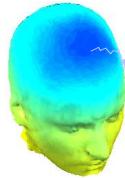


# Data import and preprocessing



## 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

- Analysis of ERPs
- Export EEG data

## Task 6

- Reject badchannels

## Task 7

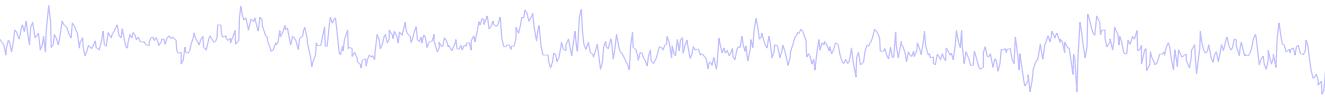
- Reject continuous data

## Task 8

- Reject data epochs

Exercise...

# Data import and preprocessing



## 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

- Analysis of ERPs
- Export EEG data

## Task 6

- Reject badchannels

## Task 7

- Reject continuous data

## Task 8

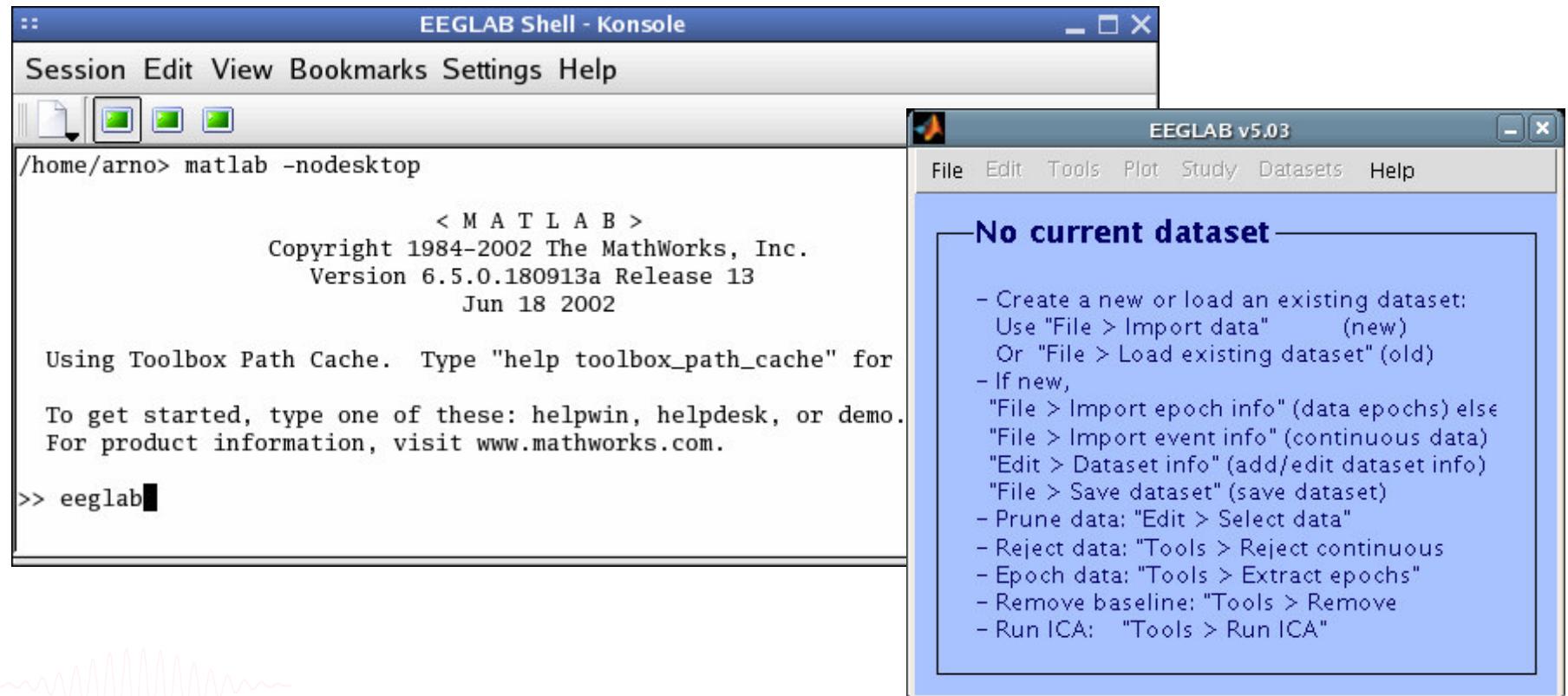
- Reject data epochs

Exercise...

# The EEGLAB Matlab software

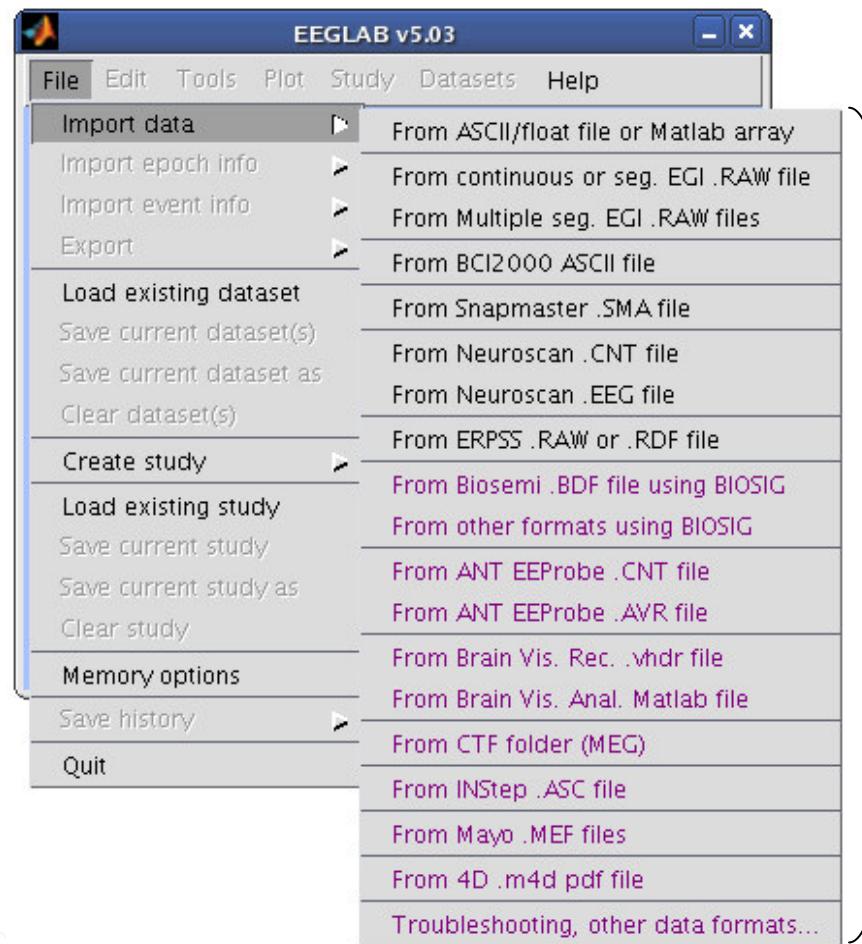
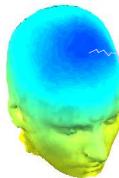


## main graphic interface



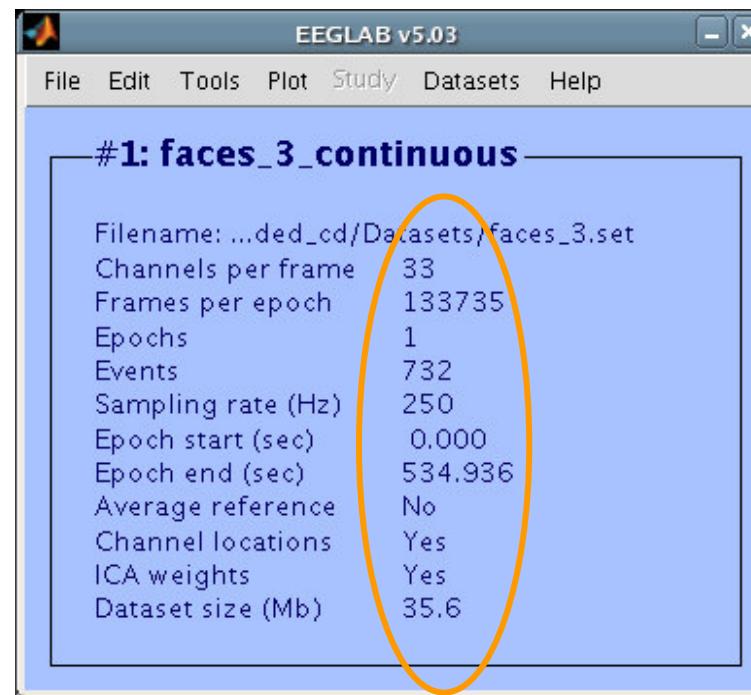
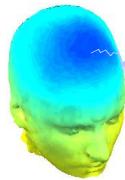
60 menus, more than 300 Matlab functions and more than 50,000 lines of code

