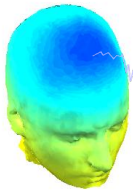
STUDY design and plotting overview



STEP 1

Build a STUDY

STEP 2

Build design(s)

STEP 3

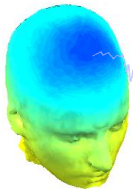
Precompute the data

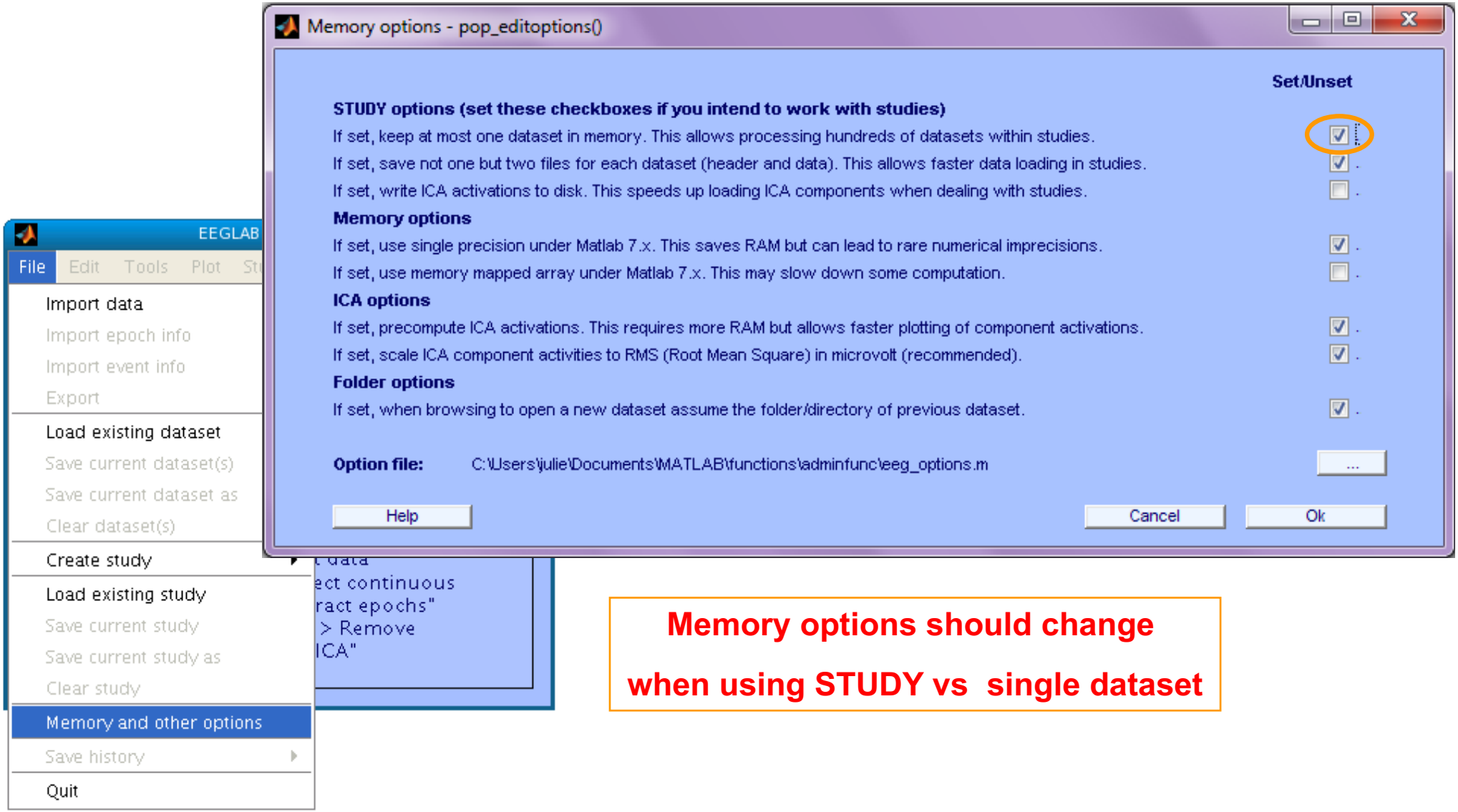
STEP 4

Plot the data

Exercise...

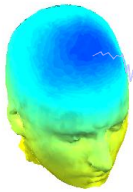
Memory options

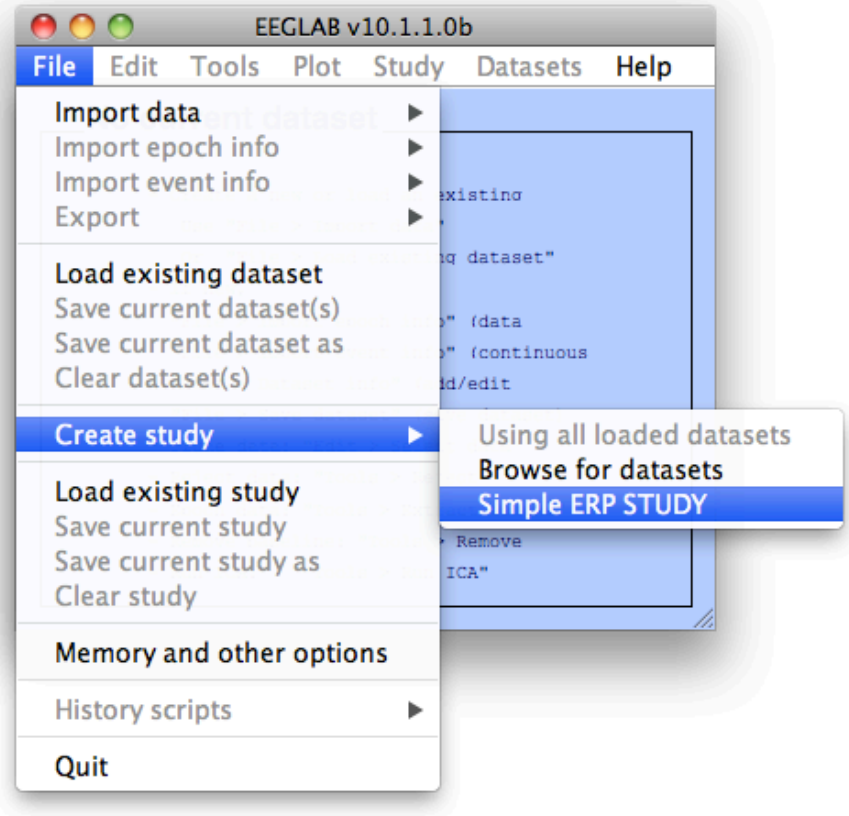


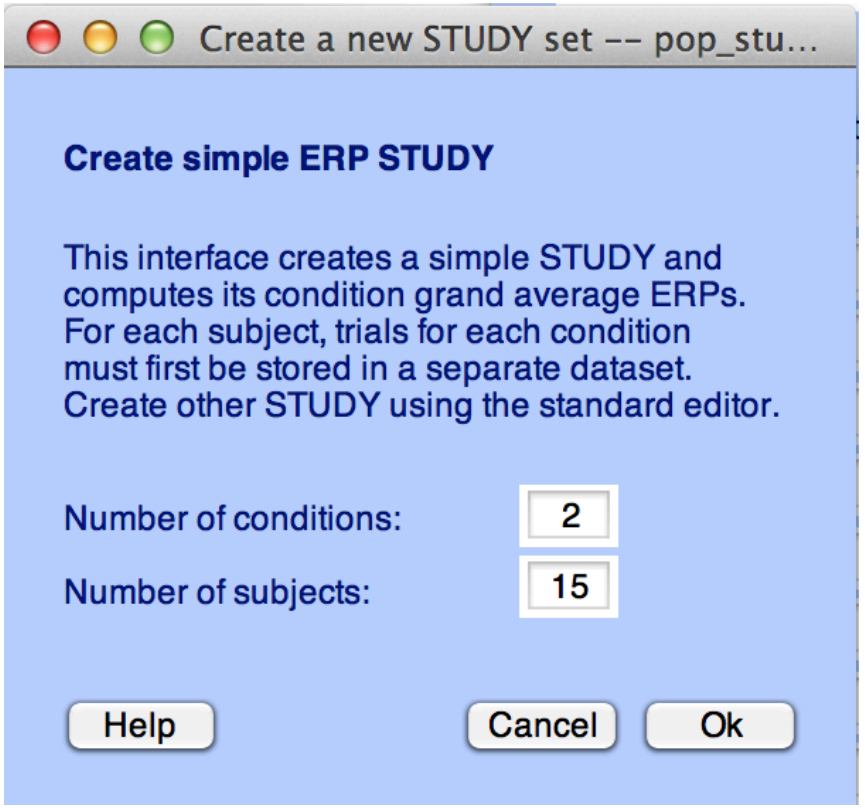


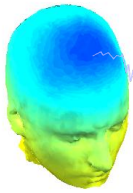
Memory options should change when using STUDY vs single dataset

Create simple ERP STUDY









Create a new STUDY set -- pop_studyerp()

Create simple ERP STUDY

STUDY set name: Letter memorization task

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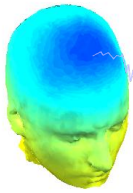
Condition 1 name	Condition 2 name
letter-ignore	letter-memorize

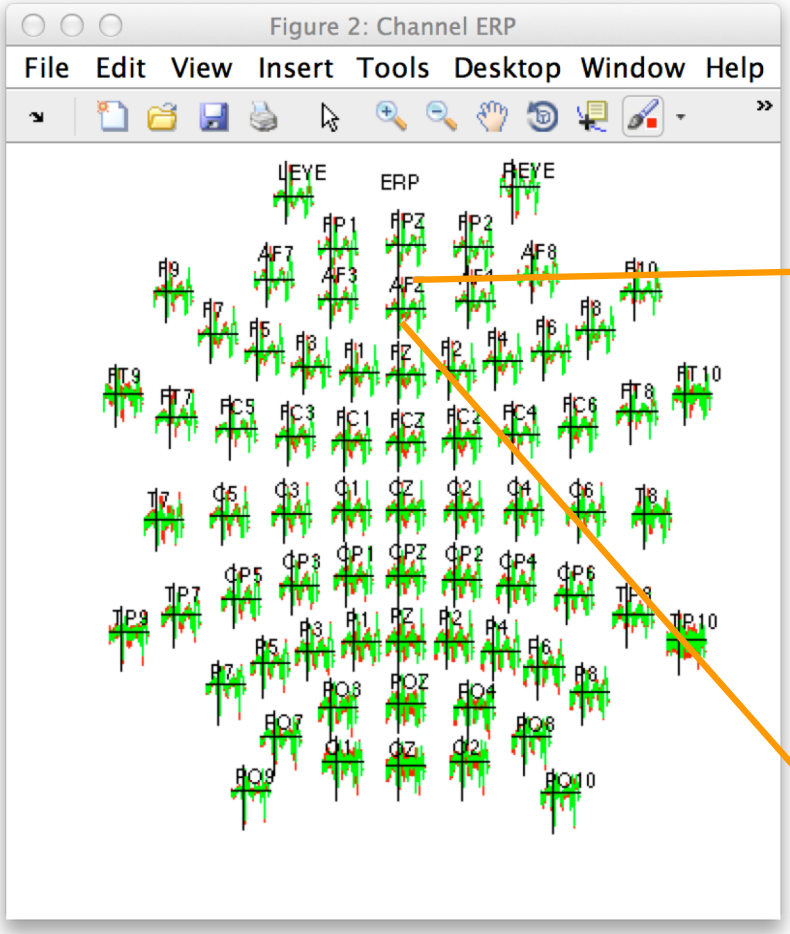
Condition 1 datasets		Condition 2 datasets	
/data/STUDY/S01/Ignore.set	...	/data/STUDY/S01/Memorize.set	...
/data/STUDY/S02/Ignore.set	...	/data/STUDY/S02/Memorize.set	...
/data/STUDY/S03/Ignore.set	...	/data/STUDY/S03/Memorize.set	...
	...		...
	...		...
	...		...
	...		...
	...		...
	...		...
	...		...
	...		...
	...		...
	...		...
	...		...
	...		...

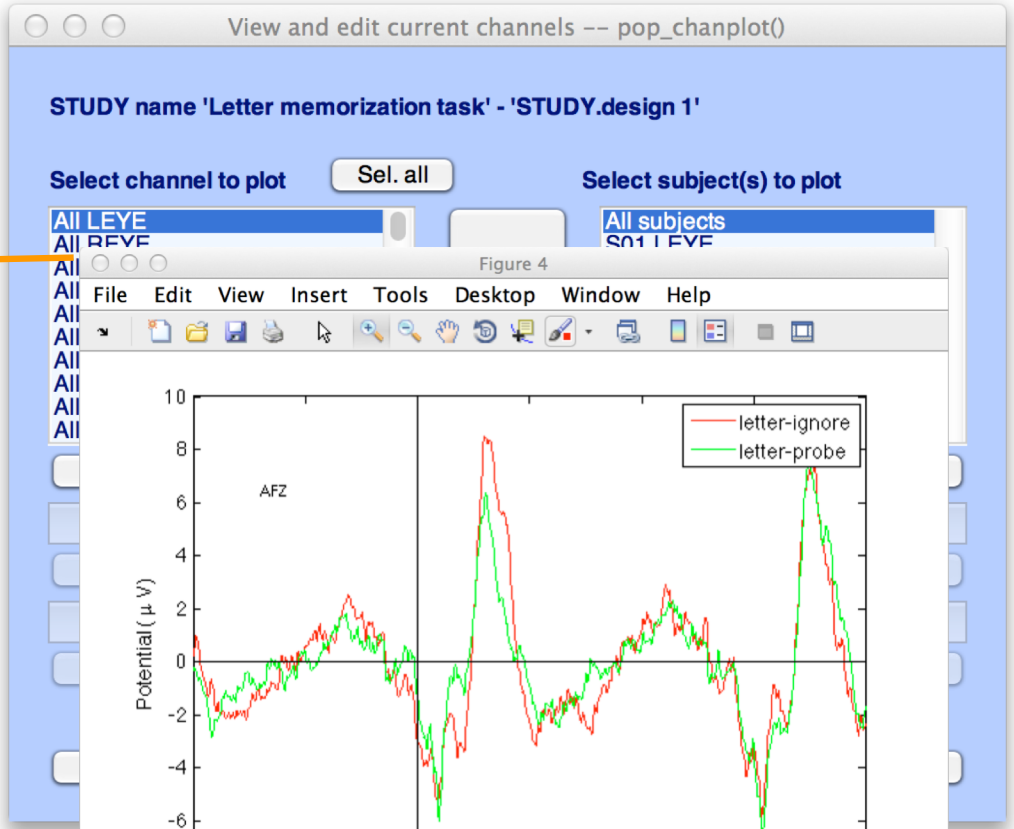
When using more than 1 condition, datasets on each line must correspond to the same subject.

