Advanced IC analysis

Task 1

Search EEG.event structure

Task 2

Use *newtimef()* to compare conditions

Task 3

Plot a RT-sorted component ERP image

Plot a type-sorted component ERP image

Plot a load-sorted component ERP image

Task 4

Use outputs from commandline ERP image

Exercise...

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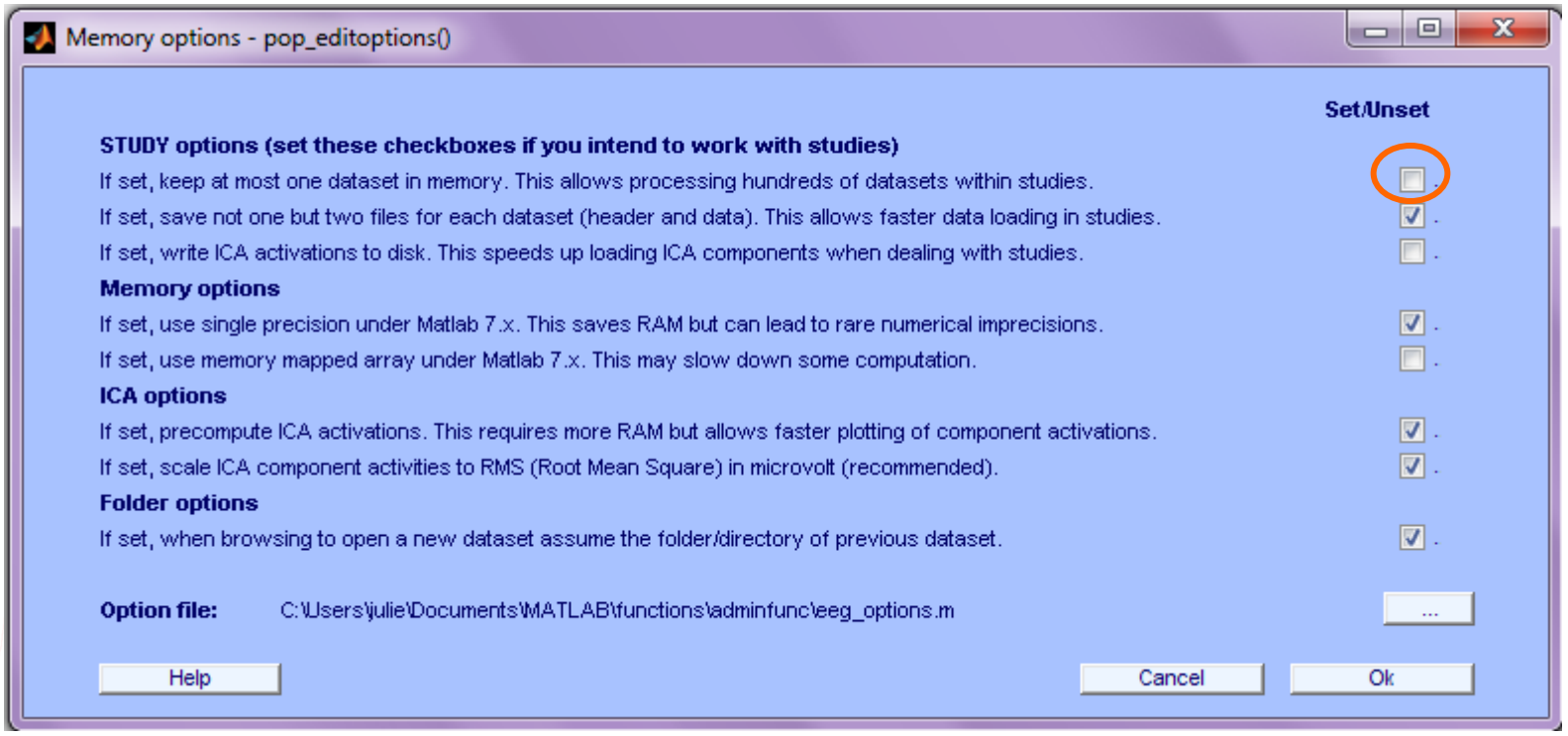
Exercise...

Set memory options

```
% you will need memory options to keep more than one dataset in memory at once:
pop_editoptions( 'option_storedisk', 0, 'option_savetwofiles', 1,…
 'option_saveica', 0, 'option_single', 1, 'option_memmapdata', 0,…
 'option_computeica', 1, 'option_scaleicarms', 1, 'option_rememberfolder', 1);
%---------------------------------------------------------------------
```



The example data: Sternberg working memory

File

../Data/stern.set

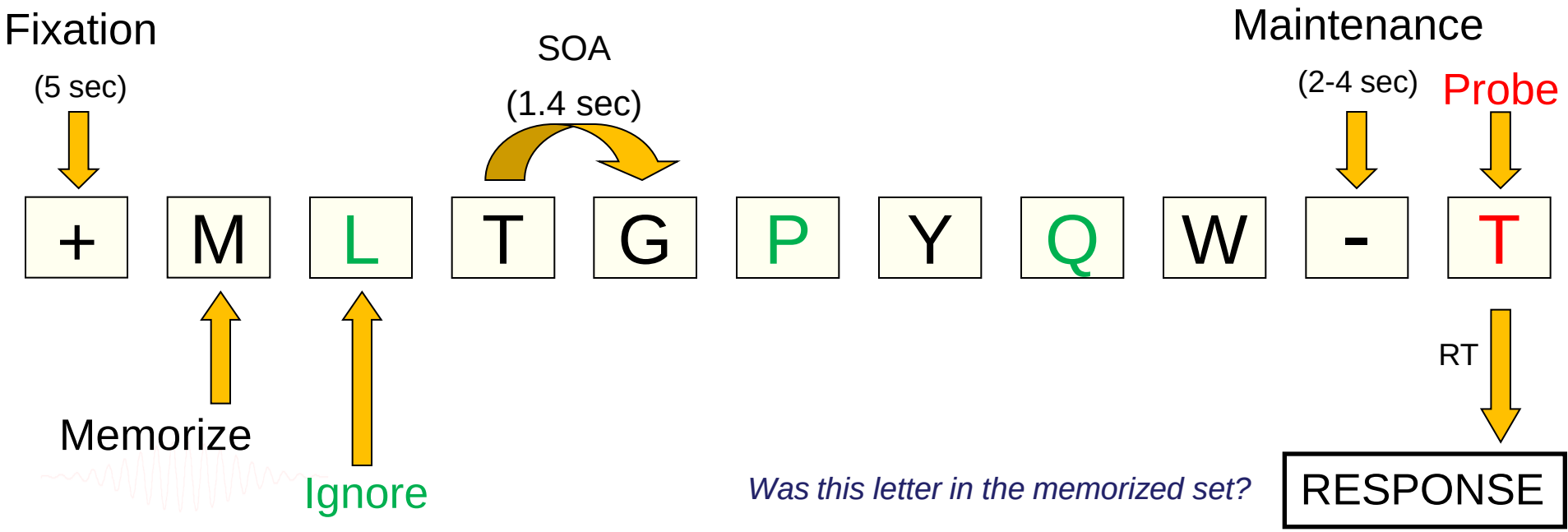
Data

Continuous data (not epoched), ref'd to right mastoid

Task

3-7 letters to memorize, among 1-5 letters to ignore

50% chance of probe letter being 'in-set'



Color-coding for tutorial scripts

```
%%%%%  Color-coding for scripts:

% Green text is comments

myvariable (bold, red) = pre-defined variable

for ep … end = … (bold, blue) = 'for loop' variable

if … end = (bold, cyan) = 'if loop' statement

newtimef() (bold, purple) = function call

[outdata,outvar,outtrials,…] (brown, in brackets)

                = function output variables
```

Search events for specific event type


```
% OBJECTIVES:
% 1) Find all Memorize letters that were preceded by an ignore letter
% 2) Find all Memorize letters that were preceded by a memorize letter
%-------------------------------------------------------------
% hint: 'memorize' event codes are single letters
epochidxM = []; % Mem preceded by a mem letter
epochidxG = []; % Mem preceded by an ignore letter
for ev = 2:length(EEG.event)
    if length(EEG.event(ev).type)==1 & length(EEG.event(ev-1).type)==1
        epochidxM = [epochidxM, ev]; % save this event
    elseif length(EEG.event(ev).type)==1 & EEG.event(ev-1).type(1)=='g'
        epochidxG = [epochidxG, ev]; % save this event
    end;
end;
```

Epoch on selected events


```
% Epoch continuous data around selected events
%-------------------------------------------------------------
[EEG, indices] = pop_epoch( EEG, [], [-2 2],'eventindices',epochidxG);
[ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, EEG, 1,…
 'setname','Mem after Ignore letter','gui', 'off');
EEG = pop_autorej(EEG,  'nogui', 'on'); % Auto-reject noisy epochs
[ALLEEG EEG CURRENTSET]=pop_newset(ALLEEG,EEG,CURRENTSET,'retrieve',1);


[EEG, indices] = pop_epoch( EEG, [], [-2 2],'eventindices',epochidxM);
[ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, EEG, 1,…
 'overwrite','on', 'setname','Mem after Mem letter','gui', 'off');
EEG = pop_autorej(EEG,  'nogui', 'on'); % Auto-reject noisy epochs
eeglab redraw
```

Confirm datasets contain expected epochs

```
>> [ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, EEG, CURRENTSET, 'retrieve',1);
>> EEG.epoch(2) %--- Select several random epochs
ans =
             event: [4 5 6]
              eventlatency: {[-1.4400e+003]  [0]  [1.4440e+003]}
              eventload: {[1]  [2]  [3]}
              eventtype: {'R'  'N'  'Z'}
              eventurevent: {[5]  [6]  [7]}
>> [ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, EEG, 2, 'retrieve',2);
>> EEG.epoch(2)
ans =
              event: [4 5 6]
              eventlatency: {[-1.4400e+003]  [0]  [1.4440e+003]}
              eventload: {[0]  [0]  [1]}
              eventtype: {'gC'  'Z'  'L'}
              eventurevent: {[15]  [16]  [17]}
```