# Importing a dataset

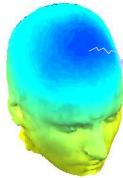


**EEGLAB supports many  
different raw data formats**

# Imported EEG data



# The example data: faces vs. objects



## File

`../data/faces_3.set`

## Data

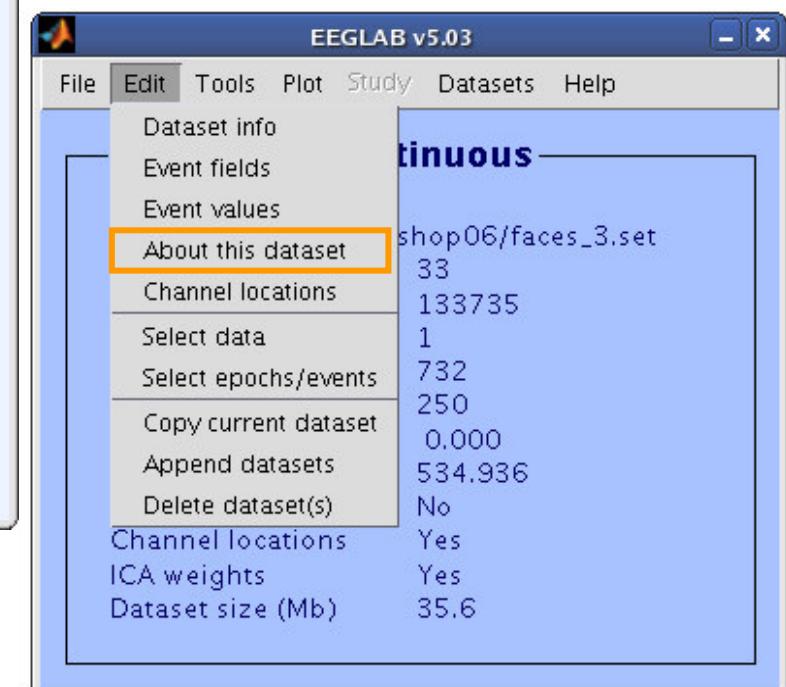
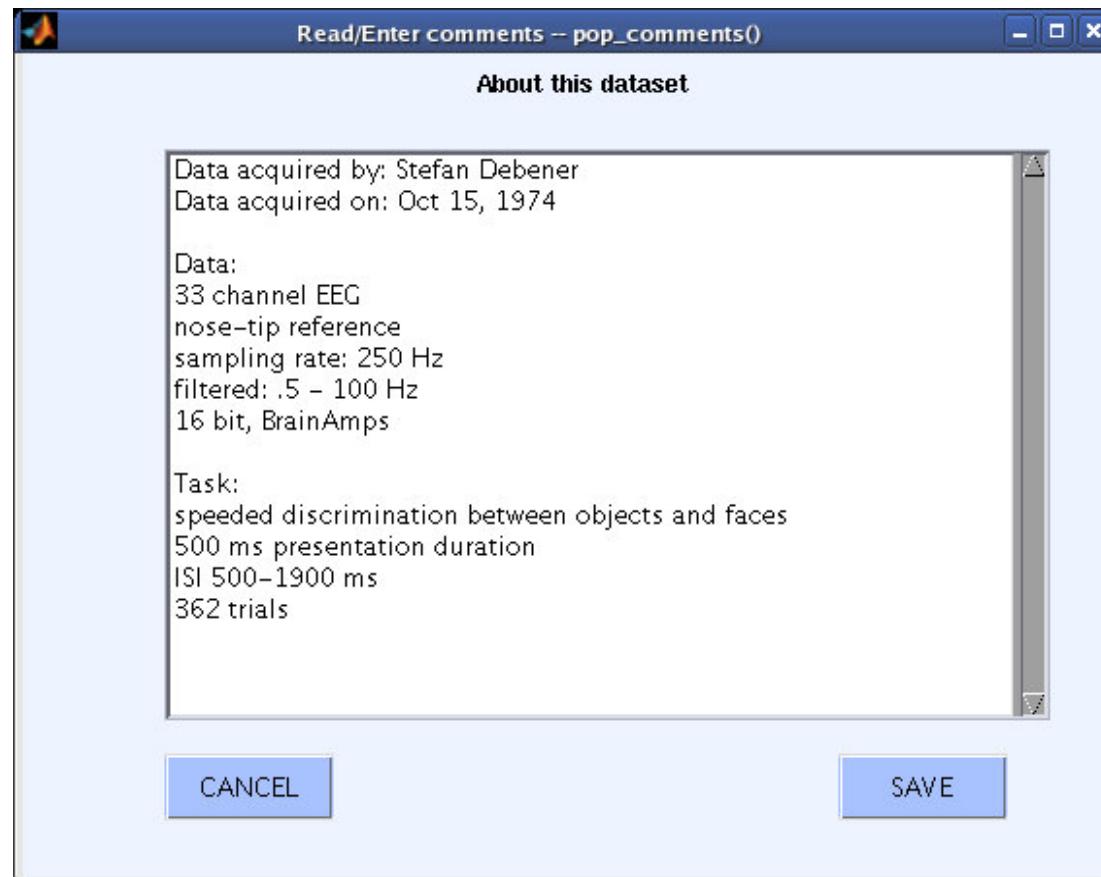
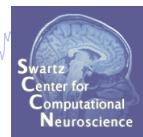
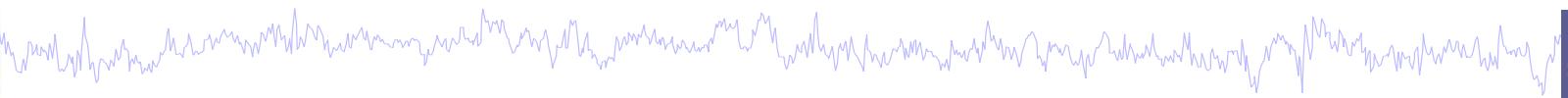
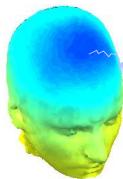
33 channel EEG, nose-tip reference, 250 Hz sampling rate, 0.5-100 Hz, 16 bit, BrainAmps

## Task

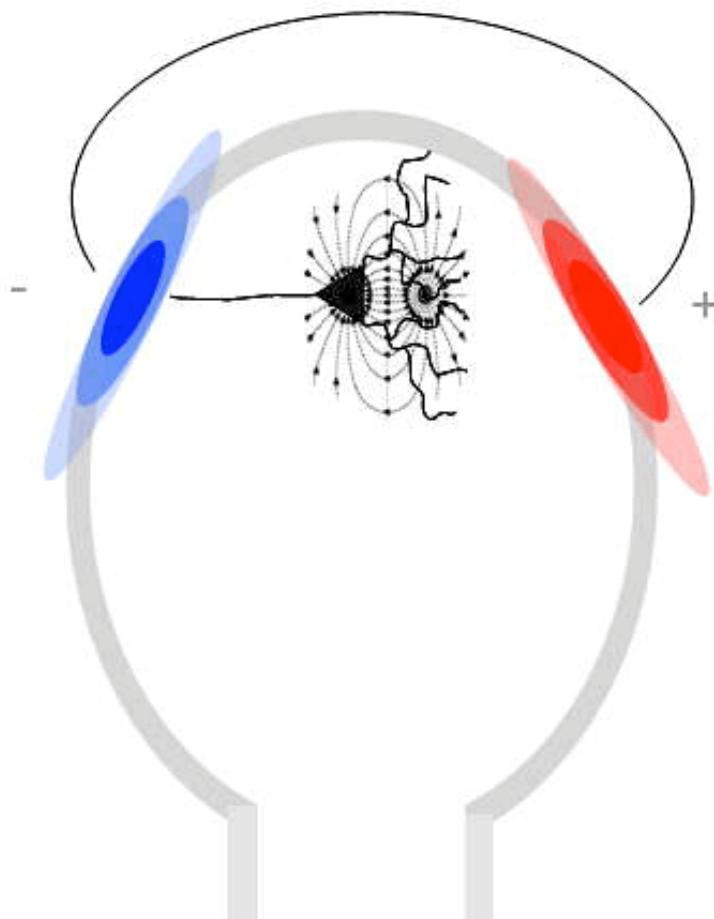
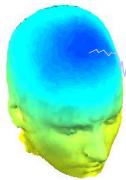
speeded discrimination between objects and faces,  
500 ms presentation duration, ISI 500-1900 ms,  
362 trials