Help Cancel Ok

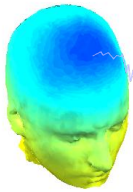
Create simple ERP STUDY





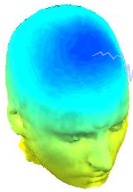


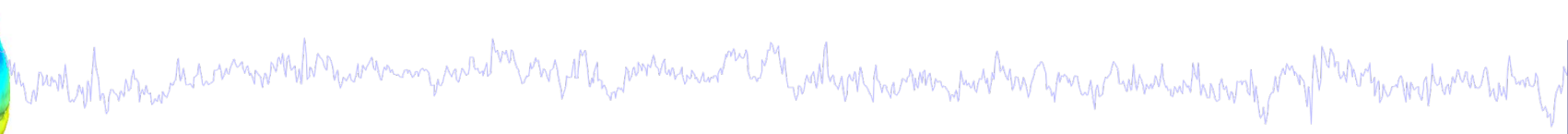
Exercises



Suggestion for exercise

1. From the GUI, select “File > Create STUDY > Simple ERP STUDY”
2. Enter 2 conditions “letter-ignore” and “letter-memorize”
3. In the column for “letter-ignore” select datasets “ignore.set” for 3 subjects S01, S02, S03 (in the STERN folder)
4. In the column for “letter-memorize” select datasets “memorize.set” for 3 subjects S01, S02, S03 (in the STERN folder)
5. Press OK.



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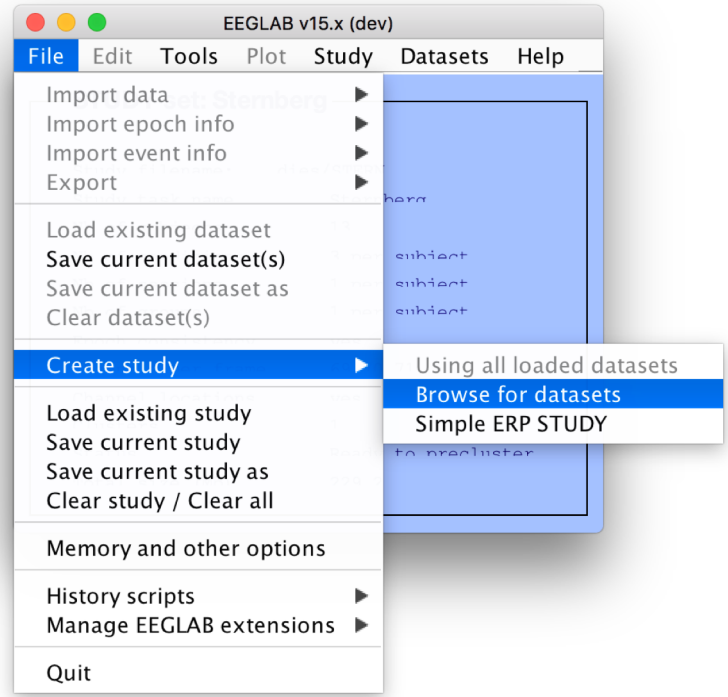
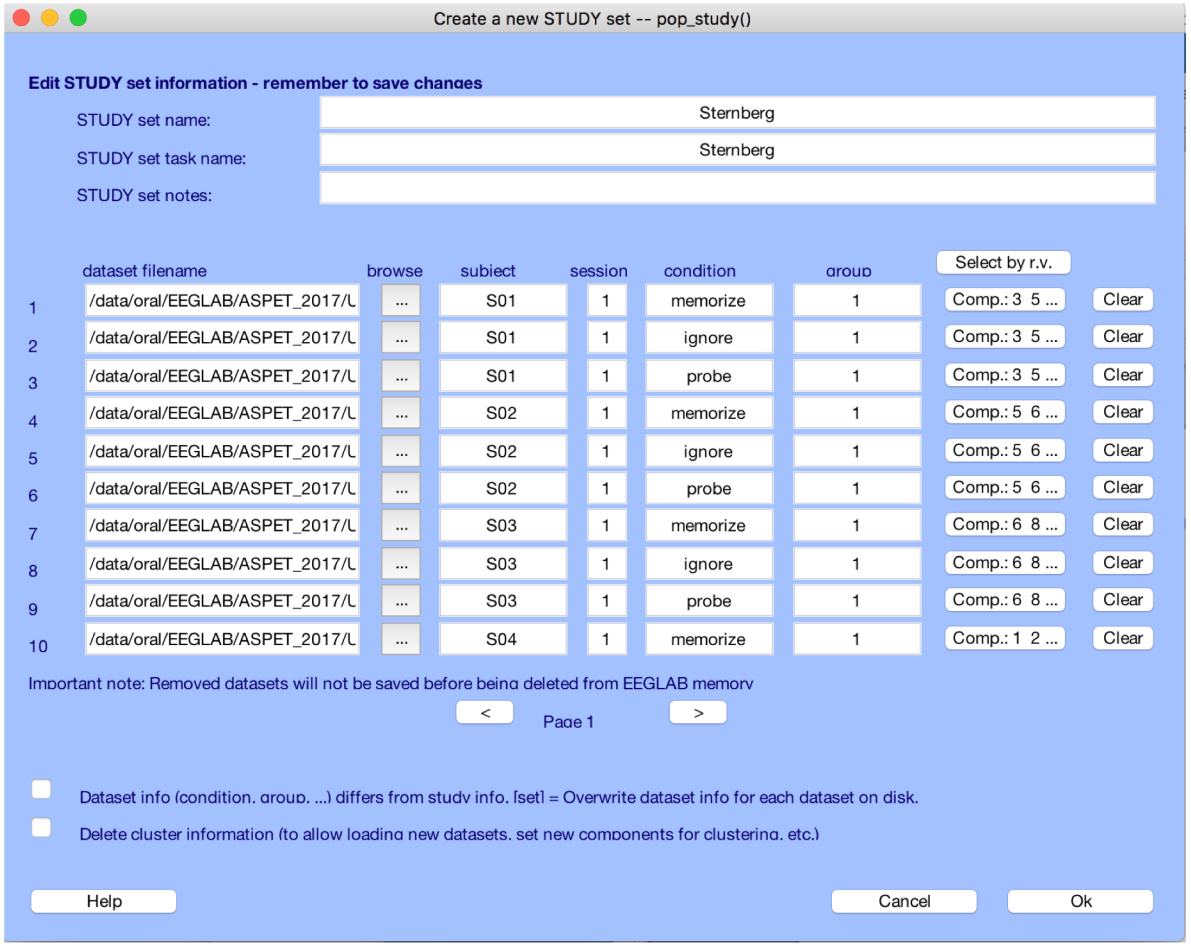
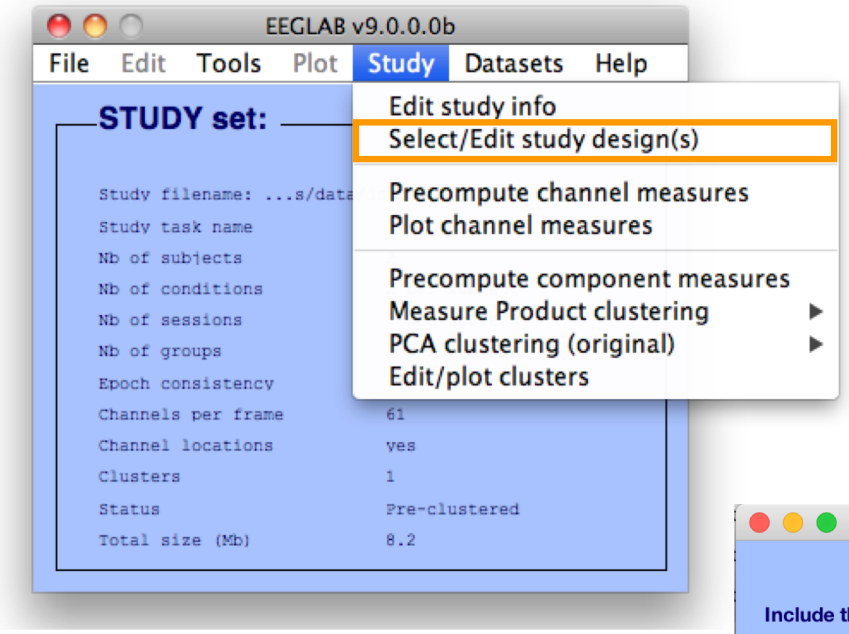
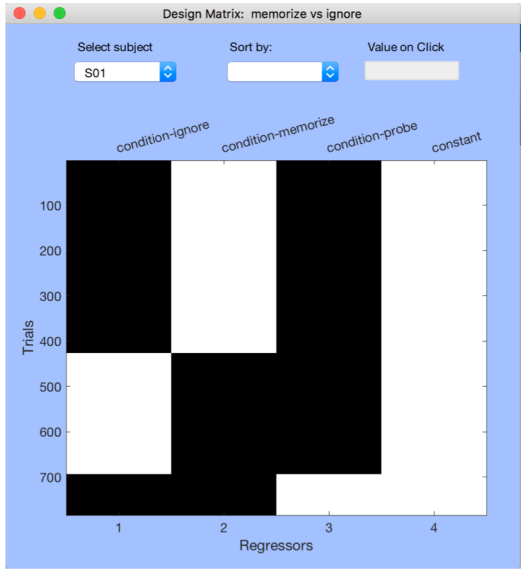
Neuroscience

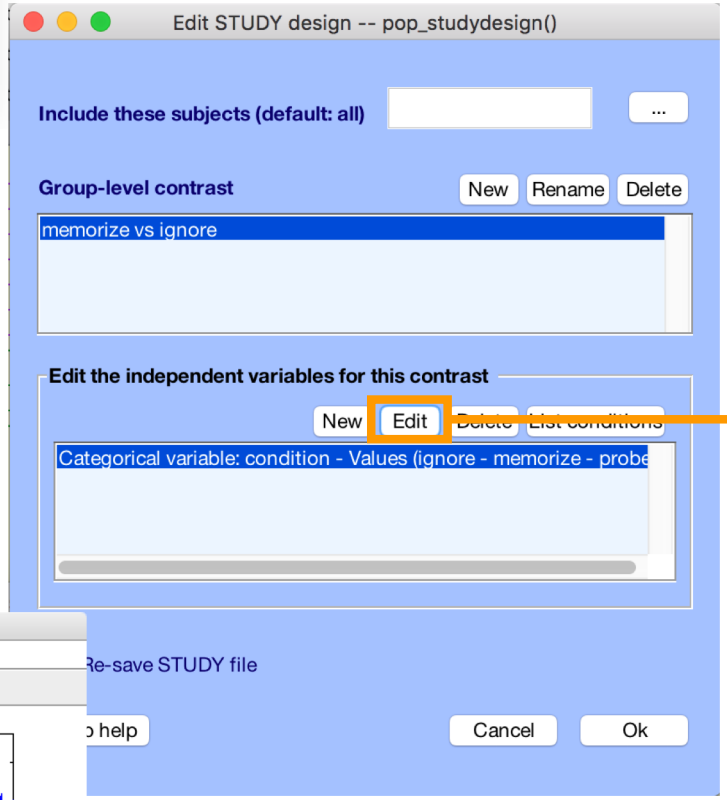

EEGLAB v15.x (dev)
File
Edit
Tools
Plot
Study
Datasets
Help
Import data
Import epoch info
Import event info
Export
Load existing dataset
Save current dataset(s)
Save current dataset as
Clear dataset(s)
Create study
Load existing study
Save current study
Save current study as
Clear study / Clear all
Memory and other options
History scripts
Manage EEGLAB extensions
Quit
Using all loaded datasets
Browse for datasets
Simple ERP STUDY

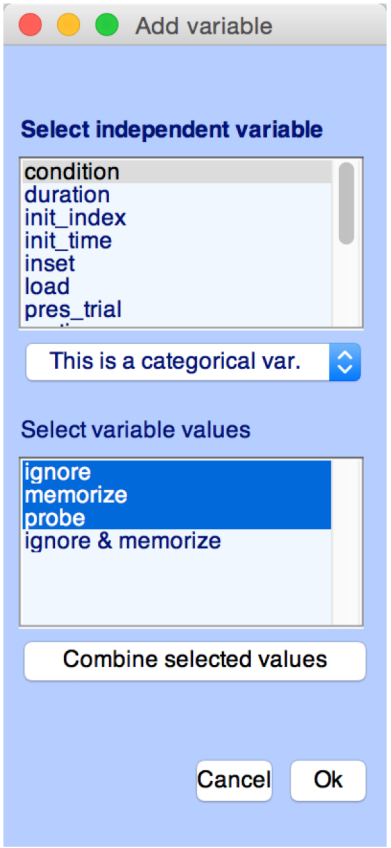

Create a new STUDY set -- pop_study()
Edit STUDY set information - remember to save changes
STUDY set name:
Sternberg
STUDY set task name:
Sternberg
STUDY set notes:
dataset filename
browse
subject
session
condition
group
Select by r.v.
1 /data/oral/EEGLAB/ASPET_2017/L ... S01 1 memorize 1 Comp.: 3 5 ... Clear
2 /data/oral/EEGLAB/ASPET_2017/L ... S01 1 ignore 1 Comp.: 3 5 ... Clear
3 /data/oral/EEGLAB/ASPET_2017/L ... S01 1 probe 1 Comp.: 3 5 ... Clear
4 /data/oral/EEGLAB/ASPET_2017/L ... S02 1 memorize 1 Comp.: 5 6 ... Clear
5 /data/oral/EEGLAB/ASPET_2017/L ... S02 1 ignore 1 Comp.: 5 6 ... Clear
6 /data/oral/EEGLAB/ASPET_2017/L ... S02 1 probe 1 Comp.: 5 6 ... Clear
7 /data/oral/EEGLAB/ASPET_2017/L ... S03 1 memorize 1 Comp.: 6 8 ... Clear
8 /data/oral/EEGLAB/ASPET_2017/L ... S03 1 ignore 1 Comp.: 6 8 ... Clear
9 /data/oral/EEGLAB/ASPET_2017/L ... S03 1 probe 1 Comp.: 6 8 ... Clear
10 /data/oral/EEGLAB/ASPET_2017/L ... S04 1 memorize 1 Comp.: 1 2 ... Clear
Important note: Removed datasets will not be saved before being deleted from EEGLAB memory
<
Page 1
>
Dataset info (condition, group, ...) differs from study info. [set] = Overwrite dataset info for each dataset on disk.
Delete cluster information (to allow loading new datasets, set new components for clustering, etc.)
Help
Cancel
Ok