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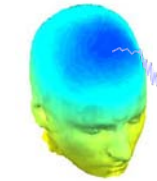
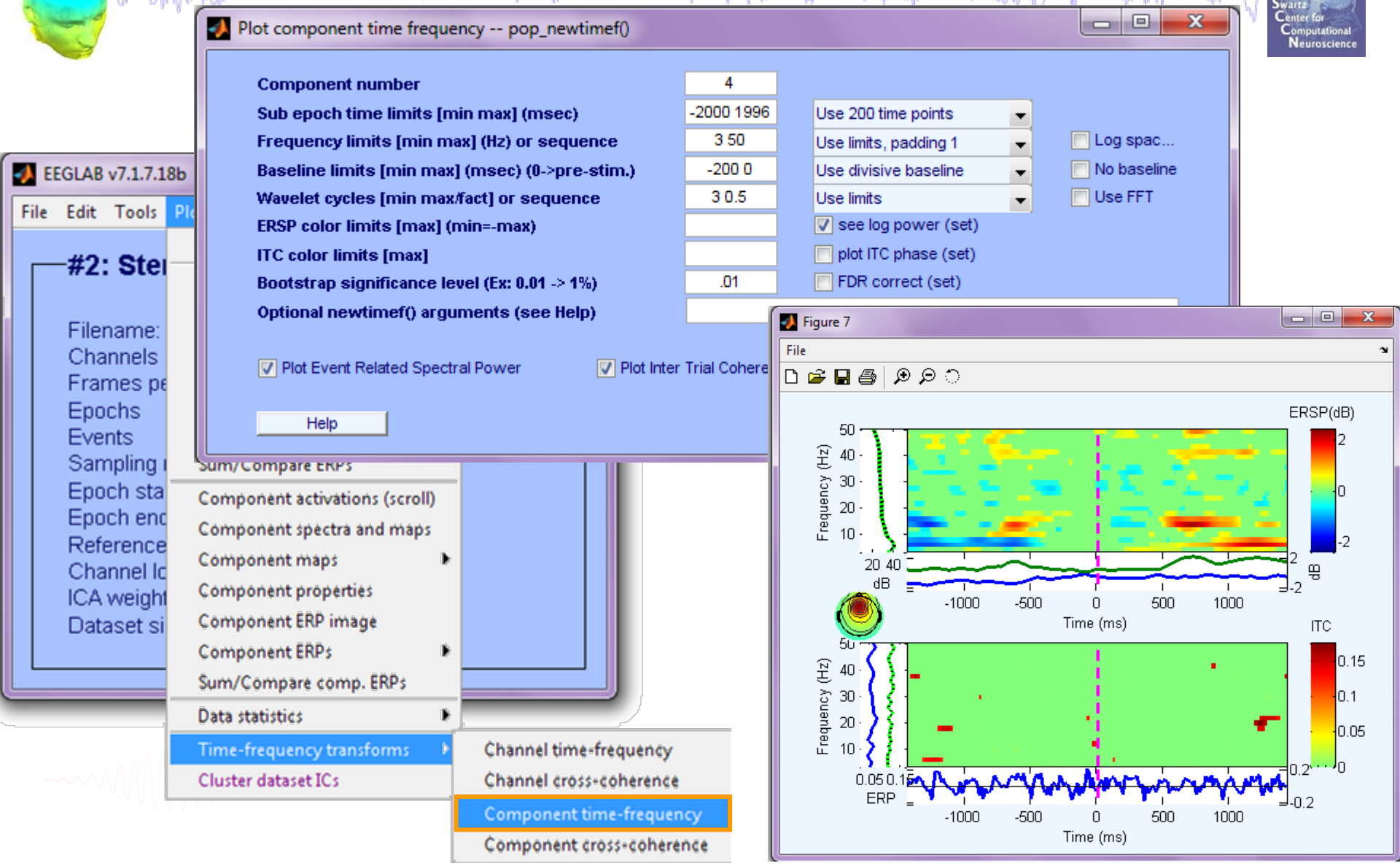
Exercise...

Get *newtimef()* command from GUI call





Use *newtimef()* to compare conditions

```
>> eegh

figure; pop_newtimef( EEG, 0, 4, [-2000  1996], [3 0.5] ,…
 'topovec', EEG.icawinv(:,4), 'elocs', EEG.chanlocs,…
 'chaninfo', EEG.chaninfo, 'baseline',[-200 0], 'alpha',.01,…
 'freqs', [3 50], 'plotphase', 'off', 'padratio', 1);

>> help newtimef
 Example using data from two conditions (EEG versus ALLEEG(2)):
    >> [ersp,itc,powbase,times,freqs,erspboot,itcboot] = ...
        newtimef({EEG.data(chan,:,:) ALLEEG(2).data(chan,:,:)}, …
        EEG.pnts, [EEG.xmin EEG.xmax]*1000, EEG.srate, cycles);
```

Task 3: Use *newtimef()* to compare conditions

```
% adapt to your script:----------------------------
% data from datasets 1 (mem after mem)
% and 2 (mem after ignore)
ic = 4; % choose a component
[ersp,itc,powbase,times,freqs,erspboot,itcboot] =  …
newtimef({ALLEEG(1).icaact(ic,:),ALLEEG(2).icaact(ic,:)}, …
EEG.pnts, [EEG.xmin EEG.xmax]*1000, EEG.srate, [3 .5],…
'type', 'phasecoher', 'topovec', EEG.icawinv(:,ic), …
'elocs', EEG.chanlocs, 'chaninfo', EEG.chaninfo, …
'title',{['IC ',int2str(ic),' M a M'],…
        ['IC ',int2str(ic),' M a Ig']},…
'baseline',[-200 0], 'alpha',.01,'padratio', 1,…
'plotphase','off', 'freqs', [3 50]);
```

