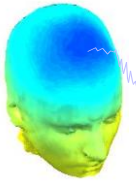
Running ICA and Plotting Measures



1) **Run ICA**

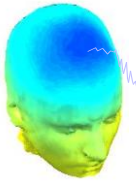
2) **Plot IC ERPs**

3) **IC spectral power**

4) **IC ERP images**

5) **IC ERSP**

Running ICA and Plotting Measures



1) **Run ICA**

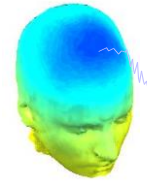
2) **Plot IC ERPs**

3) **IC spectral power**

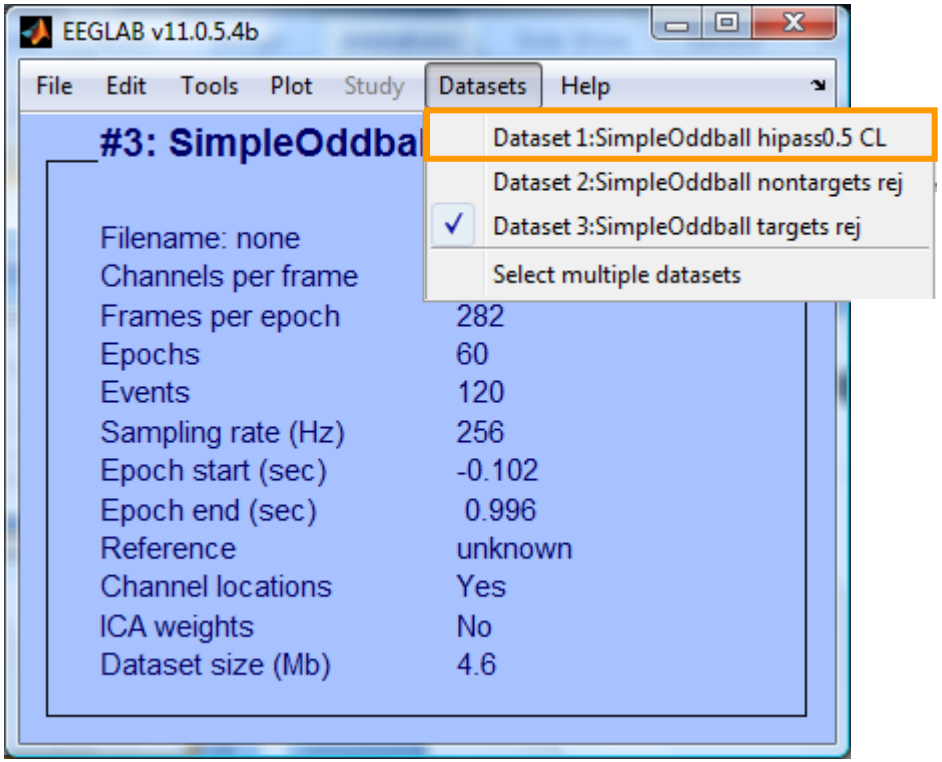
4) **IC ERP images**

5) **IC ERSP**

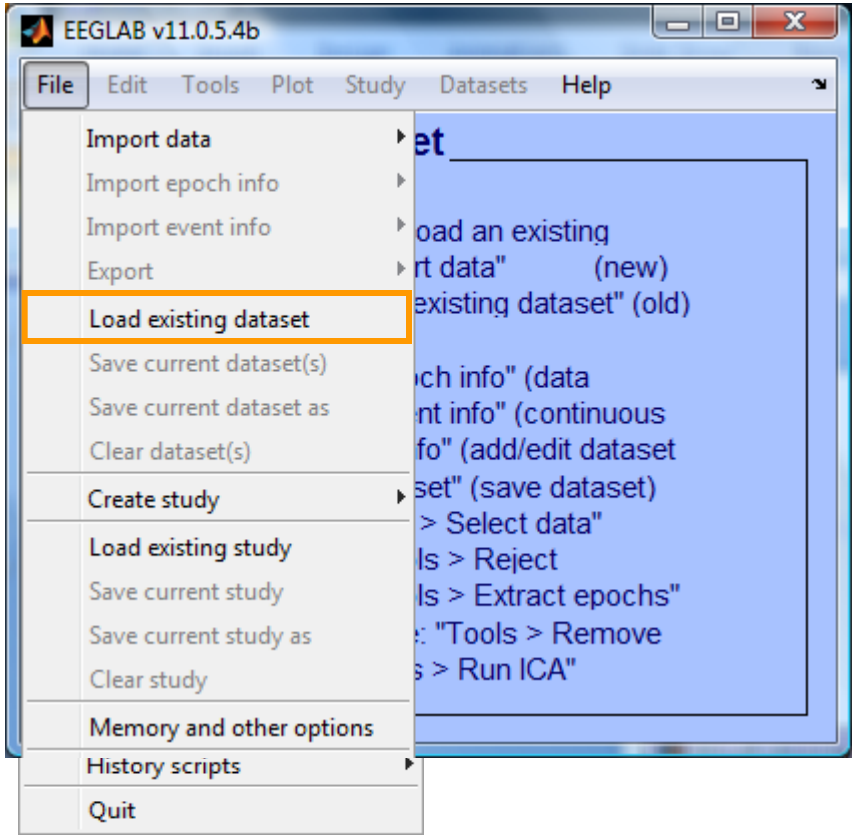
Retrieve or reload continuous EEG dataset



RETRIEVE

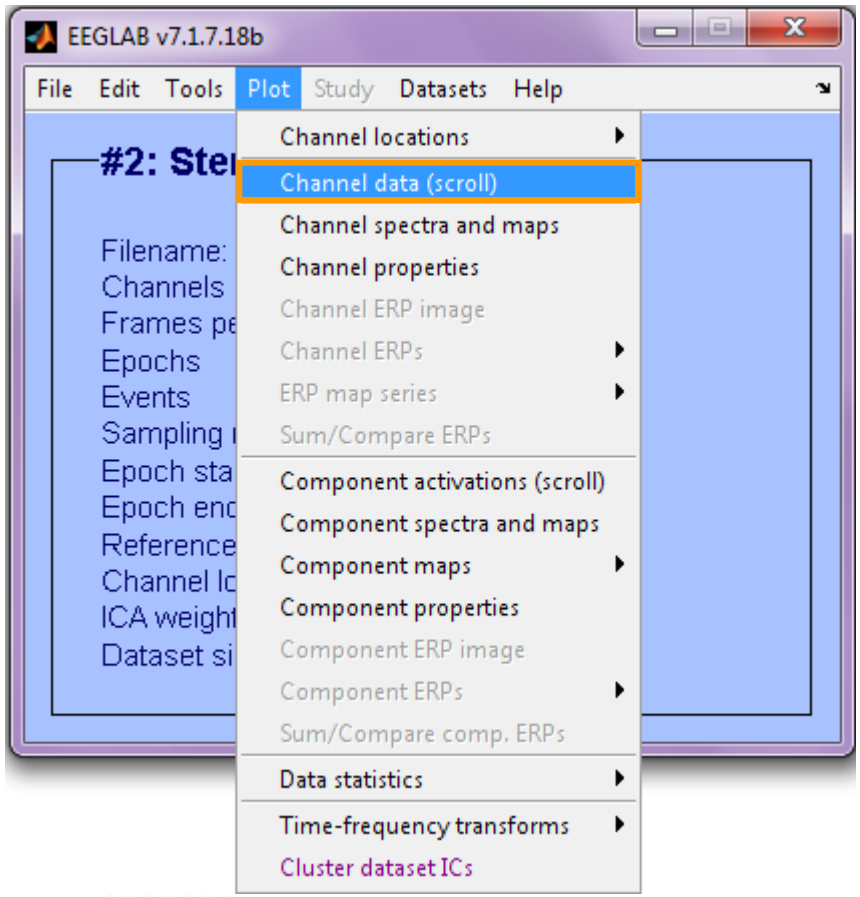


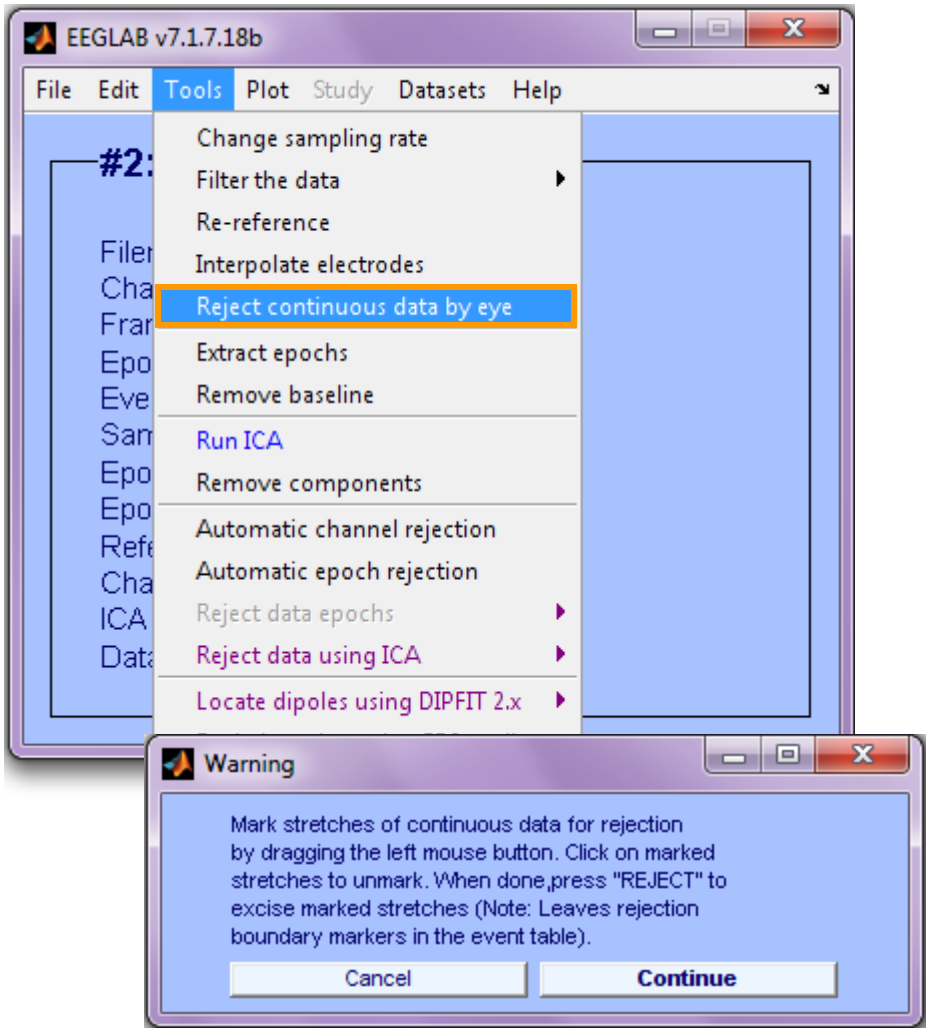
RELOAD



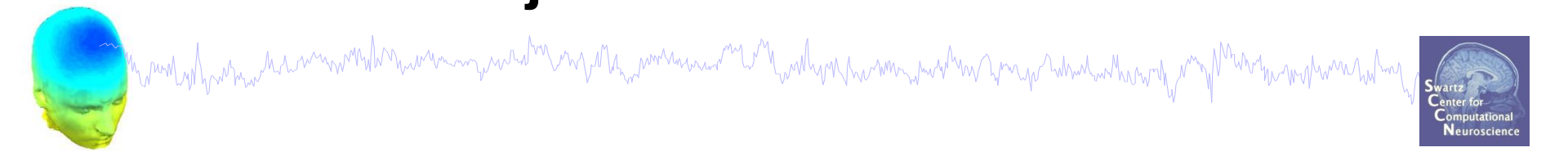
Reject continuous data

Equivalent





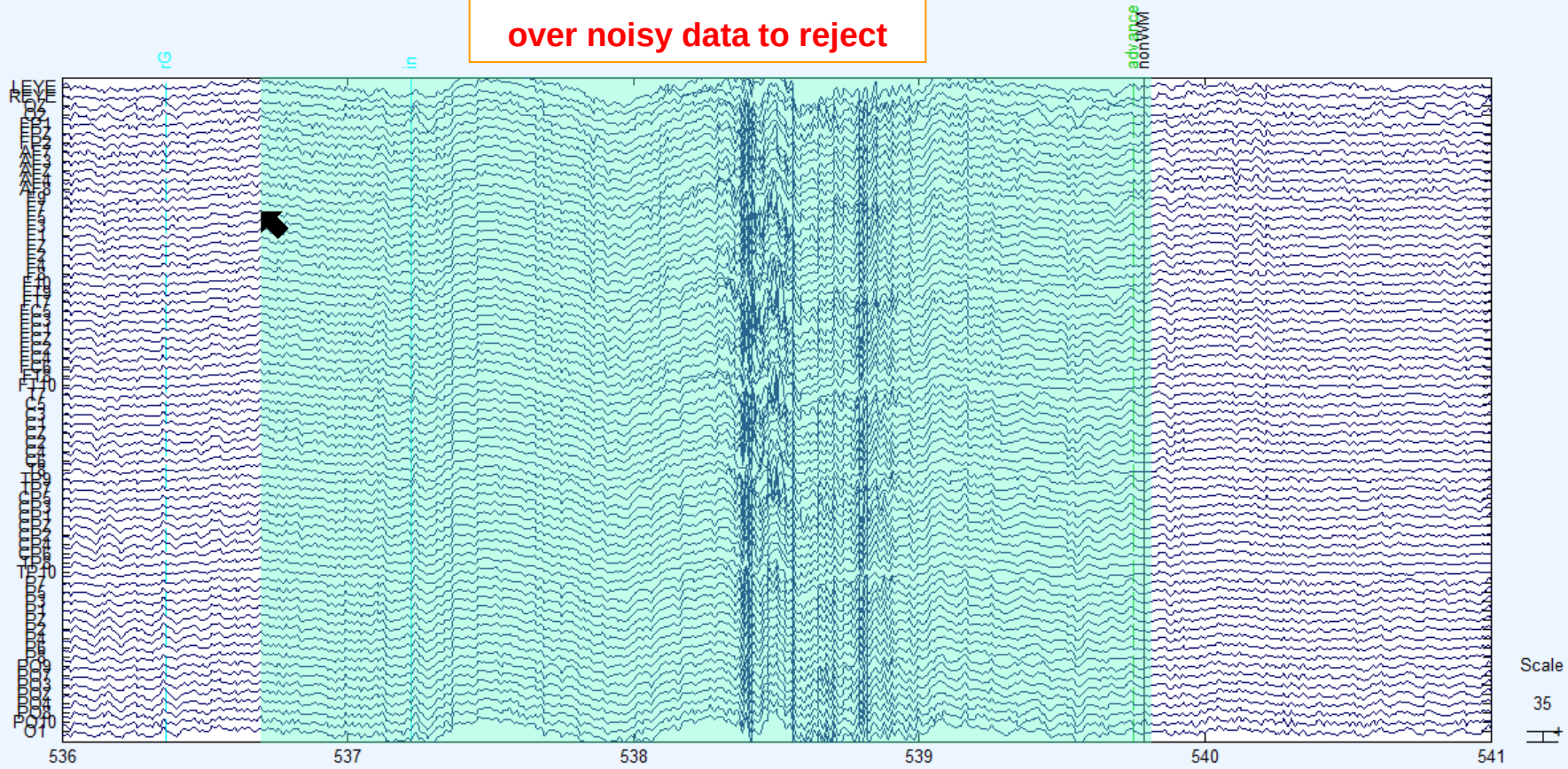
Reject continuous data



Scroll channel activities -- eegplot()

