Evaluating ICs

1. Apply ICA weights
2. IC scalp map interpretation
3. Basic IC evaluation
4. Identify IC artifacts

ICA weights in EEG structure

MATLAB 7.6.0 (R2008a)

File Edit Debug Parallel Desktop Window Help

Shortcuts How to Add What's New

New to MATLAB? Watch this Video, see Demos, or read Getting Started.

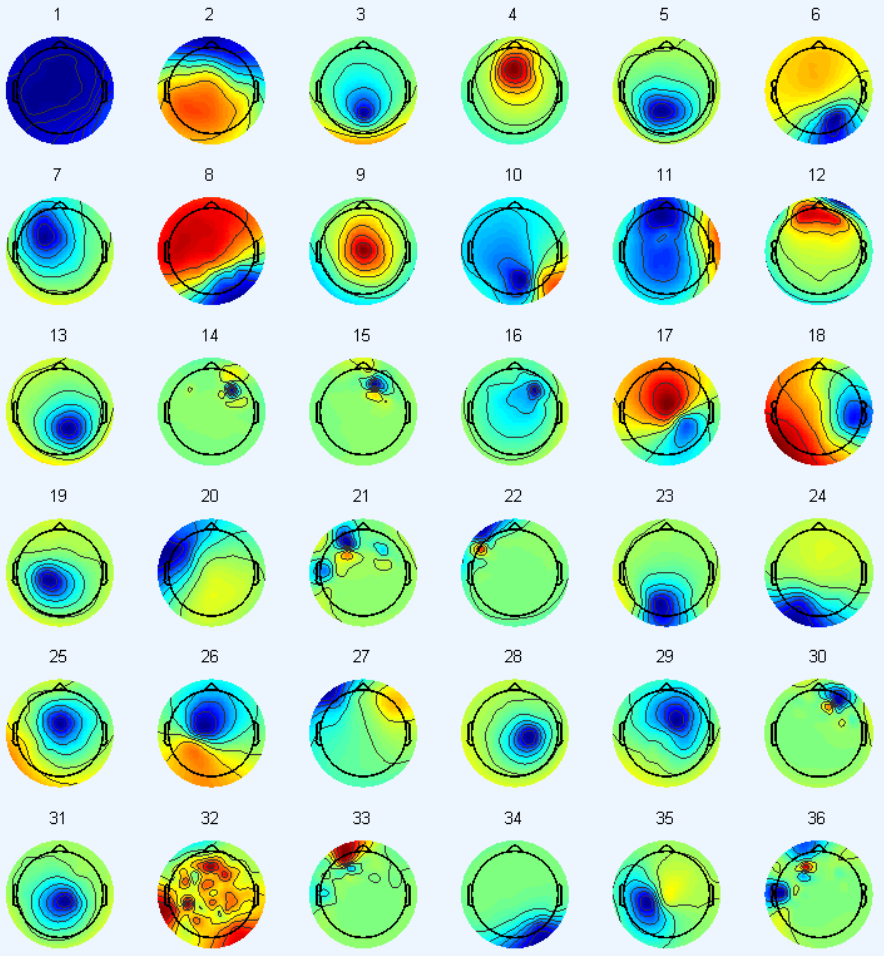
```
EEG =

            setname: 'Sternberg Continuous Data'
           filename: 'stern.set'
           filepath: [1x50 char]
            subject: ''
              group: ''
          condition: ''
            session: []
           comments: [22x108 char]
             nbchan: 71
             trials: 1
               pnts: 610133
              srate: 250
               xmin: 0
               xmax: 2.4405e+003
              times: []
               data: [71x610133 double]
            icaact: [71x610133 double]
          * icawinv: [71x71 double]
          * icasphere: [71x71 double]
        icaweights: [71x71 double]
      icachansind: [1x71 double]
         chanlocs: []
       urchanlocs: []
         chaninfo: [1x1 struct]
              ref: 'common'
            event: [1x1303 struct]
          urevent: [1x1303 struct]
  eventdescription: {1x15 cell}
```

Start OVR

Figure 4

Edit View Insert Tools Desktop Window Help

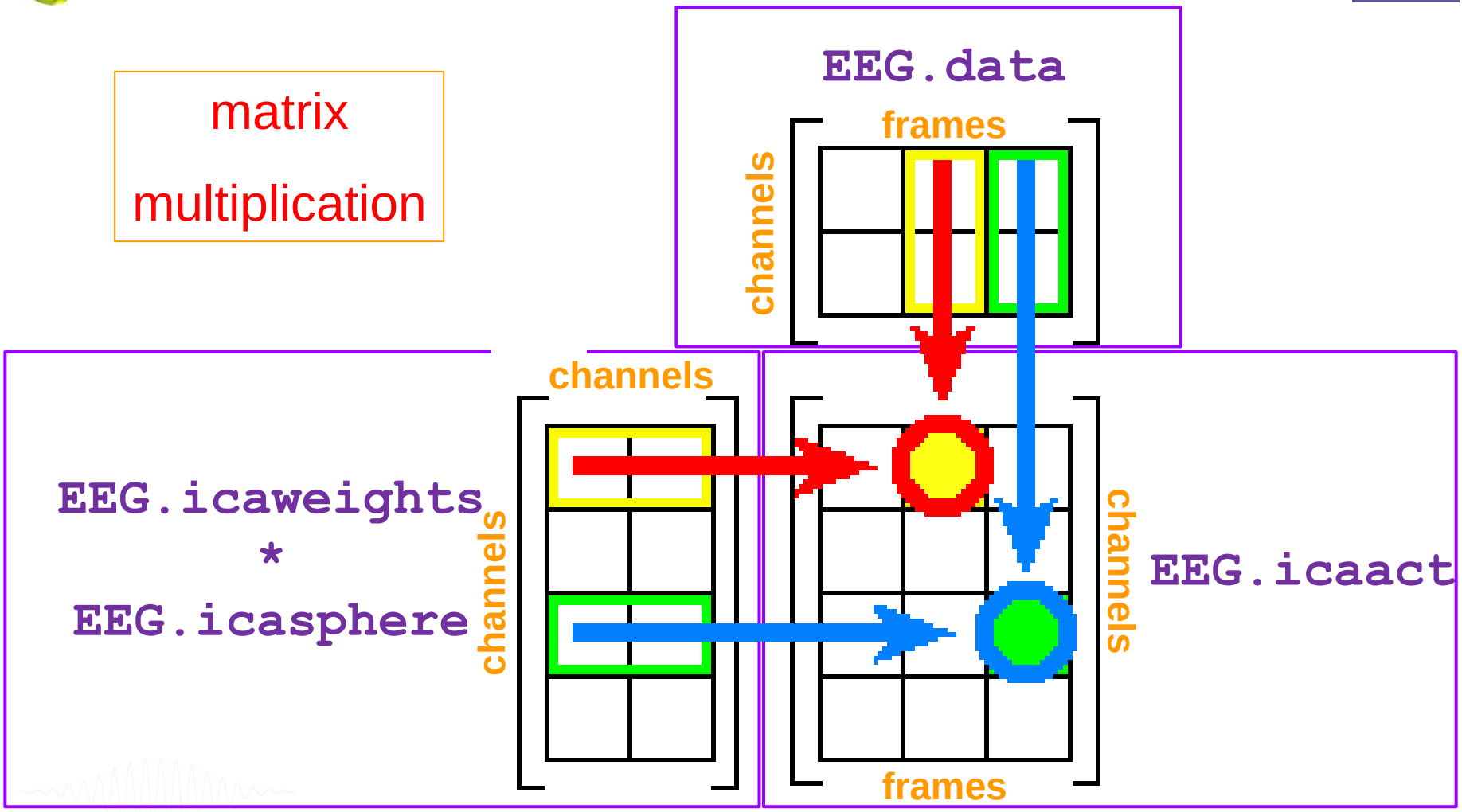


EEG.icawinv = inv(EEG.icaweights * EEG.icasphere)

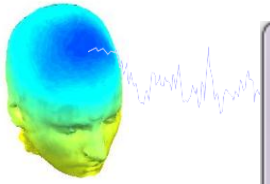
Applying ICA weights to EEG data

matrix

multiplication



Applying ICA weights to EEG data



Edit dataset information - pop_editset()

Dataset name jo74 Sternberg Data

Data sampling rate (Hz)	250	Subject code	
Time points per epoch (0->continuous)	750	Task condition	
Start time (sec) (only for data epochs)	-1	Session number	
Number of channels (0->set from data)	71	Subject group	
Ref. channel indices or mode (see help)	common	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

ICA channel indices (by default all): From other dataset

Help

EEGLAB v10.2.2.1b

File Edit Tools Plot

Dataset info
Event fields
Event values
About this data
Channel locatio...
Select data
Select data using events
Select epochs or events
Copy current dataset
Append datasets

Select a text file

Look in: StemSubj

NewICA71.sph
NewICA71.wts

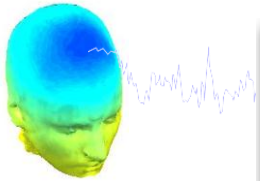
Recent Places
Desktop
Libraries
Computer
Network

File name: NewICA71.wts Open

Files of type: All Files Cancel

Note: .wts and .sph not saved as separate files by EEGLAB, you must save them yourself:
floatwrite(EEG.icaweights,'C:\MyDirectory\ICA.wts');

Applying ICA weights to EEG data



Edit dataset information - pop_editset()

Dataset name jo74 Sternberg Data

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Start time (sec) (only for data epochs)	-1	Session number	
Number of channels (0->set from data)	71	Subject group	
Ref. channel indices or mode (see help)	common	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 C:\Users\julie\Documents Browse

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

ICA channel indices (by default all): From other dataset

Help

EEGLAB v10.2.2.1b

File Edit Tools Plot

Dataset info
Event fields
Event values
About this data
Channel locatio...
Select data
Select data using events
Select epochs or events
Copy current dataset
Append datasets
Delete dataset(s)
Visually edit events and identify bad channels

Dataset size (Mb) 402.1

Select a text file

Look in: StemSubj

Recent Places
Desktop
Libraries
Computer
Network

NewICA71.sph
NewICA71.wts

Same for sphering matrix

File name: NewICA71.sph Open

Files of type: All Files Cancel

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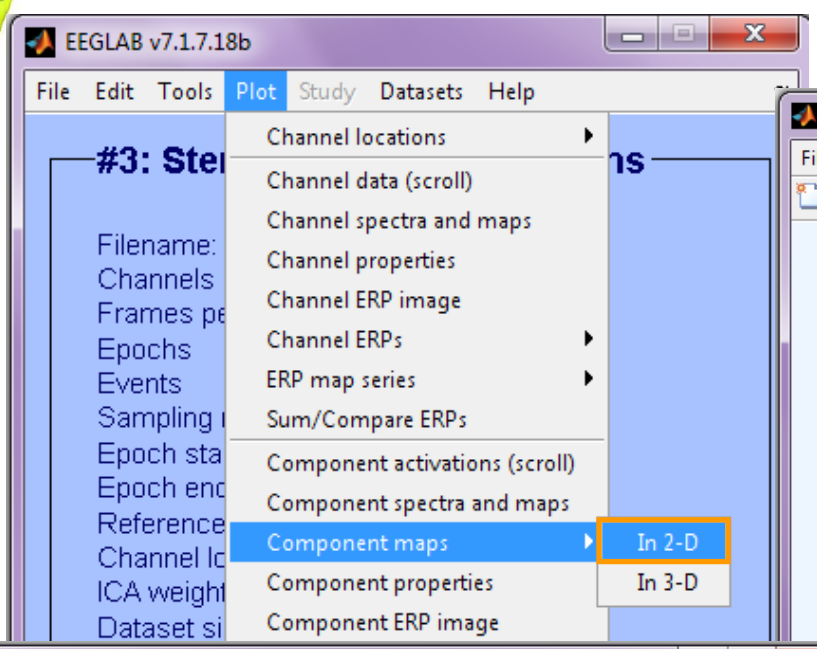
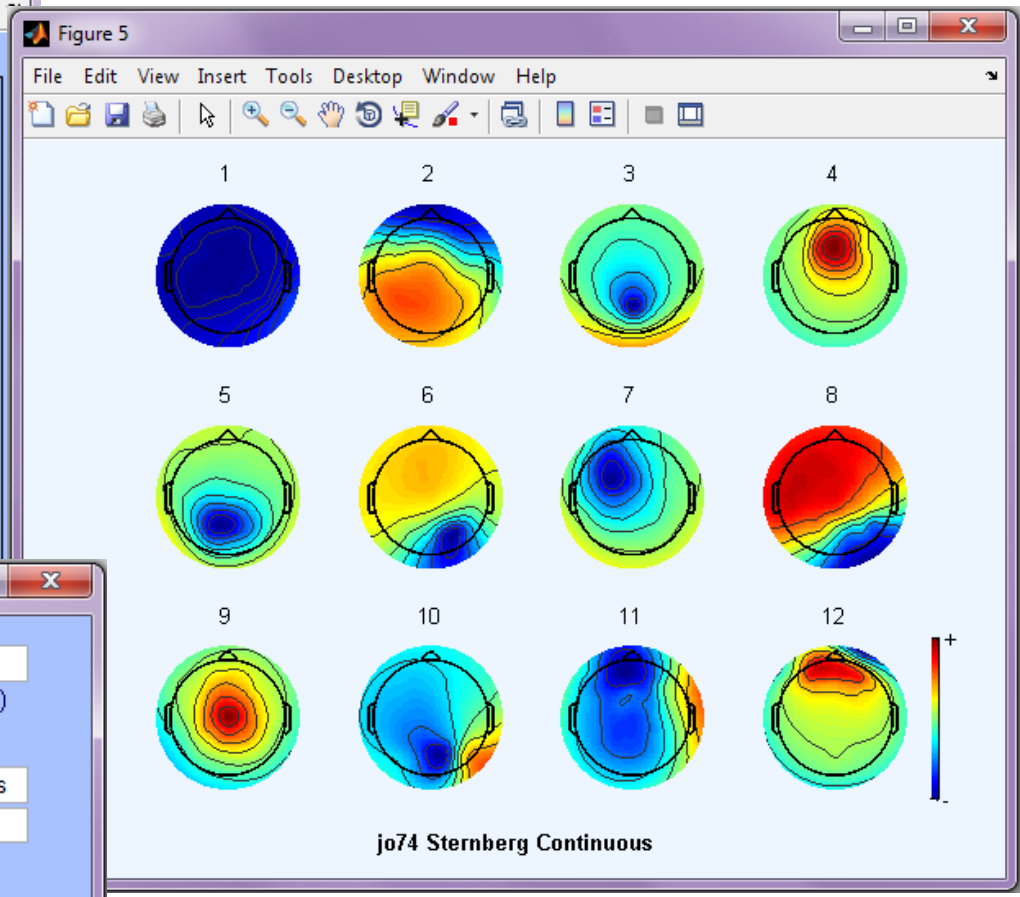
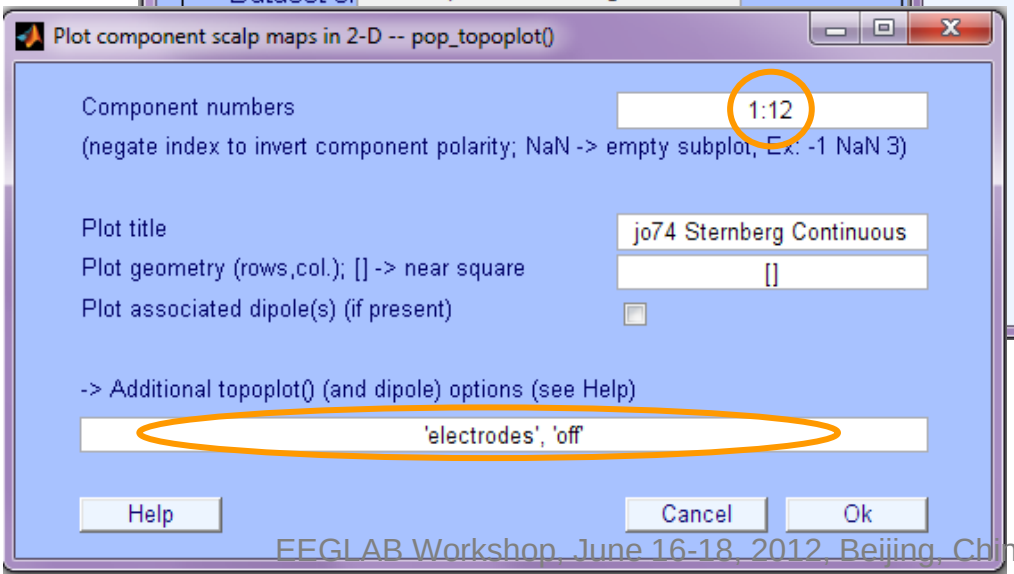
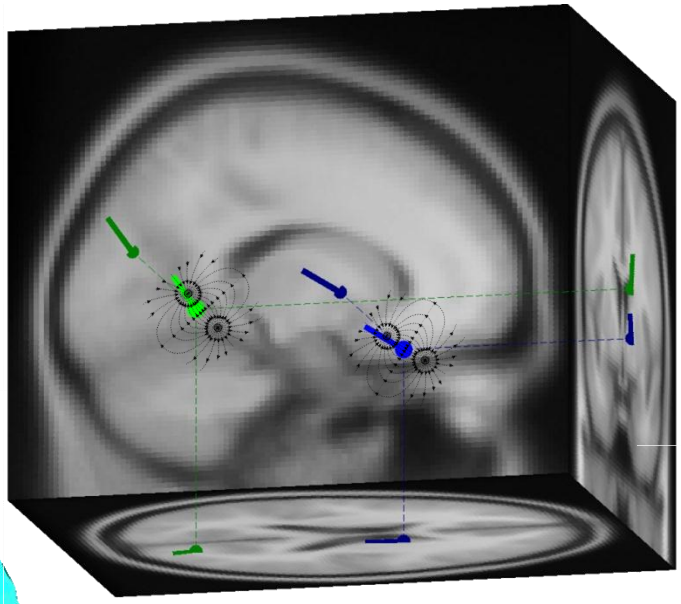
Plot ICA scalp maps

