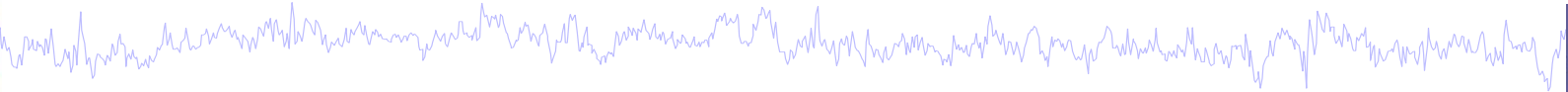


ICA decomposition and component analysis



Task 1

Run ICA

Exercise...

Task 2

Plot components

Identify components

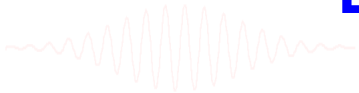
Task 3

Plot component power

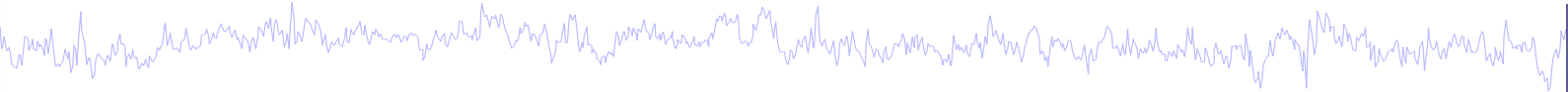
Plot component ERP & erpimages

Plot ERSP/Cross coherence

Exercise...



ICA decomposition and component analysis



Task 1

Run ICA

Exercise...

Task 2

Plot components

Identify components

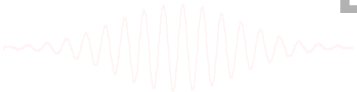
Task 3

Plot component power

Plot component ERP & erpimages

Plot ERSP/Cross coherence

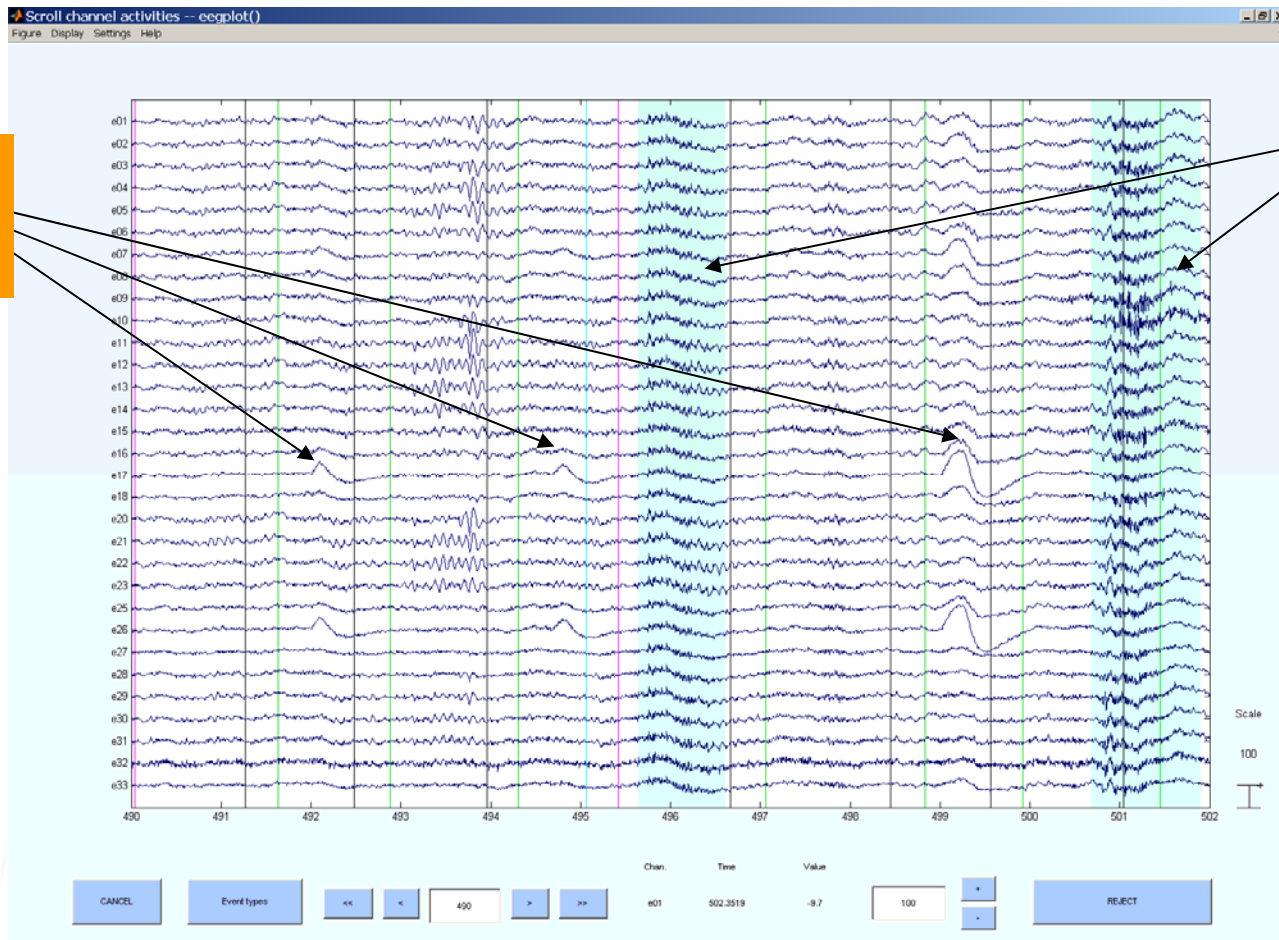
Exercise...



Reject continuous data



To prepare data for ICA, reject 'strange' artifacts but keep stereotyped artifacts!



Stereotyped
eye blinks

Strange

Independent Component Analysis

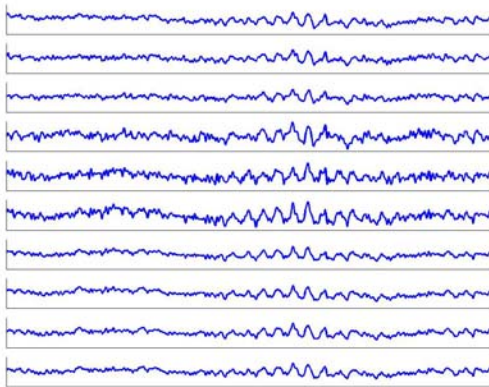


x = scalp EEG

W = unmixing matrix

u = sources

Channels

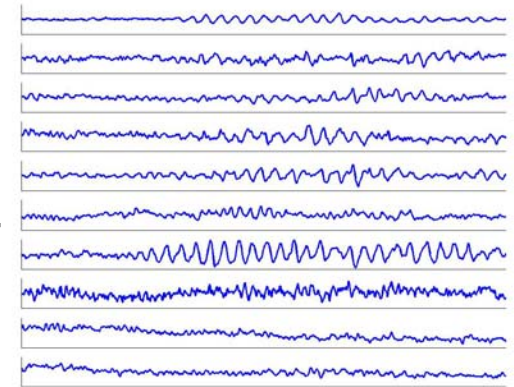


Time

$$W^*x = u$$

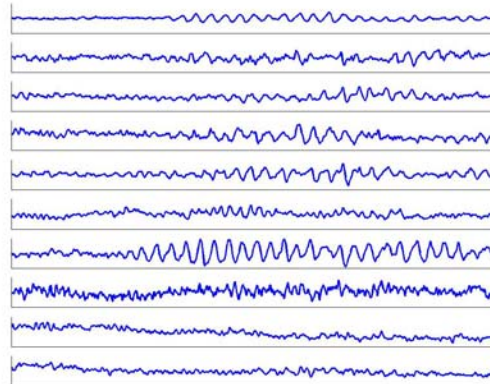
ICA

Components



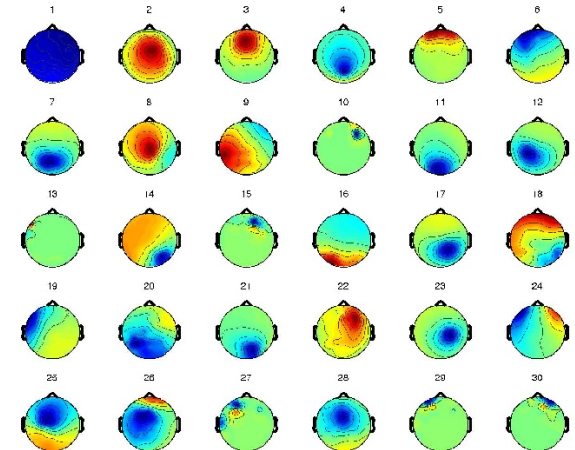
Time

u = sources

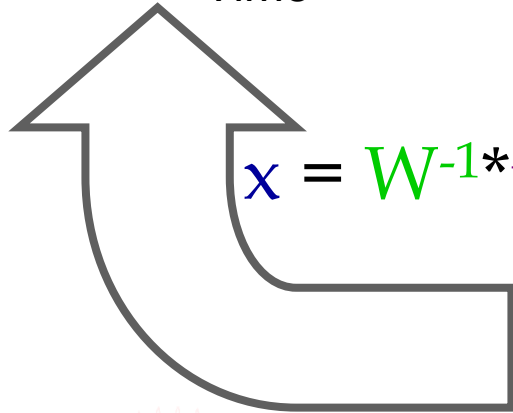


*

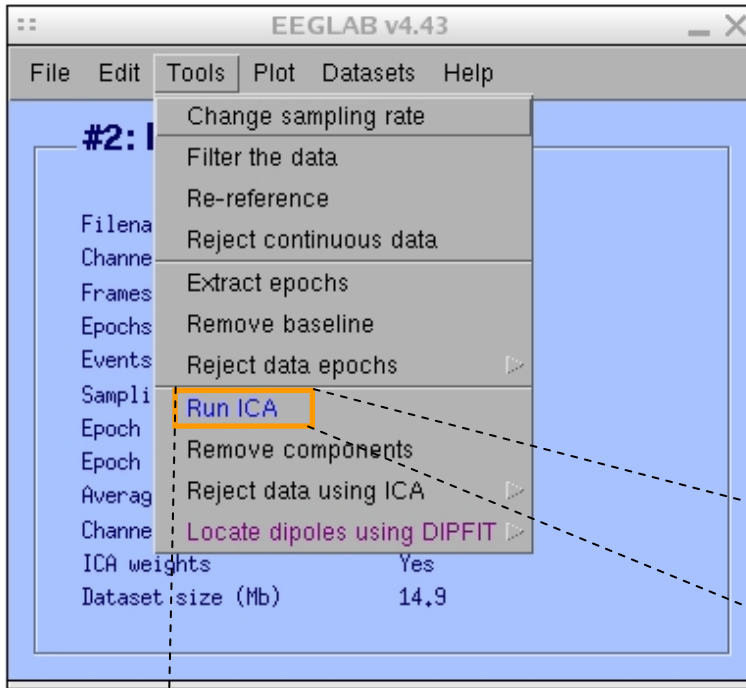
W^{-1} (scalp projections)



ICA Components

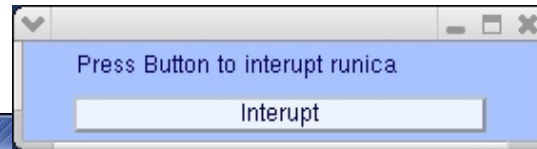


Runica/binica options



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	Should not need more?
'pca'	0 or EEG.nbchan	Decompose only a principal data subspace

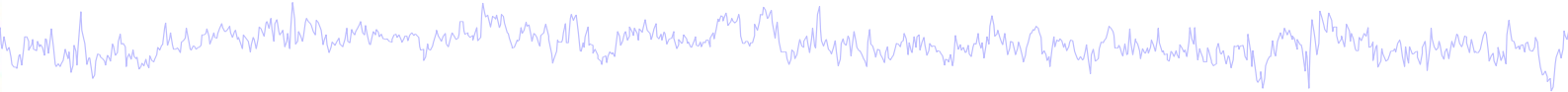
Runica Progress...



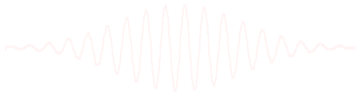
```
Input data size [33,133175] = 33 channels, 133175 frames/nFinding 33 ICA components using extended ICA.
Kurtosis will be calculated initially every 1 blocks using 6000 data points.
Decomposing 122 frames per ICA weight ((1089)^2 = 133175 weights, Initial learning rate will be 0.001, block size
Learning rate will be multiplied by 0.98 whenever angledelta >= 60 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 179,094
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 16.85061324, angledelta 0.0 deg
step 2 - lrate 0.001000, wchange 0.26760405, angledelta 0.0 deg
step 3 - lrate 0.001000, wchange 0.79058323, angledelta 104.0 deg
step 4 - lrate 0.000980, wchange 0.66700031, angledelta 147.2 deg
step 5 - lrate 0.000960, wchange 0.62849071, angledelta 146.5 deg
step 6 - lrate 0.000941, wchange 0.73967955, angledelta 150.7 deg
step 7 - lrate 0.000922, wchange 0.73727229, 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 143.7 deg
step 11 - lrate 0.000851, wchange 0.14690114, angledelta 102.5 deg
step 12 - lrate 0.000834, wchange 0.11822100, angledelta 114.3 deg
step 13 - lrate 0.000817, wchange 0.75552966, angledelta 100.6 deg
step 14 - lrate 0.000801, wchange 0.26739750, angledelta 109.1 deg
step 15 - lrate 0.000785, wchange 0.12123251, 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
```

```
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 96.9 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 0.00000023, 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 99.1 deg
step 259 - lrate 0.000001, wchange 0.00000019, 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 99.0 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 ...
>>
>>
```

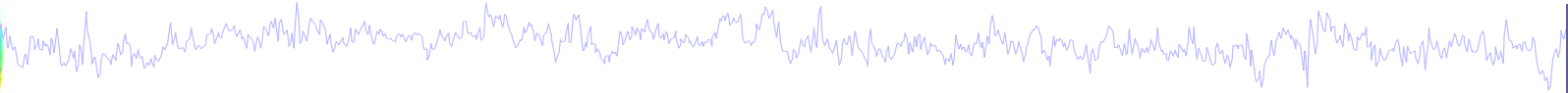
Exercise



- Load dataset '**faces_3.set**' from '**../data/**' directory
- Reject noise from continuous or epoched data
- Run ICA



ICA decomposition and component analysis



Task 1

Run ICA

Exercise...

Task 2

Plot components

Identify components

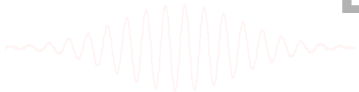
Task 3

Plot component power

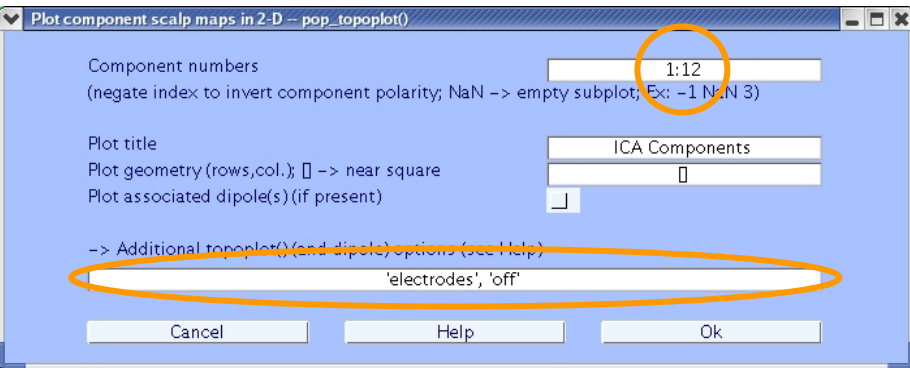
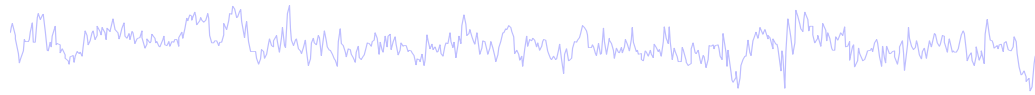
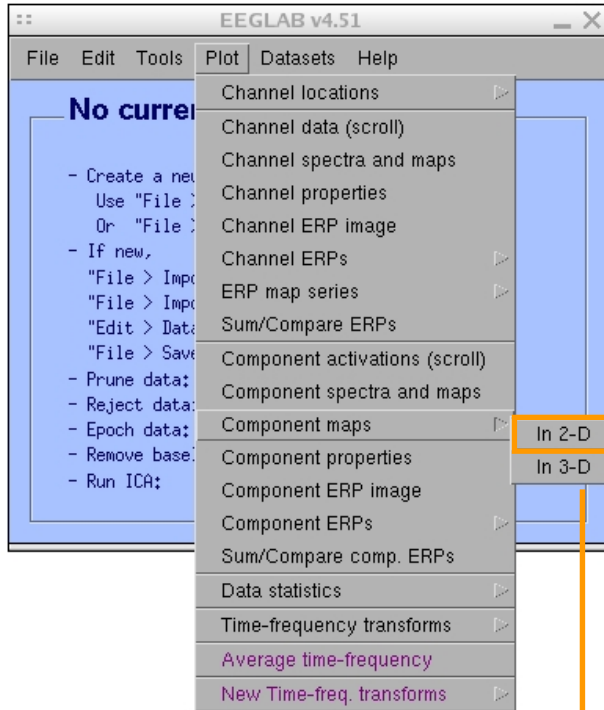
Plot component ERP & erpimages

Plot ERSP/Cross coherence

Exercise...



Plot ICA scalp maps



>>
>>
>> help topoplot

topoplot() plot a topographic map of a scalp data field in a 2-D circular view (looking down at the top of the head) using interpolation on a fine cartesian grid. Can also show specified channel location(s), or return an interpolated value at an arbitrary scalp location (see 'noplots'). By default, channel locations below head center (arc_length 0.5) are shown in a 'skirt' outside the cartoon head (see 'plotrad' and 'headrad' options below). Nose is at top of plot; left is left; right is right. Using option 'plotgrid', the plot may be one or more rectangular grids.