Figure Display Settings Help

Click and drag with mouse over noisy data to reject



CANCEL | Event types | << | < | 536 | > | >>

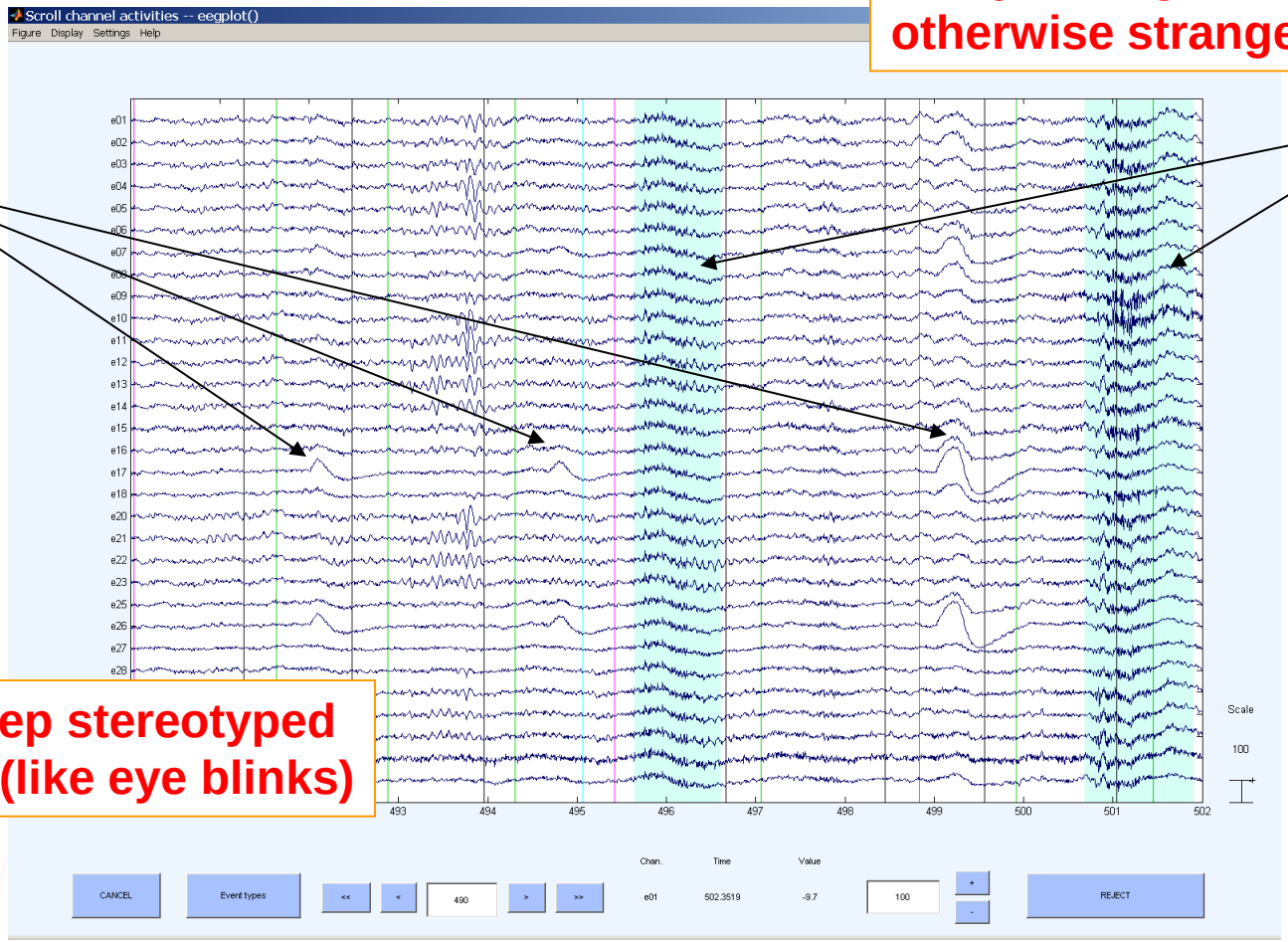
Chan.	Time	Value
FC6	539.9355	4.8773

35 + - REJECT

Rejecting data for ICA

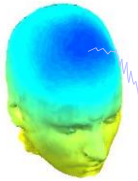
To prepare data for ICA:

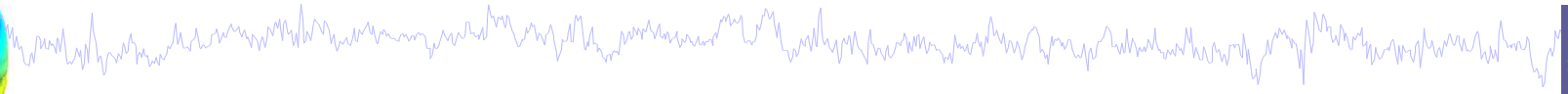
Reject large muscle or otherwise strange events...



... but keep stereotyped artifacts (like eye blinks)

Independent Component Analysis





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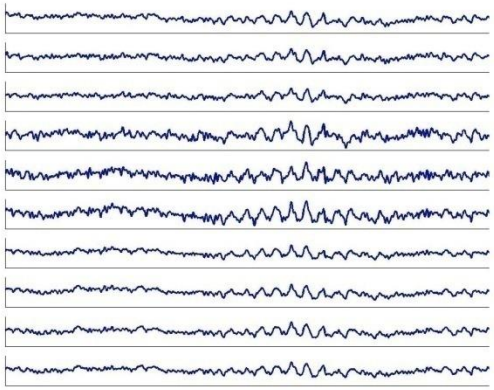
x = scalp EEG

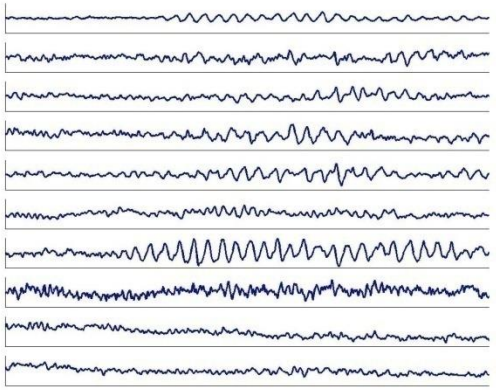
W = unmixing matrix

u = sources



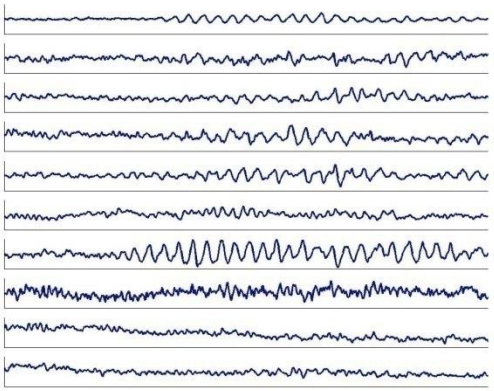
W*x = u

ICA



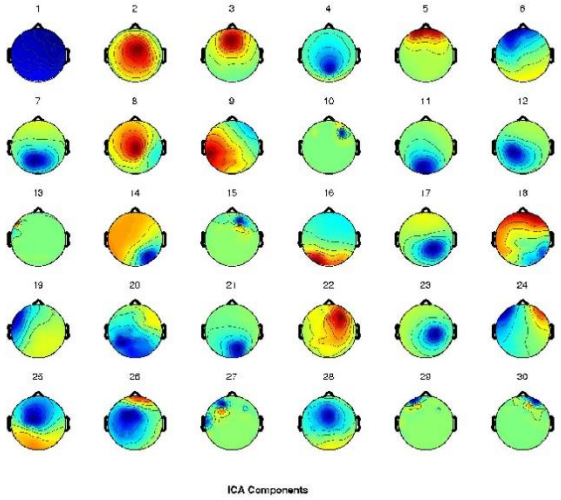
x = W^{-1}*u

u = sources

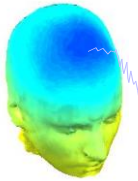


W^{-1} (scalp projections)

*

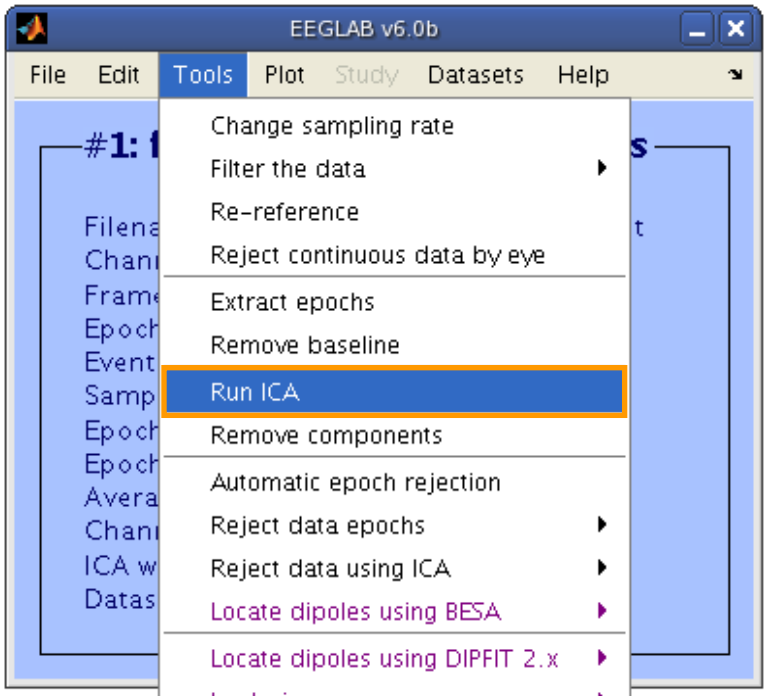


“Secrets” to a good ICA decomposition



- 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)

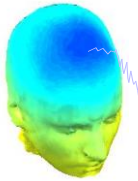
Runica options



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,acsobiro

Runica progress…



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Press Button to interupt runica

Interupt

csh

```
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
```

csh

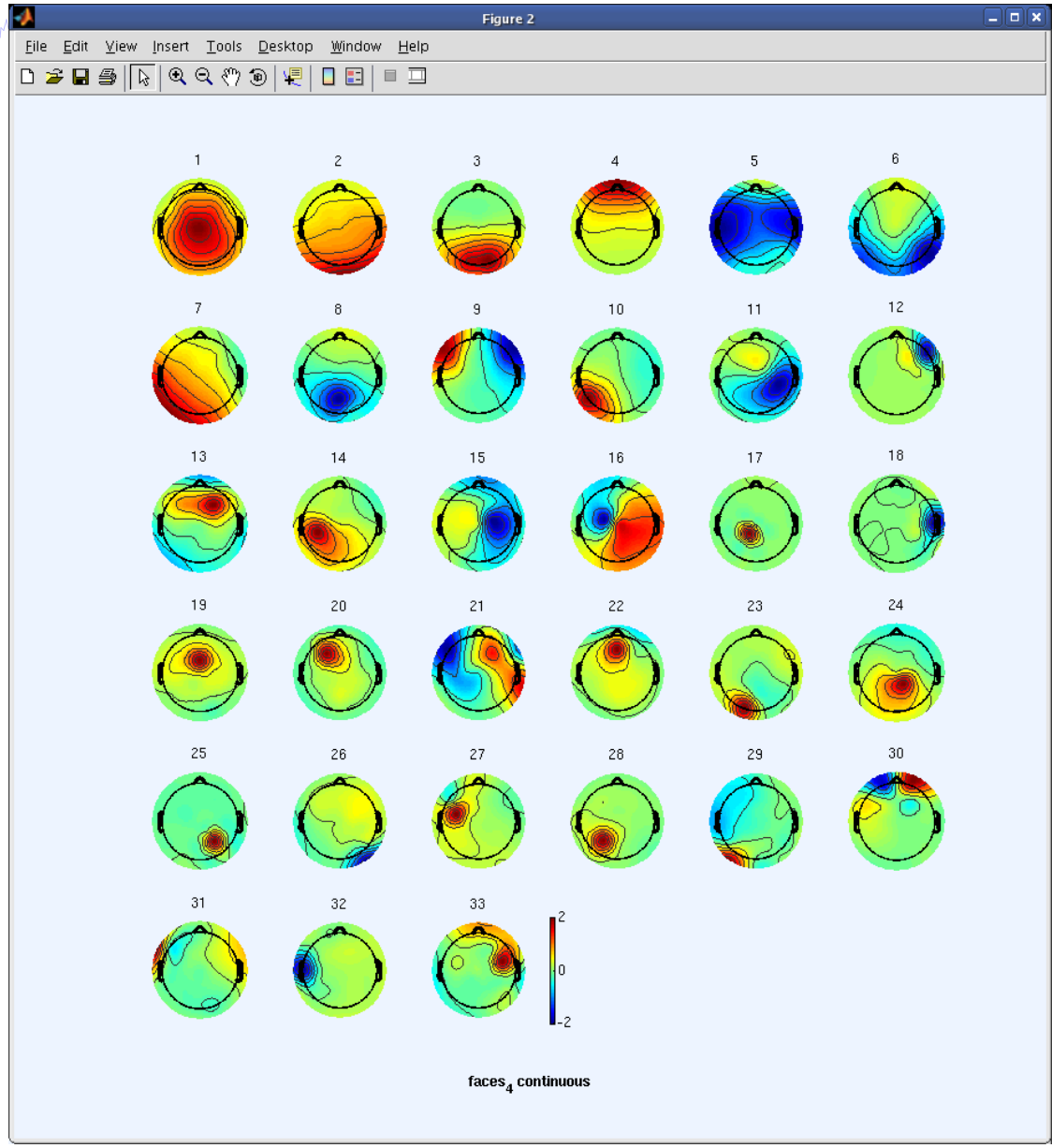
```
step 241 - lrate 0.000002, wchange 0.00000082, angledelta 101.5 deg
step 242 - lrate 0.000001, wchange 0.00000061, angledelta 96.1 deg
step 243 - lrate 0.000001, wchange 0.00000057, angledelta 97.5 deg
step 244 - lrate 0.000001, wchange 0.00000054, angledelta 93.7 deg
step 245 - lrate 0.000001, wchange 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 ...
>>
>>
```

ICA weights in EEG structure

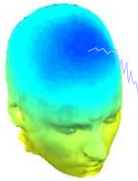
Terminal

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: []