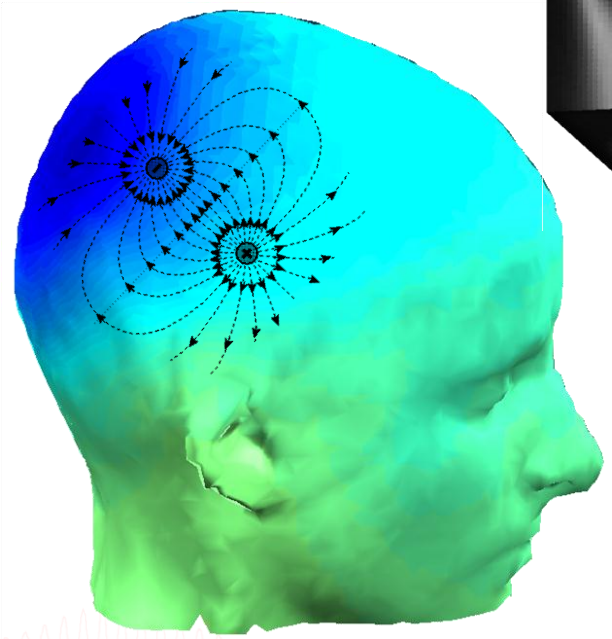


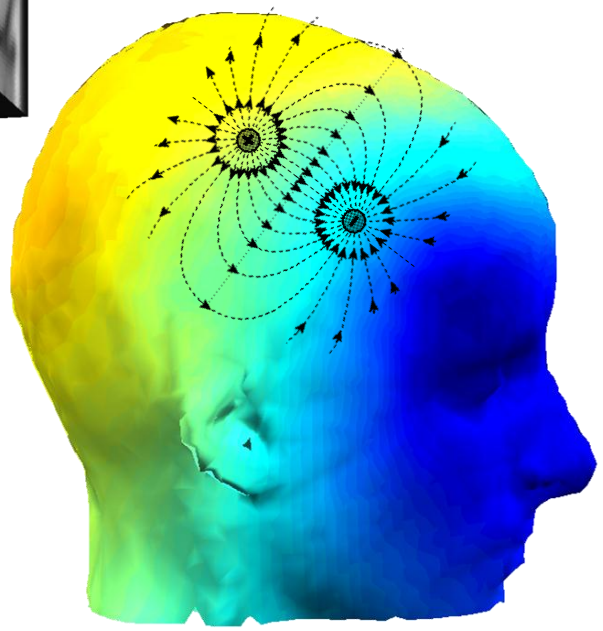




Single-dipole projections





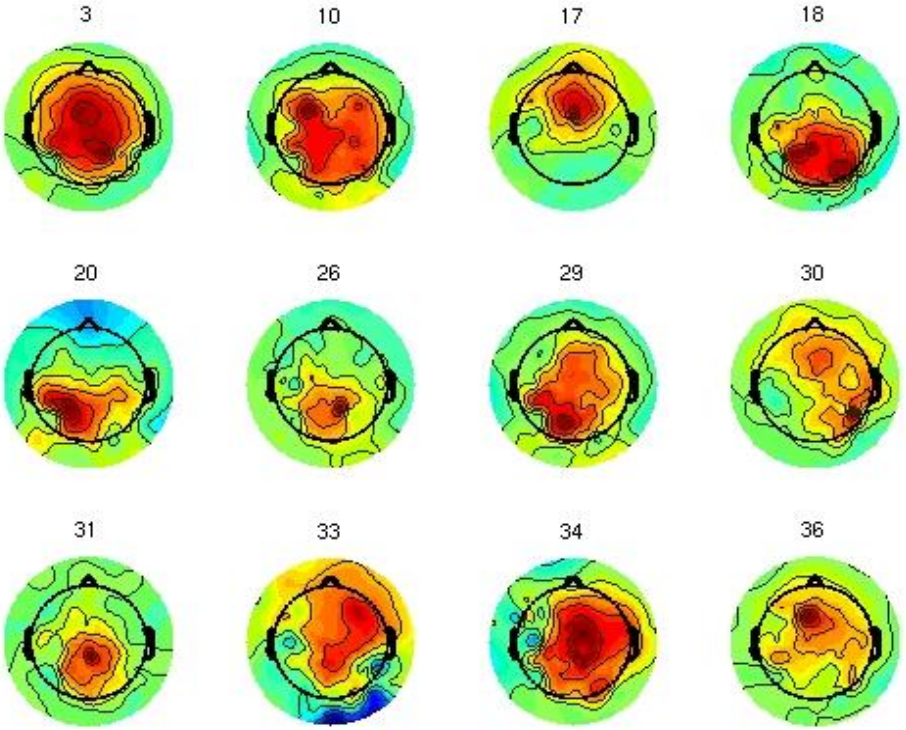


Compare 'good' and 'bad' scalp maps

chaotic gradients

no clear patterns

INconsistent with single dipoles

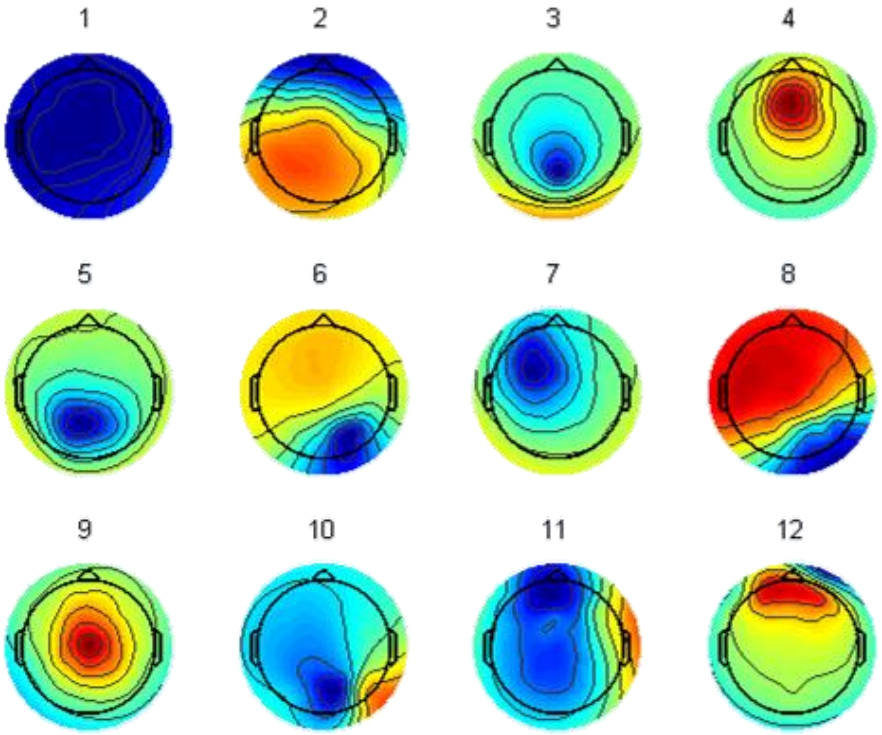


BAD ICA Components

smooth gradients

concentric rings (when radial)

consistent with single dipoles



jo74 Sternberg Continuous

Evaluating ICs

1. Apply ICA weights
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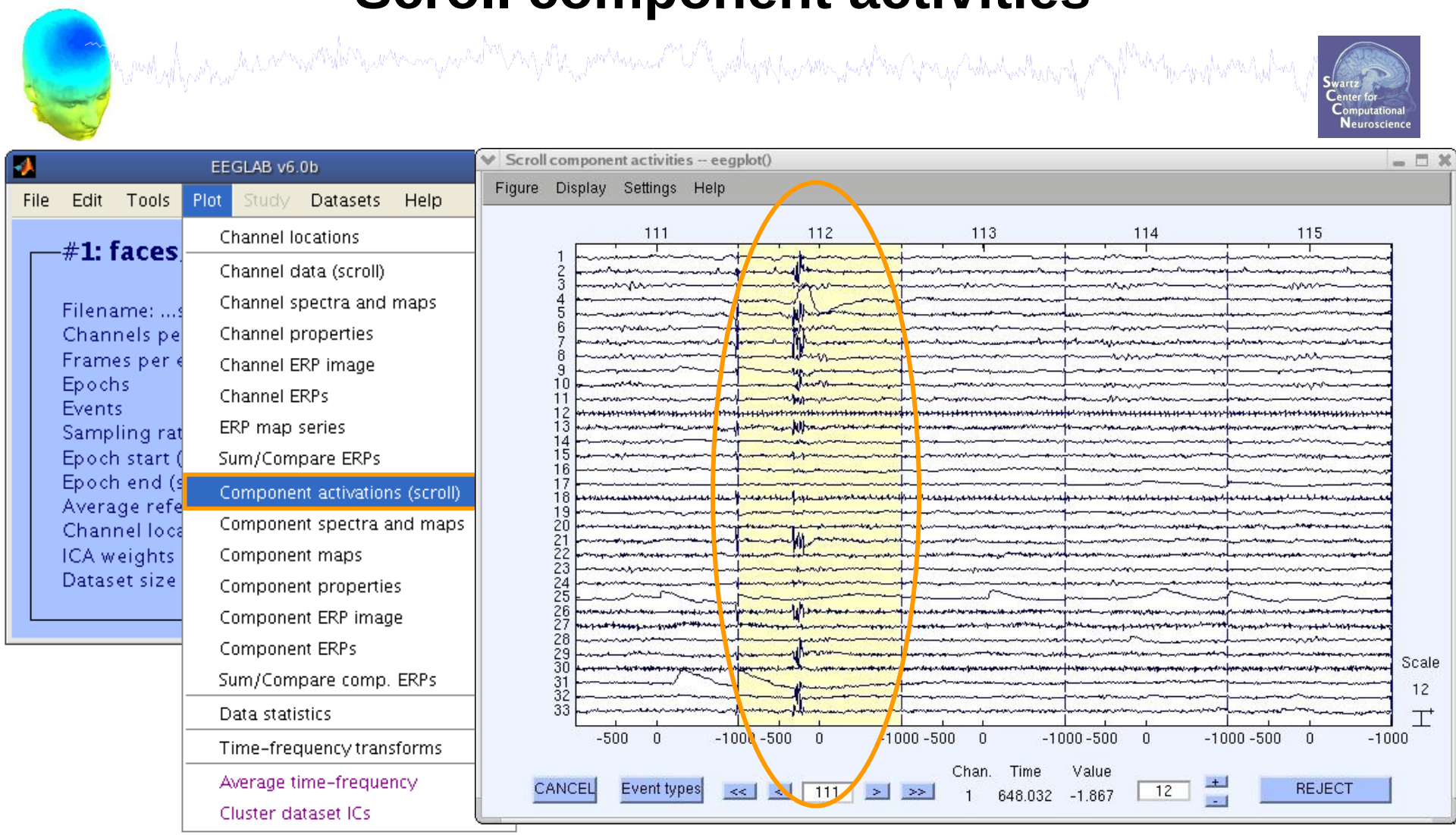
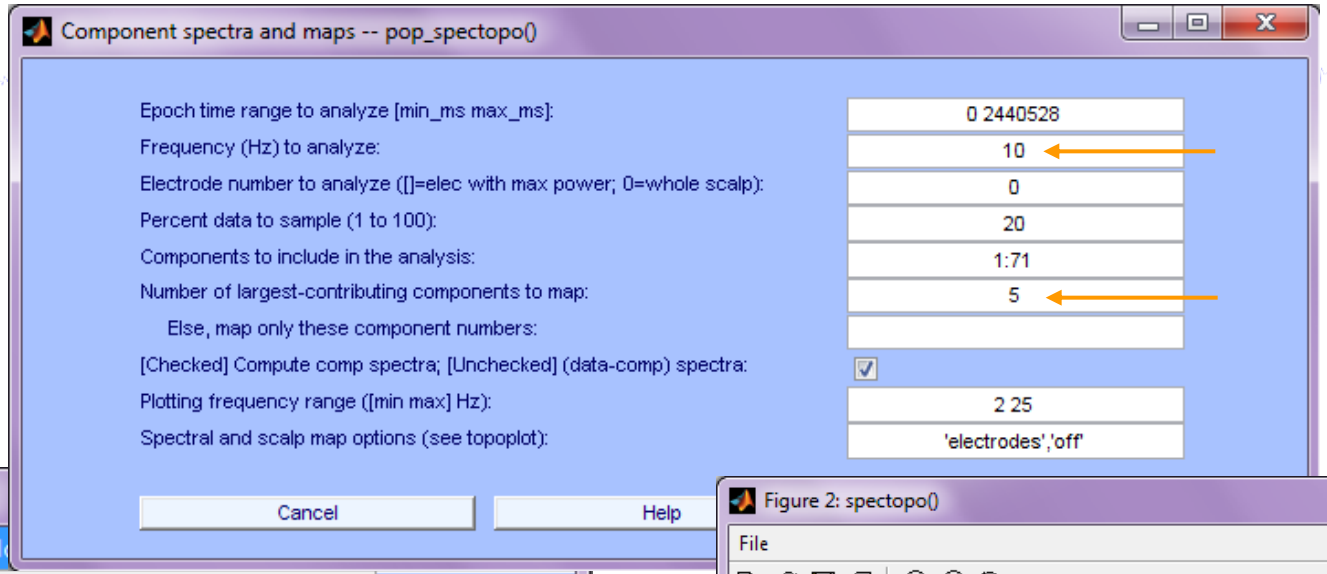
Scroll component activities

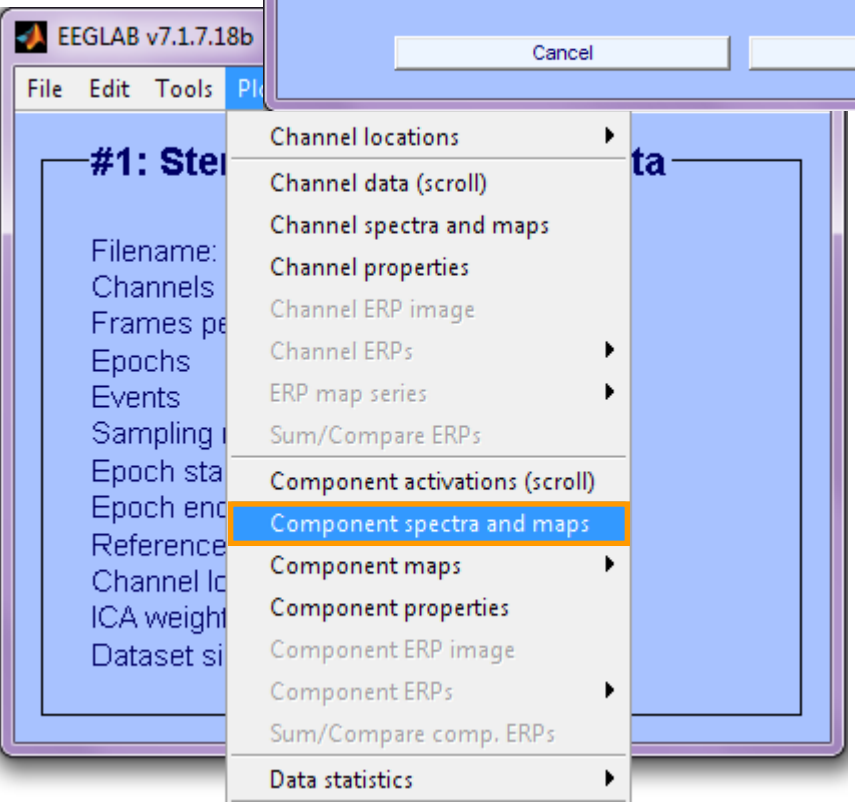


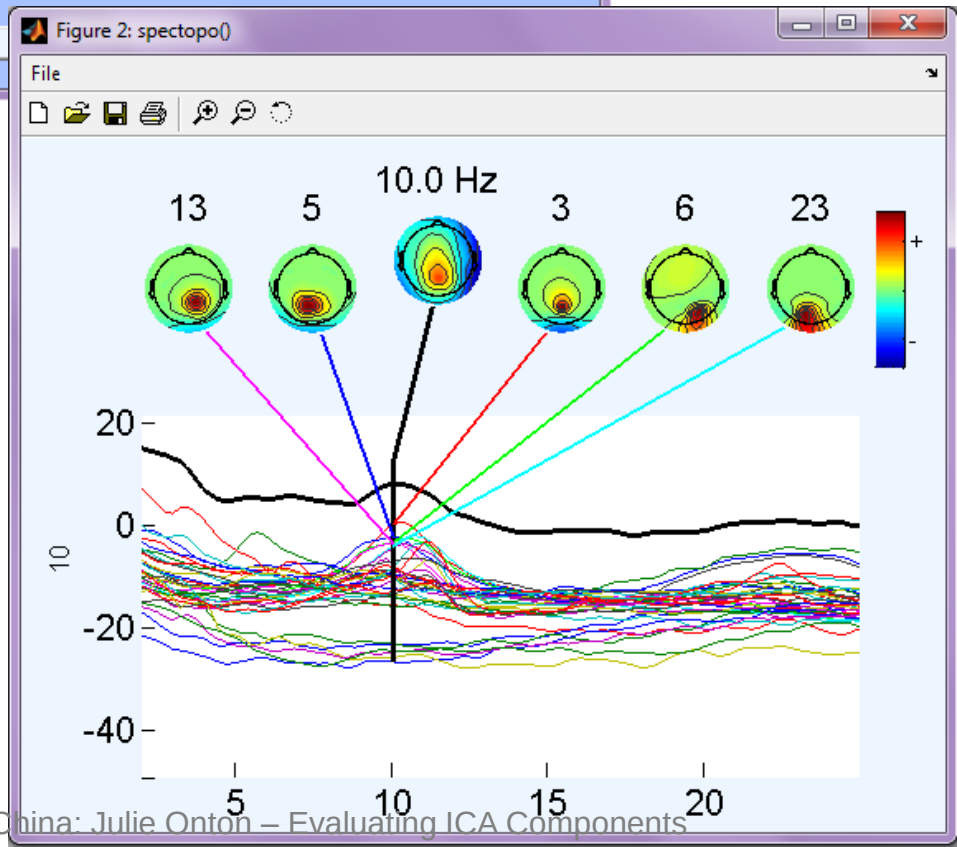
Time periods that are not independent across ICs

should be removed and ICA run again for better decomposition

Plot component power







Plot component power

Component spectra and maps -- pop_spectopo()