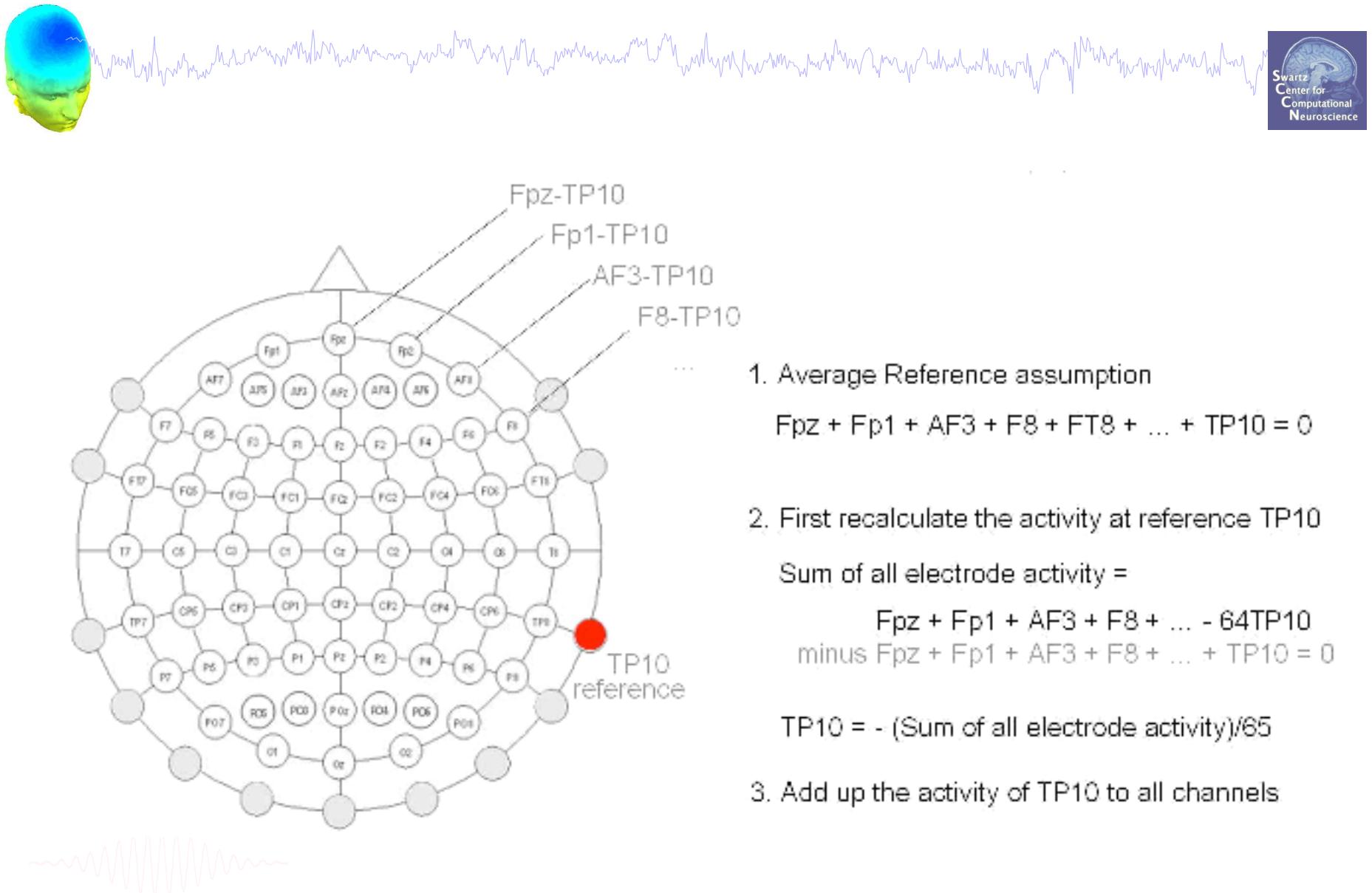
# Comments



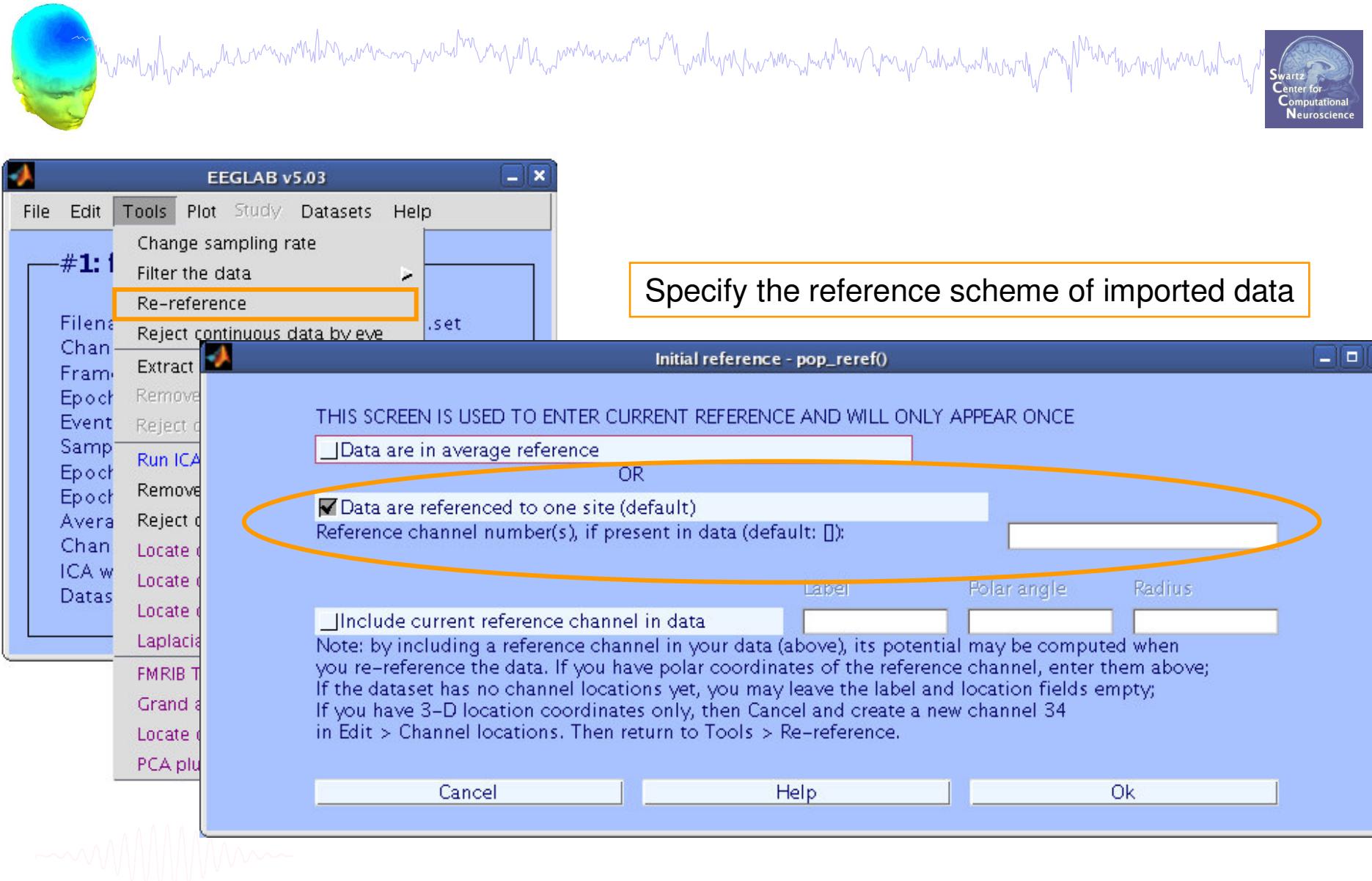
# Re-reference data



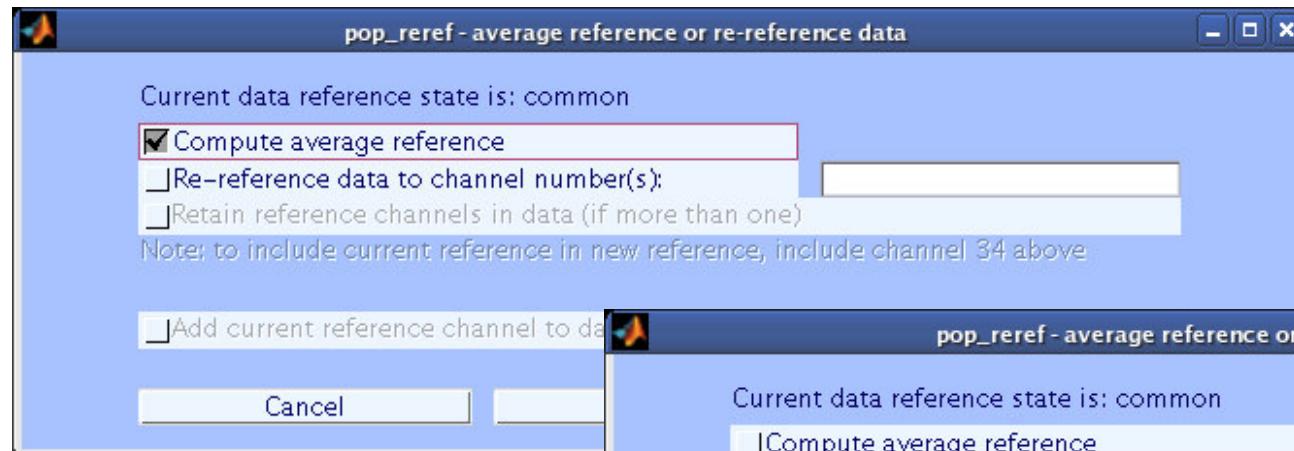
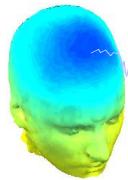
# Re-reference data