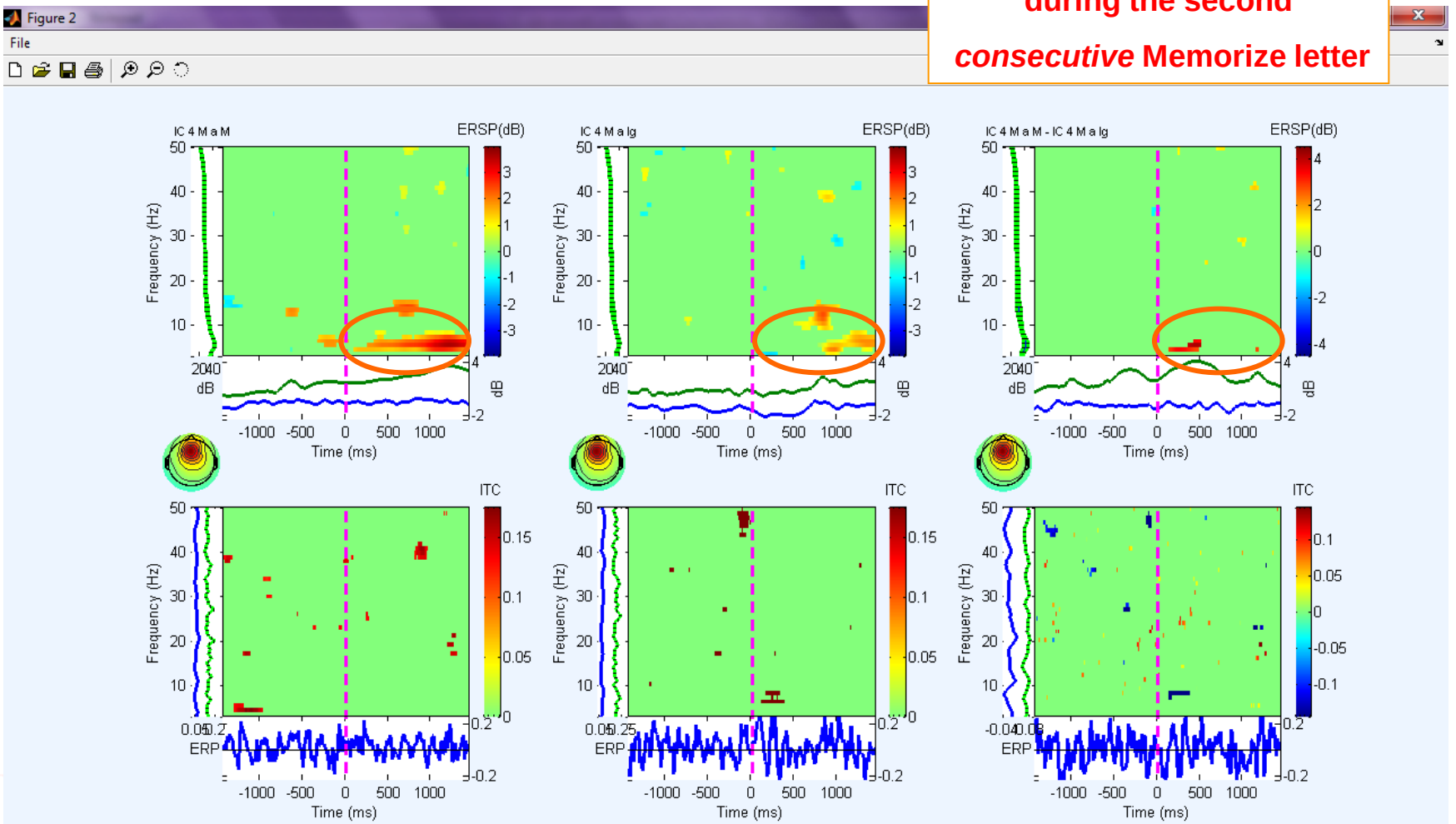
data

condition 1

condition 2

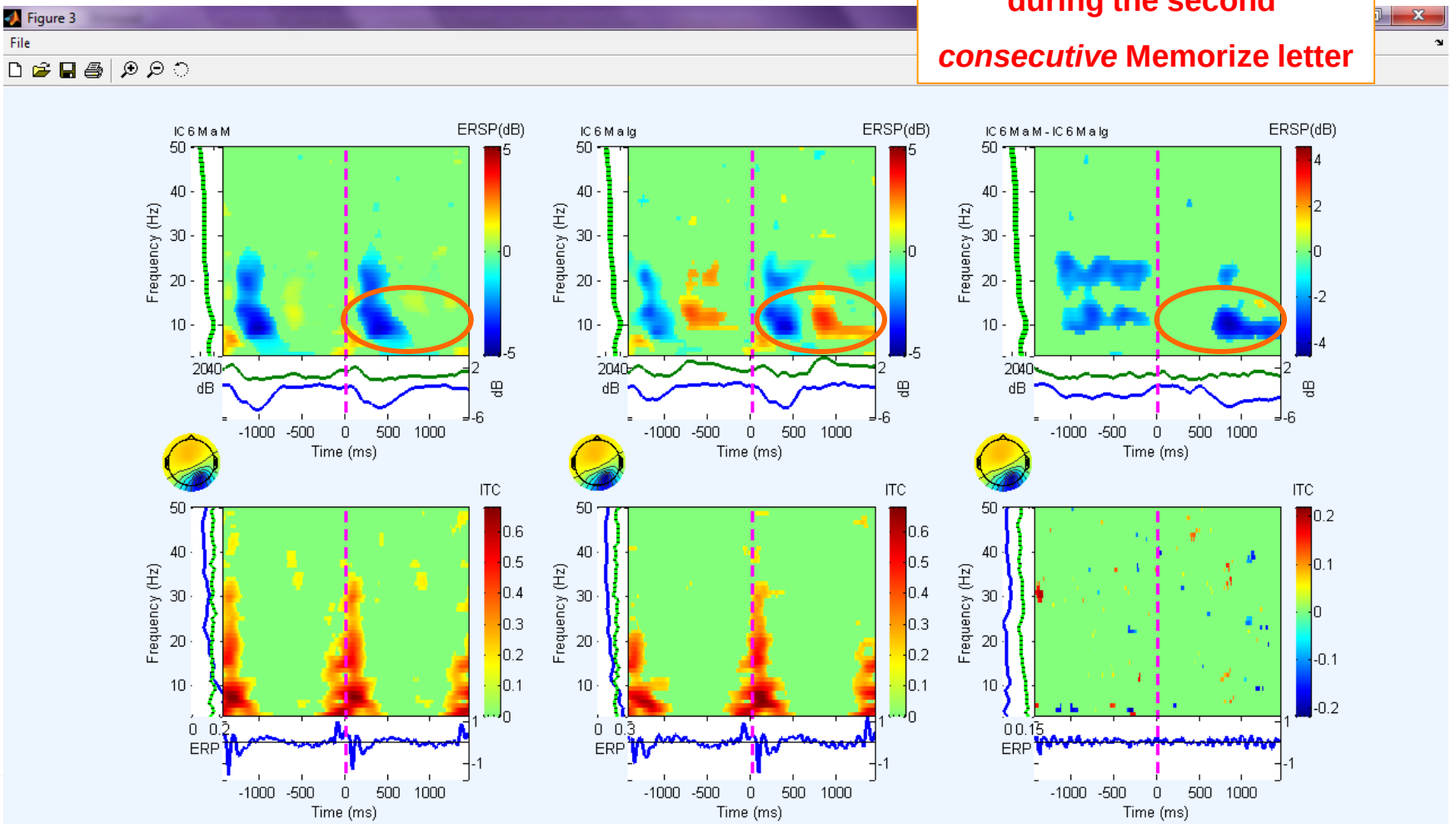
Compare conditions with *newtimef()*

Higher frontal theta during the second *consecutive* Memorize letter



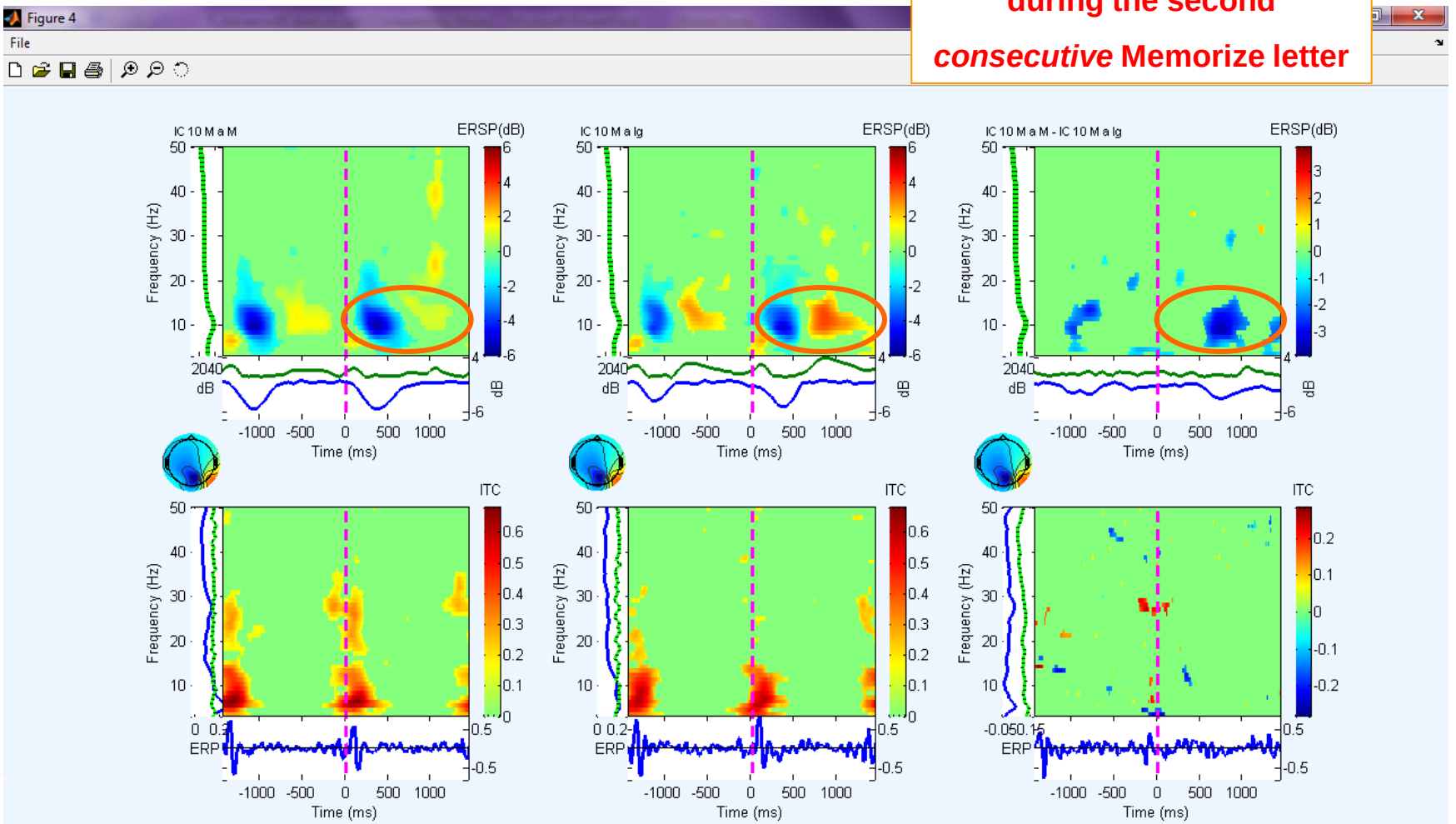
Compare conditions with *newtimef()*

Less *parietal* alpha power during the second *consecutive* Memorize letter



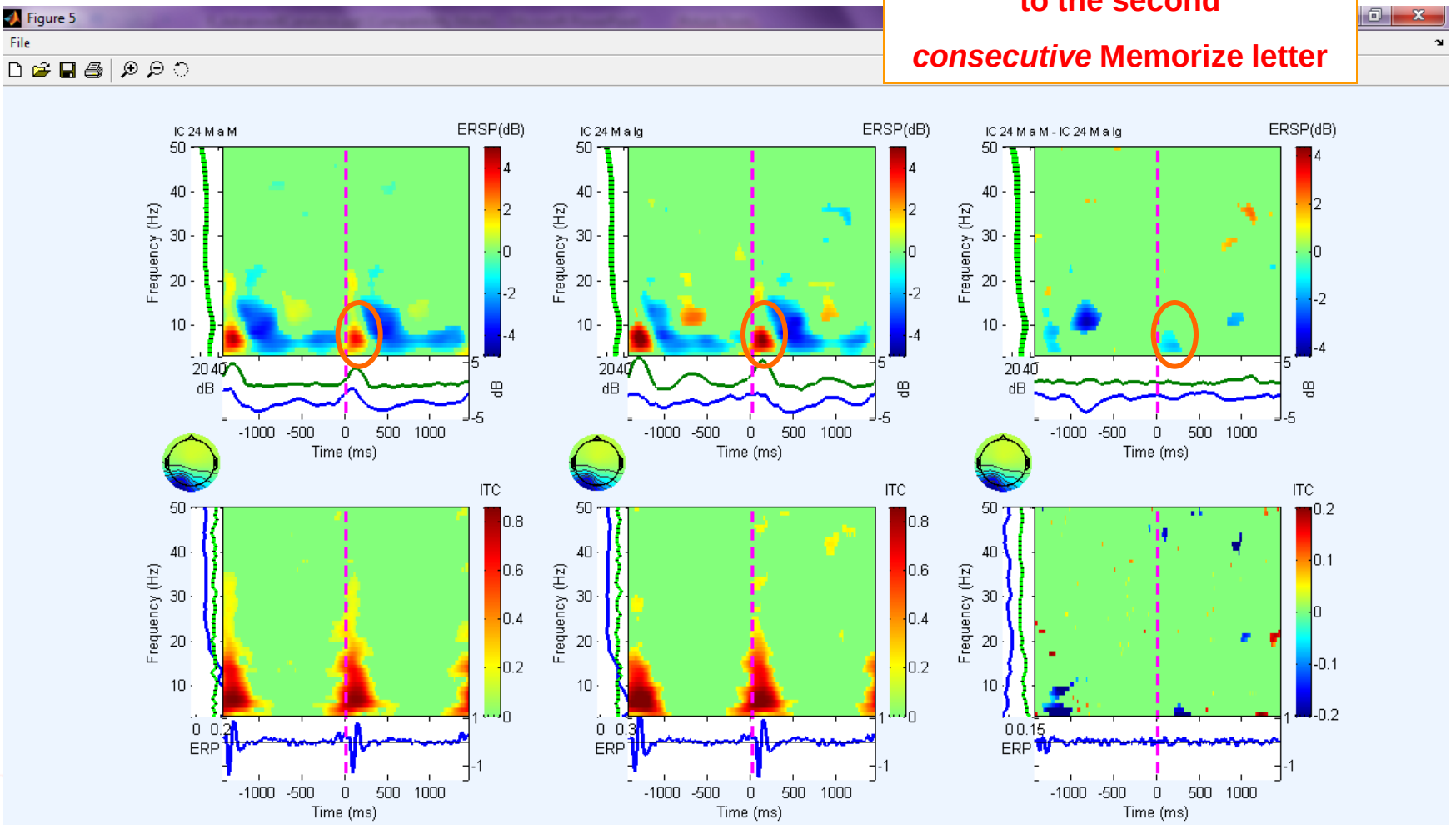
Compare conditions with *newtimef()*

Less *occipital* alpha power during the second *consecutive* Memorize letter



Compare conditions with *newtimef()*

Less visual evoked potential to the second *consecutive* Memorize letter



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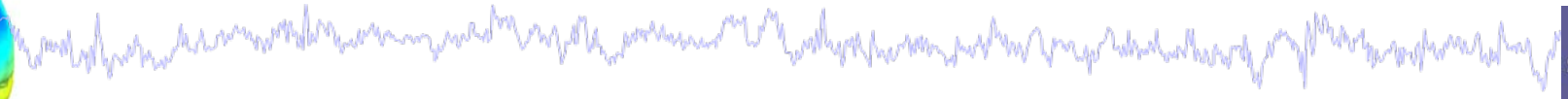
Task 4

Use outputs from commandline ERP image

Exercise...

Sort ERP image by RT



EEGLAB v7.2.7.18b

File Edit Tools Plot Study Datasets Help

#1: Ste

Filename:
Channels
Frames p
Epochs
Events
Sampling
Epoch sta
Epoch en
Reference
Channel l
ICA weigh
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 (scro
Component spectra and map
Component maps
Component properties
Component ERP image
Component ERPs
Sum/Compare comp. ERPs
Data statistics
Time-frequency transforms
Cluster dataset ICs

Component ERP image -- pop_erpimage()

Component(s) 17
Project to channel #
Smoothing 5
Downsampling 1
Time limits (ms) -3000 3000

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): in' 'out
Event time range
Rescale: no
Align
Don't sort by value
Don't plot values

Sort trials by phase

Frequency (Hz | minHz maxHz)
Percent low-amp. trials to ignore
Window center (ms)
Wavelet cycles: 3