Create design

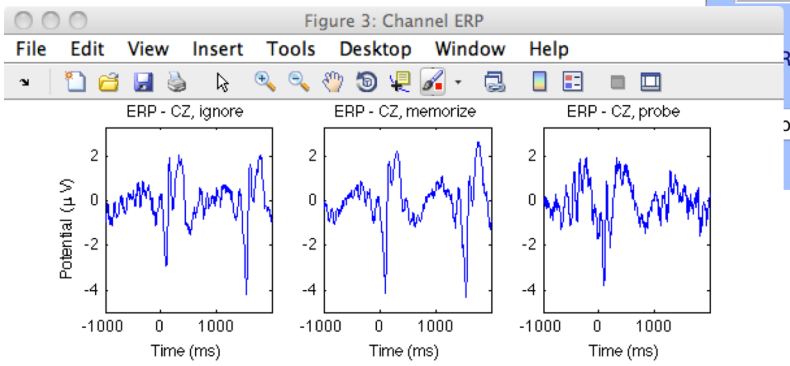


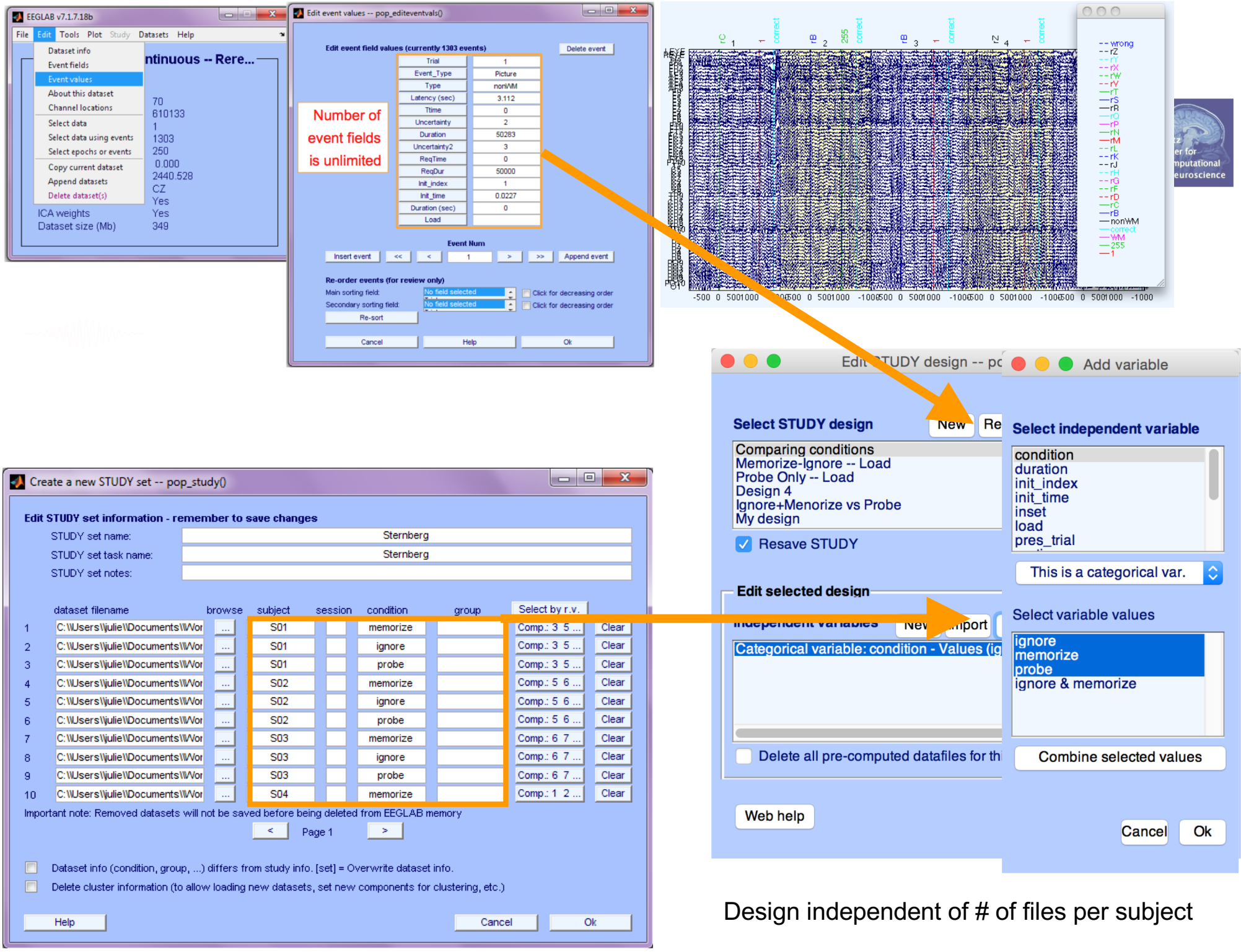






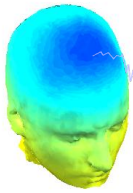
1x3 design





Design independent of # of files per subject

STUDY design and plotting overview



STEP 1

Build a STUDY

STEP 2

Build design(s)

STEP 3

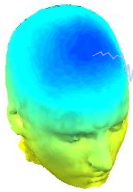
Precompute the data

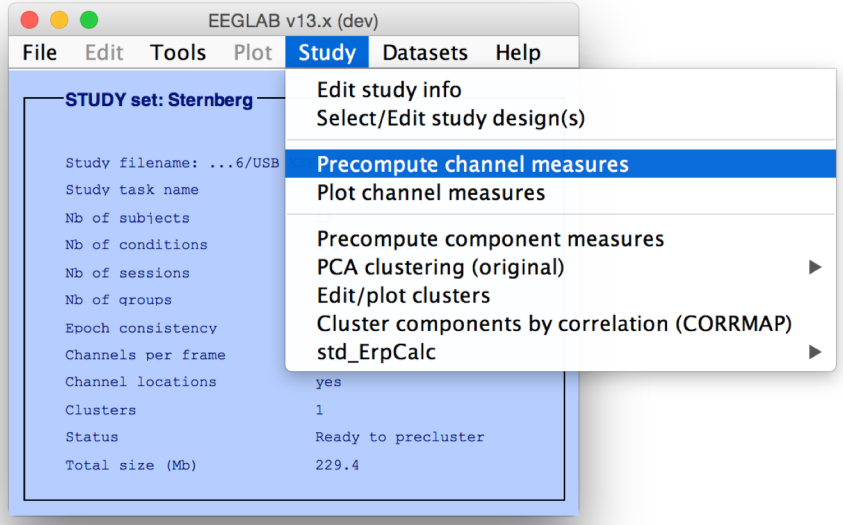
STEP 4

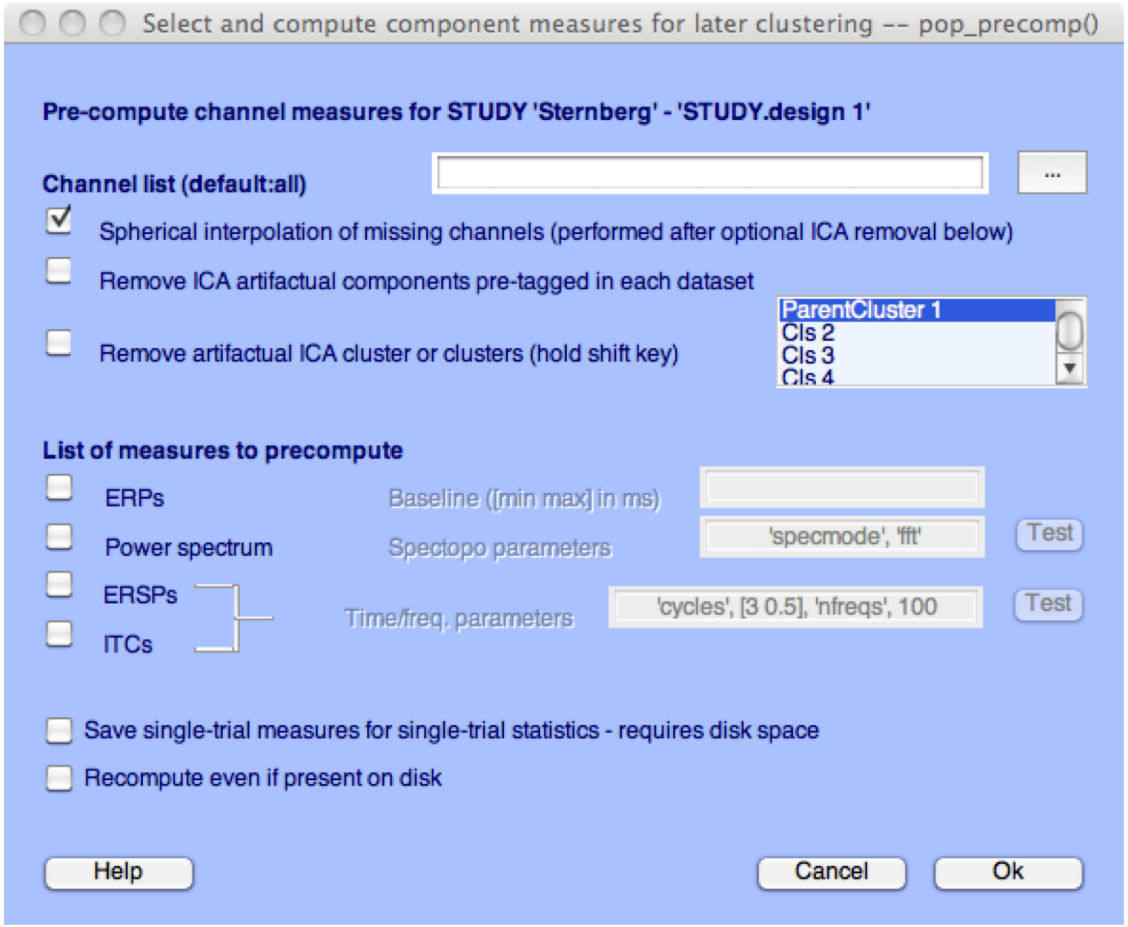
Plot the data

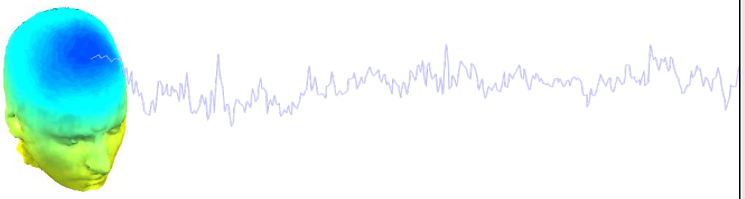
Exercise...