Usage:

```
>> topoplot(datavector, EEG.chanlocs); % plot a map using an EEG chanlocs structure
>> topoplot(datavector, 'my_chan.locs'); % read a channel locations file and plot a map
>> topoplot('example'); % give an example of an electrode location file
>> [h grid_or_val plotrad_or_grid, xmesh, ymesh]= ...
    topoplot(datavector, chan_locs, 'Input1','Value1', ...);
```

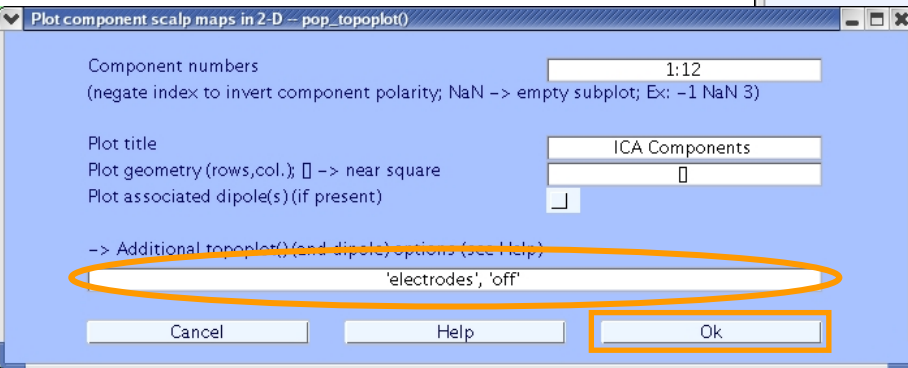
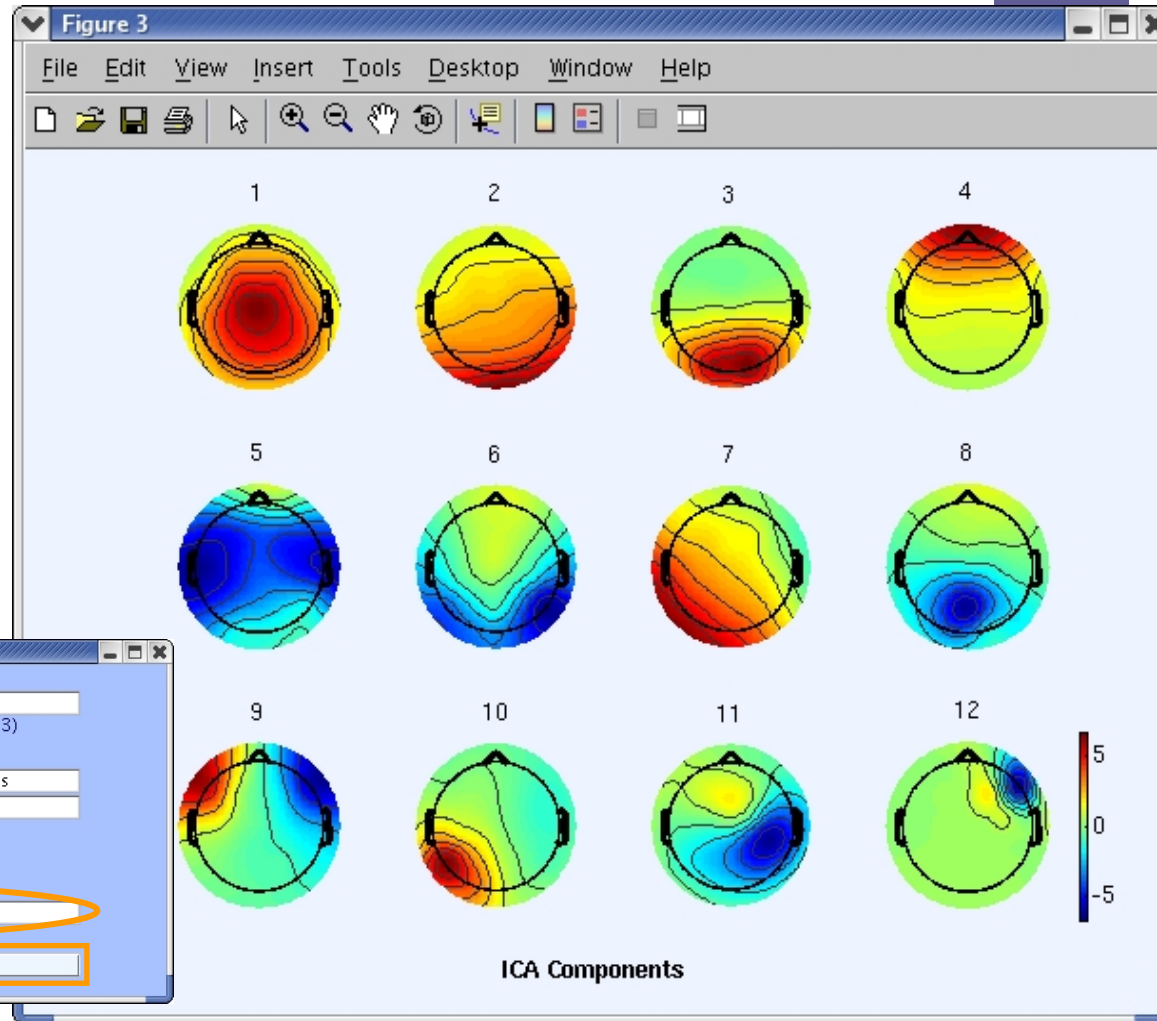
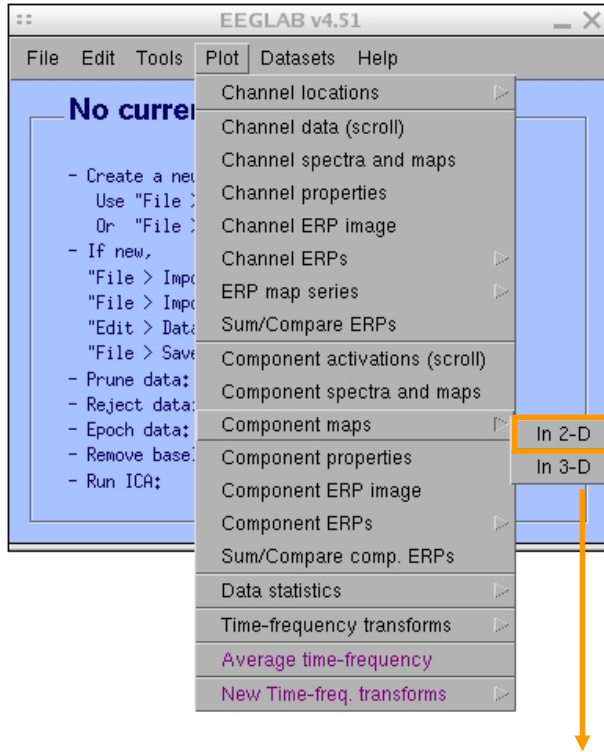
Required Inputs:

- datavector - single vector of channel values. Else, if a vector of selected subset (int) channel numbers -> mark their location(s) using 'style' 'blank'.
- chan_locs - name of an EEG electrode position file (>> topoplot example). Else, an EEG.chanlocs structure (>> help pop_editset)

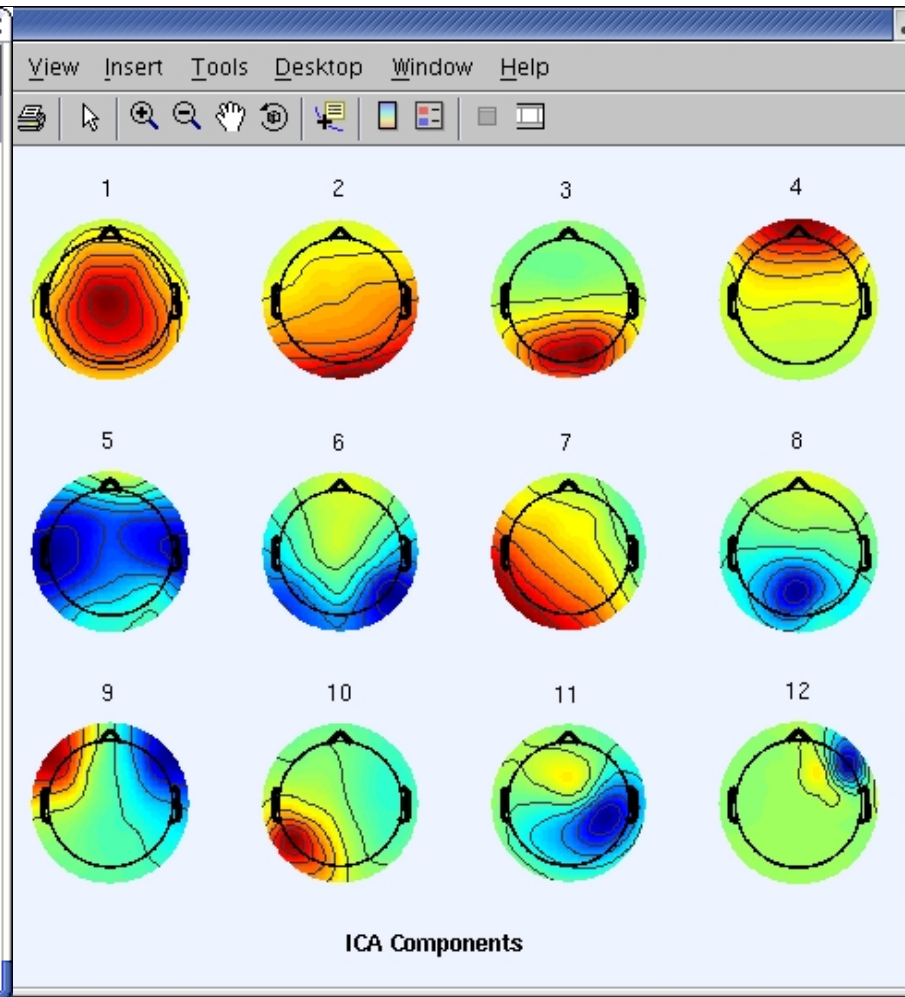
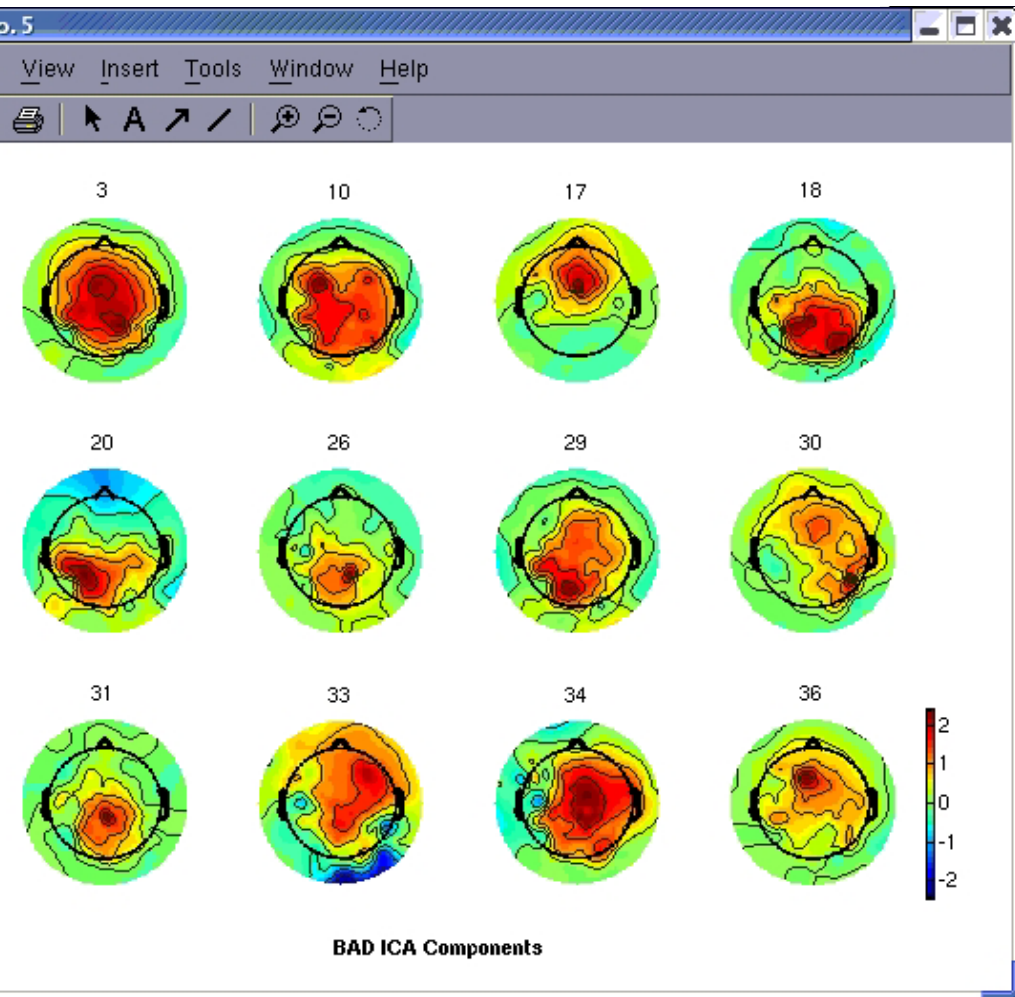
Optional inputs:

- 'maplimits' - 'absmax' -> scale map colors to +/- the absolute-max (makes green 0); 'maxmin' -> scale colors to the data range (makes green mid-range); [lo,hi] -> use user-defined lo/hi limits (default: 'absmax')
- 'style' - 'map' -> plot colored map only; 'contour' -> plot contour lines only; 'both' -> plot both colored map and contour lines; 'fill' -> plot constant color between contour lines; 'blank' -> plot electrode locations only (default: 'both')
- 'electrodes' - 'on', 'off', 'labels', 'numbers', 'ptslabels', 'ptsnumbers'. To set the 'pts' marker, see 'Plot detail options' below. (default: 'on' -> mark electrode locations with points ('.') unless more than 64 channels, then 'off').
- 'plotchans' - vector of channel indices to use in making the head plot. (default: [] -> plot all chans)
- 'plotgrid' - [channels] Plot channel data in one or more rectangular grids, as specified by [channels], a position matrix of channel numbers defining the topographic locations of the channels in the grid. Zero values are given the figure background color; negative integers, the color of the

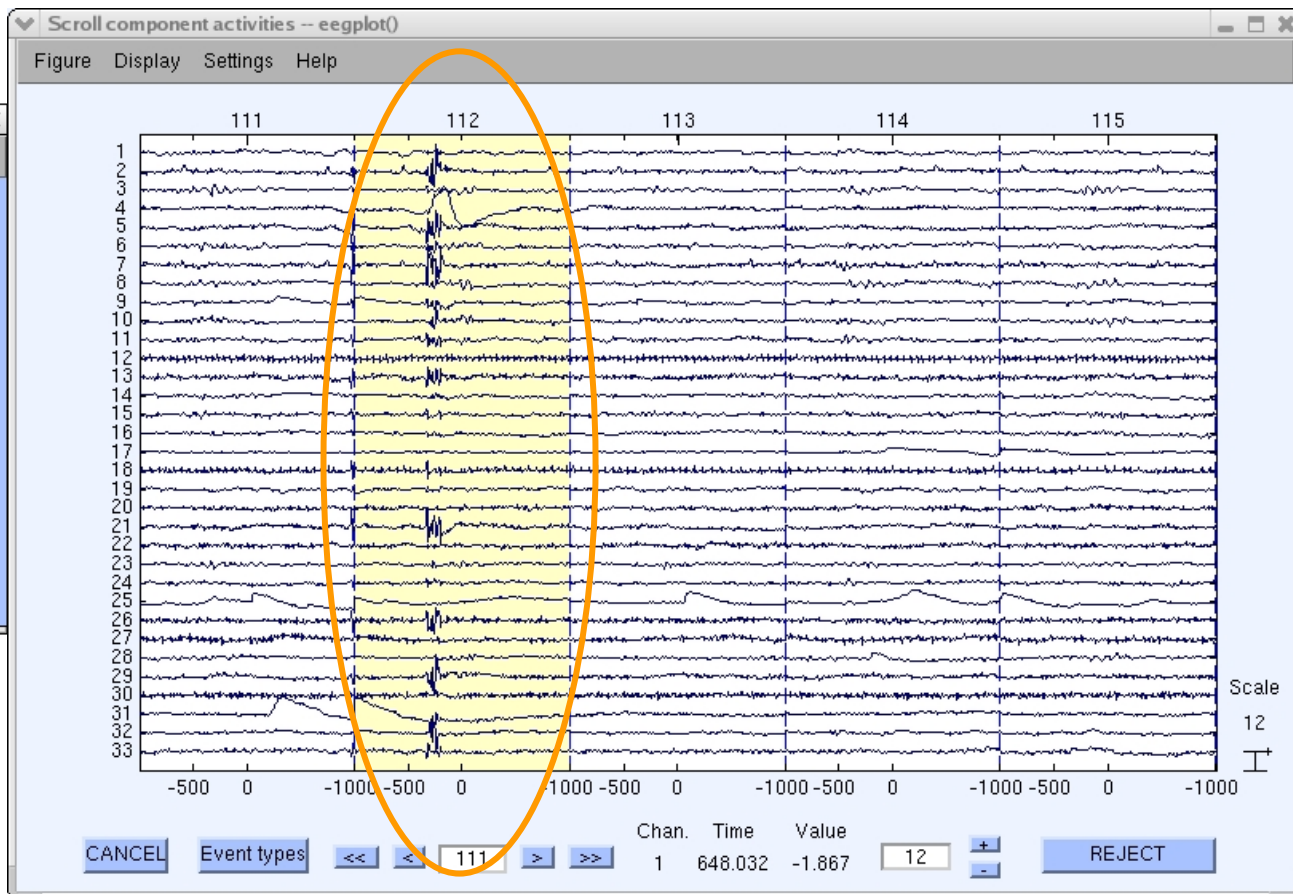
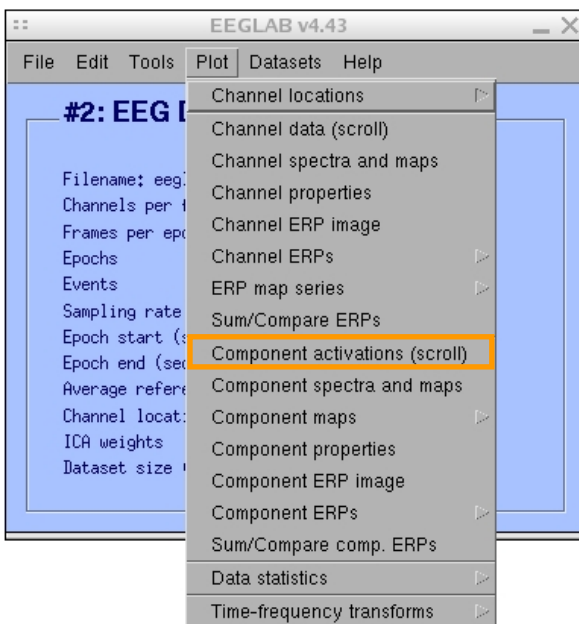
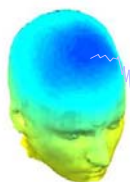
Plot ICA scalp maps



