

Data importing and channel analysis



Task 1

- Import raw data
- Re-reference data
- Scroll channel data

Task 2

- Import channel location file

Task 3

- Import data events

Task 4

- Extract data epochs
- Select epochs/events

Task 5

- Channel analysis

Exercise...



Data importing and channel analysis



Task 1

- Import raw data
- Re-reference data
- Scroll channel data

Task 2

- Import channel location file

Task 3

- Import data events

Task 4

- Extract data epochs
- Select epochs/events

Task 4

- Channel analysis

Exercise...



The EEGLAB Matlab software



main graphic interface

The screenshot shows the EEGLAB main interface. On the left, the "EEGLAB Shell - Konsole" window displays a MATLAB startup message and a command prompt where "eeglab" is typed. On the right, the "EEGLAB v5.03" window shows a menu bar and a central panel with the message "No current dataset" and a list of dataset management steps.

EEGLAB Shell - Konsole

```
Session Edit View Bookmarks Settings Help
```

```
/home/arno> matlab -nodesktop
```

```
< M A T L A B >
Copyright 1984-2002 The MathWorks, Inc.
Version 6.5.0.180913a Release 13
Jun 18 2002

Using Toolbox Path Cache. Type "help toolbox_path_cache" for

To get started, type one of these: helpwin, helpdesk, or demo.
For product information, visit www.mathworks.com.

>> eeglab
```

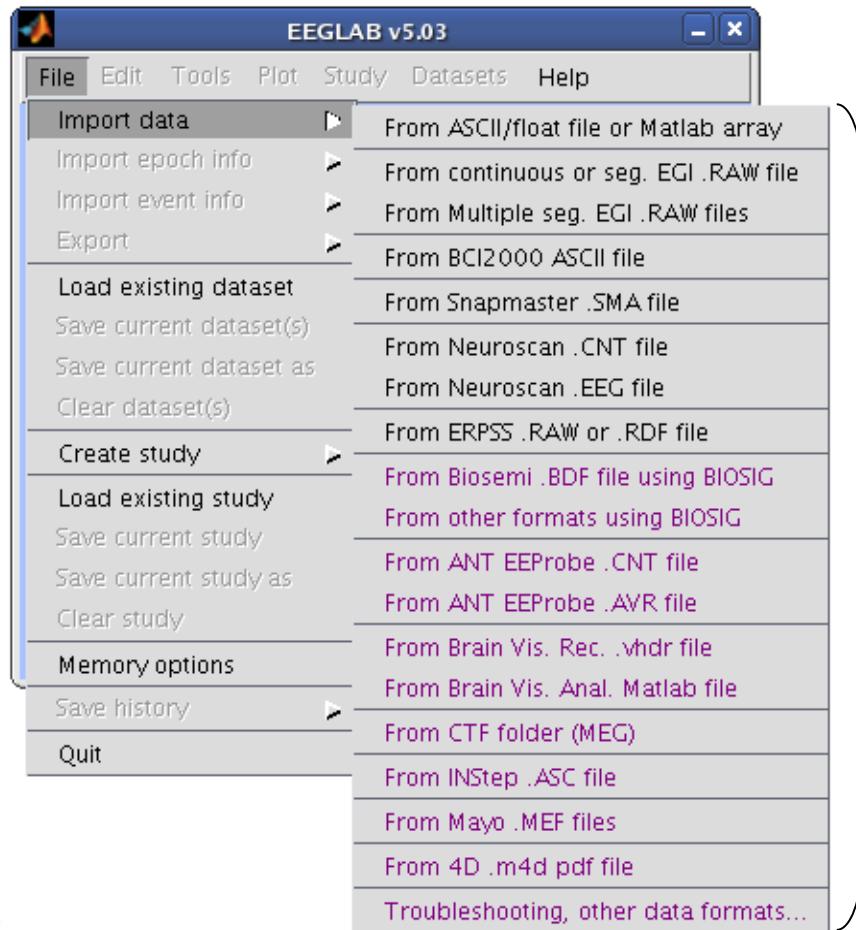
EEGLAB v5.03

```
File Edit Tools Plot Study Datasets Help
```

No current dataset

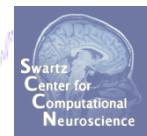
- Create a new or load an existing dataset:
Use "File > Import data" (new)
Or "File > Load existing dataset" (old)
- If new,
 - "File > Import epoch info" (data epochs) else
"File > Import event info" (continuous data)
 - "Edit > Dataset info" (add/edit dataset info)
 - "File > Save dataset" (save dataset)
- Prune data: "Edit > Select data"
- Reject data: "Tools > Reject continuous"
- Epoch data: "Tools > Extract epochs"
- Remove baseline: "Tools > Remove"
- Run ICA: "Tools > Run ICA"

Importing a dataset



**EEGLAB supports many
different raw data formats**

Imported EEG data



EEGLAB v7.1.6.18b

File Edit Tools Plot Study Datasets Help

#1: Sternberg Continuous Data

Filename:	...stralia\STUDY\S04\stern.set
Channels per frame	71
Frames per epoch	610133
Epochs	1
Events	1303
Sampling rate (Hz)	250
Epoch start (sec)	0.000
Epoch end (sec)	2440.528
Reference	unknown
Channel locations	Yes
ICA weights	Yes
Dataset size (Mb)	351.4

EEGLAB GUI
displays dataset
basics



The example data: Sternberg working memory



File

..../Data/stern.set



Data

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

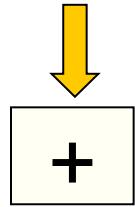
Task

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

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

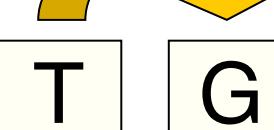
Fixation

(5 sec)



SOA

(1.4 sec)



M

L

T

G

P

Y

Q

W

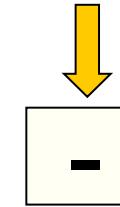
Memorize

Ignore

Maintenance

(2-4 sec)

Probe



T

RT

Was this letter in the memorized set?

RESPONSE

Comments in EEGLAB structure



Read/Enter comments -- pop_comments()

About this dataset

```
Data acquired by: Julie Onton
Data acquired on: Oct 15, 1974

Task ('eventname'):
- Every trial preceded by 5 sec fixation ('fix') -
3,5,7 letters to memorize (in black, ex, 'B')
- 5,3,1 letters to ignore (in green, ex, 'gB')
- 8-letters total per trial
- 2-4 sec variable maintenance period ('WM')
- Probe letter (in red, ex, 'rB') prompted a button
press response
- Subject was to indicate by left or right mouse
button (with right hand) whether the probe
letter was in-set (left,'in') or out-of-set
(right,'out')
- If the response was correct, subject heard one
one tone ('correct'), if incorrect, a different
tone ('wrong')

Reference electrode placed on right mastoid
(Subject indicated sleepiness toward the end of
session)
```

CANCEL SAVE

>> EEG.comments

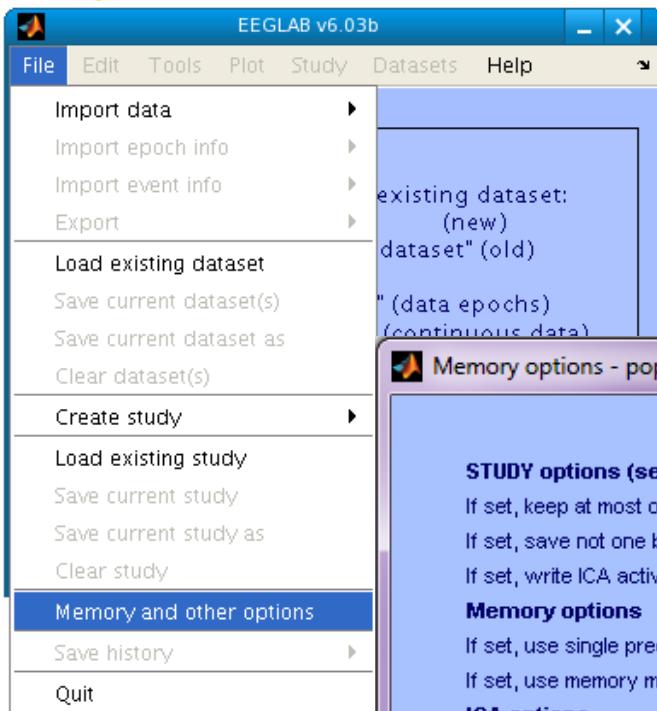
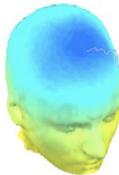
EEGLAB v7.1.6.18b

File Edit Tools Plot Study Datasets Help

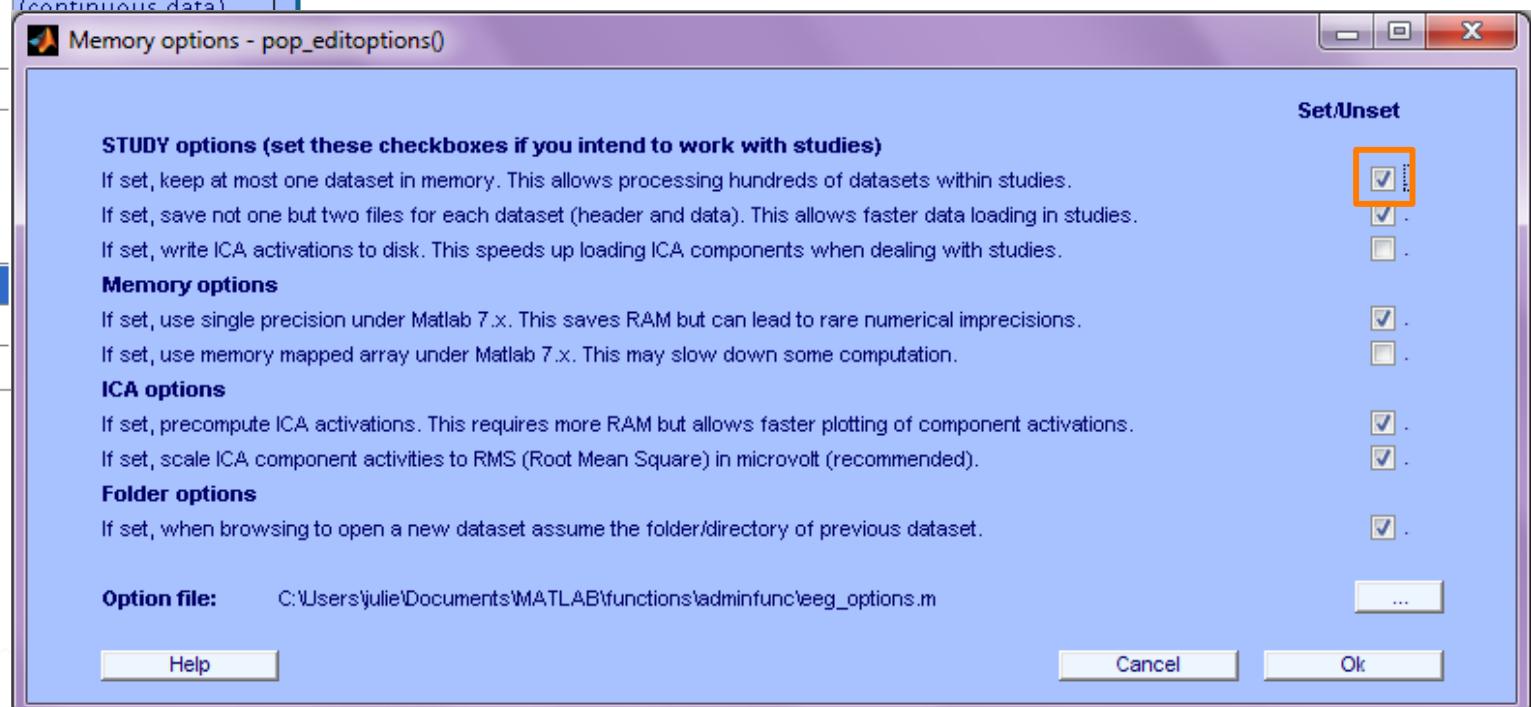
Continuous Data

Dataset info	0YAS04\stern.set
Event fields	71
Event values	610133
About this dataset	1
Channel locations	1303
Select data	250
Select data using events	0.000
Select epochs or events	2440.528
Copy current dataset	unknown
Append datasets	Yes
Delete dataset(s)	Yes
ICA weights	351.4
Dataset size (Mb)	

Memory options



Set when loading a STUDY



Re-reference data (if necessary/desired)



EEGLAB v7.1.6.18b

File Edit Tools Plot Study Datasets Help

#1:

Change sampling rate
Filter the data
Re-reference
Interpolate electrodes
Reject continuous data by eye
Extract epochs
Remove baseline
Run ICA
Remove component
Automatic channels
Automatic epoch
Reject data epoch
Reject data using
Locate dipoles using
Peak detection using
FMRIB Tools
Locate dipoles using

pop_reref - average reference or re-reference data

Current data reference state is: unknown
 Compute average reference
 Re-reference data to channel(s): **CZ**
 Retain old reference channels in data
Exclude channel indices (EMG, EOG)
Add current reference channel back to the data

Cancel Help Ok

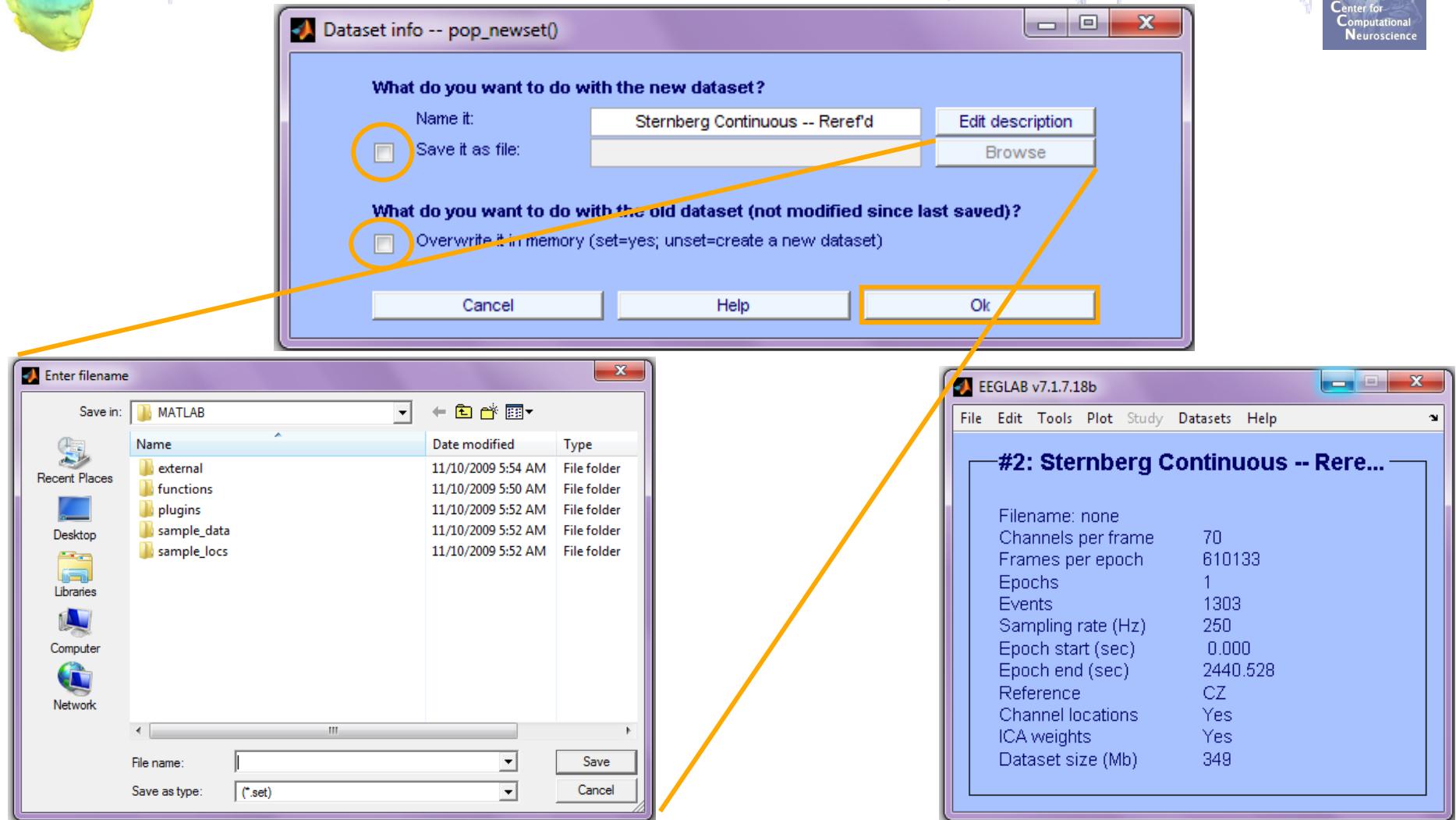
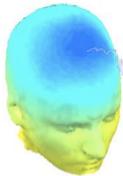
(use shift|ctrl to select several)