Epoch time range to analyze [min_ms max_ms]:	0 2440528
Frequency (Hz) to analyze:	6
Electrode number to analyze ([]=elec with max power; 0=whole scalp):	0
Percent data to sample (1 to 100):	20
Components to include in the analysis:	1:71
Number of largest-contributing components to map:	5
Else, map only these component numbers:	
[Checked] Compute comp spectra; [Unchecked] (data-comp) spectra:	☑
Plotting frequency range ([min max] Hz):	2 25
Spectral and scalp map options (see topoplot):	

Cancel

EEGLAB v7.1.7.18b

File Edit Tools Plo

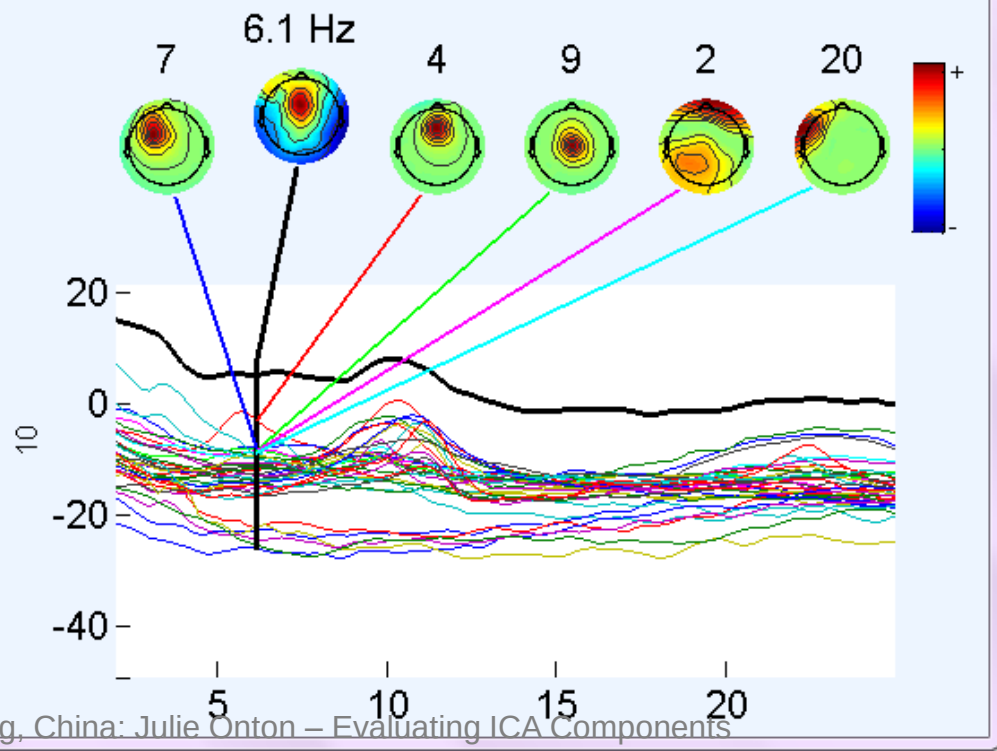
#1: Ste ta

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

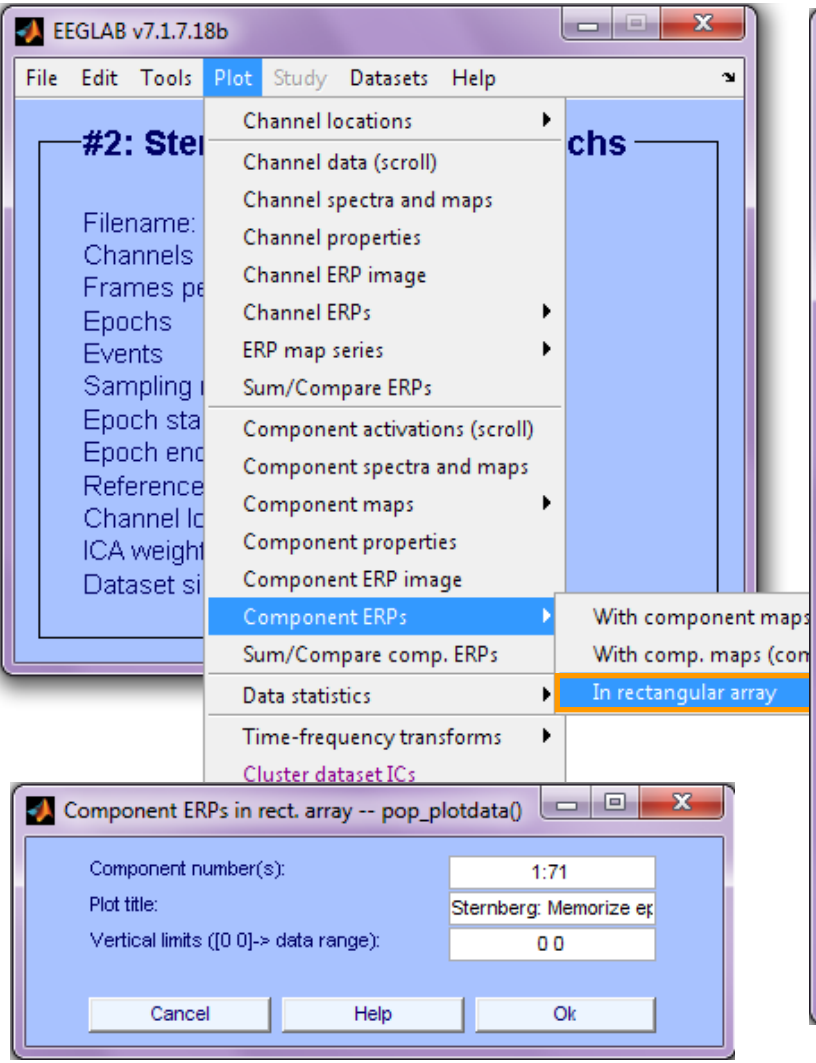
- Channel locations
- Channel data (scroll)
- Channel spectra and maps
- Channel properties
- Channel ERP image
- Channel ERPs
- ERP map series
- Sum/Compare ERPs
- Component activations (scroll)
- **Component spectra and maps**
- Component maps
- Component properties
- Component ERP image
- Component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

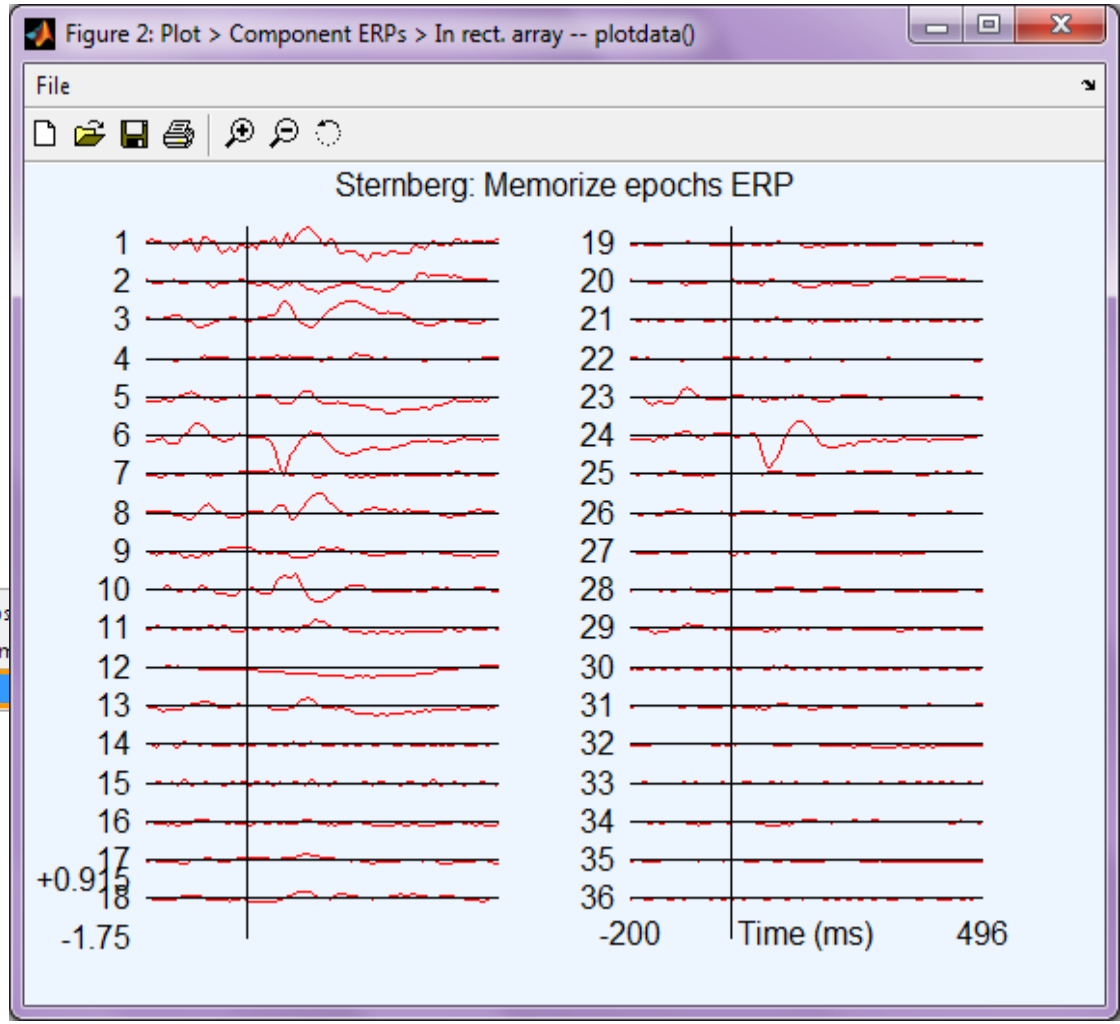
Figure 2: spectopo()