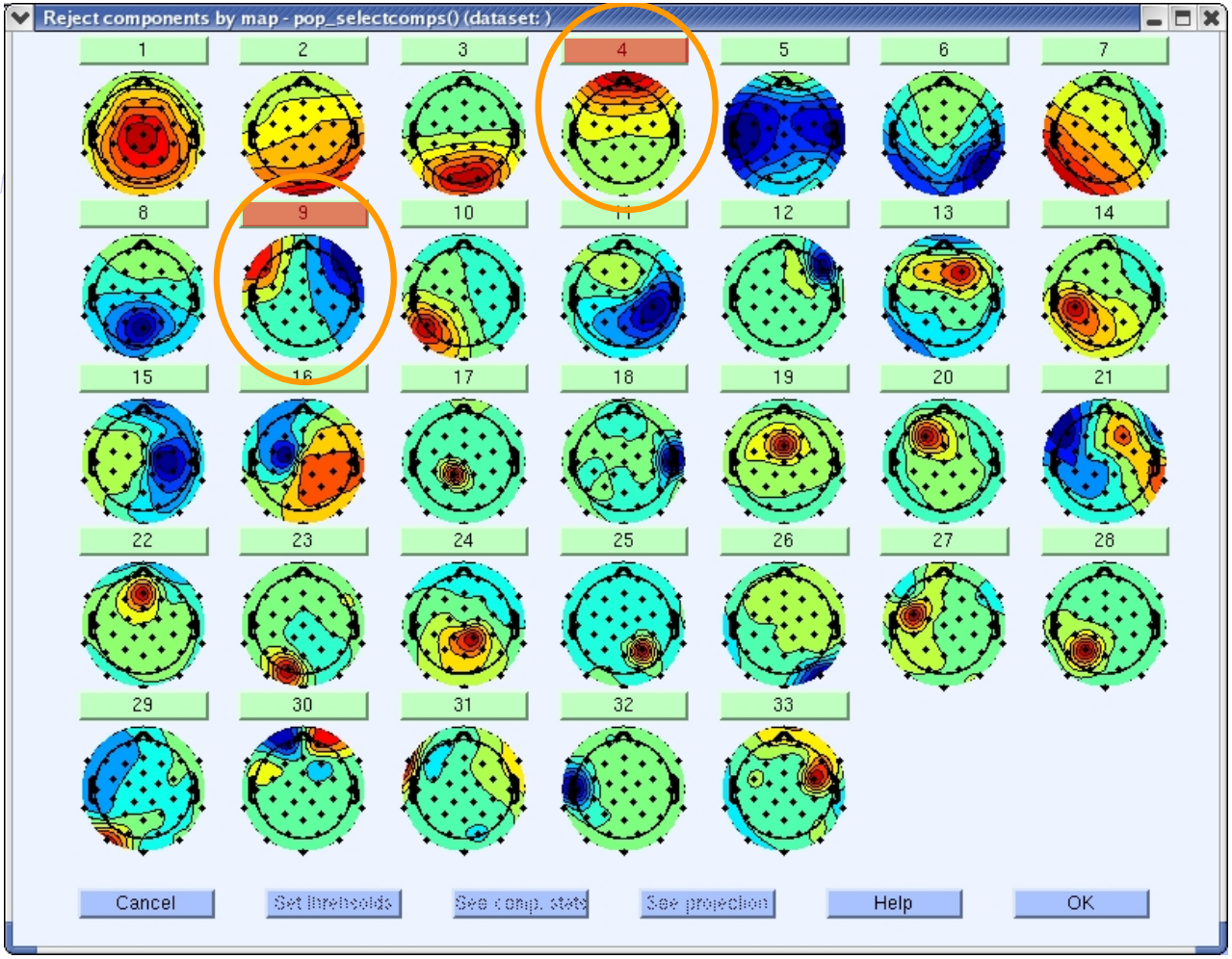
Precompute data measures

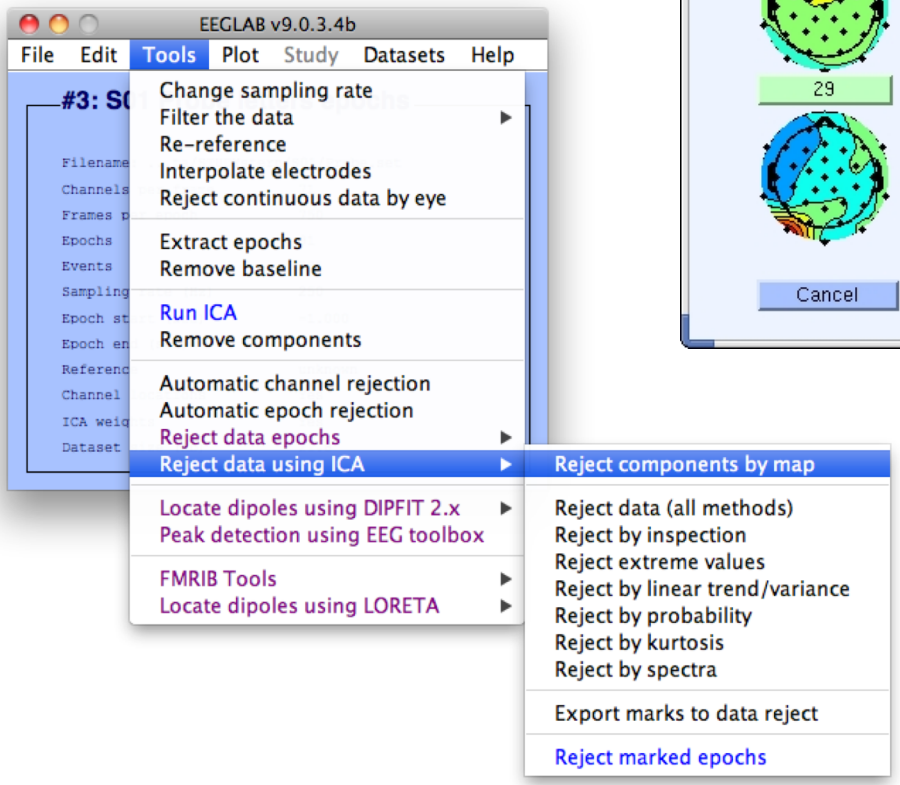


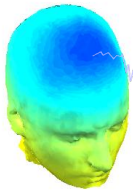


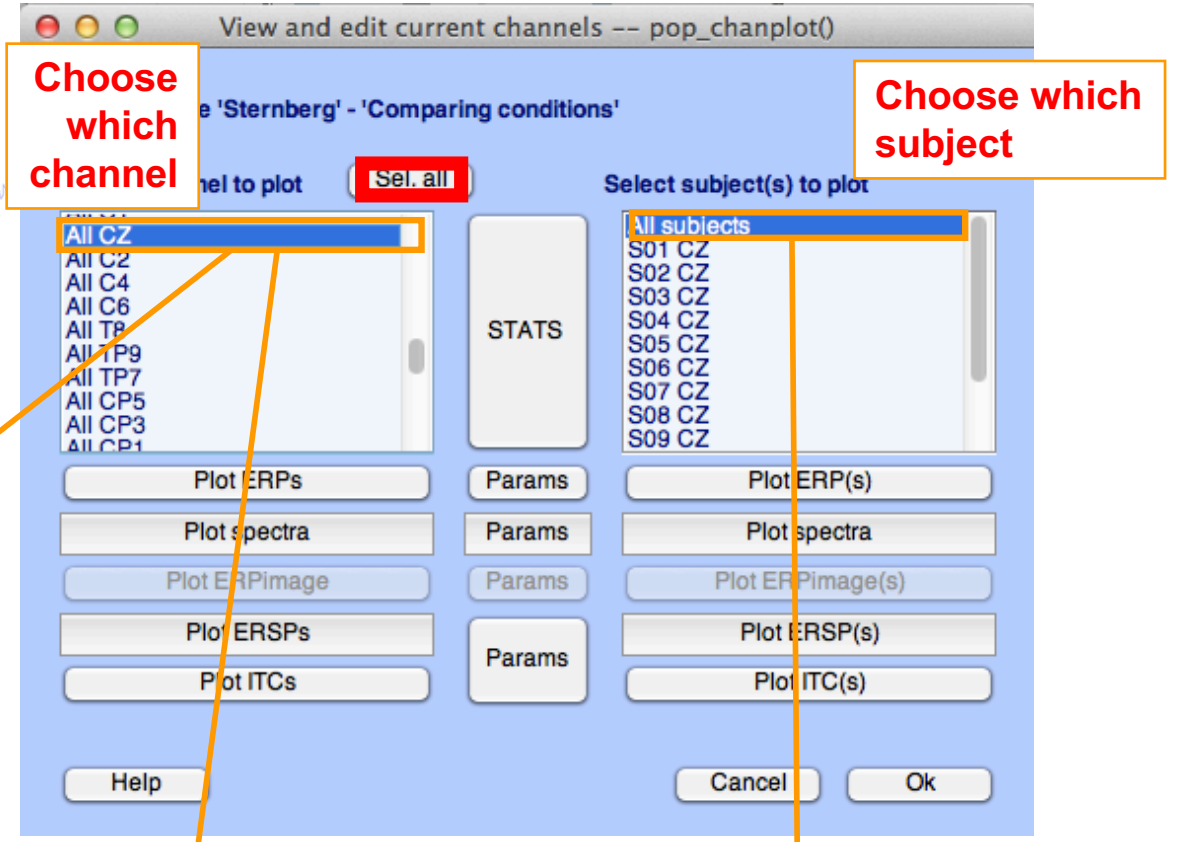





Reject components by map - pop_selectcomps() (dataset:)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
Cancel
Set thresholds
See comp. stats
See projection
Help
OK


EEGLAB v9.0.3.4b
File
Edit
Tools
Plot
Study
Datasets
Help
Change sampling rate
Filter the data
Re-reference
Interpolate electrodes
Reject continuous data by eye
Extract epochs
Remove baseline
Run ICA
Remove components
Automatic channel rejection
Automatic epoch rejection
Reject data epochs
Reject data using ICA
Locate dipoles using DIPFIT 2.x
Peak detection using EEG toolbox
FMRIB Tools
Locate dipoles using LORETA
Reject components by map
Reject data (all methods)
Reject by inspection
Reject extreme values
Reject by linear trend/variance
Reject by probability
Reject by kurtosis
Reject by spectra
Export marks to data reject
Reject marked epochs




View and edit current channels -- pop_chanplot()
Choose which channel
Choose which subject
'Sternberg' - 'Comparing conditions'
Sel. all
Select subject(s) to plot
All CZ
All C2
All C4
All C6
All T8
All TP9
All TP7
All CP5
All CP3
STATS
All subjects
S01 CZ
S02 CZ
S03 CZ
S04 CZ
S05 CZ
S06 CZ
S07 CZ
S08 CZ
S09 CZ
Plot ERPs
Plot spectra
Plot ERPimage
Plot ERSPs
Plot ITCs
Params
Plot ERP(s)
Plot spectra
Plot ERPimage(s)
Plot ERSP(s)
Plot ITC(s)
Help
Cancel
Ok

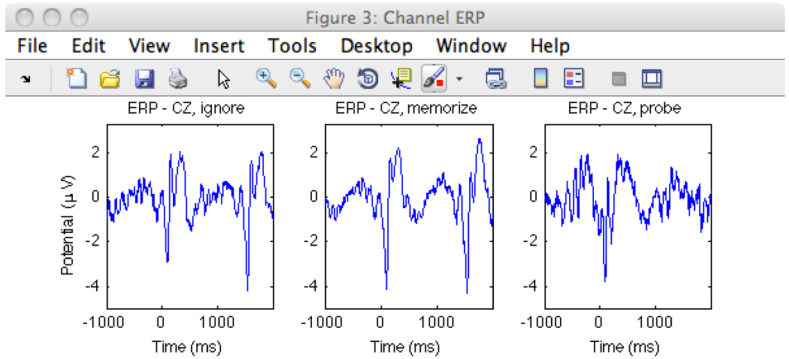


Figure 3: Channel ERP
File Edit View Insert Tools Desktop Window Help
ERP - CZ, ignore
ERP - CZ, memorize
ERP - CZ, probe
Potential (μ V)
Time (ms)

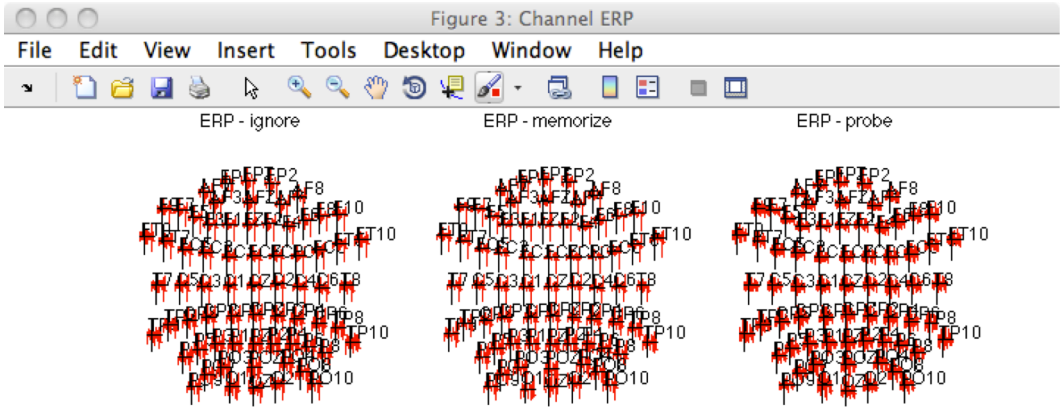


Figure 3: Channel ERP
File Edit View Insert Tools Desktop Window Help
ERP - ignore
ERP - memorize
ERP - probe

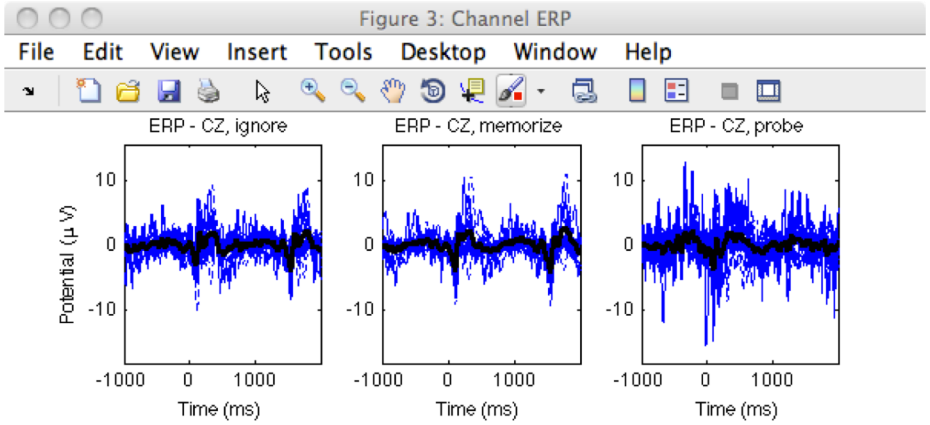
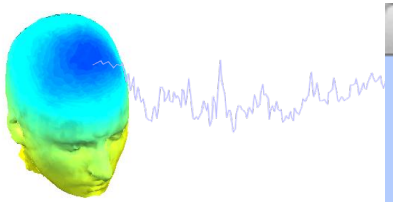


Figure 3: Channel ERP
File Edit View Insert Tools Desktop Window Help
ERP - CZ, ignore
ERP - CZ, memorize
ERP - CZ, probe
Potential (μ V)
Time (ms)



View and edit current channels -- pop_chanplot()

STUDY name 'Sternberg' - 'Comparing conditions'

Select channel to plot

Sel. all

All CZ
All C2
All C4
All C6
All T8
All TP9
All TP7
All CP5
All CP3
All CP1

STATS

Select subject(s) to p

All subjects
S01 CZ
S02 CZ
S03 CZ
S04 CZ
S05 CZ
S06 CZ
S07 CZ
S08 CZ
S09 CZ

Plot ERPs | Params | Plot ERP
Plot spectra | Params | Plot spec
Plot ERPimage | Params | Plot ERPimage(s)
ERSPs | Params | Plot ERSP(s)
ITCs | Plot ITC(s)

Cancel | Ok

ERP plotting options -- pop_erppar...

ERP plotting options

Time limits (ms) [low high]
Plot limits [low high]
Lowpass plotted data [Hz]

ERP plotting format

Plot first variable on the same panel
Plot second variable on the same panel

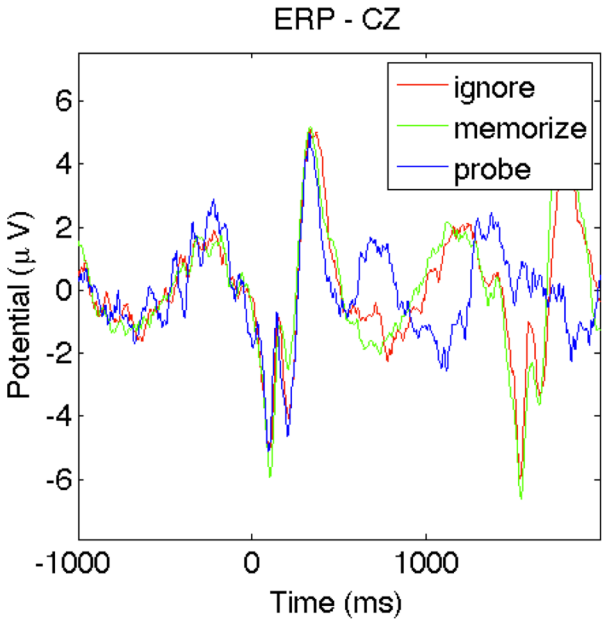
Multiple channels selection

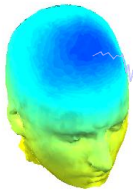
Plot channels in scalp array
Plot topography at time (ms) 200 300
Average selected channels

Cancel | Ok

Figure 4: Channel ERP

File Edit View Insert Tools Desktop Window Help





View and edit current channels -- pop_chanp

STUDY name 'Sternberg' - 'Comparing conditions'

Select channel to plot

Sel. all

All P6
All P8
All PO9
All PO7
All PO3
All POZ
All PO4
All PO8
All PO10
All O1

STATS

Select subject(s

All subjects
S01 All
S02 All
S03 All
S04 All
S05 All
S06 All
S07 All
S08 All
S09 All

Plot ERPs | Params | Plot ERP(s)

Plot spectra | Params | Plot spectra

Plot ERPimage | Params | Plot ERPimage(s)

Plot ERSPs | Params | Plot ERSP(s)

Plot ITCs | Plot ITC(s)

Help | Cancel | Ok

ERP plotting options -- pop_erppar...

ERP plotting options

Time limits (ms) [low high]

Plot limits [low high]

Lowpass plotted data [Hz]

ERP plotting format

Plot first variable on the same panel

Plot second variable on the same panel

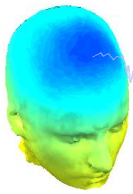
Multiple channels selection

Plot channels in scalp array

Plot topography at time (ms) 200 300

Average selected channels

Cancel | Ok



View and edit current channels -- pop_chanp

STUDY name 'Sternberg' - 'Comparing conditions'

Select channel to plot

Sel. all

All P6
All P8
All PO9
All PO7
All PO3
All POZ
All PO4
All PO8
All PO10
All O1

STATS

Select subject(s

All subjects
S01 All
S02 All
S03 All
S04 All
S05 All
S06 All
S07 All
S08 All
S09 All

Plot ERPs

Params

Plot spectra

Params

Plot spectra

Plot ERPimage

Params

Plot ERPimage(s)

ERP plotting options -- pop_erppar...