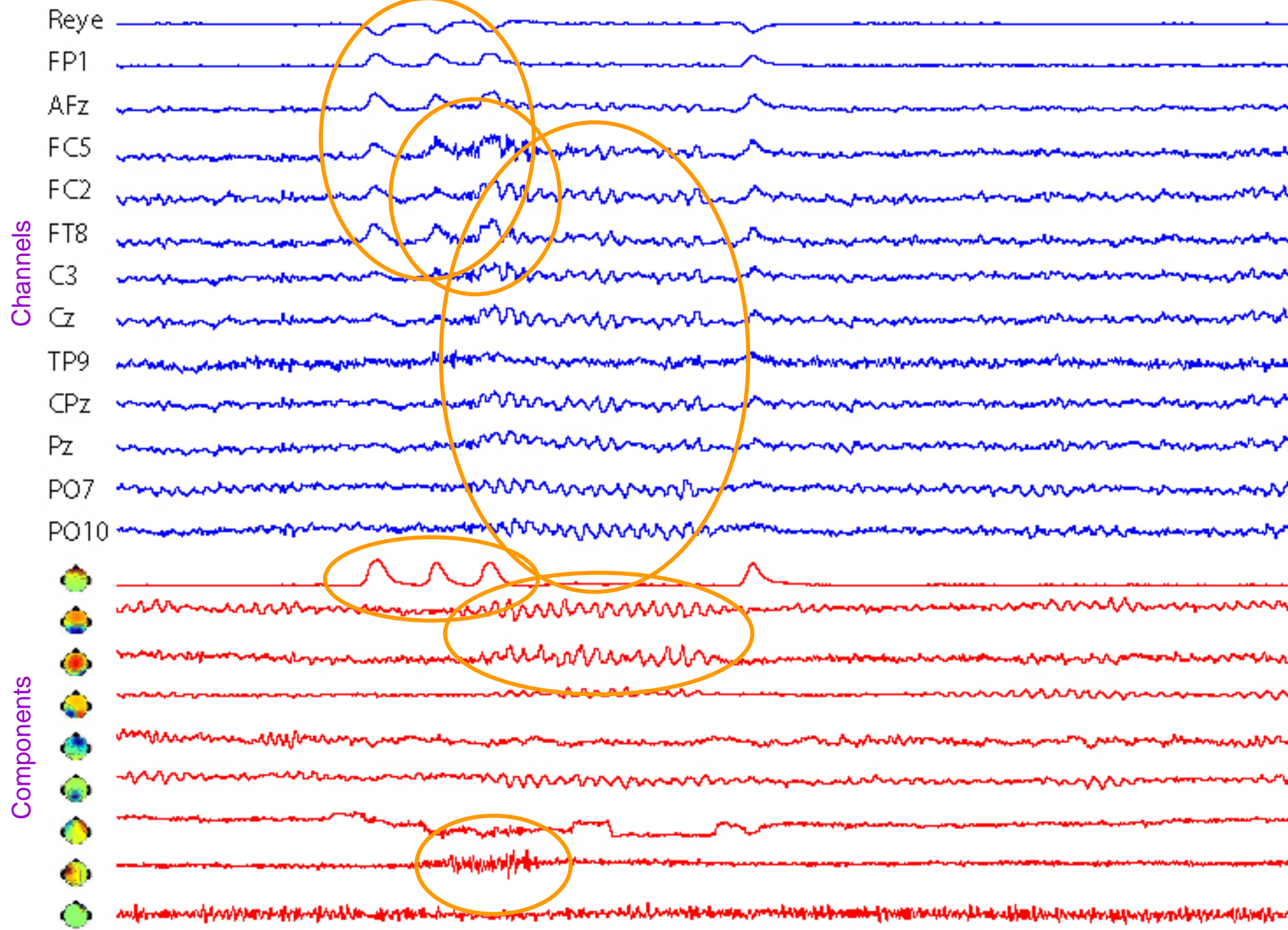
Compare 'good' and 'bad' scalp maps



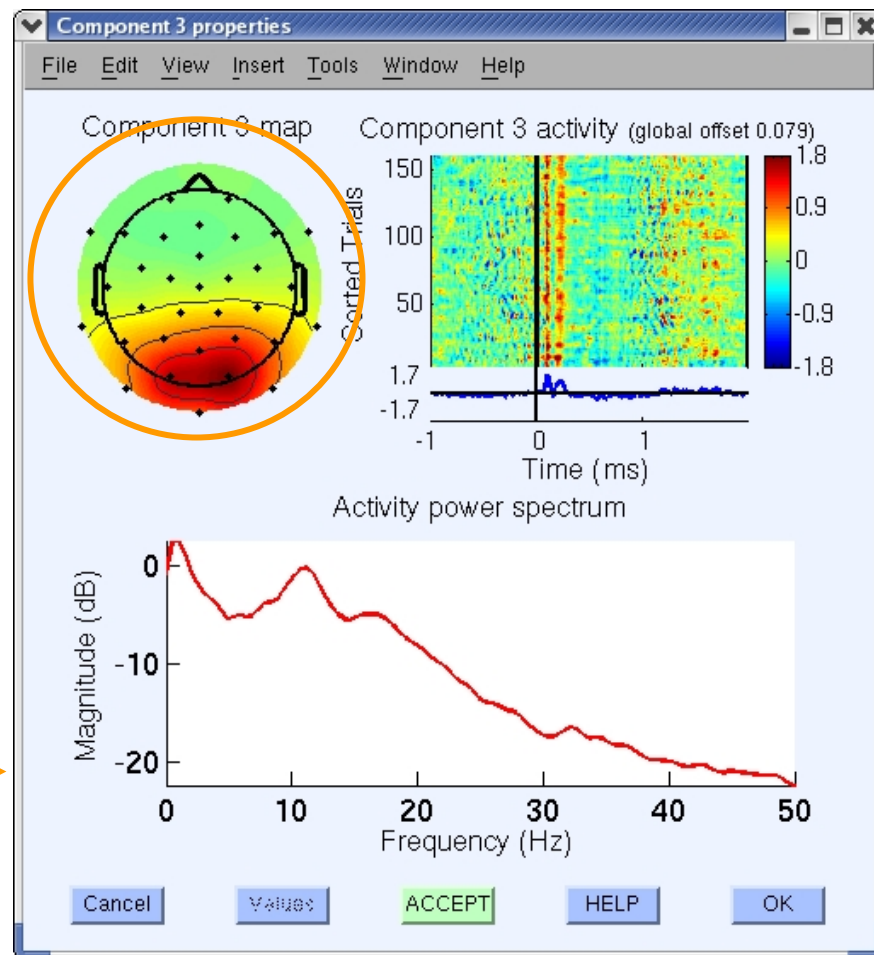
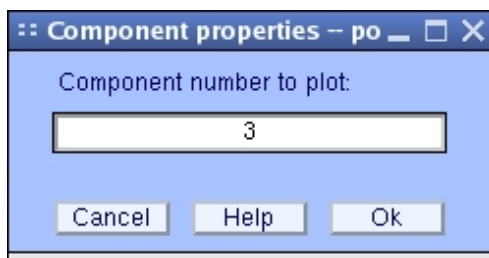
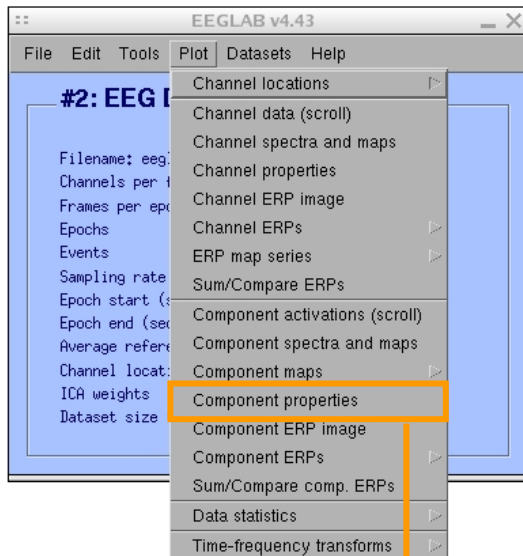
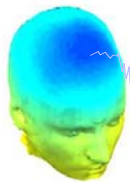
Scroll component activities



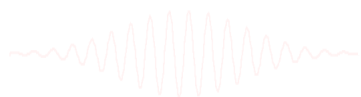
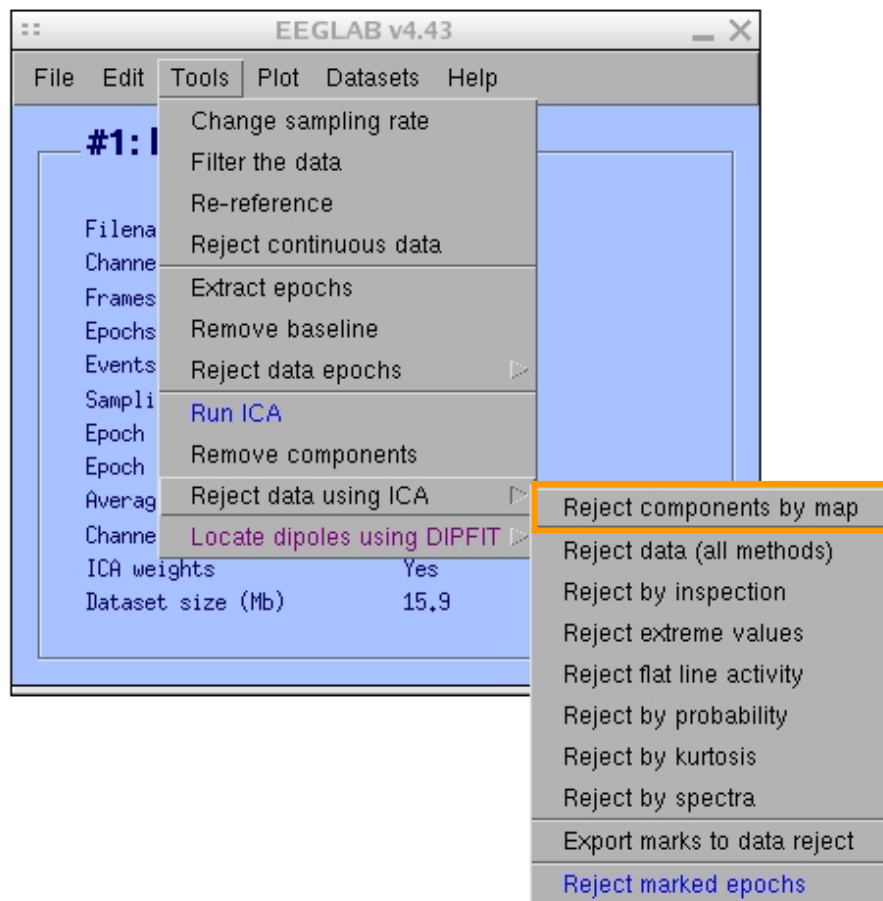
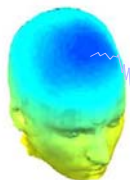
Note: Activity like this, *not* separated by ICA, should be removed and ICA run again for better decomposition



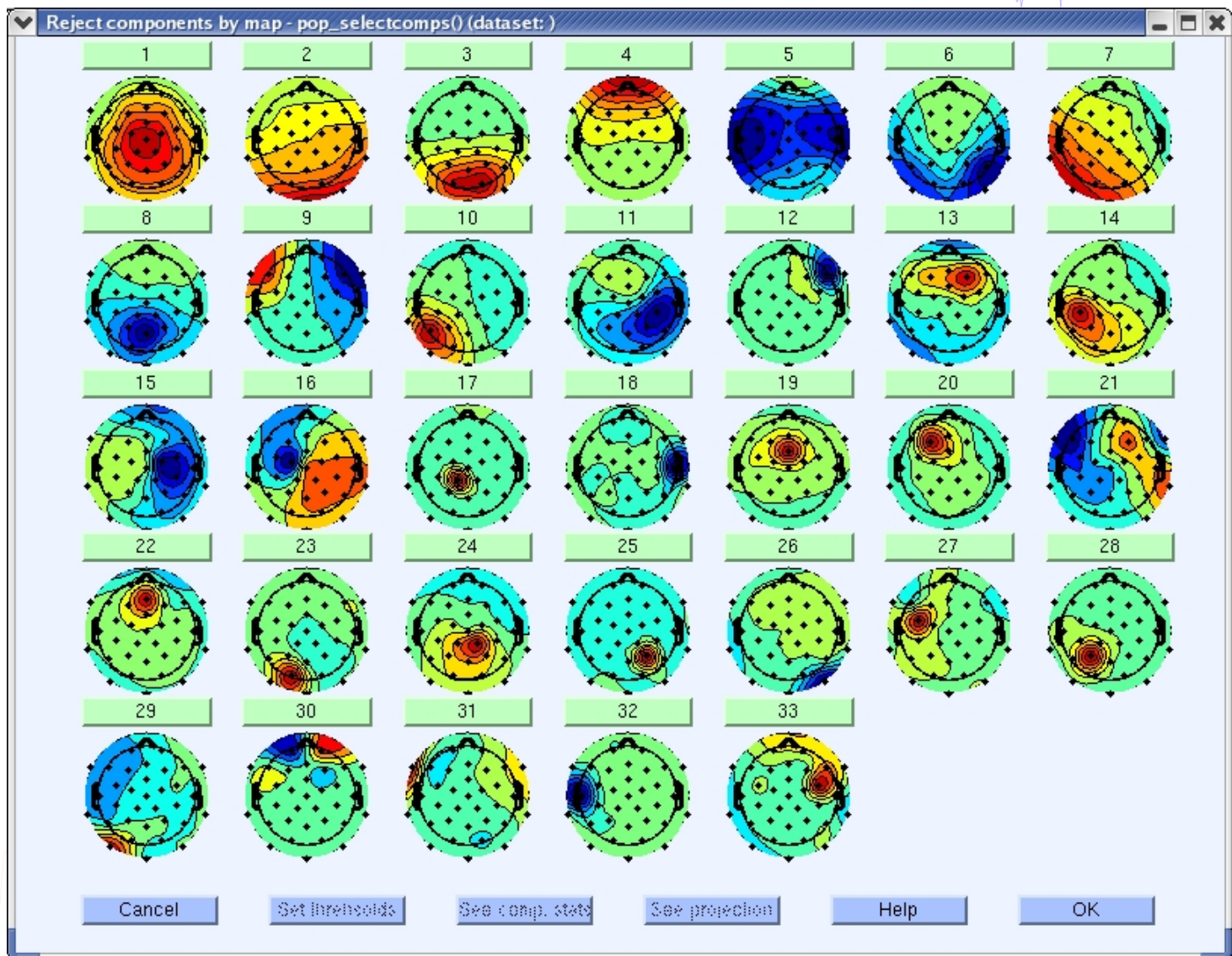
Plot ICA component properties

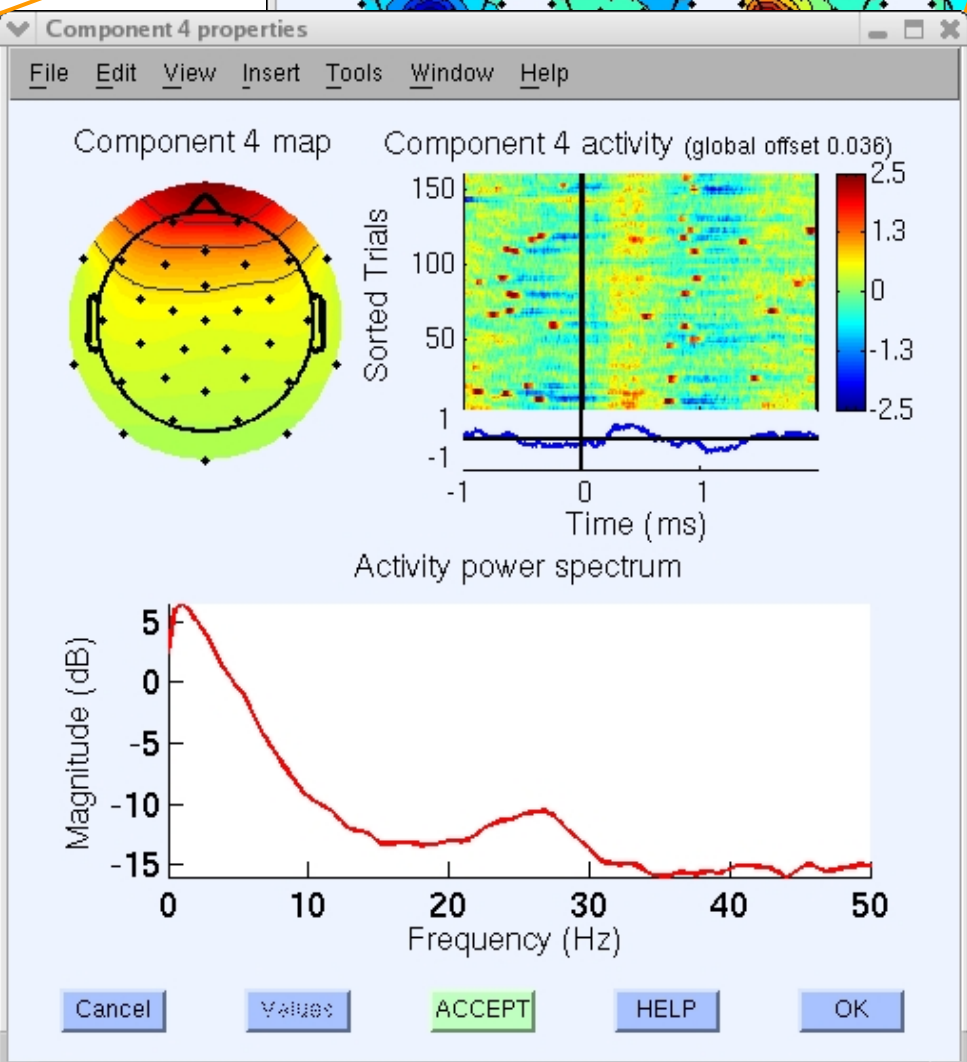
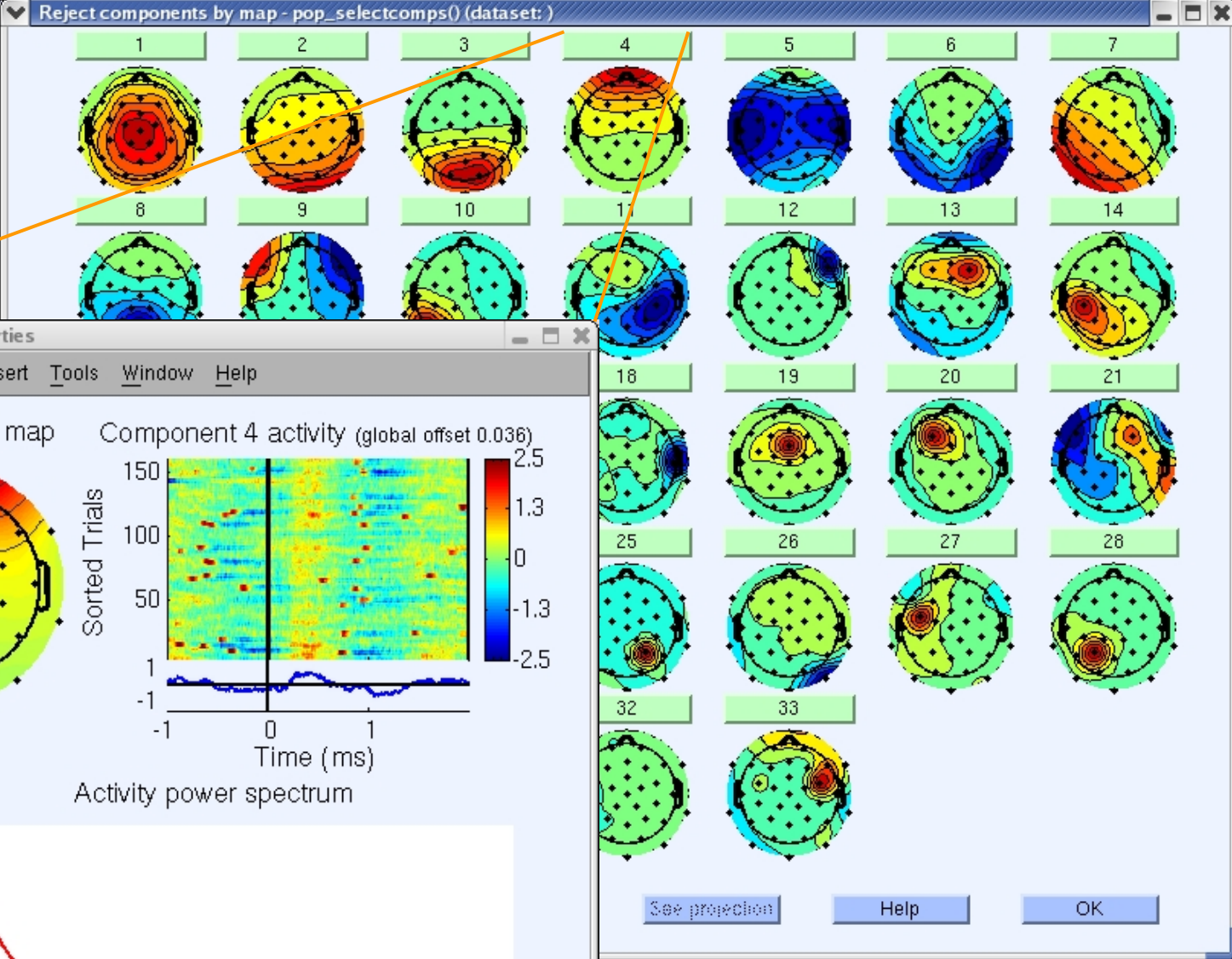