28 - FC1
29 - FCZ
30 - FC2
31 - FC4
32 - FC6
33 - FT8
34 - FT10
35 - T7
36 - C5
37 - C3
38 - C1
39 - CZ
40 - C2
41 - C4
42 - C6
43 - T8
44 - TP9
45 - TP7
46 - CP5
47 - CP3
48 - CP1
49 - CPZ
50 - CP2
51 - CP4
52 - CP6
53 - TP8

Cancel Ok

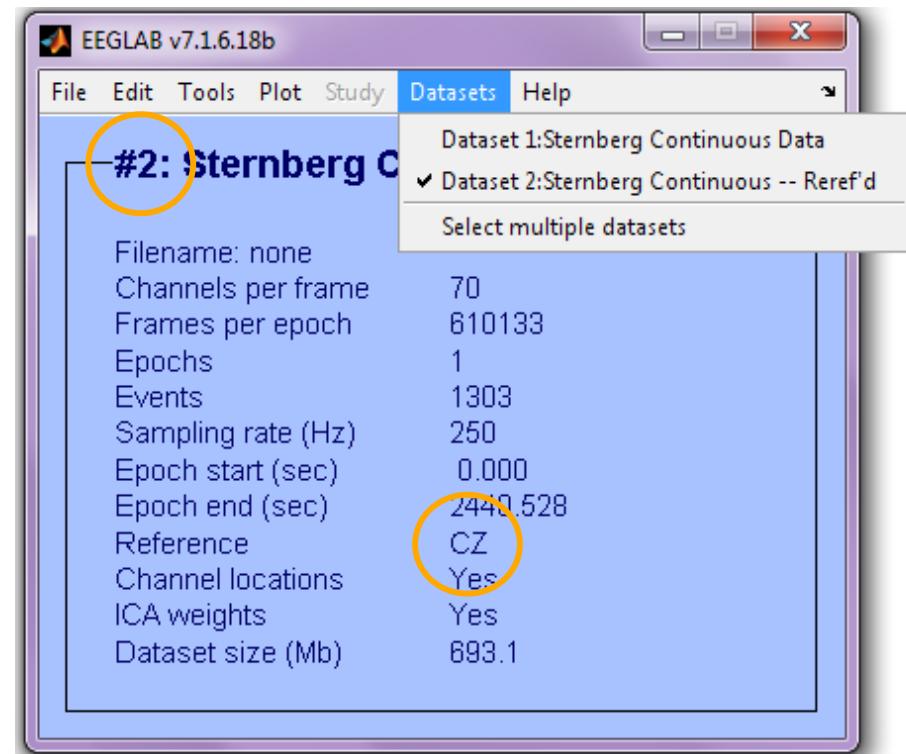
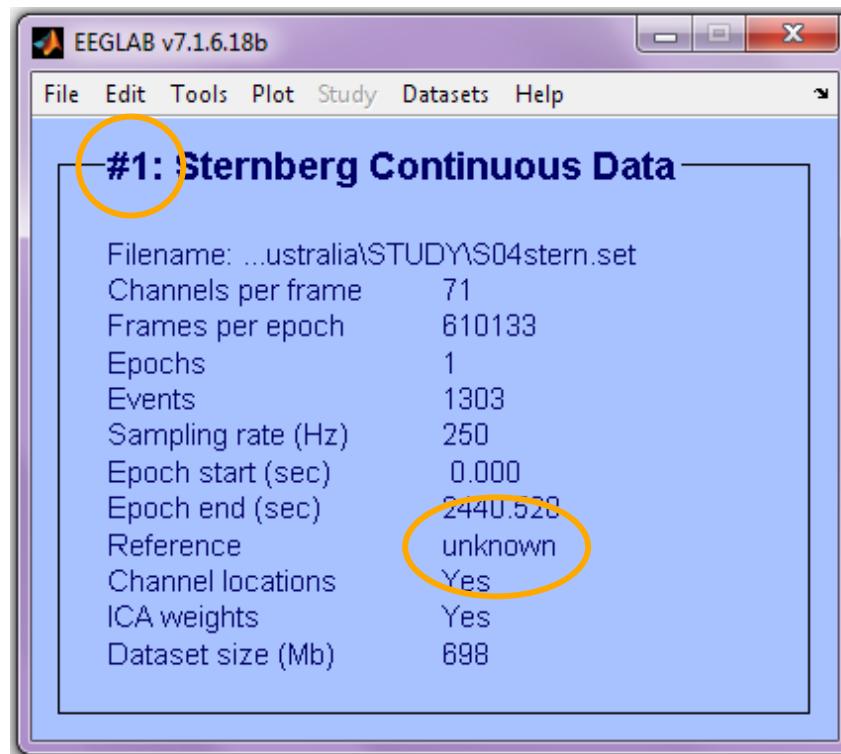
EEG = **pop_reref(EEG, 39);**

Save new dataset, keep old one

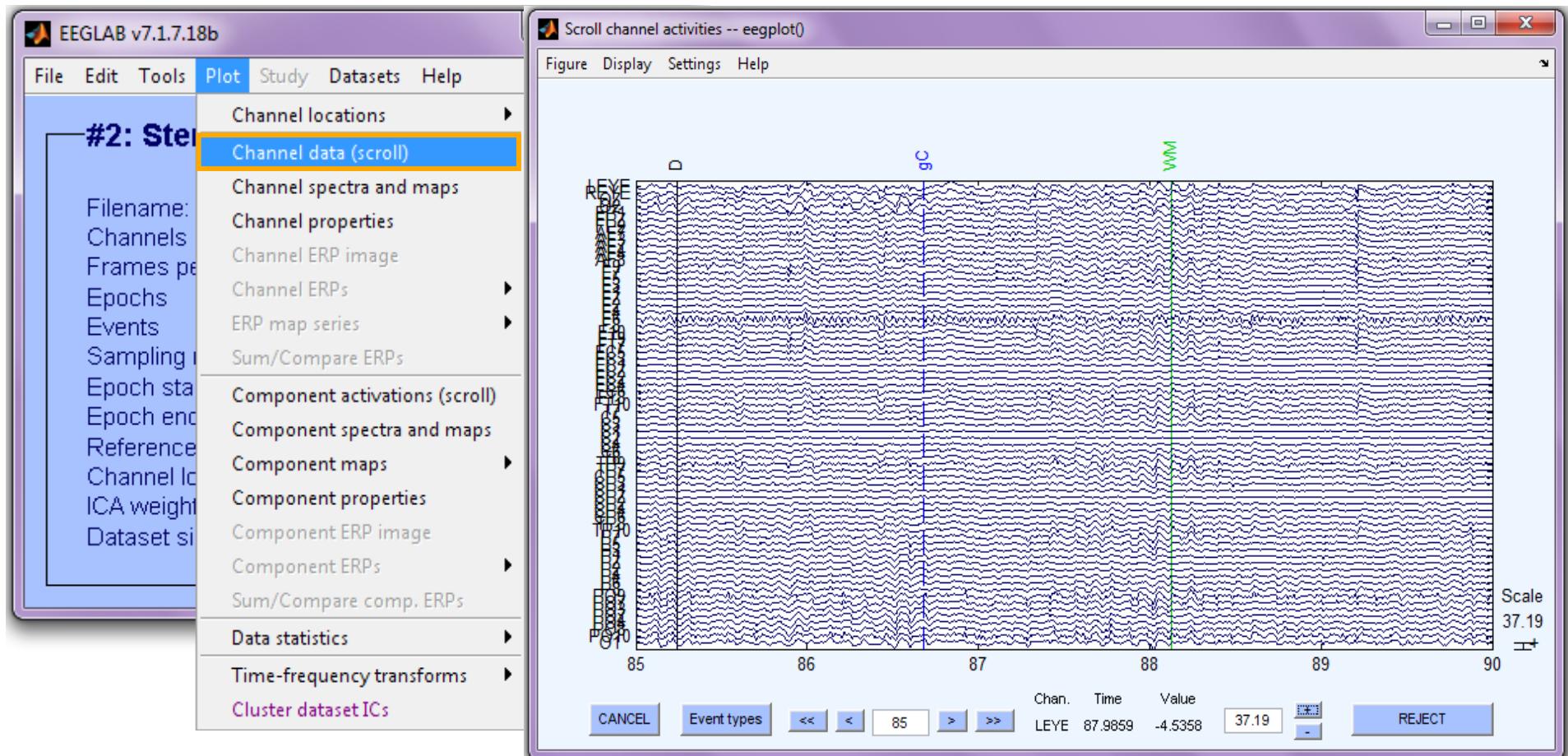


```
[ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG,EEG, 1, 'setname',...
'Sternberg Continuous -- Reref''d');
```

Multiple active datasets (ALLEEG)

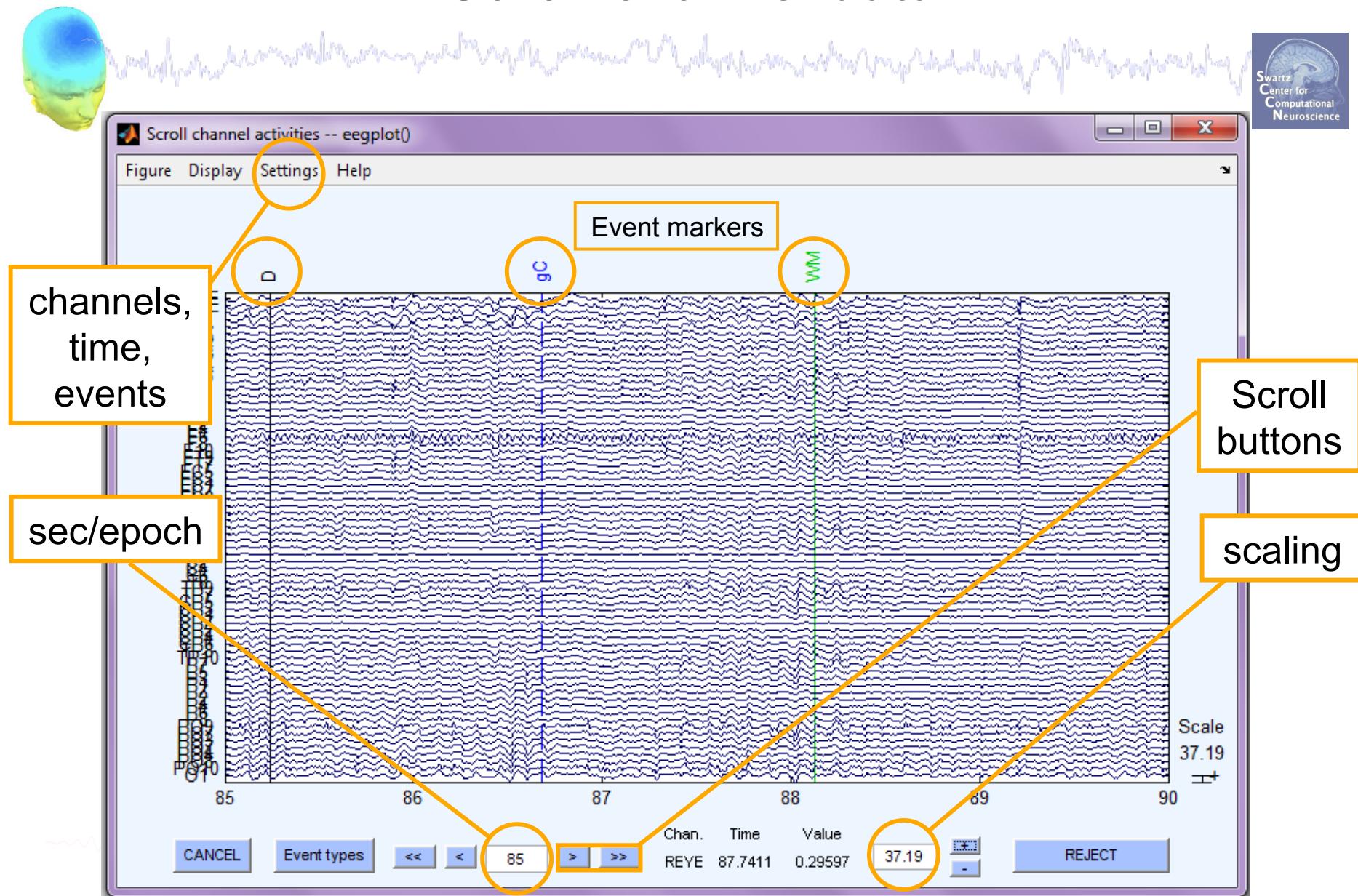


Scroll channel data

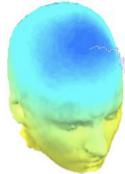


```
>> pop_eegplot(EEG,1,1,1);
```

Scroll channel data



Data importing and channel analysis



Task 1

- Import raw data
- Re-reference data
- Scroll channel data

Task 2

- Import channel location file

Task 3

- Import data events

Task 4

- Extract data epochs
- Select epochs/events

Task 4

- Channel analysis

Exercise...



Import channel locations



EEGLAB v7.1.7.18b

File Edit Tools Plot Study Datasets Help

Dataset info
Event fields
Event values
About this dataset
Channel locations
Select data
Select data using events
Select epochs or events
Copy current dataset
Append datasets
Delete dataset(s)
ICA weights
Dataset size (Mb)

70
610133
1
1303
250
0.000
2440.5
CZ
Yes
Yes
349

Edit channel info -- pop_chanedit()

Channel information ("field_name"):

Channel label ("label")	LEYE
Polar angle ("theta")	-45.1543
Polar radius ("radius")	0.54374
Cartesian X ("X")	0.79487
Cartesian Y ("Y")	0.79917
Cartesian Z ("Z")	-0.15585
Spherical horiz. angle ("sph_theta")	45.1543
Spherical azimuth angle ("sph_phi")	-7.8725
Spherical radius ("sph_radius")	1.1379
Channel type	CZ
Reference	
Index in backup 'urchanlocs' structure	
Channel in data array (set=yes)	<input checked="" type="checkbox"/>

Opt. head center
Rotate axis
Transform axes

Xyz -> polar & sph.
Sph. -> polar & xyz
Polar -> sph. & xyz

Set head radius
Set channel types
Set reference

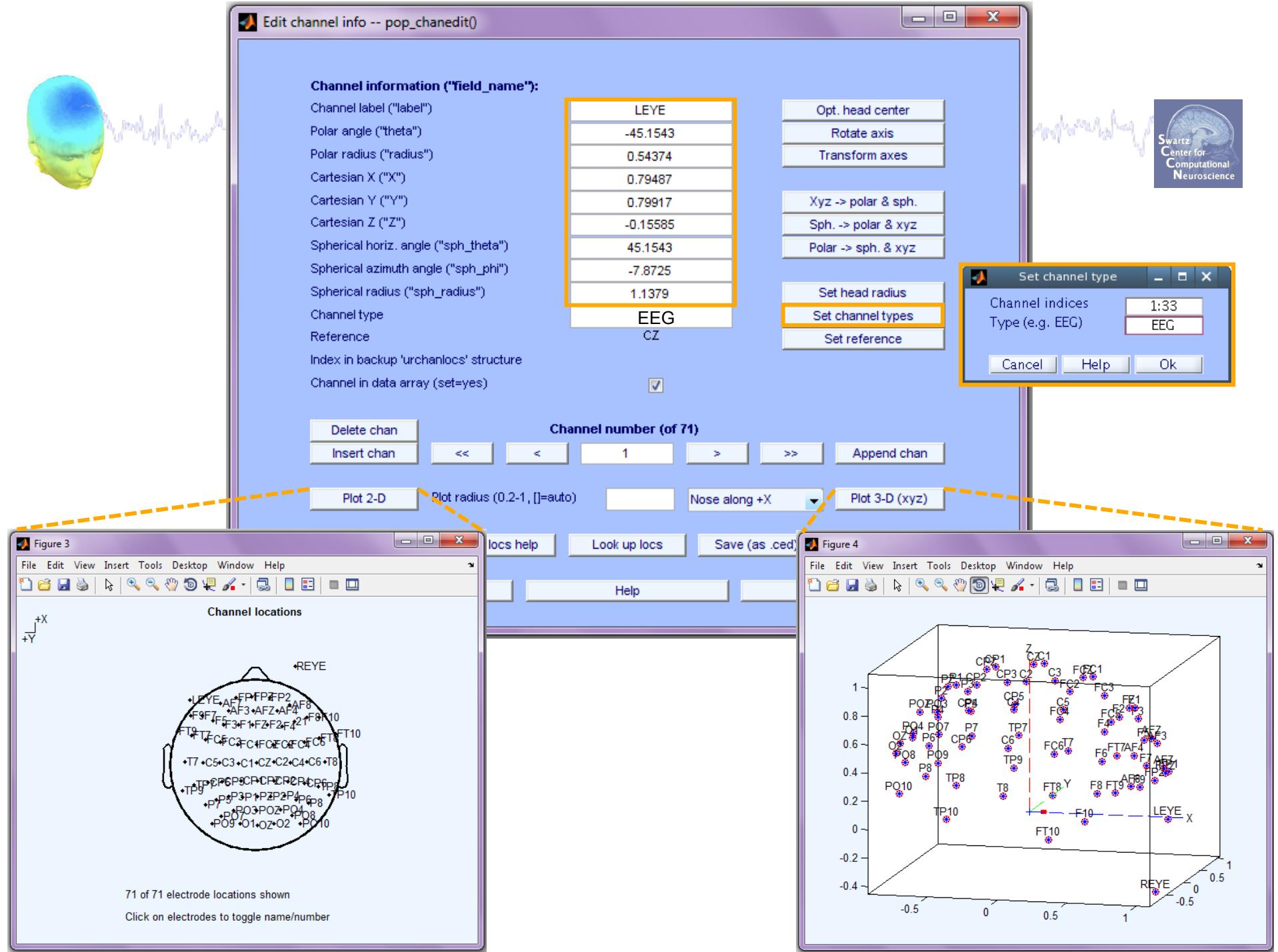
Delete chan Insert chan << < **1** > >> Append chan

