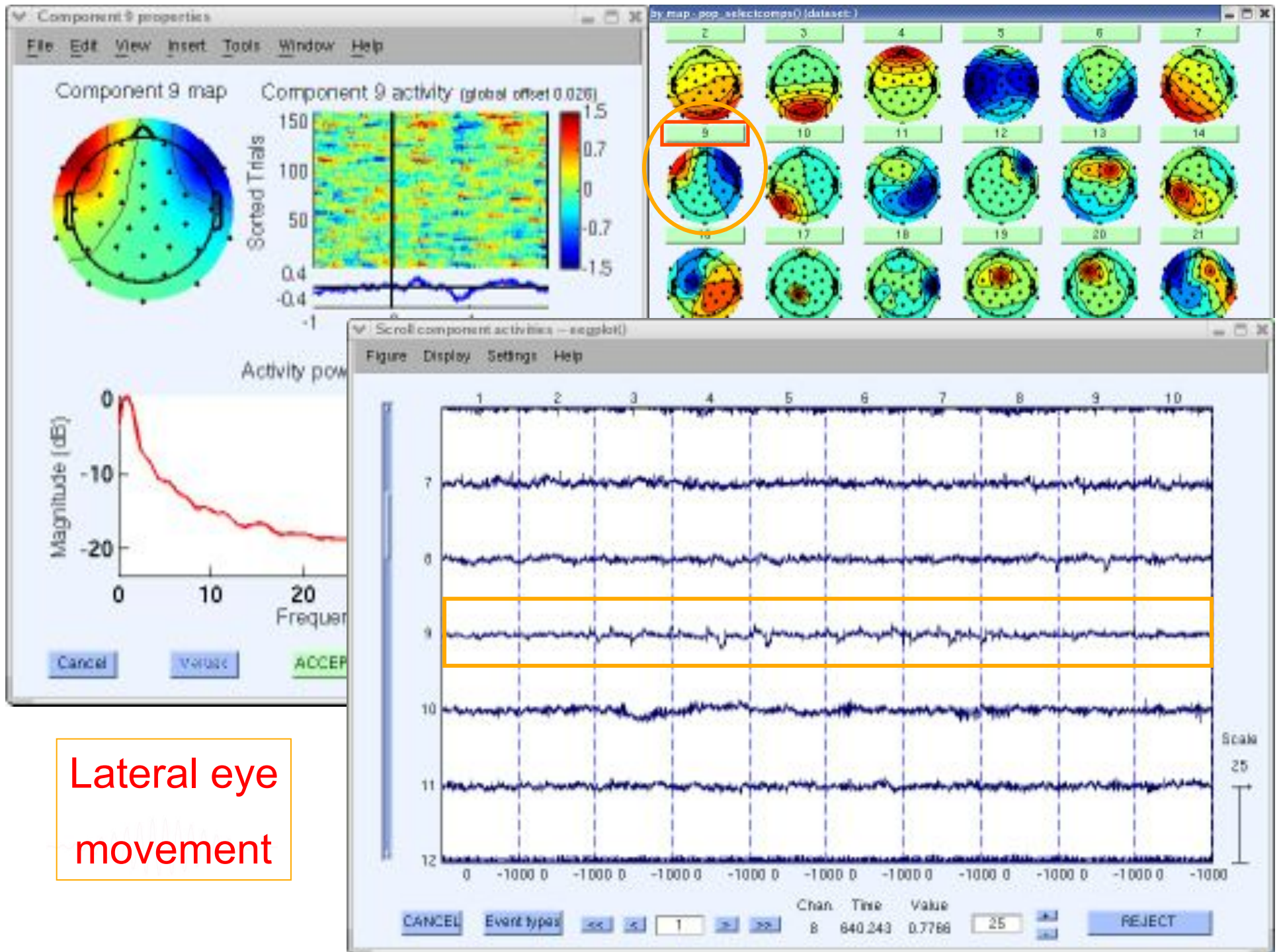
# Component scalp maps/properties

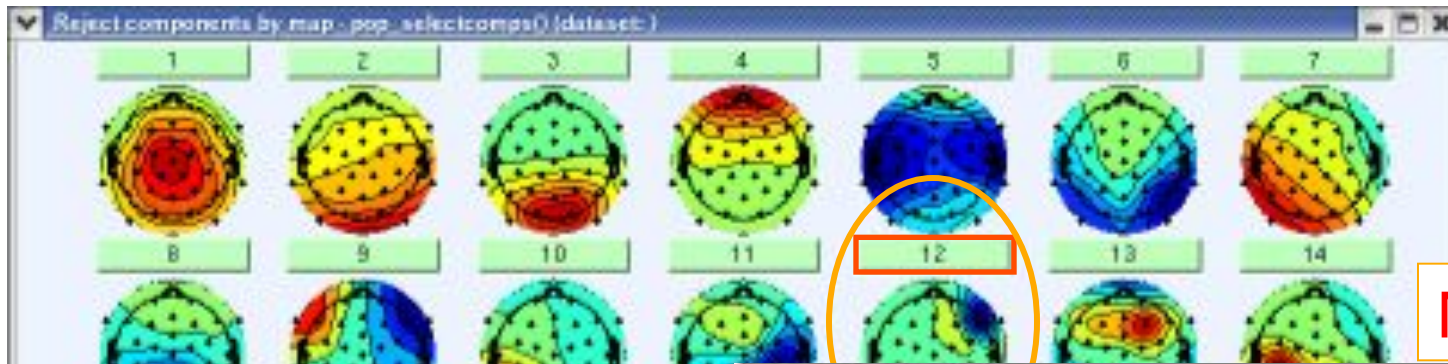




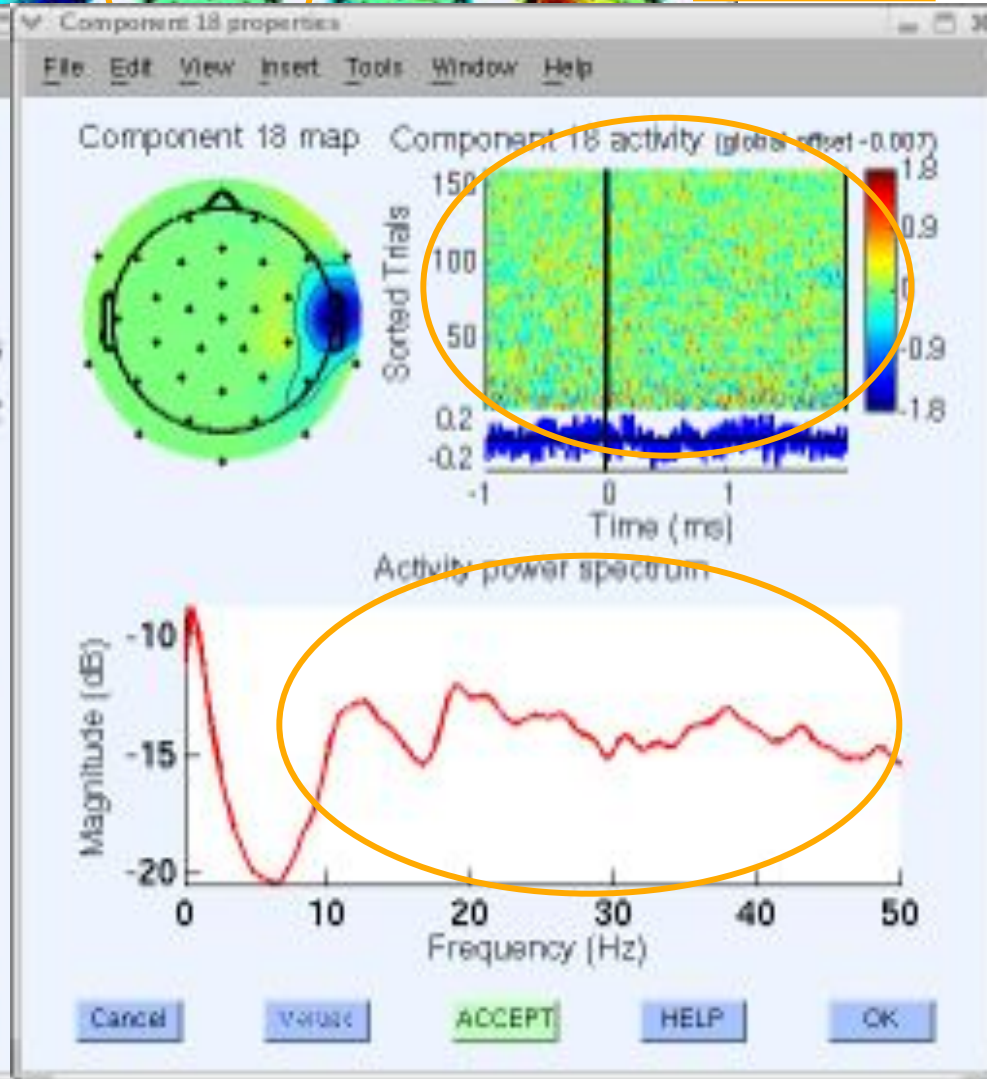
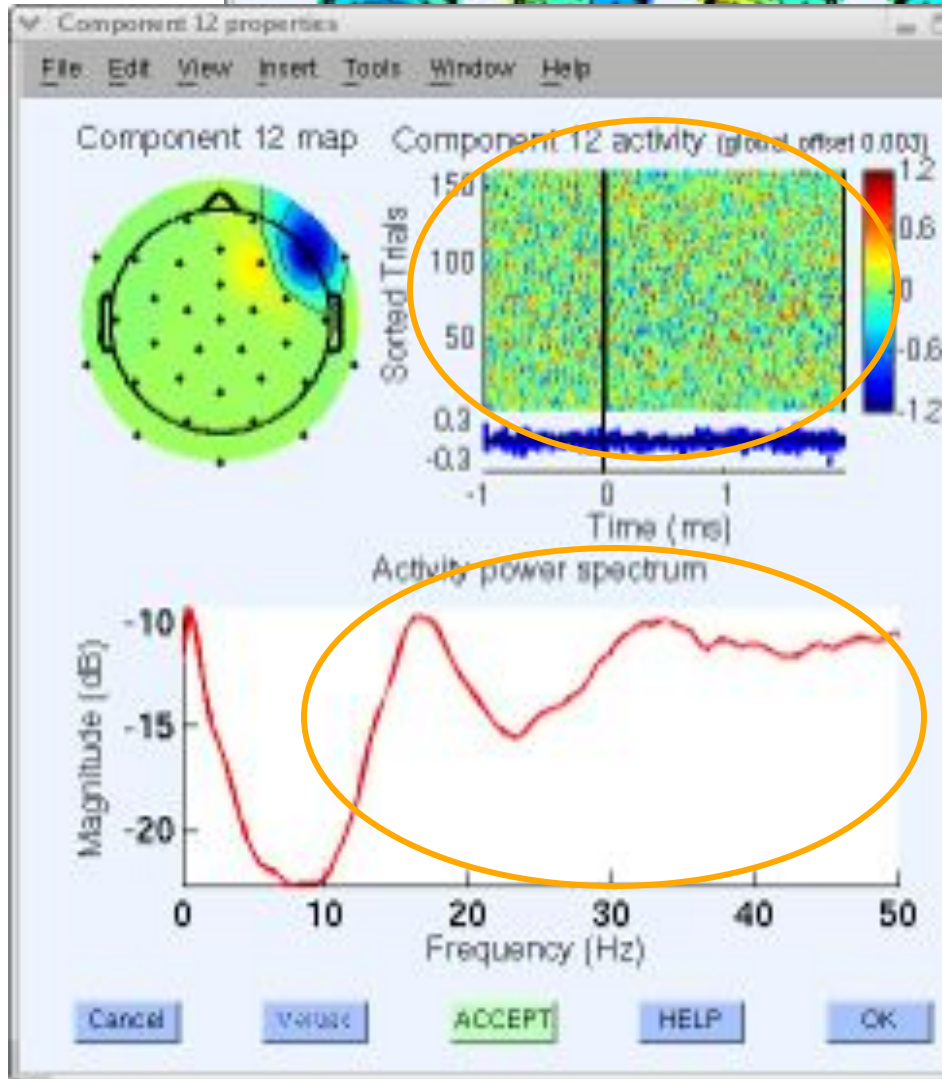
Eye blink component