Inter-trial coherence options

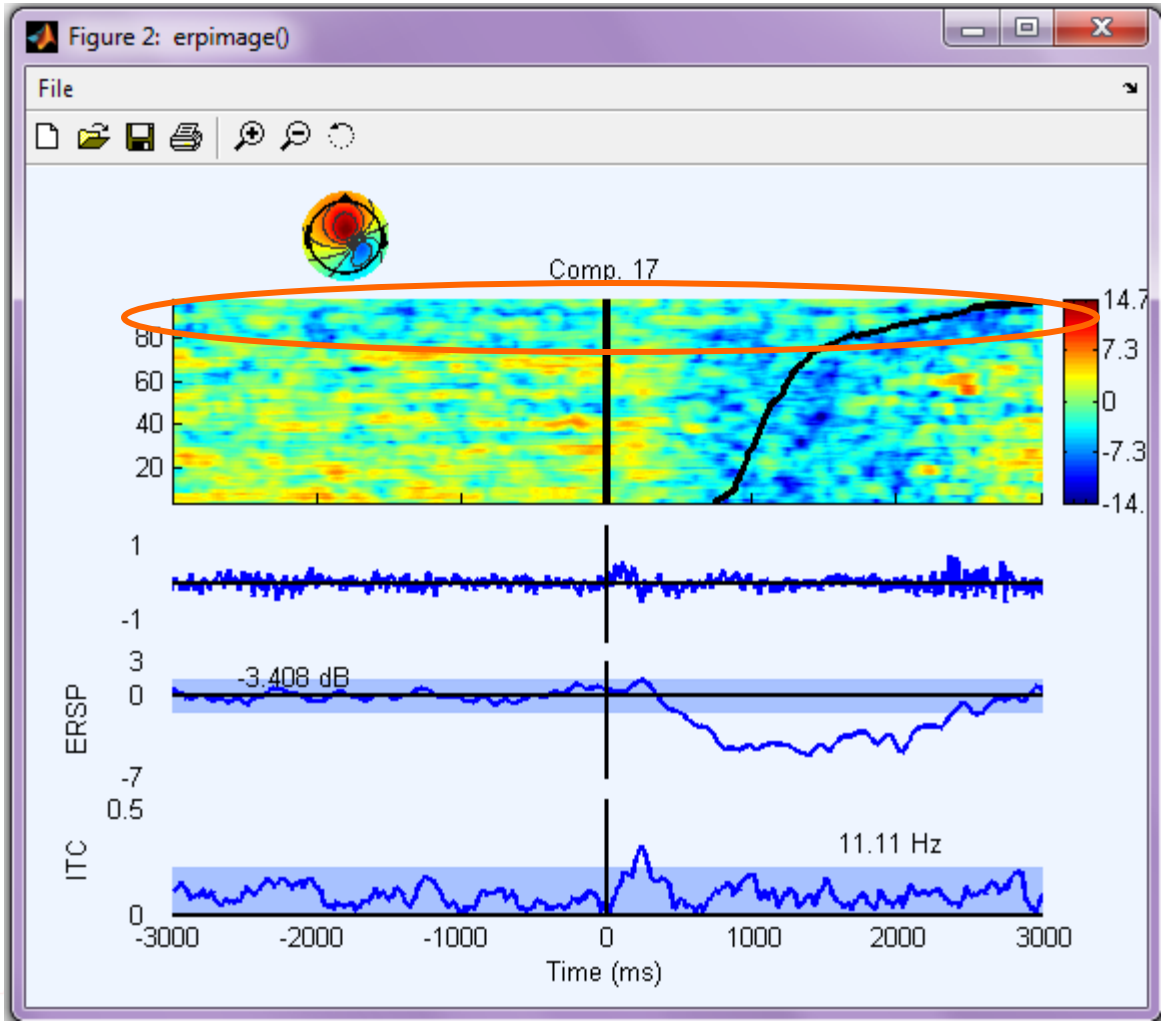
Frequency (Hz | minHz maxHz): 8 12
Signif. level (<0.20): 0.01
Amplitude limits (dB)
Coher limits (<=1)
Image amps
(Requires signif.)

Other options

Plot spectrum (minHz maxHz)
Baseline ampl. (dB)
Mark times (ms)
More options (see >> help erpimage)

Help Cancel Ok

Sort ERP image by RT



Sort ERP image by response type

Component ERP image -- pop_erpimage()

Component(s) 3
Project to channel #
Smoothing 5
Downsampling 1
Time limits (ms) -300 1000
Figure title
Plot scalp map
Plot ERP
Plot colorbar

Sort/align trials by epoch event values
Epoch-sorting field: type
Event type(s): in' 'out
Event time range
Rescale: no

Sort trials by phase
Frequency (Hz | minHz maxHz)
Percent low-amp. trials to ignore
Window

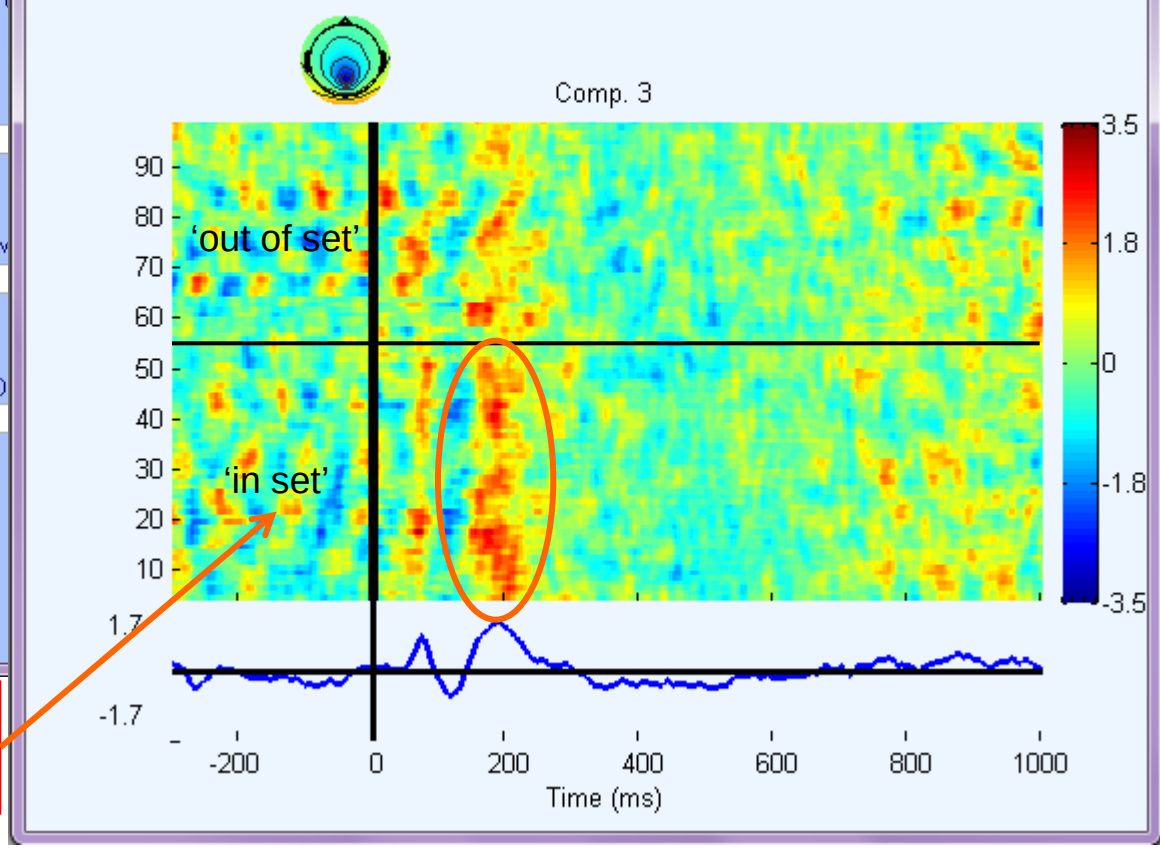
Inter-trial coherence options
Frequency (Hz | minHz maxHz)
Signif. level (<0.20)
Amplitude limits (dB)

Other options
Plot spectrum (minHz maxHz)
Baseline ampl. (dB)
Mark times (ms)

Help

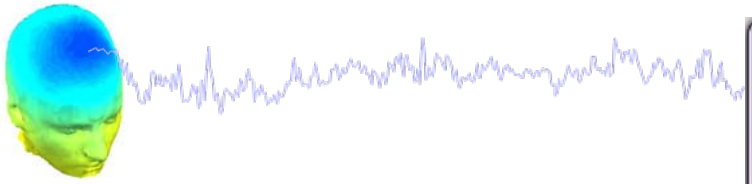
Figure 2: erpimage()