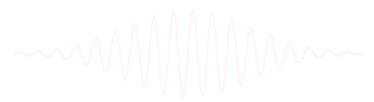
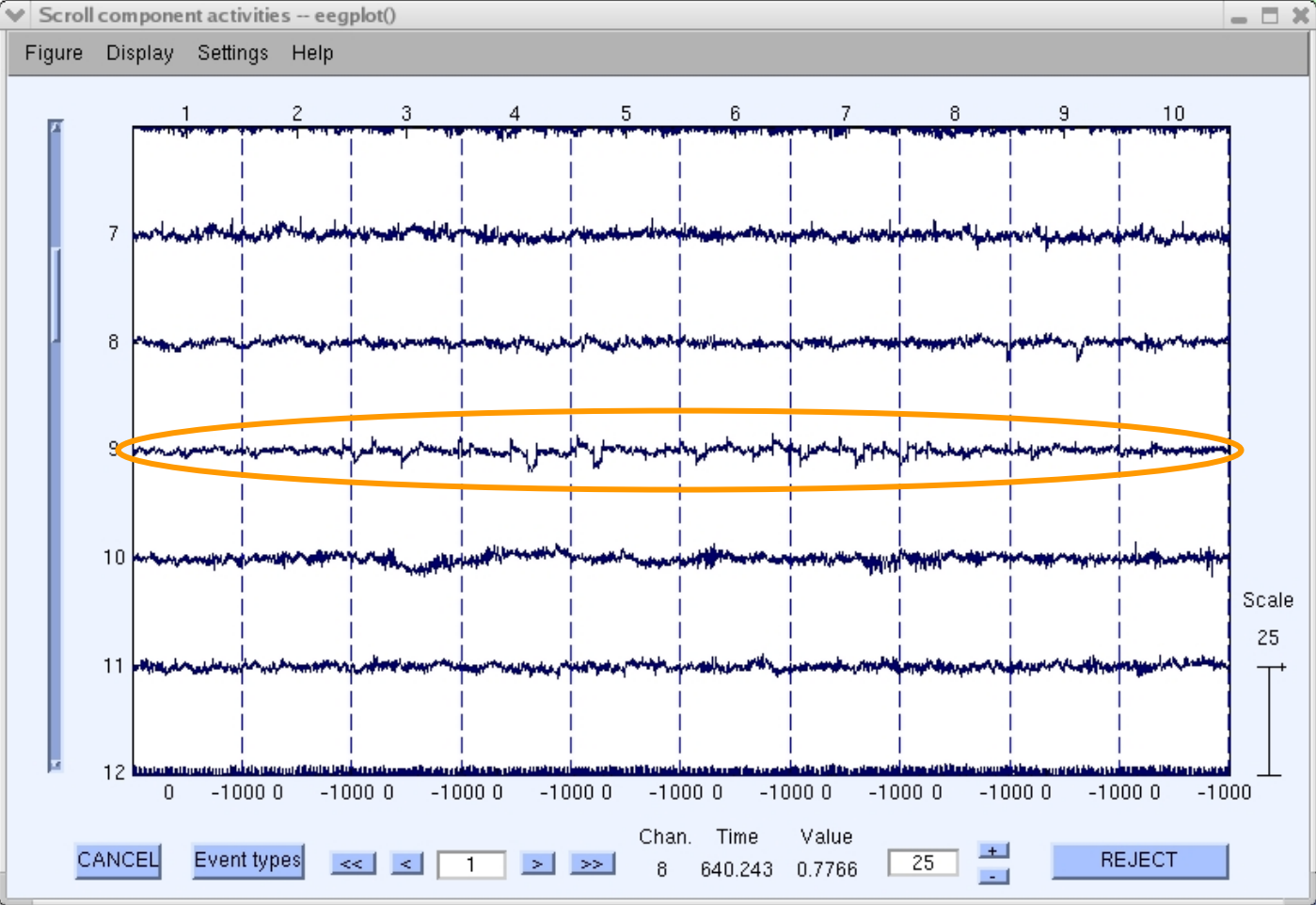
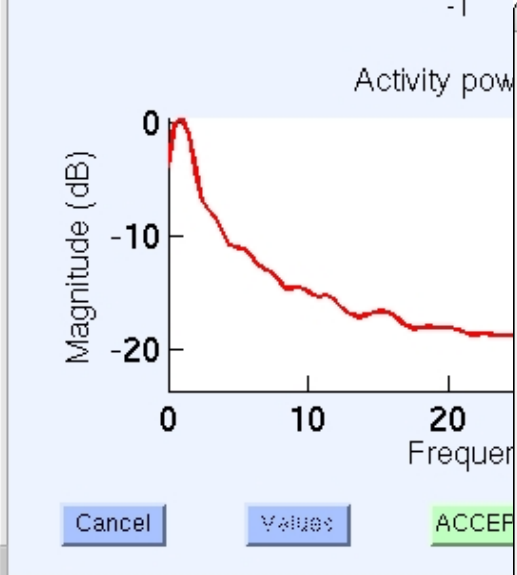
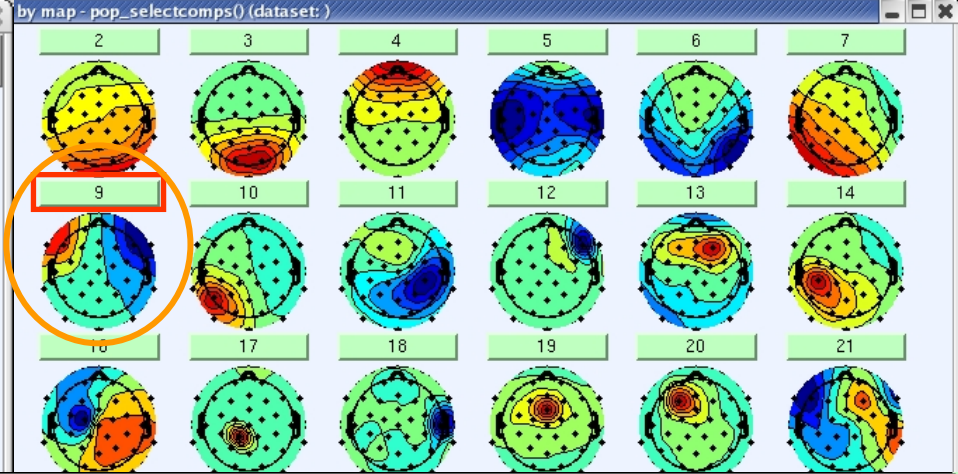
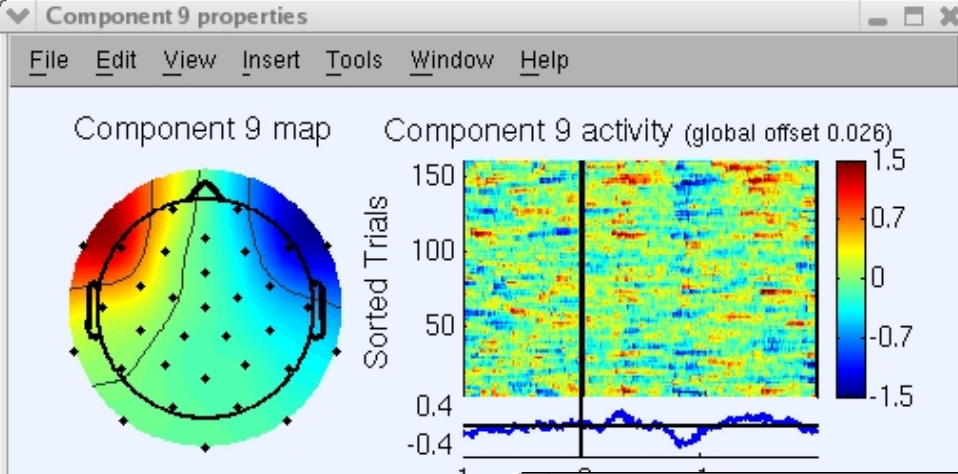
Reviewing component properties

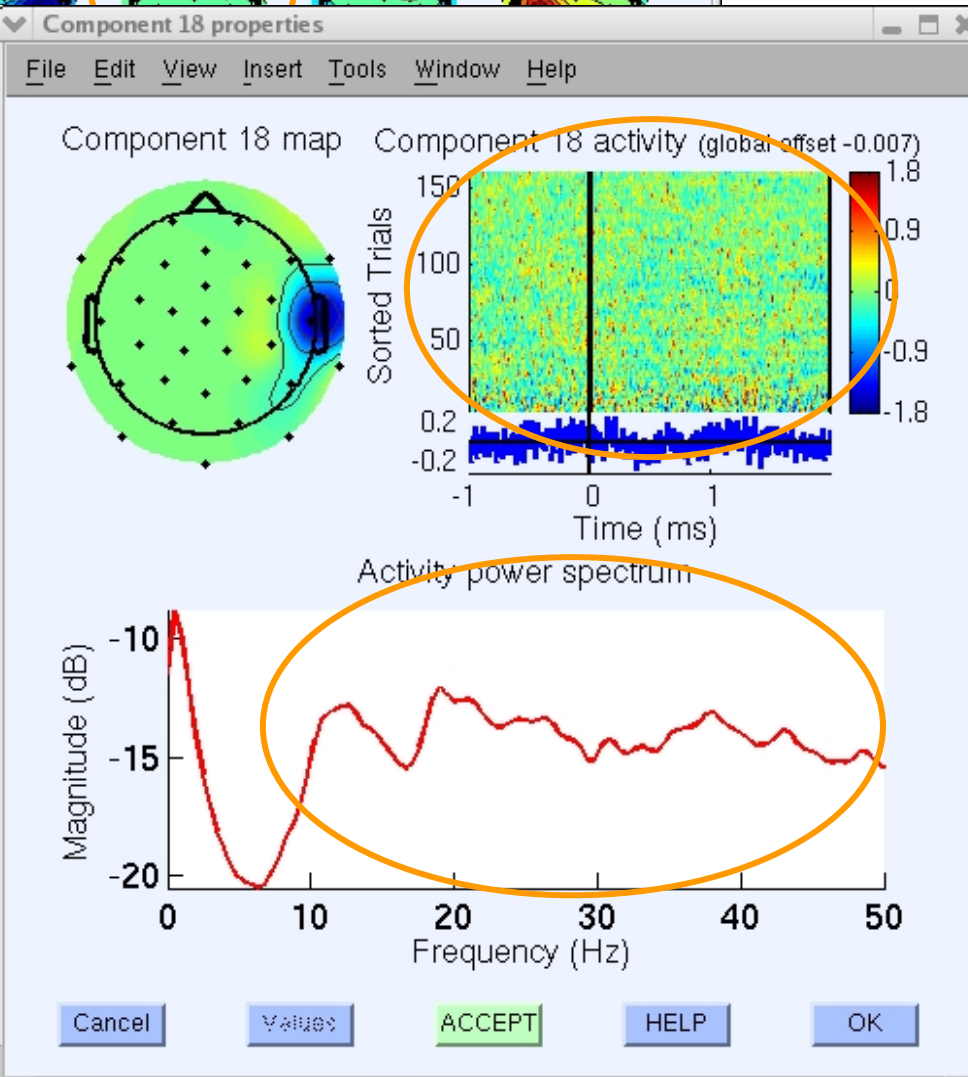
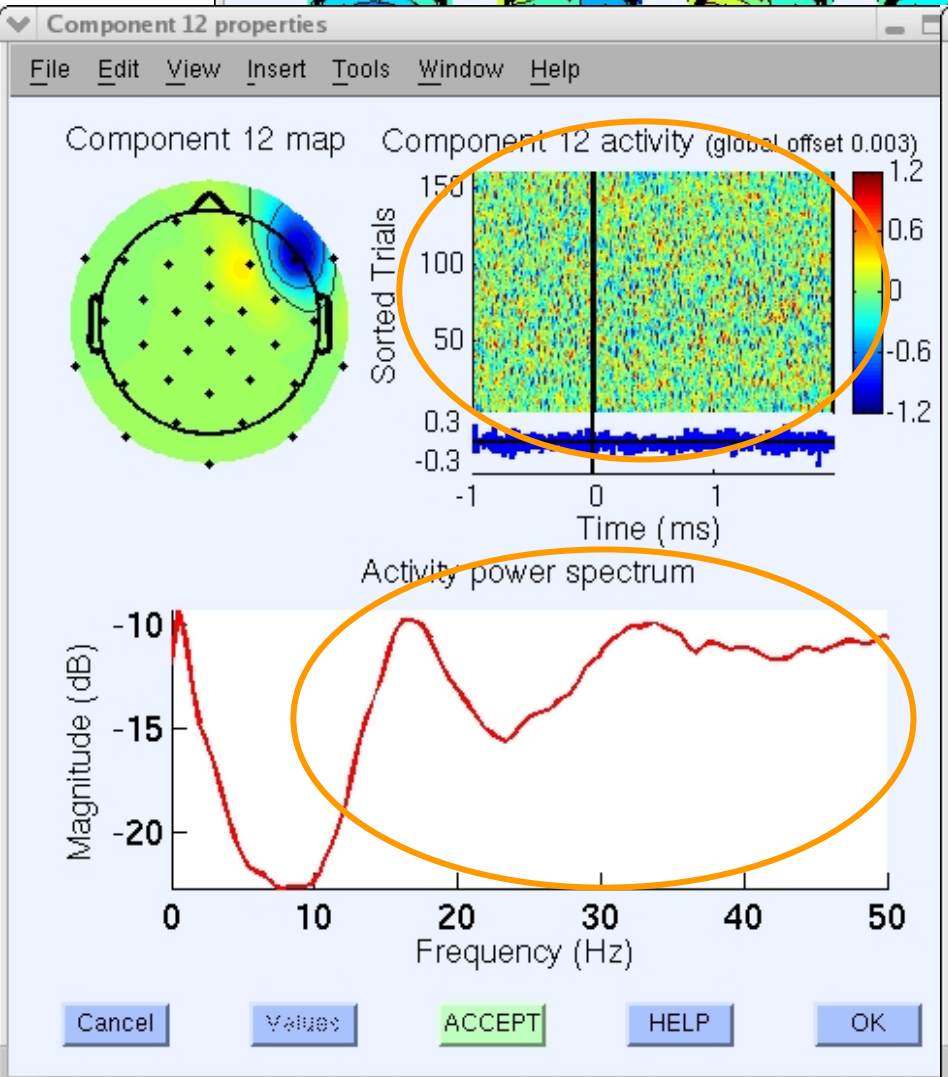
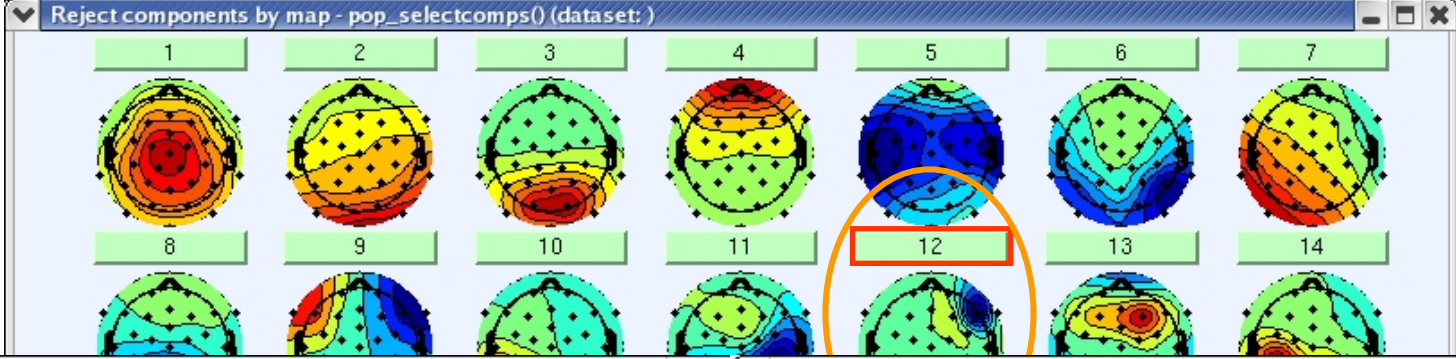


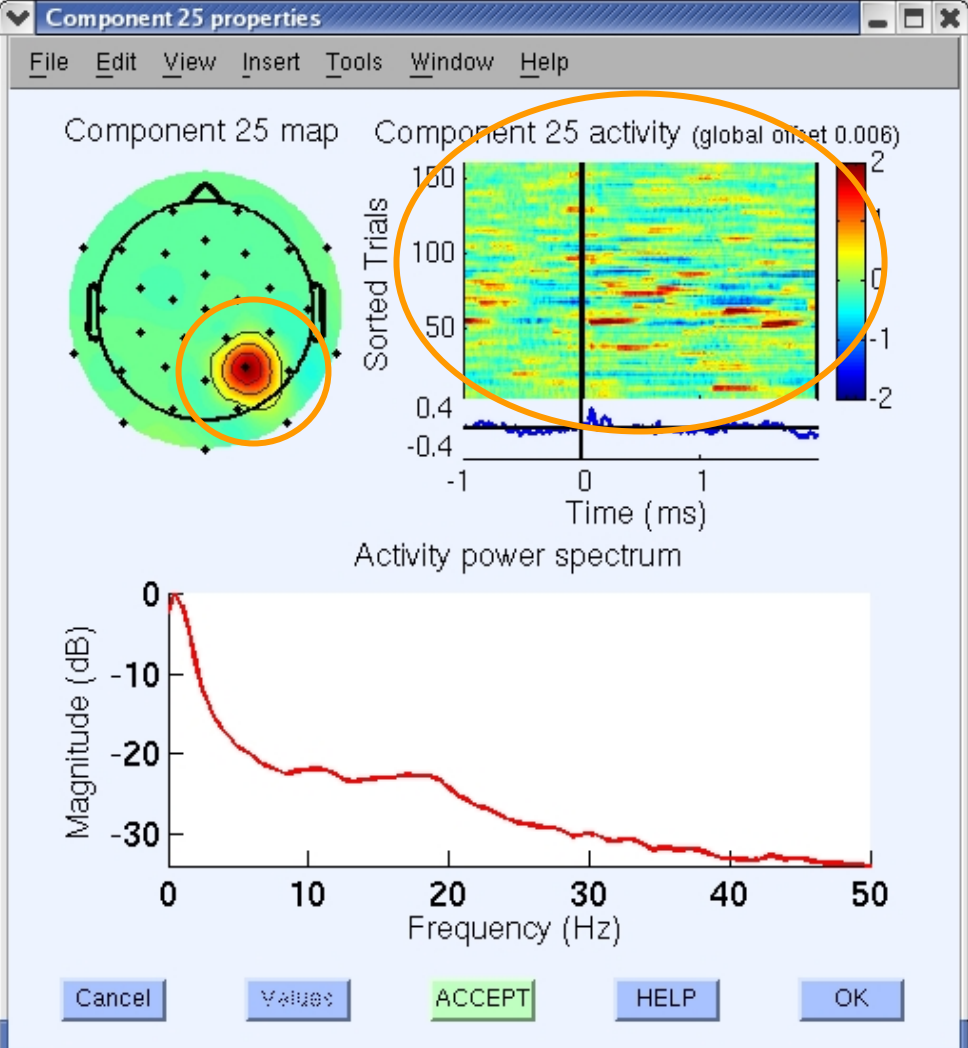
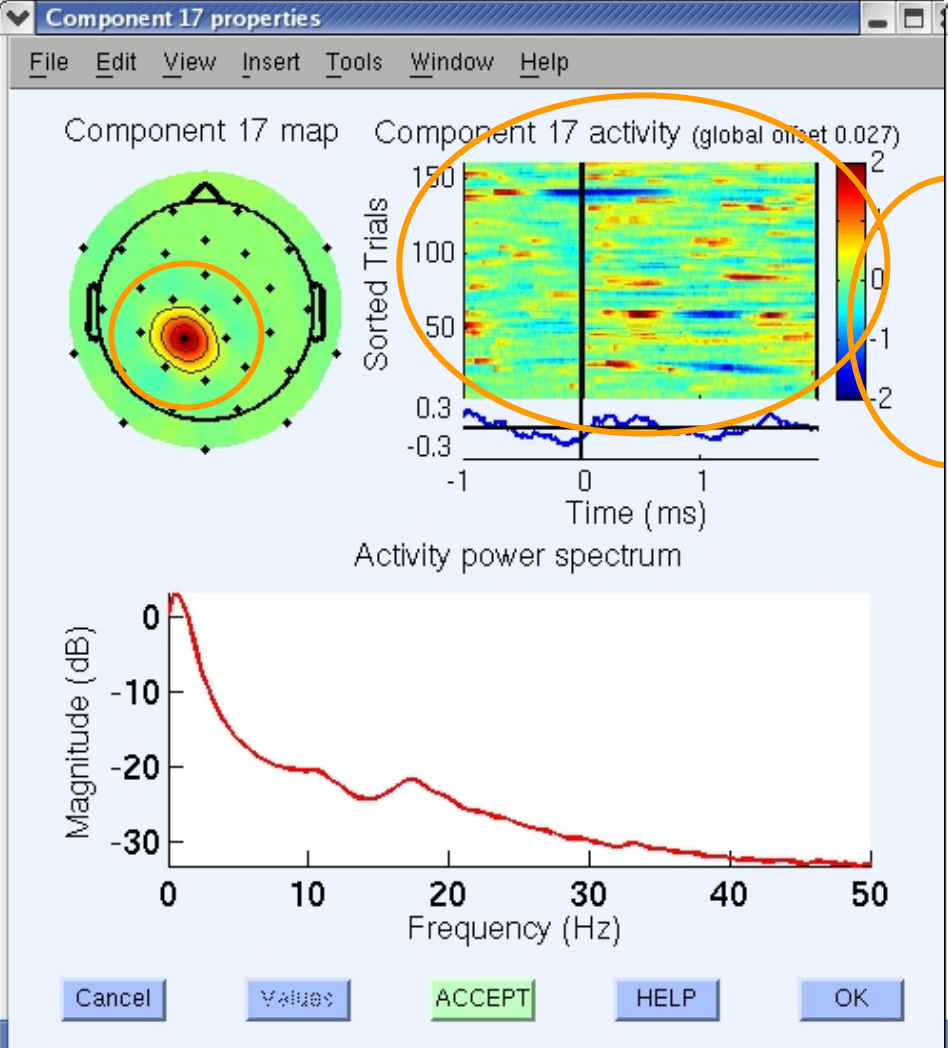
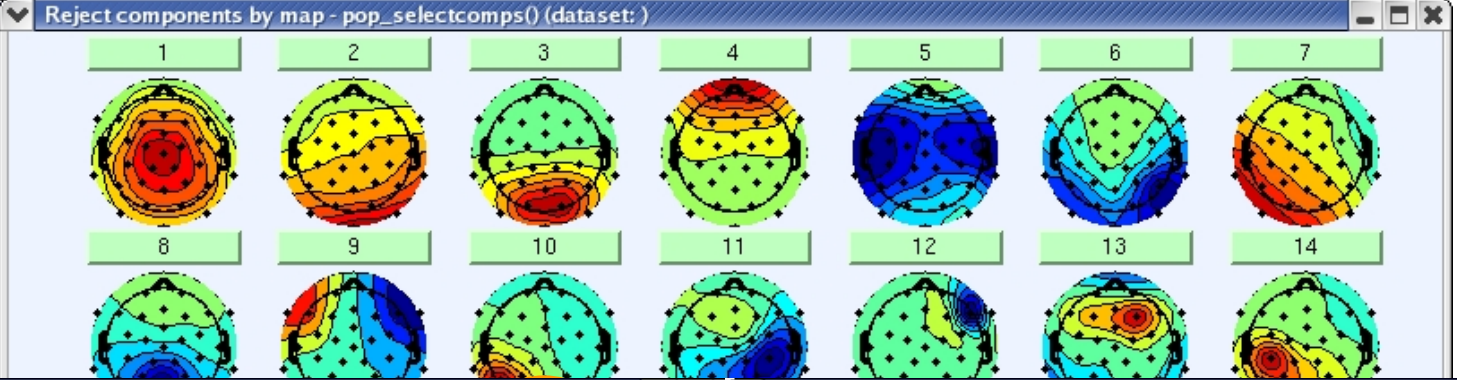
Component scalp maps/properties