>>
```



Running ICA and Plotting Measures



1) Run ICA

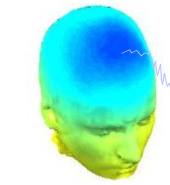
2) Plot IC ERPs

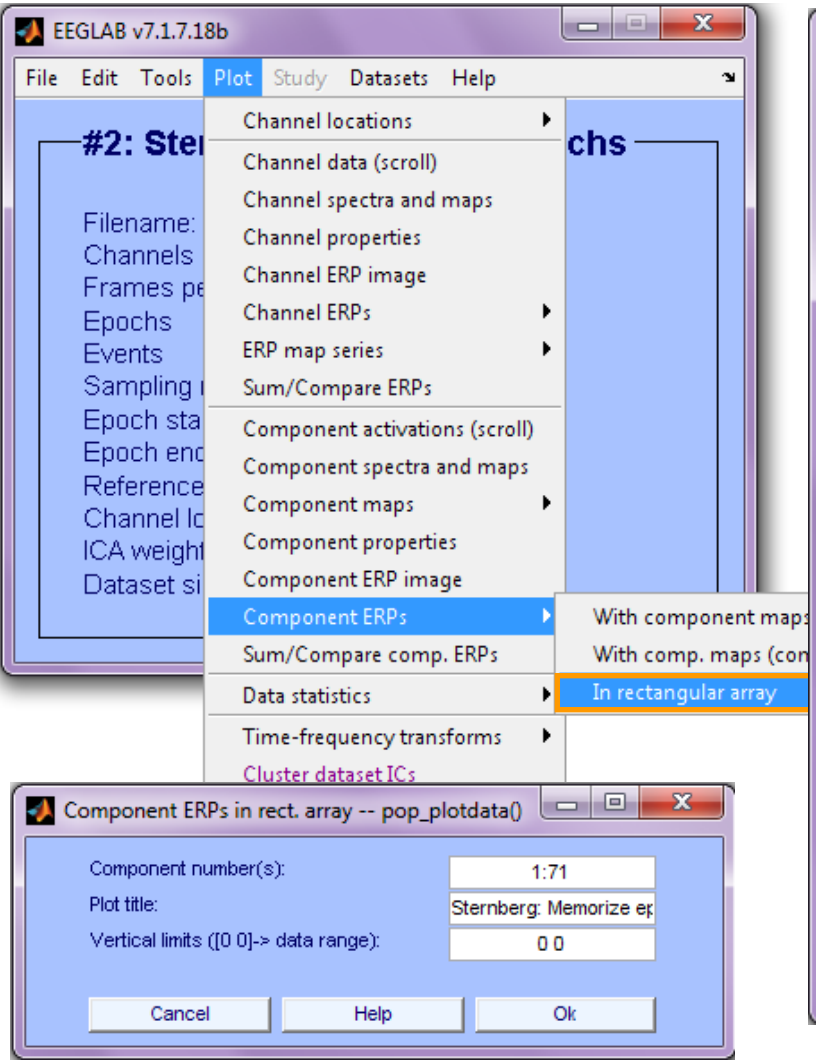
3) IC spectral power

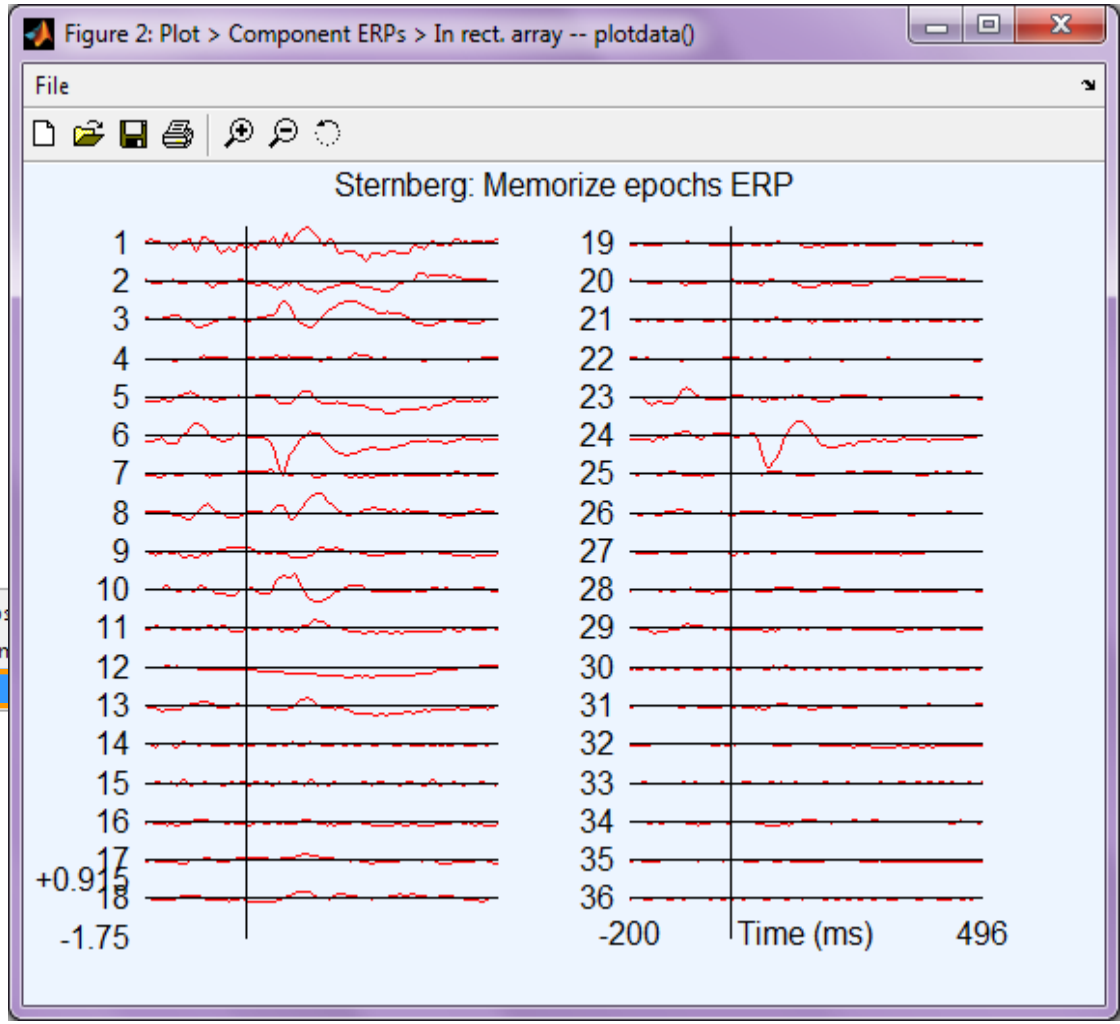
4) IC ERP images

5) IC ERSP

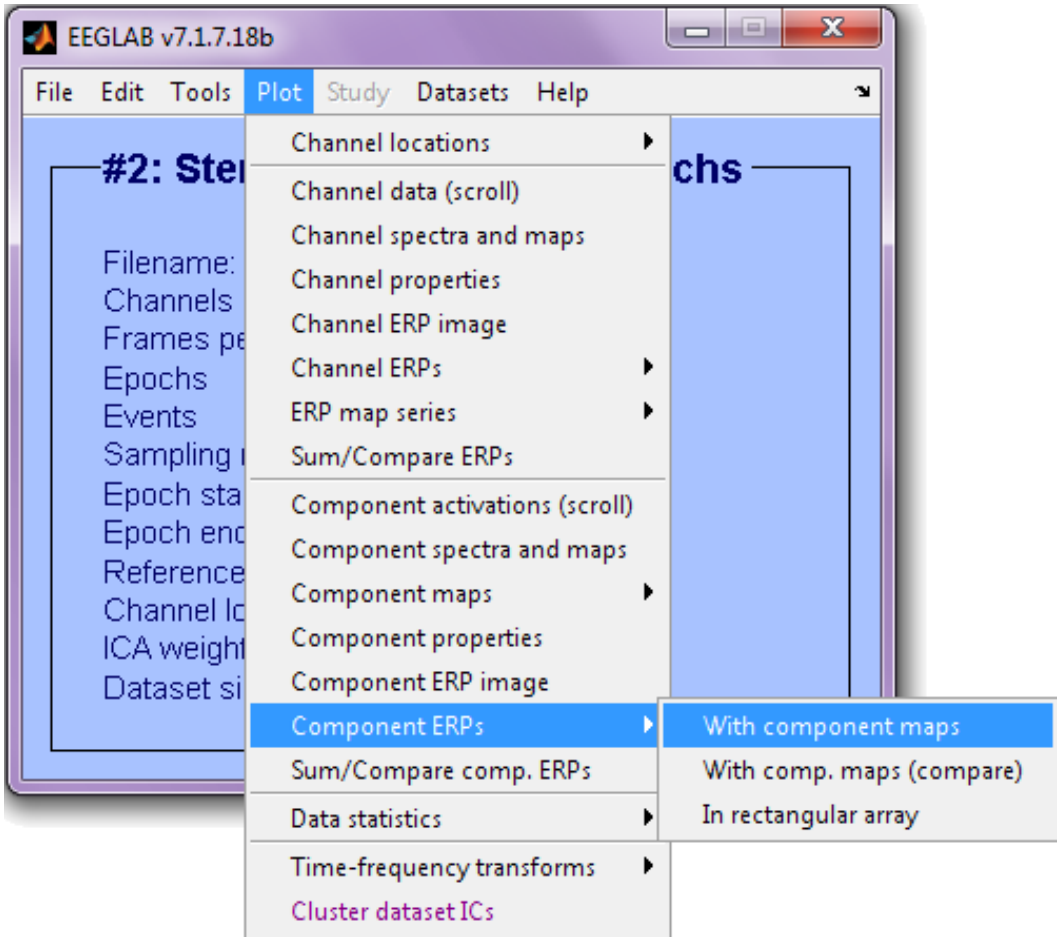
Component ERPs



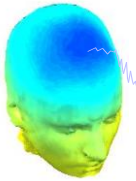


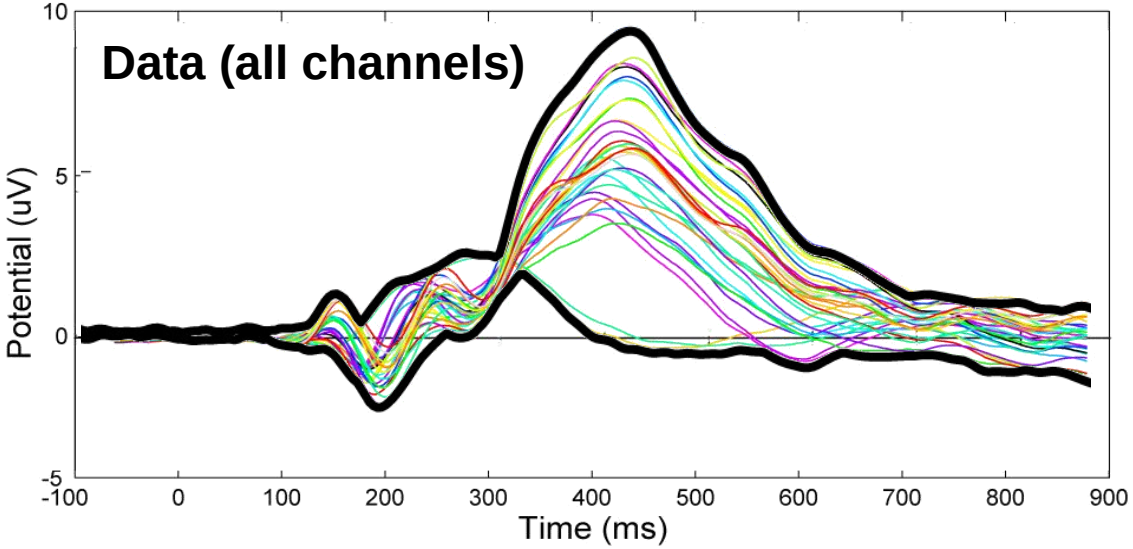


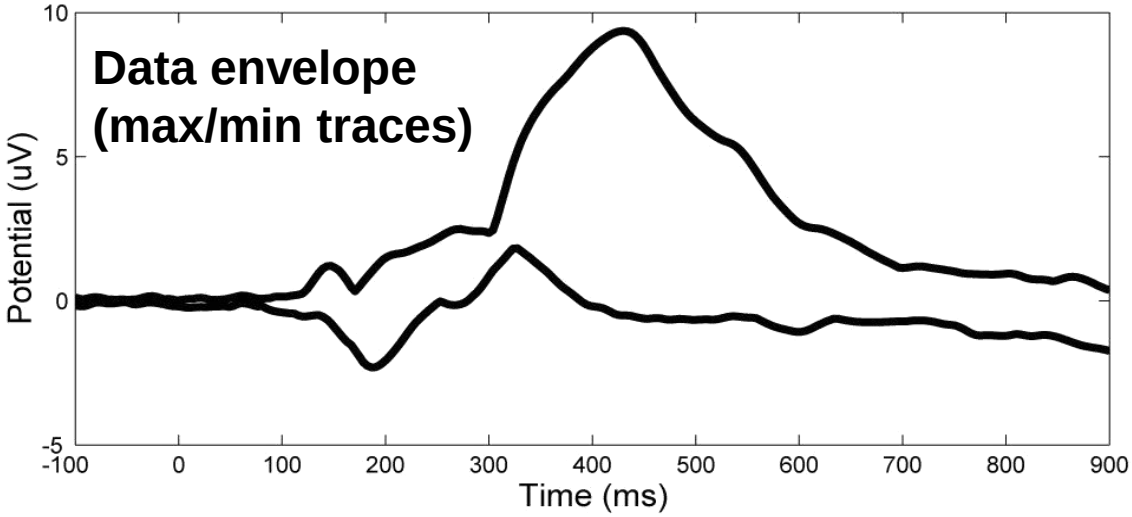
Component ERP envelope



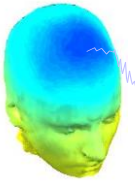
Definition: The data envelope

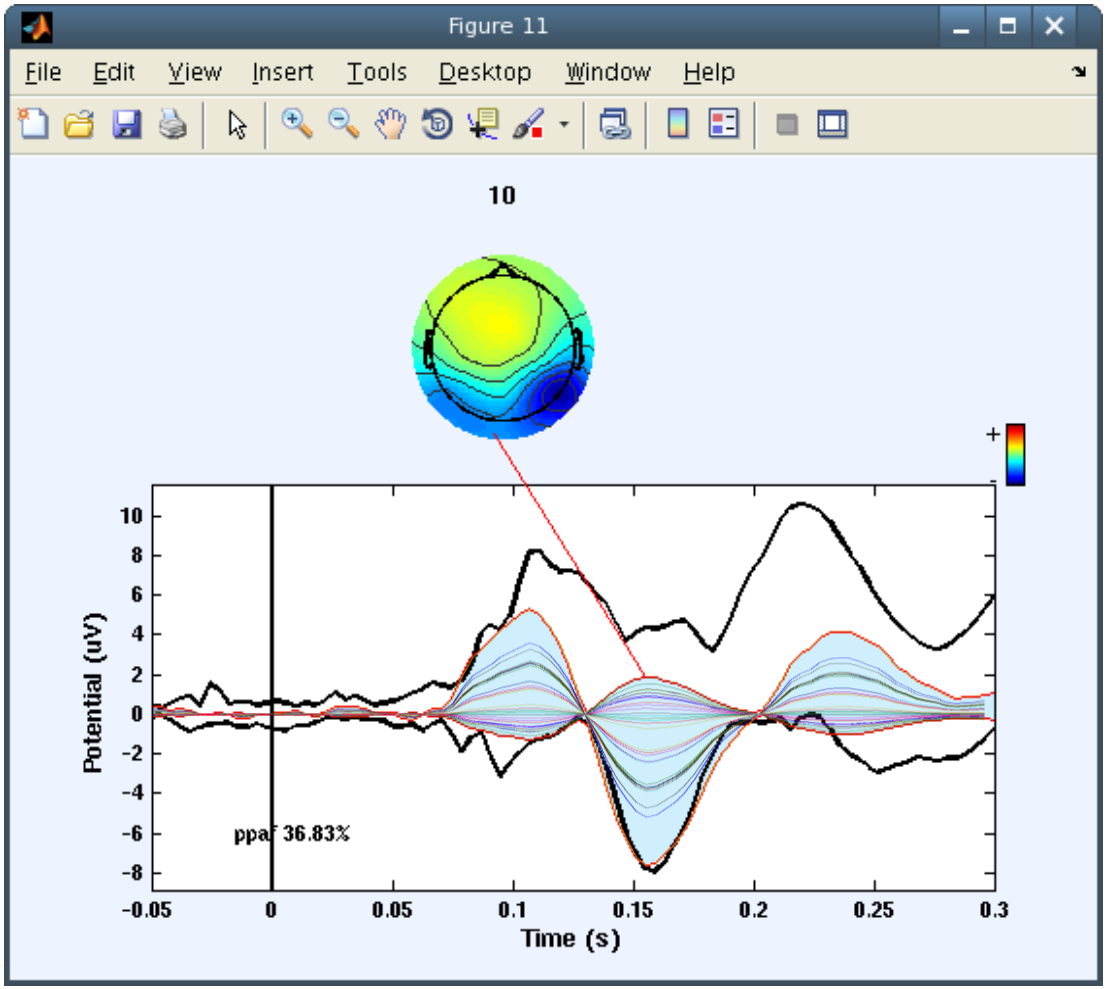




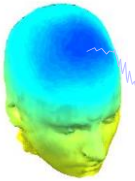


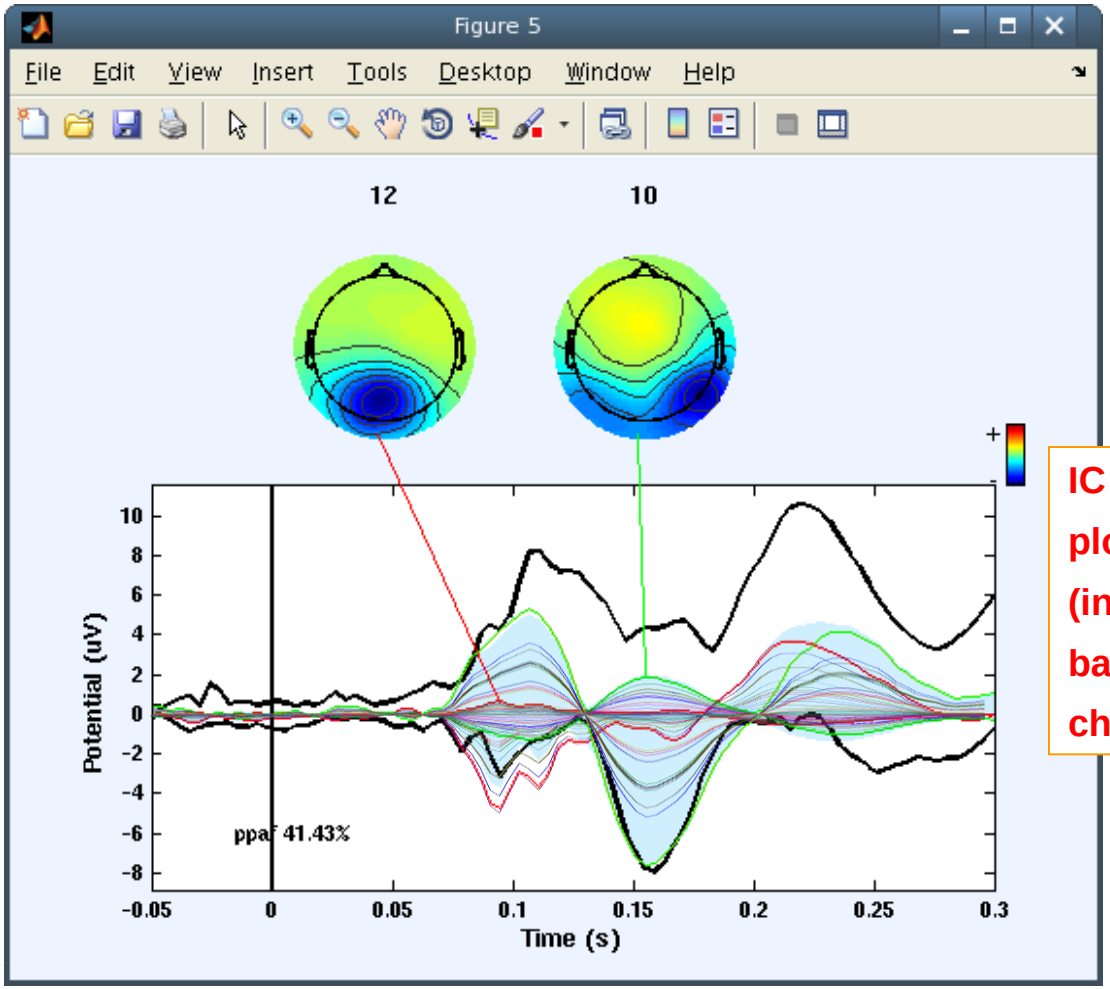
IC back-projection envelope





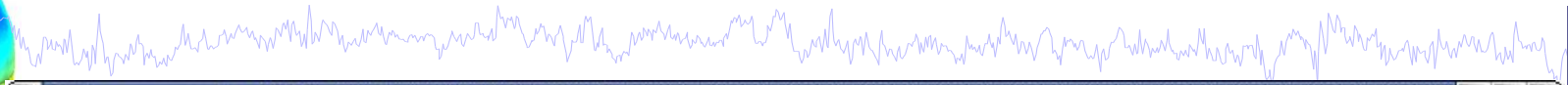
IC back-projection envelope





IC envelopes plotted for simplicity (instead of all back-projected channels)

IC contributions to ERP envelope



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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'

EEGLAB v7.1.7.18b

File Edit Tools Plot Study Datasets Help

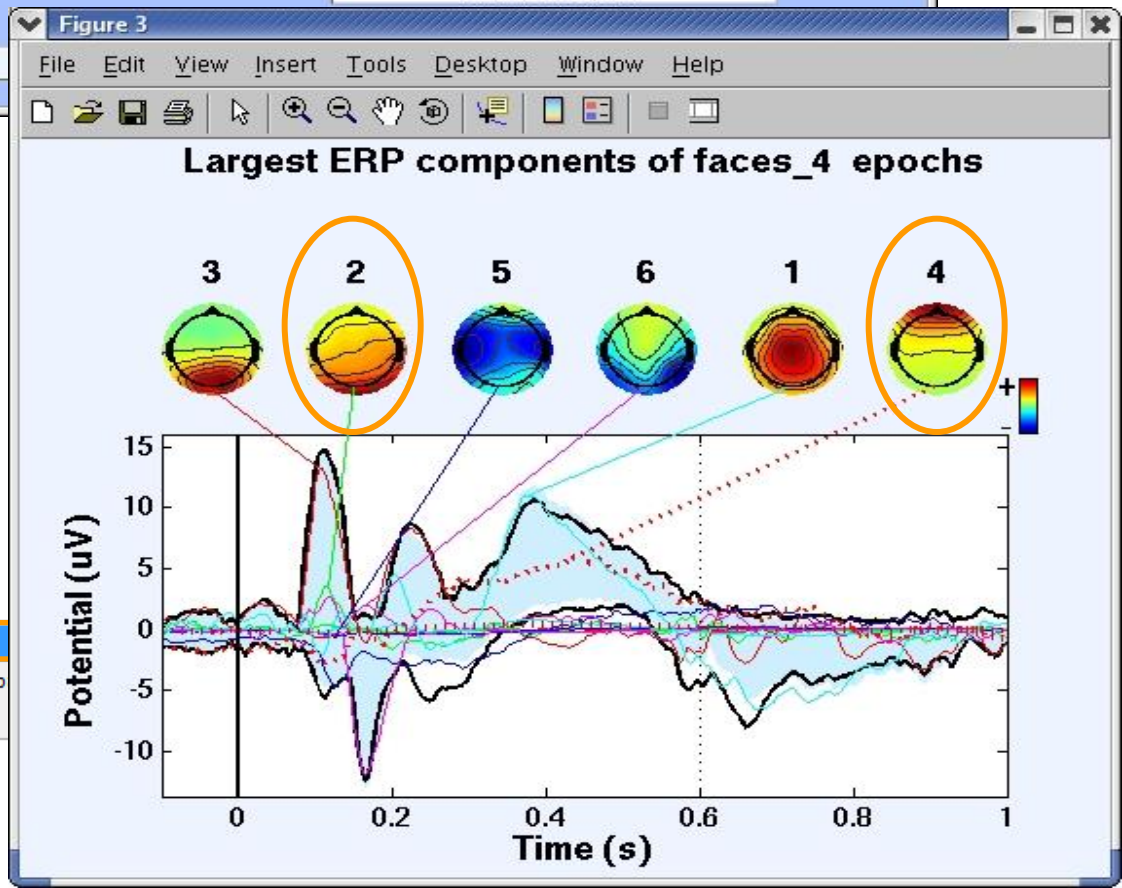
#2: Ste chs

Filename:
Channels
Frames pe
Epochs
Events
Sampling
Epoch sta
Epoch enc
Reference