Plot 2-D Plot radius (0.2-1, []=auto) Nose along +X Plot 3-D (xyz)

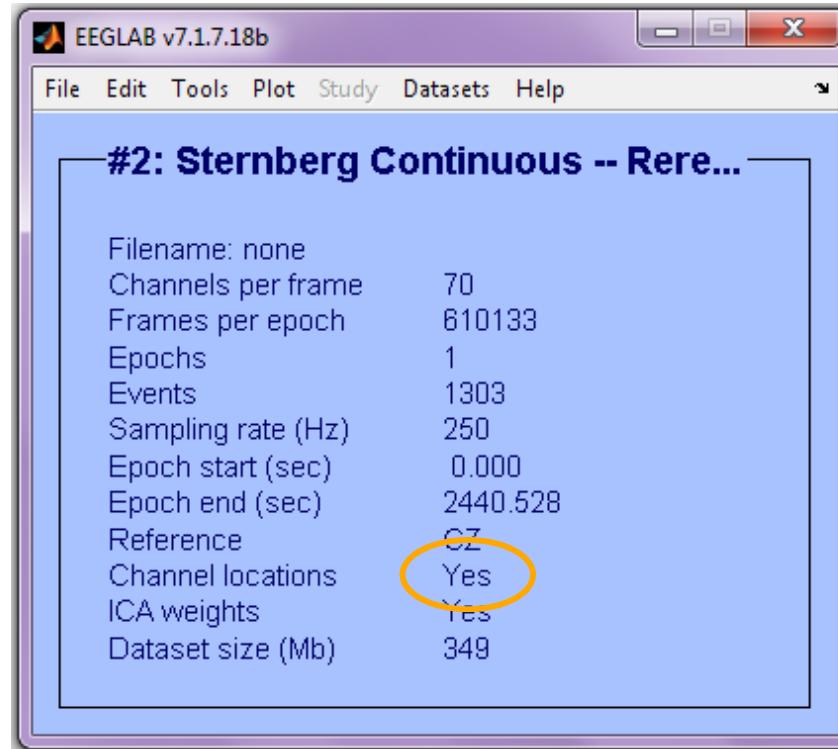
Read locations Read locs help Look up locs Save (as .ced) Save (other types)

Cancel Help Ok

7 file formats supported (Polhemus, BESA, ...)



Imported channel locations



Data importing and channel analysis



Task 1

- Import raw data
- Re-reference data
- Scroll channel data

Task 2

- Import channel location file

Task 3

- Import data events

Task 4

- Extract data epochs
- Select epochs/events

Task 4

- Channel analysis

Exercise...



Import data events



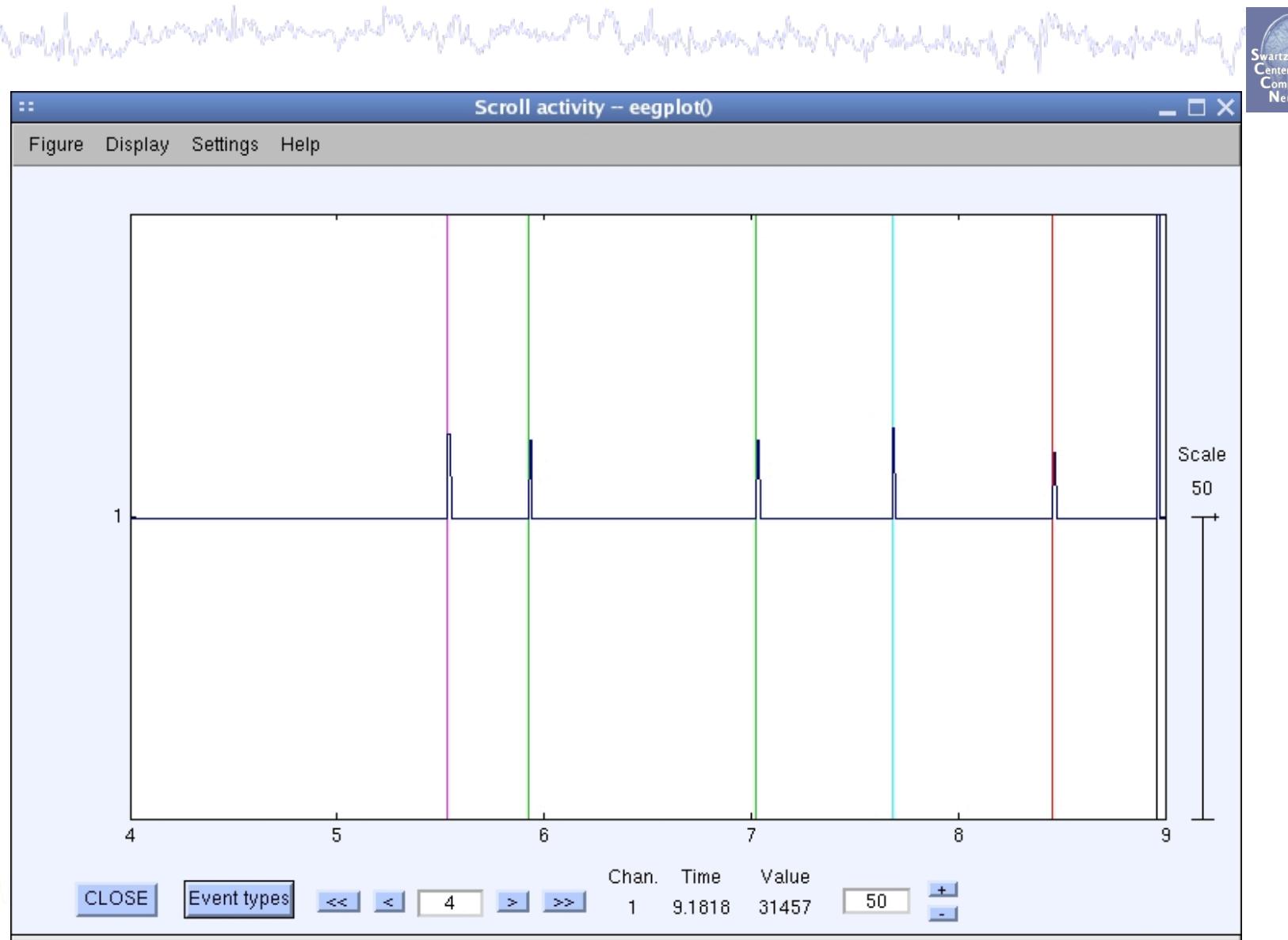
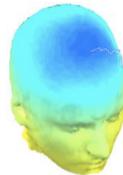
The screenshot shows the EEGLAB v7.1.7.18b software interface. The 'File' menu is open, and the 'Import event info' option is selected. A submenu is displayed with four options: 'From Matlab array or ASCII file', 'From data channel' (which is highlighted), 'From Presentation .LOG file', and 'From Neuroscan .ev2 file'. To the right of this submenu, a curly brace groups the four options under the heading 'Import events from data channel'. Below the 'File' menu, a list of dataset parameters is shown: 1303, 250, 0.000, 2440.528, CZ, Yes, Yes, and 349.

• Import events from Matlab array or ASCII file
• Import events from data channel
• Import from Presentation event file
• Import from Neuroscan file

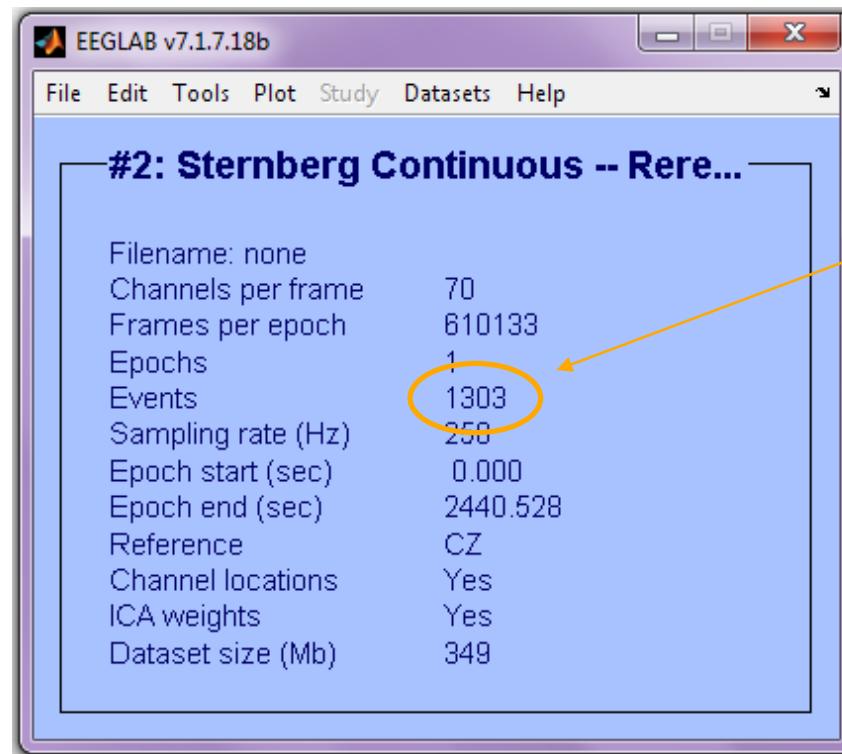
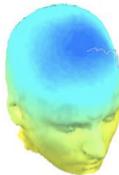
Event channel(s) (Optional. Ex: X>3
Transitions to extract? (up|down) (click to select)
Transition length (1=perfect edges)
Assign duration to each events? (set=yes)
Delete event channel(s)? (set = yes)
Delete old events if any?
All events of same type?

Cancel Help Ok

Appearance of an event channel



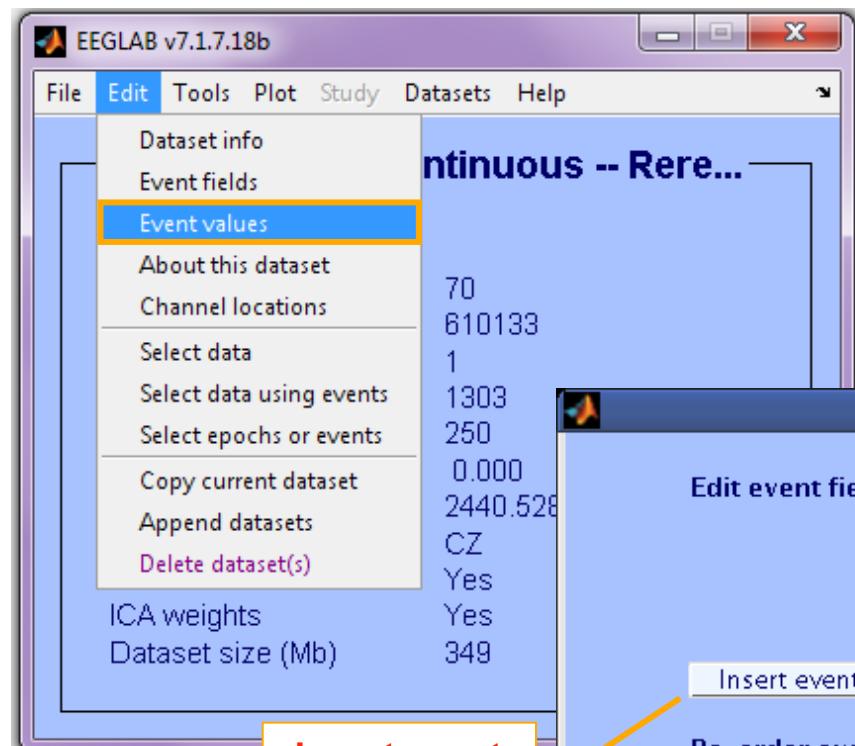
Imported data events



If event import was
successful,
you will see an
appropriate
number here



Review event values



Event 'type' and 'latency'
are recognized fields

The screenshot shows the 'Edit event values' dialog box from EEGLAB. The main window title is 'Edit event values -- pop_editeventvals()'. It displays 'Edit event field values (currently 732 events)'.

Key fields shown:

- Latency (sec): 4.964
- Type: object

Control buttons include:

- Insert event
- << < > >>
- Event Num: 2
- Append event
- Delete event

Re-order events (for review only) settings:

- Main sorting field: No field selected
- Secondary sorting field: No field selected
- Re-sort
- Click for decreasing order (checkboxes)

Dialog buttons at the bottom:

- Cancel
- Help
- Ok

Annotations with orange boxes and arrows:

- 'Insert event BEFORE current event' points to the '<<' button.
- 'To resort: first select Main sorting field' points to the 'Main sorting field' dropdown.
- 'Append event AFTER current event' points to the '>' button.
- 'Delete CURRENT event' points to the 'Delete event' button.

Review event values

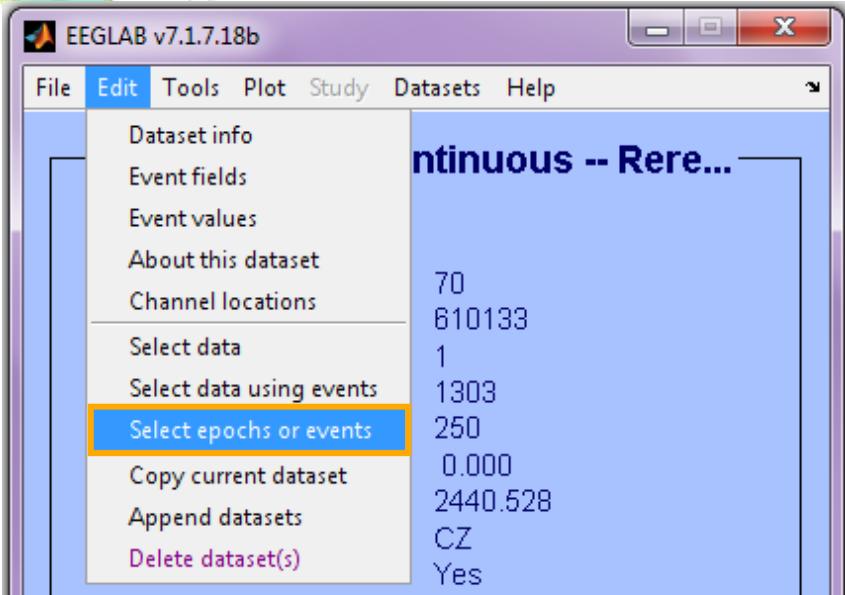
The image shows the EEGLAB v7.1.7.18b software interface. On the left, the main window displays a brain model and a waveform. The menu bar includes File, Edit, Tools, Plot, Study, Datasets, and Help. A sidebar on the left lists dataset information such as Dataset info, Event fields, Event values (which is selected), About this dataset, Channel locations, Select data, Select data using events, Select epochs or events, Copy current dataset, Append datasets, Delete dataset(s), ICA weights, and Dataset size (Mb). The central workspace shows a table of event values with the following data:

Trial	1
Event_Type	Picture
Type	nonWM
Latency (sec)	3.112
Ttime	0
Uncertainty	2
Duration	50283
Uncertainty2	3
ReqTime	0
ReqDur	50000
Init_index	1
Init_time	0.0227
Duration (sec)	0
Load	

A red box highlights the text "Number of event fields is unlimited" in the center of the workspace.

The right side shows the "Edit event values -- pop_editeventvals()" dialog box. It contains a table of event field values with the same data as above. Below the table are buttons for Insert event, <<, <, >, >>, Append event, Re-sort, Cancel, Help, and Ok. There are also dropdown menus for Main sorting field and Secondary sorting field, each with "No field selected" and "Click for decreasing order" options.

Renaming events



The screenshot shows the EEGLAB v7.1.7.18b software interface. The 'File' menu is open, and the 'Select epochs or events' option is highlighted with a blue selection bar.