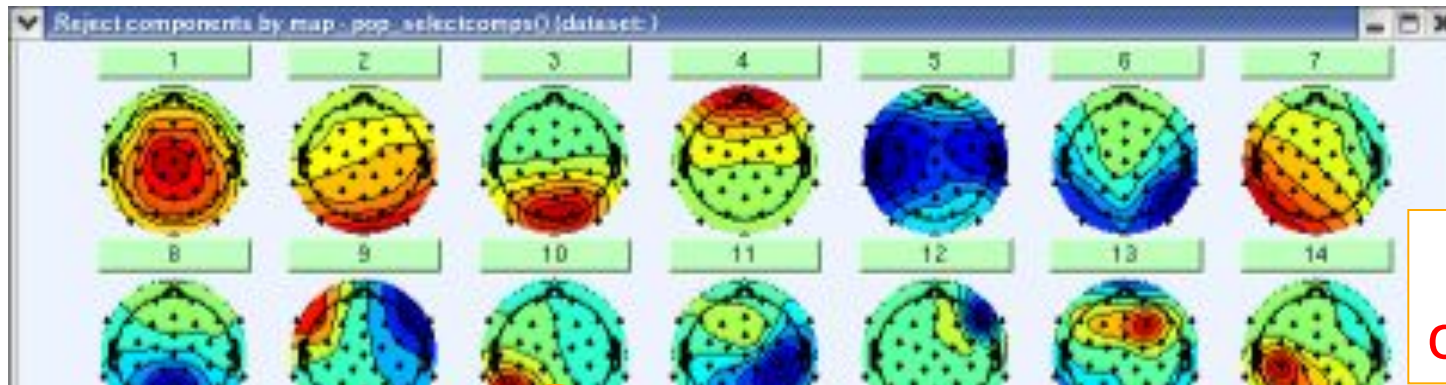




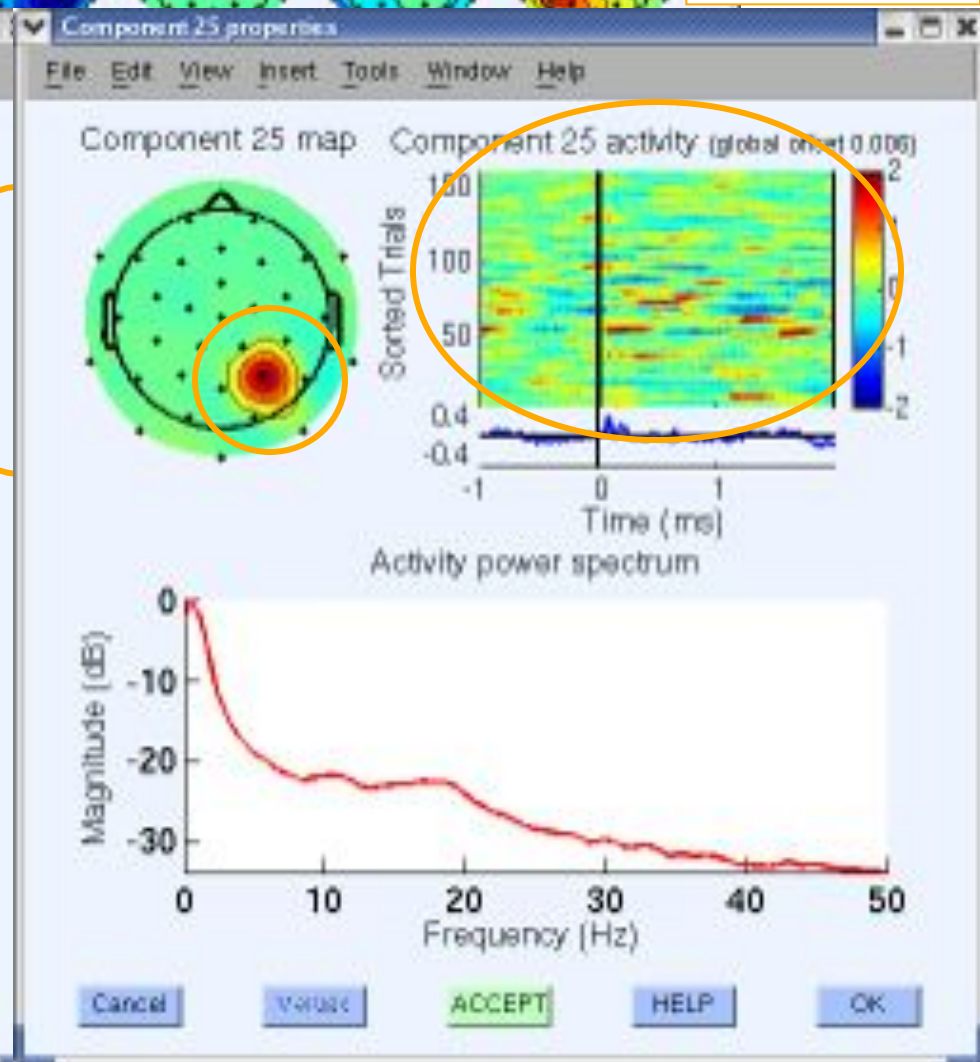
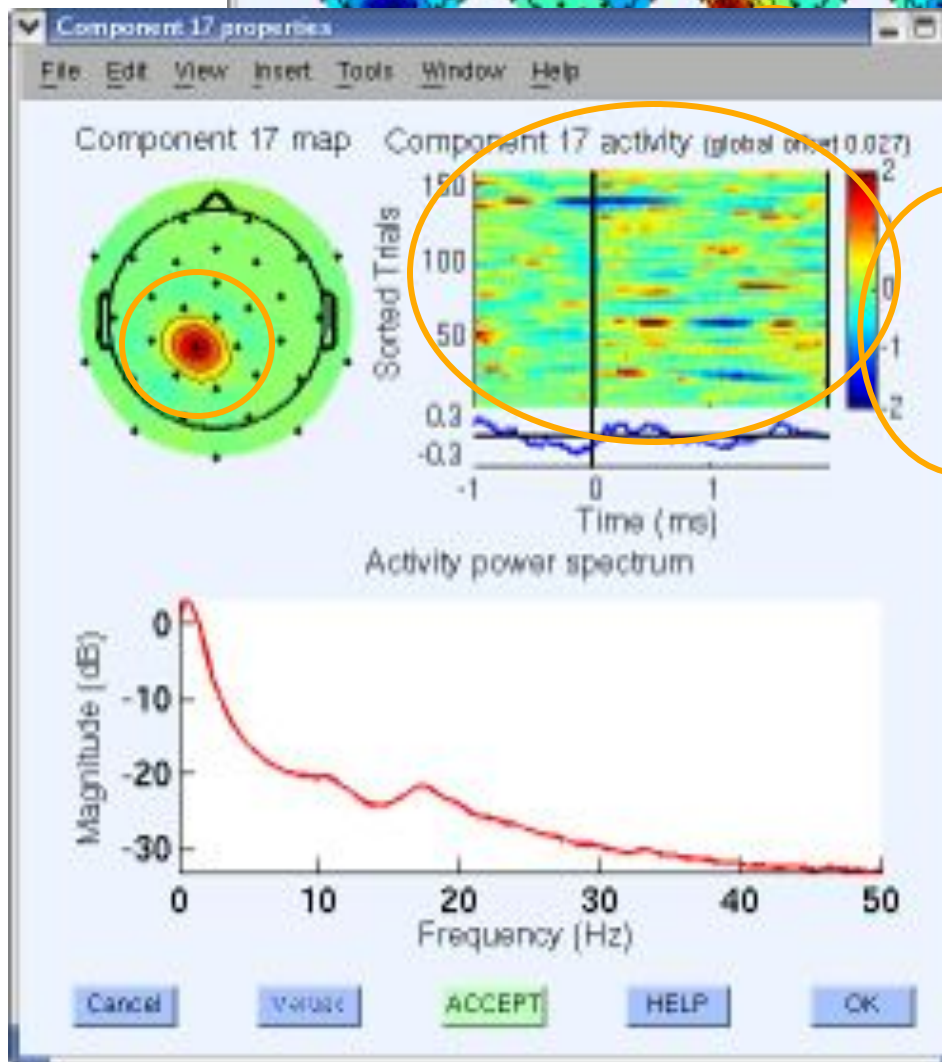
Muscle



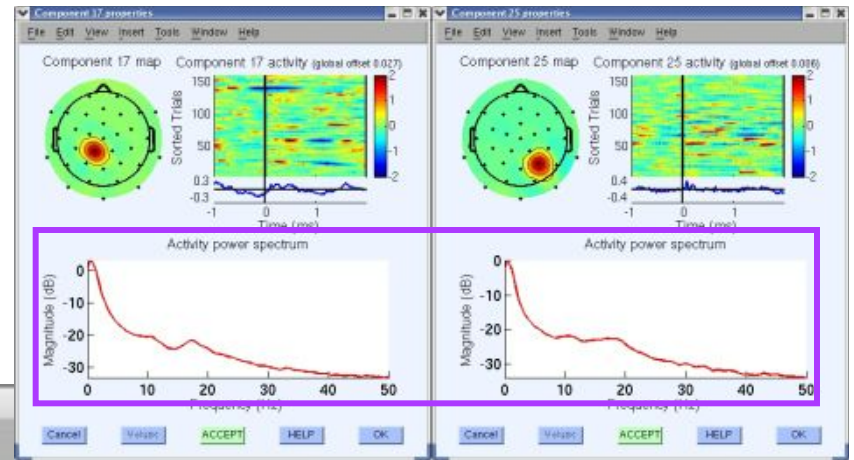
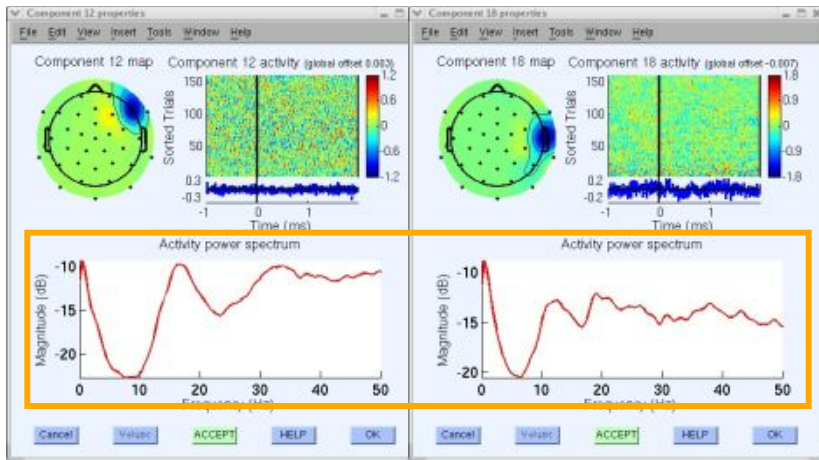