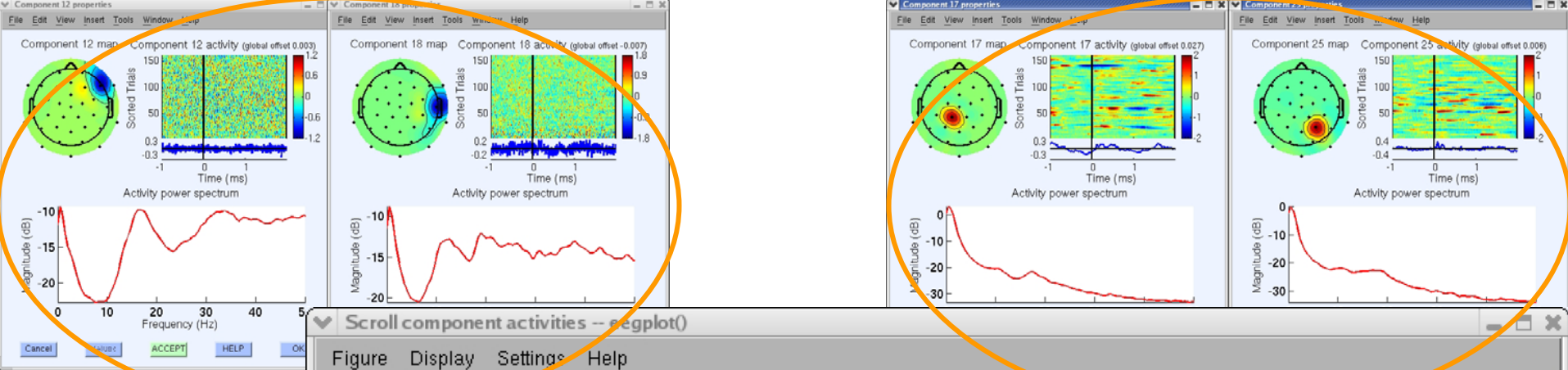






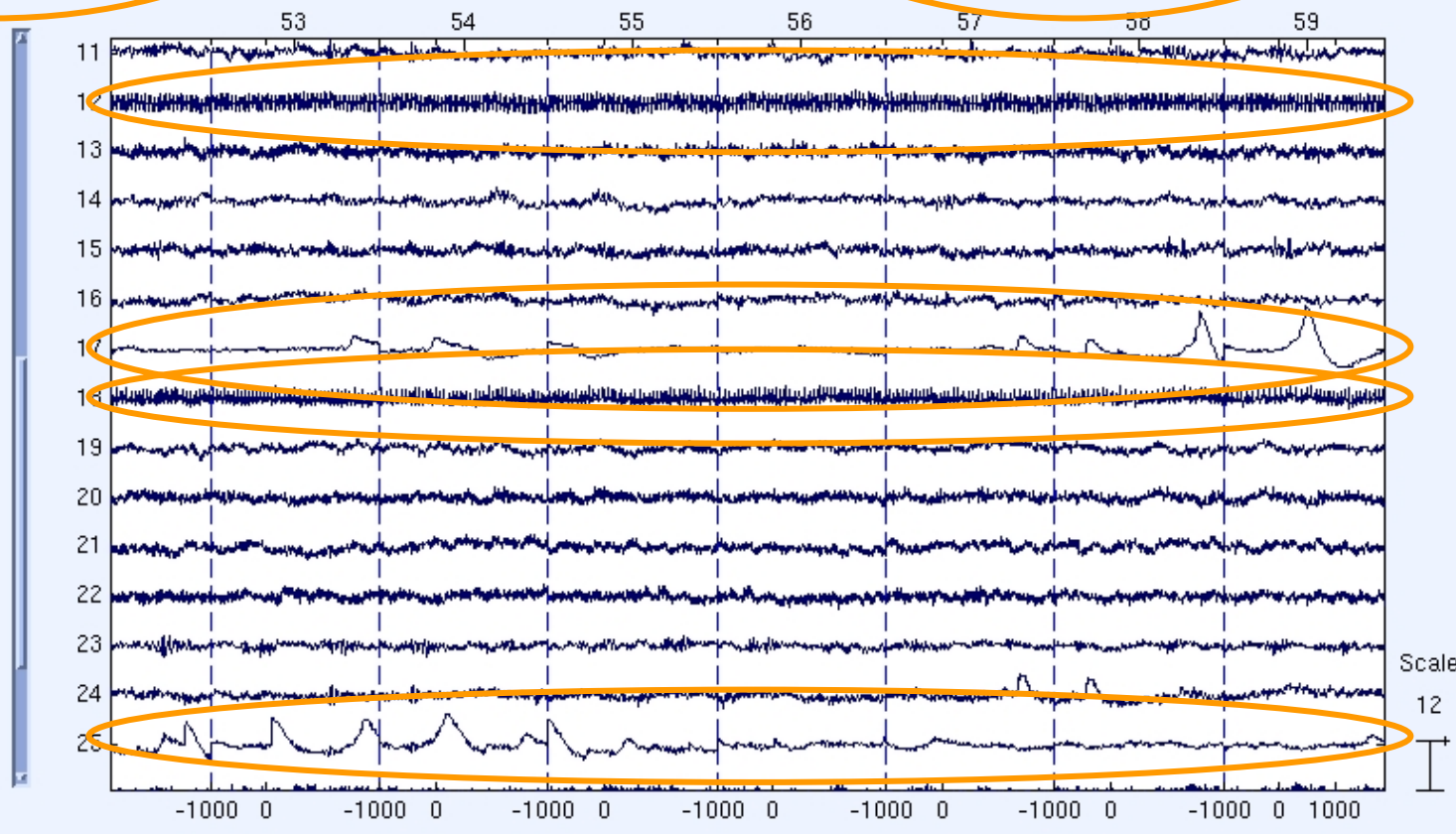






Scroll component activities -- eegplot()

Figure Display Settings Help



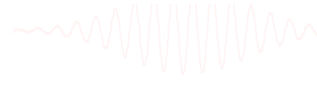
EEGLAB v4.43

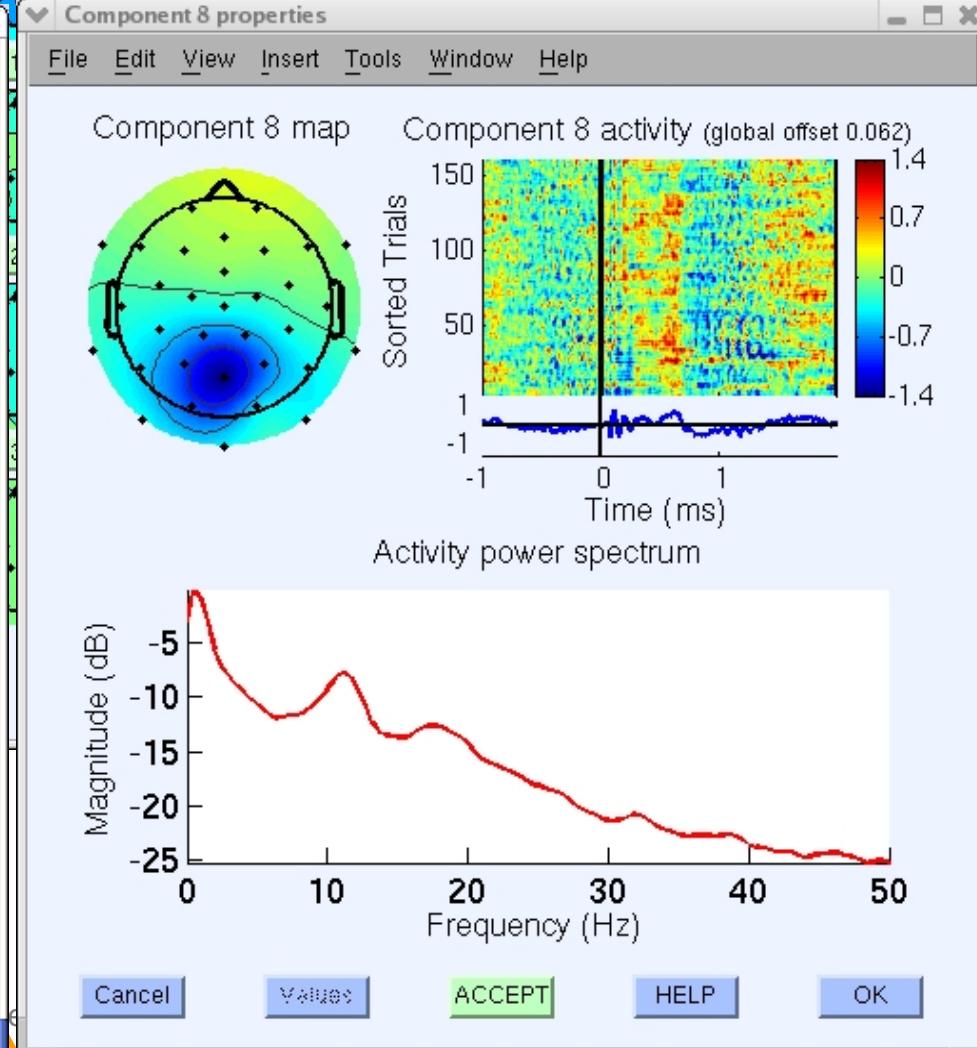
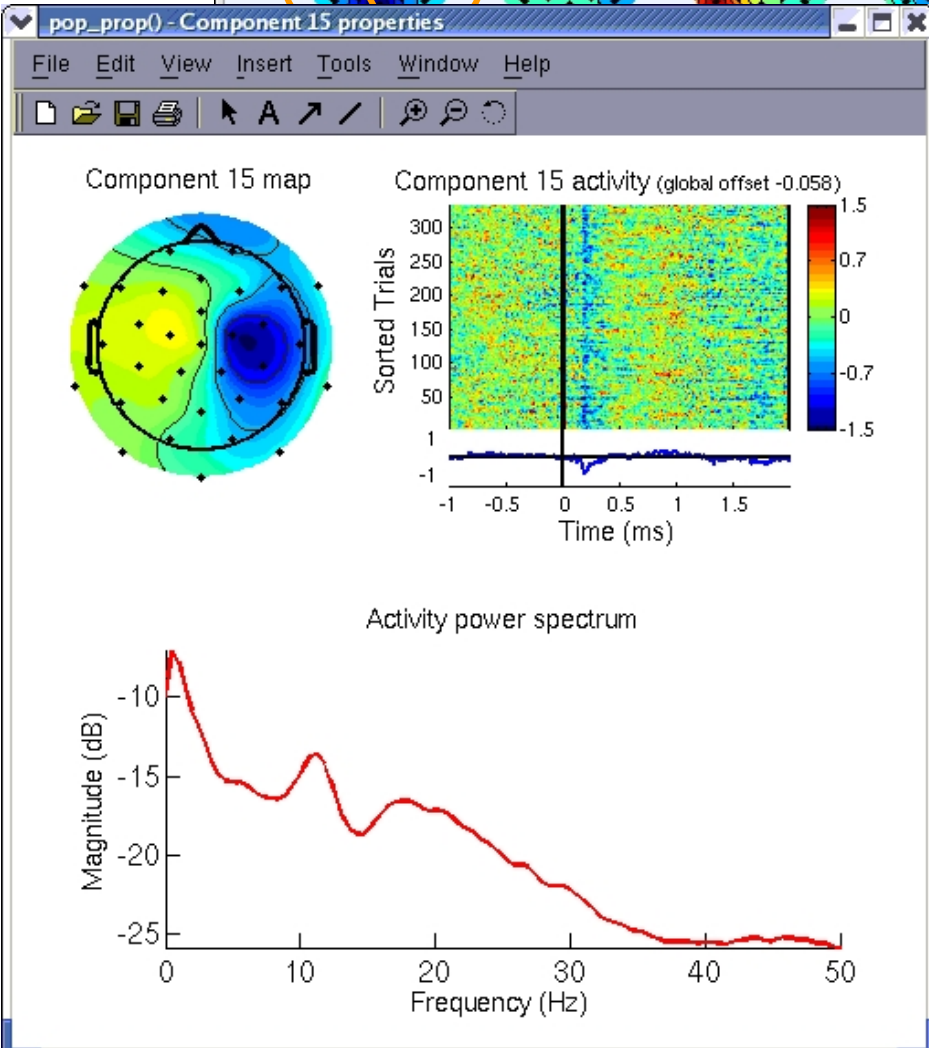
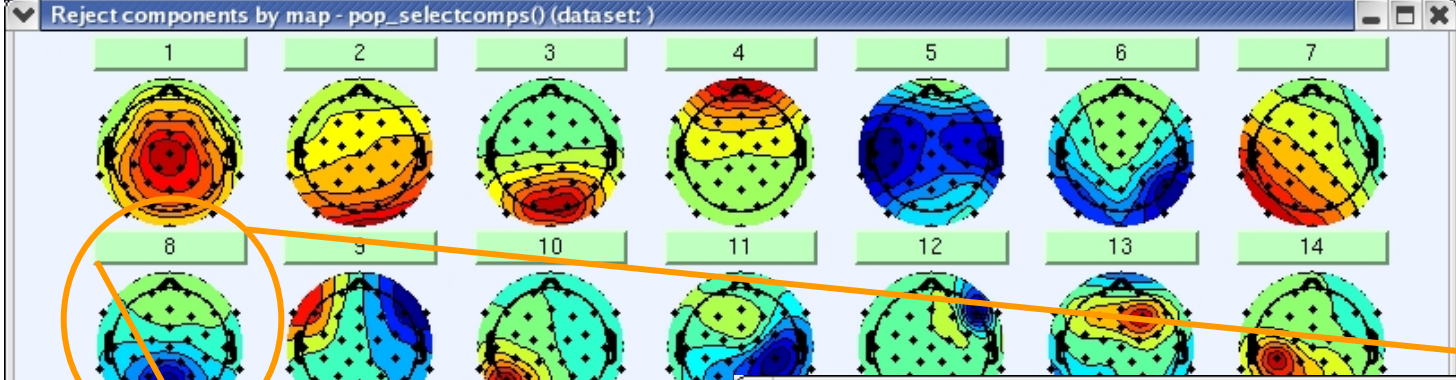
File Edit Tools Plot Datasets Help

#2: EEG I

- Channel locations
- Channel data (scr
- Channel spectra a
- Channel ERP imag
- Channel ERPs
- ERP map series
- Sum/Compare ERP
- Component activat**
- Component spectr
- Component maps
- Component proper
- Component ERP in
- Component ERPs
- Sum/Compare com
- Data statistics
- Time-frequency tra

Filename: eeg...
Channels per...
Frames per epo...
Epochs
Events
Sampling rate
Epoch start (s...
Epoch end (se...
Average refer...
Channel locat...
ICA weights
Dataset size

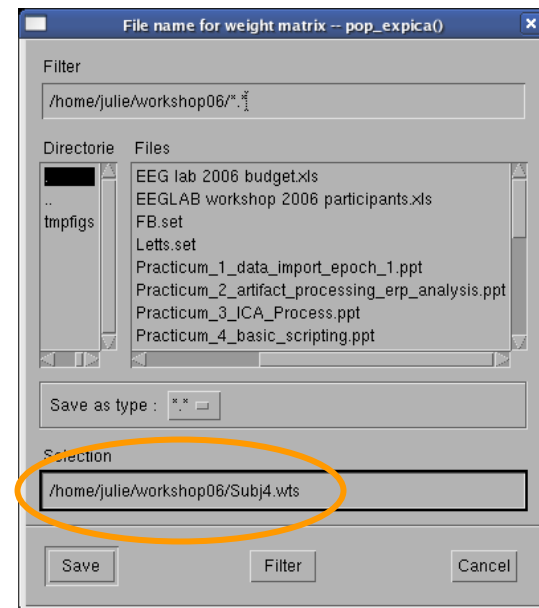
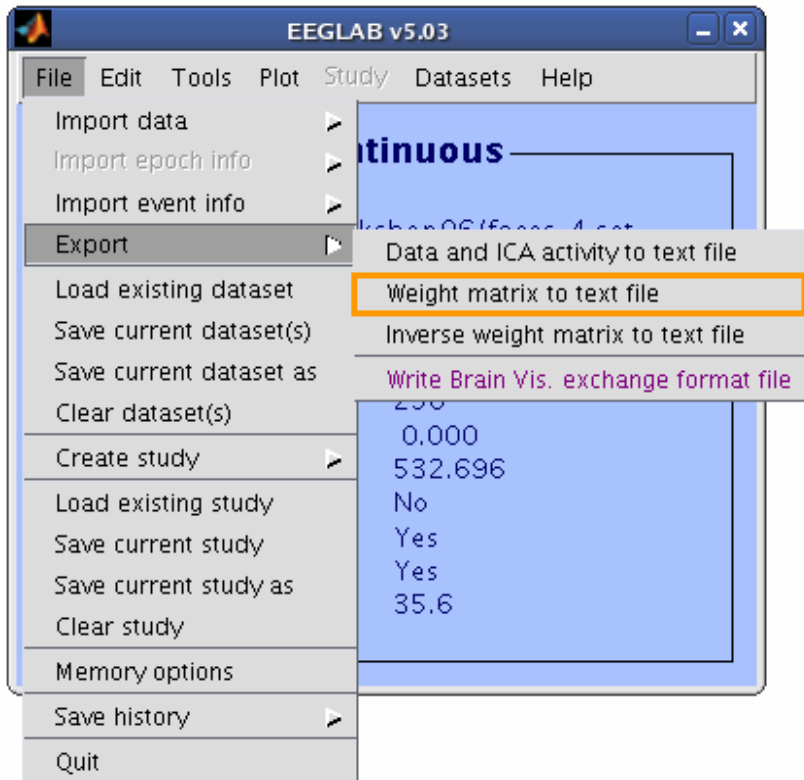




Export ICA weights

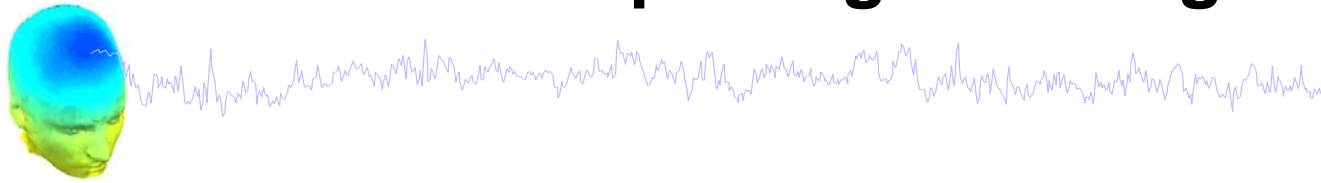


How can I apply these weights to other datasets?



Only apply weights to same subject, same session data!!

Importing ICA weights



EEGLAB v5.03

File Edit Tools Plot Study Datasets Help

Dataset info
Event fields
Event values
About this dataset
Channel locations
Select data

shop06/faces_4.set
33
133175
1

Select a text file

Filter: /home/julie/workshop06/

Directories: tmpfigs

Files: EEG lab 2006 budget.xls, EEGLAB workshop 2006 participants.xls, FB.set, Letts.set, Practicum_1_data_import_epoch_1.ppt, Practicum_2_artifact_processing_erp_analysis.ppt, Practicum_3_ICA_Process.ppt, Practicum_4_basic_scripting.ppt

Files of type: *

Selection: /home/julie/workshop06/Subj4.wts

Open Filter Cancel

Edit dataset information - pop_editset()

Dataset name: faces_4 continuous

Data sampling rate (Hz): 250

Time points per epoch (0->continuous): 133175

Start time (sec) (only for data epochs): 0

Number of channels (0->set from data): 33

Ref. channel indices or mode (see help): common

Subject code: []

Task condition: []

Session number: []

Subject group: []

About this dataset: []

Enter comments: []

Channel location file or info: [] From other dataset [] Browse

Note: The file format may be auto-detected from its file extension. See menu "Edit > Channel locations" for other options.