Select events -- pop_selectevent()

Selection

Field	Description
Event indices	To edit: Edit > Event fields
latency (s)	No description
type	No description

Field Descriptions
To edit: Edit > Event fields

Selection (value, list or real range "min<=max")
Ex: "Target" or 2:4.5 or 4.5 <= 13

If set, select all BUT these

bp1

Select all events NOT selected above

Set this button (to left) and "all BUT" buttons (above) for logical OR

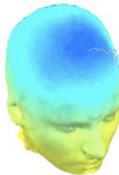
Rename selected event type(s) as type:
Retain old event type name(s) in (new) field named:

Keep only selected events and remove all other events

Cancel Help Ok

A yellow circle highlights the 'bp1' entry in the 'If set, select all BUT these' list. Another yellow circle highlights the 'button1' button below the 'Rename selected event type(s) as type:' label. A large yellow oval encloses the 'Keep only selected events and remove all other events' checkbox at the bottom.

Renaming events



EEGLAB v7.1.7.18b

File Edit Tools Plot Study Datasets Help

Dataset info
Event fields
Event values
About this dataset
Channel locations
Select data
Select data using events
Select epochs or events
Copy current dataset
Append datasets
Delete dataset(s)

ICA weights
Dataset size (Mb)

70
610133
1
1303
250
0.000
2440.528
CZ
Yes
Yes
349

ntinuous -- Rere...

Edit event values -- pop_editeventvals()

Edit event field values (currently 732 events)

Latency (sec) 5.724
Type button1

Delete event

Event Num 3

Insert event << < > >> Append event

Re-order events (for review only)

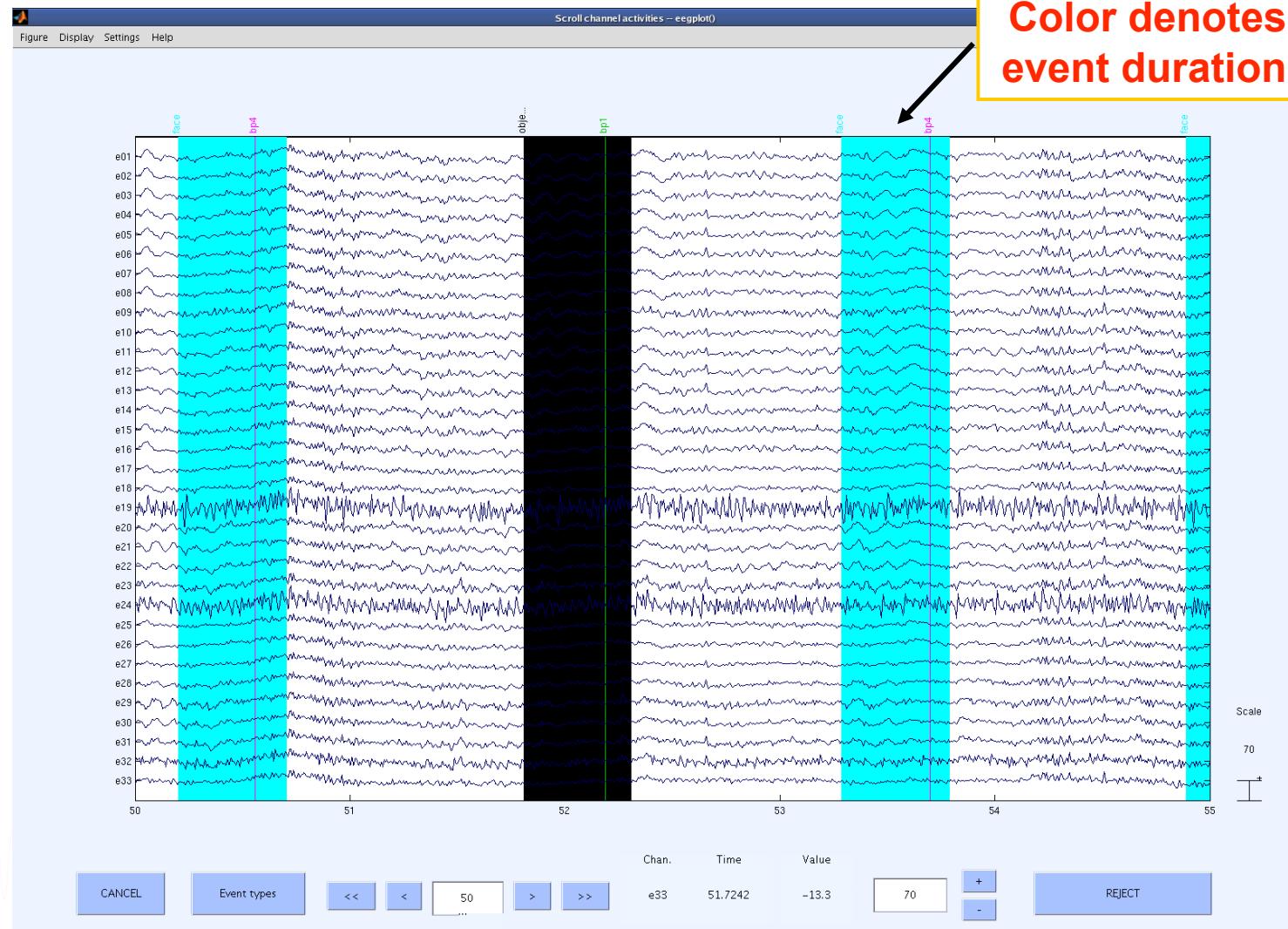
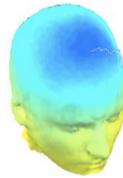
Main sorting field: No field selected Click for decreasing order

Secondary sorting field: No field selected Click for decreasing order

Re-sort

Cancel Help Ok

Event durations



Data importing and channel analysis



Task 1

- Import raw data
- Re-reference data
- Scroll channel data

Task 2

- Import channel location file

Task 3

- Import data events

Task 4

- Extract data epochs
- Select epochs/events

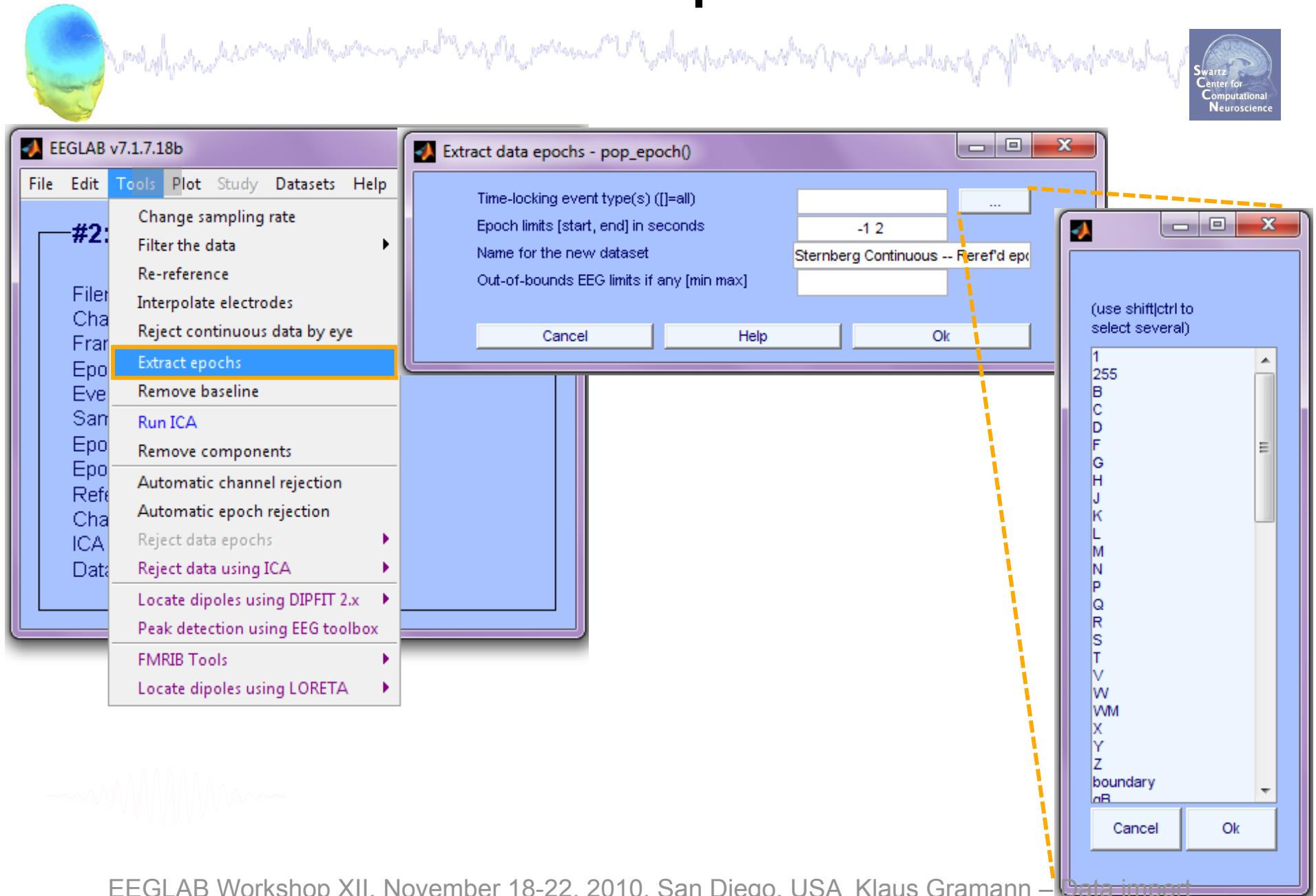
Task 4

- Channel analysis

Exercise...



Extract epochs



Extract epochs



Dataset info -- pop_newset()

What do you want to do with the new dataset?

Name it: Sternberg Response Epochs

Save it as file:

Some changes have not been saved. What?

Overwrite it in memory (set=yes; unset=cancel)

Save it as file:

Cancel

Epoch baseline removal -- pop_rmbase()

Baseline latency range (min_ms max_ms)

-1000

Else, baseline points vector (ex:1:56)
(overwritten by latency range above)

Cancel Help

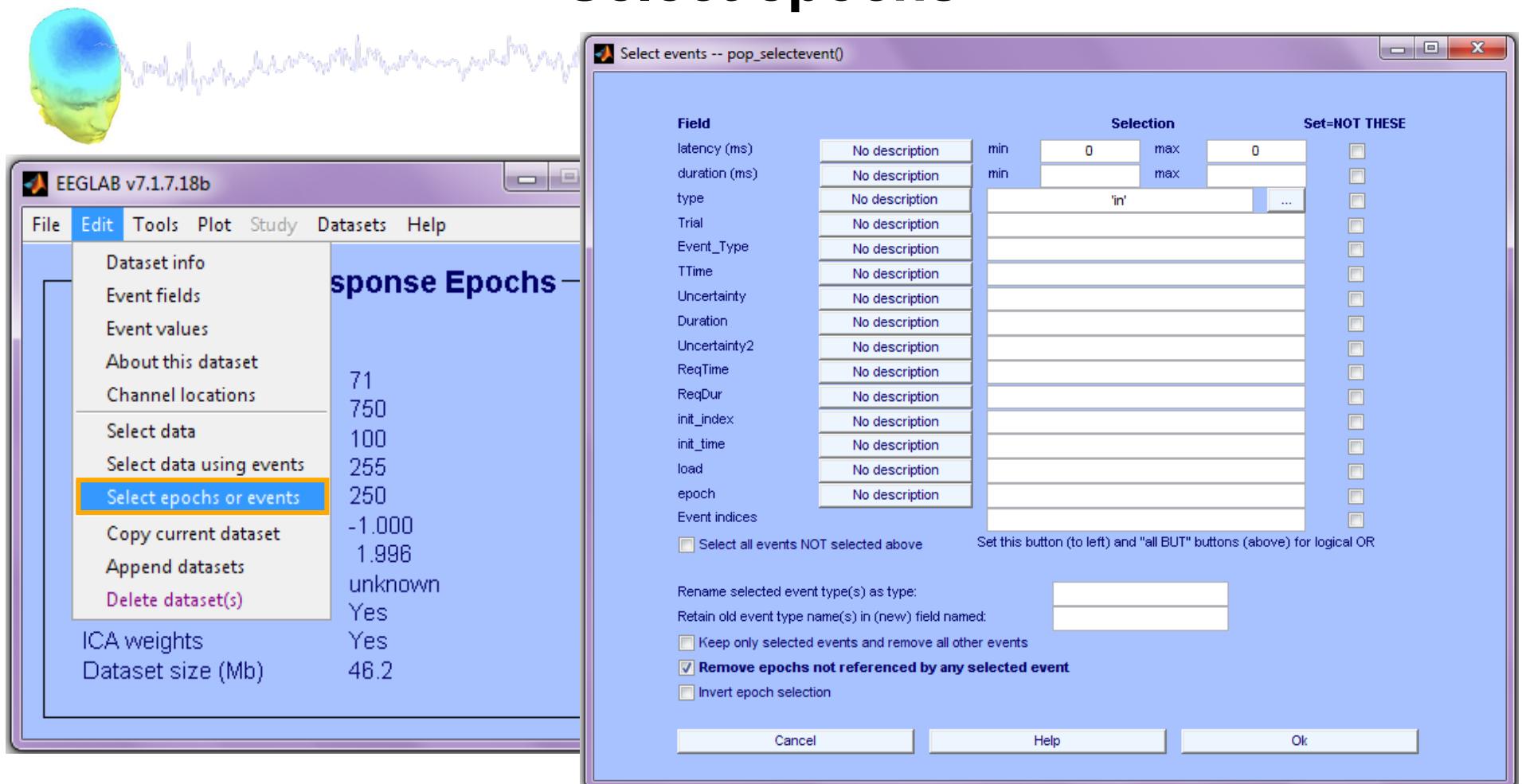
EEGLAB v7.1.7.18b

#2: Sternberg Response epochs

Filename:	none
Channels per frame:	71
Frames per epoch:	750
Epochs:	100
Events:	255
Sampling rate (Hz):	250
Epoch start (sec):	-1.000
Epoch end (sec):	1.996
Reference:	unknown
Channel locations:	Yes
ICA weights:	Yes
Dataset size (Mb):	46.2

```
EEG = pop_epoch ( EEG, {'out', 'in' }, ...
[-1 2], 'newname',...
'Sternberg Continuous -- Reref'd epochs',...
'epochinfo', 'yes');
[ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, ...
EEG, 2,'setname','Sternberg Response Epochs',...
'gui', 'off');
EEG = pop_rmbase ( EEG, [-1000 0]);
```

Select epochs



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

Select epochs with specific events



EEGLAB v7.2.7.18b

File Edit Tools Plot Study Datasets Help

Dataset info
Event fields
Event values
About this dataset
Channel locations
Select data
Select data using events
Select epochs or events
Copy current dataset
Append datasets
Delete dataset(s)
Channel locations
ICA weights
Dataset size (Mb)

probe
Data
71
1500
100
346
250
-1.000
4.996
unkno
Yes
Yes
89.2

Select events -- pop_selectevent()

Field Selection Set=NOT THESE

Field	Description	min	Selection	max	Set=NOT THESE
latency (ms)	No description	0	0	5000	<input type="checkbox"/>
duration (ms)	No description				<input type="checkbox"/>
type	No description				<input type="checkbox"/>
Trial	No description				<input type="checkbox"/>
Event_Type	No description				<input type="checkbox"/>
TTime	No description				<input type="checkbox"/>
Uncertainty	No description				<input type="checkbox"/>
Duration	No description				<input type="checkbox"/>
Uncertainty2	No description				<input type="checkbox"/>
ReqTime	No description				<input type="checkbox"/>
ReqDur	No description				<input type="checkbox"/>
init_index	No description				<input type="checkbox"/>
init_time	No description				<input type="checkbox"/>
load	No description				<input type="checkbox"/>
epoch	No description				<input type="checkbox"/>
Event indices	No description				<input type="checkbox"/>

Event selection

Select all events NOT selected above (Set this button and "all BUT" buttons (above) for logical OR)

Keep only selected events and remove all other events

rename selected event type(s) as type:

retain old event type name(s) in (new) field named:

selection

Remove epochs not referenced by any selected event

Invert epoch selection

Confirmation

Warning: delete 44 (out of 100) un-referenced epochs ?

Cancel Ok

Help Cancel Ok

Repeat for ‘out-of-set’ responses



Save without overwriting and go back to all epochs

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 do?