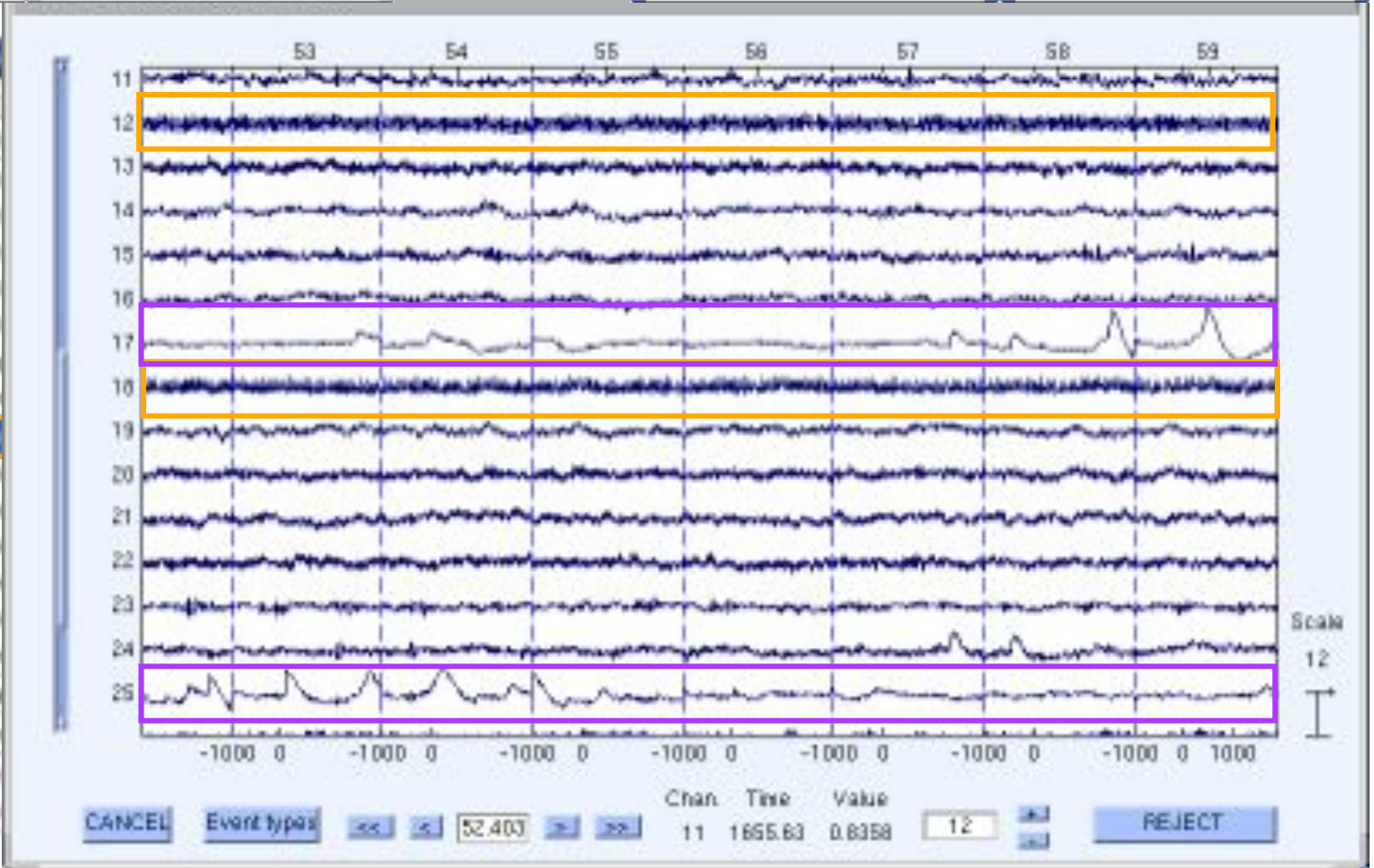
Bad channels



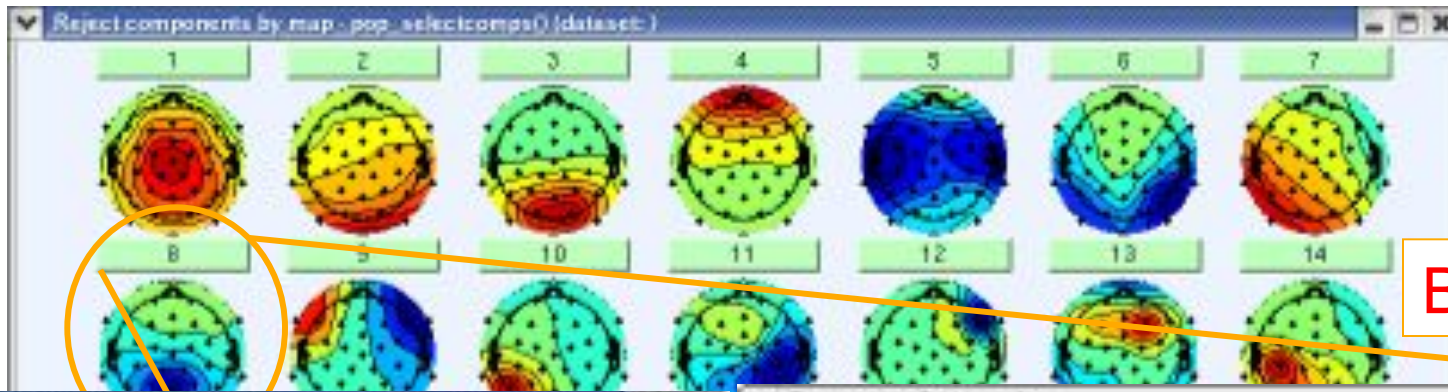




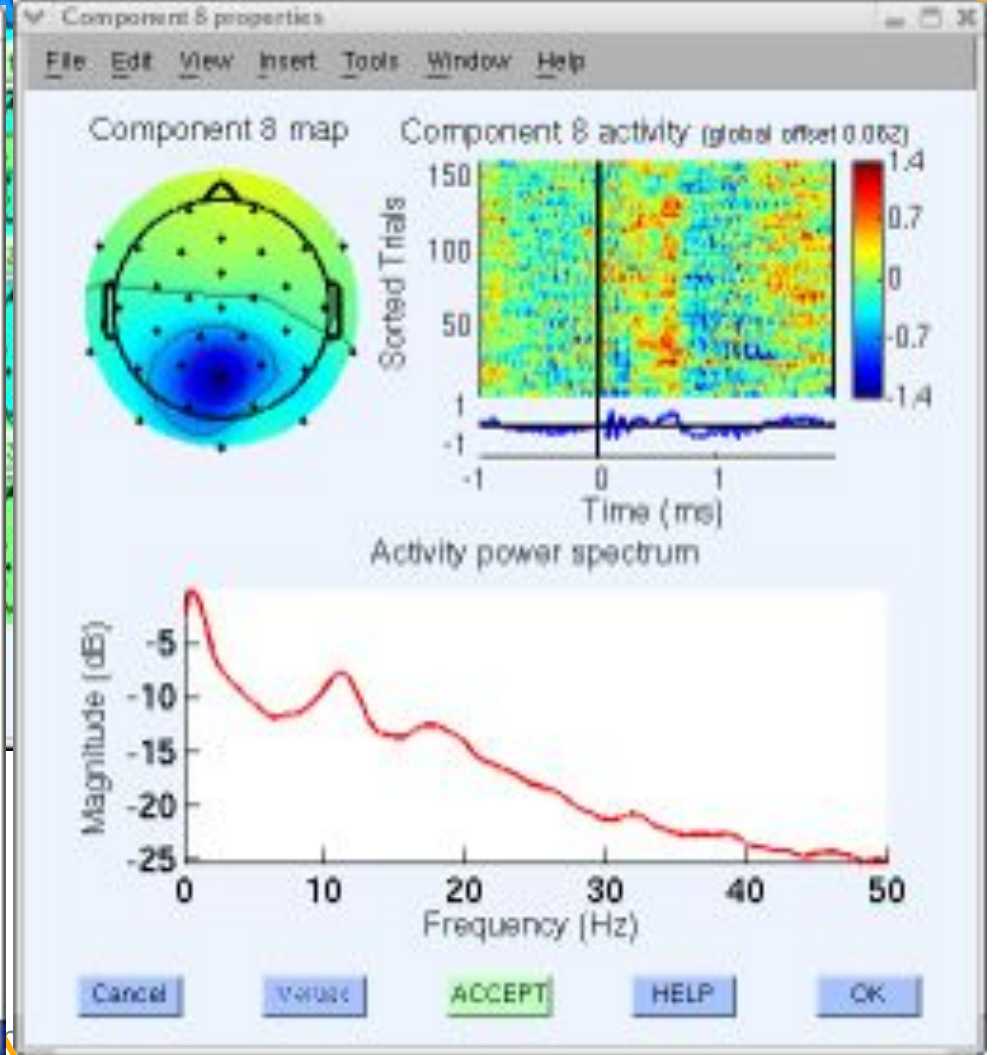
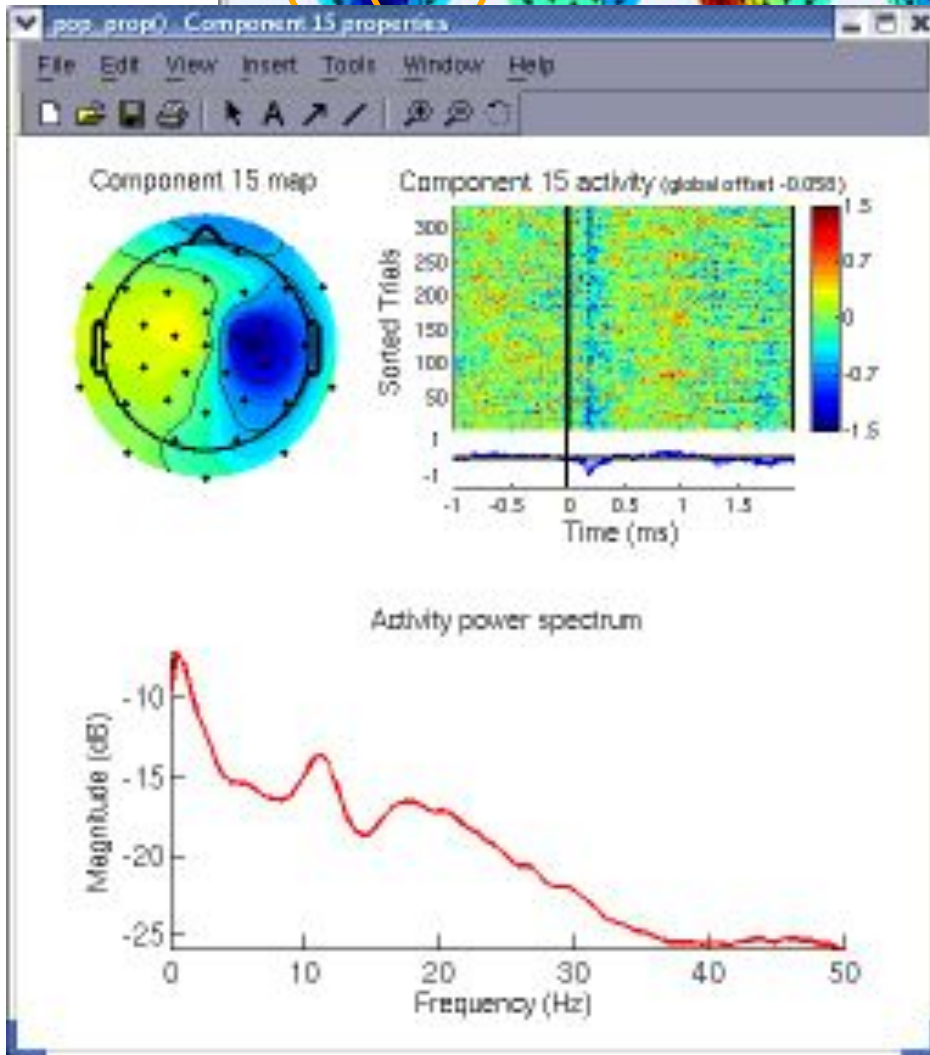
EEG software menu showing channel selection options. The menu is open to the 'Channels' section, which includes options like 'Channels per...', 'Frames per...', 'Epochs', 'Events', 'Sampling rate', 'Epoch start', 'Epoch end', 'Average reference', 'Channel location', 'ICA weights', and 'Dataset size'. The 'Channels' option is highlighted with a blue box.