File

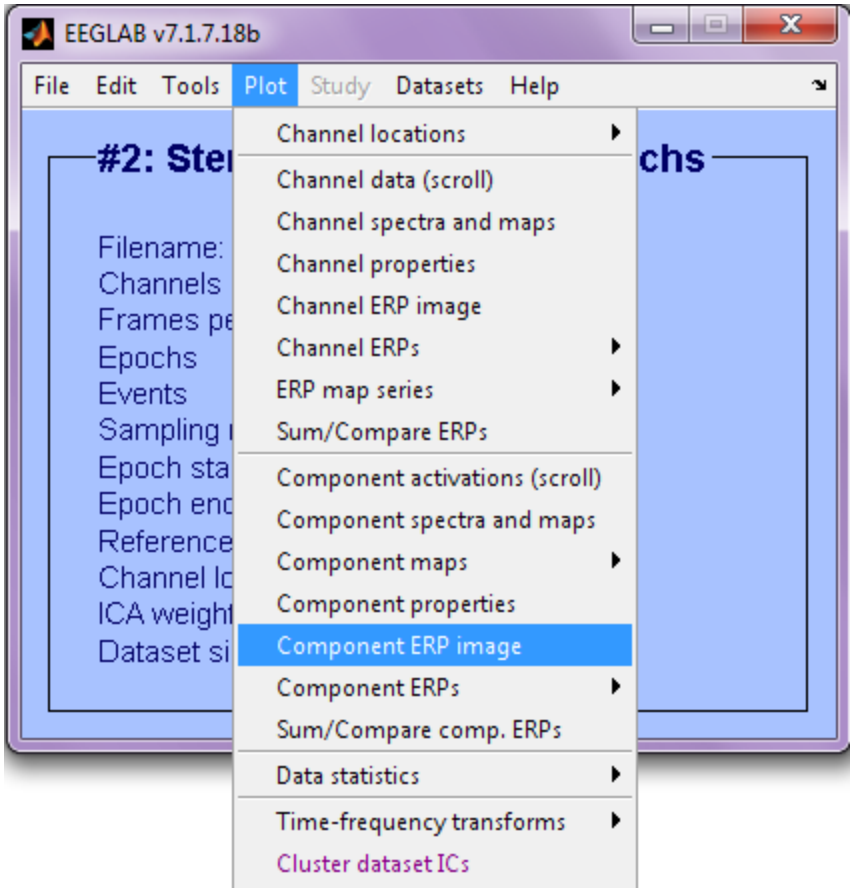


Component ERPs





Component ERP image



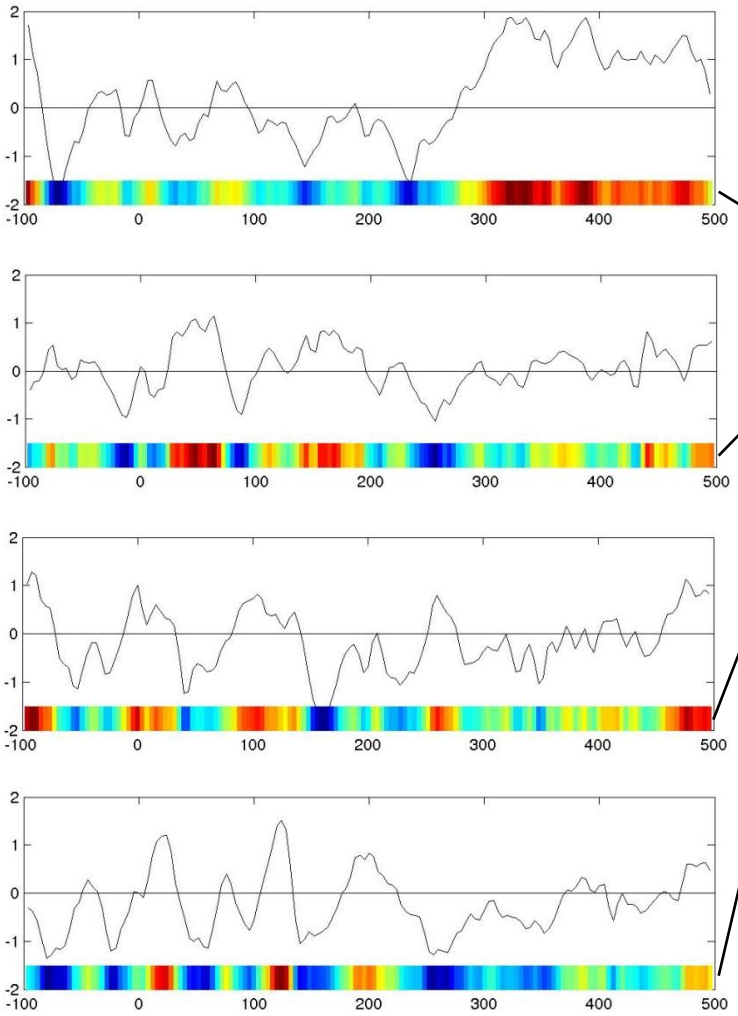
ERP Image basics

Trial 1

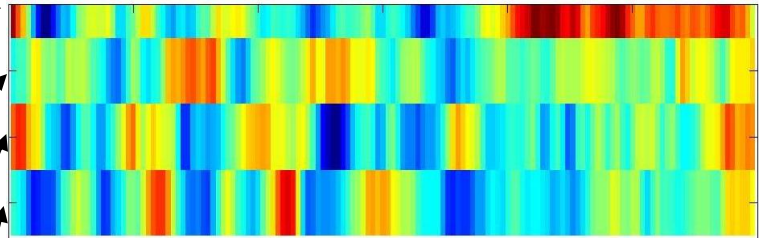
Trial 2

Trial 3

Trial 4

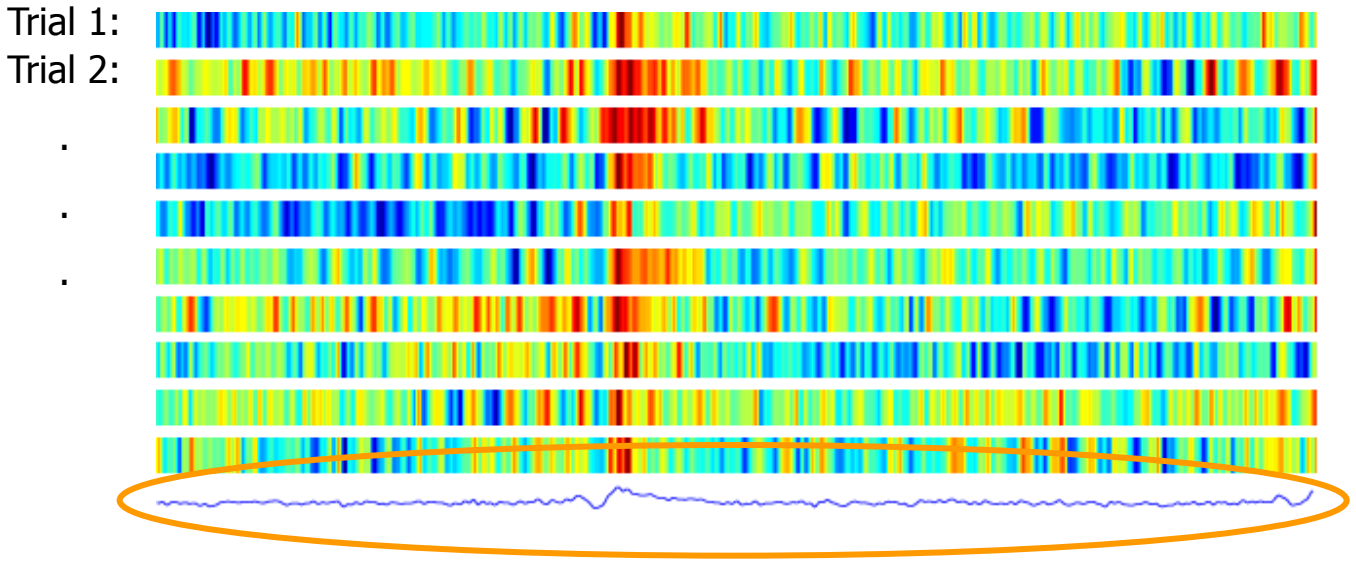


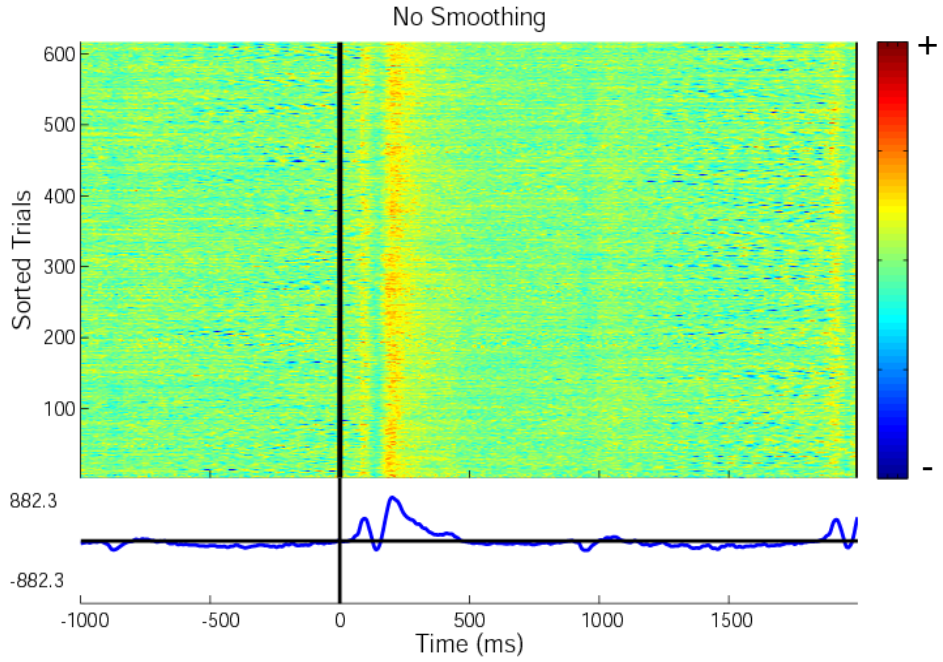
ERP Image

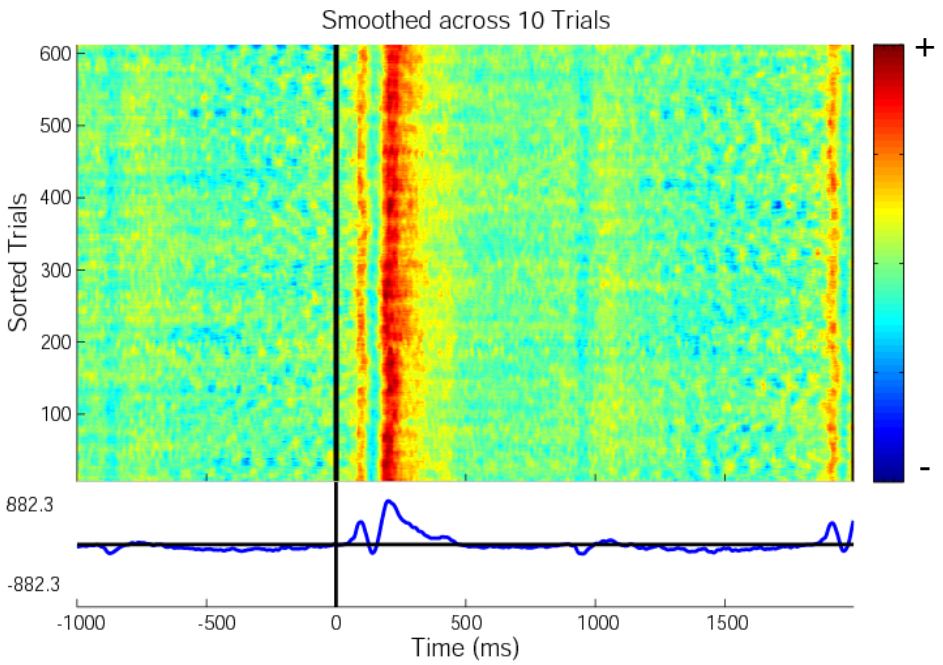


by default, sorted by time-on-task
(1st trial, 2nd trial, ...)

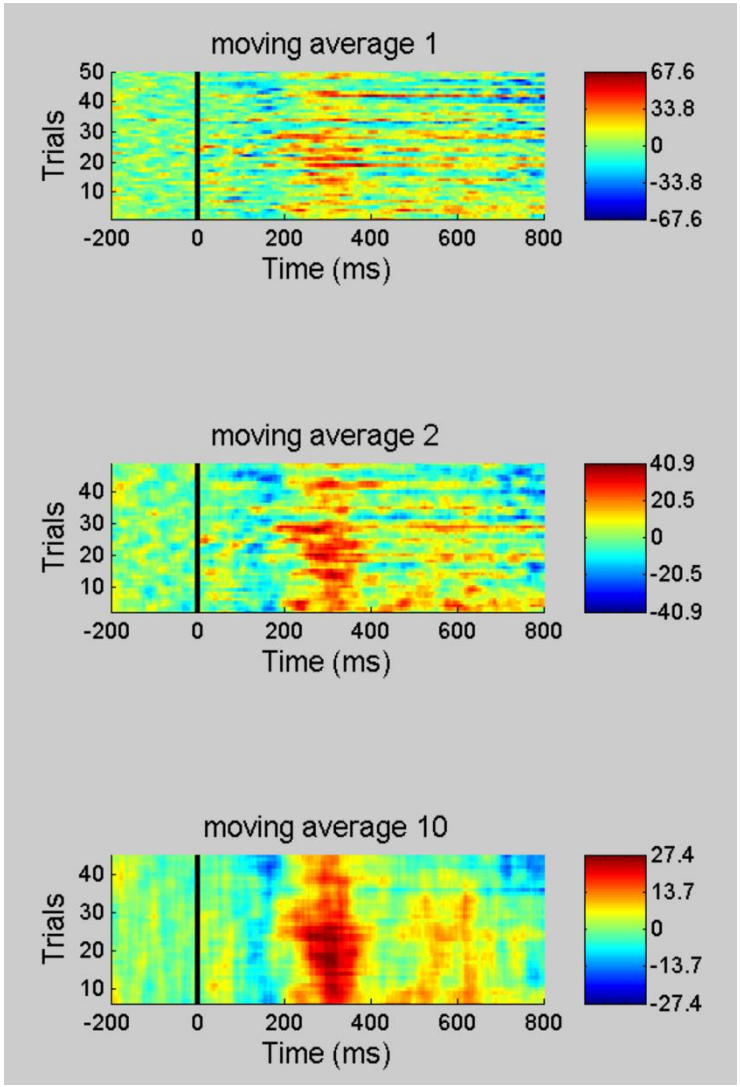
ERP Image basics







ERP Images: smoothing across trials



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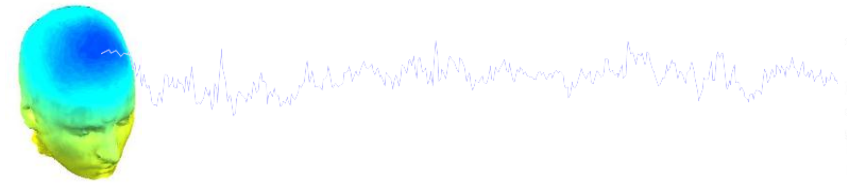
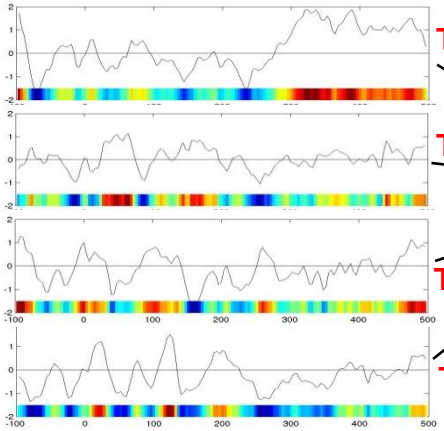
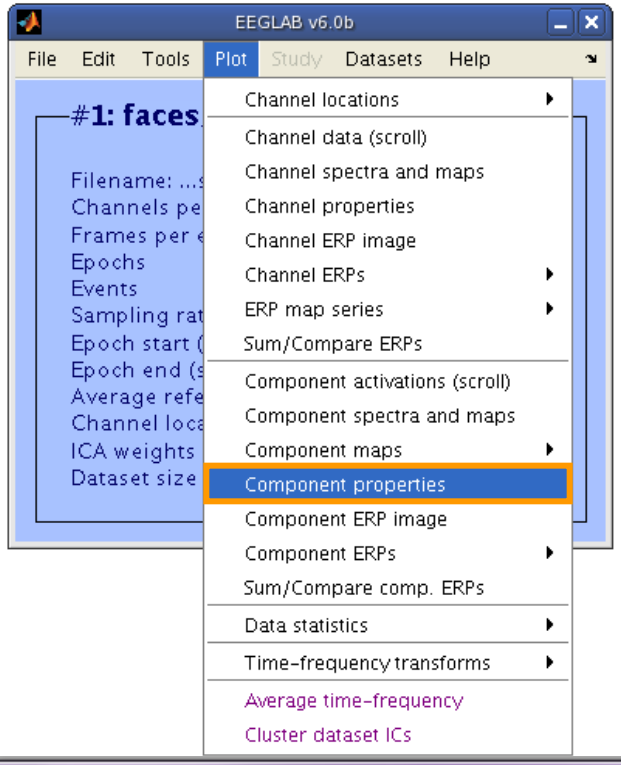
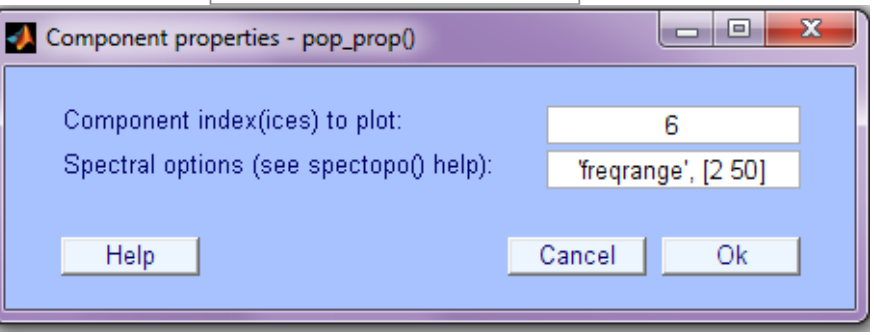
Plot ICA component properties