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

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

Help

Select events -- pop_selectevent()

Field	Selection	Set=NOT THESE
latency (ms)	No description	<input type="checkbox"/>
duration (ms)	No description	<input type="checkbox"/>
type	No description	<input type="checkbox"/>
Trial	No description	<input type="checkbox"/>
Event_Type	No description	<input type="checkbox"/>
TTime	No description	<input type="checkbox"/>
Uncertainty	No description	<input type="checkbox"/>
Duration	No description	<input type="checkbox"/>
Uncertainty2	No description	<input type="checkbox"/>
ReqTime	No description	<input type="checkbox"/>
ReqDur	No description	<input type="checkbox"/>
init_index	No description	<input type="checkbox"/>
init_time	No description	<input type="checkbox"/>

min 0 max 5000
min max 'out' ...

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

named:
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

Save it as file:

Edit description Browse

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

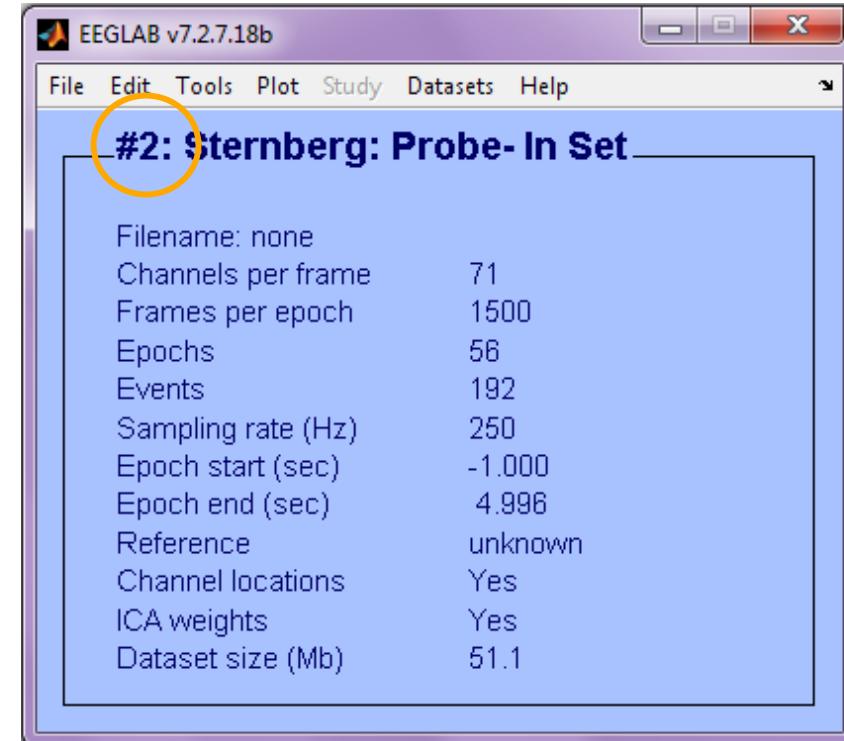
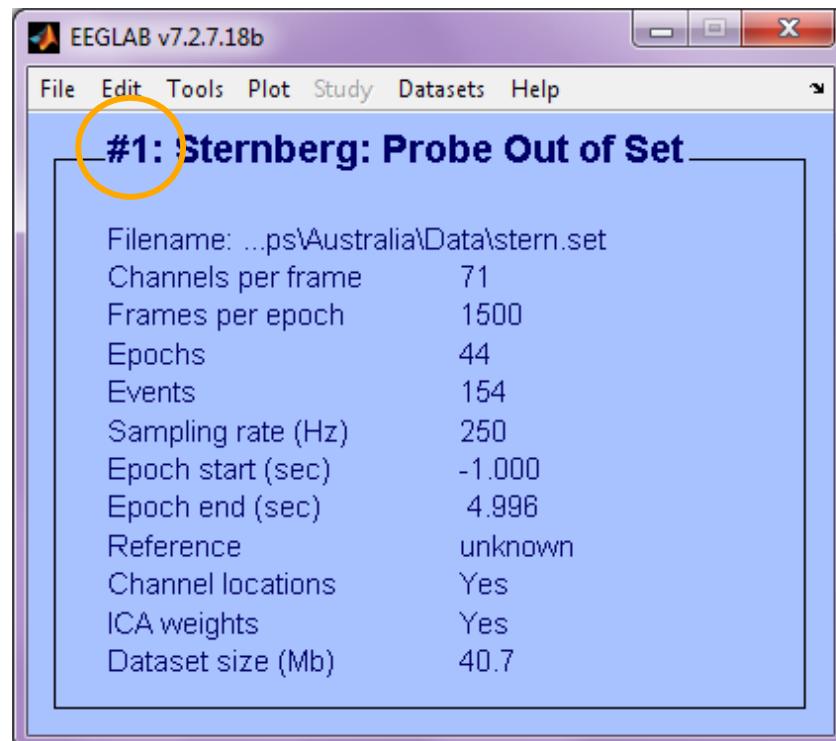
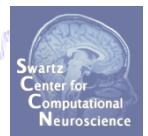
Overwrite it in memory (set=yes; unset=create a new dataset)

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

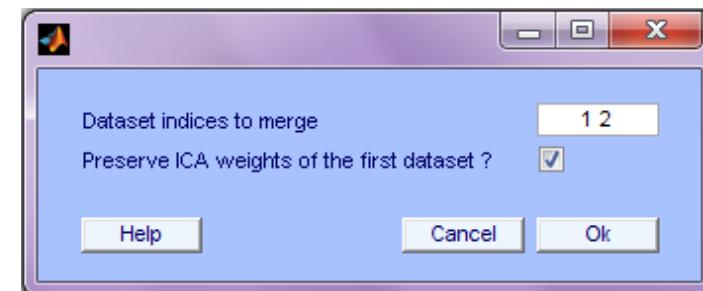
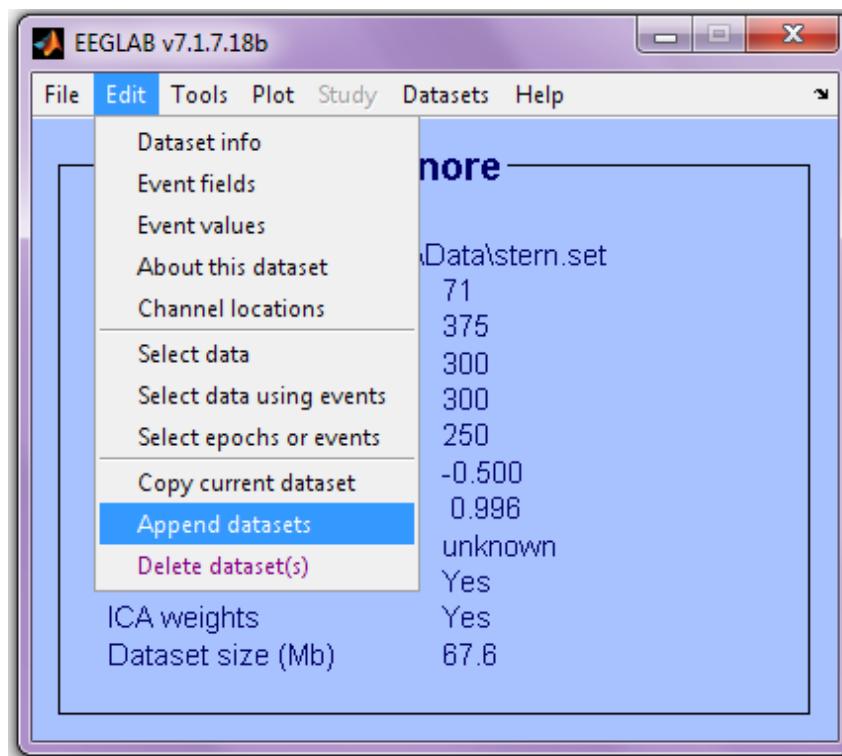
Browse

Help Cancel Ok

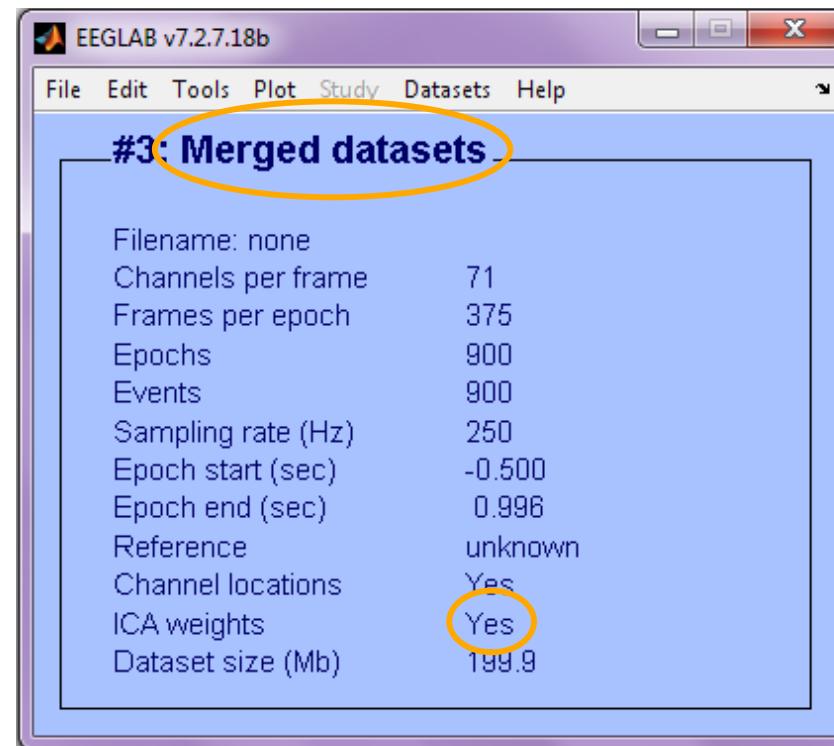
Separate datasets with different conditions



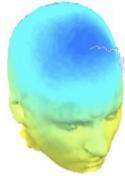
Merge (append) datasets



Merged datasets



Data importing and channel analysis



Task 1

- Import raw data
- Re-reference data
- Scroll channel data

Task 2

- Import channel location file

Task 3

- Import data events

Task 4

- Extract data epochs
- Select epochs/events

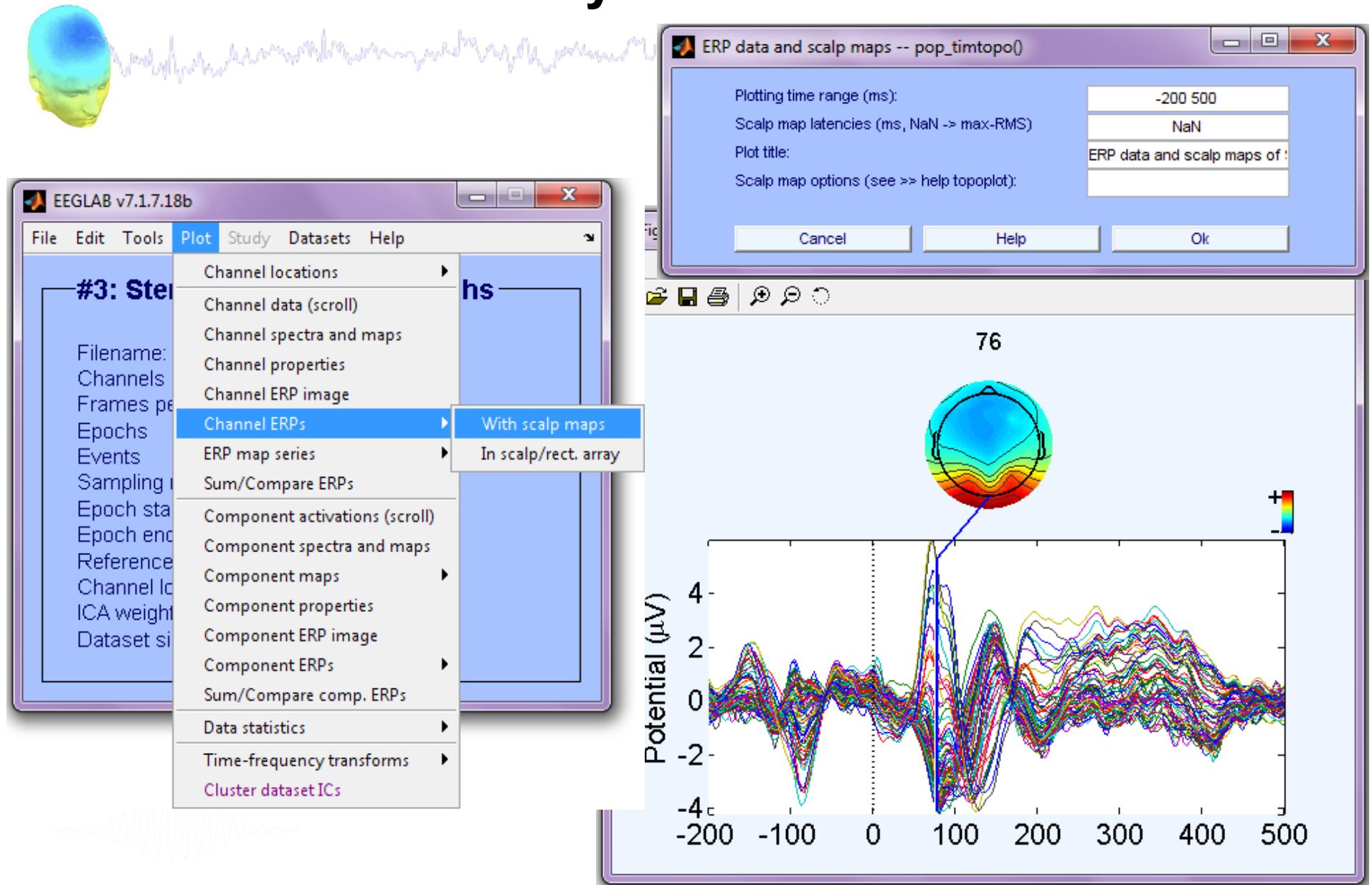
Task 4

- Channel analysis

Exercise...

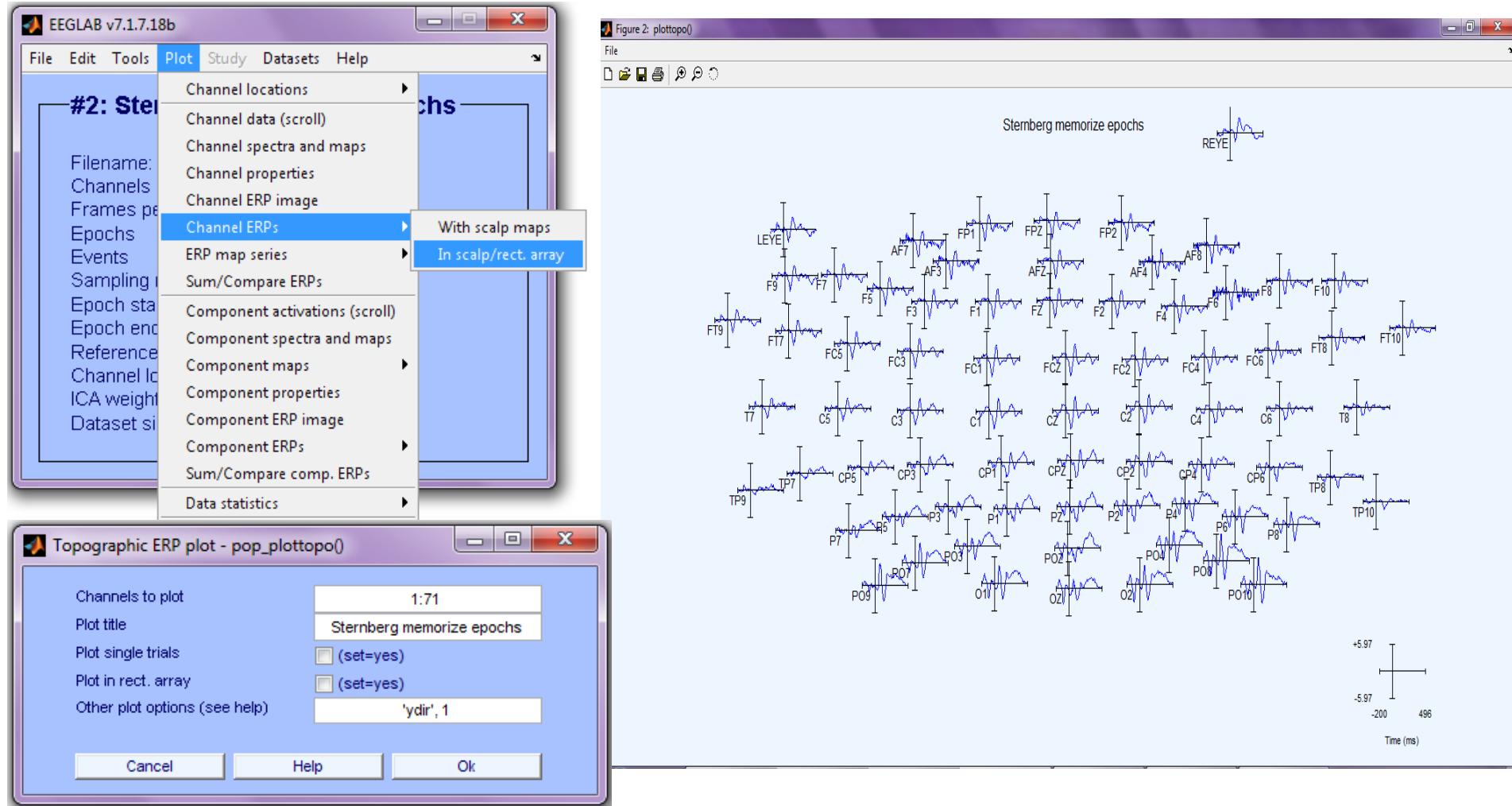
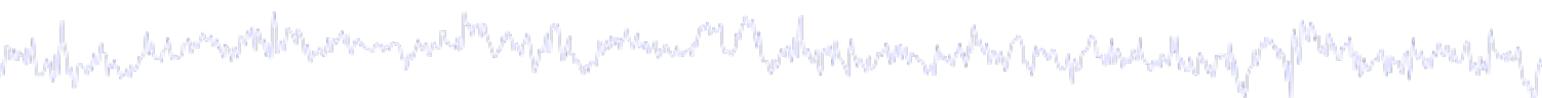