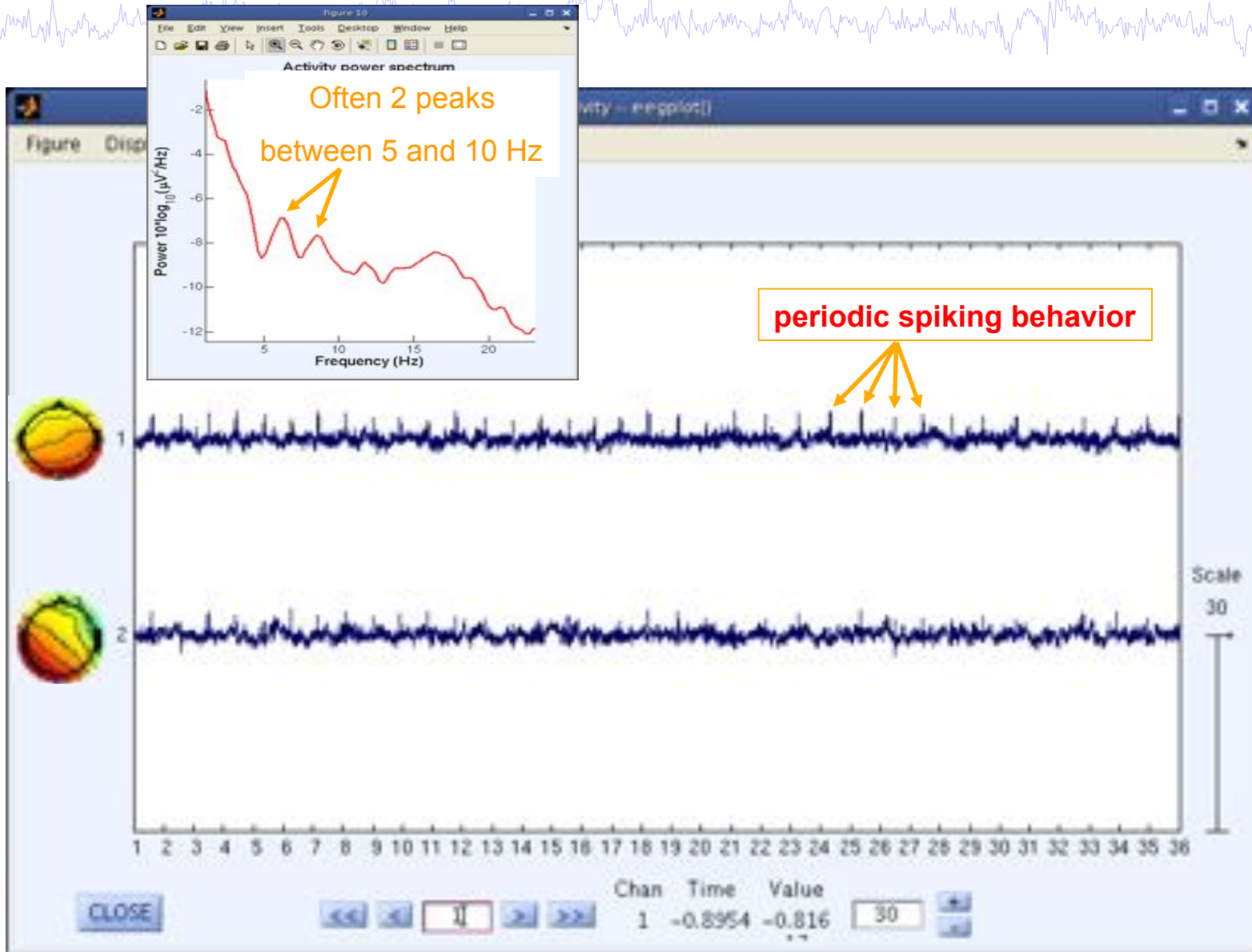




Brain ICs

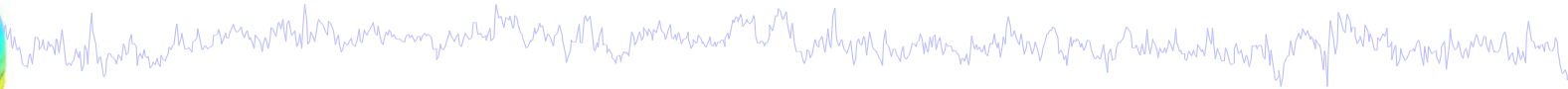


# Pulse artifacts





# Artifact rejection and running ICA



## Task 1

Reject noisy data

## Task 2

Run ICA

## Task 3

Plot components