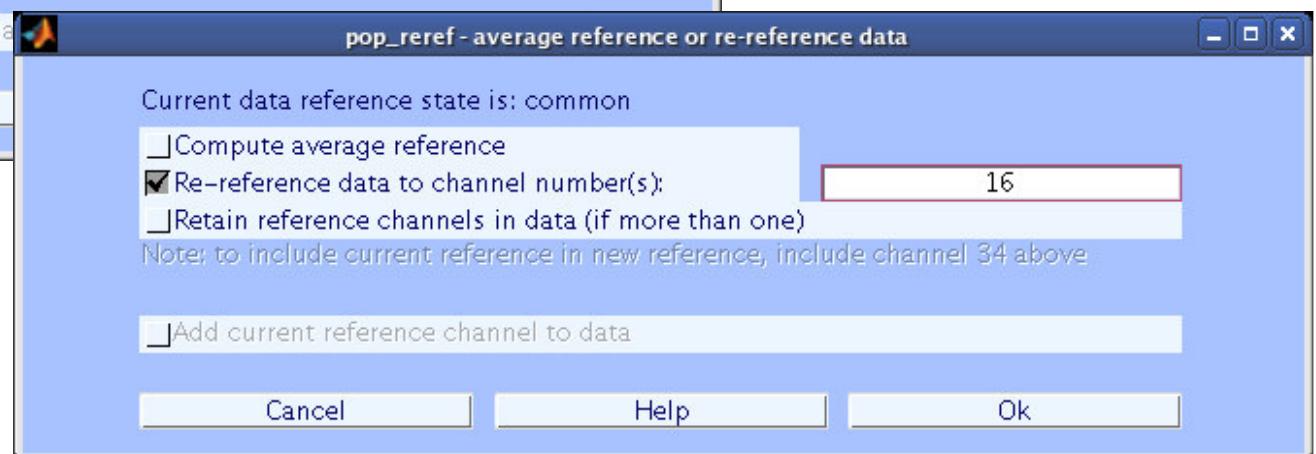
# Re-reference data



# Rerefencing, cont'd



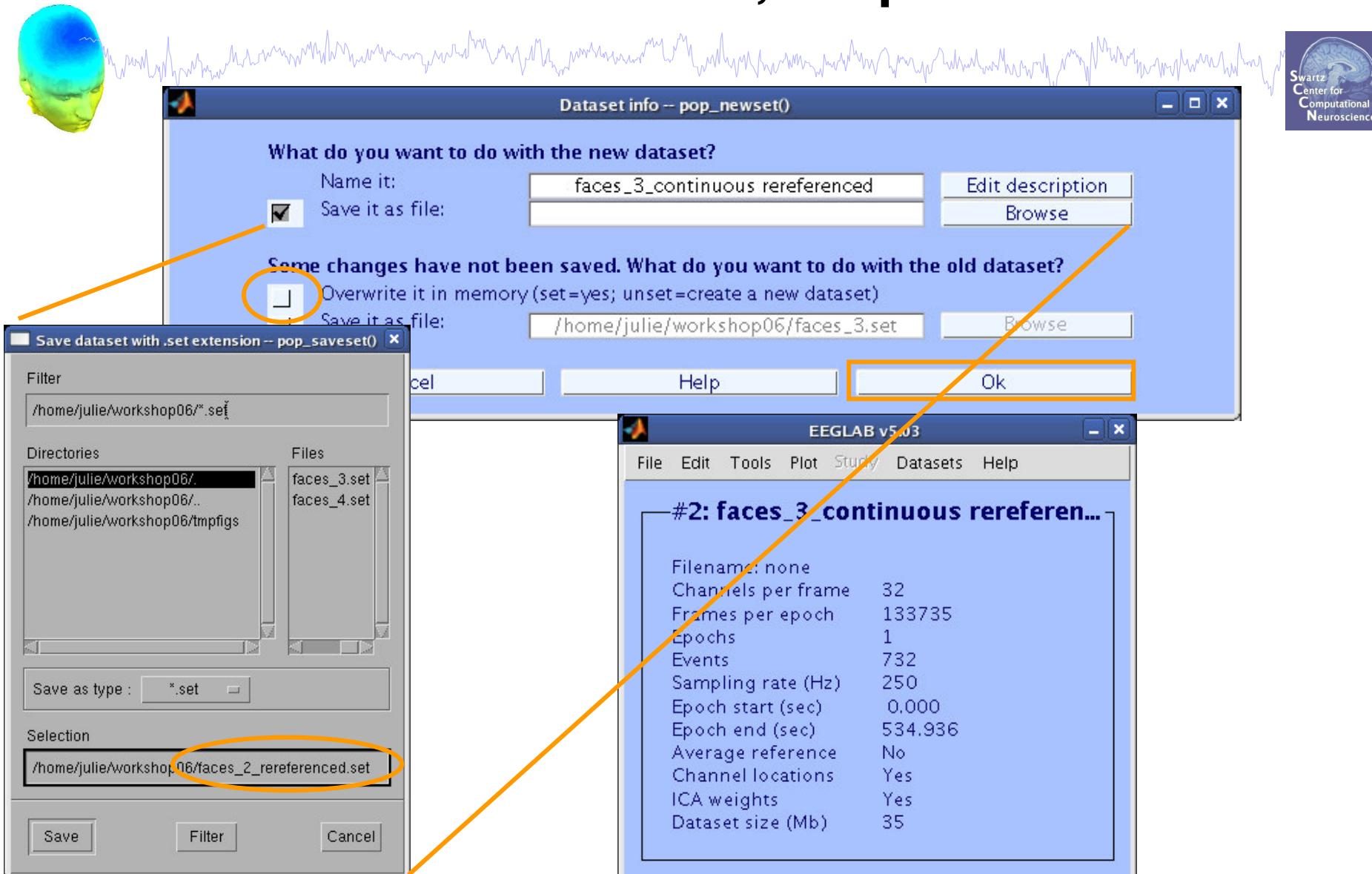
2 re-reference  
choices



`EEG = pop_reref( EEG, 16, 'refstate', 0);`

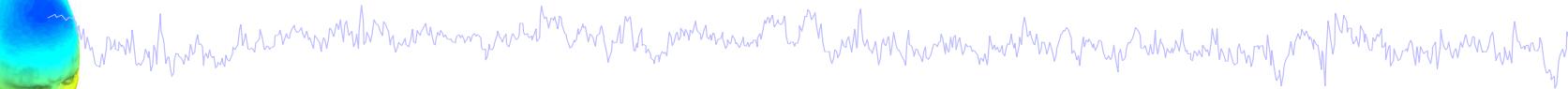
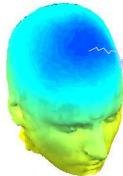


# Save new dataset, keep old one



[ALLEEG EEG CURRENTSET] = **pop\_newset**(ALLEEG, ...  
EEG, 1, 'setname', 'rerefereced data');

# Multiple active datasets (ALLEEG)

Two side-by-side windows of the EEGLAB v5.03 software interface. Both windows have a title bar "EEGLAB v5.03" and a menu bar with File, Edit, Tools, Plot, Study, Datasets, and Help. The left window shows dataset "#1: faces\_3\_continuous" with the following parameters:

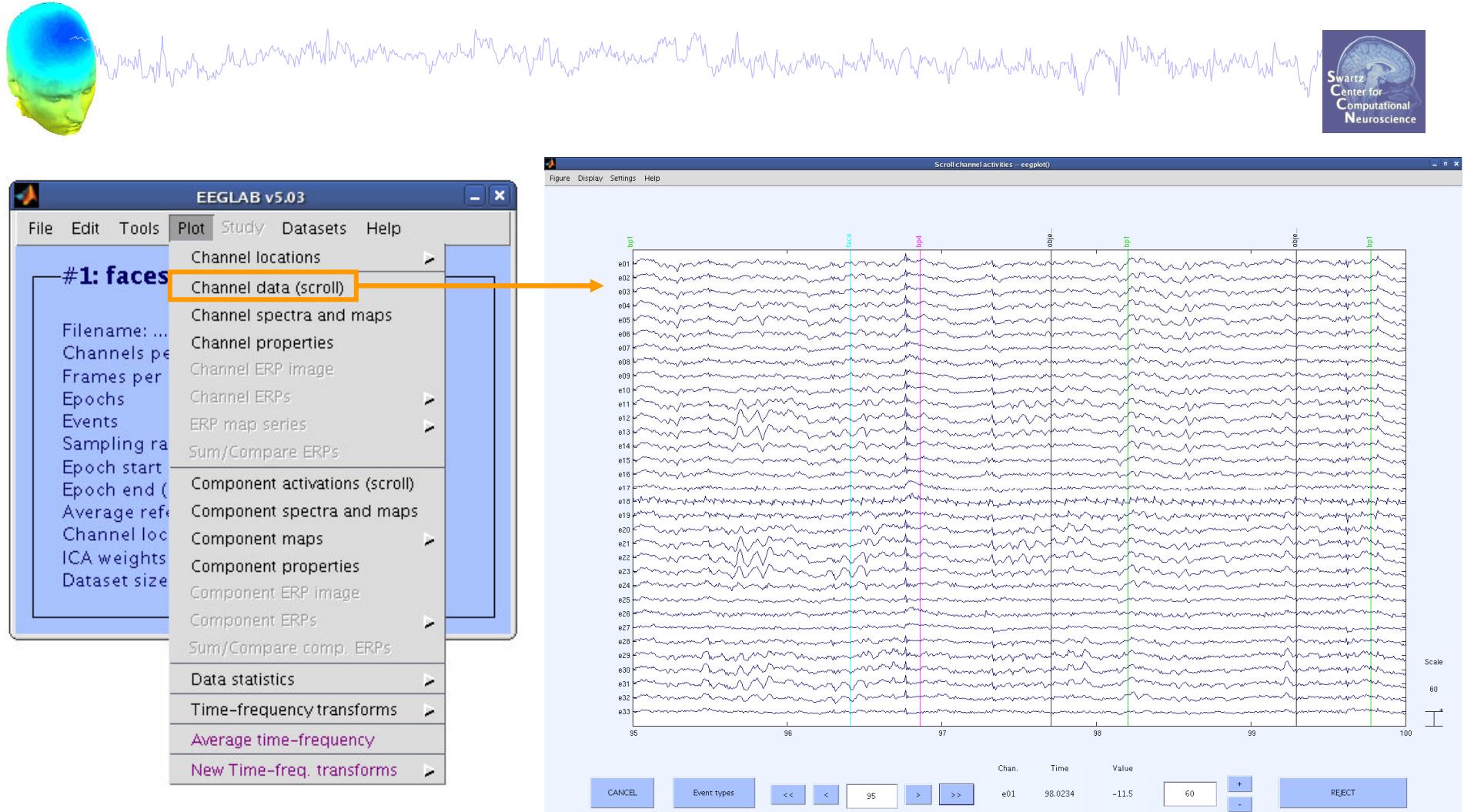
Filename:	...ulie/workshop06/faces_3.set
Channels per frame	33
Frames per epoch	133735
Epochs	1
Events	732
Sampling rate (Hz)	250
Epoch start (sec)	0.000
Epoch end (sec)	534.936
Average reference	No
Channel locations	Yes
ICA weights	Yes
Dataset size (Mb)	35.6