ERP plotting options

Time limits (ms) [low high]

Plot limits [low high]

Lowpass plotted data [Hz]

ERP plotting format

Plot first variable on the same panel

Plot second variable on the same panel

Multiple channels selection

Plot channels in scalp array

Plot topography at time (ms) 200 300

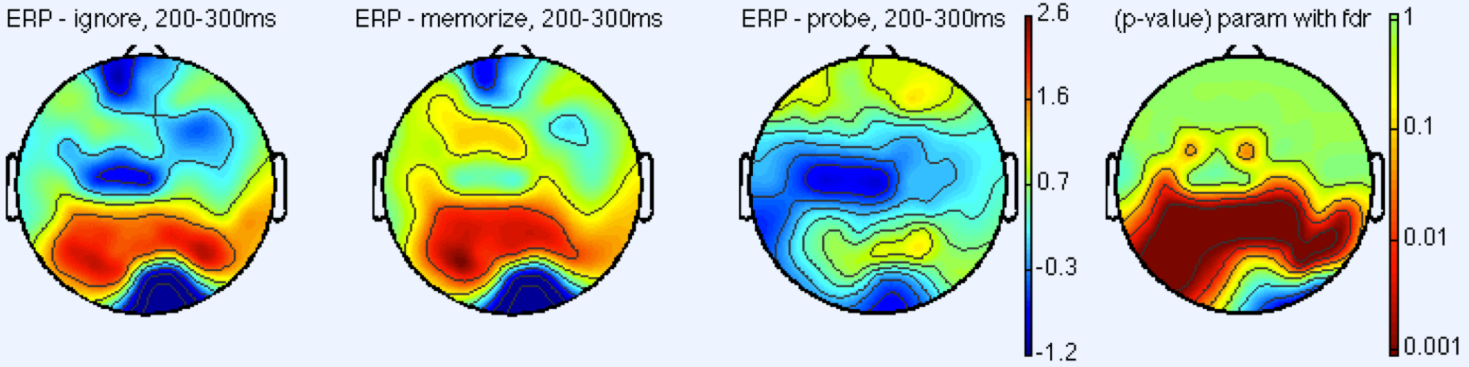
Average selected channels

Cancel

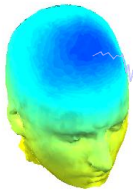
Ok

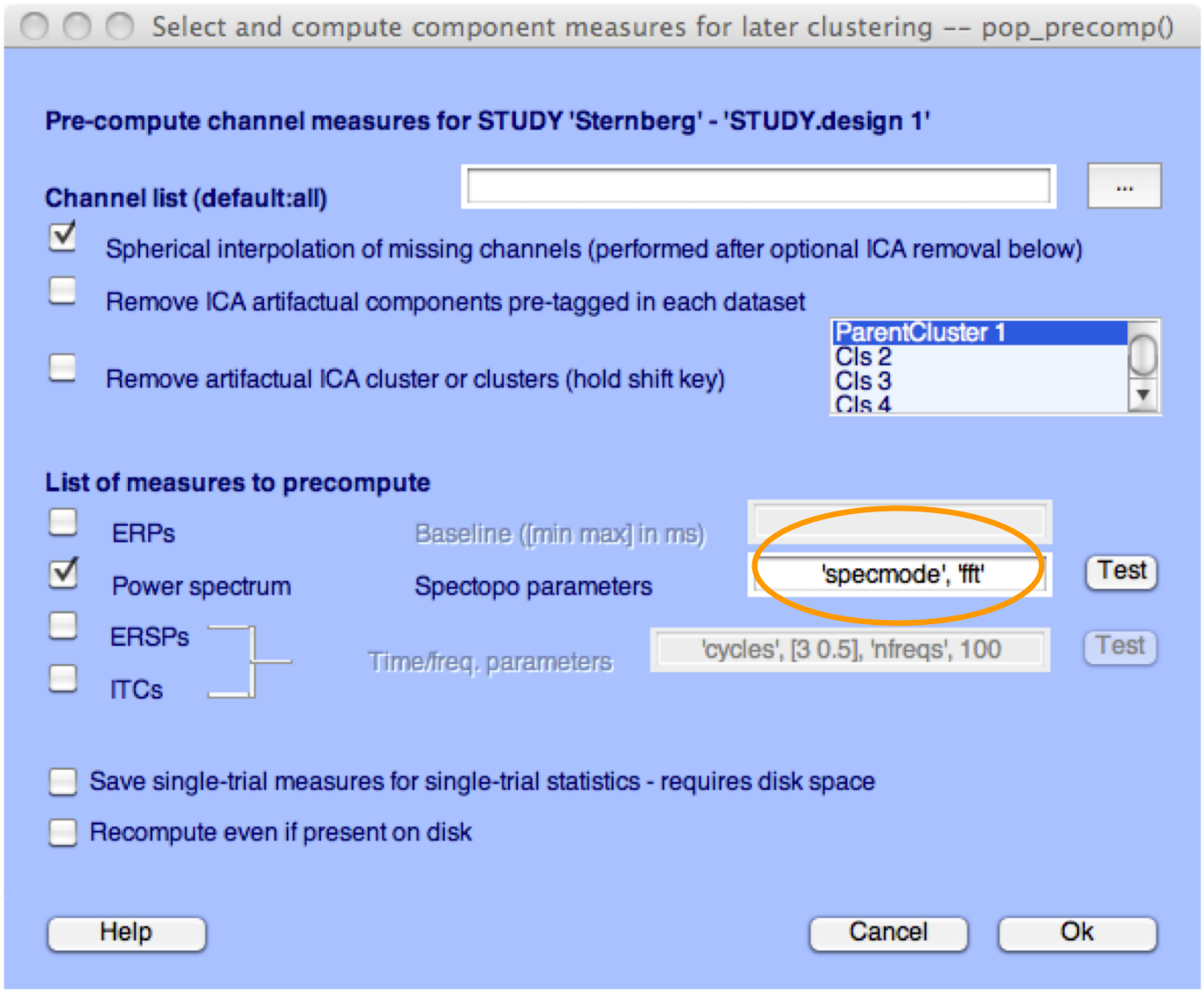
Figure 5: Channel ERP

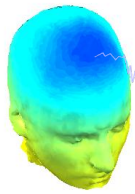
File Edit View Insert Tools Desktop Window Help



Computing Spectrum







Choose which channel

View and edit current channels -- pop_chanplot()

STUDY name 'Sternberg' - 'STUDY.design 1'

Select channel to plot

Sel. all

All FT8
All FT10
All T7
All C5
All C3
All C1
All CZ
All C2
All C4

Select subject(s) to plot

All subjects
S01 CZ
S02 CZ
S03 CZ
S04 CZ
S05 CZ
S06 CZ
S07 CZ
S08 CZ
S09 CZ

Params
Plot ERP(s)
Params
Plot spectra
Params
Plot ERSP(s)
Plot ITC(s)

Choose which subject

Figure 4: Channel Spectrum

File Edit View Insert Tools Desktop Window Help

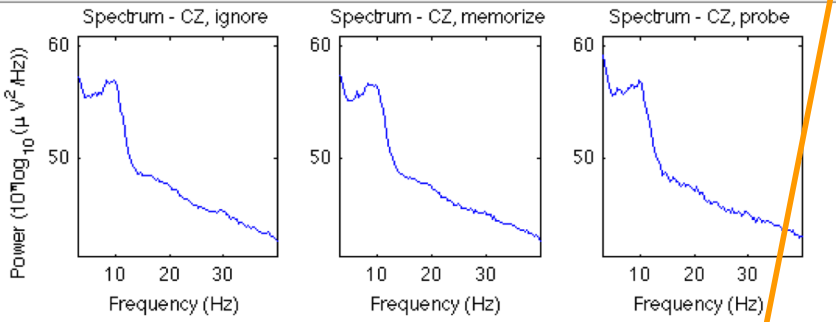


Figure 5: Channel Spectrum

File Edit View Insert Tools Desktop Window Help

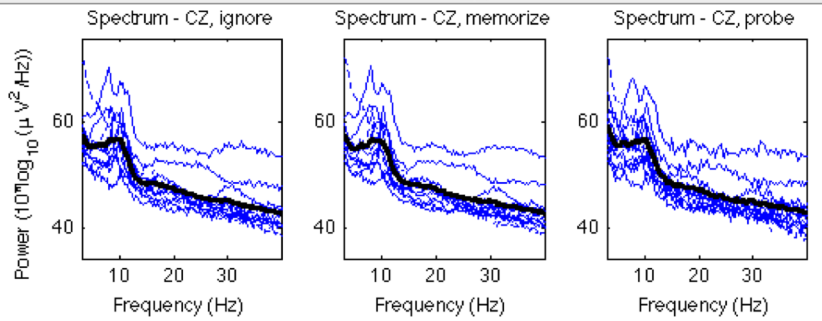


Figure 6: Channel Spectrum

File Edit View Insert Tools Desktop Window Help

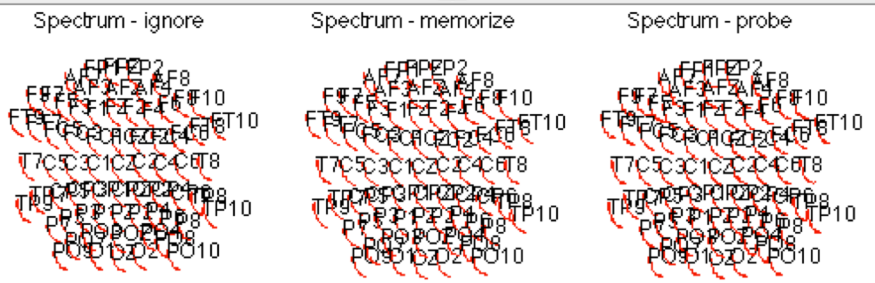
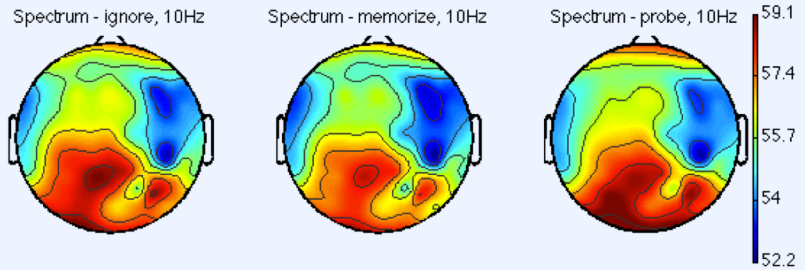


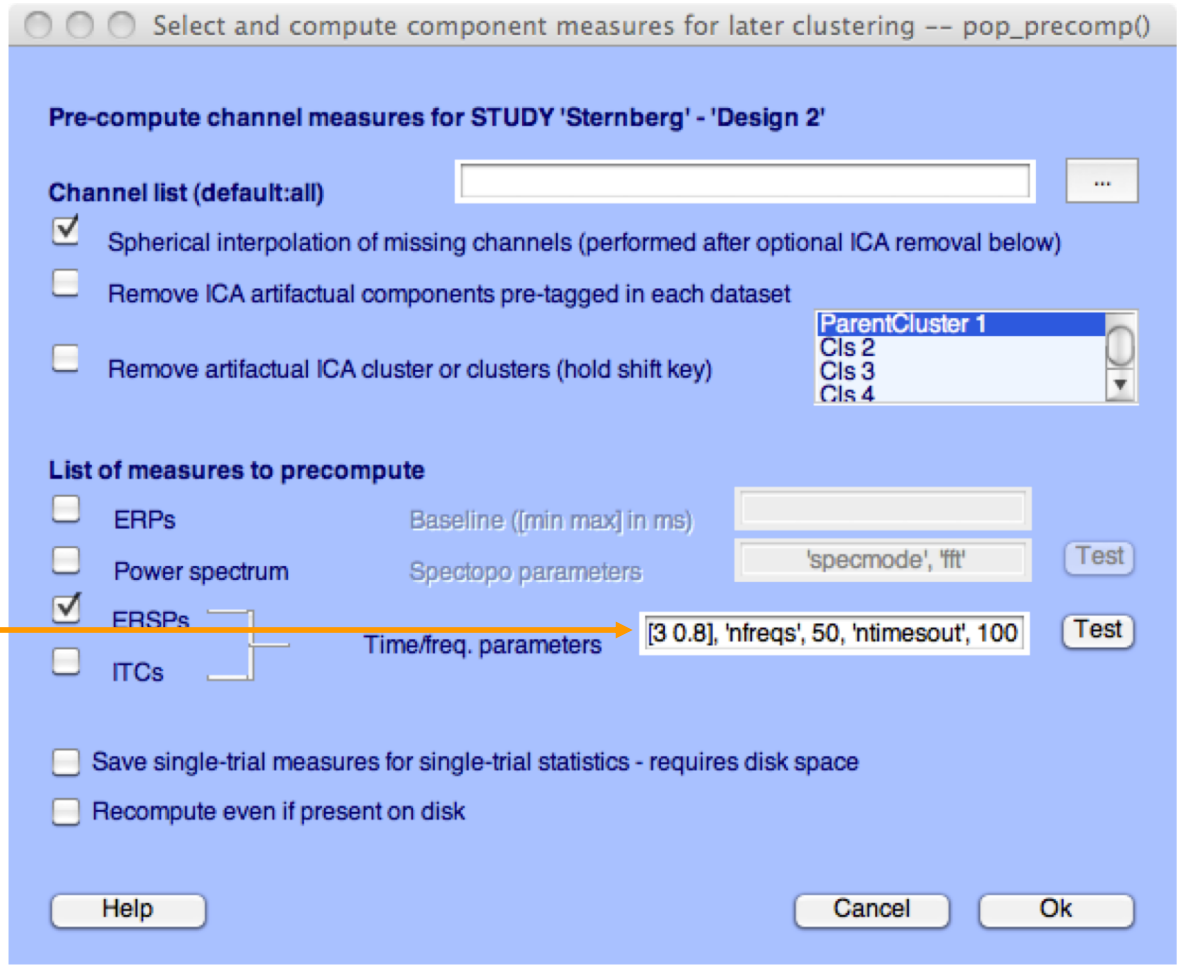
Figure 4: Channel Spectrum

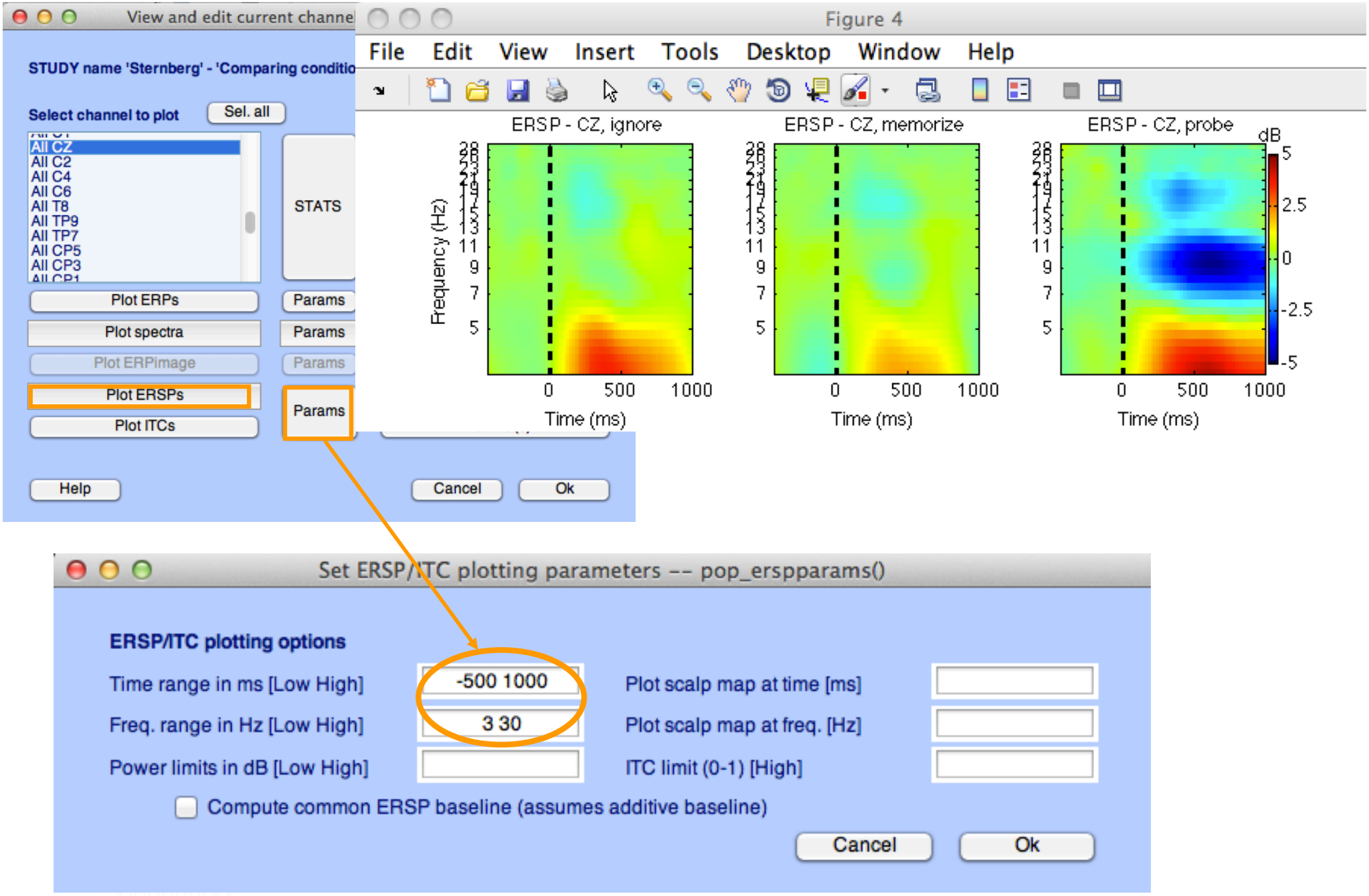
File Edit View Insert Tools Desktop Window Help