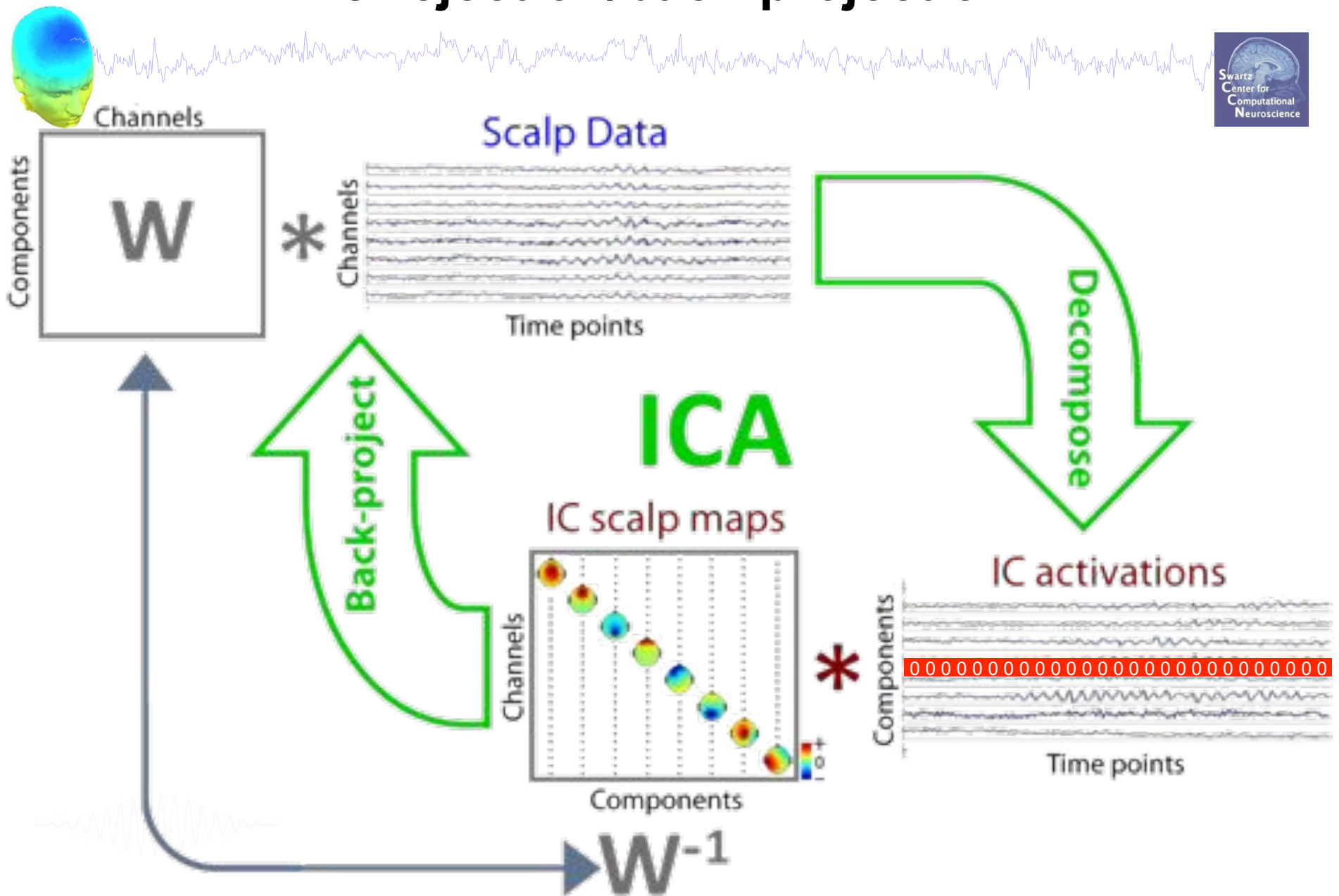
## Task 4

Remove components  
(i.e. back-projection)

**Exercise...**



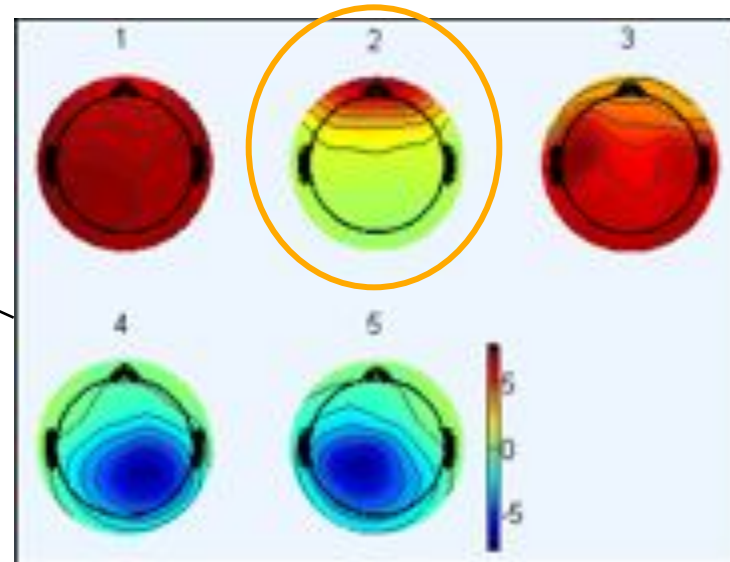
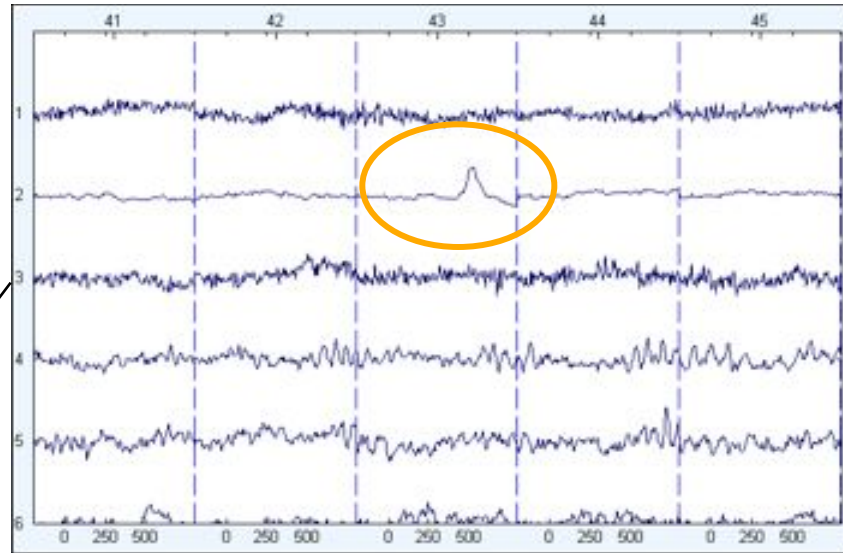
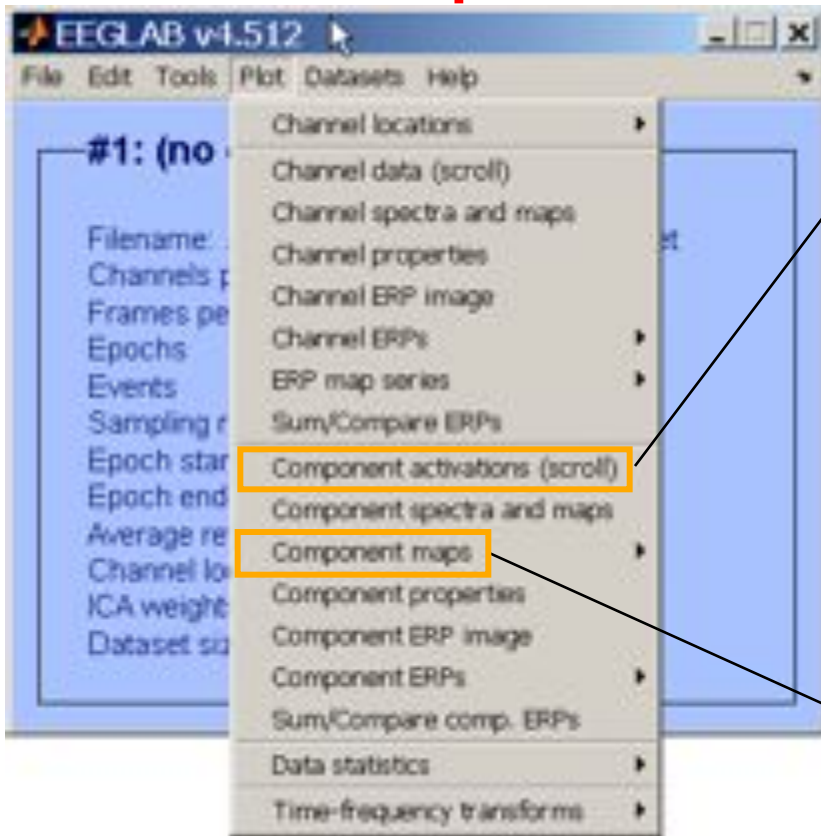
# IC rejection/back-projection