The right window shows dataset "#2: faces\_3\_continuous" with the following parameters:

Filename:	none
Channels per frame	33
Frames per epoch	133735
Epochs	1
Events	732
Sampling rate (Hz)	250
Epoch start (sec)	0.000
Epoch end (sec)	534.936
Average reference	No
Channel locations	Yes
ICA weights	Yes
Dataset size (Mb)	35

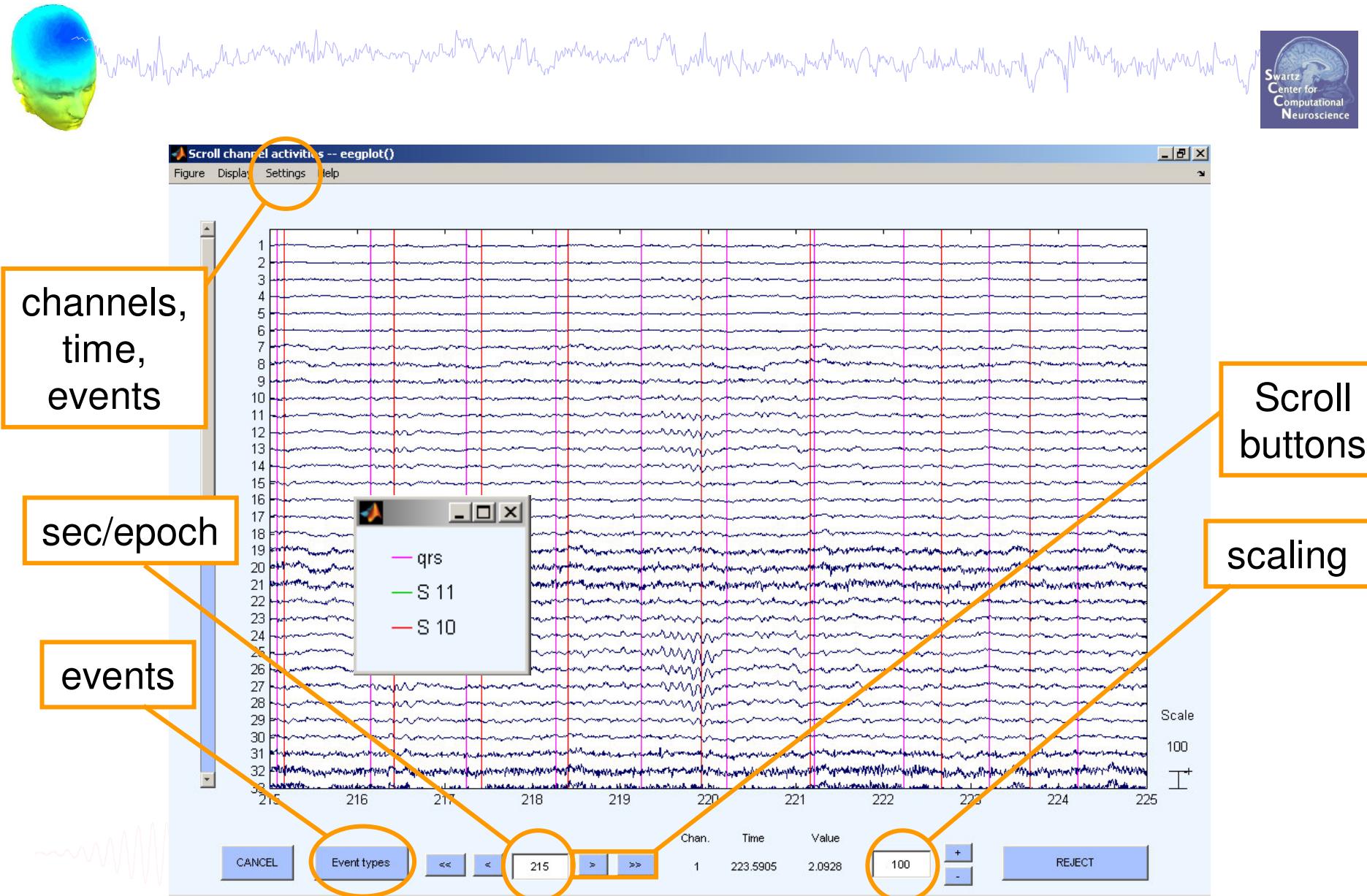
In both windows, the "Study" menu is open, showing "Dataset 1:faces\_3\_continuous" and "Dataset 2:faces\_3\_continuous rerefenced". A dropdown menu "Select multiple datasets" is also visible in the right window's Study menu.