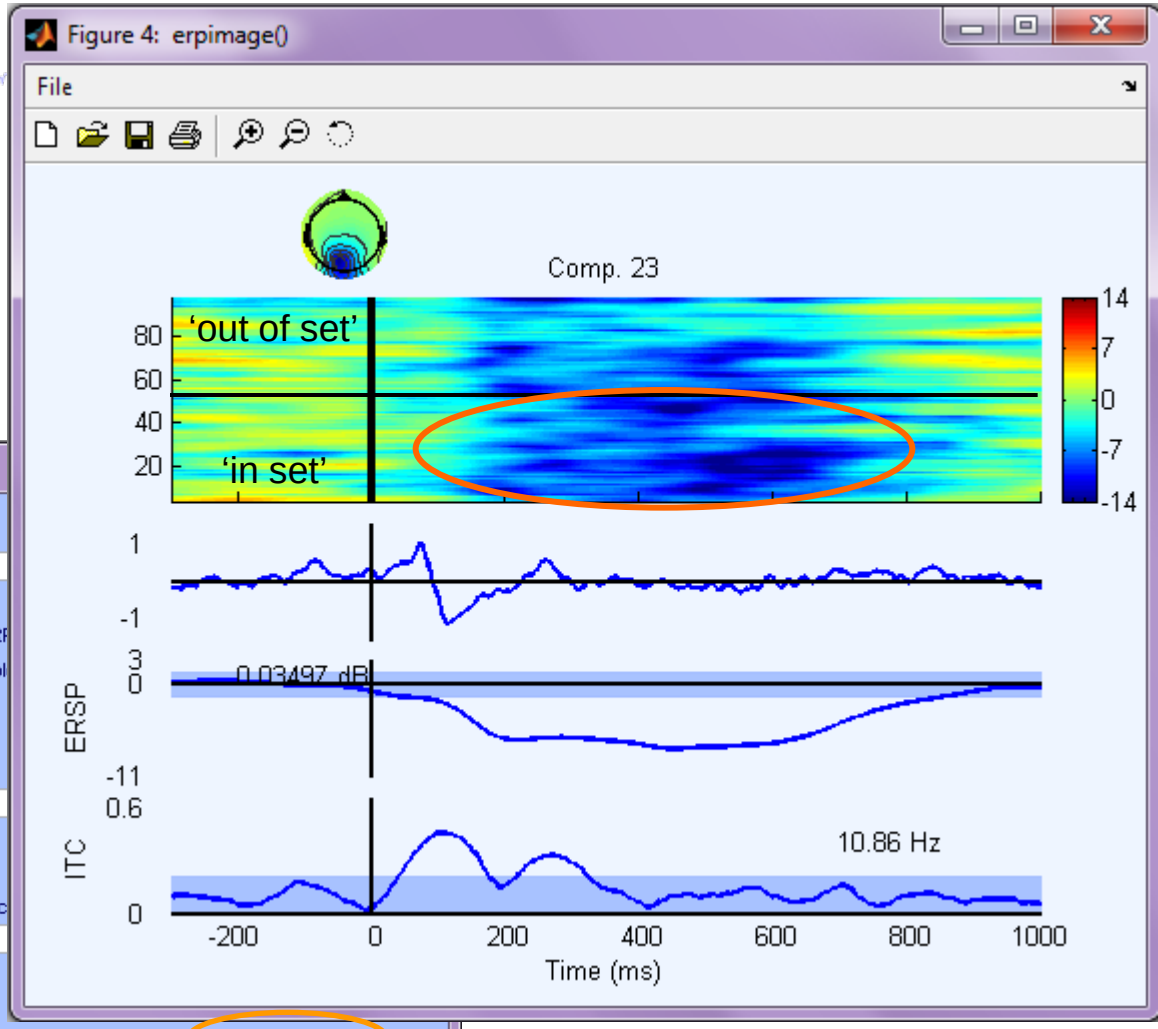
File

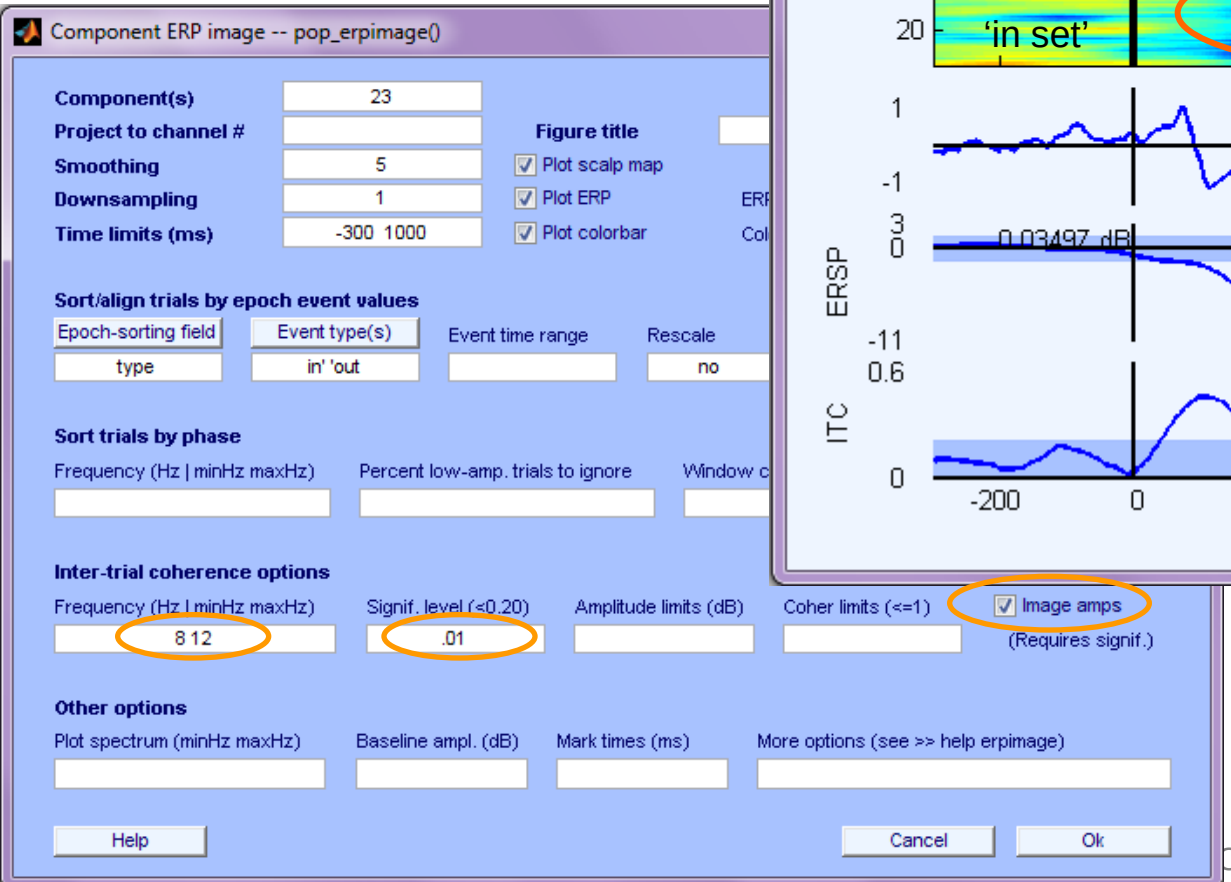


Labels were added for clarity
(not plotted by ERP image)

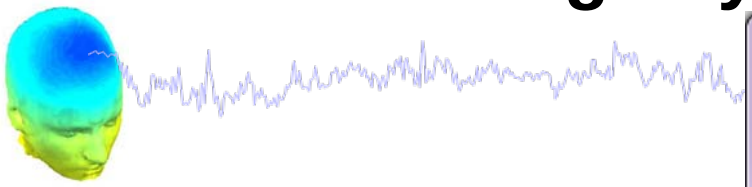
Sort ERP image by response type

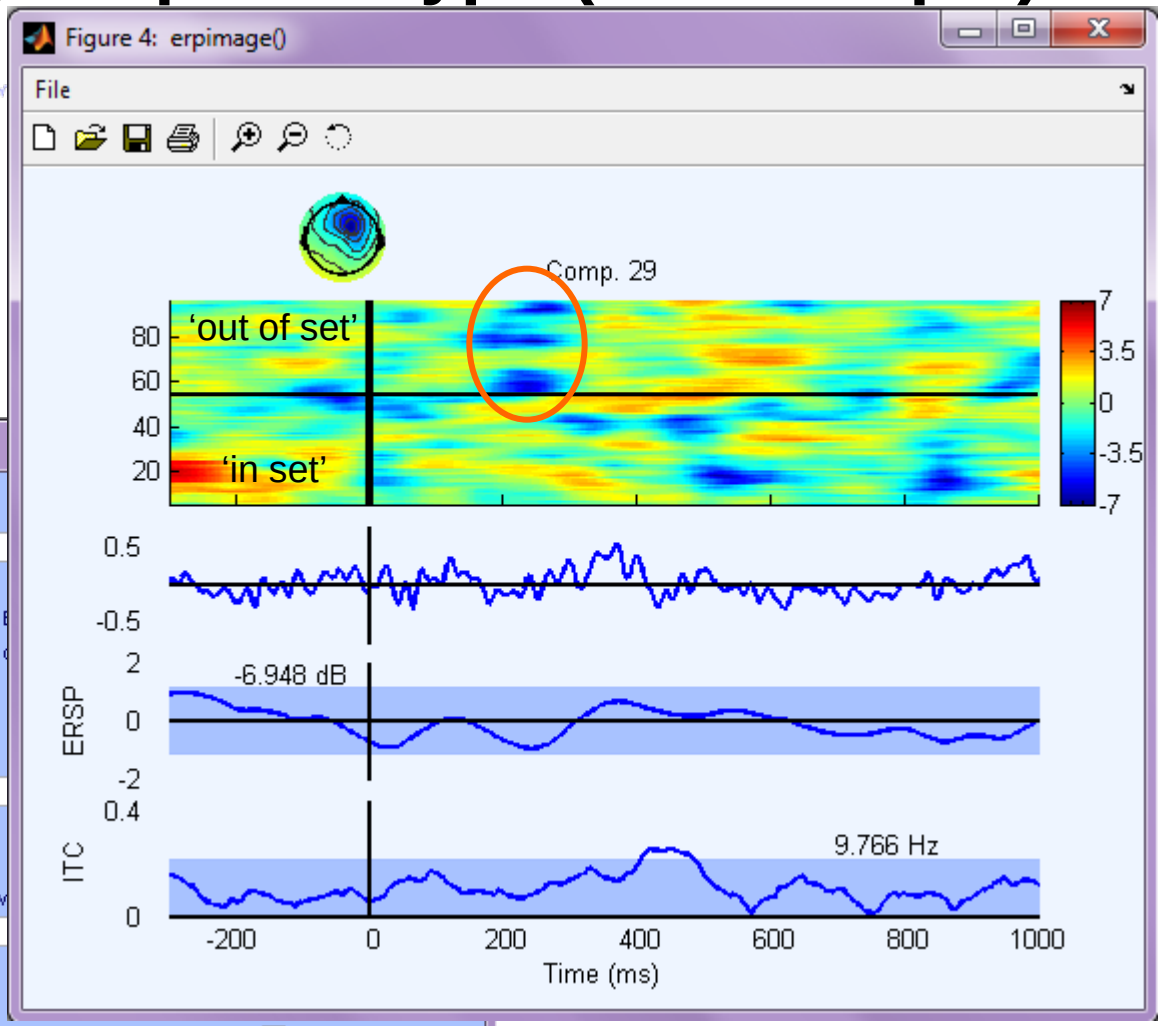


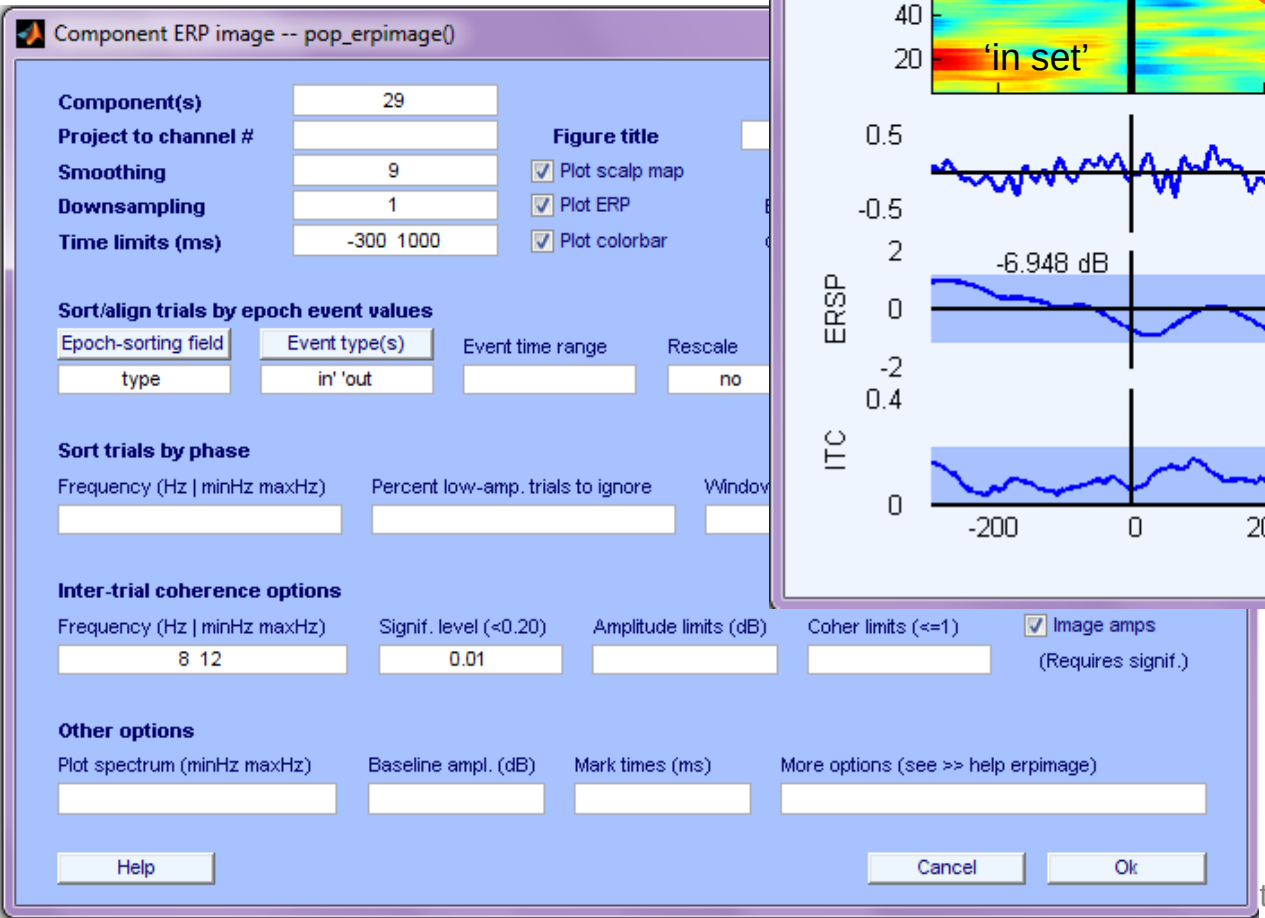




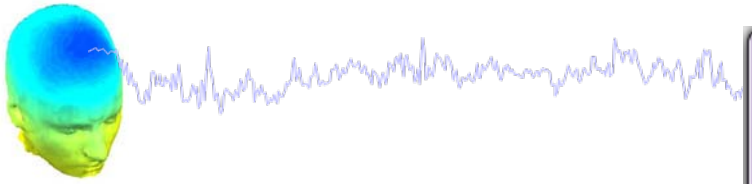
Sort ERP image by response type (2nd example)