ICA weights array or text/binary file (if any): [] From other dataset [] Browse

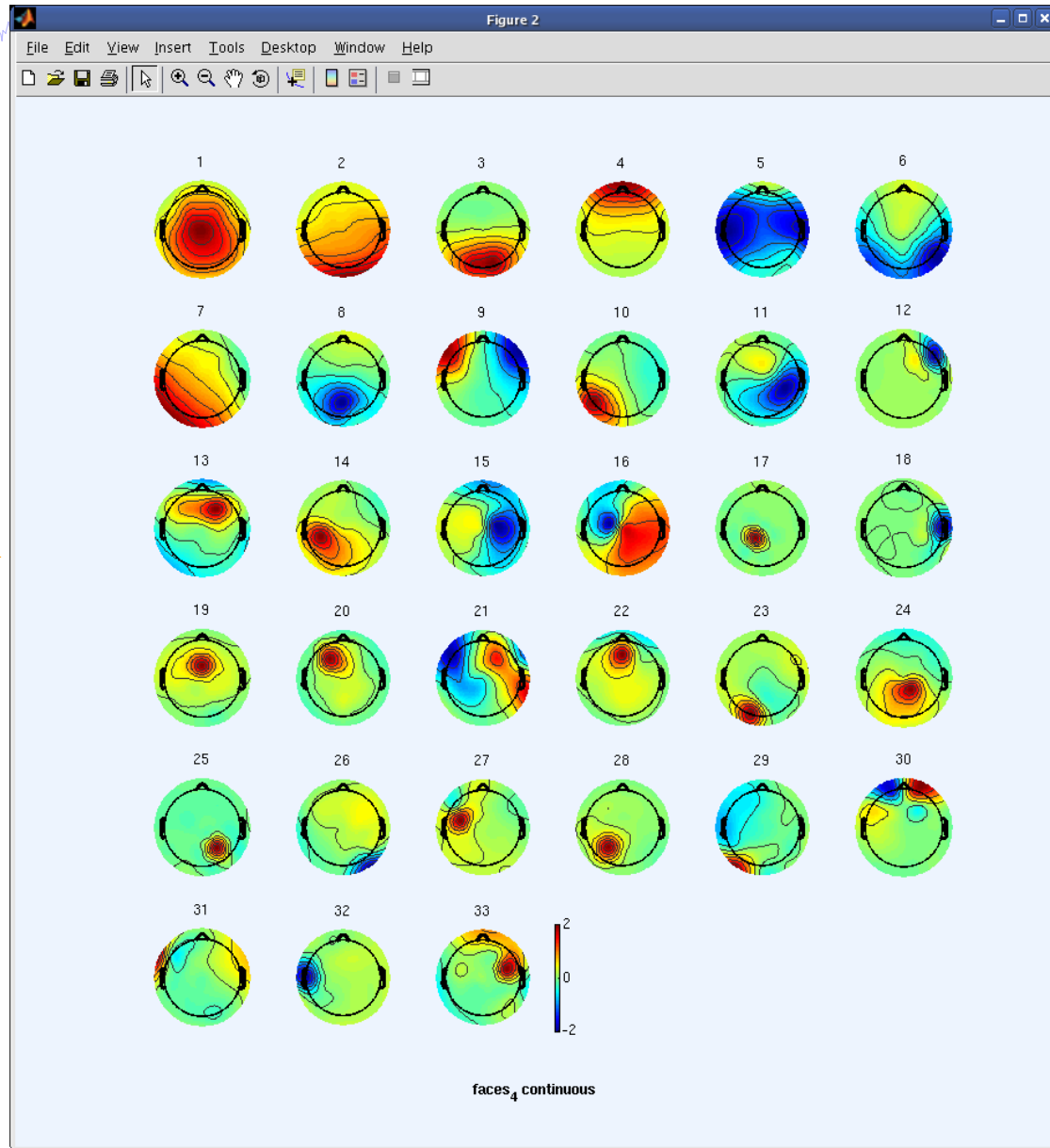
ICA sphere array or text/binary file (if any): [] From other dataset [] Browse