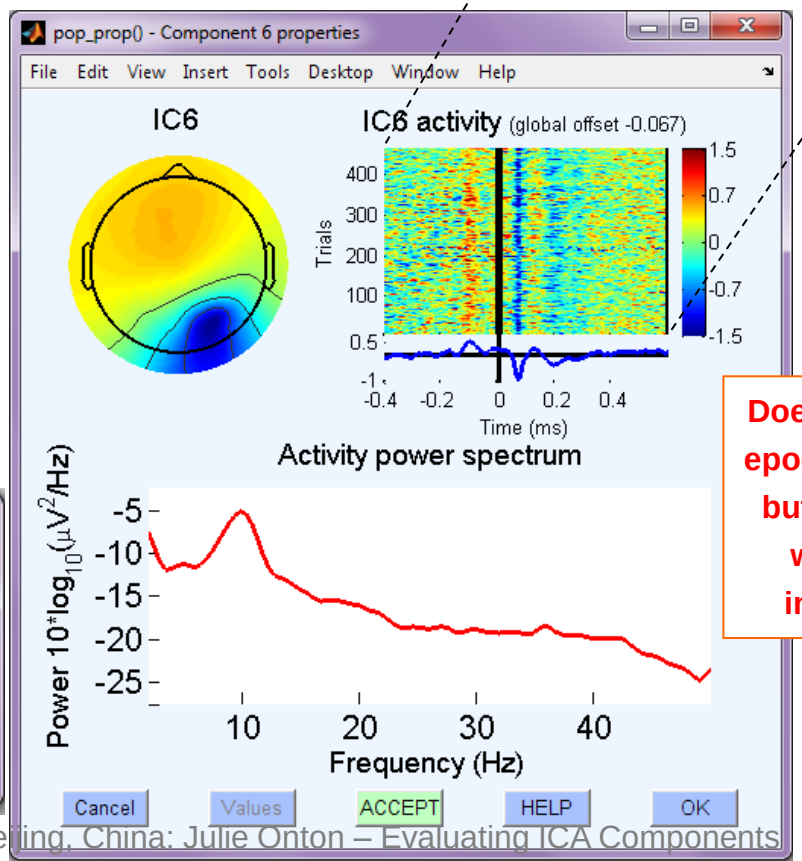




ERP Image

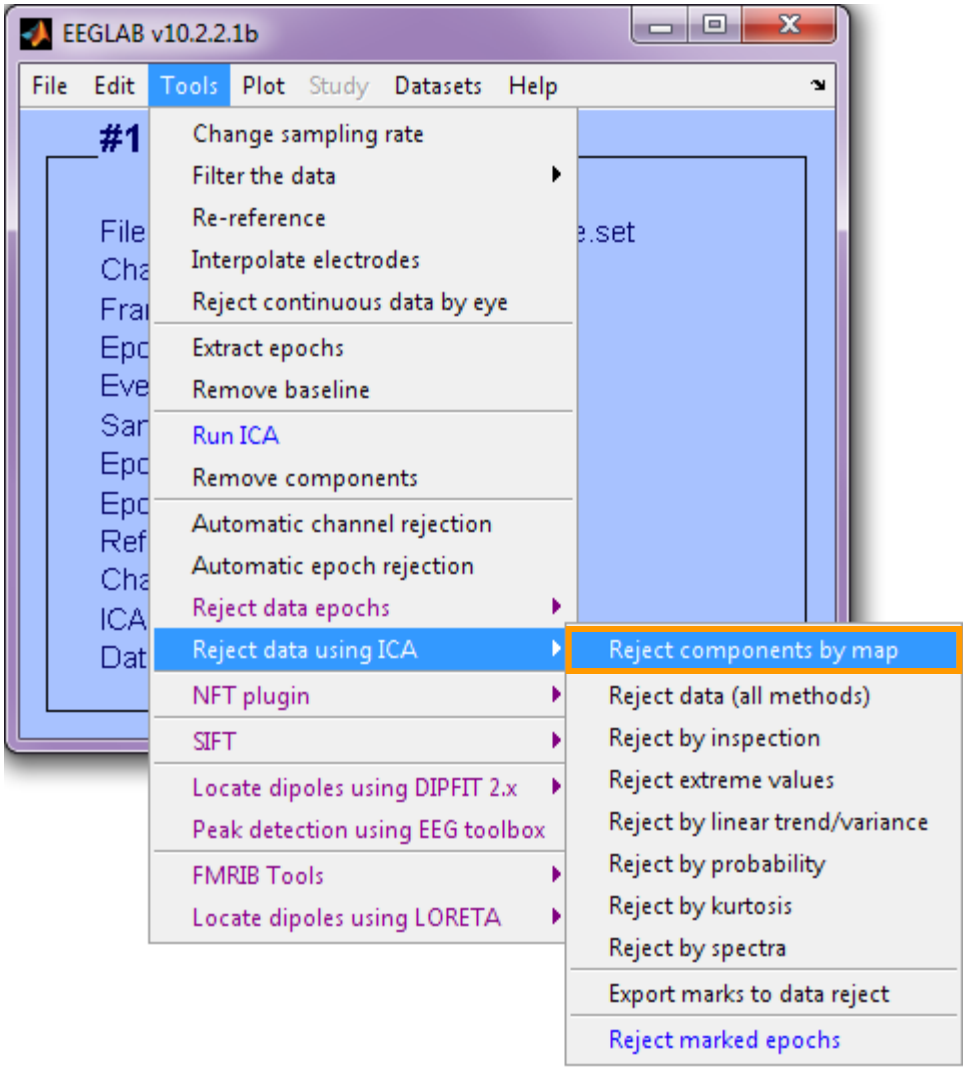




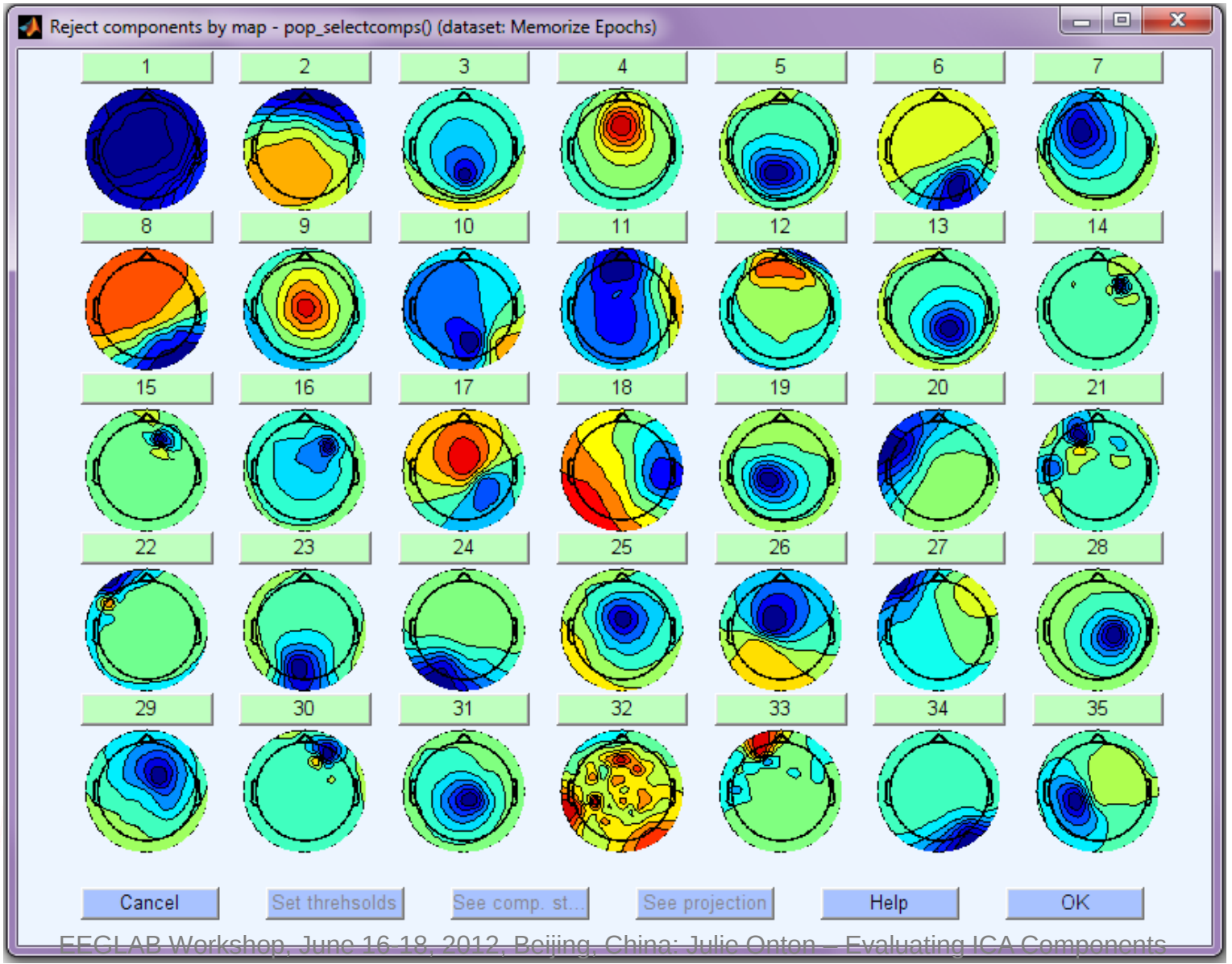


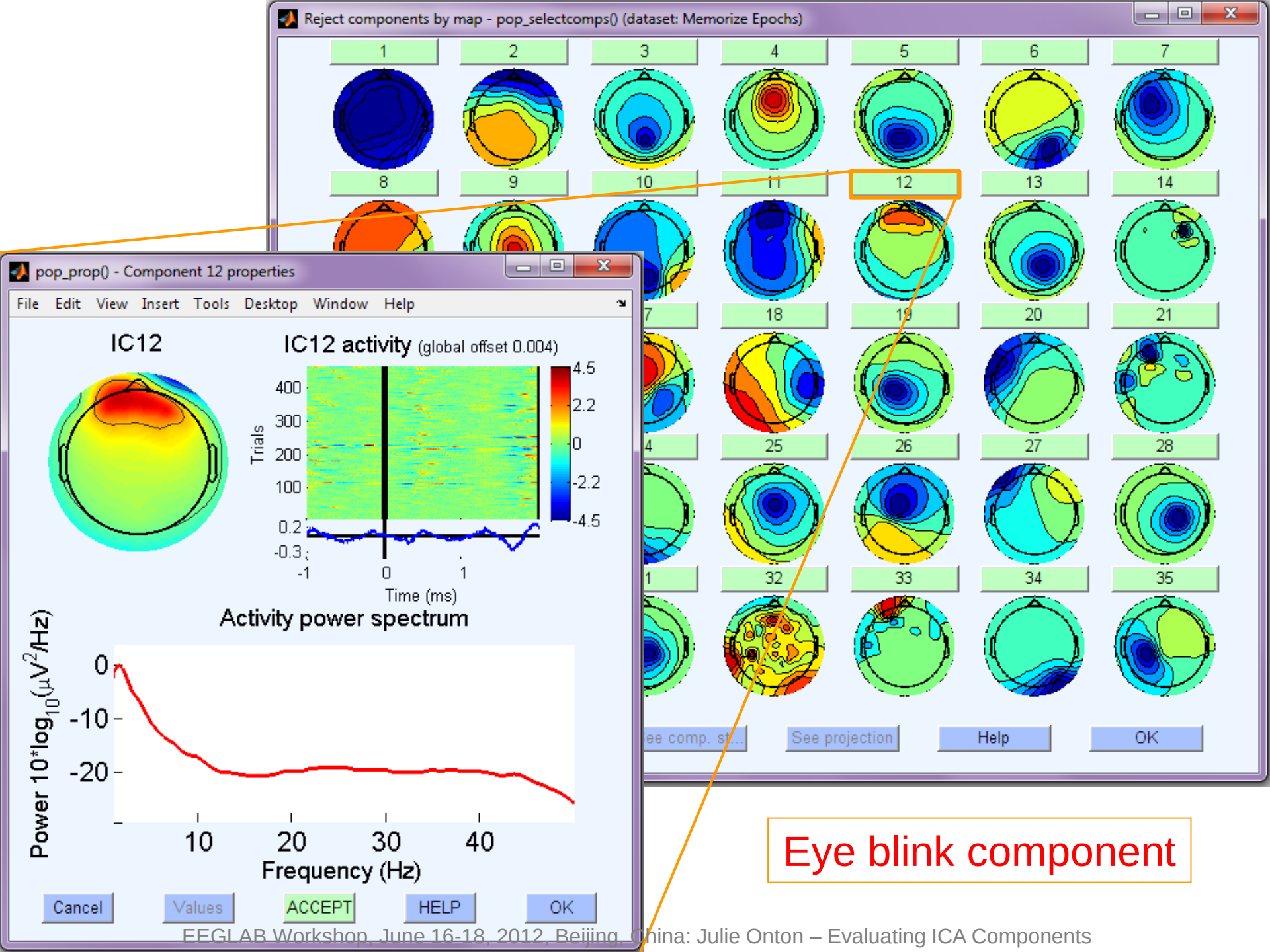
Does not require epoched dataset, but ERP image will be less informative

Reviewing component properties



Component scalp maps/properties




Reject components by map - pop_selectcomps() (dataset: Memorize Epochs)
1
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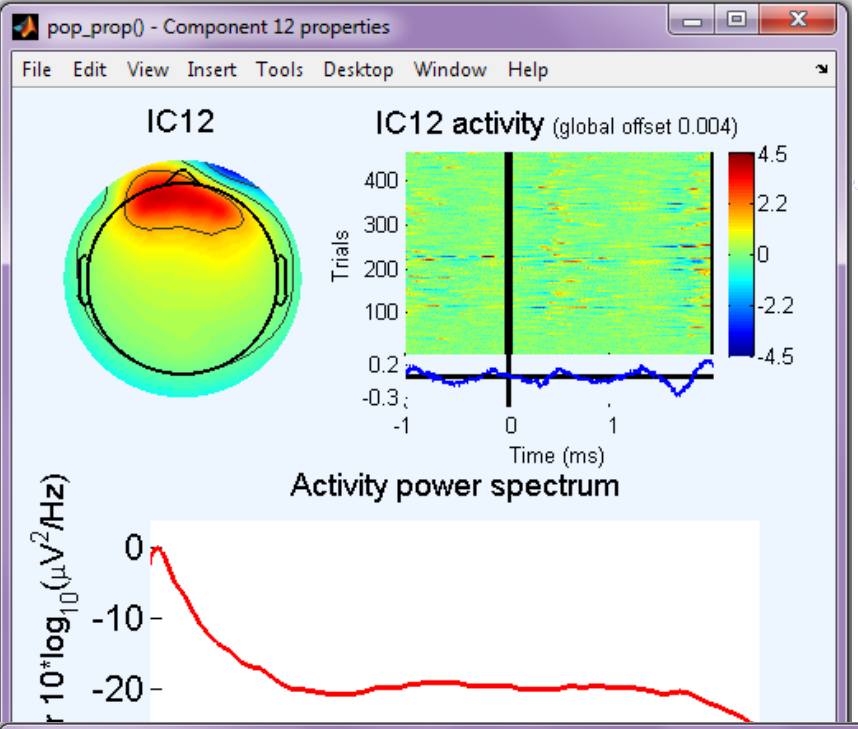
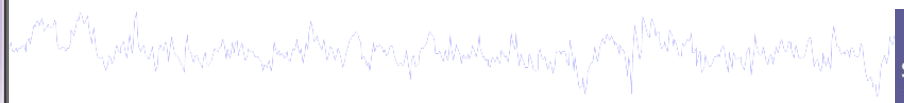
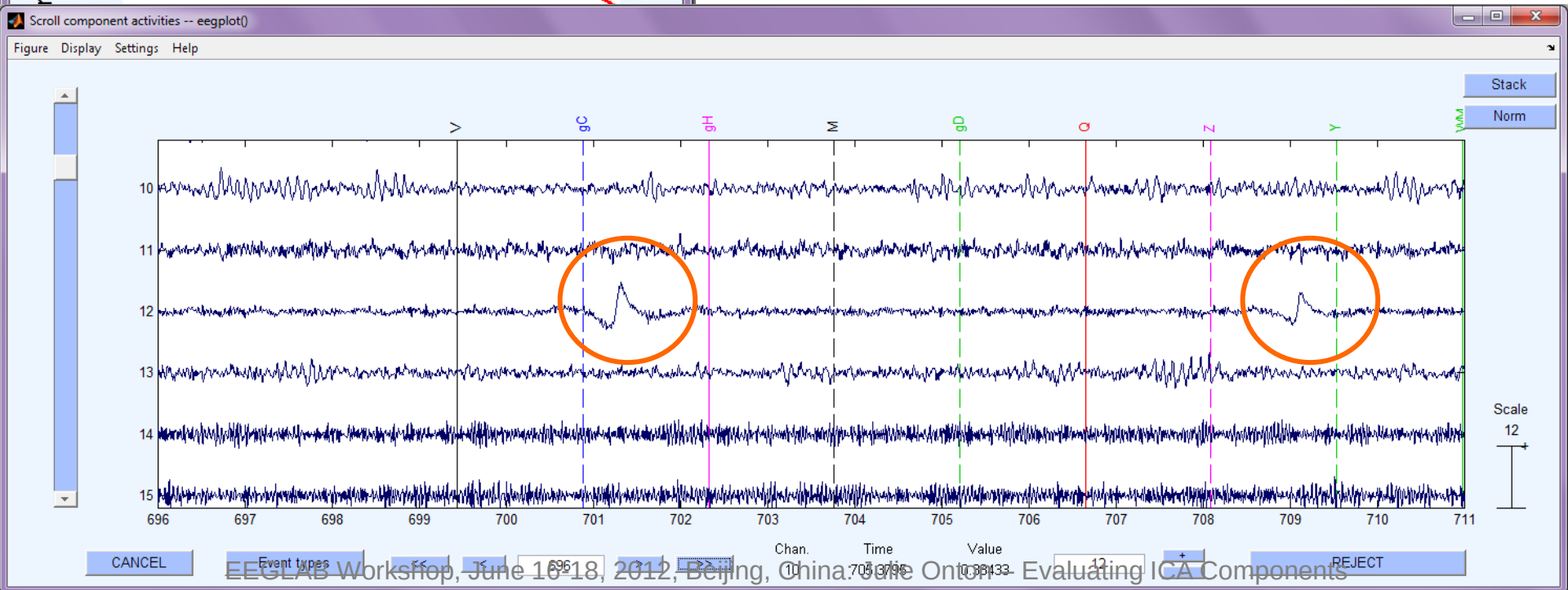
35
See projection
Help
OK
pop_prop() - Component 12 properties
File Edit View Insert Tools Desktop Window Help
IC12
IC12 activity (global offset 0.004)
Trials
Time (ms)
Activity power spectrum
Power 10*log10(μV²/Hz)
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK
Eye blink component



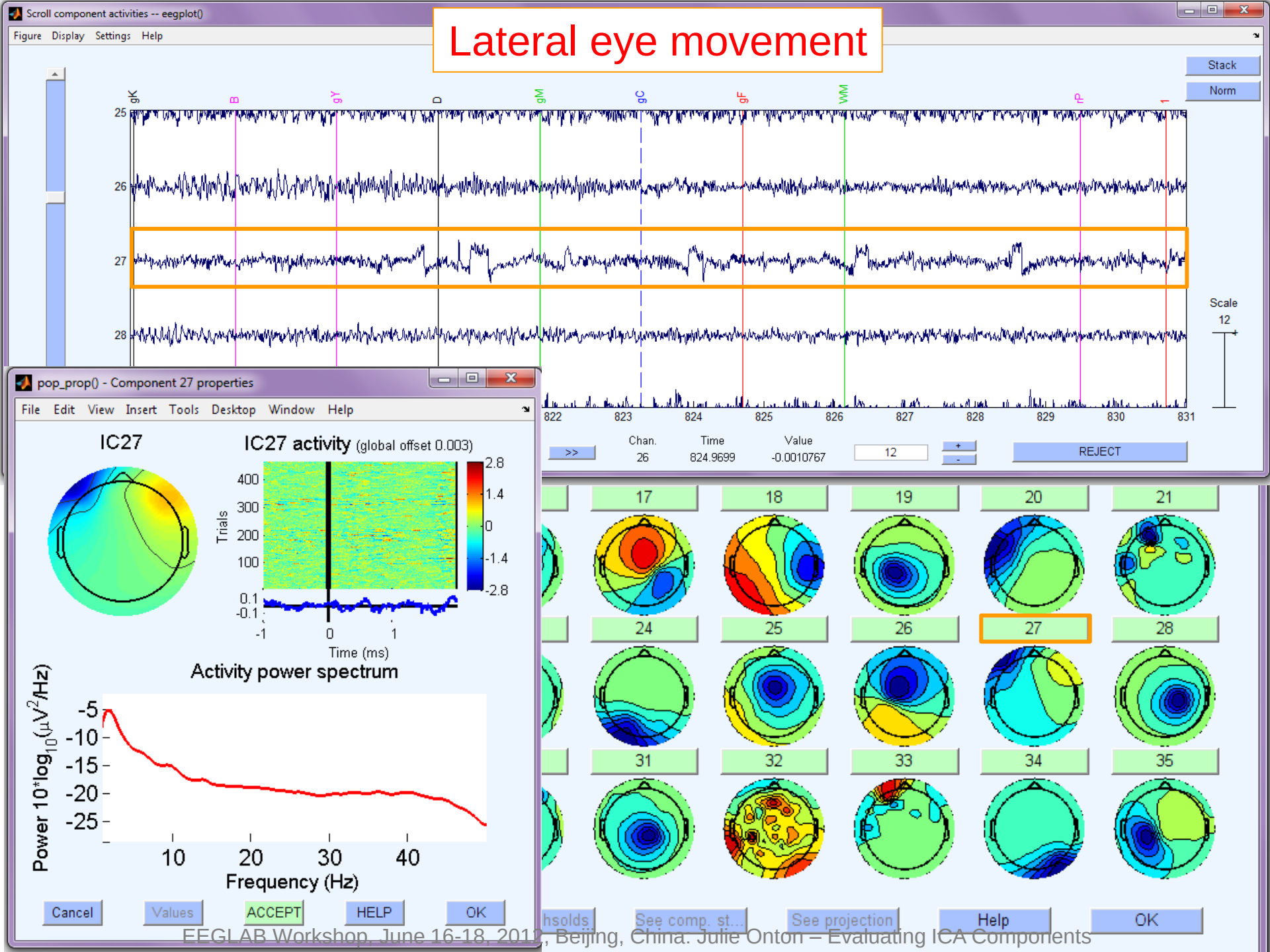


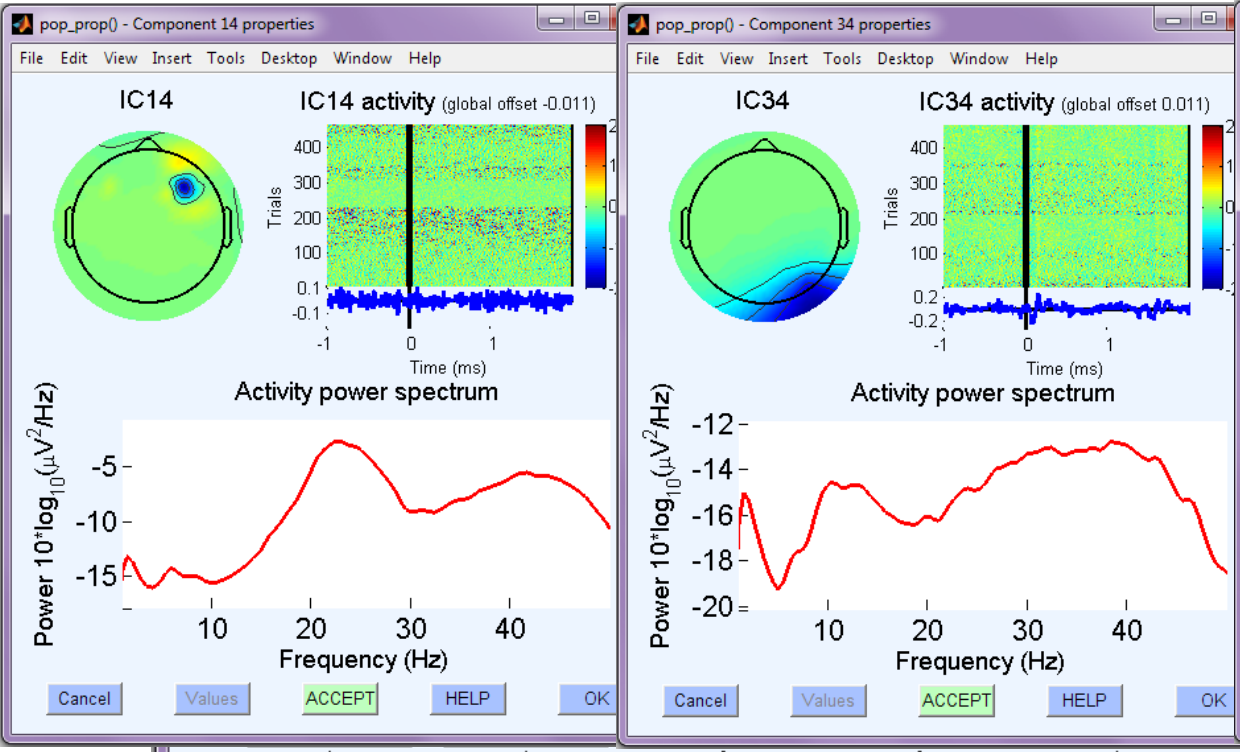
Swartz Center for Computational Neuroscience