Channel lo
ICA weight
Dataset si

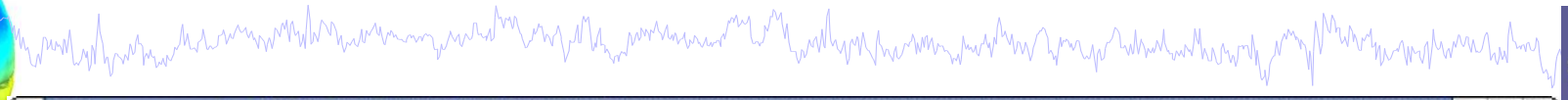
- Channel locations
- Channel data (scroll)
- Channel spectra and maps
- Channel properties
- Channel ERP image
- Channel ERPs
- ERP map series
- Sum/Compare ERPs
- Component activations (scroll)
- Component spectra and maps
- Component maps
- Component properties
- Component ERP image
- Component ERPs → With component maps / With comp. maps (comp / In rectangular array
- Sum/Compare comp. ERPs
- Data statistics
- Time-frequency transforms
- Cluster dataset ICs

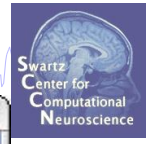
Figure 3

File Edit View Insert Tools Desktop Window Help



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):	
Component numbers to remove from data before plotting:	2, 4, 7, 9, 12, 17,18,25
Plot title:	ERP components of faces_4 epochs
Optional topoplot() and spectopo() arguments:	'electrodes','off'

Cancel

Artifact components

EEGLAB v6.0b

File Edit Tools Plot Study Datasets Help

#1: faces

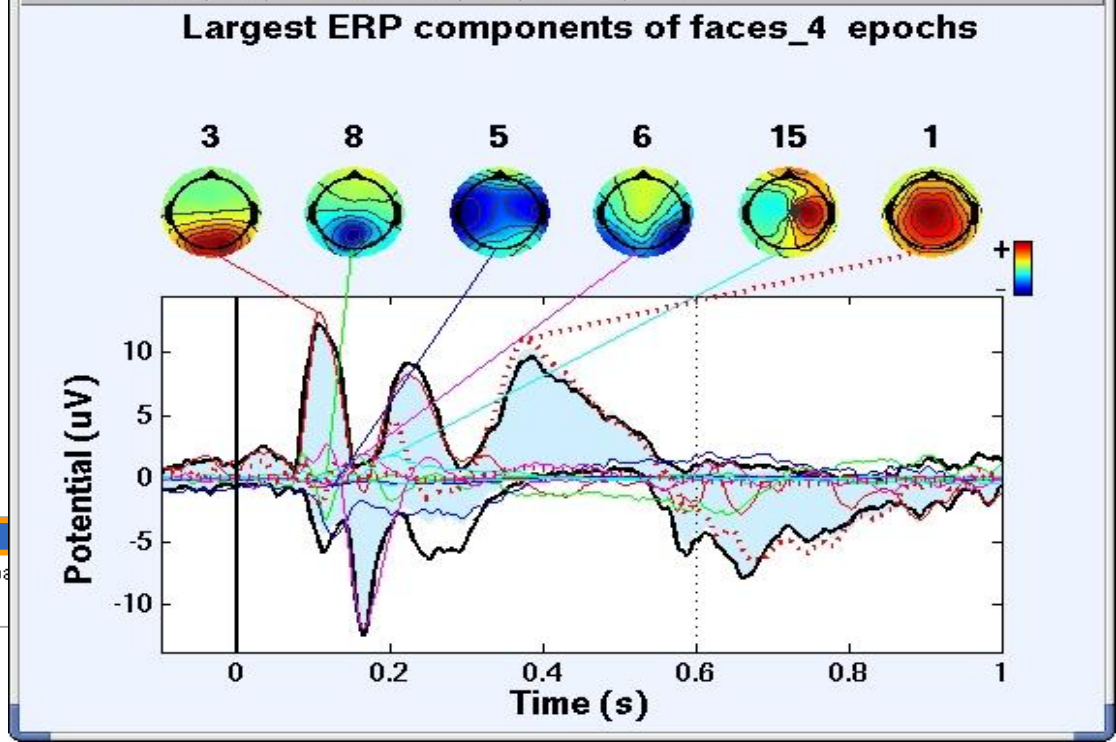
Filename: ...s
Channels pe
Frames per e
Epochs
Events
Sampling rat
Epoch start (
Epoch end (s
Average refe
Channel loca
ICA weights
Dataset size