# Eye blink correction

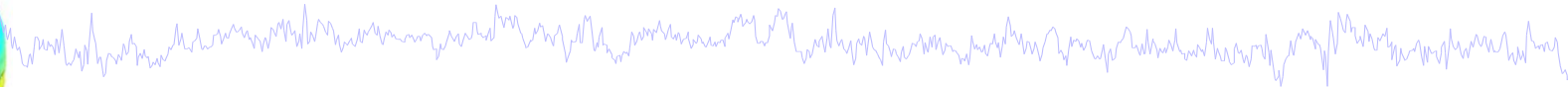


Identify eye-blink components:

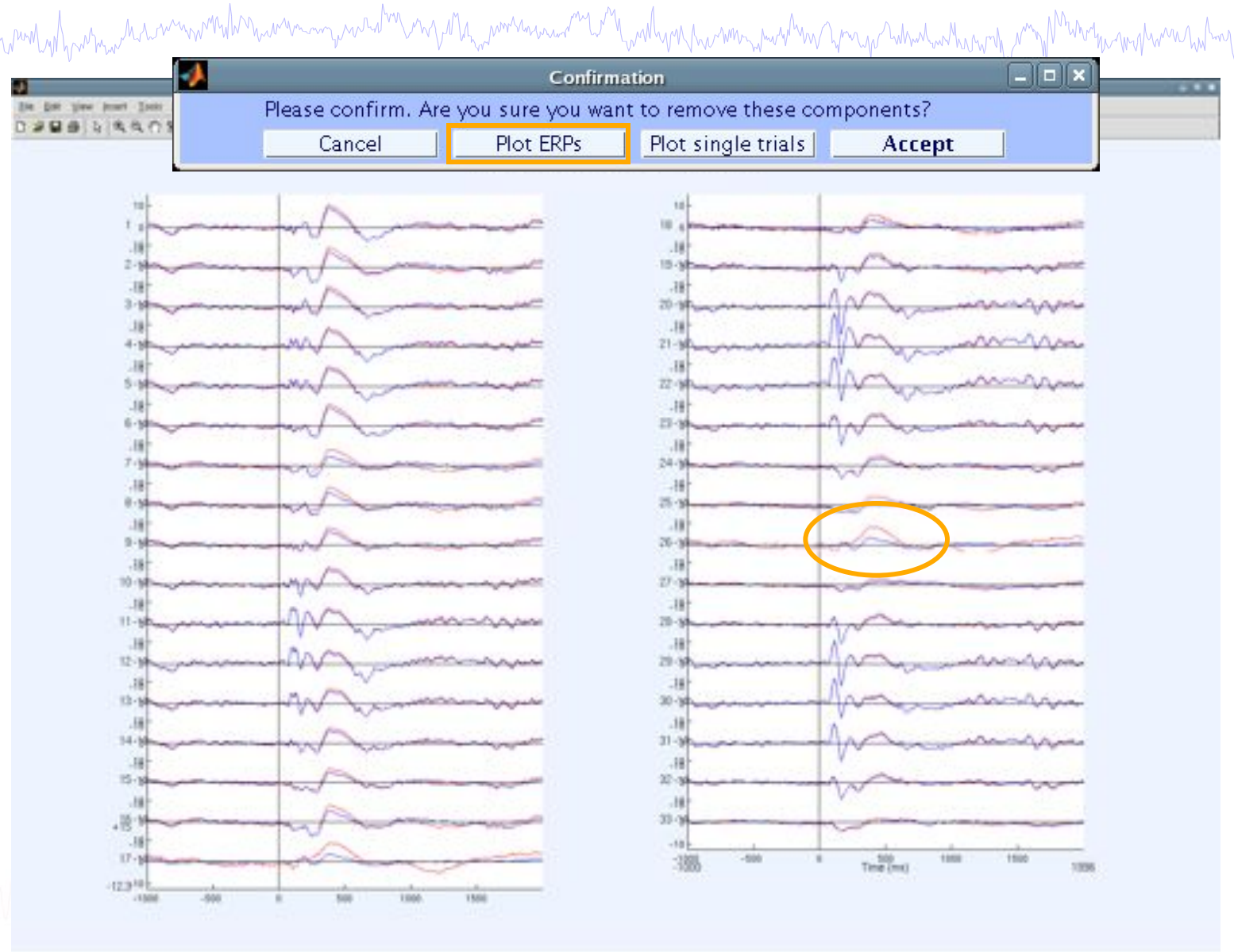




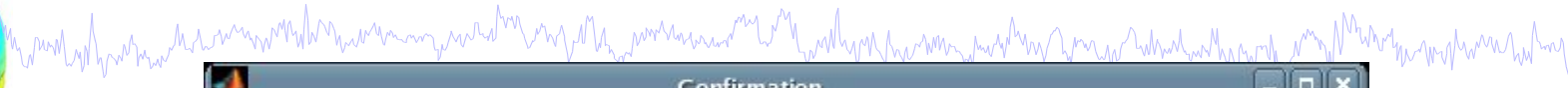
# Eye blink correction



# Eye blink correction

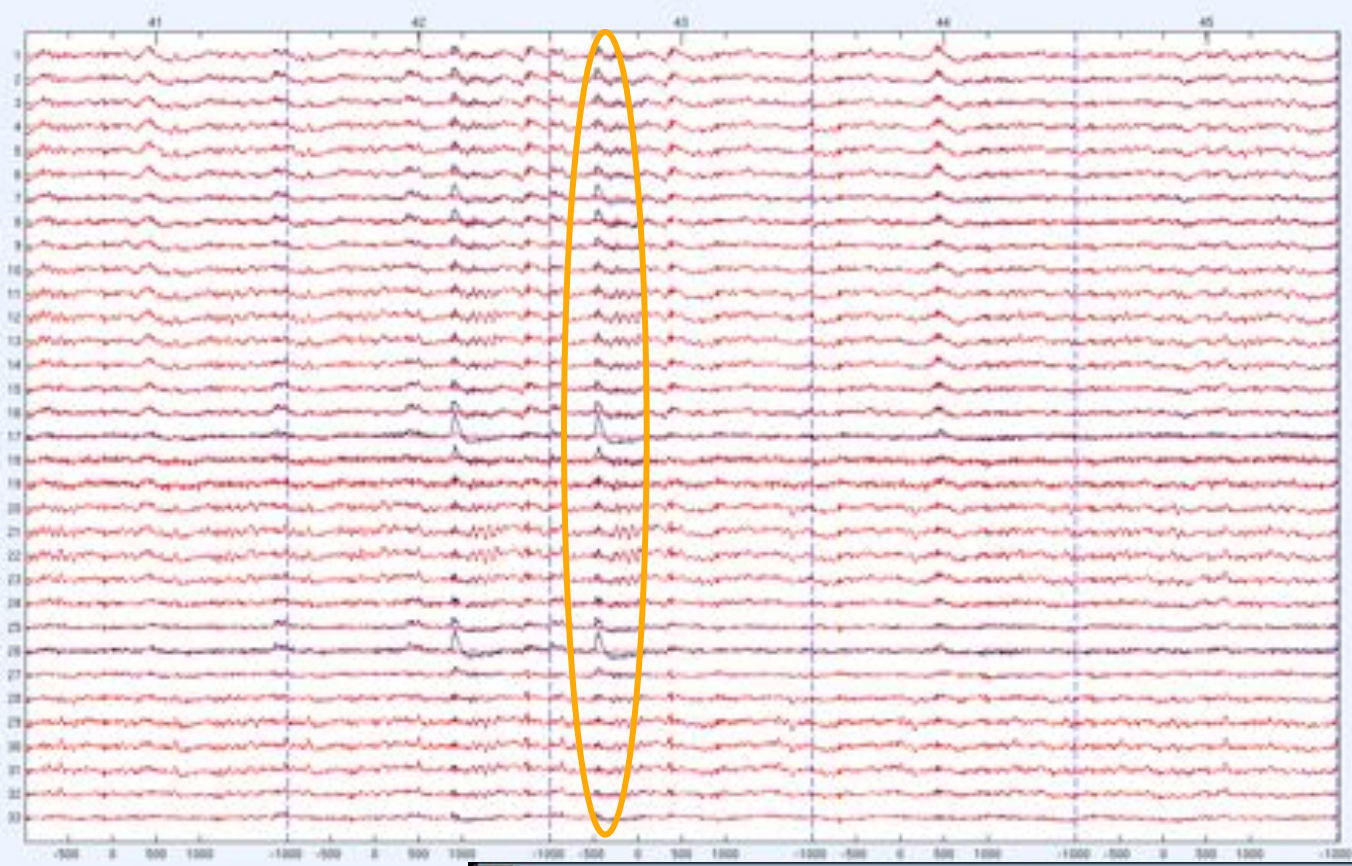


# Eye blink correction



Confirmation

Please confirm. Are you sure you want to remove these components?



Confirmation

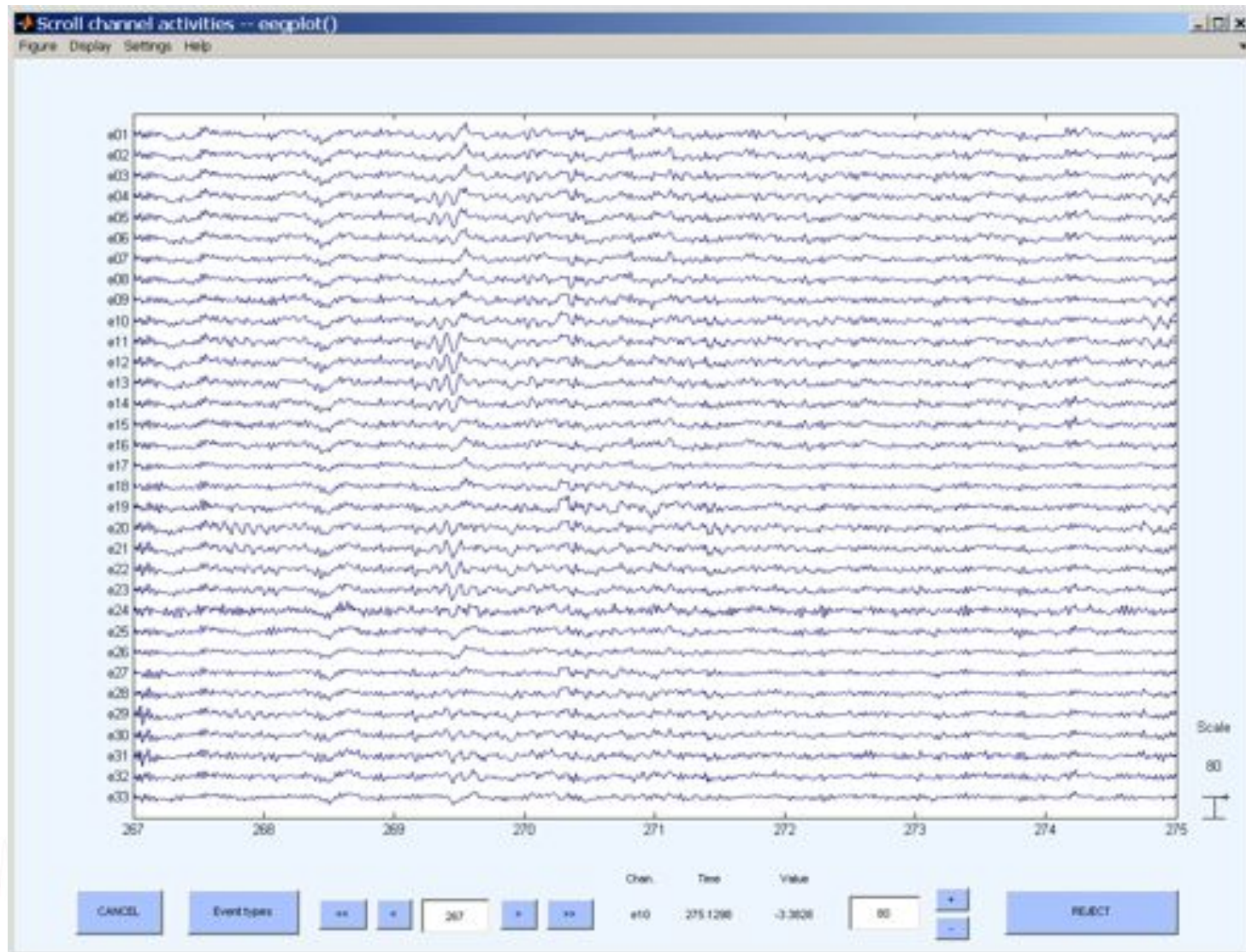
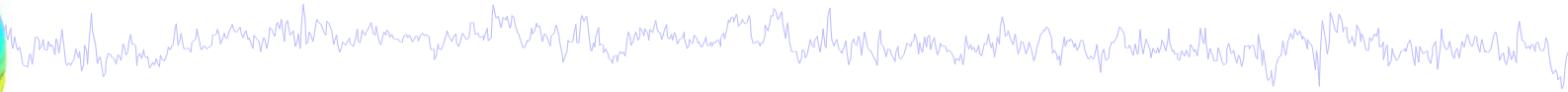
Please confirm. Are you sure you want to remove these components?

Close

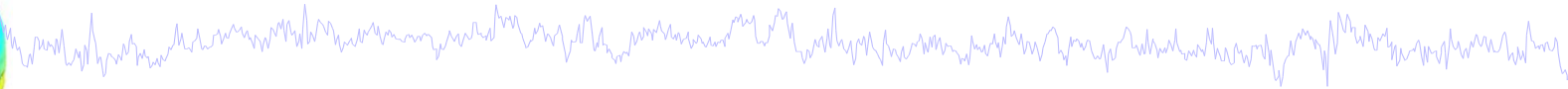
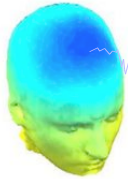
41



# Eye blink correction



# Exercise



- Load `stern_125Hz.set`
- Epoch the data on **memorize** (ie B, C,...) letters
- Find and identify “artifact” ICs
- How can you be sure that an IC is artifact?
- Practice removing a component from the EEG data (do not save this way!). Alternatively, try **KEEPING** just one component. What does the EEG data scroll look like?