# Scroll data

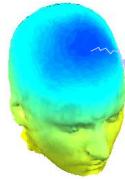


```
>> pop_eegplot(EEG,1,1,1);
```

# Scroll channel data



# Data import and preprocessing



## 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

- Analysis of ERPs
- Export EEG data

## Task 6

- Reject badchannels

## Task 7

- Reject continuous data

## Task 8

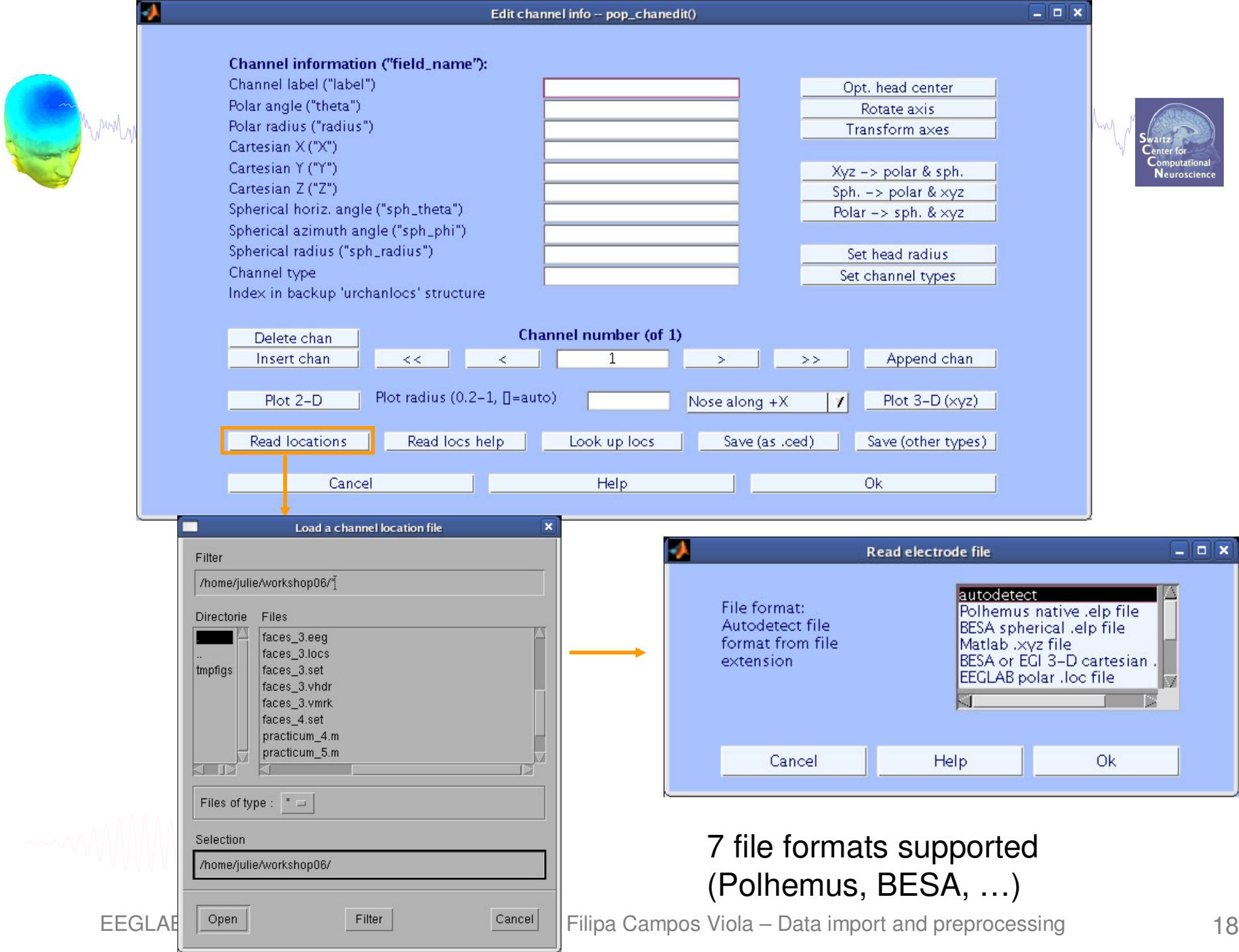
- Reject data epochs

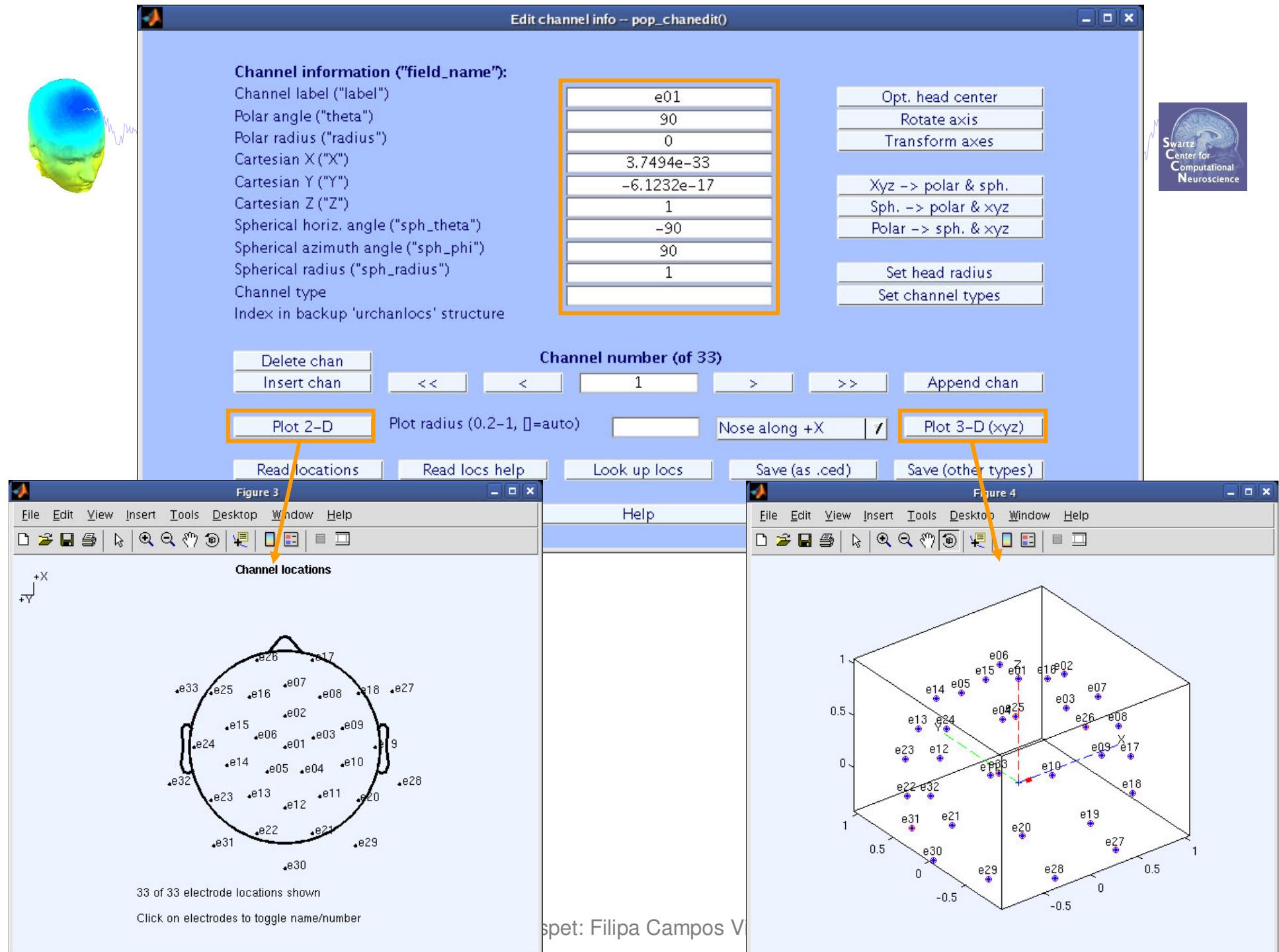
Exercise...

# Import channel locations

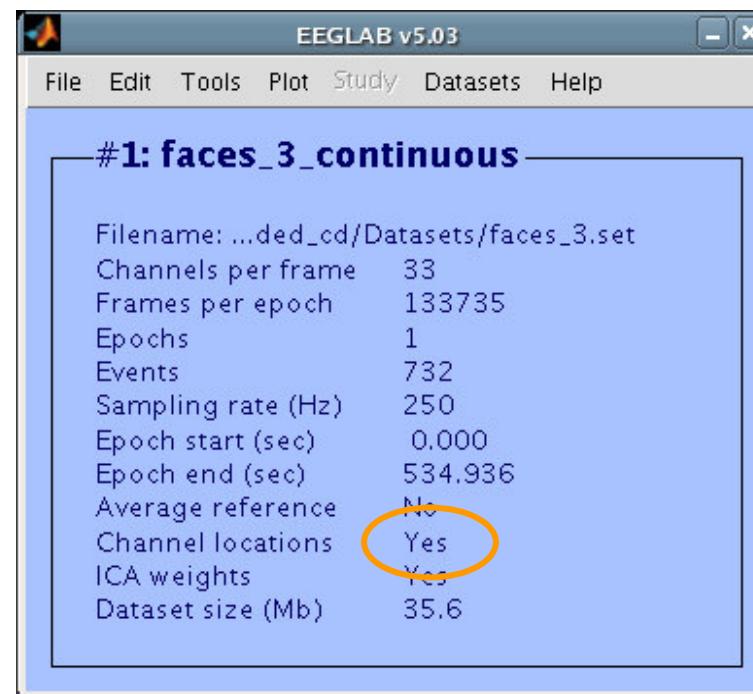
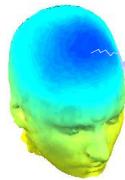
The image shows the EEGLAB software interface. The main window is titled "Edit channel info - pop\_chanedit()". It contains a list of channel information fields with corresponding input boxes. On the right side, there are several buttons grouped in boxes, some of which are highlighted with orange outlines: "Opt. head center", "Rotate axis", "Transform axes", "Xyz -> polar & sph.", "Sph. -> polar & xyz", "Polar -> sph. & xyz", "Set head radius", and "Set channel types". Below these are buttons for "Delete chan", "Insert chan", "Plot 2-D", "Plot radius (0.2-1, []=auto)", "Nose along +X", "Plot 3-D (xyz)", "Read locations" (highlighted), "Read locs help", "Look up locs" (highlighted), "Save (as .ced)", and "Save (other types)". At the bottom are "Cancel", "Help", and "Ok" buttons. A dashed orange arrow points from the "Read locations" button in the main dialog to a smaller window titled "EEGLAB v5.03" which displays a list of dataset files and their properties.

- Use channel names and automatically assign channel location
- Import channel location file
- Modify/stretch/rotate channel locations
- Set channel types...

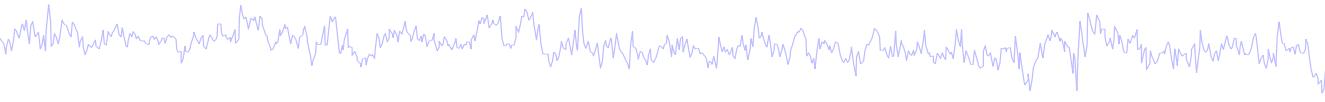
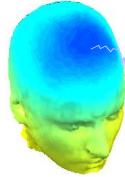