- 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
- Average time-frequency
- Cluster dataset ICs

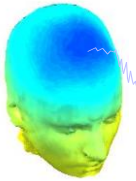
Component ERPs → With component maps / With comp. maps (compa / In rectangular array

Figure 5

File Edit View Insert Tools Desktop Window Help



Running ICA and Plotting Measures



1) Run ICA

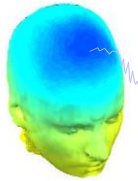
2) Plot IC ERPs

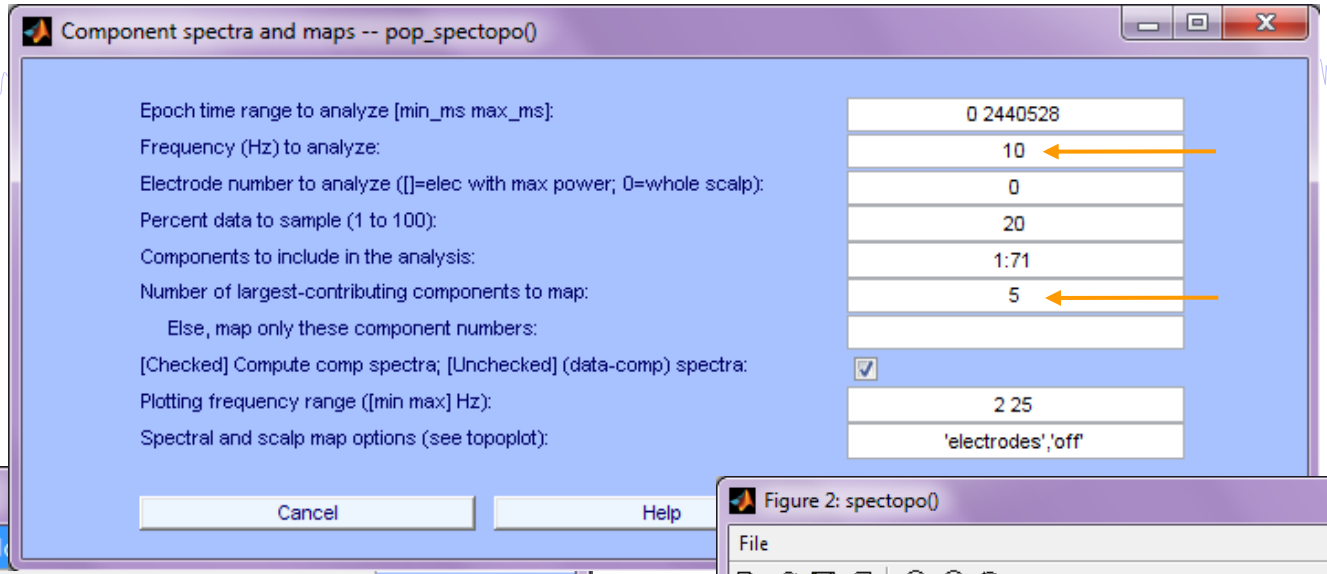
3) IC spectral power

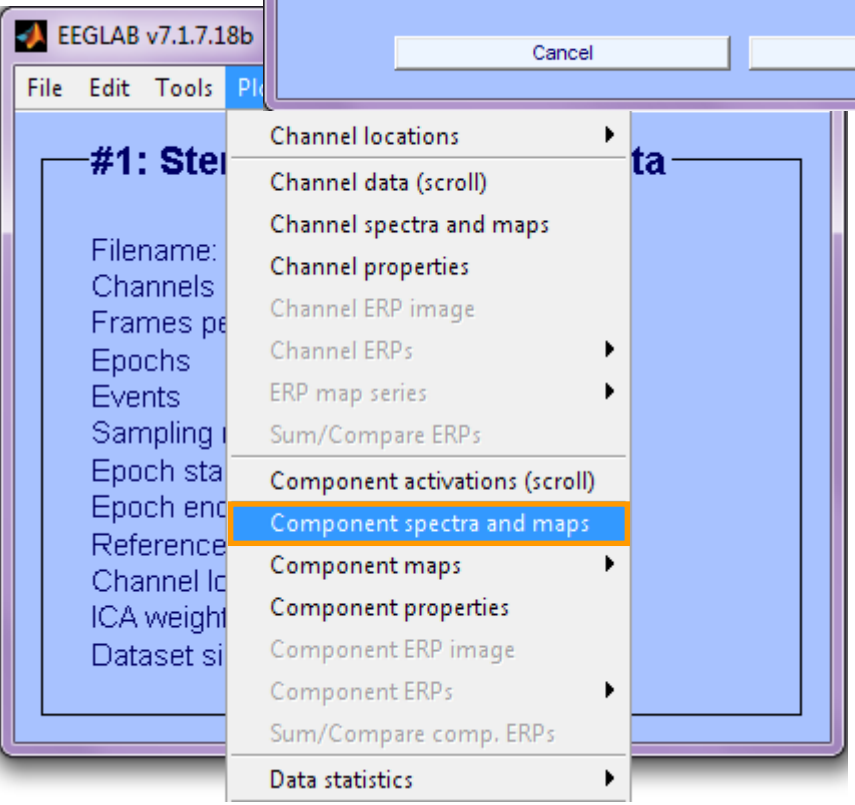
4) IC ERP images

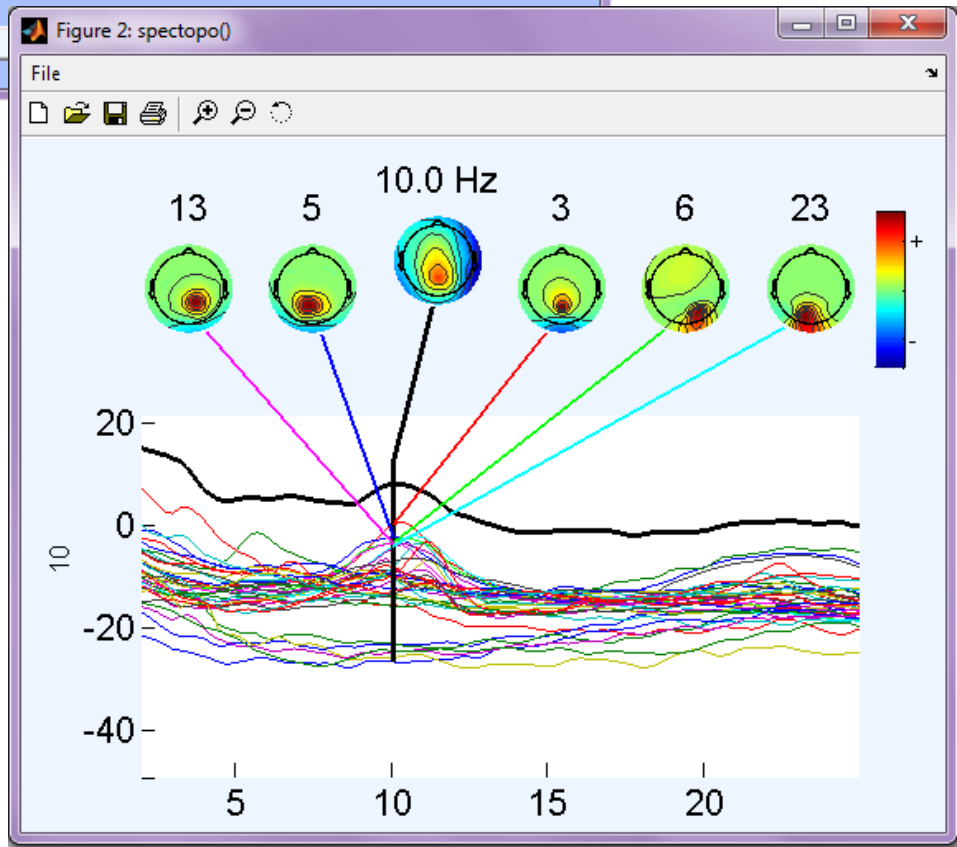
5) IC ERSP

Plot component power

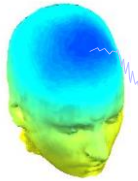


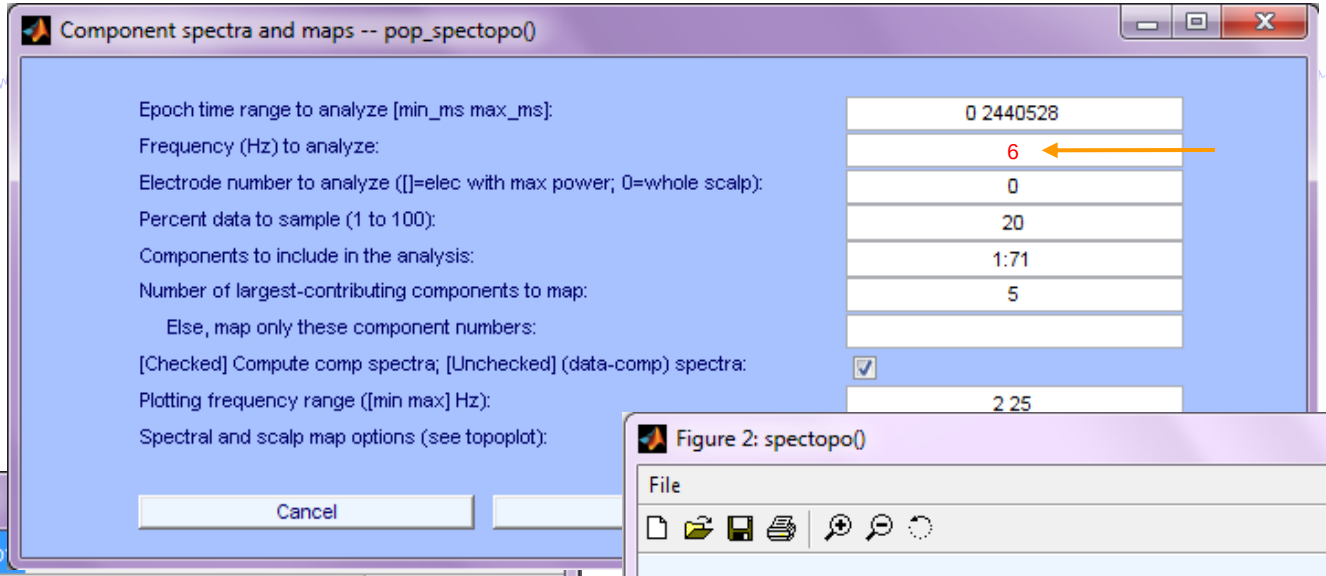


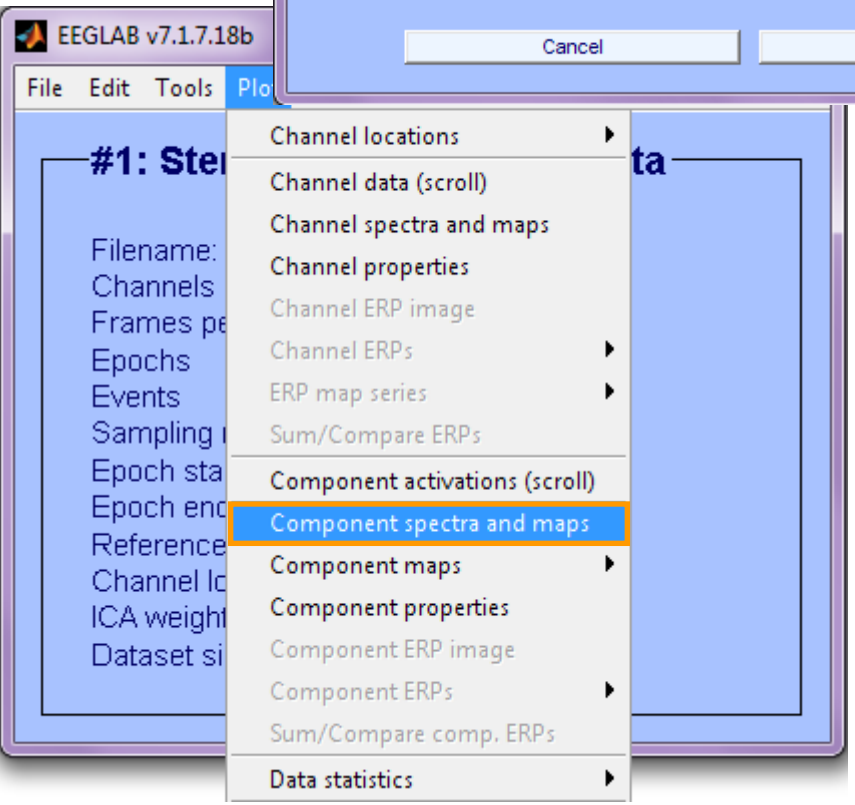


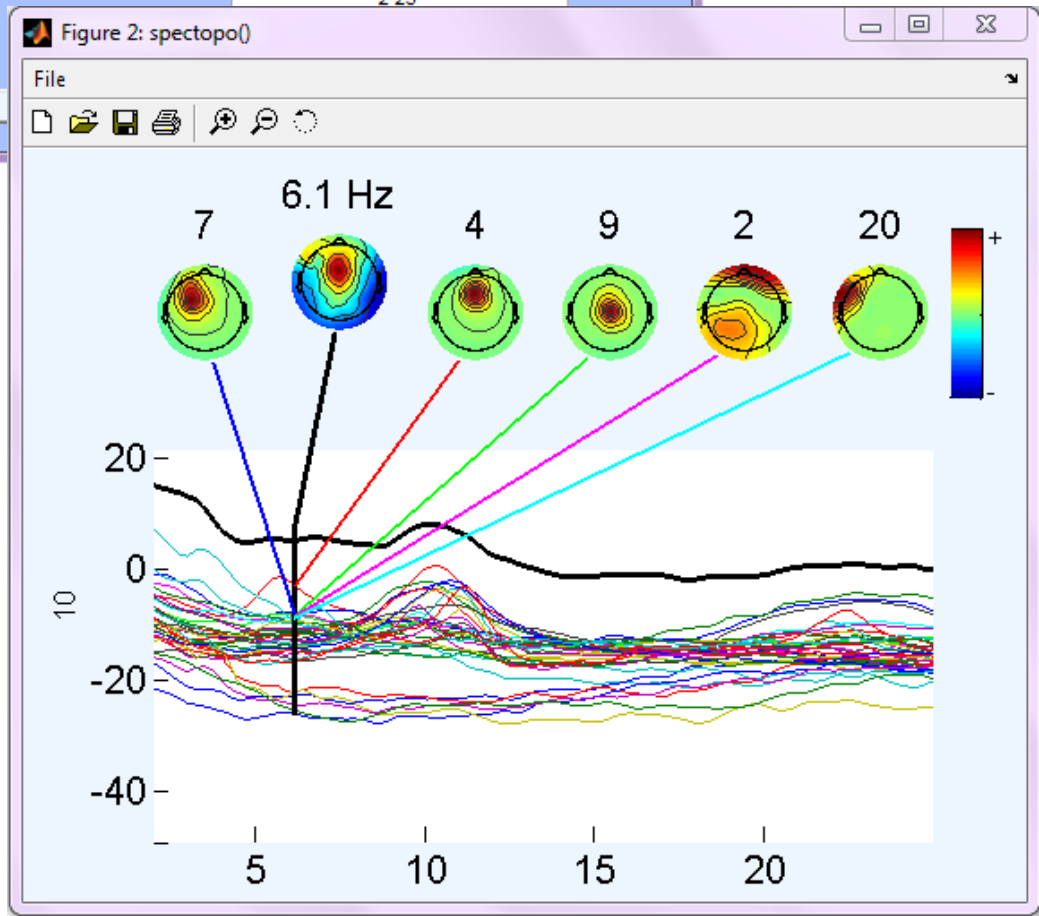


Plot component power



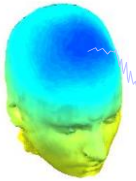






Swartz Center for Computational Neuroscience

Running ICA and Plotting Measures



1) Run ICA

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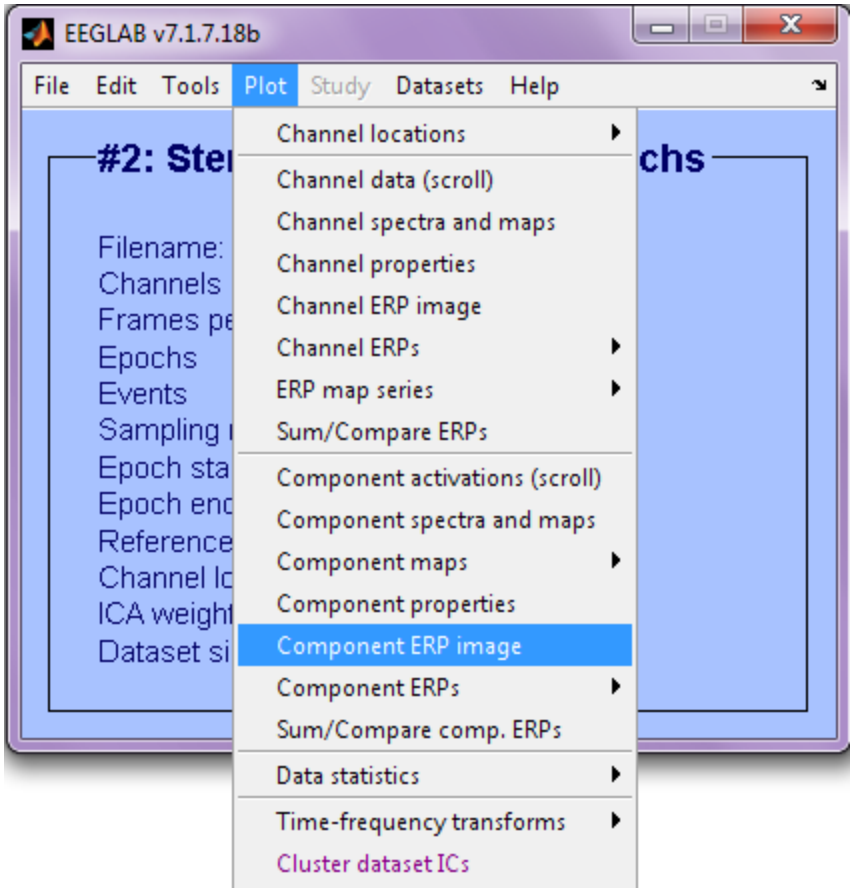
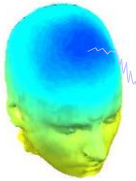
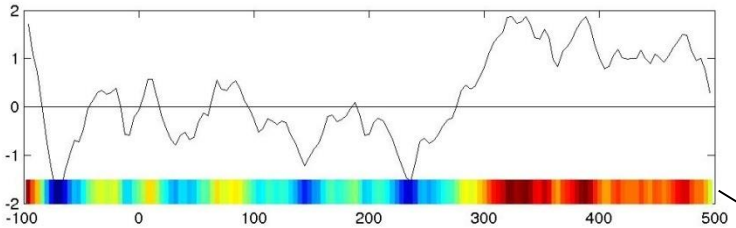
Component ERP image



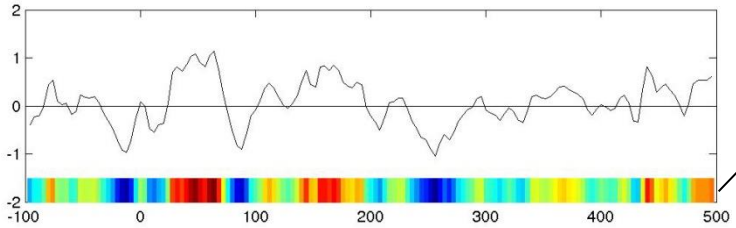
ERP Image basics



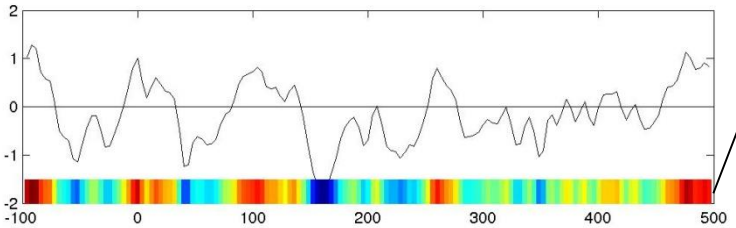