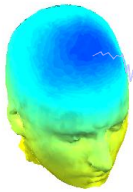
Computing ERSP

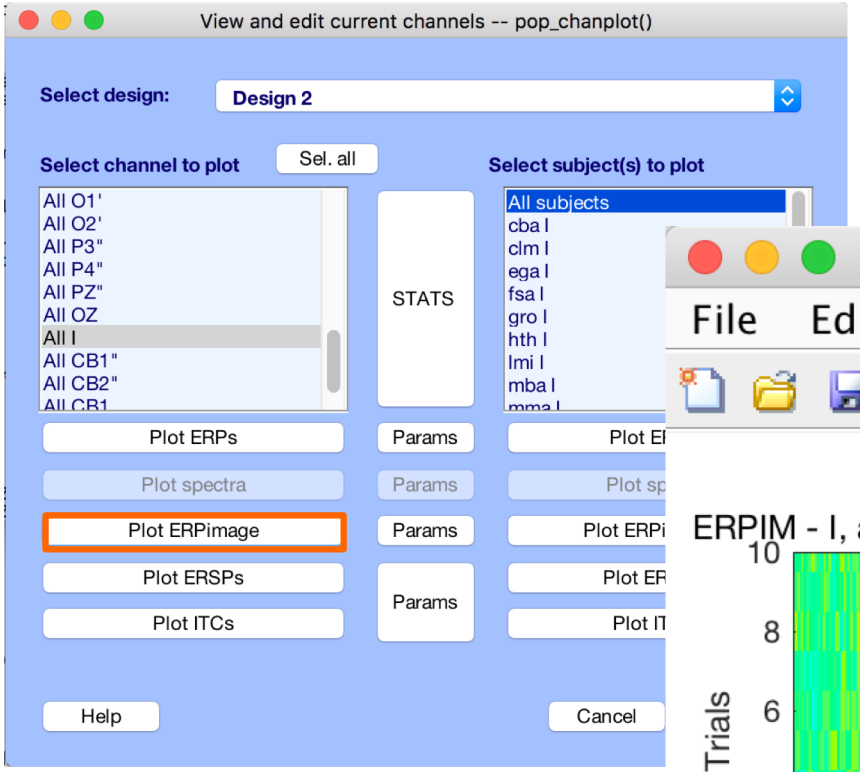
'cycles', [3 0.8], 'nfreqs', 50, 'ntimesout', 100



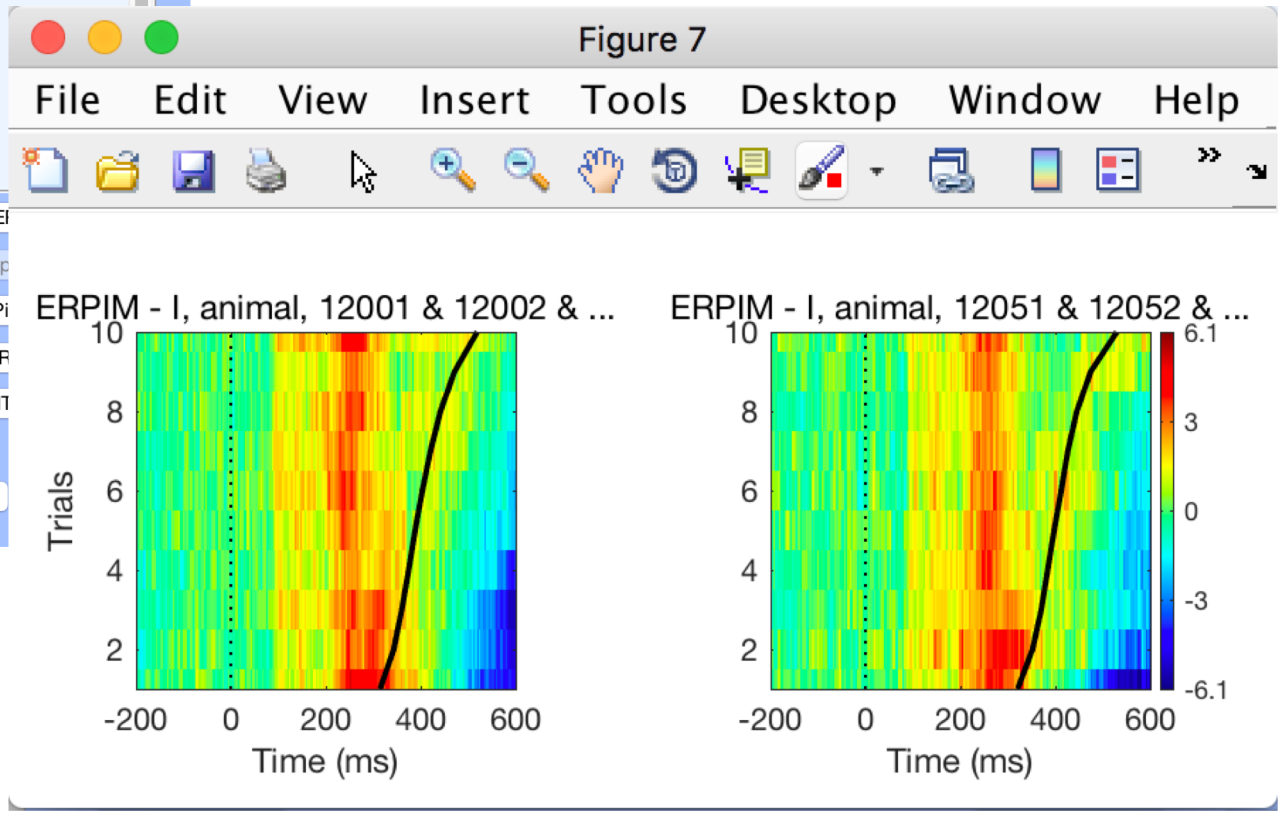

View and edit current channe
STUDY name 'Sternberg' - 'Comparing conditio
Select channel to plot
Sel. all
All CZ
All C2
All C4
All C6
All T8
All TP9
All TP7
All CP5
All CP3
STATS
Plot ERPs
Params
Plot spectra
Params
Plot ERPimage
Params
Plot ERSPs
Params
Plot ITCs
Help
Cancel
Ok
Figure 4
File Edit View Insert Tools Desktop Window Help
ERSP - CZ, ignore
ERSP - CZ, memorize
ERSP - CZ, probe
Frequency (Hz)
Time (ms)
dB
Set ERSP/ITC plotting parameters -- pop_erspparams()
ERSP/ITC plotting options
Time range in ms [Low High]
-500 1000
Freq. range in Hz [Low High]
3 30
Power limits in dB [Low High]
Plot scalp map at time [ms]
Plot scalp map at freq. [Hz]
ITC limit (0-1) [High]
Compute common ERSP baseline (assumes additive baseline)
Cancel
Ok

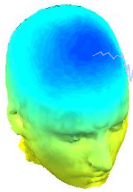
ERP-image across subjects

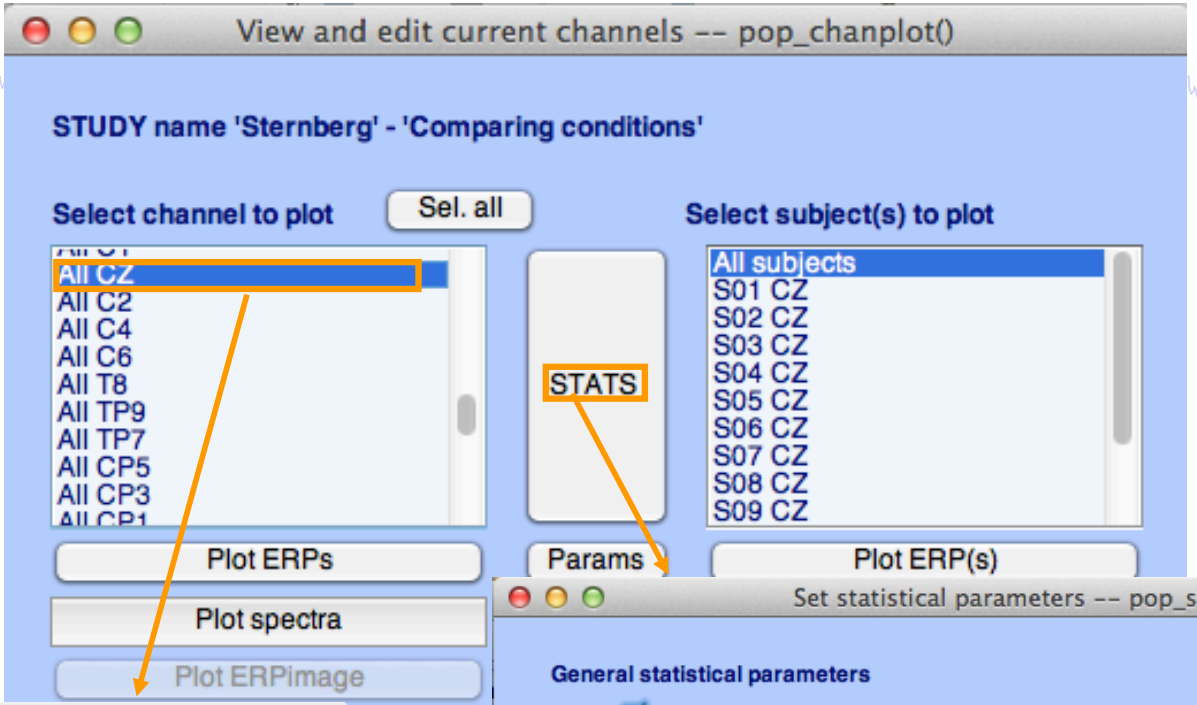




Delorme, A., Miyakoshi., M., Jung, T.P., Makeig, S. (2014) **Grand average ERP-image plotting and statistics: A method for comparing variability in event-related single-trial EEG activities across subjects and conditions.** J Neurosci Methods. 2014 Oct 22. pii: S0165-0270(14)00363-X. doi: 10.1016/j.jneumeth.2014.10.003






View and edit current channels -- pop_chanplot()
STUDY name 'Sternberg' - 'Comparing conditions'
Select channel to plot
Sel. all
All CZ
All C2
All C4
All C6
All T8
All TP9
All TP7
All CP5
All CP3
STATS
Select subject(s) to plot
All subjects
S01 CZ
S02 CZ
S03 CZ
S04 CZ
S05 CZ
S06 CZ
S07 CZ
S08 CZ
S09 CZ
Plot ERPs
Params
Plot ERP(s)
Plot spectra
Plot ERPimage