# Import channel locations



# Data import and preprocessing



## 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

- Analysis of ERPs
- Export EEG data

## Task 6

- Reject badchannels

## Task 7

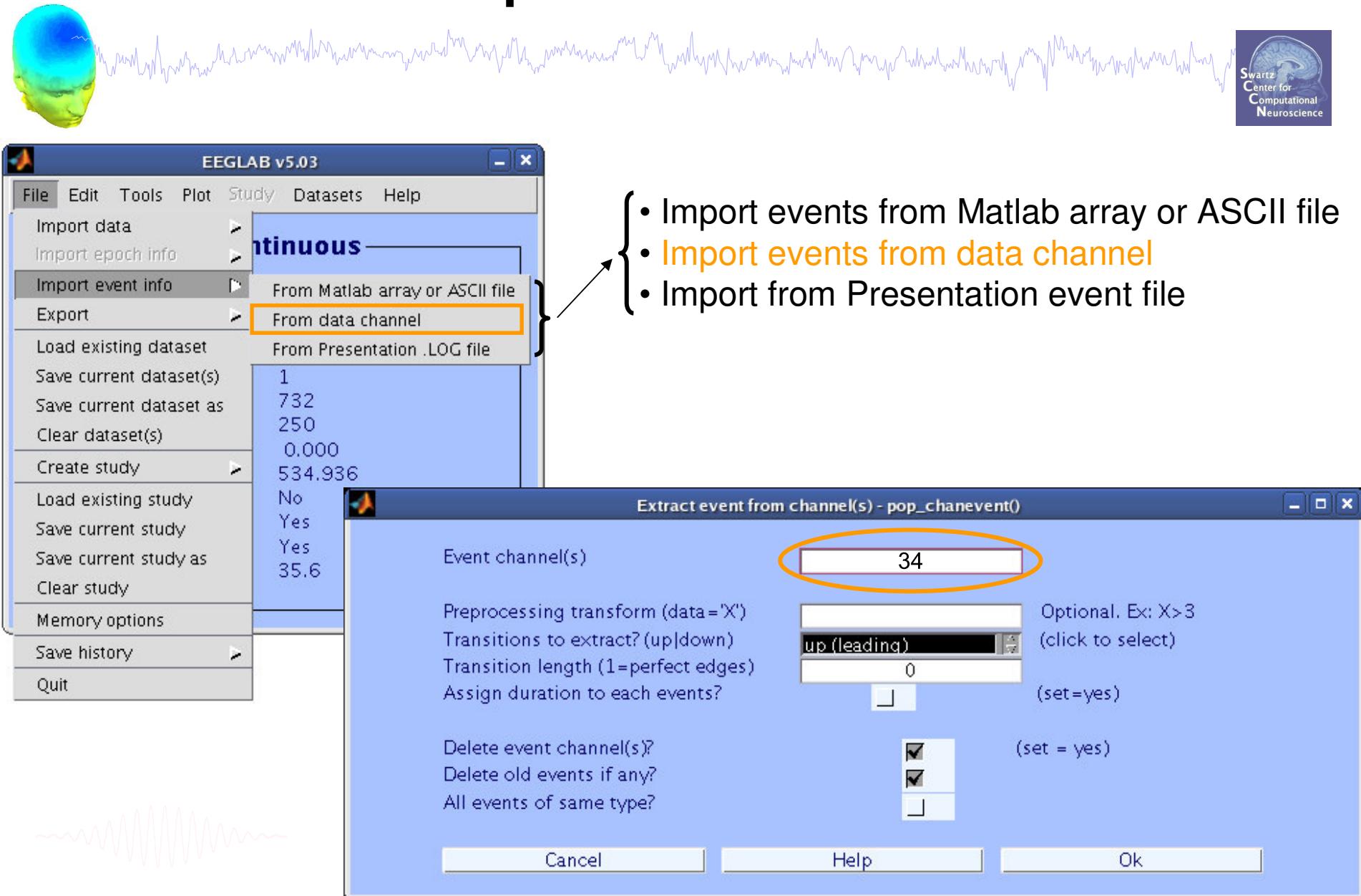
- Reject continuous data

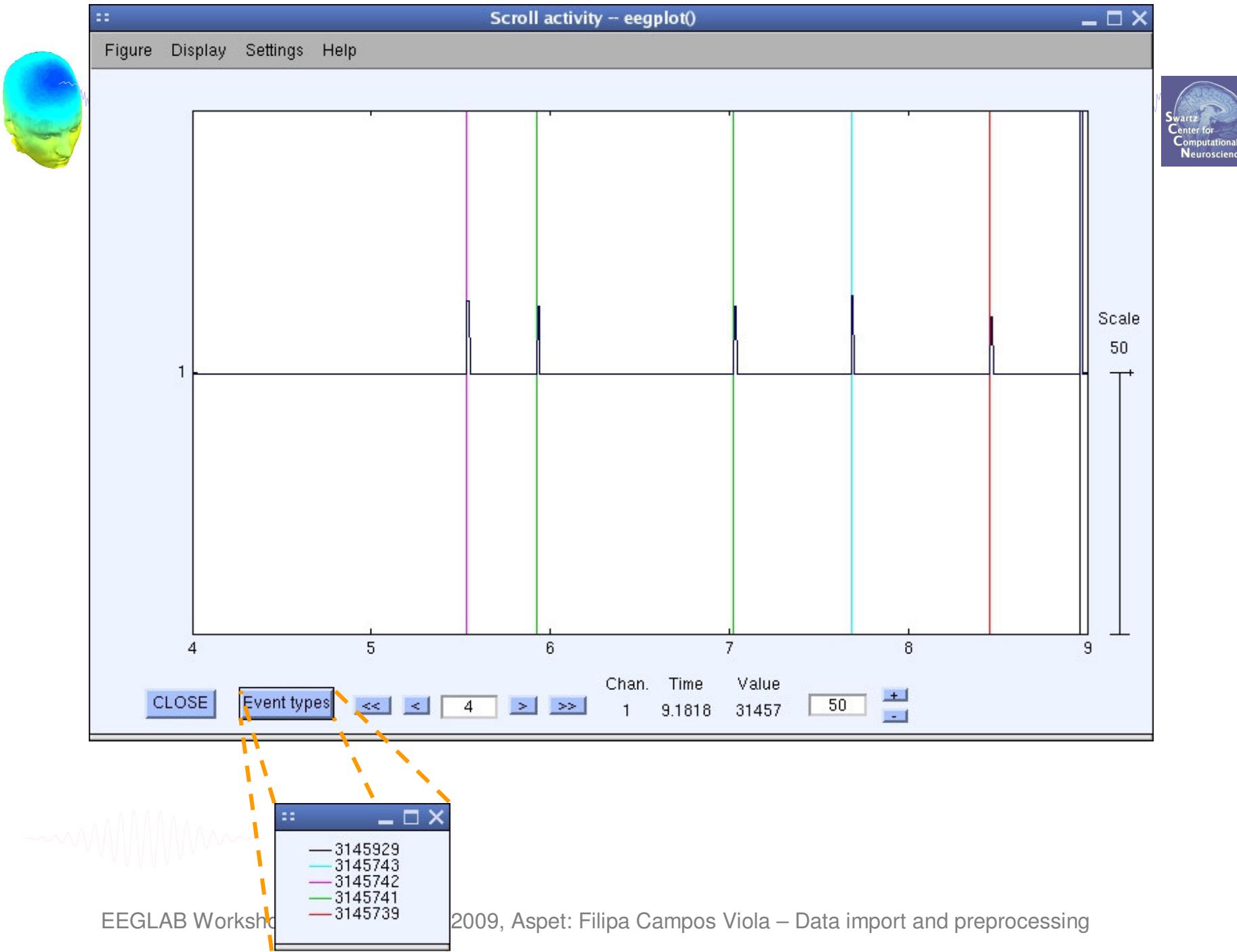
## Task 8

- Reject data epochs

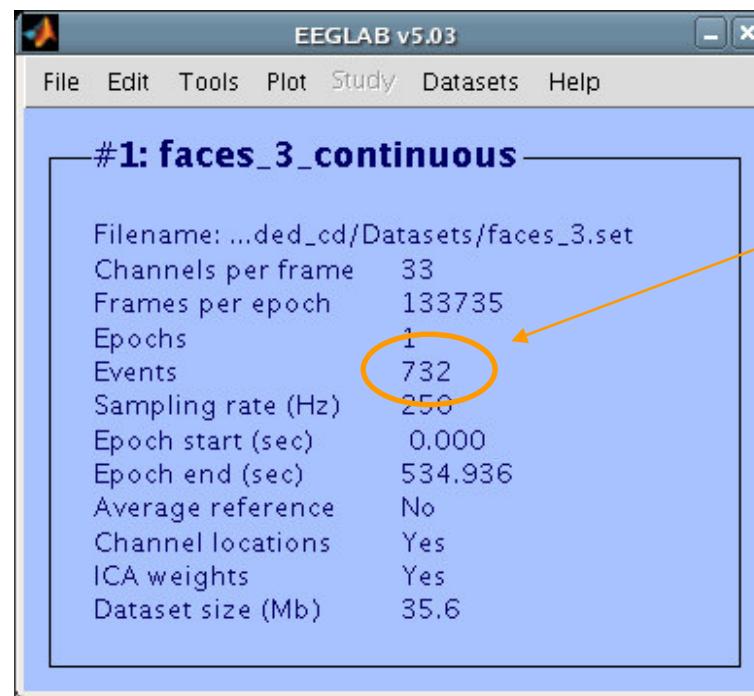
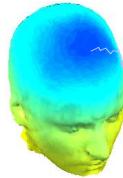
Exercise...

# Import data events





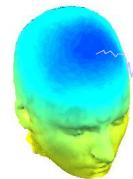
# Import data events



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



# Review event values



EEGLAB v5.03

File Edit Tools Plot Study Datasets Help

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

tinuous

shop06/faces\_3.set

33	133735
1	732
250	534.936
0.000	No
534.936	Yes
No	Yes
35.6	

Event 'type' and 'latency' are recognized fields

Edit event values – pop\_editeventvals()

Edit event field values (currently 732 events)

Latency (sec)	4.964
Type	object

Event Num: 2 > >> Append event

Insert event << < > >> Delete 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

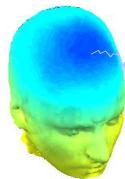
**Insert event BEFORE current event**

**To resort: first select Main sorting field**

**Append event AFTER current event**

**Delete CURRENT event**

# Alternative method for importing events: Import events from event file



EEGLAB v5.03

File Edit Tools Plot Study Datasets Help

Import data > EEG Data

Import epoch info >

Import event info > From Matlab array or ASCII file

Export > From data channel

From Presentation .LOG file

1  
154  
123  
0.000

Choose a file from Presentation -- pop\_importpres()

Filter /home/www/eeglab/download/

Directories www/eeglab/download/. www/eeglab/download/..

Files DSEYES.LOG DSEYES.SMA TEST.CNT TEST.DAT TEST.EDF tutorial\_eventable.txt

Files of type : \*

Selection /home/www/eeglab/download/DSEYES.LOG

Open Filter Cancel

...  
Check alignment between pre-existing (old) and loaded event latencies:  
Old event latencies (10 first): 10789 21315 31375 41902 51962 62489 ...  
New event latencies (10 first): 10789 21315 31376 41902 51963 62489 ...  
Best sampling rate ratio found is 0.9999895. Below latencies after adjustment  
Old event latencies (10 first): 10789 21315 31376 41902 51963 62488 ...  
New event latencies (10 first): 10789 21315 31375 41902 51962 62489 ...  
...