Trial 1



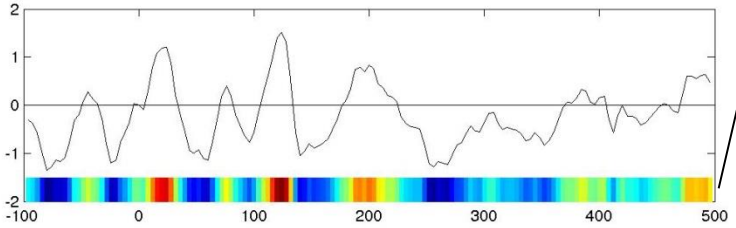
Trial 2



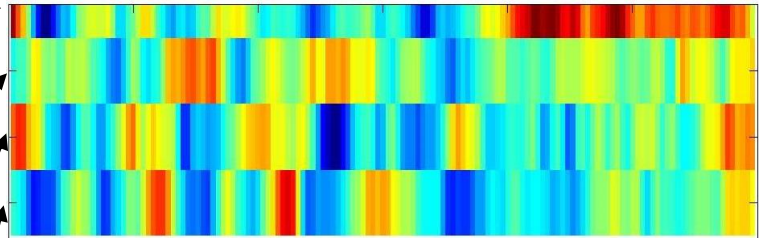
Trial 3



Trial 4

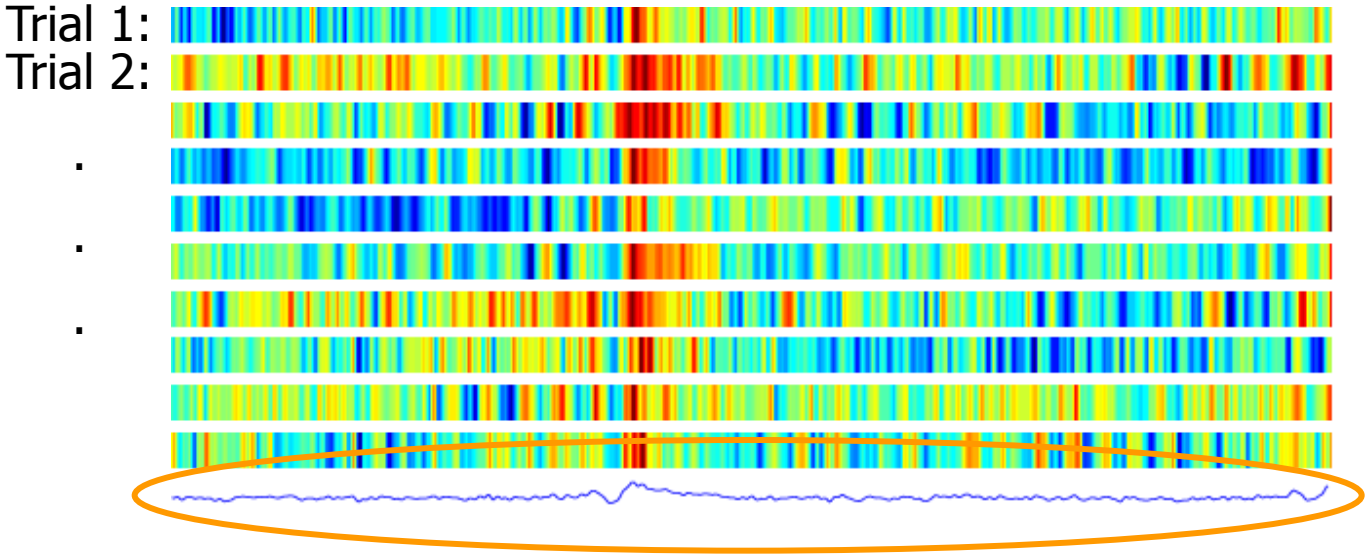


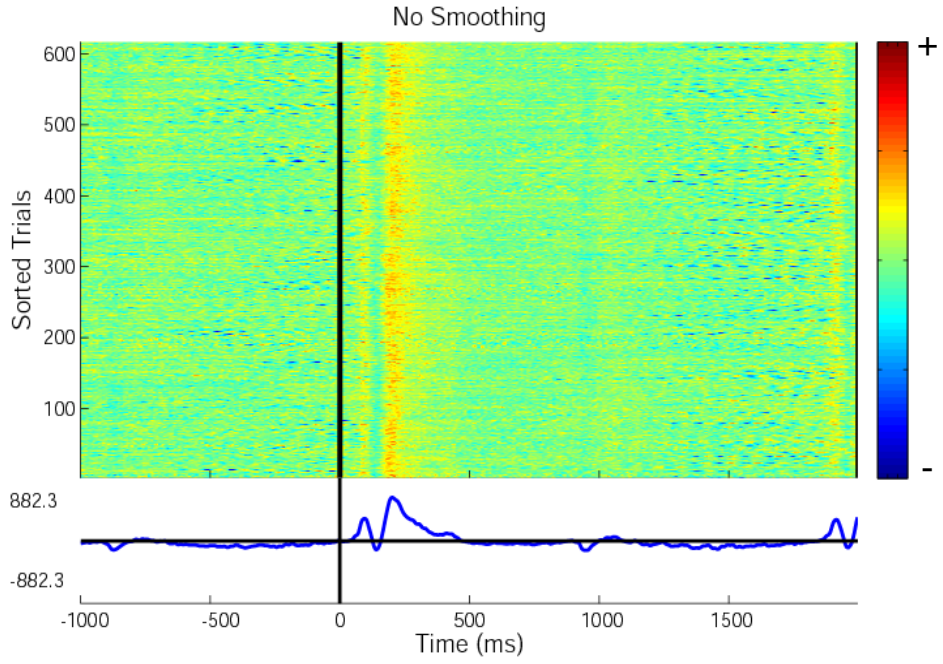
ERP Image

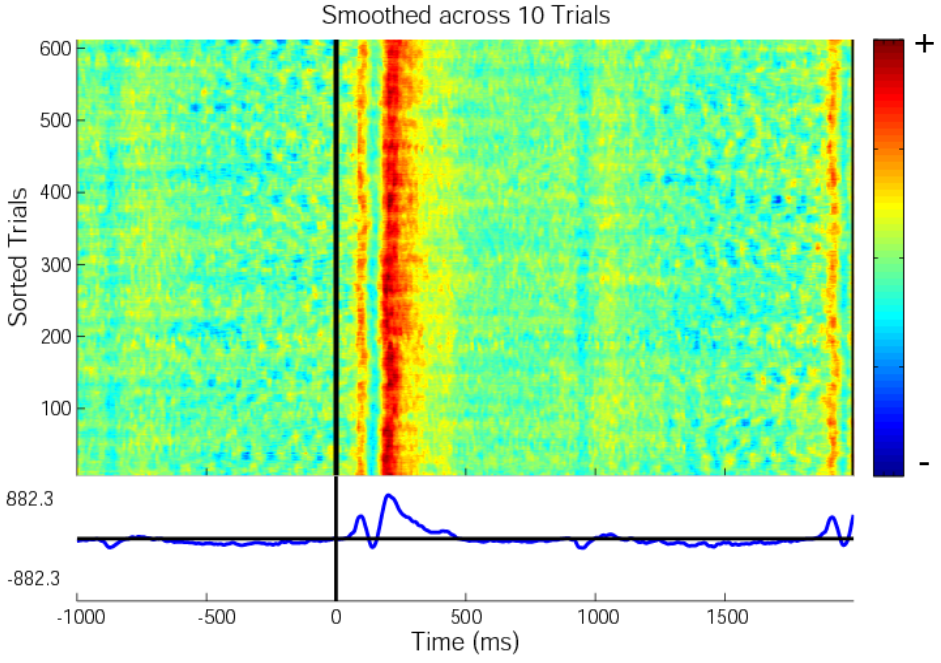


by default, sorted by time-on-task
(1st trial, 2nd trial, ...)

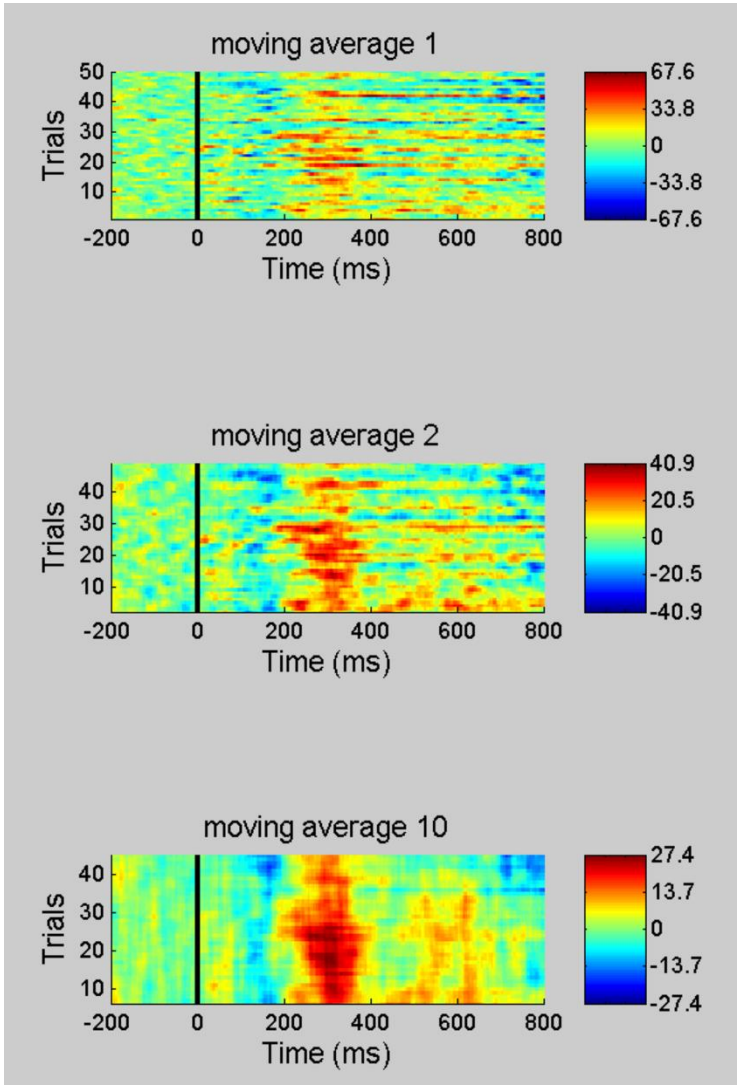
ERP Image basics



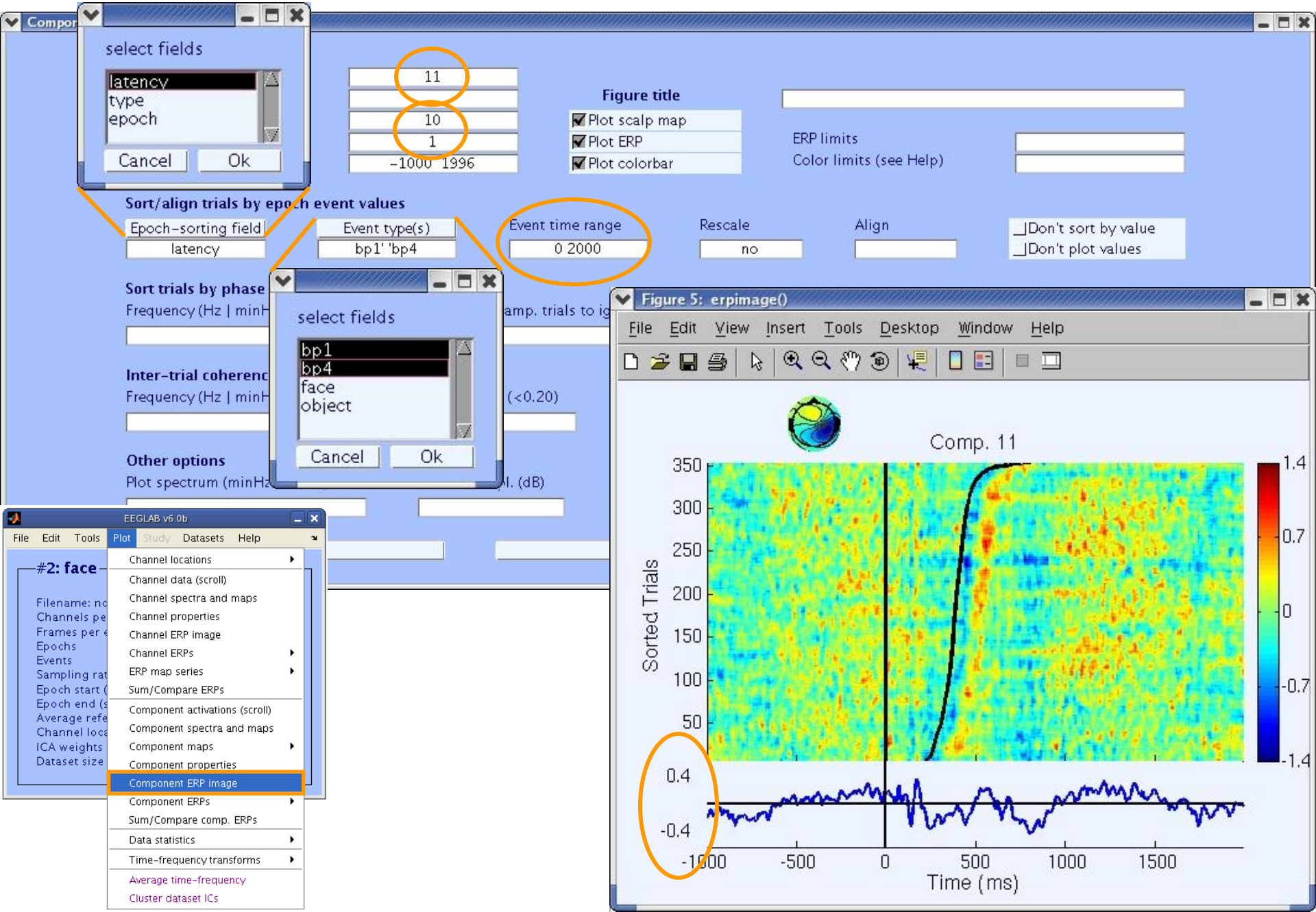




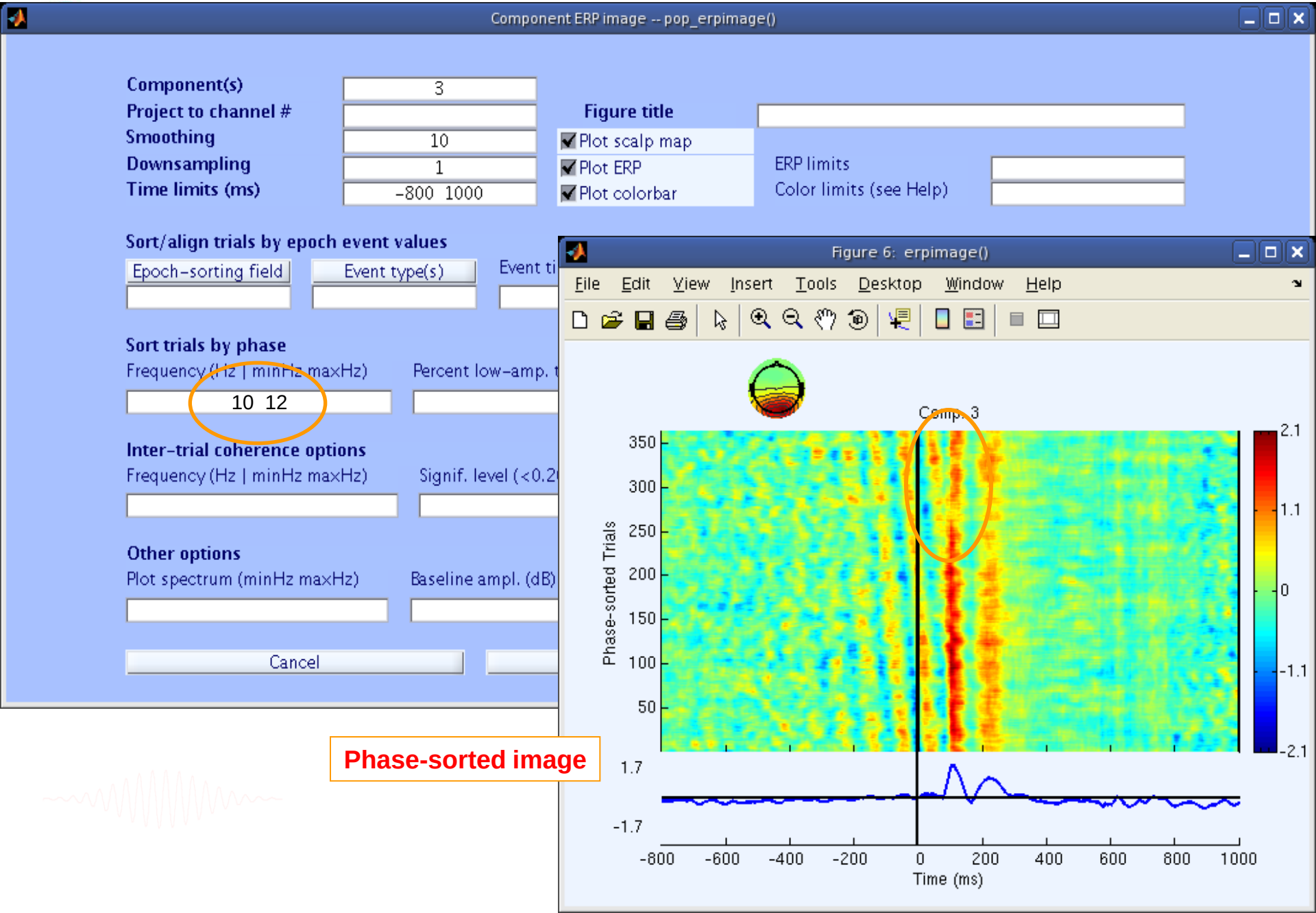
ERP Images: smoothing across trials



Component ERP Images

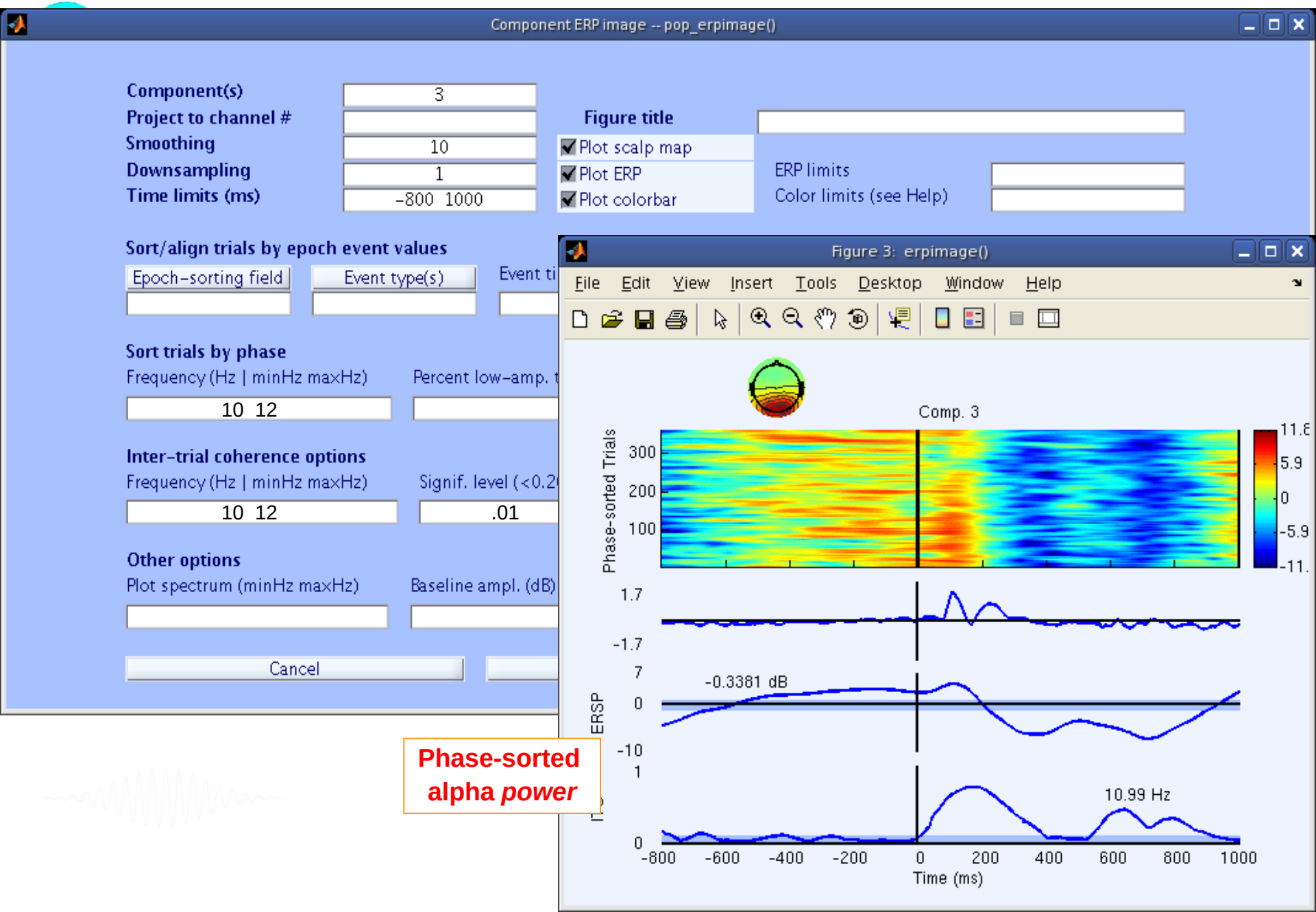


Component ERP Images



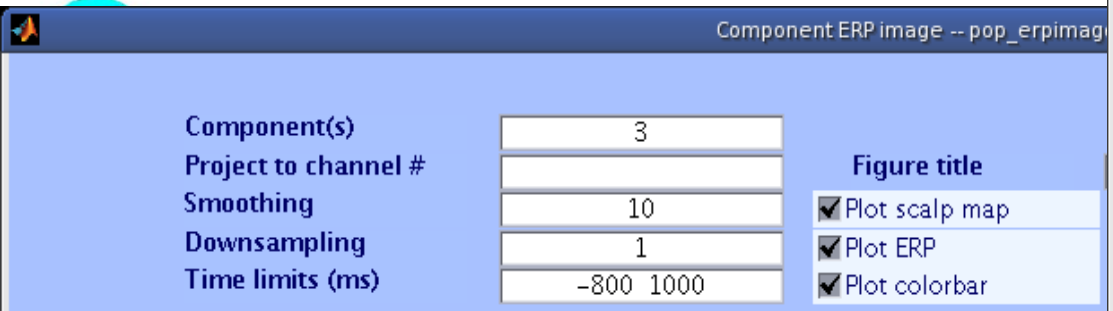
Phase-sorted image

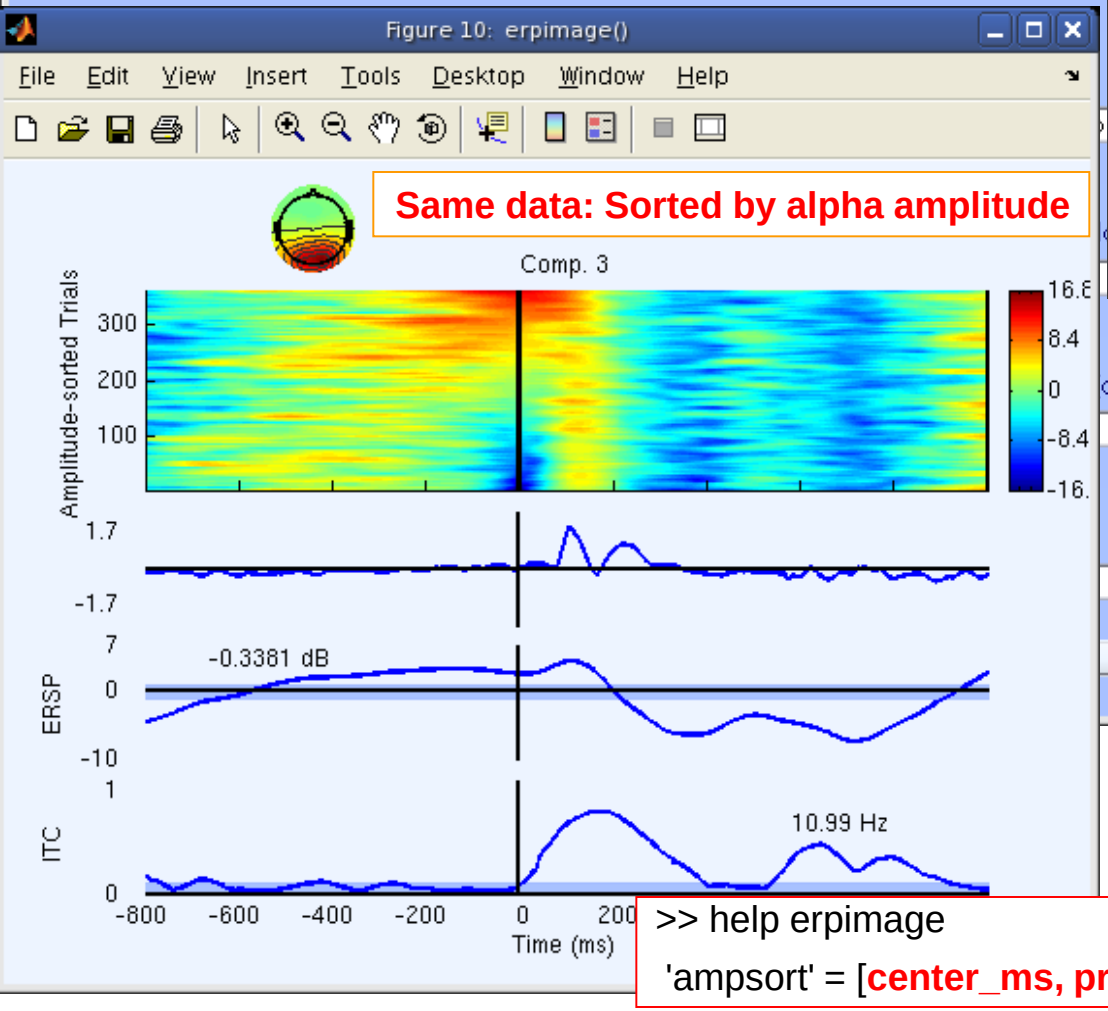
Component ERP Images

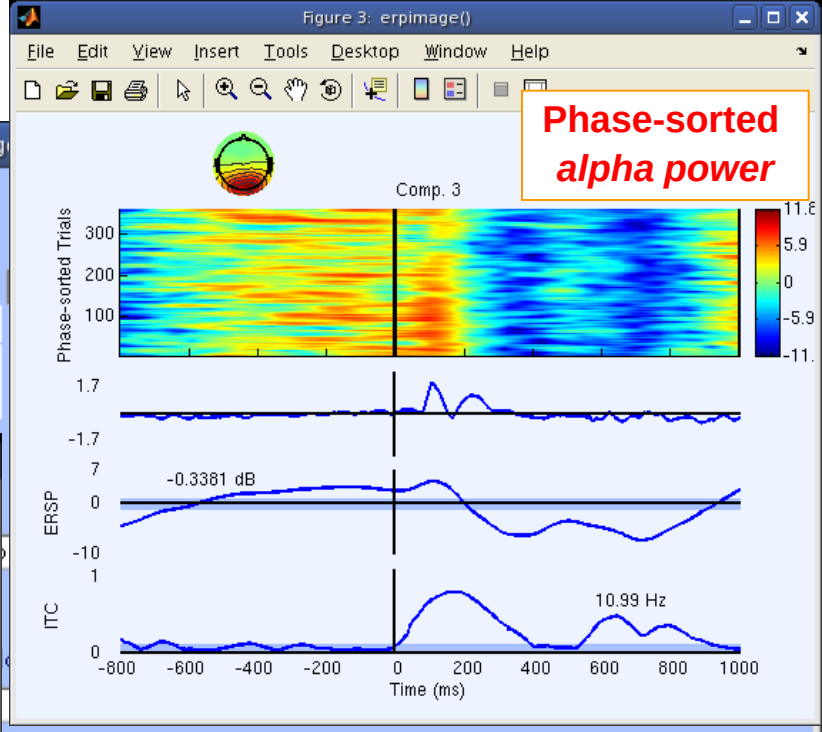


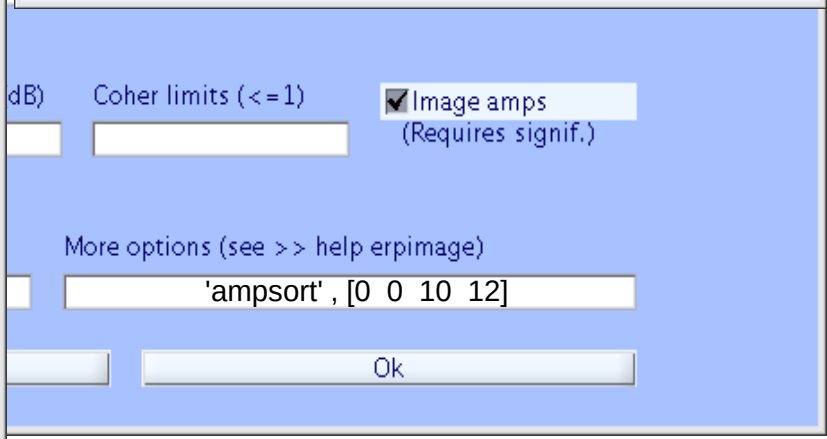
Phase-sorted alpha *power*

Component ERP





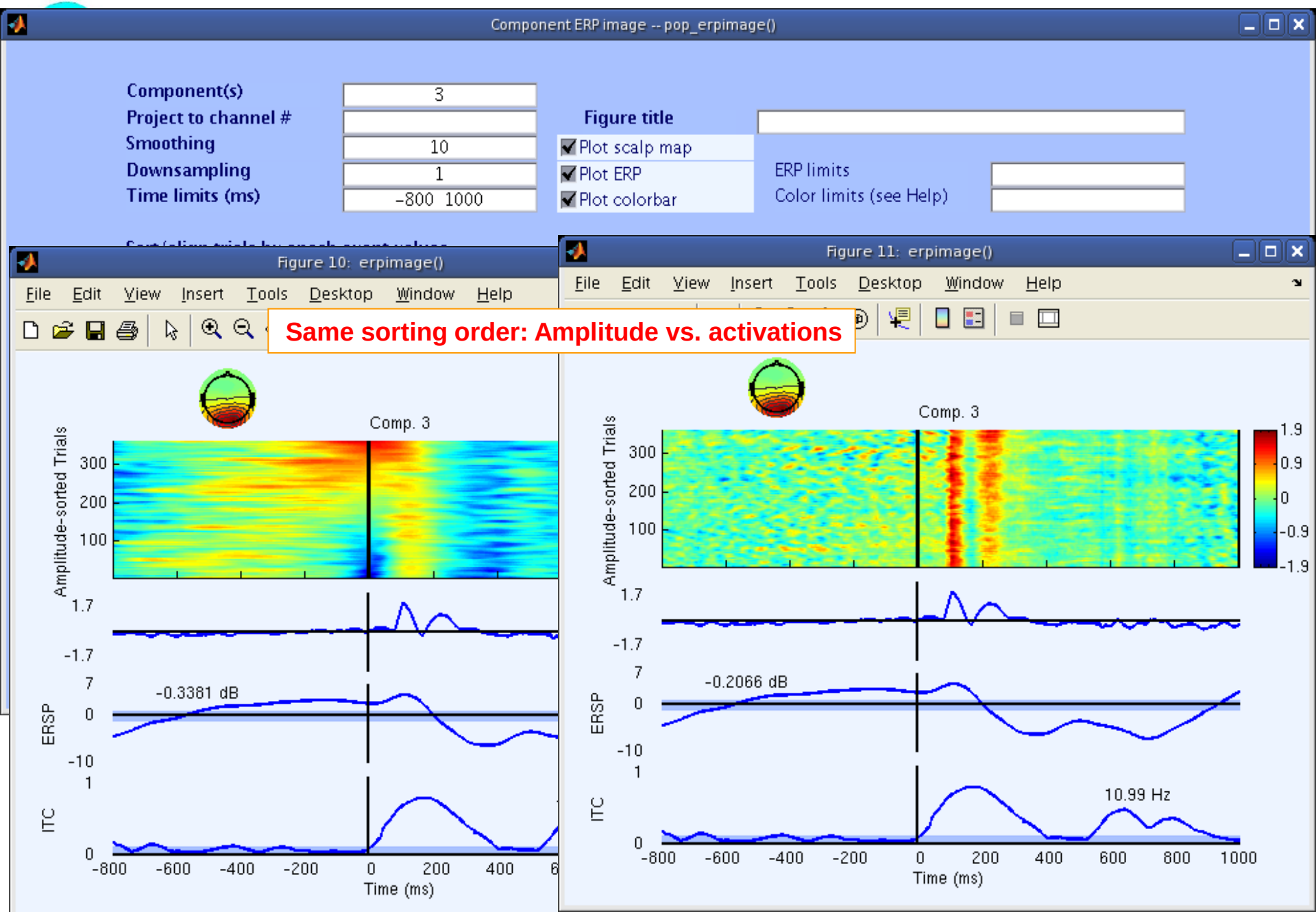




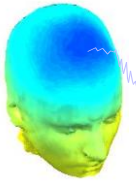
>> help erpimage

'ampsort' = [**center_ms, prcnt, freq, maxfreq**] Sort epochs by amplitude.

Component ERP Images



Running ICA and Plotting Measures



1) Run ICA

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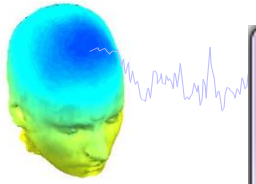