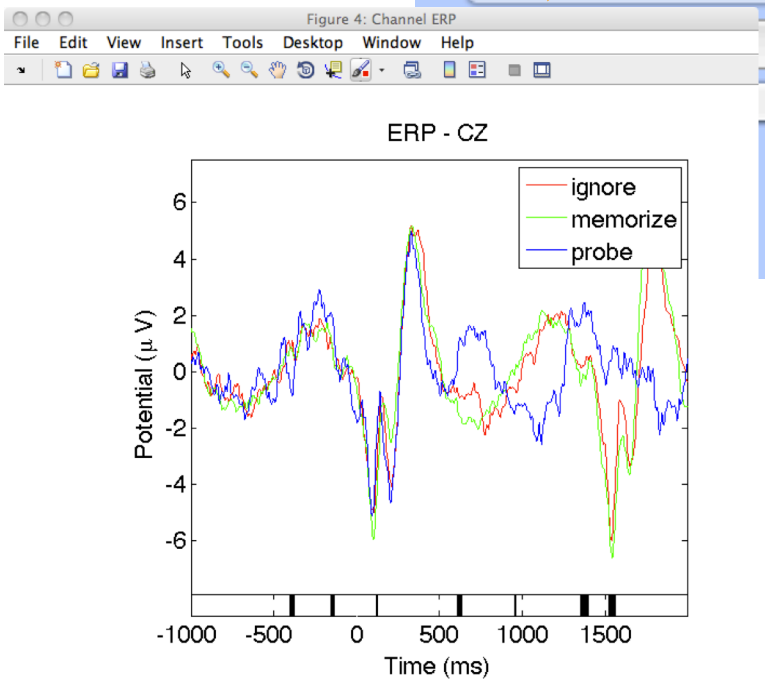
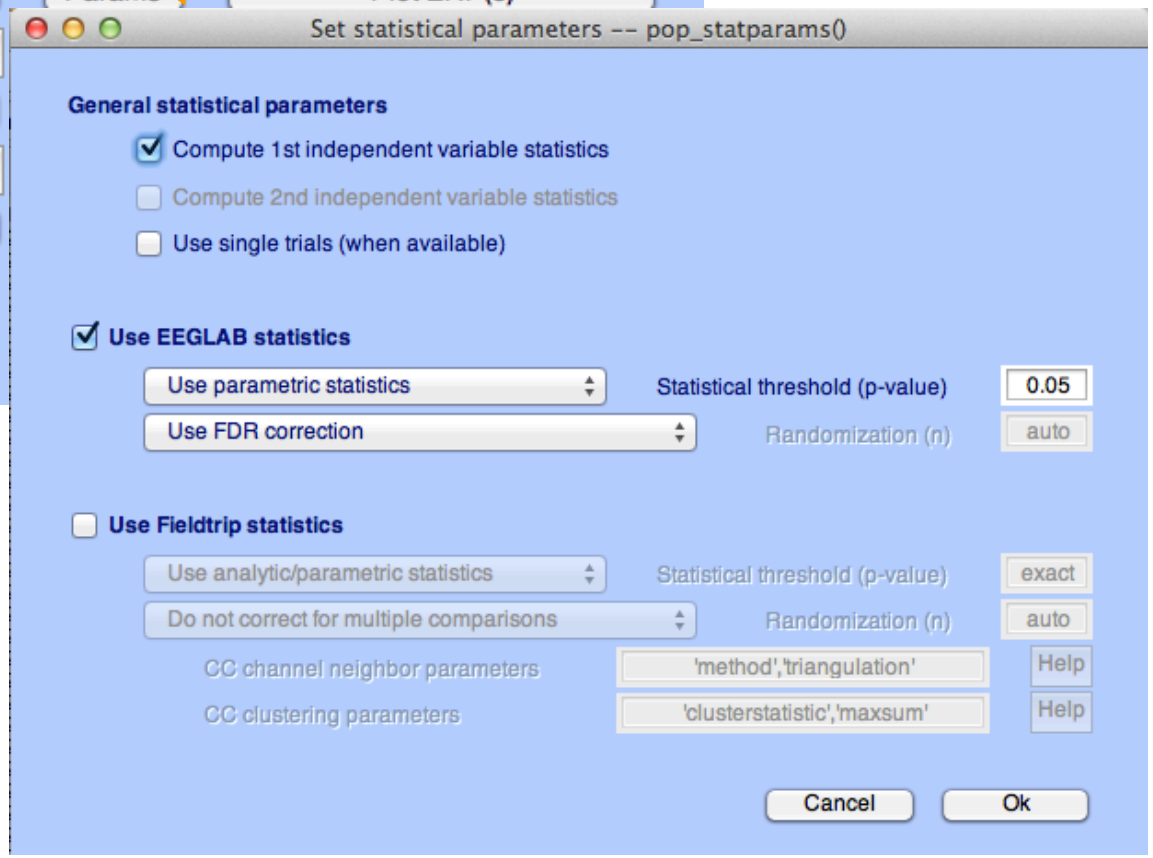
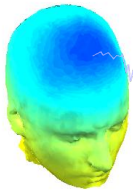
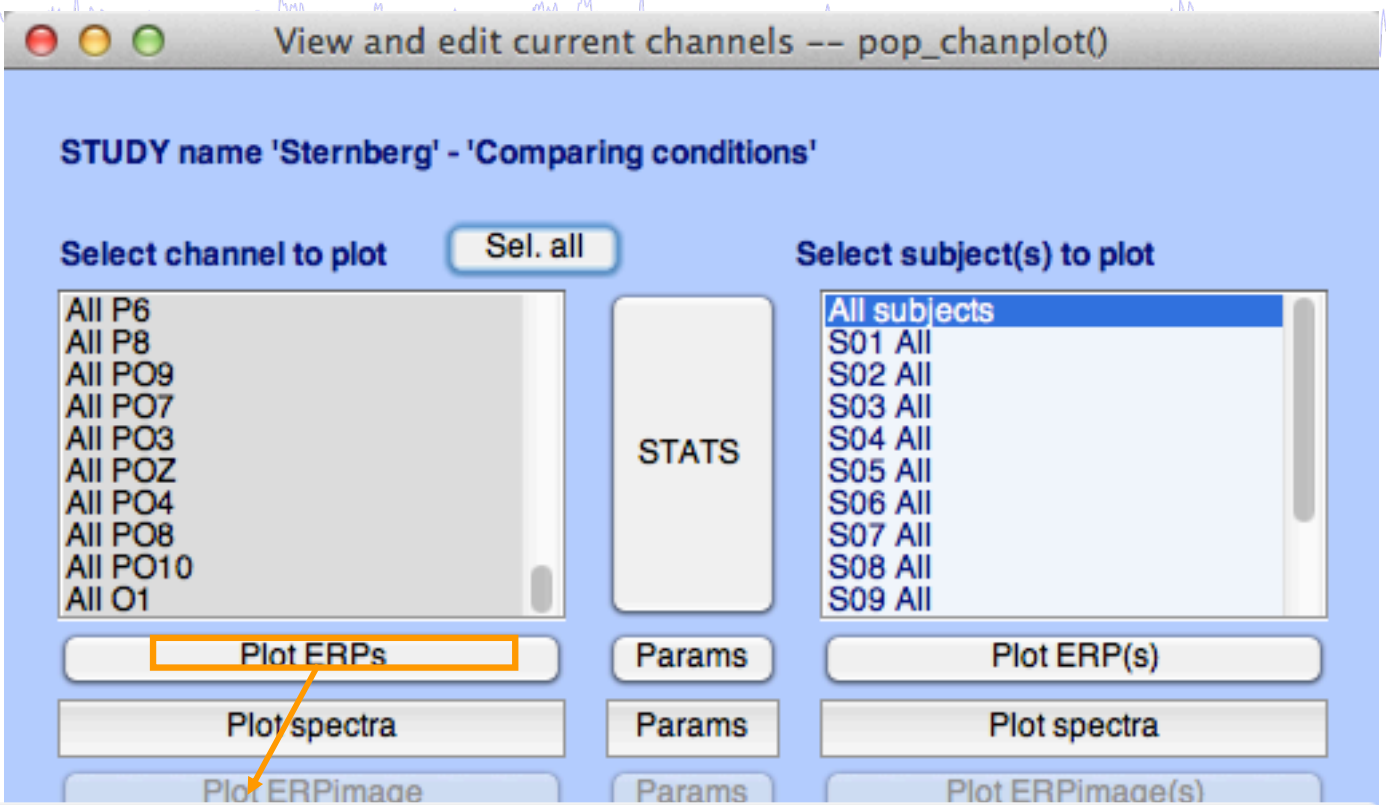


Figure 4: Channel ERP
File Edit View Insert Tools Desktop Window Help
ERP - CZ
ignore
memorize
probe
Potential (µ V)
6
4
2
0
-2
-4
-6
-1000 -500 0 500 1000 1500
Time (ms)


Set statistical parameters -- pop_statparams()
General statistical parameters
Compute 1st independent variable statistics
Compute 2nd independent variable statistics
Use single trials (when available)
Use EEGLAB statistics
Use parametric statistics
Statistical threshold (p-value)
0.05
Use FDR correction
Randomization (n)
auto
Use Fieldtrip statistics
Use analytic/parametric statistics
Statistical threshold (p-value)
exact
Do not correct for multiple comparisons
Randomization (n)
auto
CC channel neighbor parameters
'method','triangulation'
Help
CC clustering parameters
'clusterstatistic','maxsum'
Help
Cancel
Ok




View and edit current channels -- pop_chanplot()
STUDY name 'Sternberg' - 'Comparing conditions'
Select channel to plot
Sel. all
All P6
All P8
All PO9
All PO7
All PO3
All POZ
All PO4
All PO8
All PO10
All O1
STATS
Select subject(s) to plot
All subjects
S01 All
S02 All
S03 All
S04 All
S05 All
S06 All
S07 All
S08 All
S09 All
Plot ERPs
Params
Plot ERP(s)
Plot spectra
Params
Plot spectra
Plot ERPimage
Params
Plot ERPimage(s)

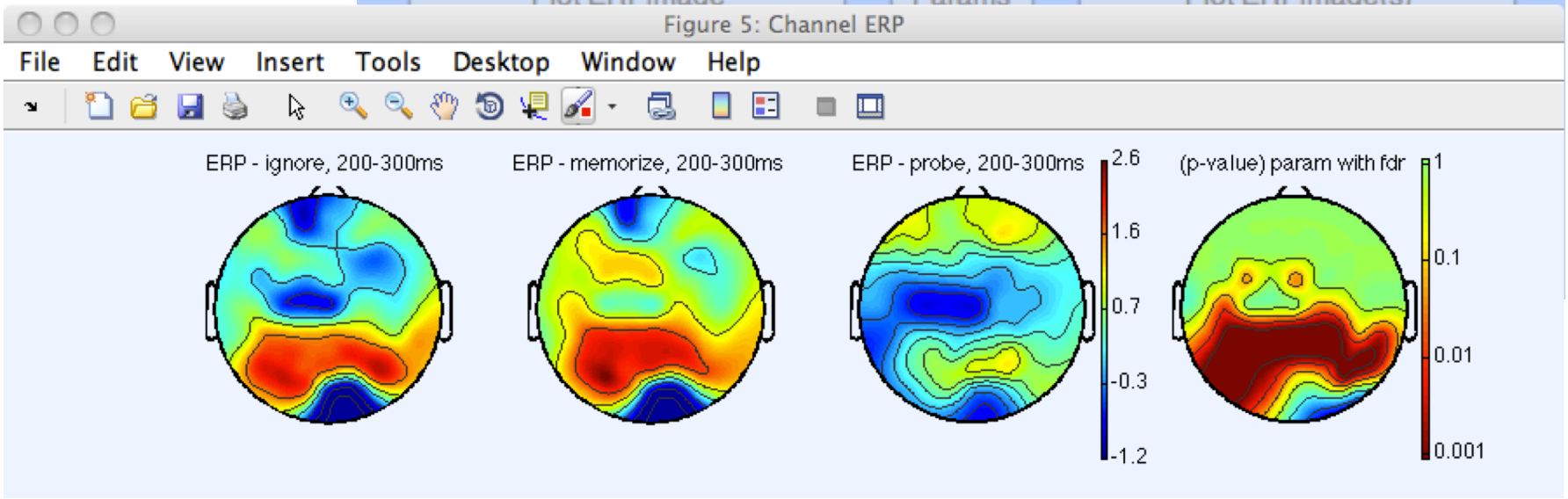
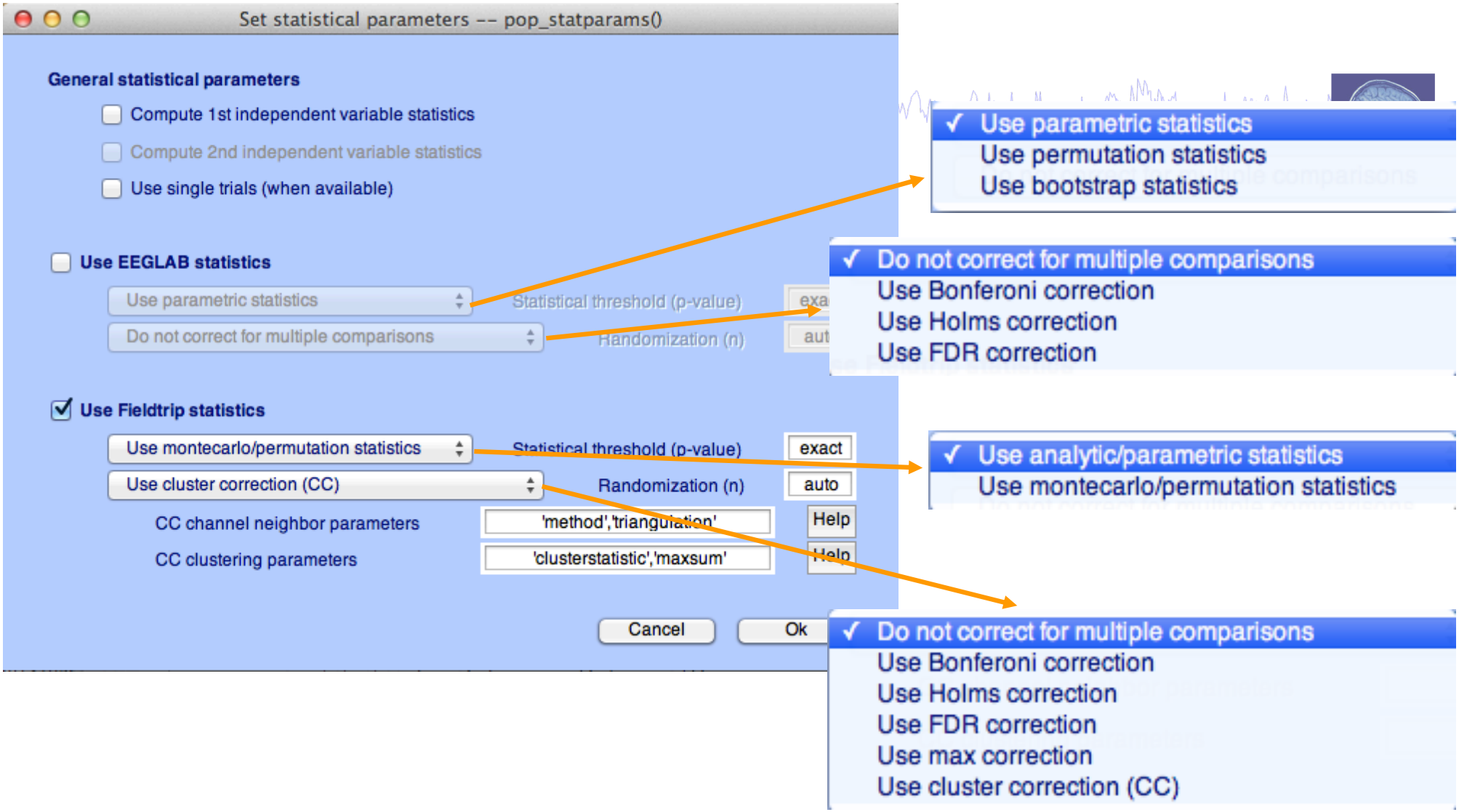
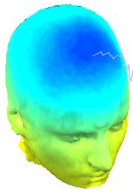


Figure 5: Channel ERP
File Edit View Insert Tools Desktop Window Help
ERP - ignore, 200-300ms
ERP - memorize, 200-300ms
ERP - probe, 200-300ms
2.6
1.6
0.7
-0.3
-1.2
(p-value) param with fdr
1
0.1
0.01
0.001

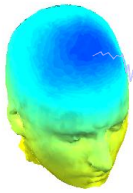


std_stat() function in EEGLAB

Exercises



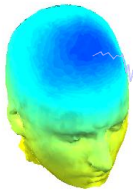
1. Load “stern.study” file in STUDY folder
2. Edit STUDY design and delete current variable(s)
3. Create a new indep. Variable design to compare Ignore vs. Memorize letter
4. Recompute spectrum and ERP.
5. Plot spectrum and ERP for electrode Cpz
6. Plot scalp topography at 10 Hz (spectrum) and 200-300 ms (ERP) for both conditions
7. Plot spectrum for electrode CPz within 1 to 50 Hz and compute parametric statistics (with and without FDR correction)
8. Plot scalp topography at 10Hz for both conditions using permutation statistics cluster correction (Fieldtrip – statistics)