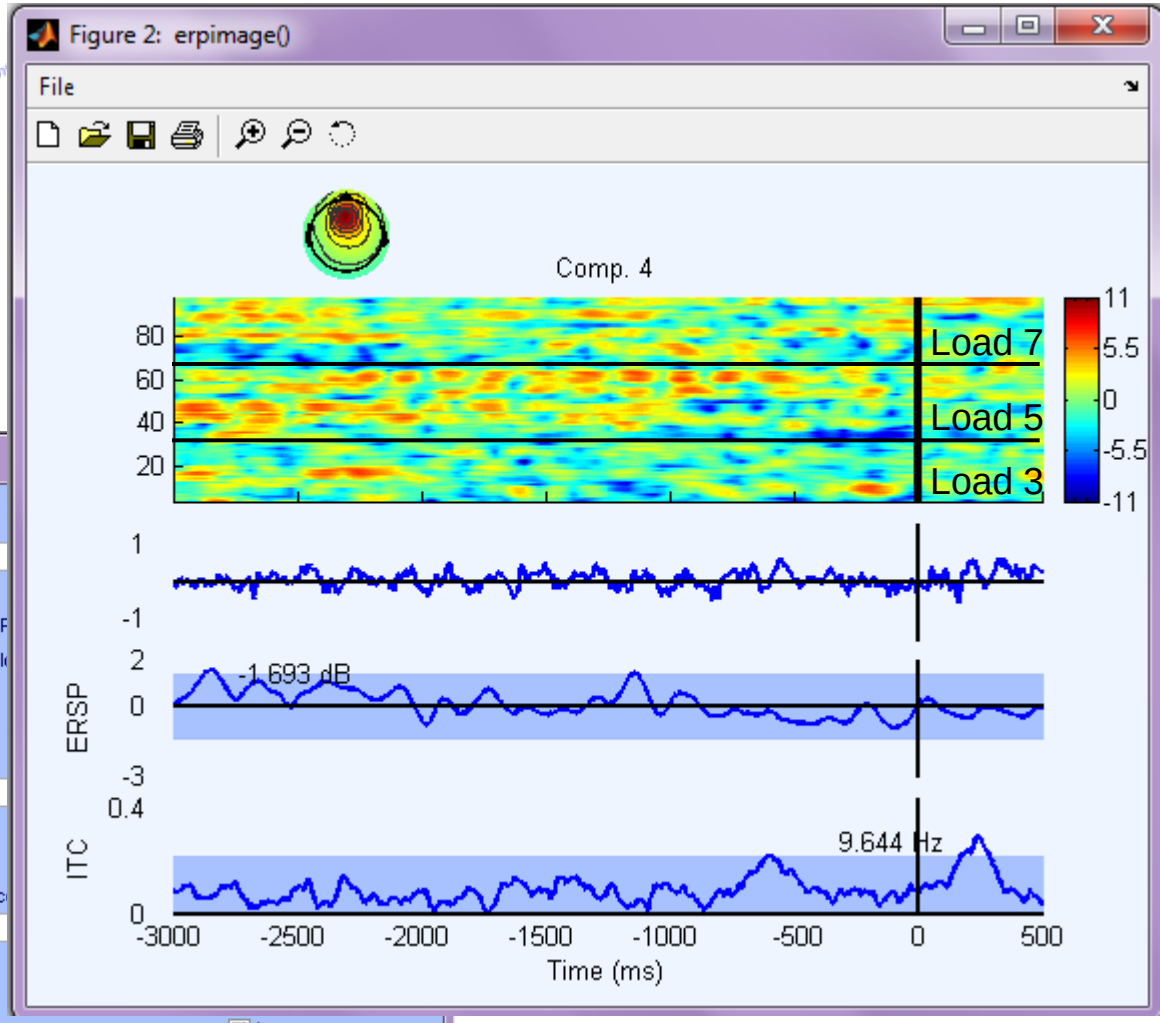






Sort ERP image by memory load





Component ERP image -- pop_erpimage()

Component(s)	4		
Project to channel #		Figure title	
Smoothing	5	Plot scalp map	
Downsampling	1	Plot ERP	
Time limits (ms)	-3000 500	Plot colorbar	

Sort/align trials by epoch event values

Epoch-sorting field	Event type(s)	Event time range	Rescale
load	rB' 'rC' 'rD' 'rF' 'rG' 'r		no

Sort trials by phase

Frequency (Hz | minHz maxHz)	Percent low-amp. trials to ignore	Window c

Inter-trial coherence options

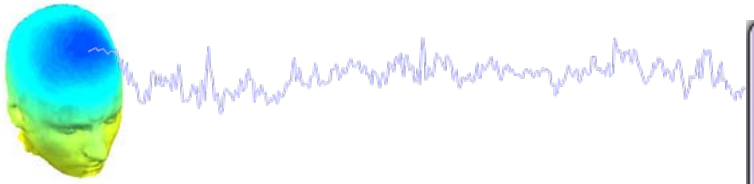
Frequency (Hz | minHz maxHz)	Signif. level (<0.20)	Amplitude limits (dB)	Coher limits (<=1)	Image amps
8 12	0.01			(Requires signif.)

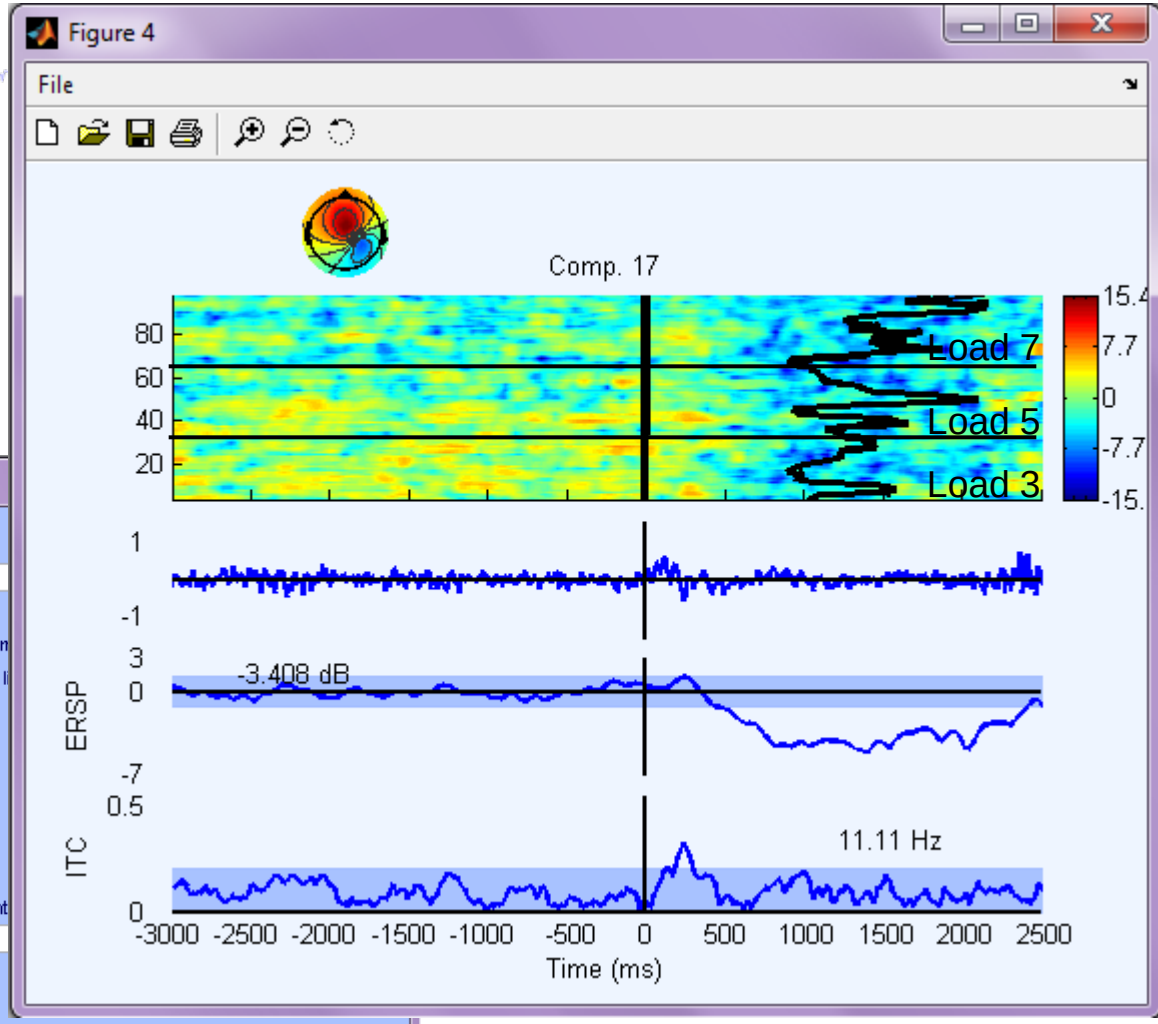
Other options

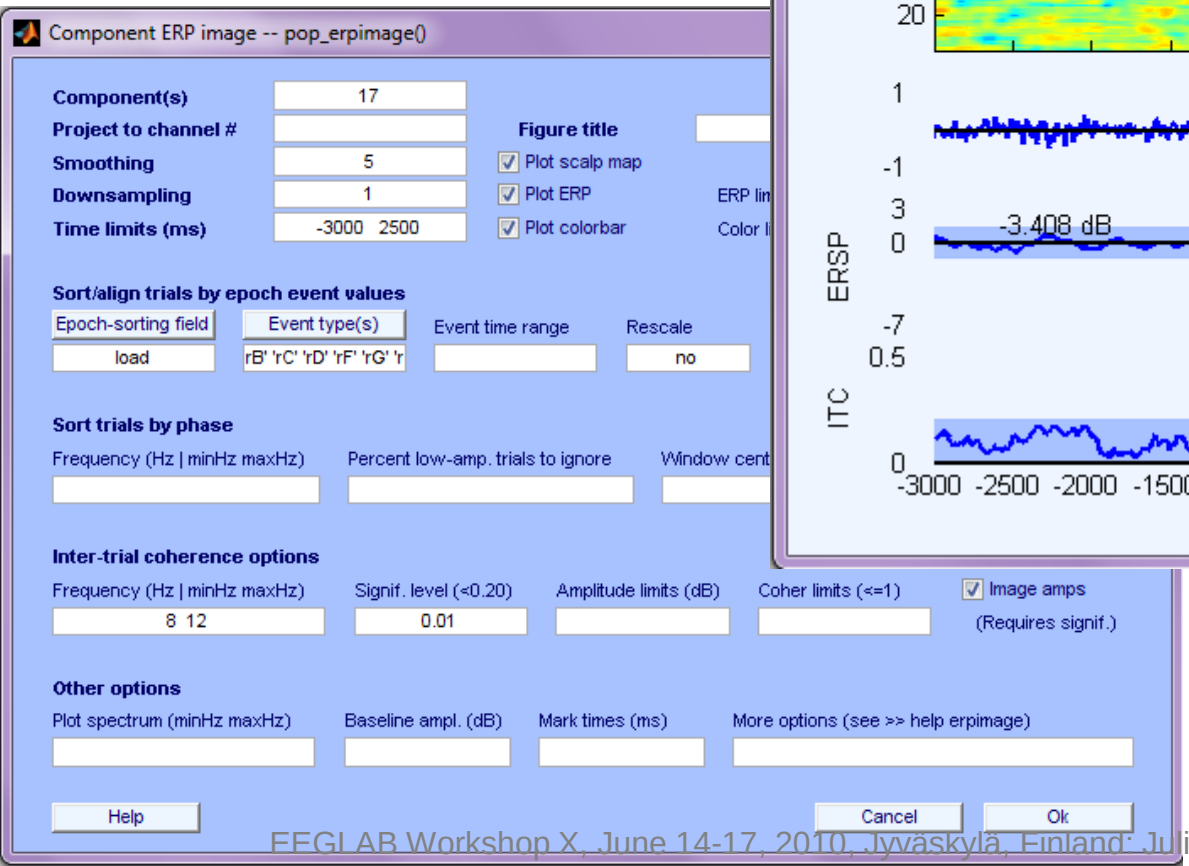
Plot spectrum (minHz maxHz)	Baseline ampl. (dB)	Mark times (ms)	More options (see >> help erpimage)