Plot IC ERSP



Plot component time frequency -- pop_newtimef()

Component number 3
Sub epoch time limits [min max] (msec) -1000 1996
Frequency limits [min max] (Hz) or sequence
Baseline limits [min max] (msec) (0->pre-stim.) 0
Wavelet cycles [min max/fact] or sequence 3 0.5
ERSP color limits [max] (min=
ITC color limits [max]
Bootstrap significance level (
Optional newtimef() argumen

Use 200 time points
Use limits, padding 1
Use divisive baseline
Use limits
Log spaced
No baseline
Use FFT

Plot Event Related Spectral Po
Cancel

EEGLAB v7.1.7.18b

File Edit Tools Plot

#2: Ste

Filename:
Channels
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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
Cluster dataset ICs

Channel t
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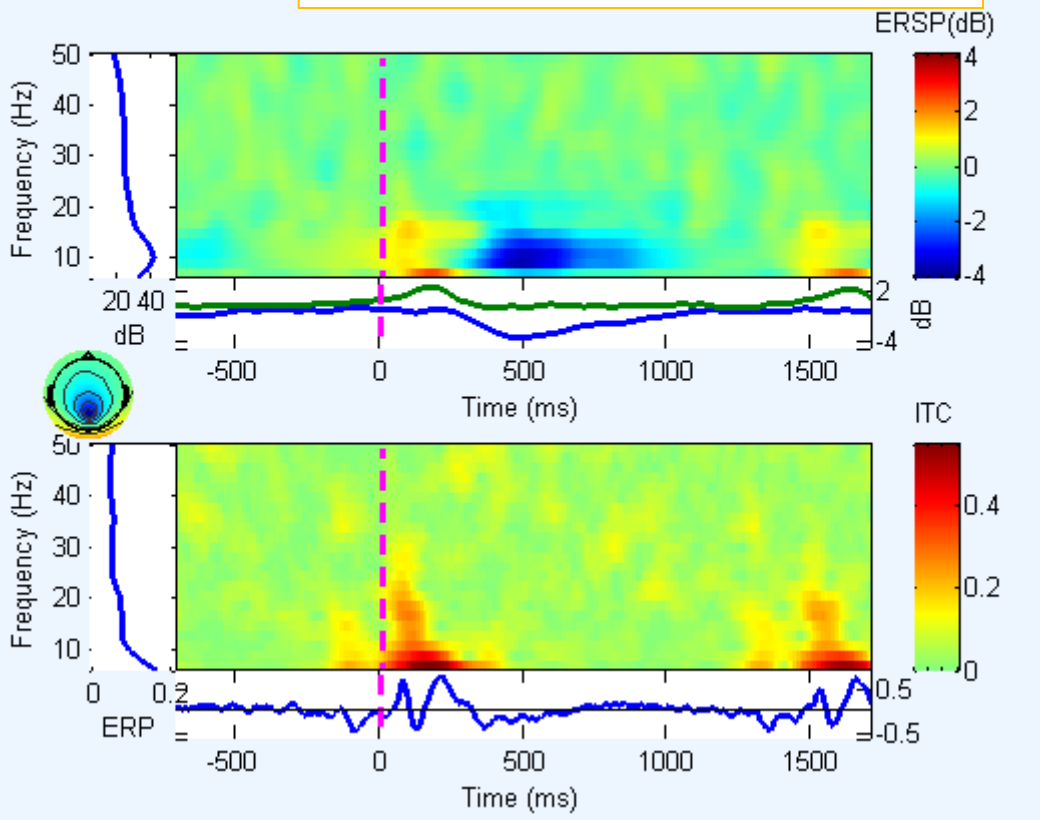
Compone

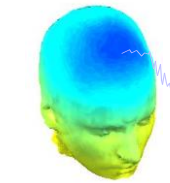
Figure 3

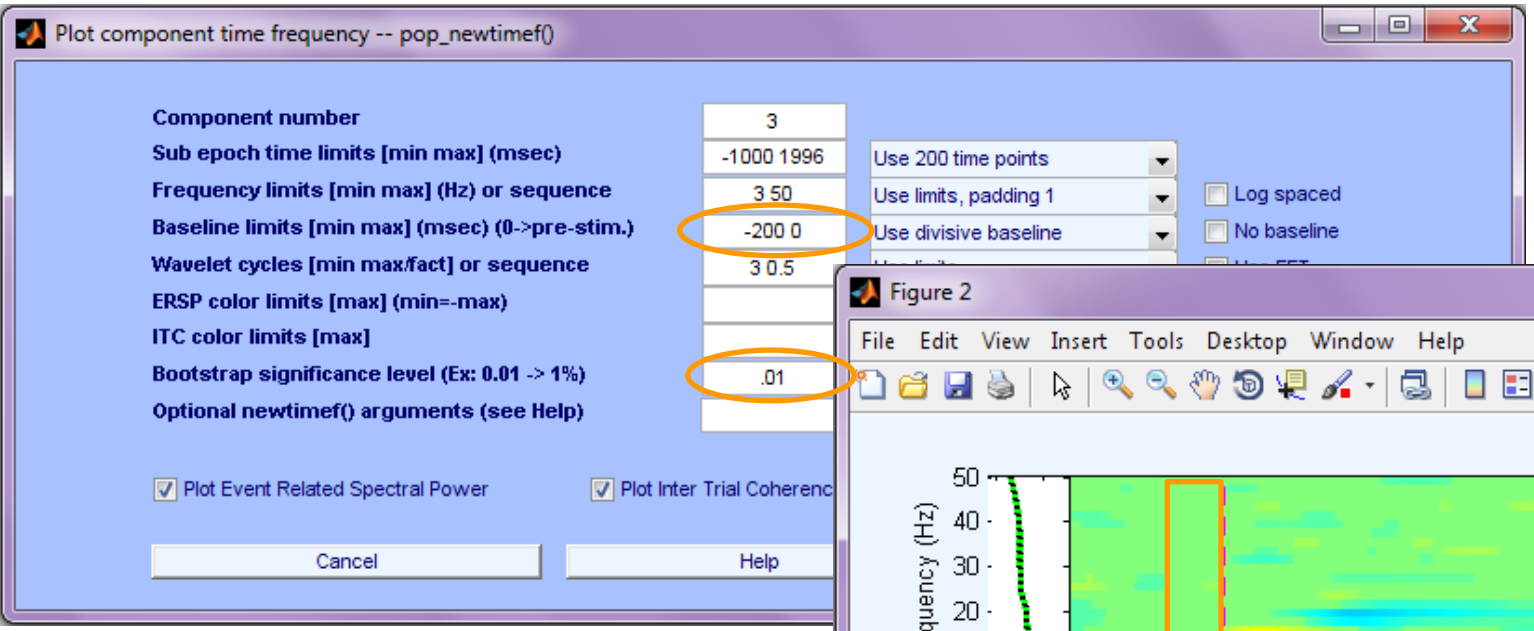
File

Time points lost at beginning and end of epoch



Plot IC ERSP




Plot component time frequency -- pop_newtimef()
Component number
3
Sub epoch time limits [min max] (msec)
-1000 1996
Use 200 time points
Frequency limits [min max] (Hz) or sequence