Eye blink component

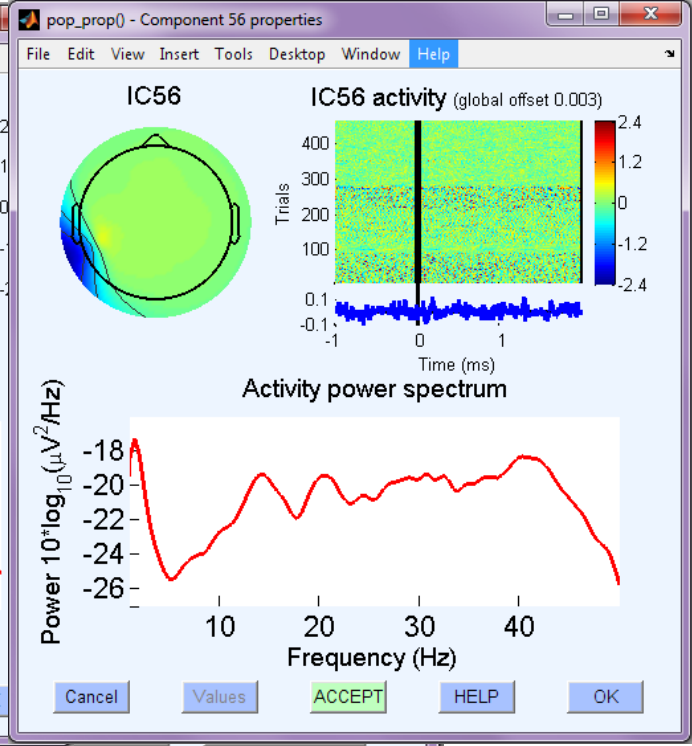


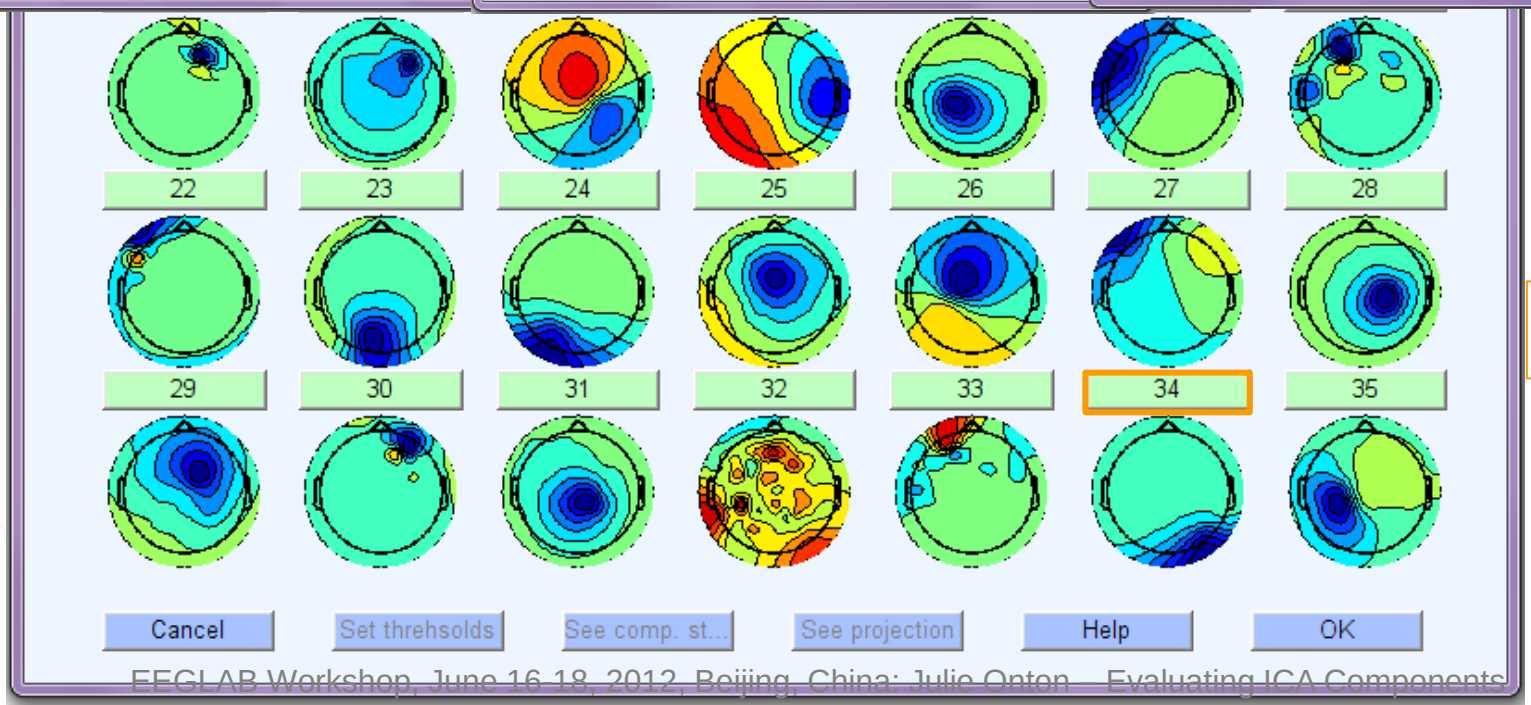
Lateral eye movement




pop_prop() - Component 14 properties
File Edit View Insert Tools Desktop Window Help
IC14
IC14 activity (global offset -0.011)
Trials
Time (ms)
Activity power spectrum
Power 10*log10(μV²/Hz)
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

pop_prop() - Component 34 properties
File Edit View Insert Tools Desktop Window Help
IC34
IC34 activity (global offset 0.011)
Trials
Time (ms)
Activity power spectrum
Power 10*log10(μV²/Hz)
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK


pop_prop() - Component 56 properties
File Edit View Insert Tools Desktop Window Help
IC56
IC56 activity (global offset 0.003)
Trials
Time (ms)
Activity power spectrum
Power 10*log10(μV²/Hz)
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK


22
23
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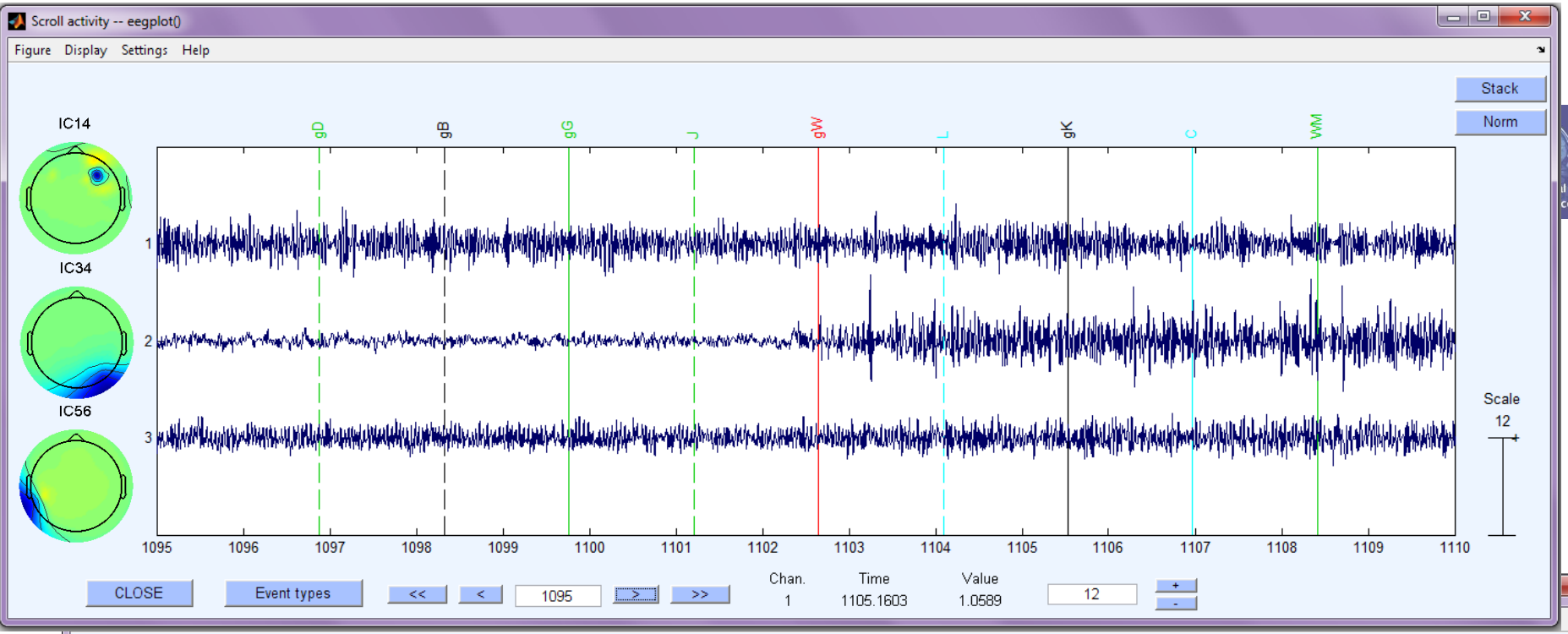
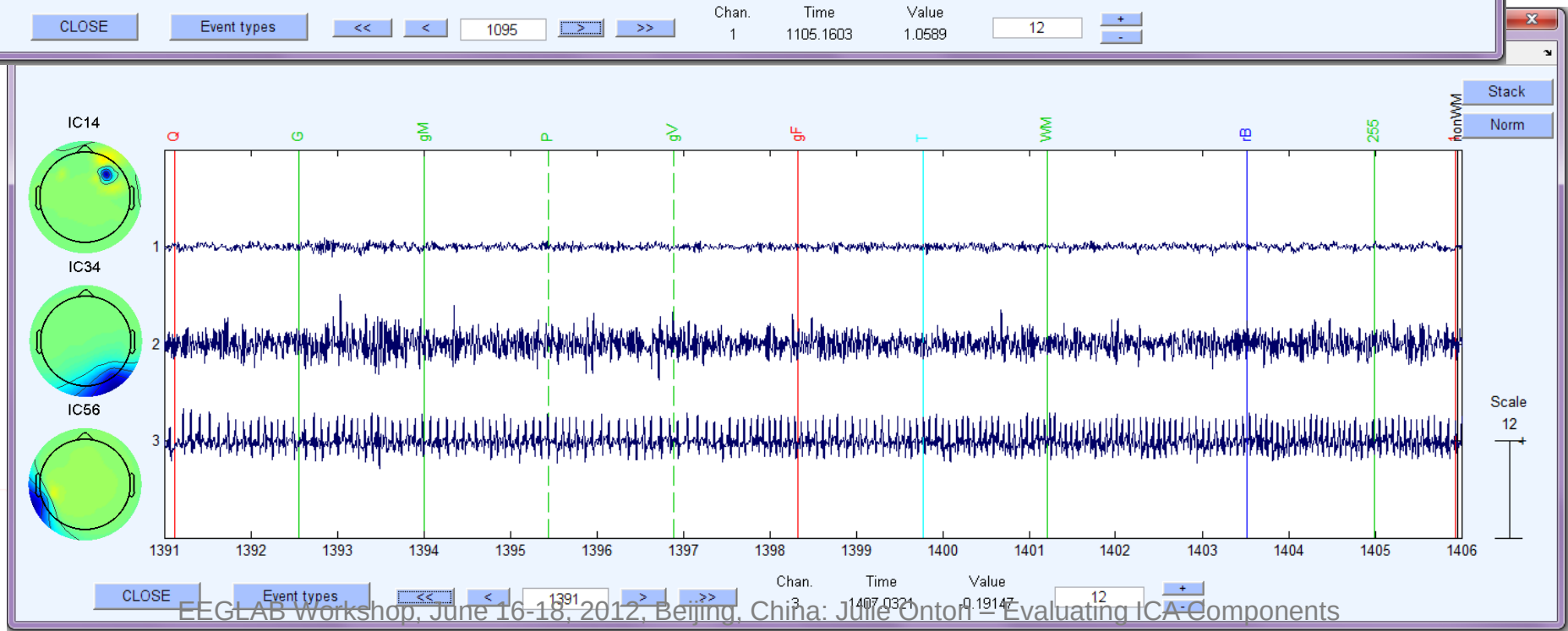
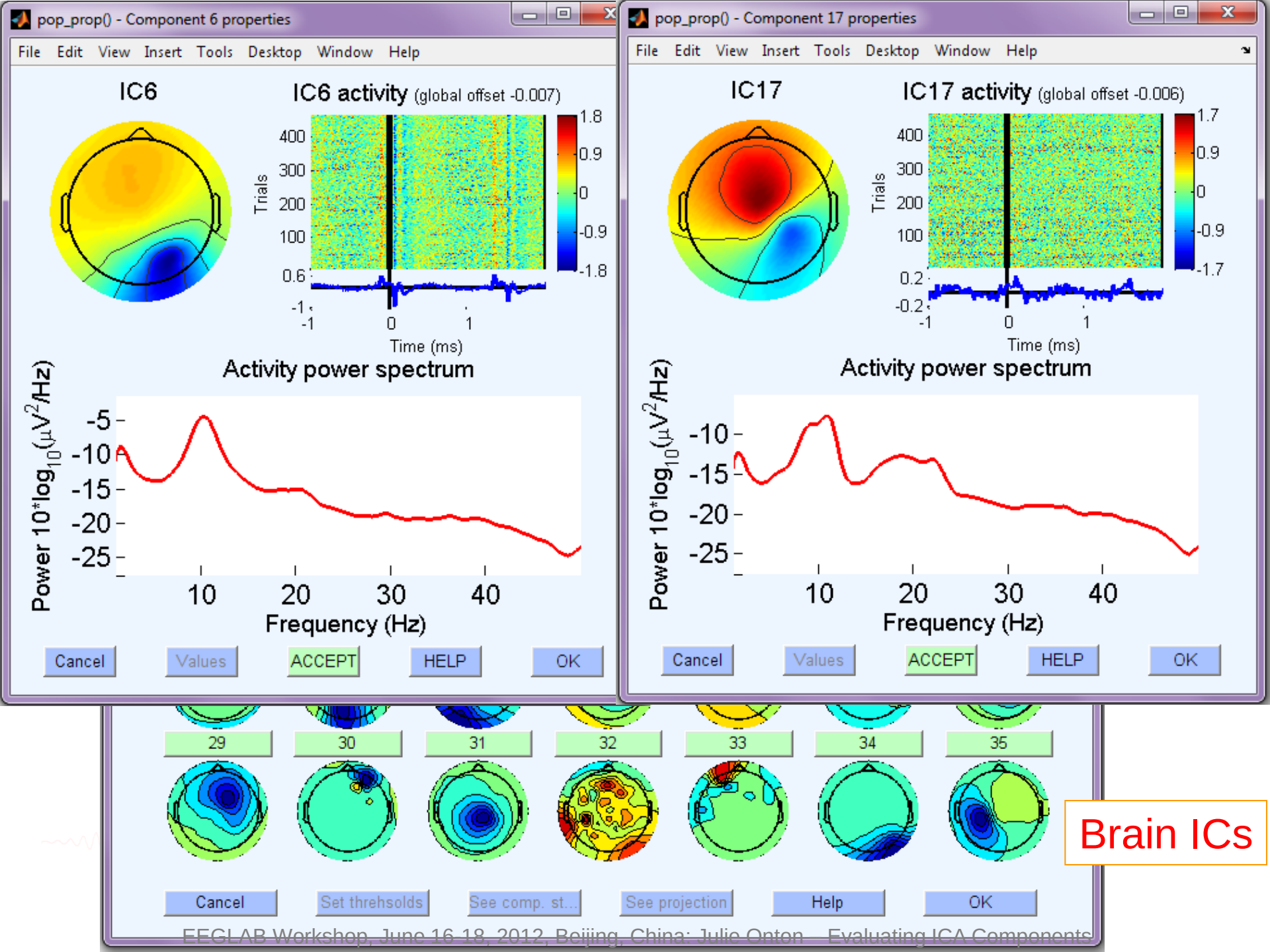
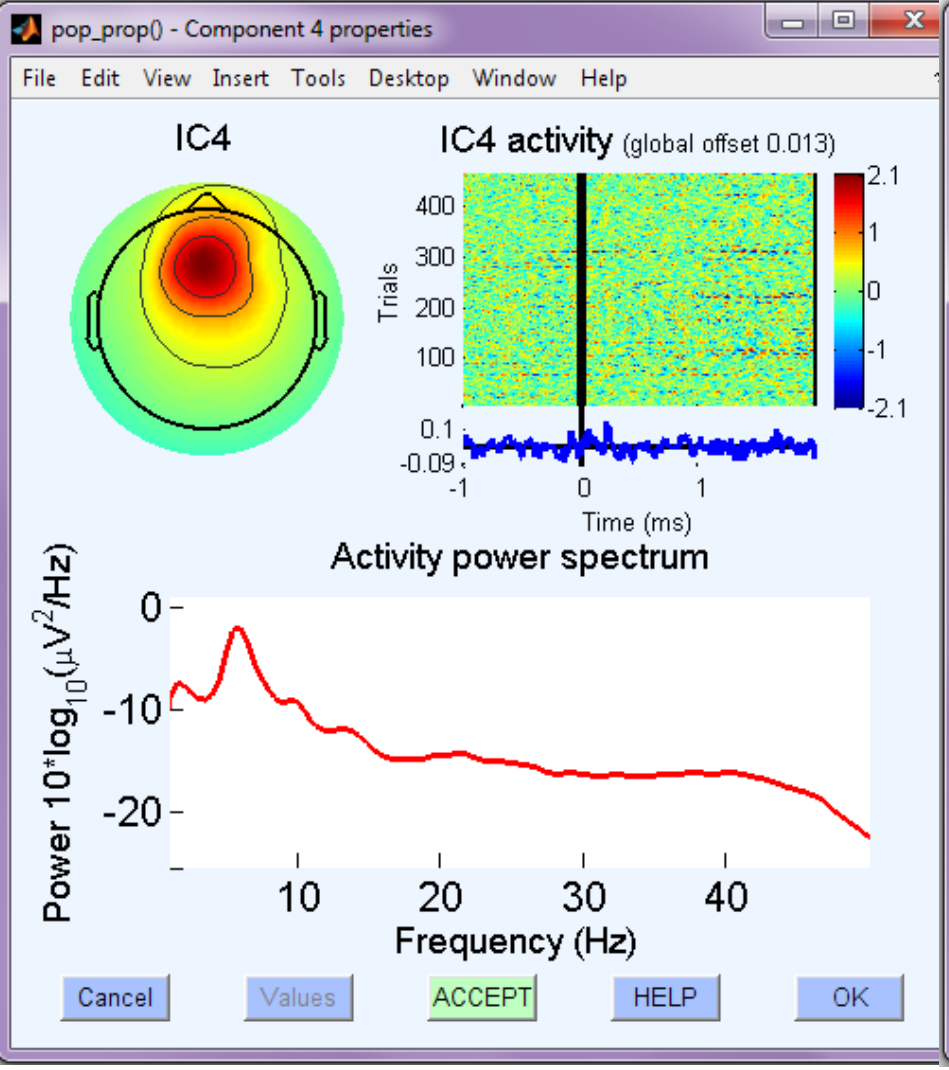
30
31
32
33
34
35
Cancel
Set threhsolds
See comp. st...
See projection
Help
OK