Cancel Help Ok

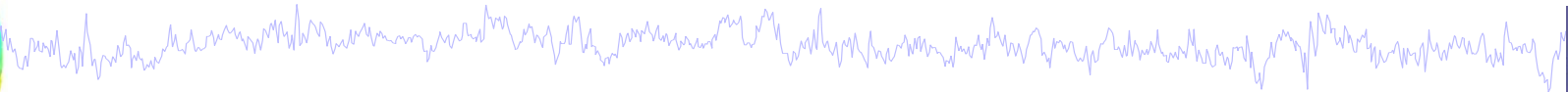
Imported weights

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

    setname: 'faces_4 continuous'
    filename: 'faces_4.set'
    filepath: '/home/julie/workshop06/'
    subject: ''
    group: ''
    condition: ''
    session: []
    comments: [15x48 char]
    nbchan: 33
    trials: 1
    pnts: 133175
    srate: 250
    xmin: 0
    xmax: 532.6960
    times: []
    data: [33x133175 single]
    icaact: [33x133175 single]
    icawinv: [33x33 double]
    icasphere: [33x33 double]
    icaweights: [33x33 double]
    icachansind: [1x33 double]
    chanlocs: [1x33 struct]
    urchanlocs: []
    chaninfo: [1x1 struct]
        ref: 'common'
        event: [1x731 struct]
        urevent: [1x731 struct]
    eventdescription: {[] []}
    epoch: []
    epochdescription: {}
    reject: [1x1 struct]
    stats: [1x1 struct]
    specdata: []
    specicaact: []
    splinefile: ''
    icasplinefile: ''
    dipfit: [1x1 struct]
    history: [1x1633 char]
    saved: 'no'
    etc: []
>>
```



ICA decomposition and component analysis



Task 1

Run ICA

Exercise...

Task 2

Plot components

Identify components

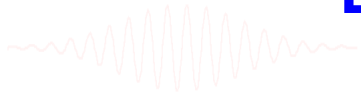
Task 3

Plot component power

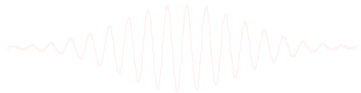
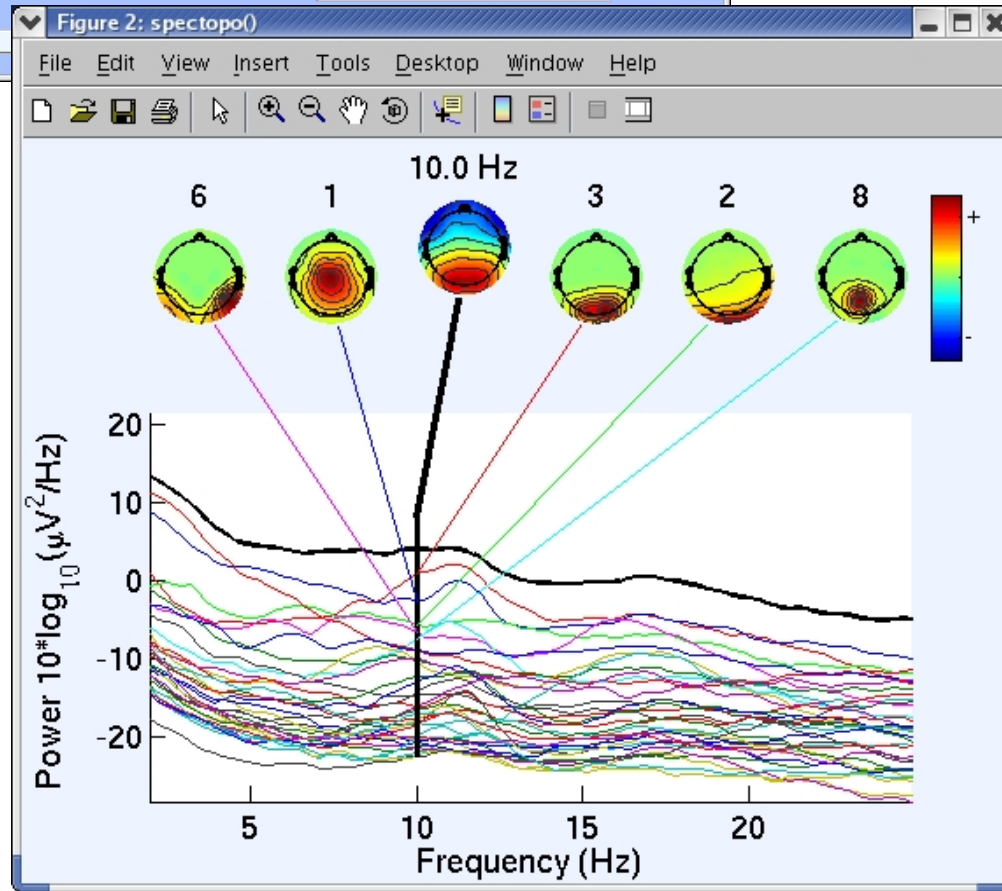
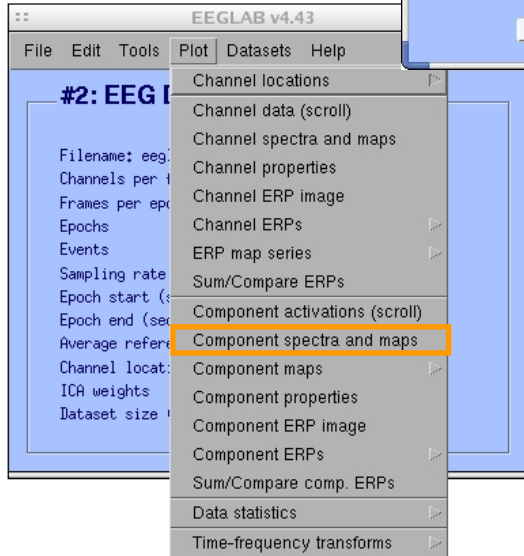
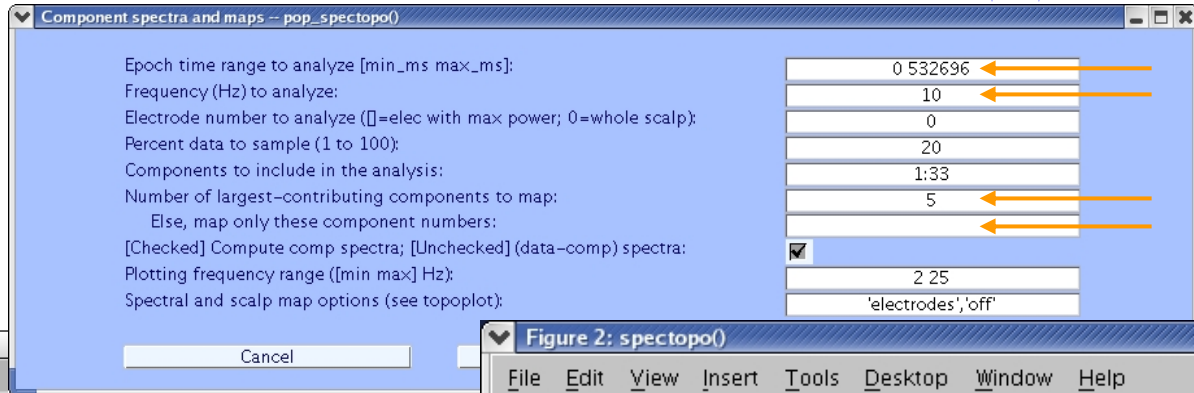
Plot component ERP & erpimages

Plot ERSP/Cross coherence

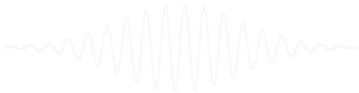
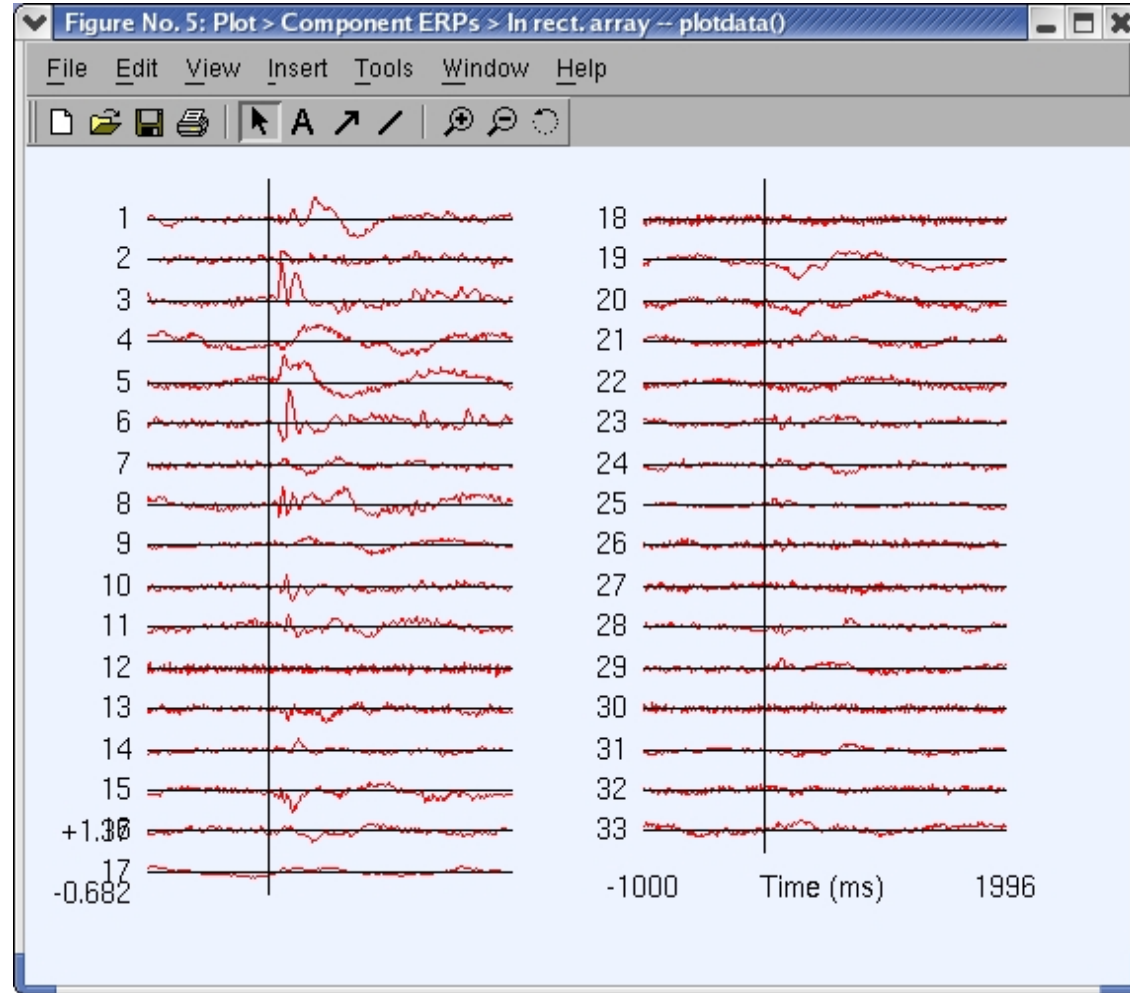
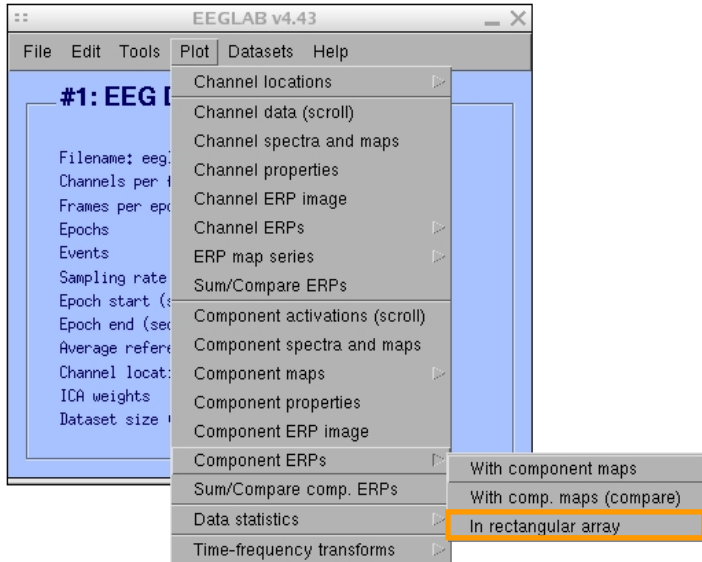
Exercise...



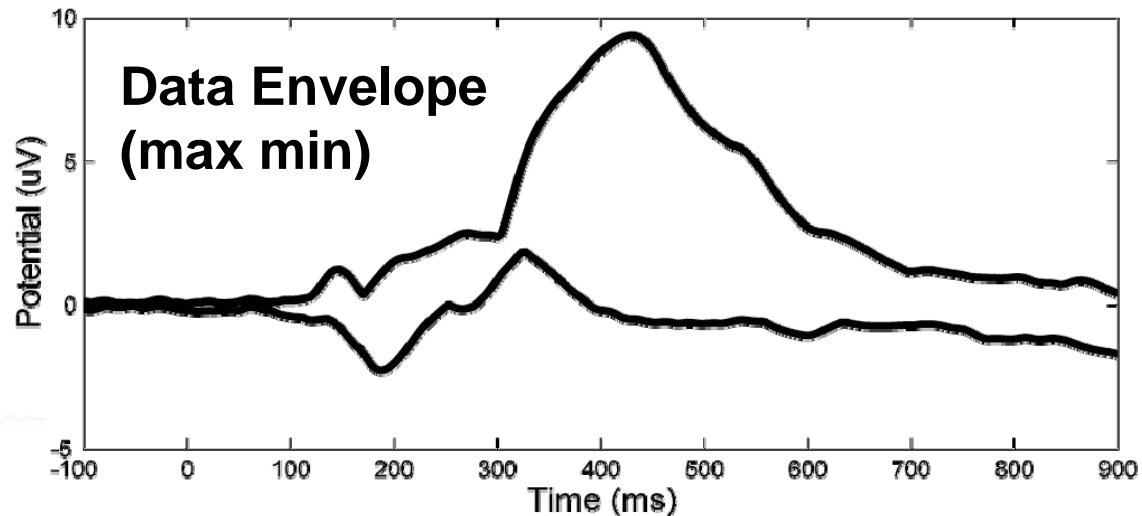
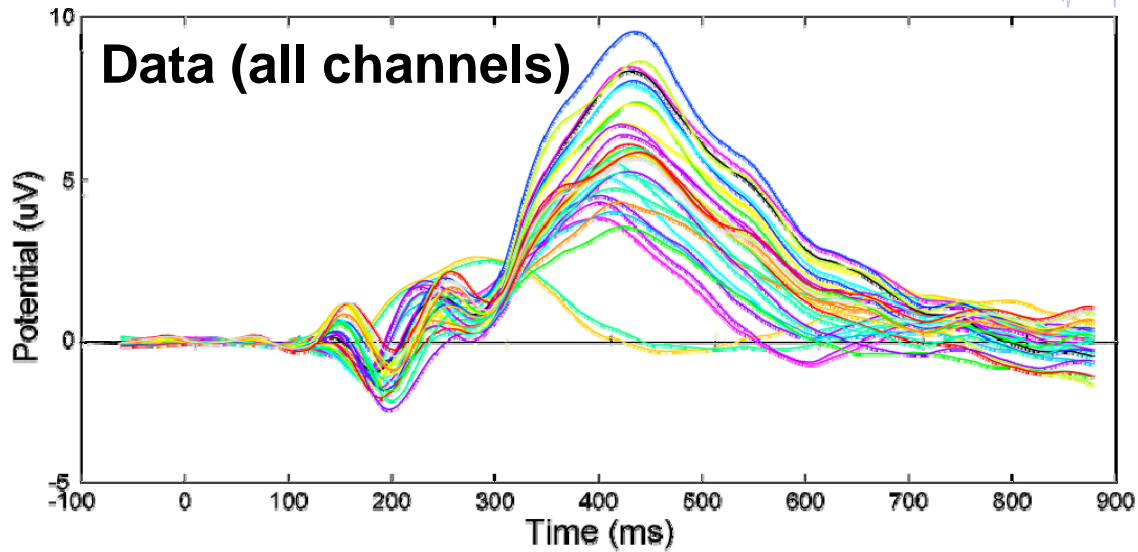
Plot component power



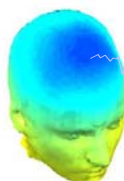
Component ERPs



Definition: The data envelope



Component contributions to the dataset ERP



Plot component and ERP envelopes – pop_envtopo()

Enter time range (in ms) to plot: -100 1000

Enter time range (in ms) to rank component contributions: 0 600

Number of largest contributing components to plot (1-20): 6

Else plot these component numbers only (<21) (Ex: 2;4,7):

Component numbers to remove from data before plotting:

Plot title: ERP components of faces_4 epochs

Optional topoplot() and spectopo() arguments: 'electrodes','off'

Cancel

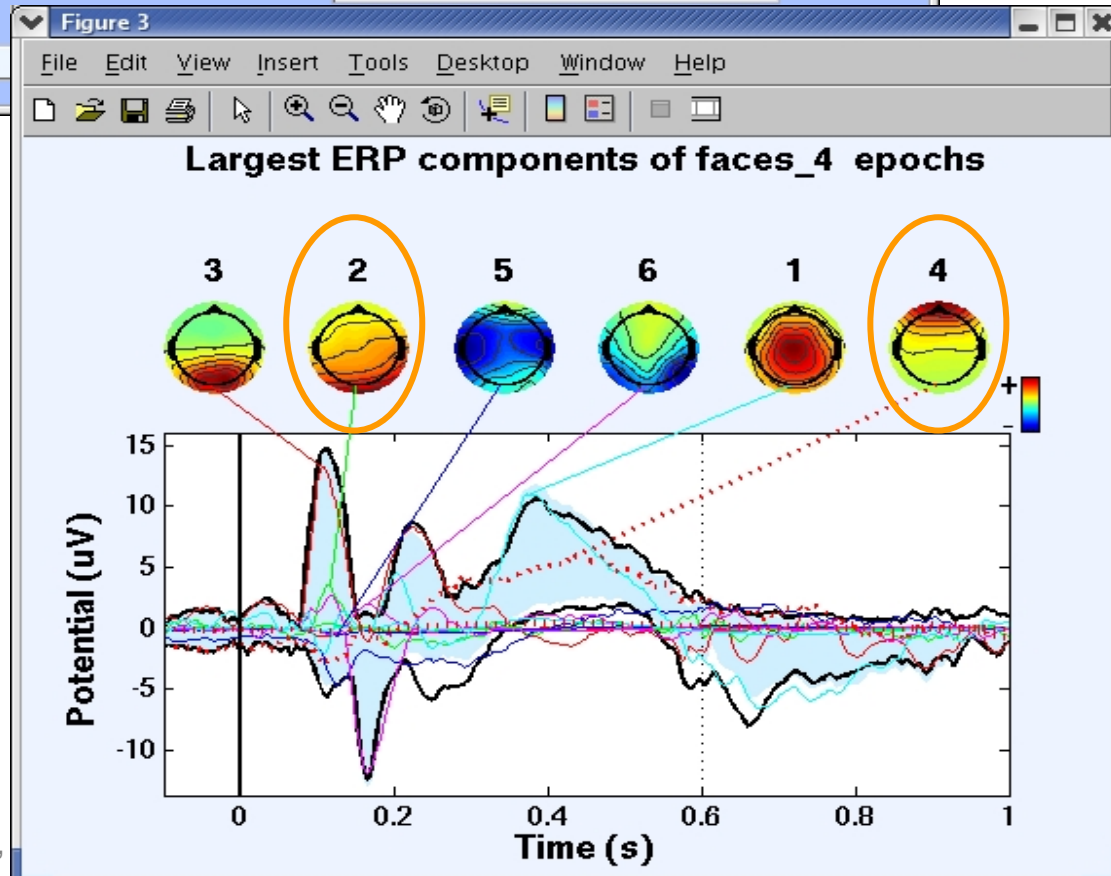
EEGLAB v4.43

- Channel locations
- Channel data (scroll)
- Channel spectra and maps
- Channel properties
- Channel ERP image
- Channel ERPs
- ERP map series
- Sum/Compare ERPs
- Component activations (scroll)
- Component spectra and maps
- Component maps
- Component properties
- Component ERP image
- Component ERPs
- Sum/Compare comp. ERPs
- Data statistics
- Time-frequency transforms

With component maps

With comp. maps (compare)

In rectangular array



Component contribution to the dataset ERP



Plot component and ERP envelopes -- pop_envtopo()

Enter time range (in ms) to plot: -100 1000

Enter time range (in ms) to rank component contributions: 0 600

Number of largest contributing components to plot (1-20): 6

Else plot these component numbers only (<21) (Ex: 2,4,7): **2, 4, 7, 9, 12, 17,18,25**

Component numbers to remove from data before plotting:

Plot title: ERP components of faces_4 epochs

Optional topoplot() and spectopo() arguments: 'electrodes','off'

Cancel

Artifact Components!

EEGLAB v4.43

File Edit Tools Plot Datasets Help

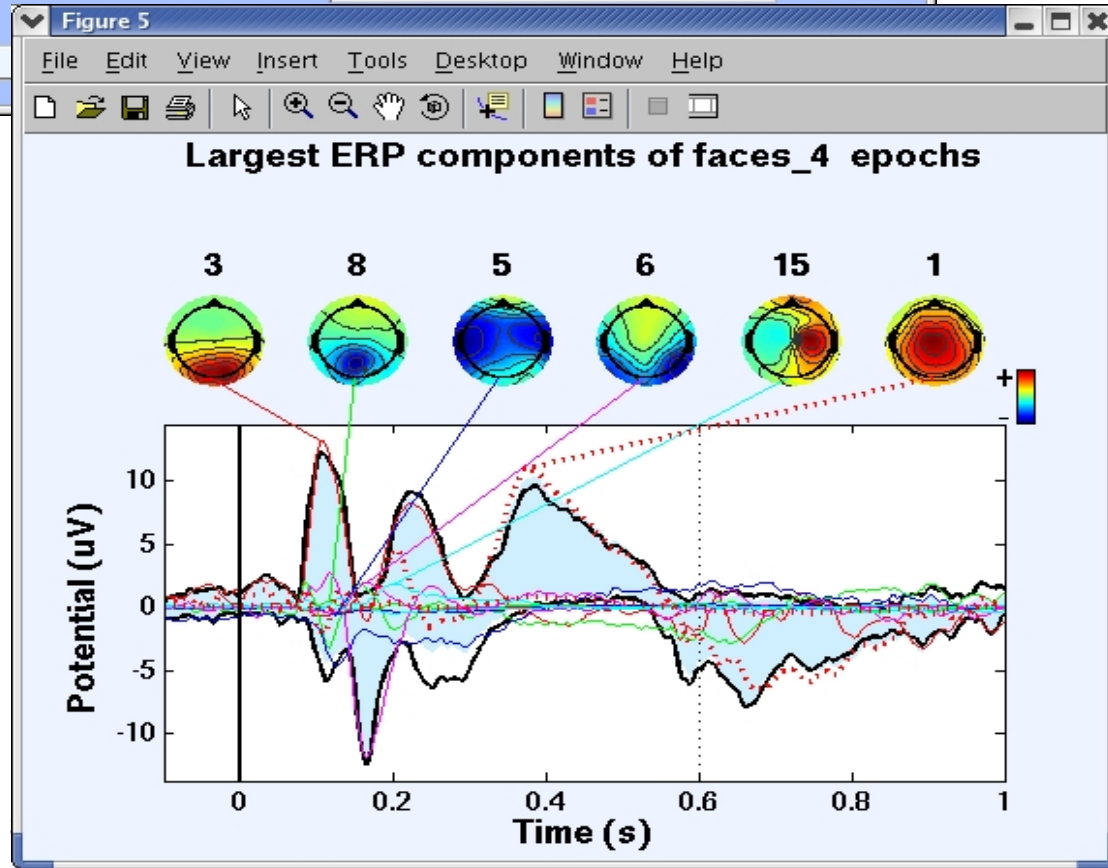
#1: EEG I

- Channel locations
- Channel data (scroll)
- Channel spectra and maps
- Channel properties
- Channel ERP image
- Channel ERPs
- ERP map series
- Sum/Compare ERPs
- Component activations (scroll)
- Component spectra and maps
- Component maps
- Component properties
- Component ERP image
- Component ERPs
- Sum/Compare comp. ERPs
- Data statistics
- Time-frequency transforms

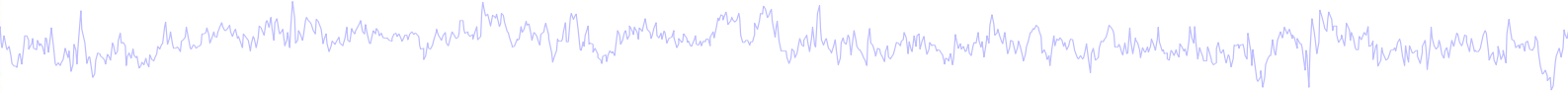
With component maps

With comp. maps (compare)

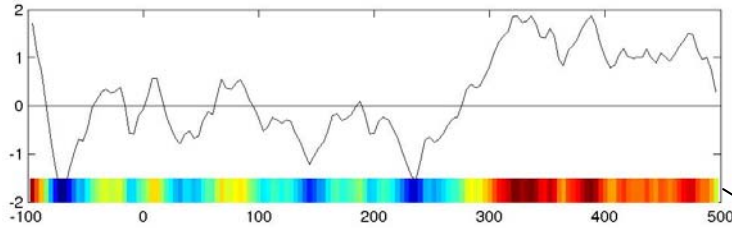
In rectangular array



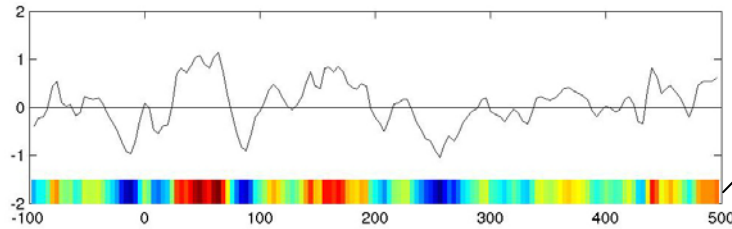
ERP Image basics



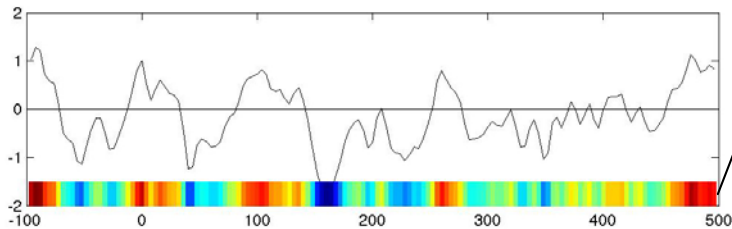
Trial 1



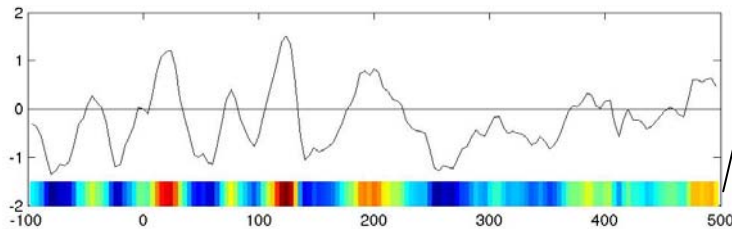
Trial 2



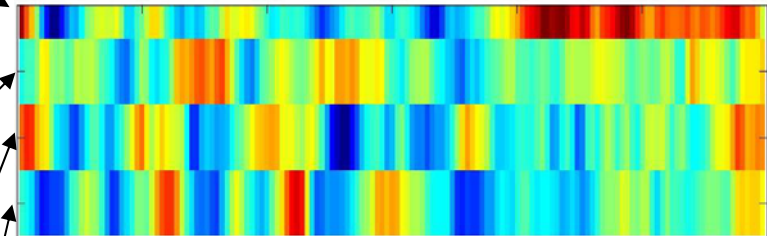
Trial 3



Trial 4

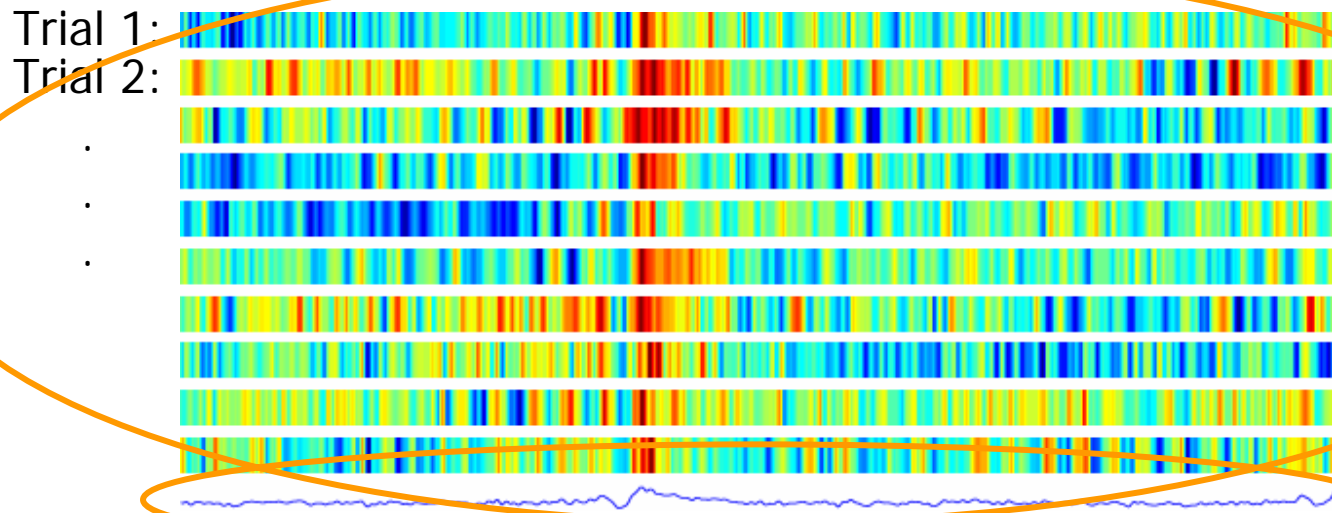


ERP Image

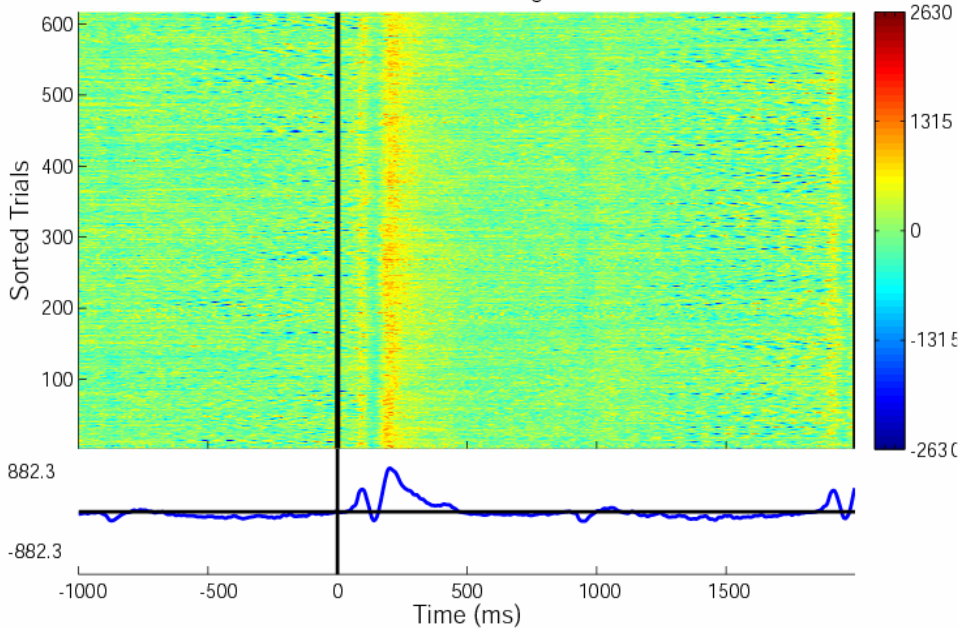