Analysis of ERPs

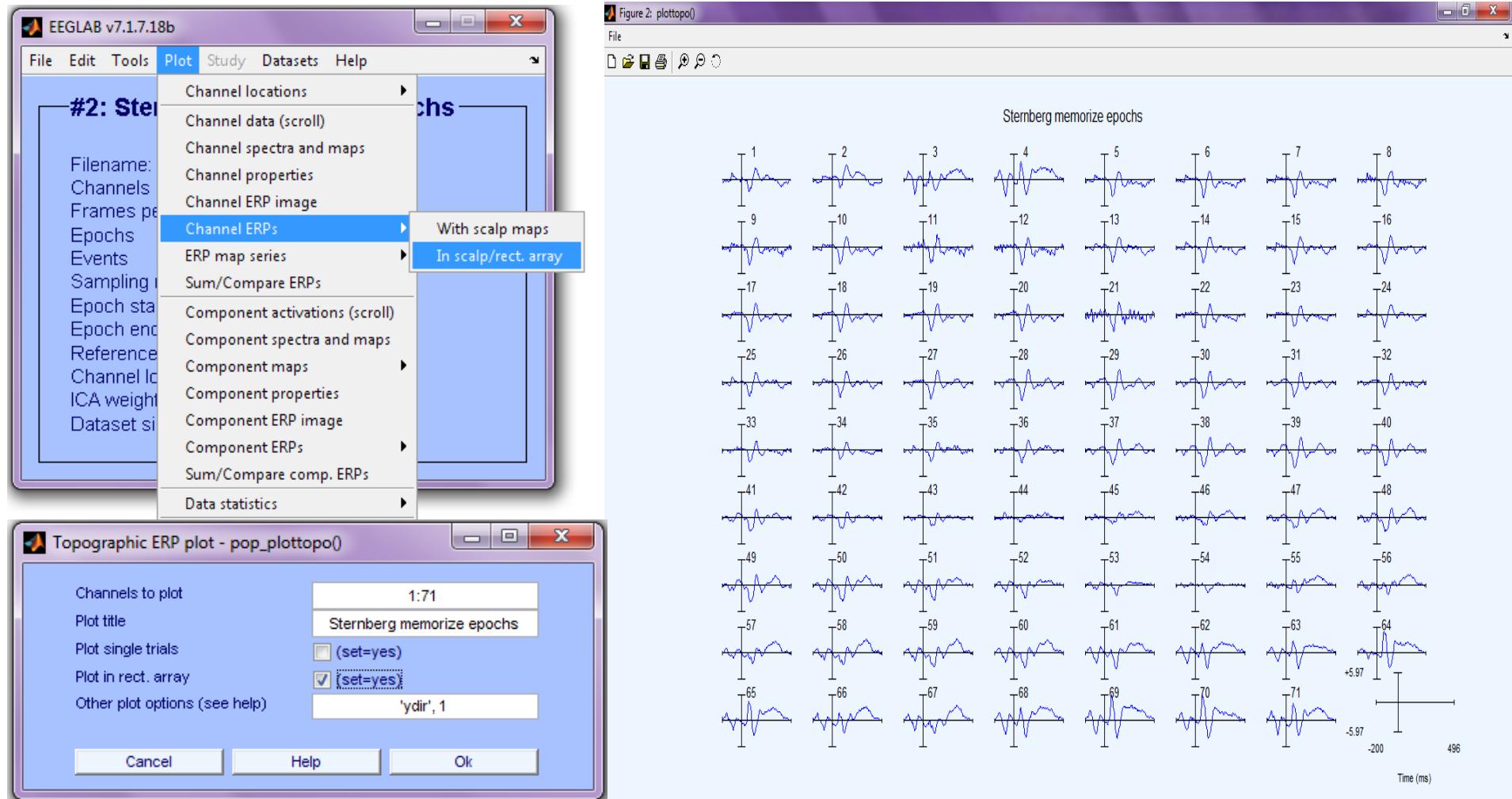


```
>> pop_timtopo(EEG, [-200 500], [NaN], 'ERP data and scalp maps');
```

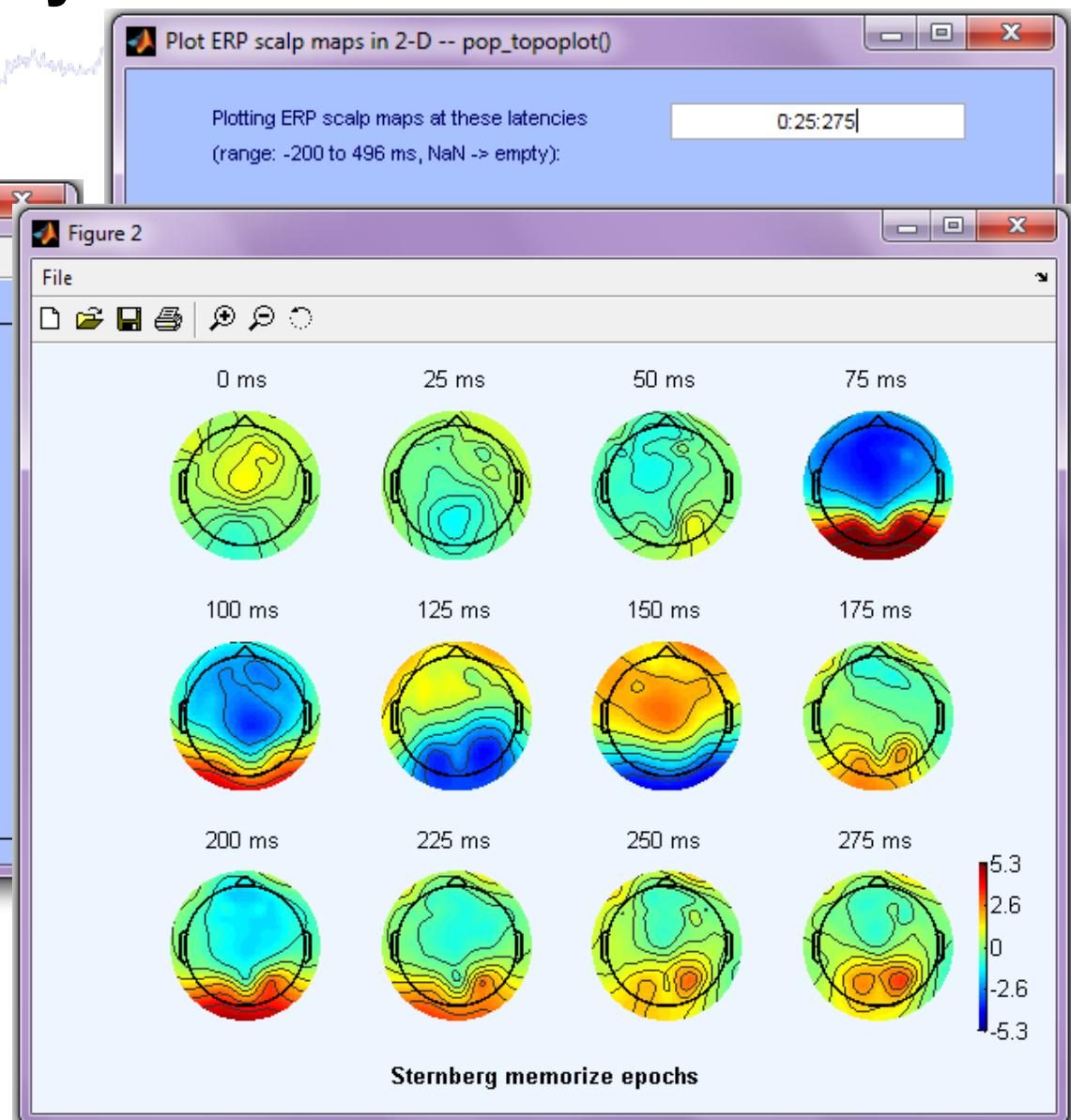
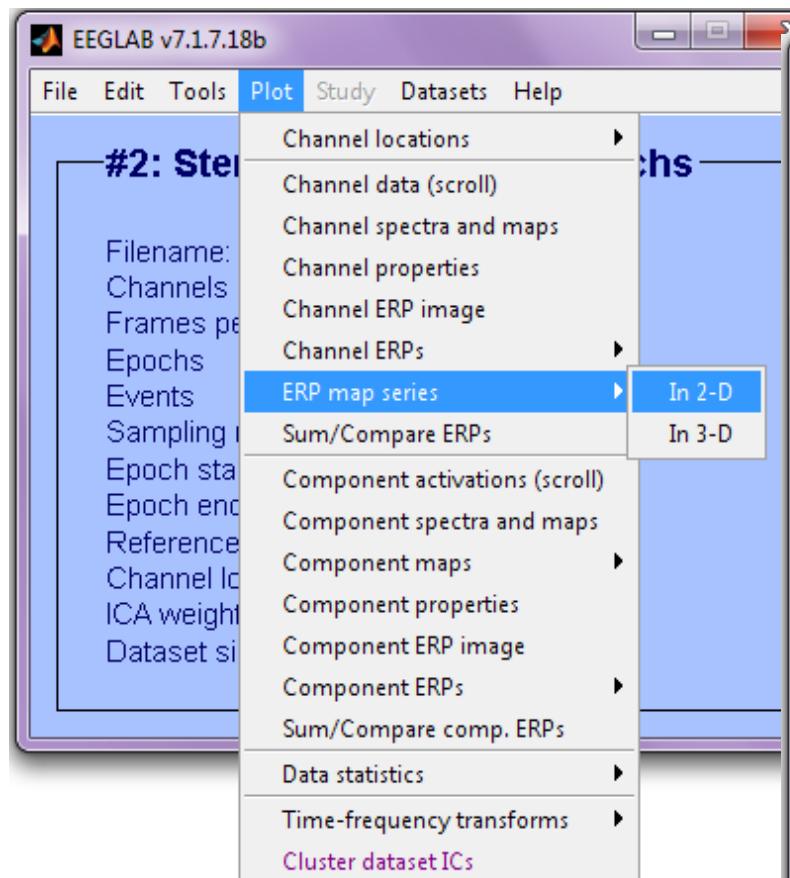
Analysis of ERPs



Channel ERP in rectangular array



Analysis of ERPs



```
pop_topoplot(EEG,1,[0:25:275], 'Memorize', [3 4], 0, 'electrodes', 'off');
```

Compare ERPs across conditions



EEGLAB v7.1.7.18b

File Edit Tools Plot Study Datasets Help

#2: Sternberg N

Dataset 1:Sternberg Continuous Data
✓ Dataset 2:Sternberg Memorize epochs
Dataset 3:Sternberg Ignore epochs
Select multiple datasets

Filename:	none
Channels per frame	
Frames per epoch	175
Epochs	600
Events	600
Sampling rate (Hz)	250
Epoch start (sec)	-0.200
Epoch end (sec)	0.496
Reference	unknown
Channel locations	Yes
ICA weights	Yes
Dataset size (Mb)	64.5

How do 'Memorize'
and 'Ignore' ERPs
differ?



Compare ERPs across conditions



#2: Step

EEGLAB v7.1.7.18b

File Edit Tools Plot Study Datasets Help

ERP grand average/RMS - pop_comperp0

Compare ERPs from two conditions

Datasets to average (ex: 1 3 4): 2 3 avg. std. all ERPs

Datasets to average and subtract (ex: 5 6 7):

Plot difference

Channels subset ([]=all):

Highlight significant regions (.01 -> p=.01)

Use RMS instead of average (check):

Low pass (Hz) (for display only): 20

Plottopo options ('key', 'val'): 'ydir', 1

Cancel Help Ok

Sum/Compare ERPs

Component activation

Component spectra

Component maps

Component properties

Component ERPs

Component ERPs

Sum/Compare components

Data statistics

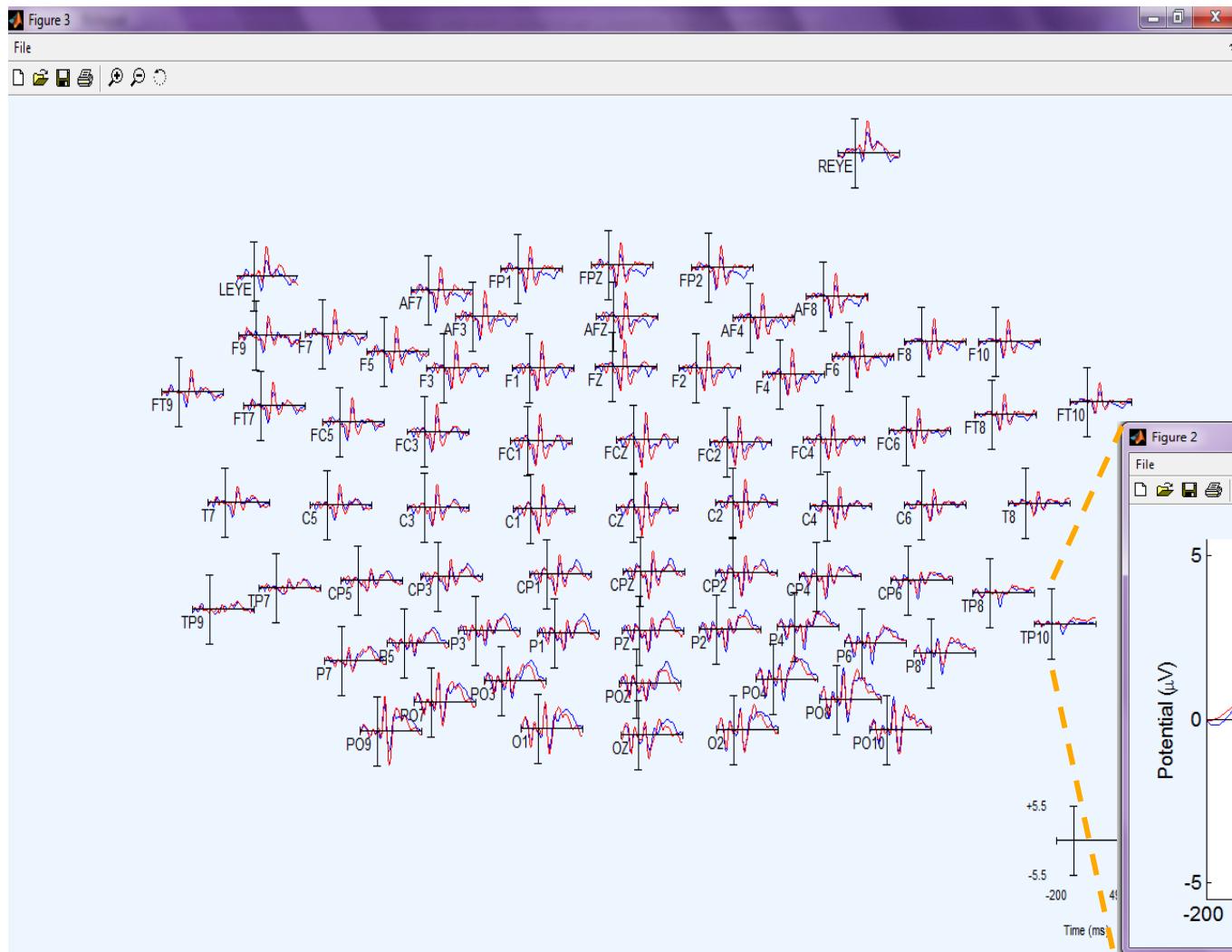
Time-frequency transforms

Cluster dataset ICs

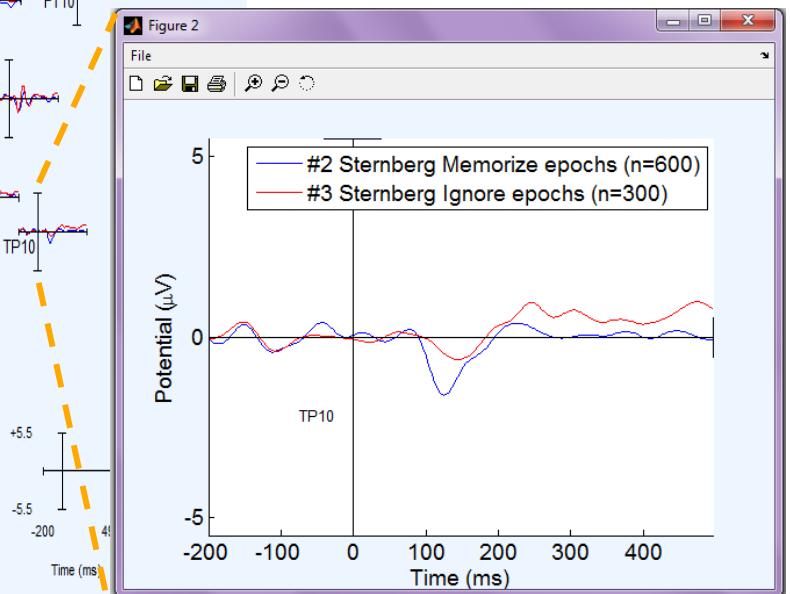
```
>>pop_comperp(ALLEEG,1,[2 3],[],'addavg','off','addstd','off',...
    'addall','on','diffavg','off','diffstd','off','lowpass',20,...
    'tplotopt',{'ydir',1});
```