3 50
Use limits, padding 1
Log spaced
Baseline limits [min max] (msec) (0->pre-stim.)
-200 0
Use divisive baseline
No baseline
Wavelet cycles [min max/fact] or sequence
3 0.5
ERSP color limits [max] (min=-max)
ITC color limits [max]
Bootstrap significance level (Ex: 0.01 -> 1%)
.01
Optional newtimef() arguments (see Help)
Plot Event Related Spectral Power
Plot Inter Trial Coherenc
Cancel
Help

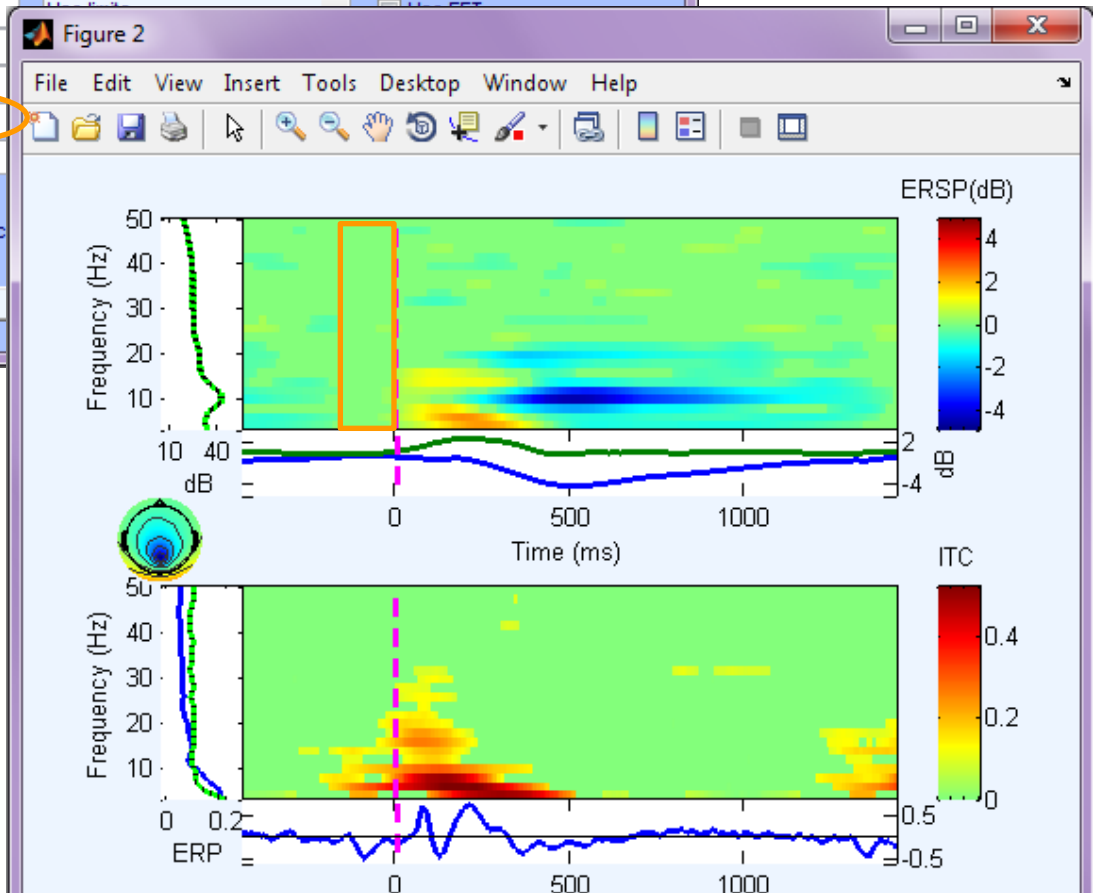
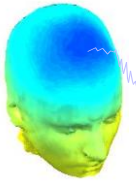


Figure 2
File Edit View Insert Tools Desktop Window Help
ERSP(dB)
Frequency (Hz)
50
40
30
20
10
10 40
dB
0
500
1000
Time (ms)
4
2
0
-2
-4
dB
ITC
0.4
0.2
0
0 0.2
ERP
0.5
-0.5

Exercise



- **ALL**

  - Load stern_125Hz.set (has ICA weights already) or SimpleOddball.set
  - Epoch on Memorize letters (or event of choice), reject noise

- **Novice / Intermediate**

  - From the GUI, plot component ERPs with maps
  - Pick an interesting IC and plot an ERP image of it
  - Try sorting by phase, is there any relationship to the IC activation pattern? What about power in a frequency band of choice?
  - Plot ERSPs for selected ICs
    - ~ Compare FFT, wavelet(s), and multi-taper methods for ERSP