Help | Cancel | Ok

Sort ERP image by memory load







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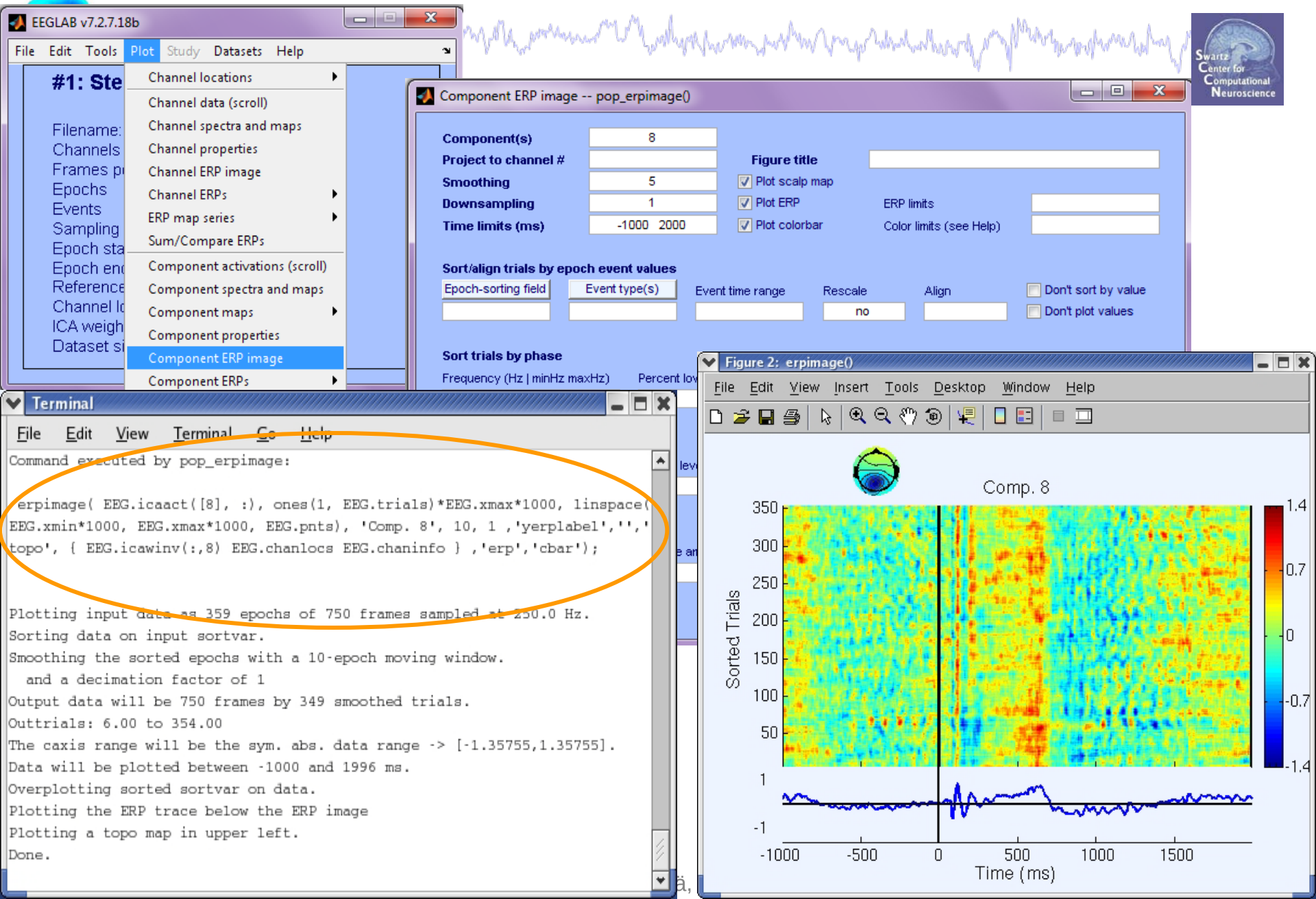
Use outputs from commandline ERP image

Exercise...

ERP image from the commandline



Task 1: Retrieve *erpimage()* call

Command executed by pop_erpimage:

```
erpimage( EEG.icaact([8], :), ones(1, EEG.trials)*EEG.xmax*1000, …
linspace(EEG.xmin*1000, EEG.xmax*1000, EEG.pnts),'Comp. 8', 10, 1 , …
'yerplabel','','topo', { EEG.icawinv(:,8) EEG.chanlocs EEG.chaninfo },…
'erp','cbar');
```

data

sortvar

EEG.times

title

smooth/decimate

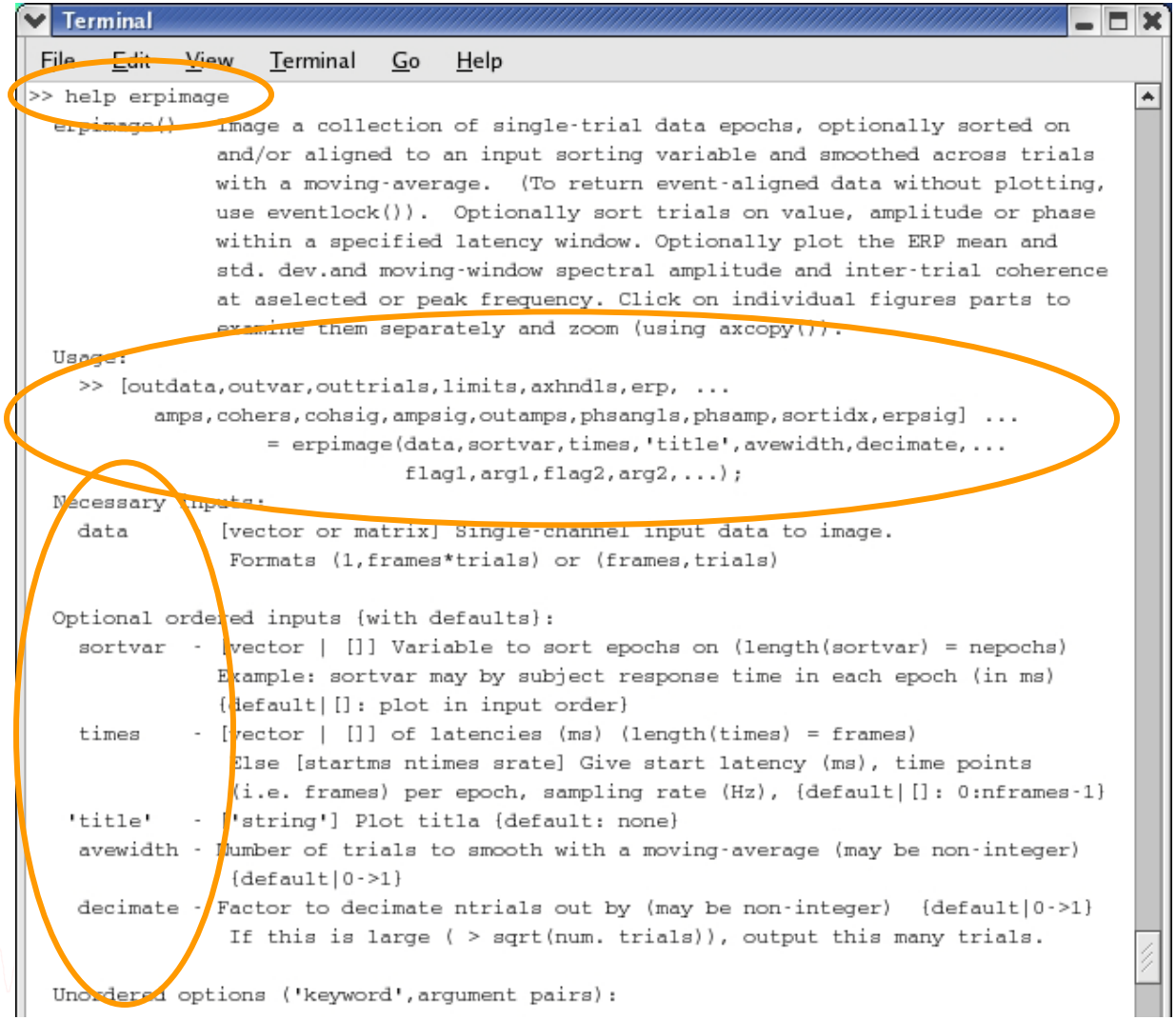
Plotting options/scalp map

Plot ERP and colorbar

To adapt this command to include more *erpimage()* options:

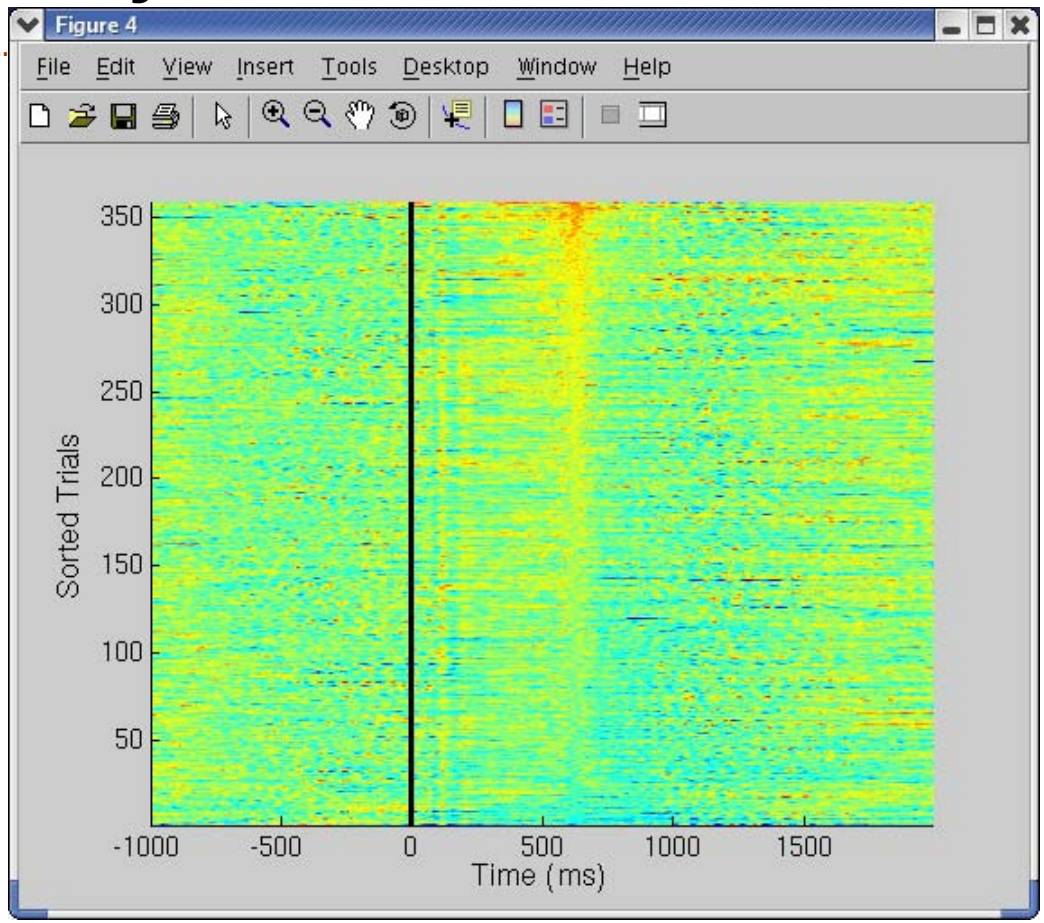
>> help erpimage

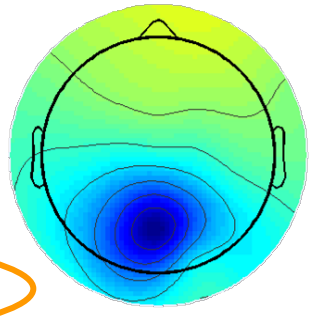
Use ‘help’ command to build script



ERP image sorted by activation value

```
[outdata,outvar,outtrials,limits,axhndls,…
erp,amps,cohers,cohsig,ampsig,outamps,…
phsangls,phsamp,sortidx,erpsig] = …
erpimage(data, sortvar, times, 'title',…
avewidth, decimate, flag1, arg1,...);

%%%%% VARIABLES %%%%%%%%%%%%%%%%%%%%%
comp1 = 8;  % Comp number to plot
data = squeeze(EEG.icaact(comp1,:,:));
sortvar = []; % no sorting
startms = 580; % ms
endms   = 620; % ms
smoothby = 1;
%%%%% PLOT ERPIMAGE %%%%%%%%%%%%%%%%%%%%
figure;
[outdata,outvar, outtrials,limits, axhndls, erp, …
amps, cohers, cohsig, ampsig, outamps, phsangls, …
phsamps, sortidx, erpsig] …
                = erpimage( data, sortvar, EEG.times, …
                        '', smoothby , 1, 'valsort', [startms endms]);
```