EEGLAB Workshop XII, November 18-22, 2010, San Diego, USA Klaus Gramann – Data import

Compare ERPs across conditions



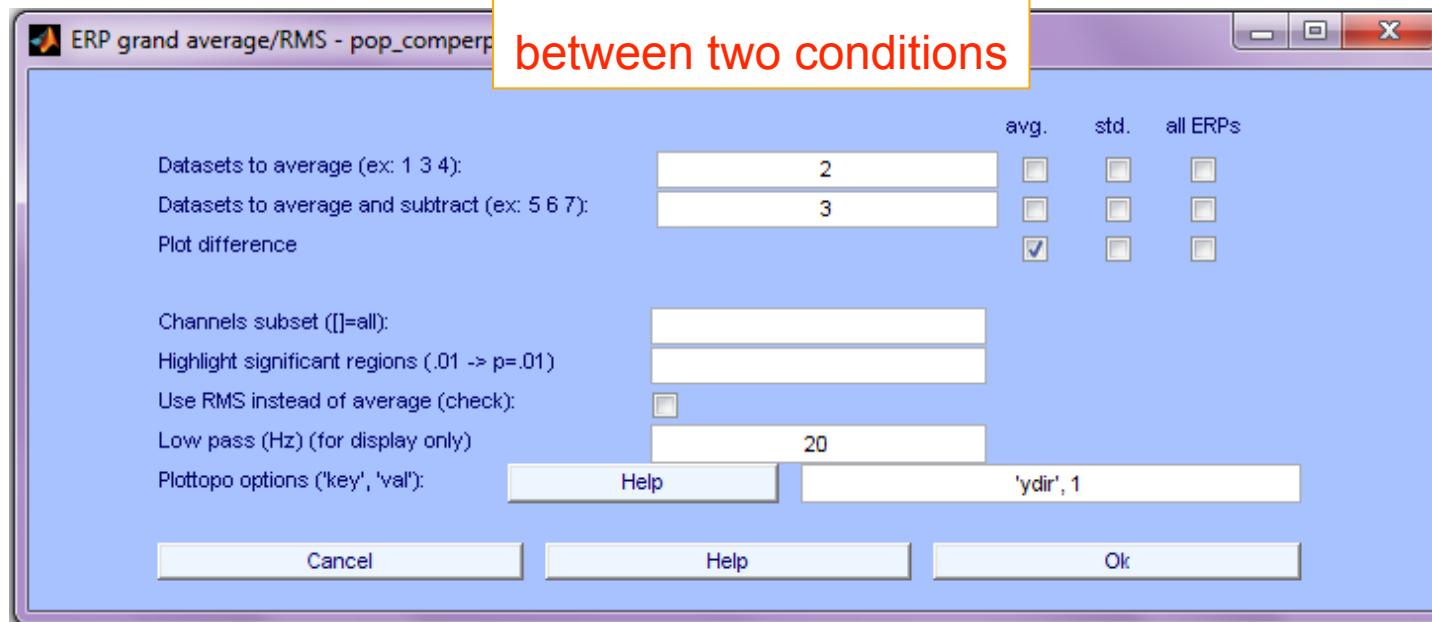
Click on an axis
to see larger image



Analysis of ERP differences

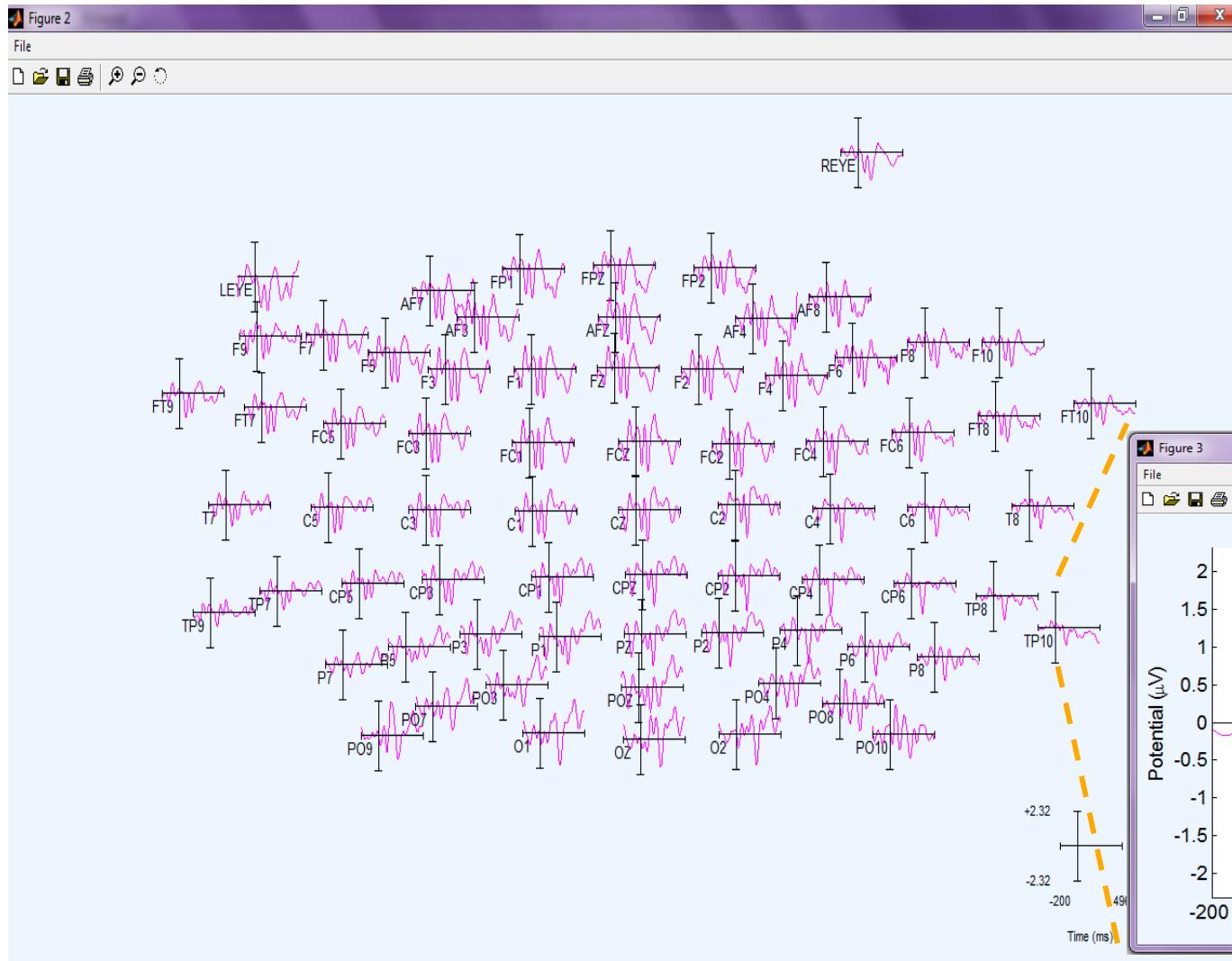


Plot difference
between two conditions

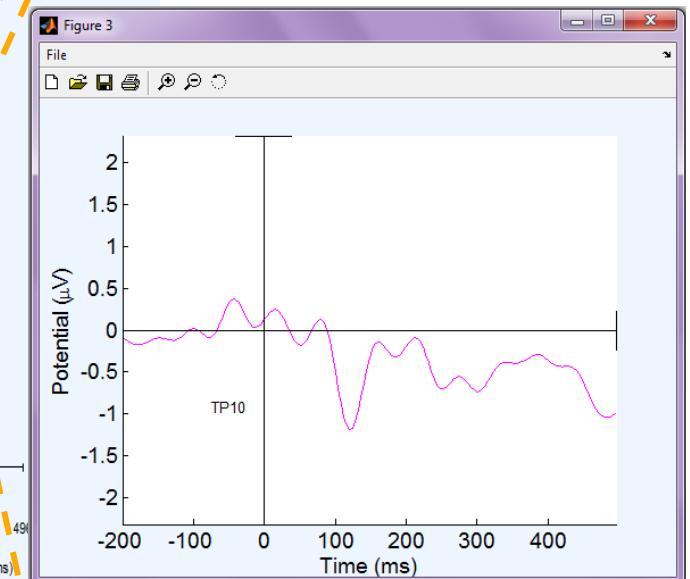


```
>> pop_comperp(ALLEEG,1, 2, 3,'addavg','off',...
    'addstd','off', 'diffavg','on','diffstd','off', ...
    'lowpass',20, 'tplotopt',{'ydir',1});
```

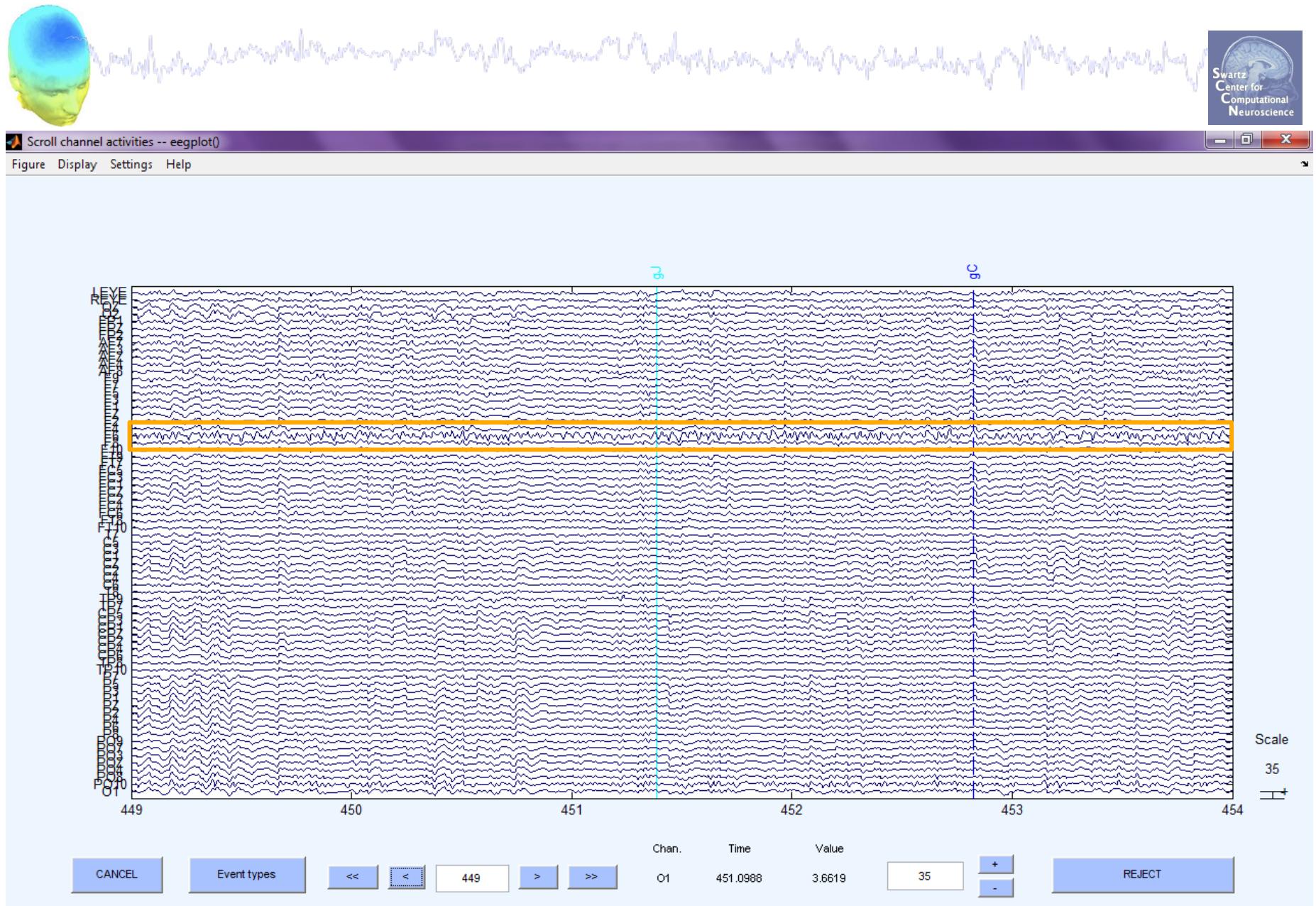
Analysis of ERP differences



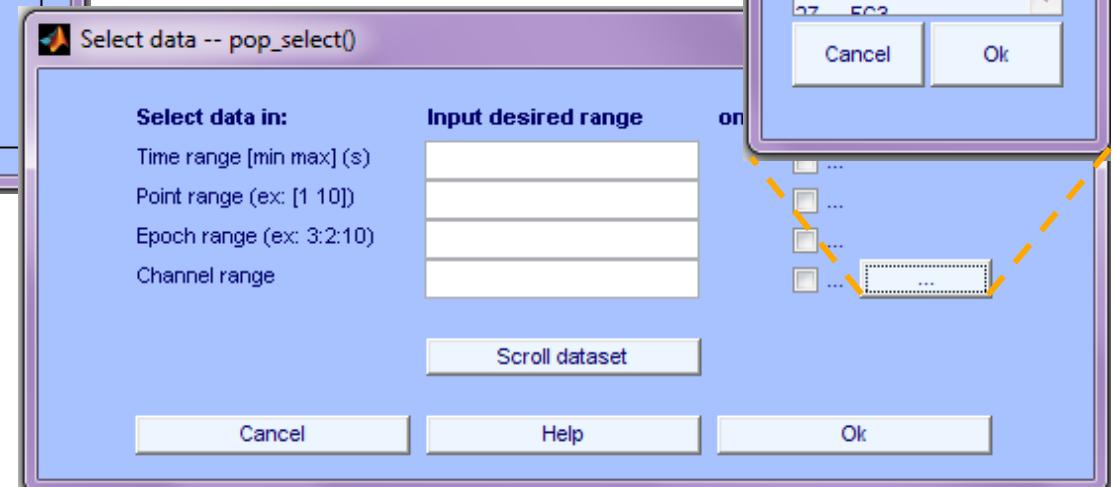
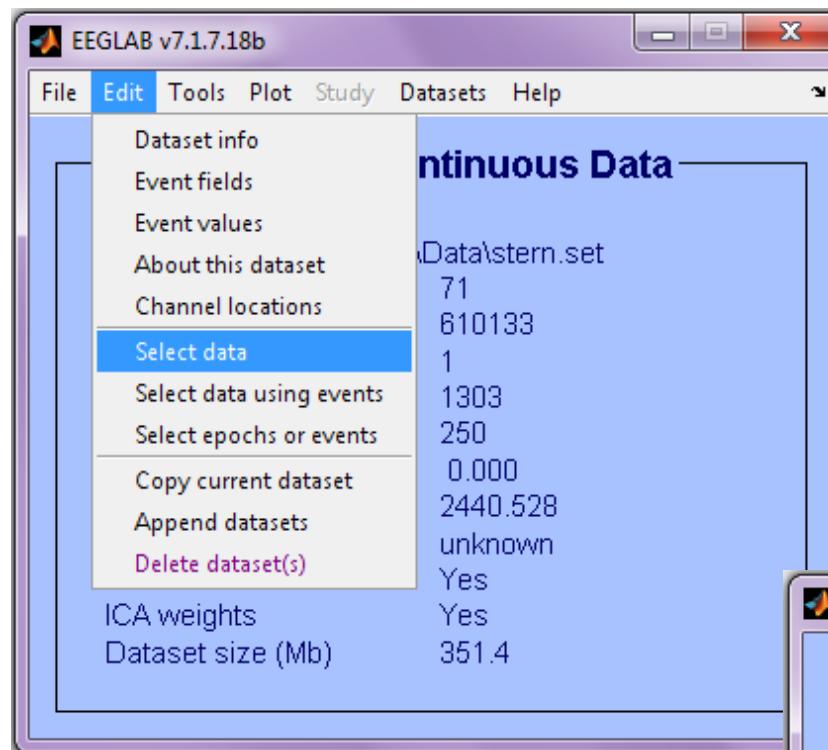
ERP
difference
between
2 conditions