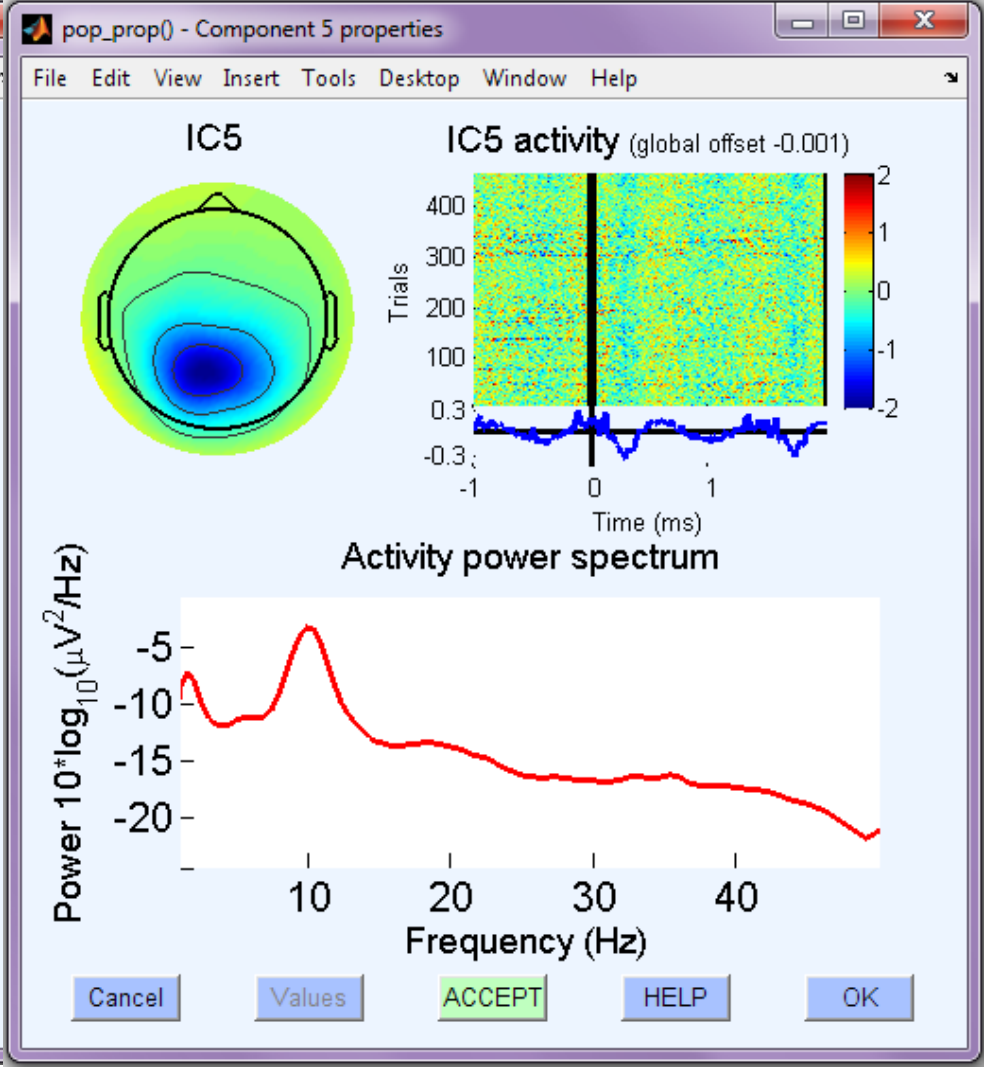
Muscle


Scroll activity -- eegplot()
Figure Display Settings Help
Stack
Norm
IC14
IC34
IC56
gD gB gG J gW L gK C WM
1 2 3
Scale
12
1095 1096 1097 1098 1099 1100 1101 1102 1103 1104 1105 1106 1107 1108 1109 1110
CLOSE
Event types
<< < 1095 > >>
Chan. Time Value
1 1105.1603 1.0589
12
+ -


Stack
Norm
IC14
IC34
IC56
Q G gM P gV gF T WM rB 255 lonWM
1 2 3
Scale
12
1391 1392 1393 1394 1395 1396 1397 1398 1399 1400 1401 1402 1403 1404 1405 1406
CLOSE
Event types
<< < 1391 > >>
Chan. Time Value
3 1407.0321 0.19147
12
+ -

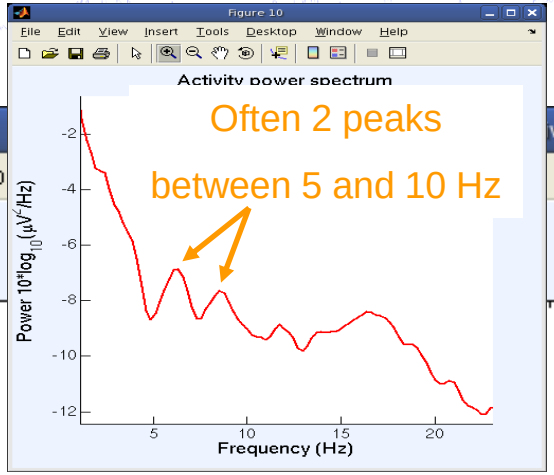

pop_prop() - Component 6 properties
File Edit View Insert Tools Desktop Window Help
IC6
IC6 activity (global offset -0.007)
Trials
Time (ms)
Activity power spectrum
Power 10*log10(μV²/Hz)
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK
pop_prop() - Component 17 properties
File Edit View Insert Tools Desktop Window Help
IC17
IC17 activity (global offset -0.006)
Trials
Time (ms)
Activity power spectrum
Power 10*log10(μV²/Hz)
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK
29
30
31
32
33
34
35
Cancel
Set threhsolds
See comp. st...
See projection
Help
OK
Brain ICs





more brain ICs

Pulse artifacts



Exercise

- **ALL**

  - Load stern.set (continuous data, contains ICA weights)

- **Novice**

  - Plot IC scalp maps

  - Scroll the IC activations and compare to channel data scroll

  - Identify “artifact” ICs

    > How can you be sure it is an artifact?

- **Intermediate / Advanced**

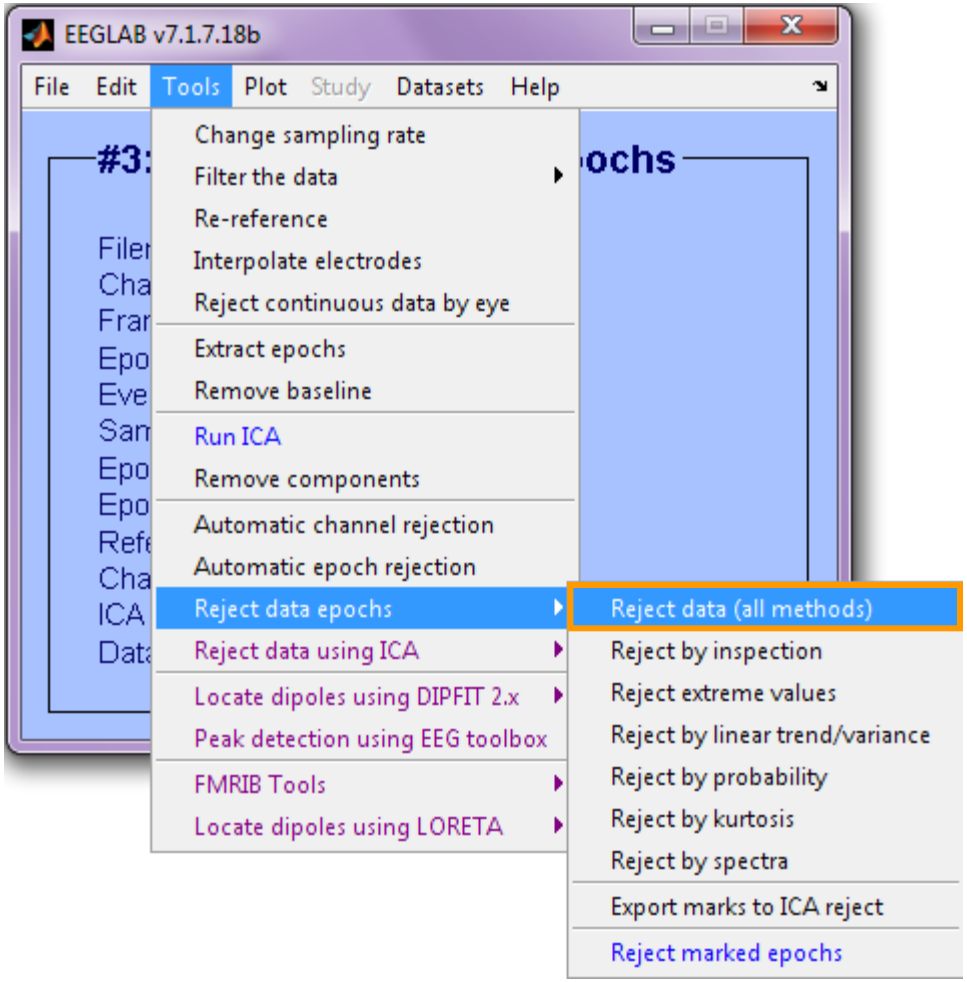
  - Practice saving EEG.icaweights and EEG.icasphere as .wts and .sph files and re-apply the weights again to stern.set

  - Plot IC power, try different parameters from the GUI

  - From supplementary material, try automatic data epoch rejection.

Supplementary lessons

Auto-reject data epochs



Reject data epochs

visual inspection

probability

Reject trials using data statistics - pop_rejmenu()

Mark trials by appearance | Scroll Data | Marked trials 0

Find abnormal values

Upper limit(s) (uV)	25	Lower limit(s) (uV)	-25
Start time(s) (ms)	-500	Ending time(s) (ms)	496
Electrode(s)	1:70	Currently marked trials	0
Calc / Plot			Help

Find abnormal trends

Max slope (uV/epoch)	50	R-squared limit (0 to 1)	0.3
Electrode(s)	1:70	Currently marked trials	0
Calc / Plot			Help

Find improbable data

Single-channel limit (std. dev.)	5	All channels limit (std. dev.)	5
Electrode(s)	1:70	Currently marked trials	0
Calculate	Scroll Data	Plot	Help

Find abnormal distributions

Single-channel limit (std. dev.)	5	All channels limit (std. dev.)	5
Electrode(s)	1:70	Currently marked trials	0
Calculate	Scroll Data	Plot	Help

Find abnormal spectra (slow)

Upper limit(s) (dB)	25	Lower limit(s) (dB)	-25
Low frequency(s) (Hz)	0	High frequency(s) (Hz)	50
Electrode(s)	1:70	Currently marked trials	0
Calc / Plot			Help

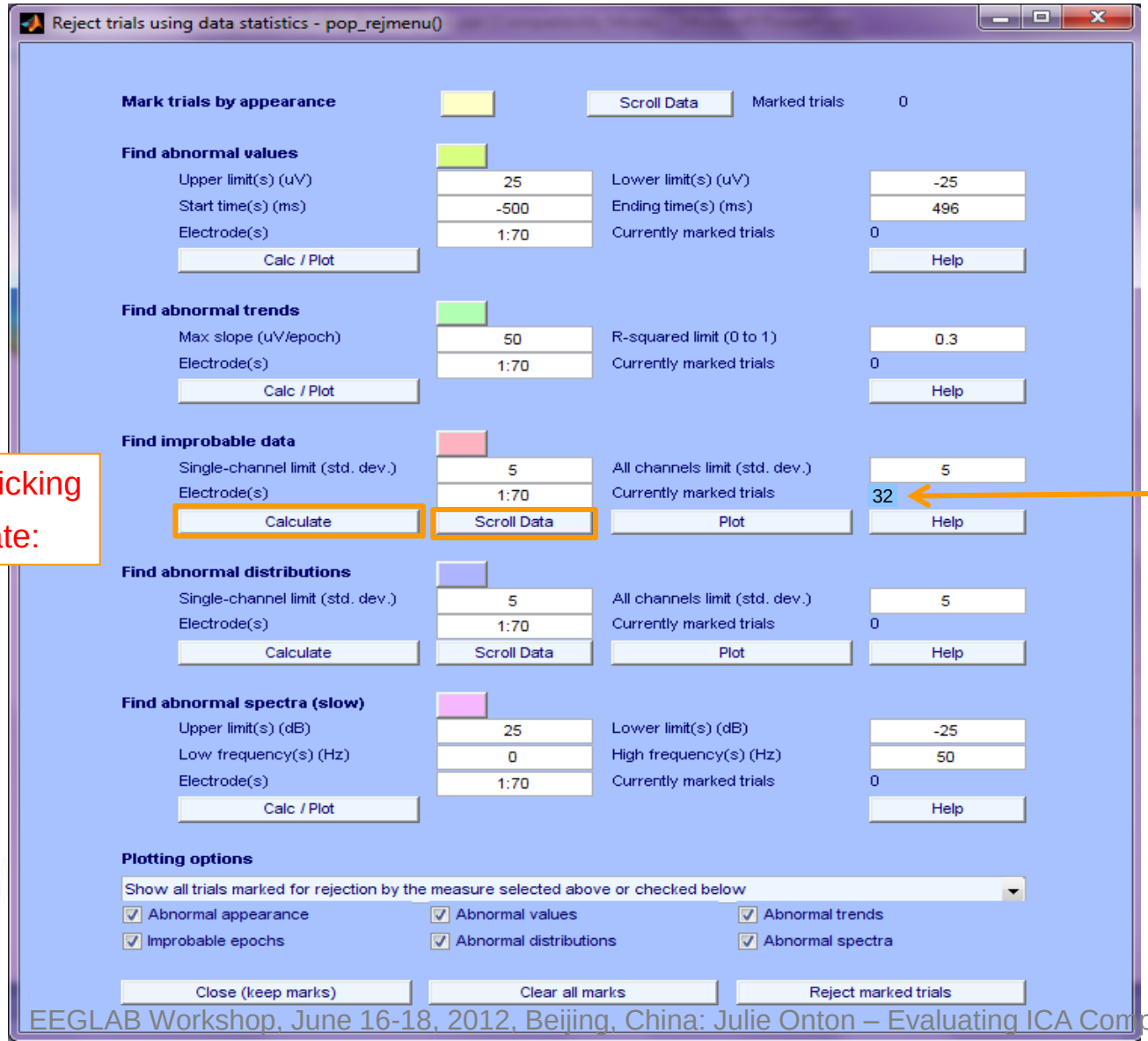
Plotting options

Show all trials marked for rejection by the measure selected above or checked below

- [x] Abnormal appearance
- [x] Abnormal values
- [x] Abnormal trends
- [x] Improbable epochs
- [x] Abnormal distributions
- [x] Abnormal spectra

Close (keep marks) | Clear all marks | Reject marked trials

Reject data epochs

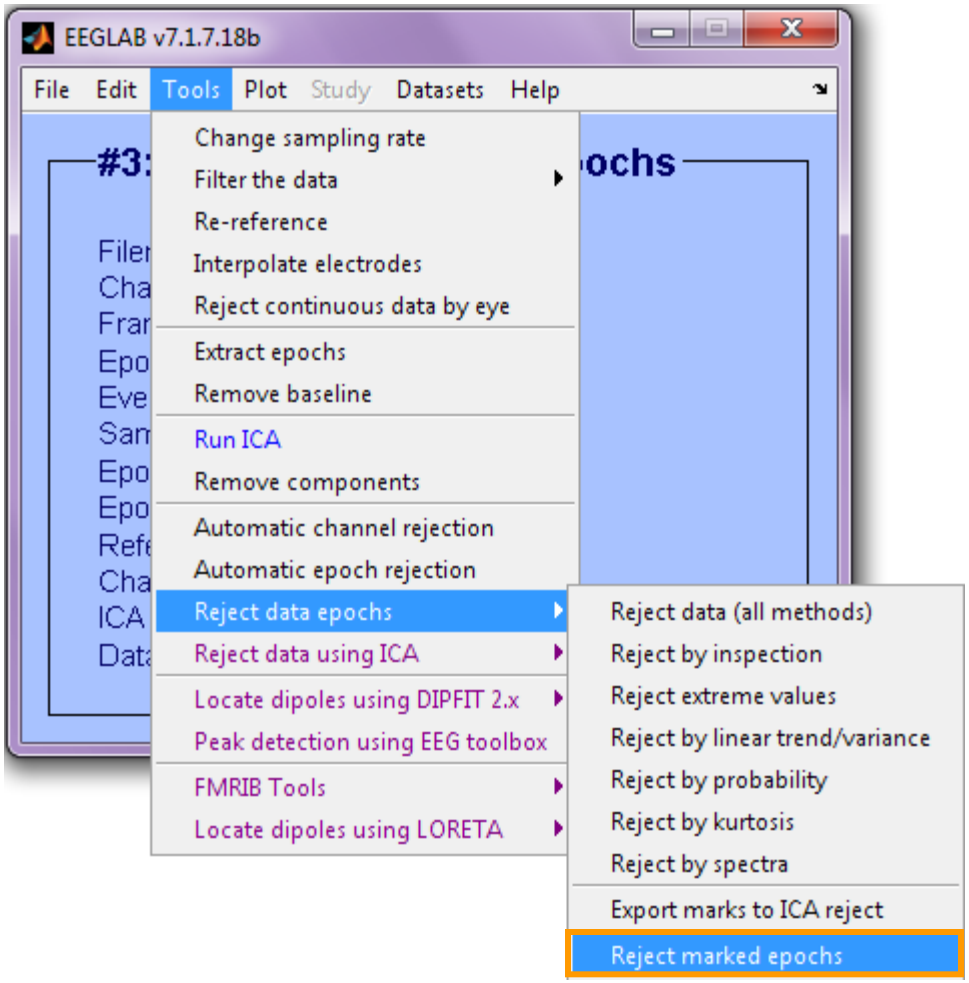


Start by clicking Calculate:

Number of epochs above threshold indicated here

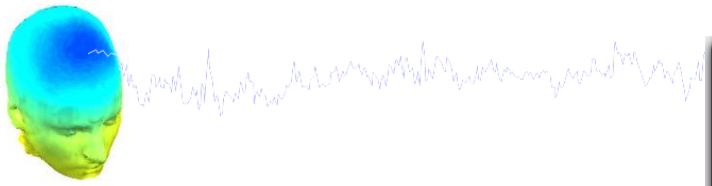
Reject or retain marked epochs

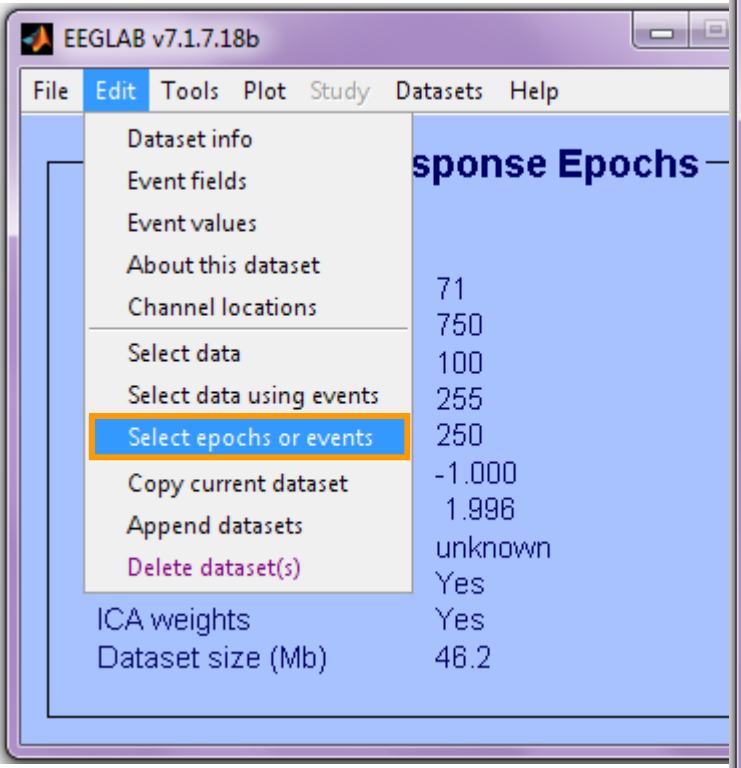
Reject marked epochs

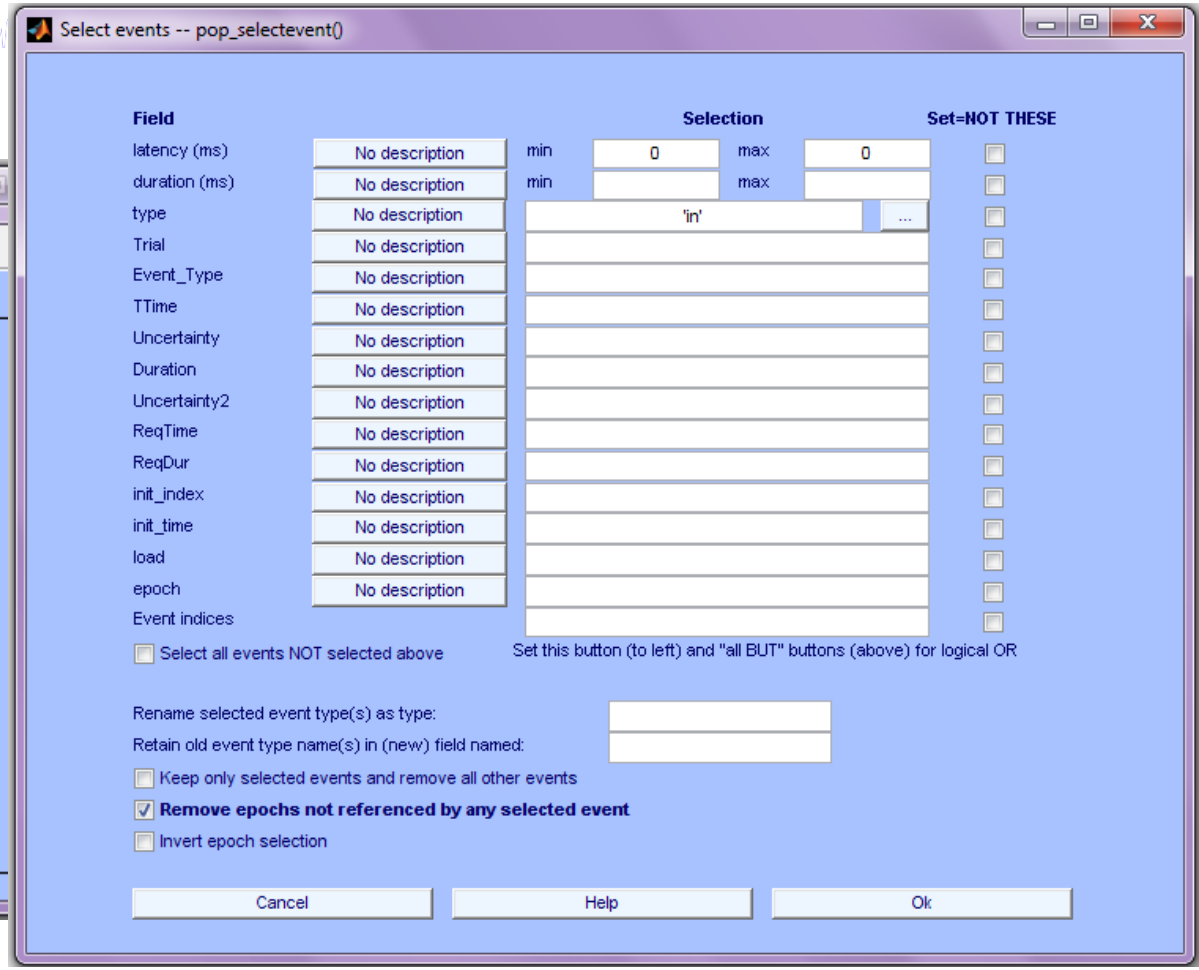



```
>> EEG = pop_jointprob(EEG,1,[1:70],5,5,0,0);
>> EEG = pop_rejepoch(EEG,find(EEG.reject.rejglobal),0);
```

Select epochs

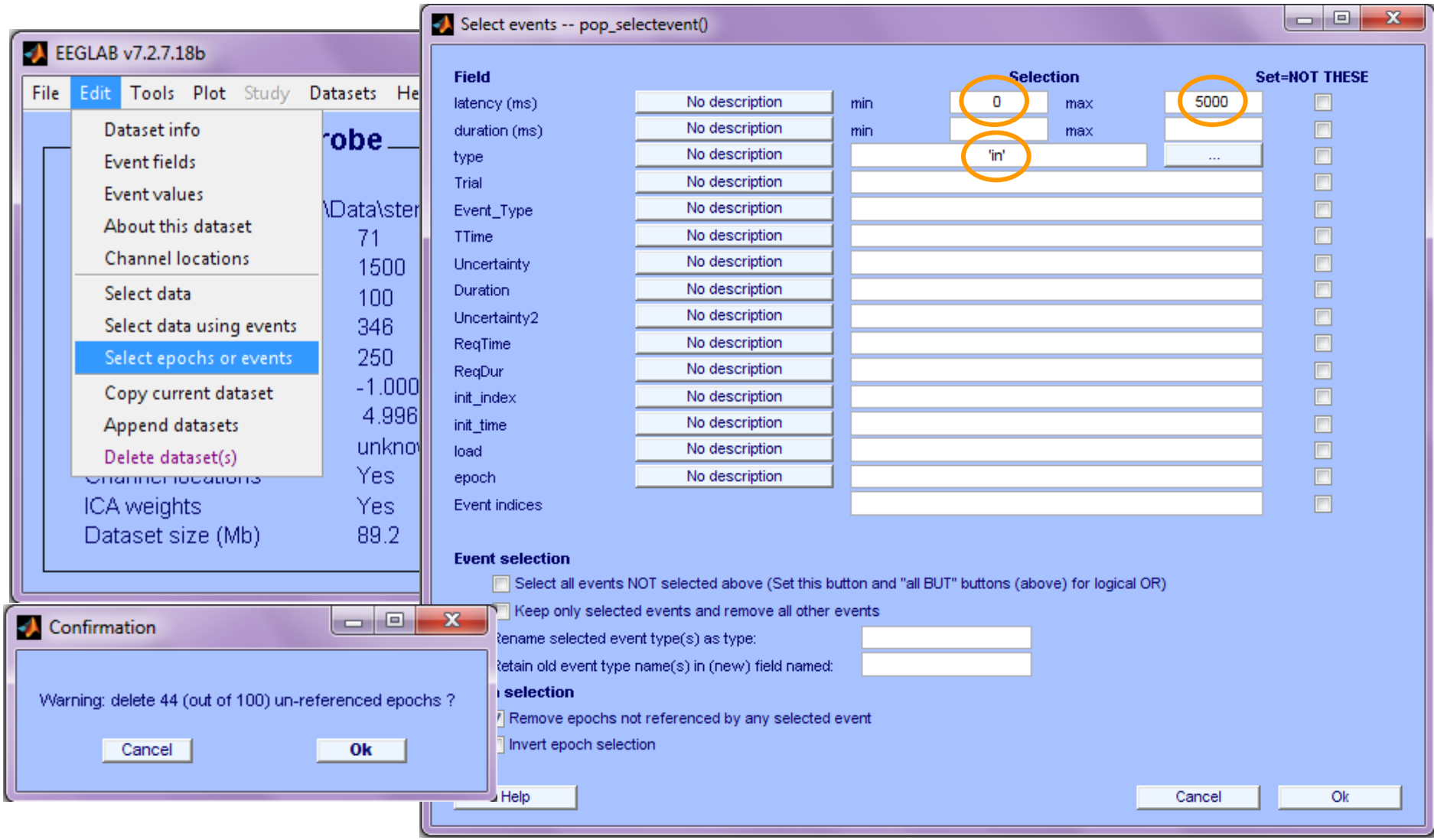







```
>> EEG = pop_selectevent(EEG,'type',{'in'},...
    'deleteevents', 'off','deleteepochs','on');
>> [ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG,EEG,4,...
  'setname','faces only epochs');
```

Select epochs with specific events



Repeat for ‘out-of-set’ responses

Save without overwriting and go back to all epochs

Repeat process for ‘out’ trials

Dataset info -- pop_newset()

What do you want to do with the new dataset?

Name it: Sternberg: Probe- In Set

Save it as file:

Some changes have not been saved. What do you want to

Overwrite it in memory (set=yes; unset=create a new dat

Save it as file: C:\Users\julie\Documents\Worksho

Help

Select events -- pop_selectevent()

Field		Selection			Set=NOT THESE
latency (ms)	No description	min 0	max 5000		
duration (ms)	No description	min	max		
type	No description	'out'	...		
Trial	No description				
Event_Type	No description				
TTime	No description				
Uncertainty	No description				
Duration	No description				
Uncertainty2	No description				
ReqTime	No description				
ReqDur	No description				
init_index	No description				
init_time	No description				

is button and "all BUT" buttons (above) for logical OR)

her events

ned:

ted event

Cancel Ok

Dataset info -- pop_newset()

What do you want to do with the new dataset?

Name it: Sternberg: Probe Out of Set Edit description

Save it as file: Browse

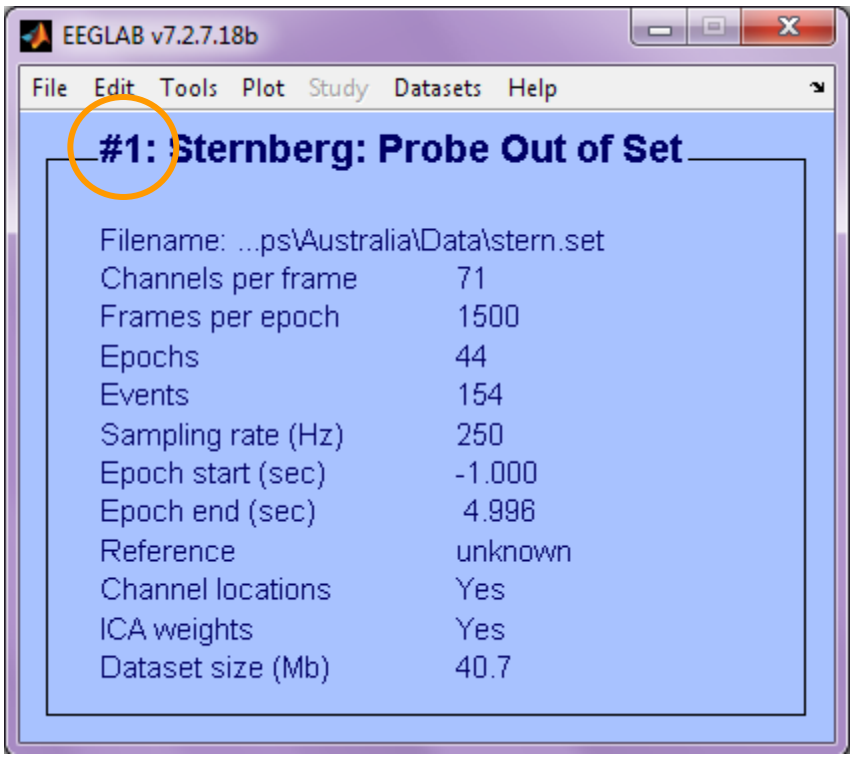
Some changes have not been saved. What do you want to do with the old dataset?

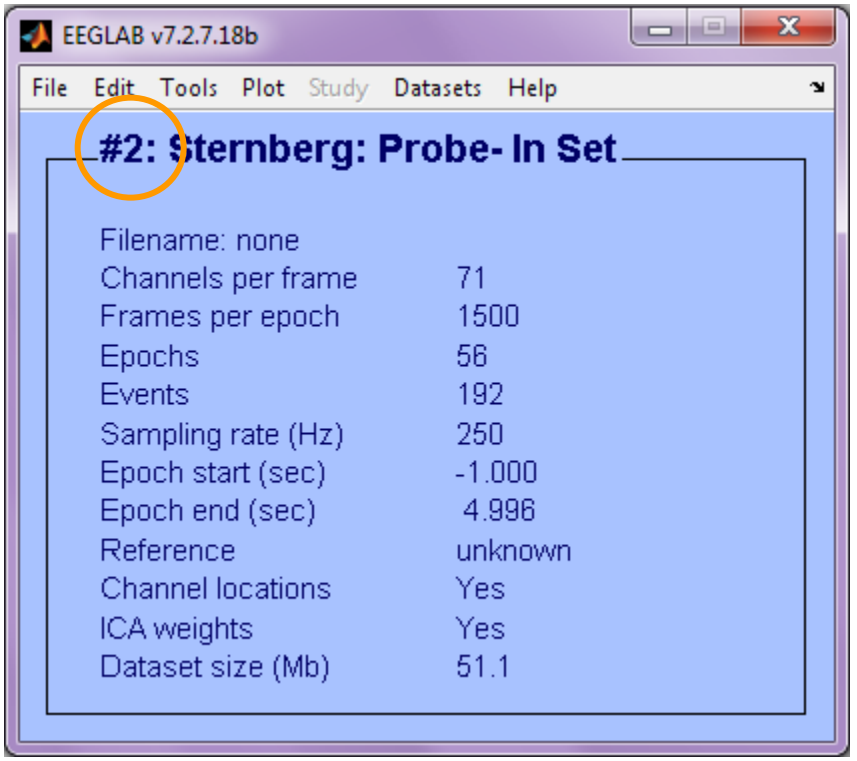
Overwrite it in memory (set=yes; unset=create a new dataset)

Save it as file: C:\Users\julie\Documents\Workshops\Aust Browse

Help Cancel Ok

Separate datasets with different conditions

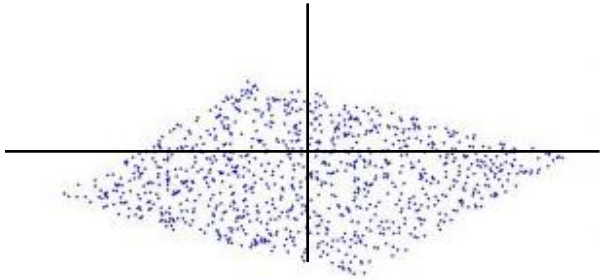




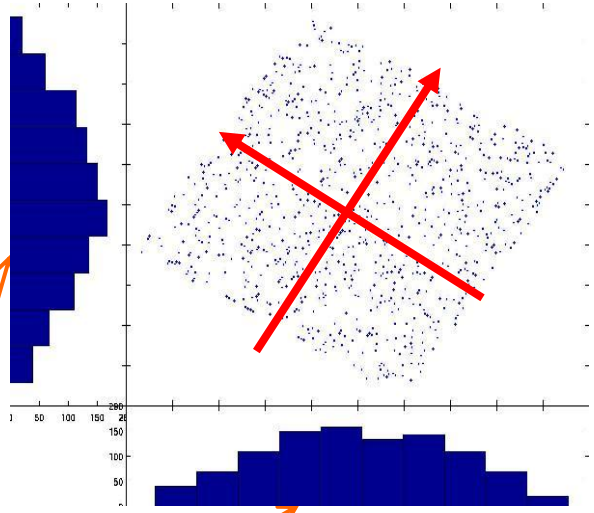
Explanation of "sphering"

Sphered data

Original data



"Sphering":
Remove channel correlations



Like ICA, sphering is also a linear operation, so re-projecting to original space simply requires multiplying with weight matrix

Equal variance on both (all) axes

For more explanation, see:

http://sccn.ucsd.edu/~arno/indexica.html

and http://sccn.ucsd.edu/wiki/Linear_Representations_and_Basis_Vectors