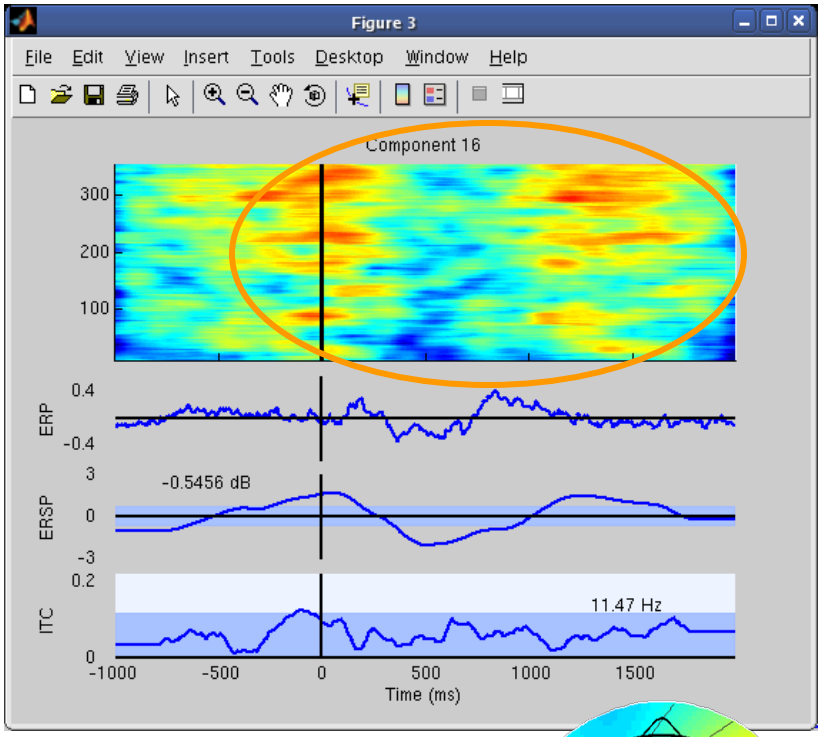
Matlab index definition

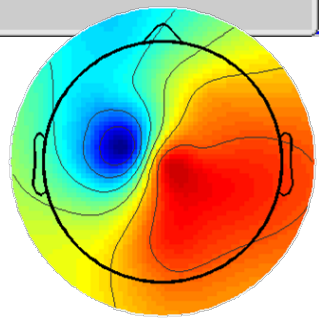
```
>> my_numbers = [101,102,103,104,105,106,107,108,109,110];
my_numbers =

   101   102   103   104   105   106   107   108   109   110

>> new_order = [8,2,5,1,10,9,4,6,3,7]; % analogous to sortidx
>> my_numbers(new_order)

ans =

                ...

   108   102   105   101   110   109   104   106   103   107
```

Use sort index to sort a *new* ERP image

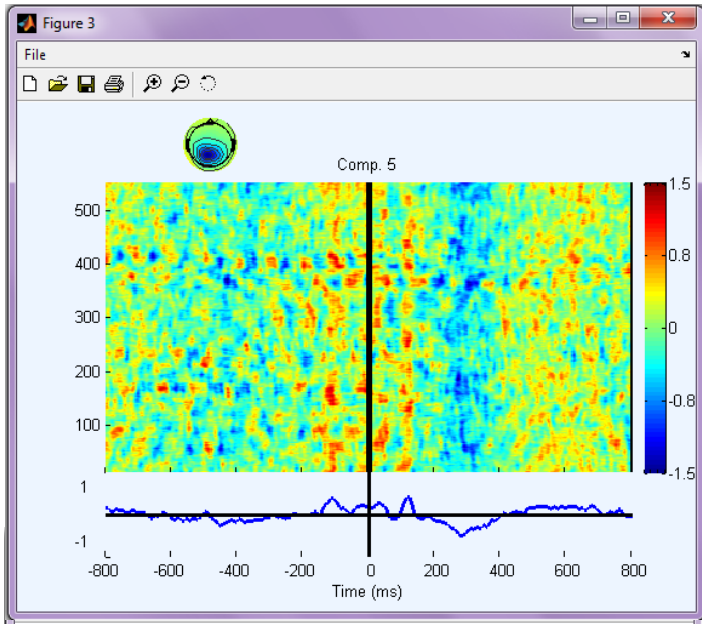
Objective: Use sort order (***sortidx***) from ' **valsort** ' of comp1 to create a new ERP image of another component with the same sort order

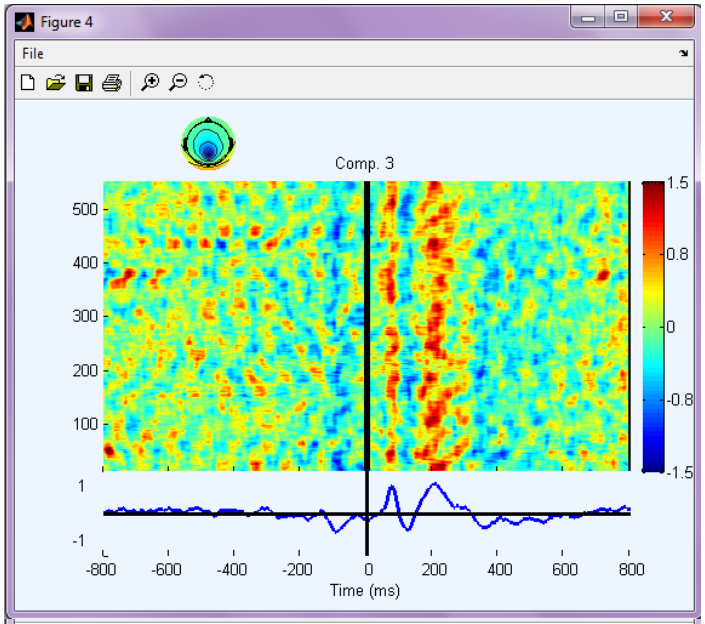
```
%%%%% VARIABLES %%%%%%%%%%%%%%%%%%%%
comp1 = 8;
data = squeeze(EEG.icaact(comp1,:,:));
sortvar = [];
startms = 580;
endms   = 620;
smoothby = 1;
%%%%% 1st ERPIMAGE %%%%%%%%%%%%%%%%%%%
figure;
[outdata,outvar, outtrials,limits, axhndls, erp, …
amps, cohers, cohsig, ampsig, outamps, phsangls, …
phsamps,sortidx, erpsig] = erpimage(data,sortvar,…
EEG.times,'',smoothby , 1,'valsort',[startms endms]);

%%%%% 2nd ERPIMAGE %%%%%%%%%%%%%%%%%%%
%%%%% Sort by previous sort order %%%%%%%%%%%
comp2 = 16;
data2 = squeeze(EEG.icaact(comp2,:, sortidx));
minfrq = 9;        % specify freq range for
maxfrq = 12;       % amplitude plot
smoothby = 20;
figure;
[outdata,outvar, outtrials,limits, axhndls, erp, amps, …
cohers, cohsig, ampsig, outamps, phsangls,phsamps, sortidx2, erpsig] …
     = erpimage( data2, sortvar, EEG.times, ['Component ',int2str(comp2)],…
           smoothby , 1, 'coher', [minfrq maxfrq .01],'plotamps');
```





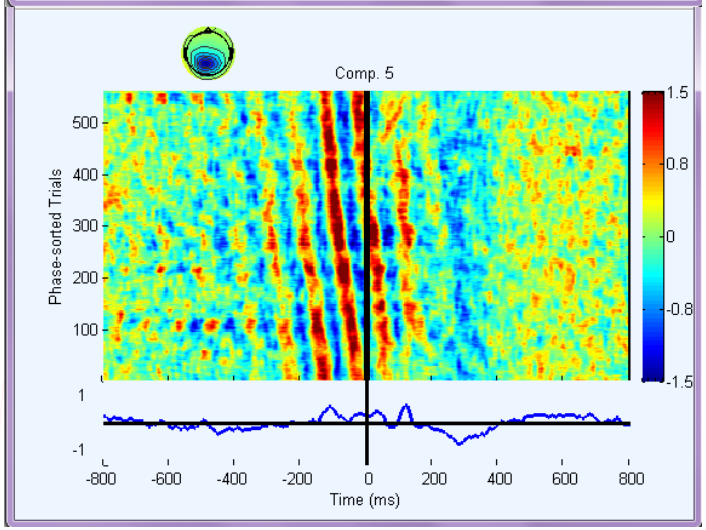
Phase-sort applied to second IC

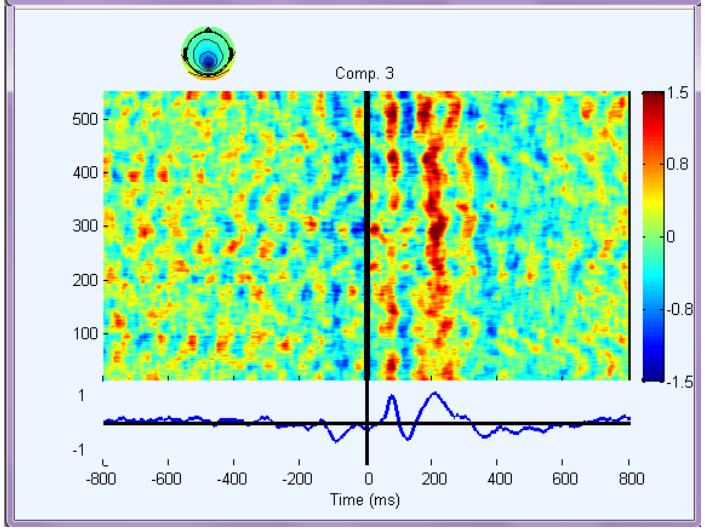




No sort

No sort





Phase-sort -75 ms center

Sorted by IC 5 phase-sort

Exercise

- **Intermediate:**
  - Use EEG.event structure to select specific trial types.
    -Epoch on these trials and plot ERSP and/or ERP images
  - Plot a two-condition ERSP of a chosen IC (start with loading continuous data, epoching, etc)
  - Start with GUI call and adapt a script using 'eegh'
  - Collect RTs and include in ERP image plots

- **Advanced**:
  - From a *'valsort'* ERP image, collect ***sortidx*** output
  - Apply sort order to an ERP image of *another* component (try different smoothing factors)

** Example scripts for exercises can be found in …/workshop/Scripts/Tutorial_6_ICanalysis.m