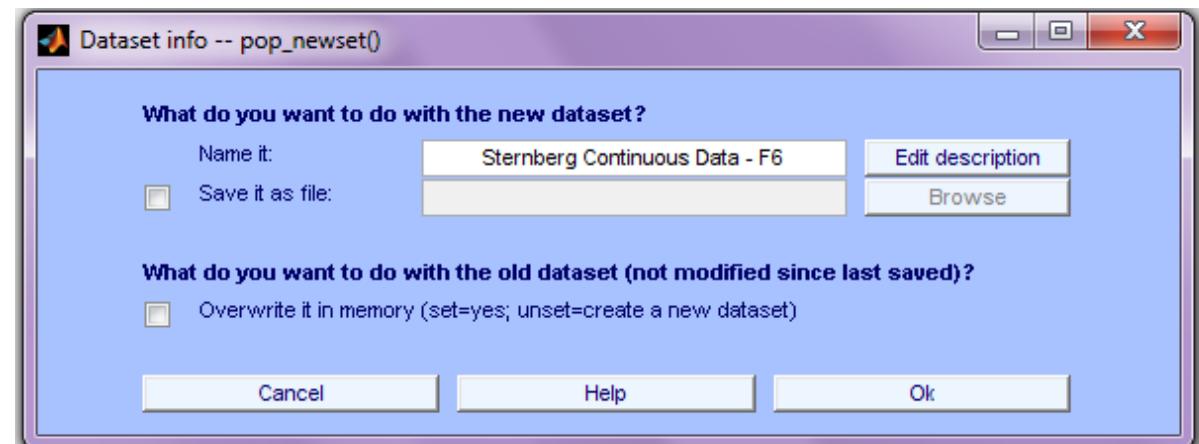
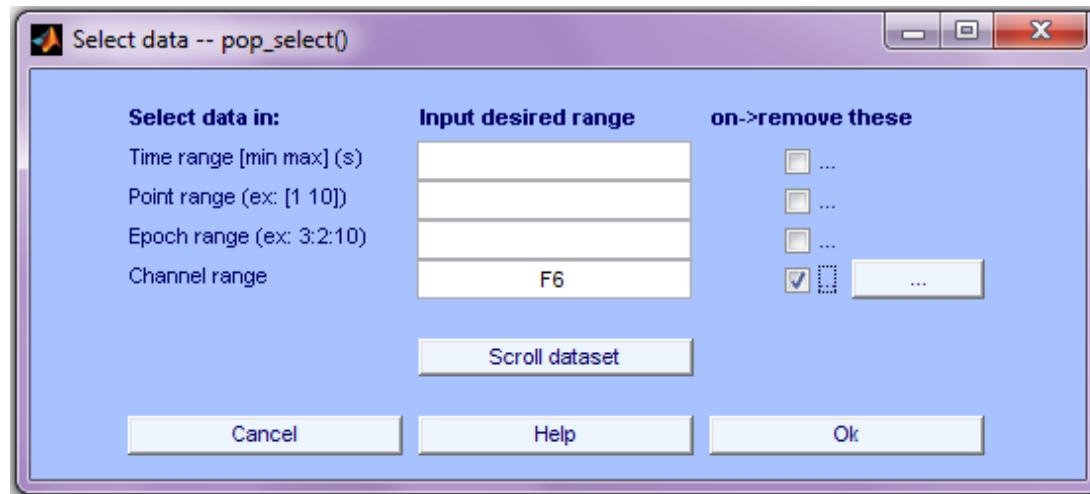
Remove channel



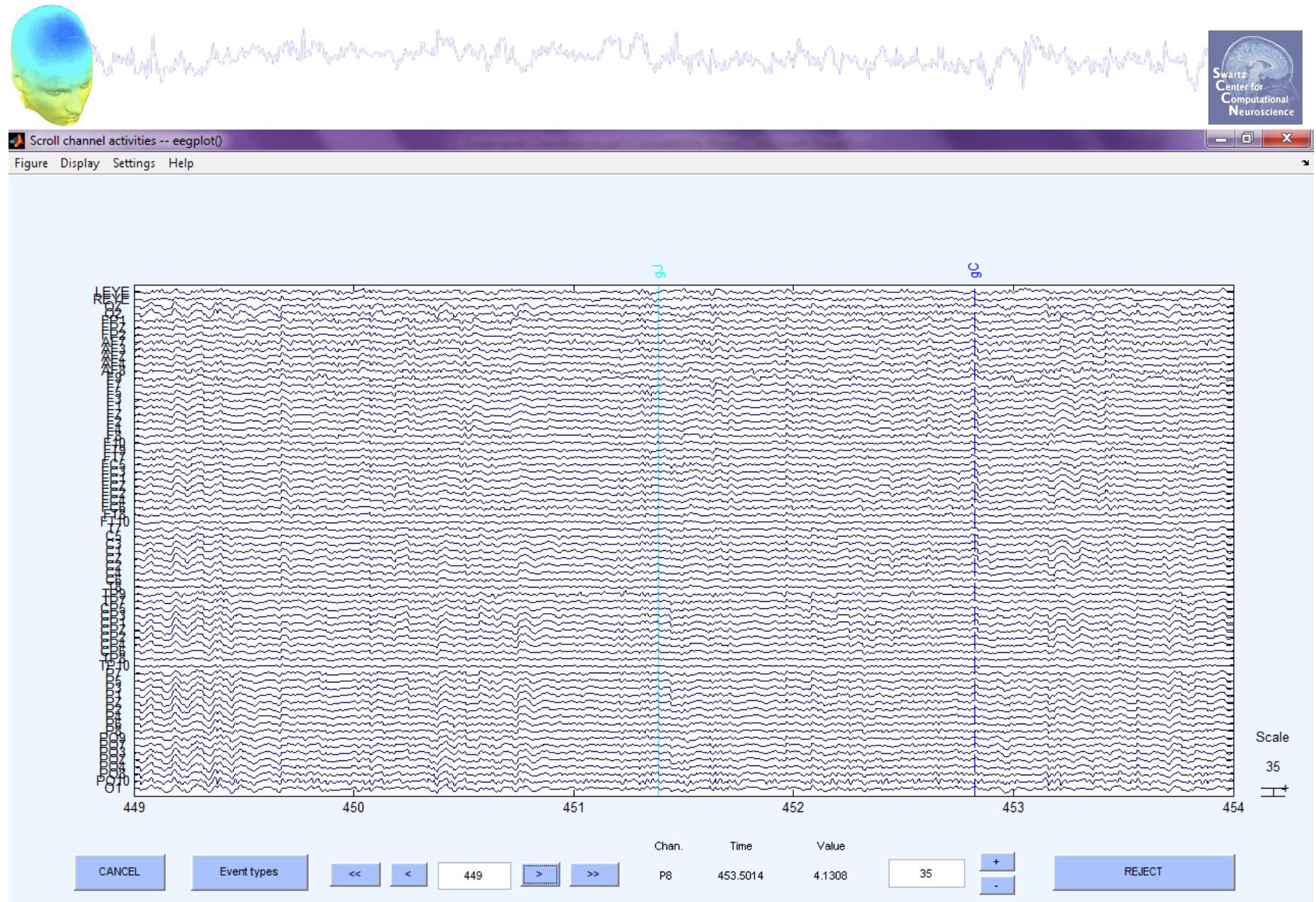
Remove channel(s)



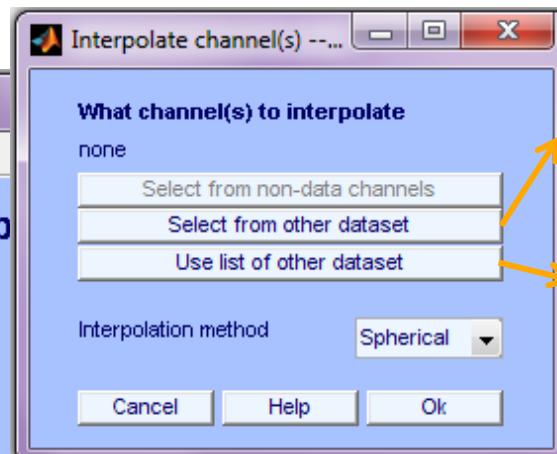
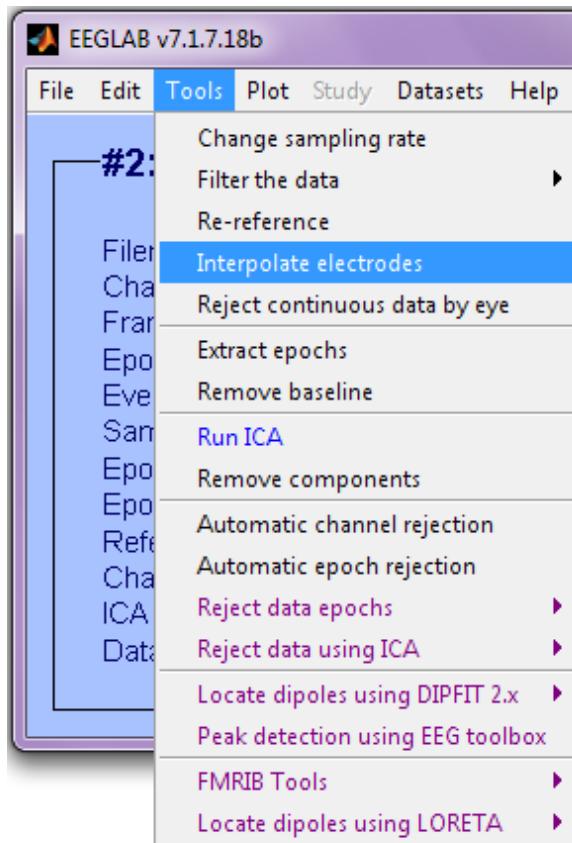
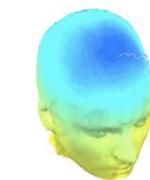
Removing channel(s)



Channel removed

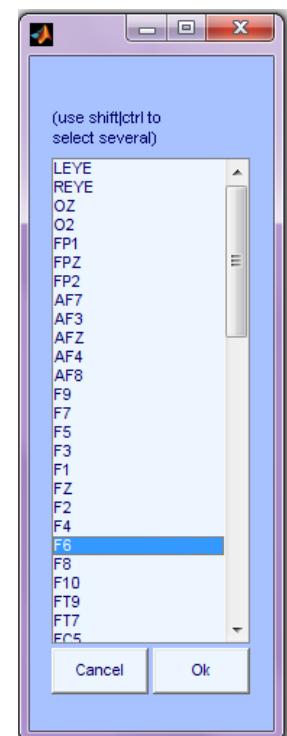
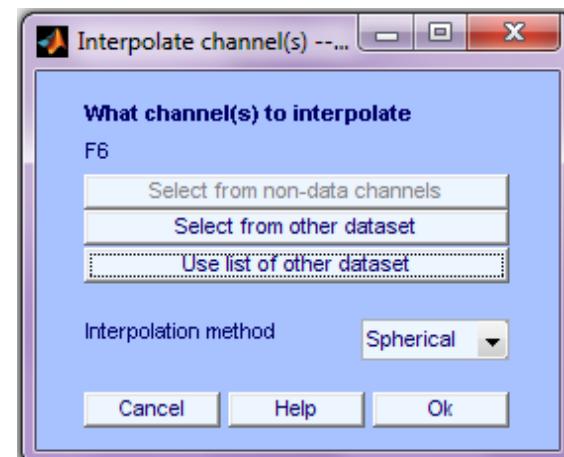
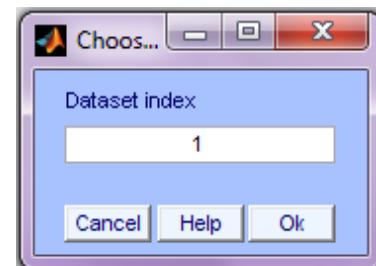


Interpolate bad channel

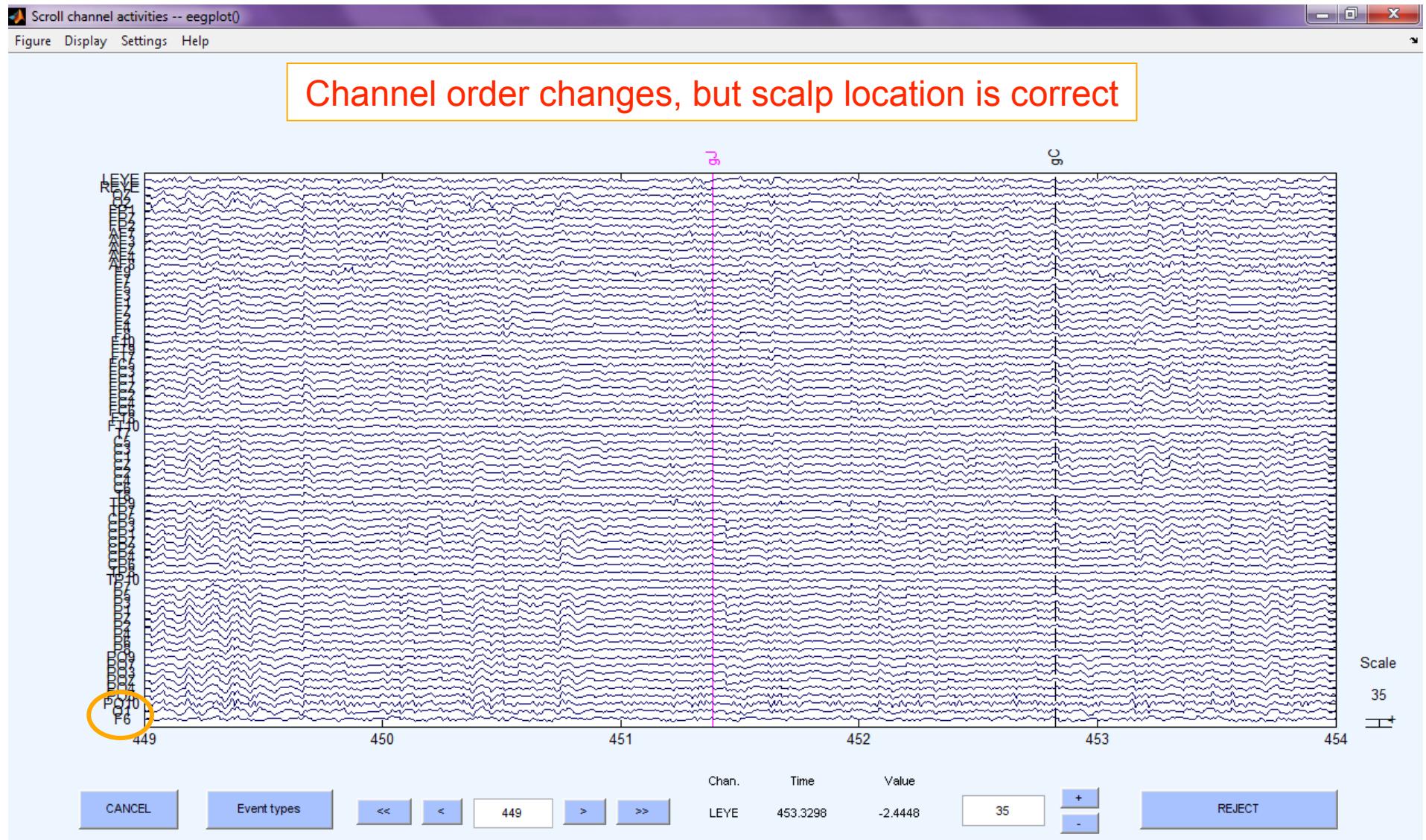


Choose a channel from other dataset

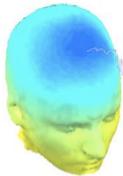
Auto-select deleted
channel from other dataset



Interpolated channel



Exercise



- **ALL**
 - Load stern.set
 - Do not save your changes under the same filename!
- **Novice**
 - Re-reference the data to Cz.
 - Scroll data and explore plotting options under 'Settings'.
- **Intermediate**
 - Review events in Edit->Event values, rename an event in Select epochs/events.
 - Remove a channel and then replace it by interpolation.
- **Advanced**
 - Epoch the data on Memorize and Ignore letters separately, then use pop_comperp to compare ERPs between conditions.
 - Explore other menu options.