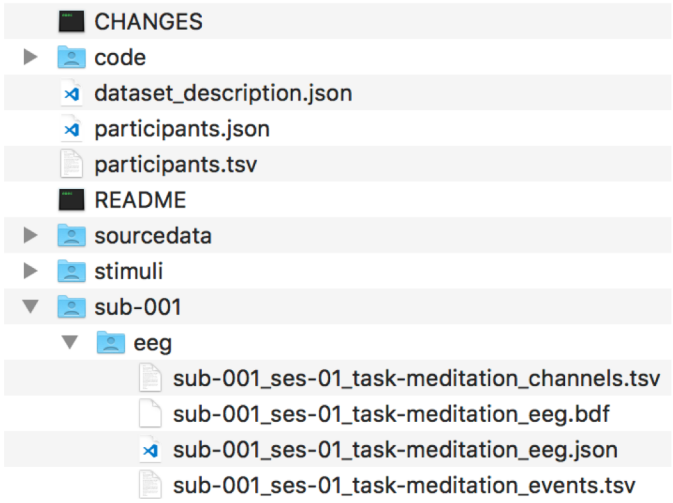
EEGLAB and BIDS

- Export EEGLAB STUDY to BIDS
- Import BIDS to EEGLAB STUDY
- HED support (meta-tags)
- Mapping the BIDS architecture

https://github.com/sccn/bids-matlab-tools



BIDS data structure…

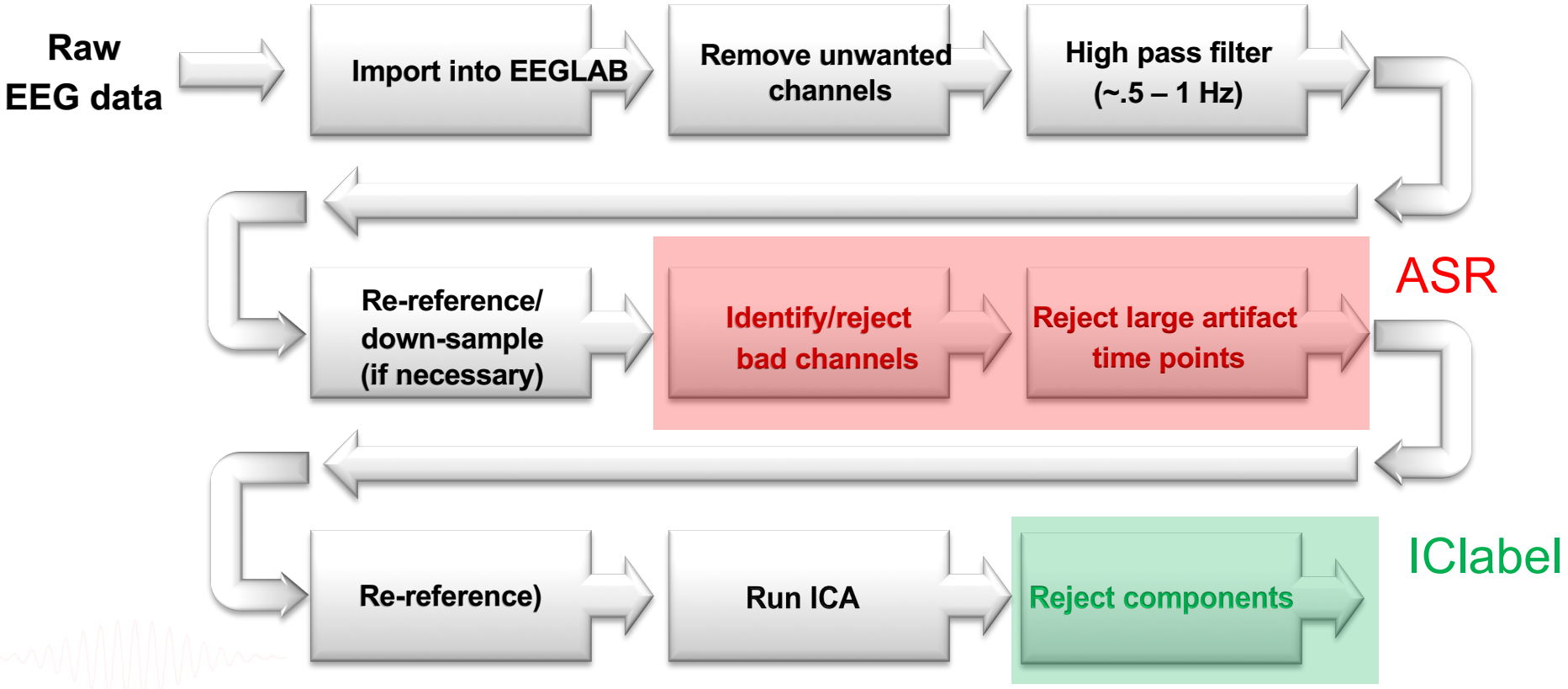


- changes compared to previous release of data
- scripts and program to process/convert the data
- description of dataset in JSON format
- description of participants table file columns (below)
- participants table files in tab delimited format
- readme file for users
- original raw data if converted to a supported format
- original stimuli (sound files and images)
- anonymized subject 1 folder

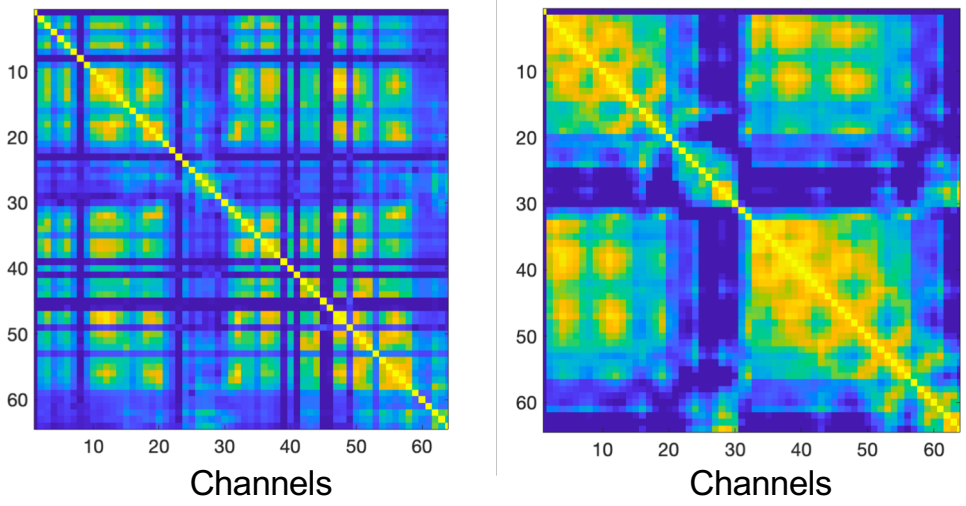
- file describing channels
- raw EEG data file (not all raw formats are possible)
- amplifier and recording information
- events in tabular format

BIDS-EEG: an Addition to the Brain Imaging Data Structure (BIDS) Specification for Electroencephalography (2019) Cyril R Pernet, Stefan Appelhoff, Guillaume Flandin, Christophe Phillips, Arnaud Delorme, Robert Oostenveld. Scientific data, in press.

Preprocessing pipeline



Pairwise correlation to find bad channels



ASR finds and reconstructs bad portions of data

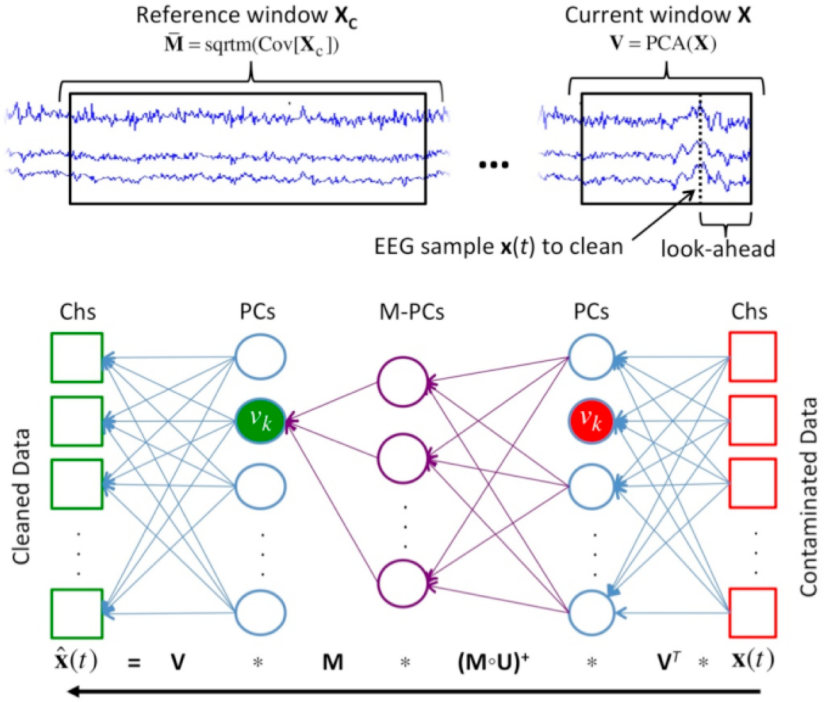
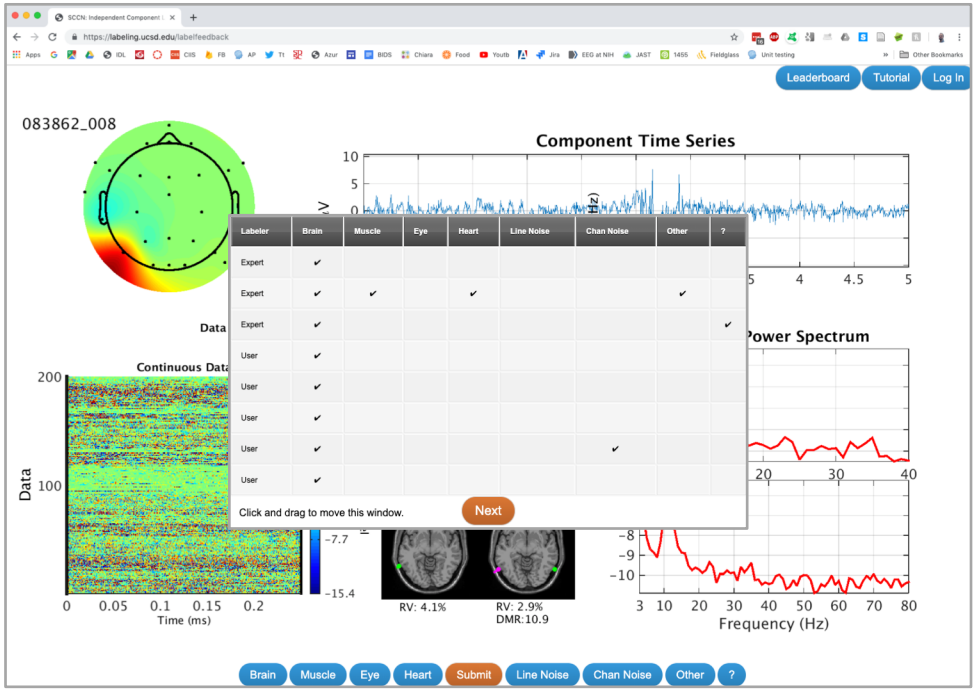
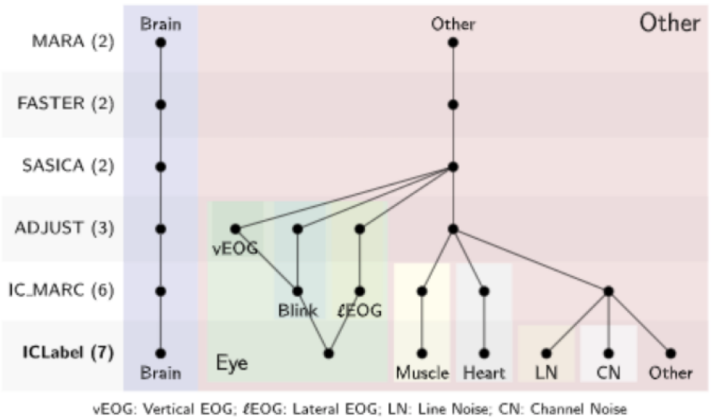


Fig. 3. The Artifact Subspace Reconstruction method. High-variance

Tim R. Mullen, Christian Kothe, et al.(2015) Real-time neuroimaging and cognitive monitoring using wearable dry EEG. Published in IEEE Transactions on Biomedical Engineering. DOI:10.1109/TBME.2015.2481482

IC label





vEOG: Vertical EOG; ℓEOG: Lateral EOG; LN: Line Noise; CN: Channel Noise

Pion-Tonachini L et al. (2019) ICLabel: An automated electroencephalographic independent component classifier, dataset, and website. Neuroimage, 98:181-197. doi: 10.1016/j.neuroimage.2019.05.026.

STUDY Script

```
% Create Stern STUDY
[ALLEEG EEG CURRENTSET ALLCOM] = eeglab;
pop_editoptions( 'option_storedisk', 1);
subjects = {'S01' 'S02' 'S03' 'S04' 'S05' 'S06' 'S07' 'S08' 'S09' 'S10' 'S11' 'S12'};
filepath = '/Users/arno/temp/STUDY'; % XXXXX Change path here XXXXX
if ~exist(filepath), error('You need to change the path to the STUDY'); end;
commands = {}; % initialize STUDY dataset list

% Loop through all of the subjects in the study to create the dataset
for loopnum = 1:length(subjects) %for each subject
    IgnoreFile   = fullfile(filepath, subjects{loopnum}, 'Ignore.set');
    MemorizeFile = fullfile(filepath, subjects{loopnum}, 'Memorize.set');
    ProbeFile    = fullfile(filepath, subjects{loopnum}, 'Probe.set');
    commands = {commands{:} ...
        {'index' 3*loopnum-2 'load' IgnoreFile   'subject' subjects{loopnum} 'condition' 'Ignore'} ...
        {'index' 3*loopnum-1 'load' MemorizeFile 'subject' subjects{loopnum} 'condition' 'Memorize'} ...
        {'index' 3*loopnum   'load' ProbeFile    'subject' subjects{loopnum} 'condition' 'Probe'}};
end;
% Uncomment the line below to select ICA components with less than 15% residual variance
% commands = {commands{:} {'dipselect', 0.15}};
[STUDY, ALLEEG] = std_editset(STUDY, ALLEEG, 'name','Sternberg','commands',commands,'updatedat','on');

% Update workspace variables and redraw EEGLAB
CURRENTSTUDY = 1; EEG = ALLEEG; CURRENTSET = [1:length(EEG)];
[STUDY, ALLEEG] = std_checkset(STUDY, ALLEEG);
eeglab redraw

[STUDY ALLEEG] = std_precomp(STUDY, ALLEEG, {},'rmicacomps','on','interp','on','recompute','on','erp','on');
STUDY = pop_erpparams(STUDY, 'topotime',[200 300] );
[STUDY erpdata] = std_erpplot(STUDY,ALLEEG,'channels',{'LEYE' 'REYE' 'OZ' 'O2' 'FP1' 'FPZ' 'FP2' 'AF7' ...
            'AF3' 'AFZ' 'AF4' 'AF8' 'F9' 'F7' 'F5' 'F3' 'F1' 'FZ' 'F2' 'F4' 'F6' 'F8' 'F10' 'FT9' ...
            'FT7' 'FC5' 'FC3' 'FC1' 'FCZ' 'FC2' 'FC4' 'FC6' 'FT8' 'FT10' 'T7' 'C5' 'C3' 'C1' 'CZ' ...
            'C2' 'C4' 'C6' 'T8' 'TP9' 'TP7' 'CP5' 'CP3' 'CP1' 'CPZ' 'CP2' 'CP4' 'CP6' 'TP8' 'TP10' ...
            'P7' 'P5' 'P3' 'P1' 'PZ' 'P2' 'P4' 'P6' 'P8' 'PO9' 'PO7' 'PO3' 'POZ' 'PO4' 'PO8' 'PO10' 'O1'});

dlmwrite('erpfile.txt',squeeze(erpdata{1}),'delimiter', '\t', 'precision', 2);
dlmwrite('erpfile.txt',squeeze(erpdata{2}),'-append', 'roffset', 1, 'delimiter', '\t', 'precision', 2);
dlmwrite('erpfile.txt',squeeze(erpdata{2}),'-append', 'roffset', 1, 'delimiter', '\t', 'precision', 2);
```