by default, sorted by
time-on-task
(1st trial, 2nd trial, ...)

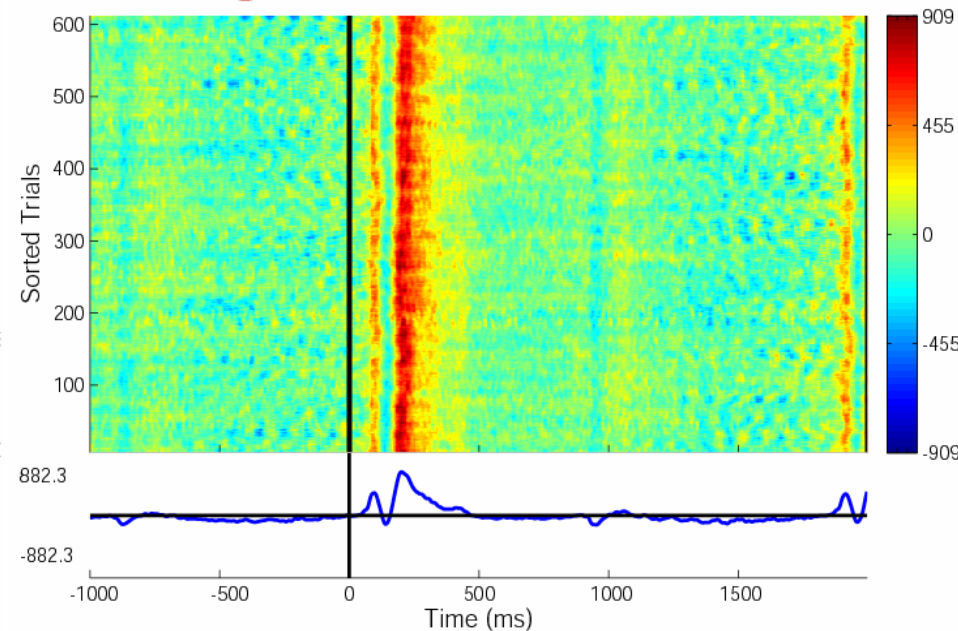
ERP Image basics



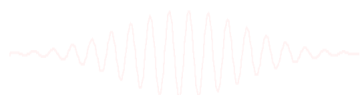
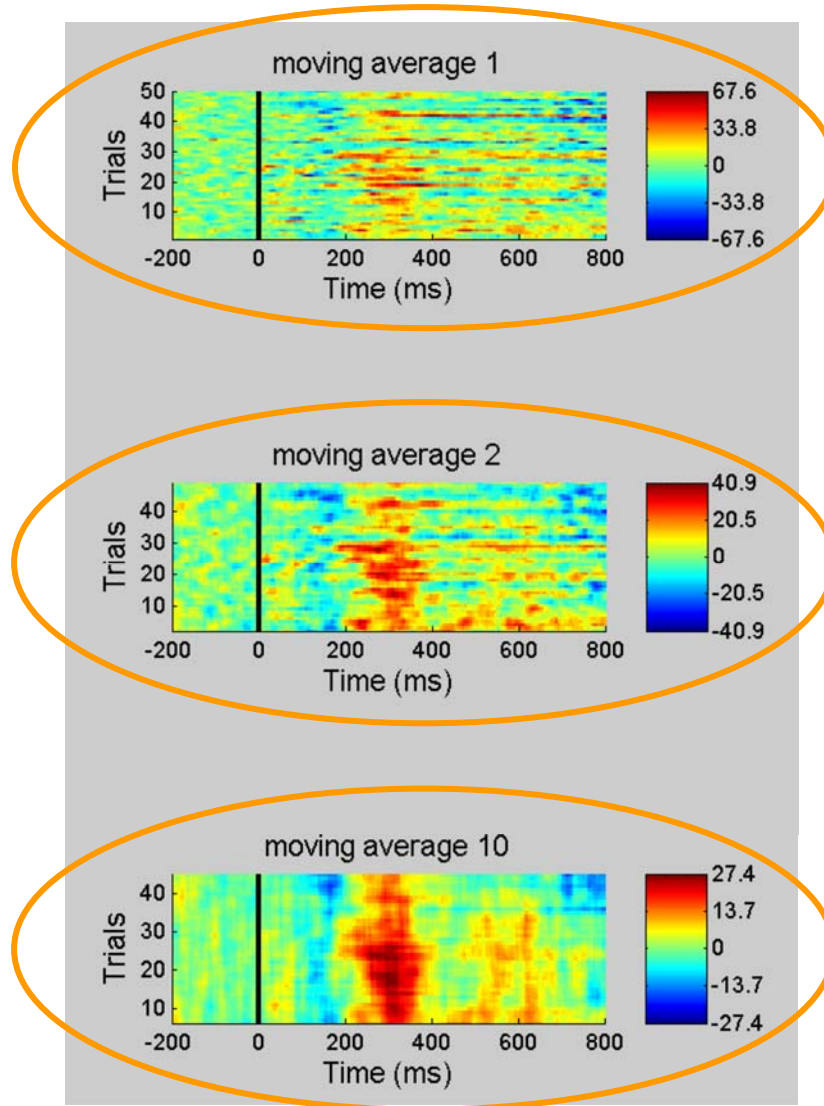
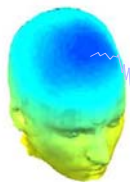
No Smoothing



Smoothed across 10 Trials



ERP Images: smoothing across trials



Component ERP Images

select fields

latency
type
epoch

Cancel Ok

11
10
1
-1000 1996

Figure title

Plot scalp map
 Plot ERP
 Plot colorbar

ERP limits
Color limits (see Help)

Sort/align trials by epoch event values

Epoch-sorting field: latency
Event type(s): bp1' 'bp4
Event time range: 0 2000

Rescale: no
Align:
_Don't sort by value
_Don't plot values

Sort trials by phase

select fields

bp1
bp4
face
object

Cancel Ok

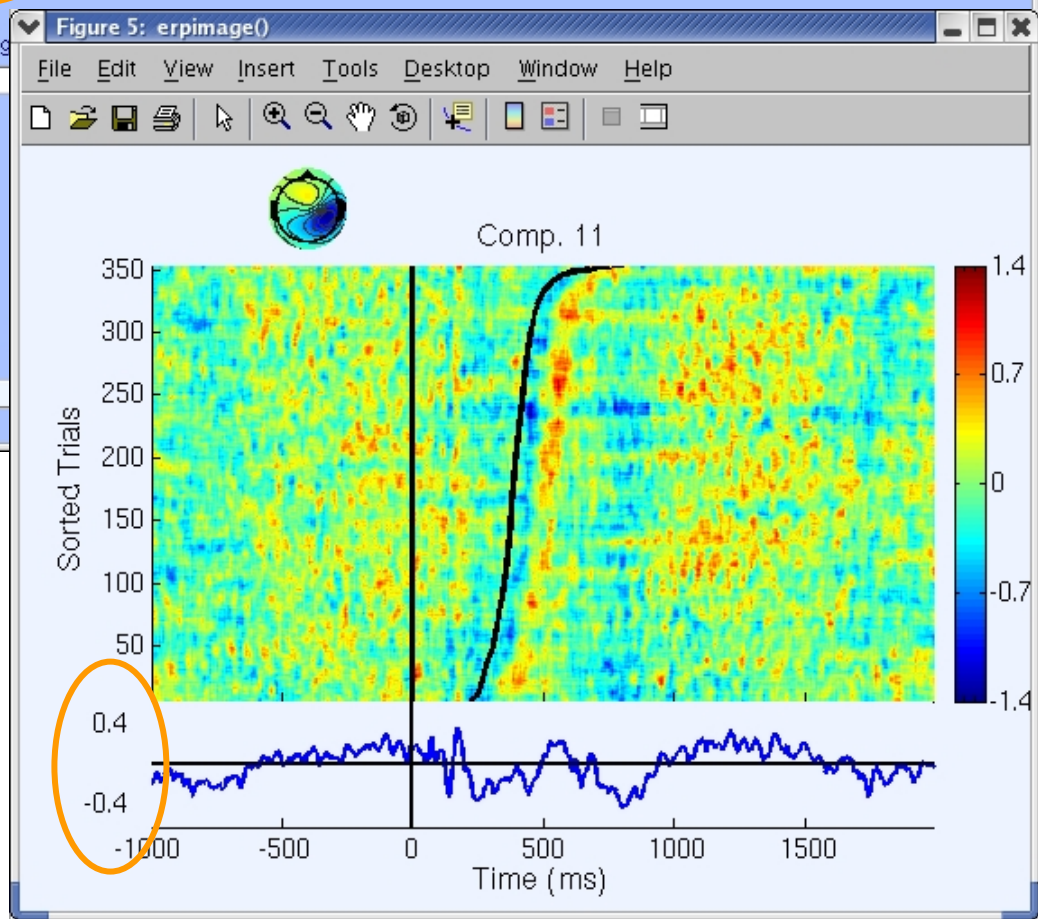
EEGLAB v4.43

File Edit Tools Plot Datasets Help

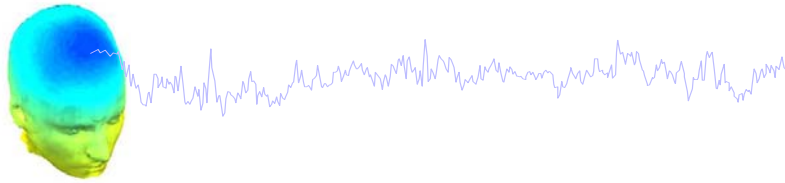
#2: EEG I

Filename: eeg...
Channels per t...
Frames per epo...
Epochs
Events
Sampling rate
Epoch start (s...
Epoch end (sec...
Average referen...
Channel locat...
ICA weights
Dataset size

Channel locations
Channel data (scroll)
Channel spectra and maps
Channel properties
Channel ERP image
Channel ERPs
ERP map series
Sum/Compare ERPs
Component activations (scroll)
Component spectra and maps
Component maps
Component properties
Component ERP image
Component ERPs
Sum/Compare comp. ERPs
Data statistics
Time-frequency transforms



Plot IC ERSP



EEGLAB v5.03

File Edit Tools **Plot** Study Datasets Help

#1: faces

- Filename: ...
- Channels per ...
- Frames per ...
- Epochs
- Events
- Sampling ra...
- Epoch start
- Epoch end (...)
- Average refe...
- Channel loc...
- ICA weights
- Dataset size

Channel locations

Channel data (scroll)

Channel spectra and maps

Channel properties

Channel ERP image

Channel ERPs

ERP map series

Sum/Compare ERPs

Component activations (scroll)

Component spectra and maps

Component maps

Component properties

Component ERP image

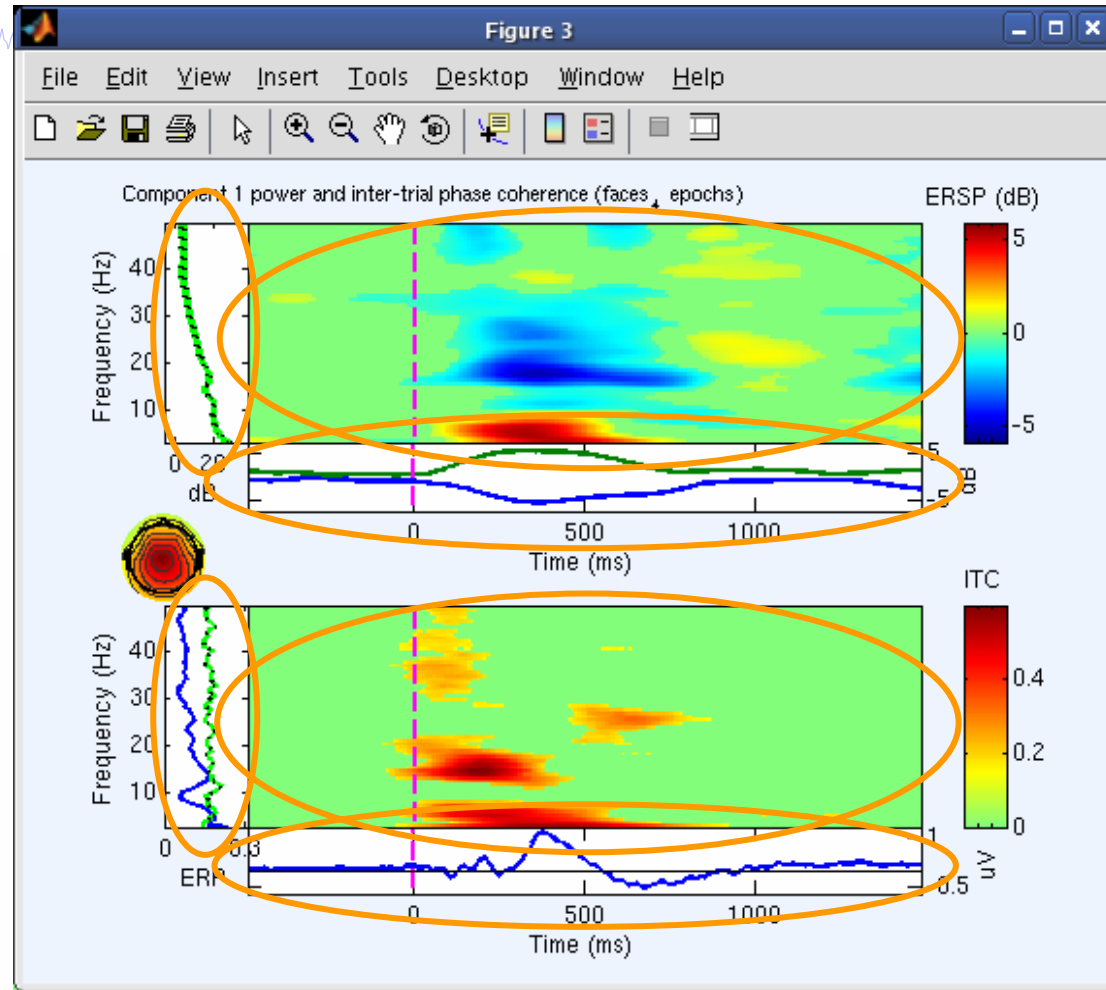
Component ERPs

Sum/Compare comp. ERPs

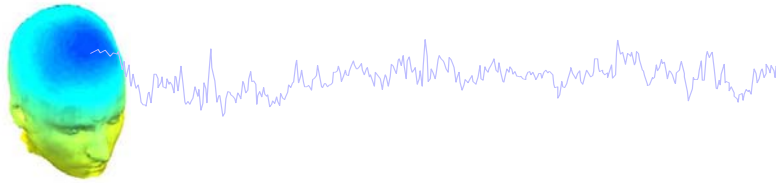
Data statistics

Time-frequency transforms

- Channel time-frequency
- Channel cross-coherence
- Component time-frequency**
- Component cross-coherence



Plot IC cross coherence



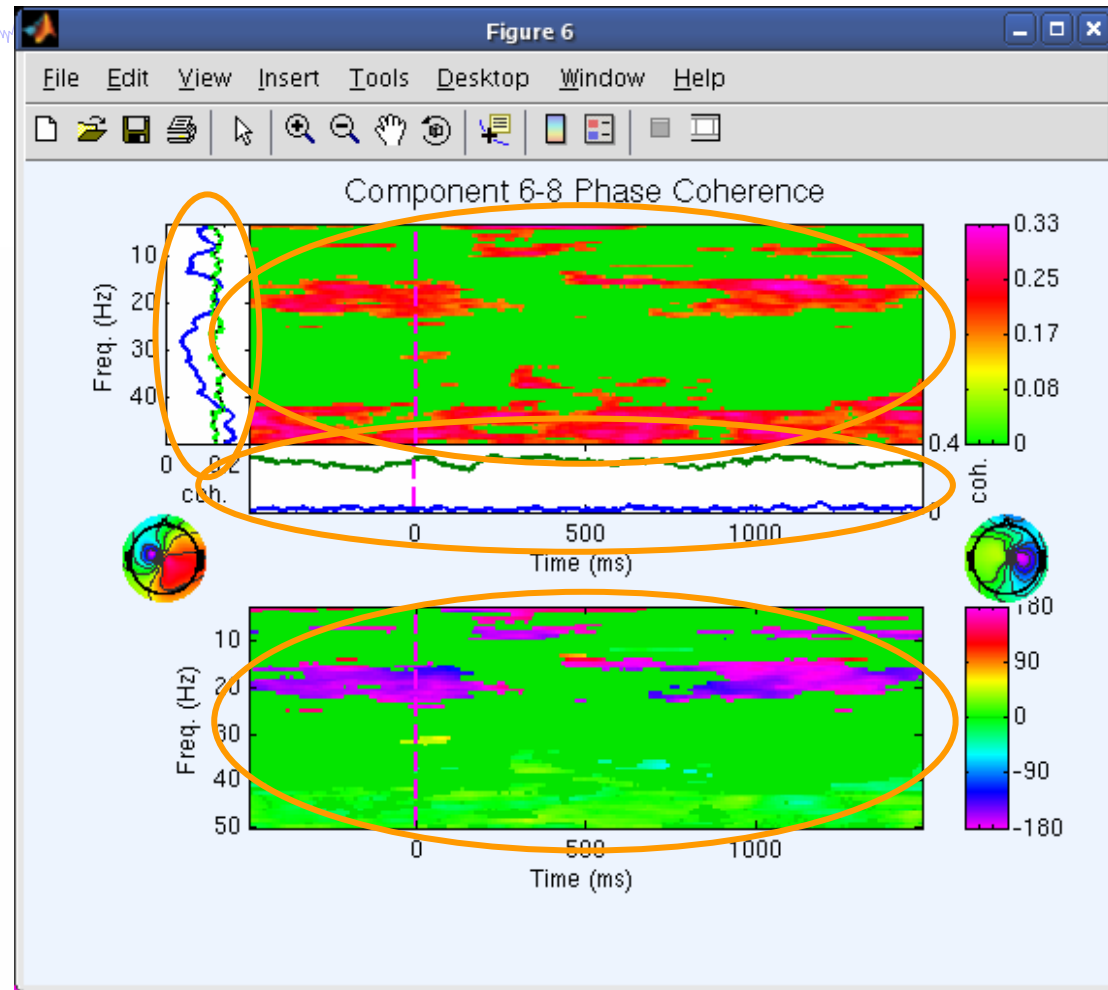
EEGLAB v5.03

File Edit Tools **Plot** Study Datasets Help

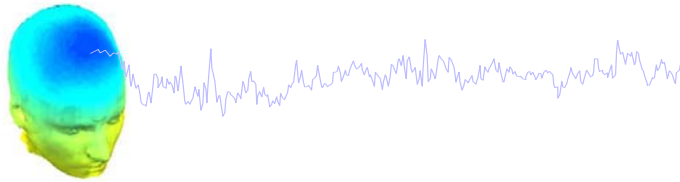
#1: faces

Filename: ...
Channels per ...
Frames per ...
Epochs
Events
Sampling ra...
Epoch start...
Epoch end (...
Average refe...
Channel loc...
ICA weights...
Dataset size...

- Channel locations
- Channel data (scroll)
- Channel spectra and maps
- Channel properties
- Channel ERP image
- Channel ERPs
- ERP map series
- Sum/Compare ERPs
- Component activations (scroll)
- Component spectra and maps
- Component maps
- Component properties
- Component ERP image
- Component ERPs
- Sum/Compare comp. ERPs
- Data statistics
- Time-frequency transforms
 - Channel time-frequency
 - Average time-frequency
 - New Time-freq. transforms
 - Component time-frequency
 - Component cross-coherence**



Channel/IC statistics



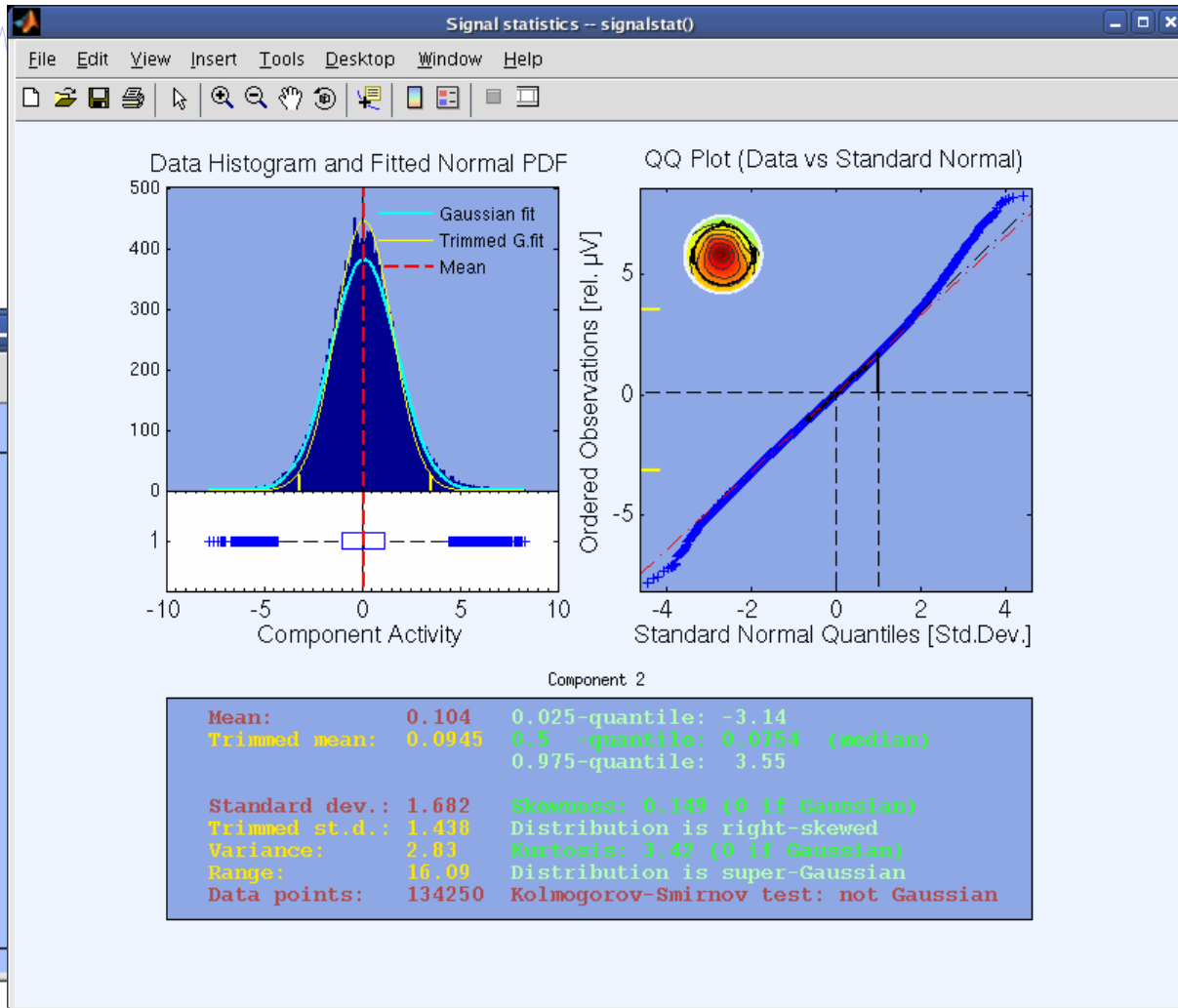
EEGLAB v5.03

File Edit Tools **Plot** Study Datasets Help

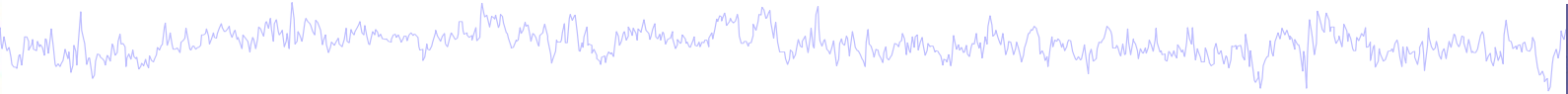
#2: faces

Filename: ...
Channels per ...
Frames per ...
Epochs
Events
Sampling rate
Epoch start
Epoch end (...
Average reference
Channel locations
ICA weights
Dataset size

- Channel locations
- Channel data (scroll)
- Channel spectra and maps
- Channel properties
- Channel ERP image
- Channel ERPs
- ERP map series
- Sum/Compare ERPs
- Component activations (scroll)
- Component spectra and maps
- Component maps
- Component properties
- Component ERP image
- Component ERPs
- Sum/Compare comp. ERPs
- Data statistics**
 - Channel statistics
 - Component statistics**
 - Event statistics
- Time-frequency transforms
 - Average time-frequency
 - New Time-freq. transforms



Exercise



- Look at your component maps/activations
- Find **components** that contribute most to:
 - Data power spectrum at **6 Hz**
 - The **ERP** between **100 and 500 ms**
 - Remove noise components when plotting
- Plot and study different ERP images for these components
- Plot ERSP and/or IC cross coherence for selected ICs