Import presentation file - pop\_importpres()

File field containing event types

File field containing event latencies

File field containing event durations

Note: scroll lists then click to select field

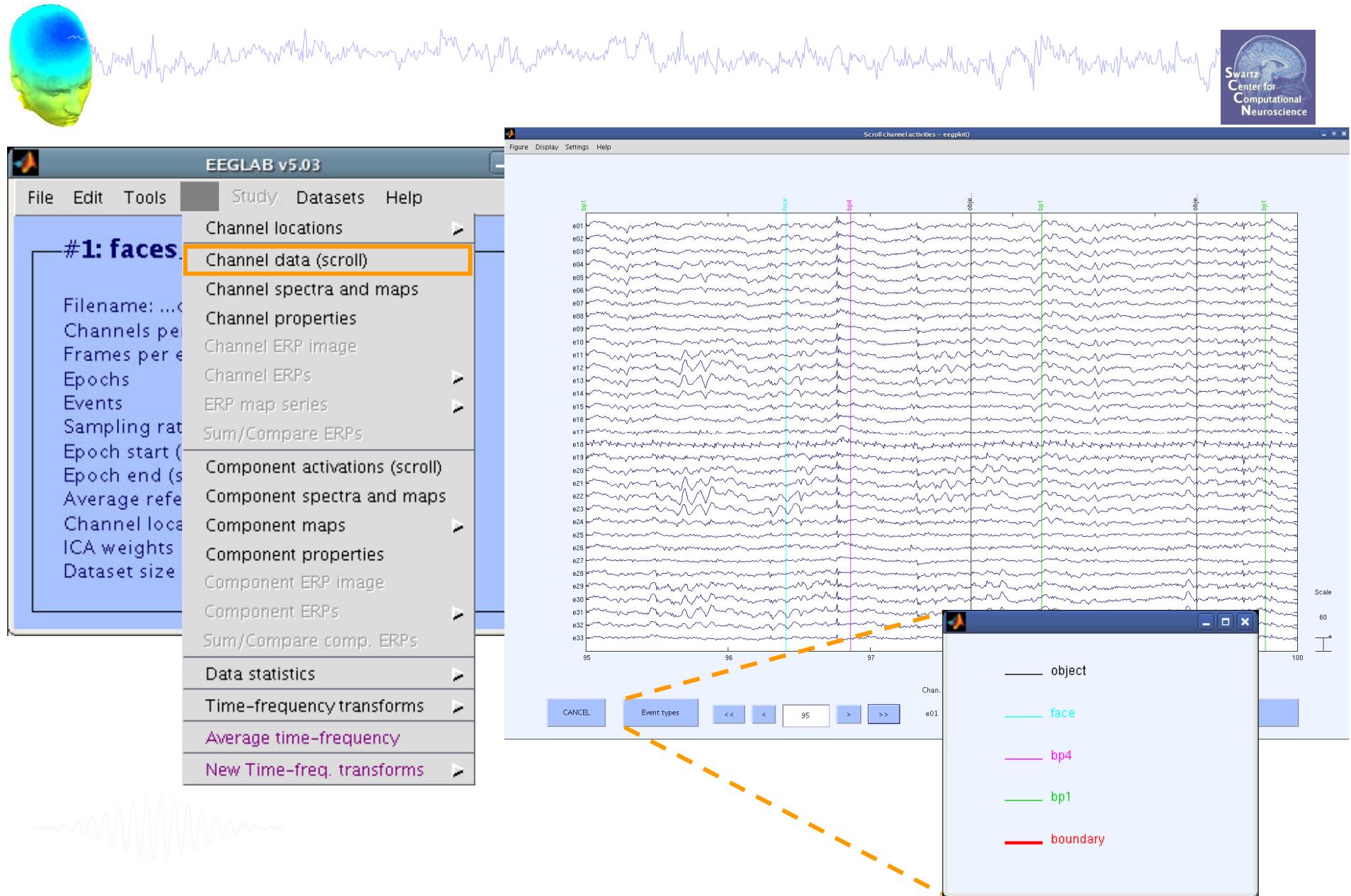
Trial Event Type Code Time None Trial Event Type Code Time

Cancel Help Ok

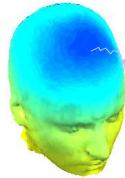
, Jun. 7-10, 2009, Aspet: Filipa Campos Viola – Data import and preprocessing

26

# Scroll data with events



# Data import and preprocessing



## 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

- Analysis of ERPs
- Export EEG data

## Task 6

- Reject badchannels

## Task 7

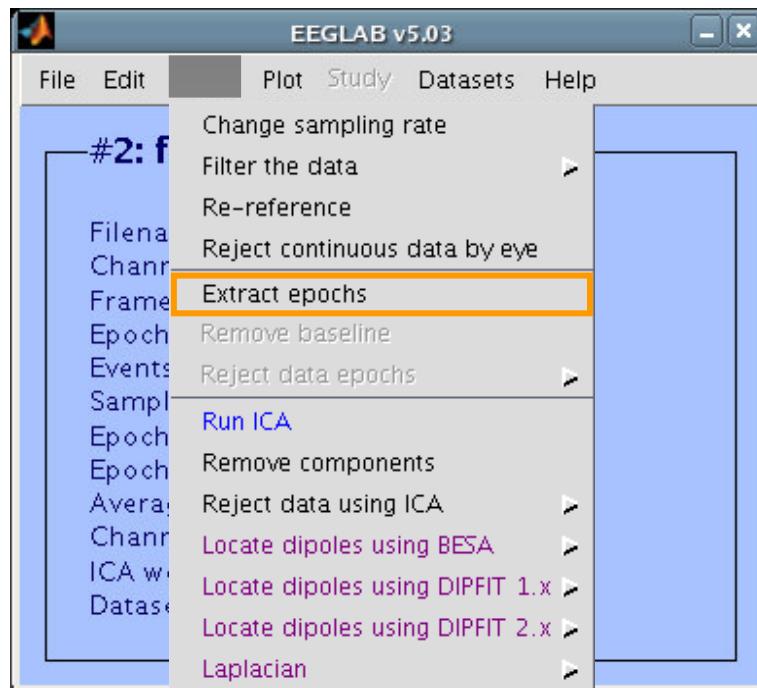
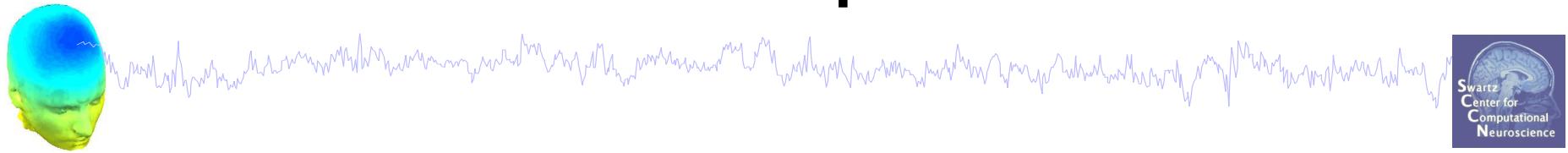
- Reject continuous data

## Task 8

- Reject data epochs

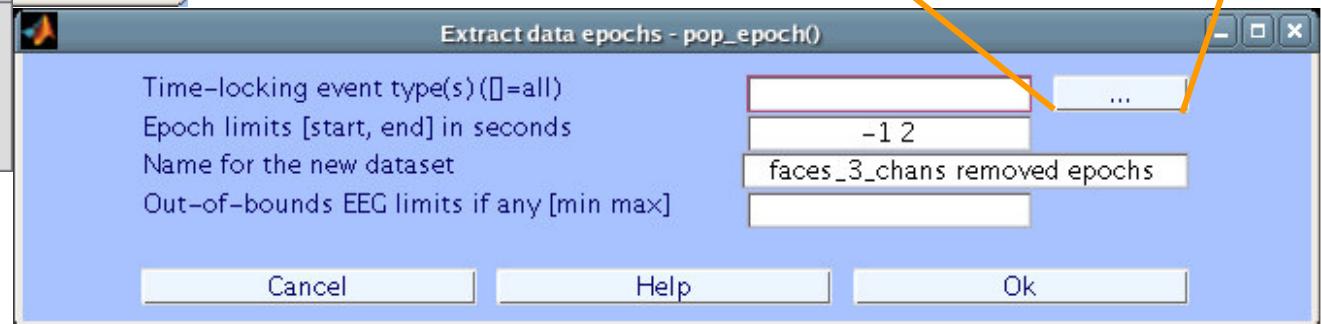
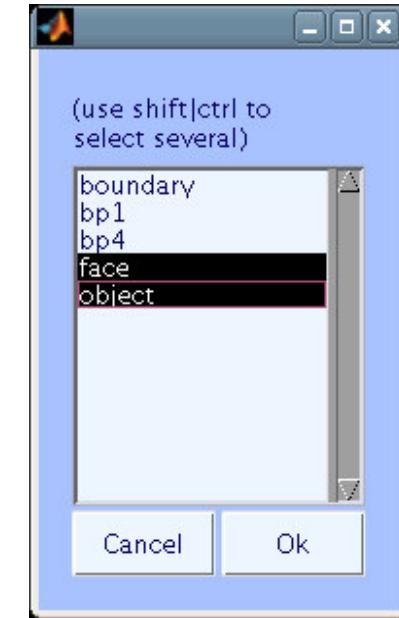
Exercise...

# Extract epochs



```
>> eeg_eventtypes (EEG)
```

<b>boundary</b>	1
<b>bp1</b>	183
<b>bp4</b>	184
<b>face</b>	182
<b>object</b>	182



# Extract epochs

The image illustrates the process of extracting epochs from EEG data using EEGLAB. At the top left is a 3D head model with colored regions (red, yellow, green) overlaid by a blue wavy line representing an EEG signal. To the right is the Swartz Center for Computational Neuroscience logo.

Below the visualization is a command-line session:

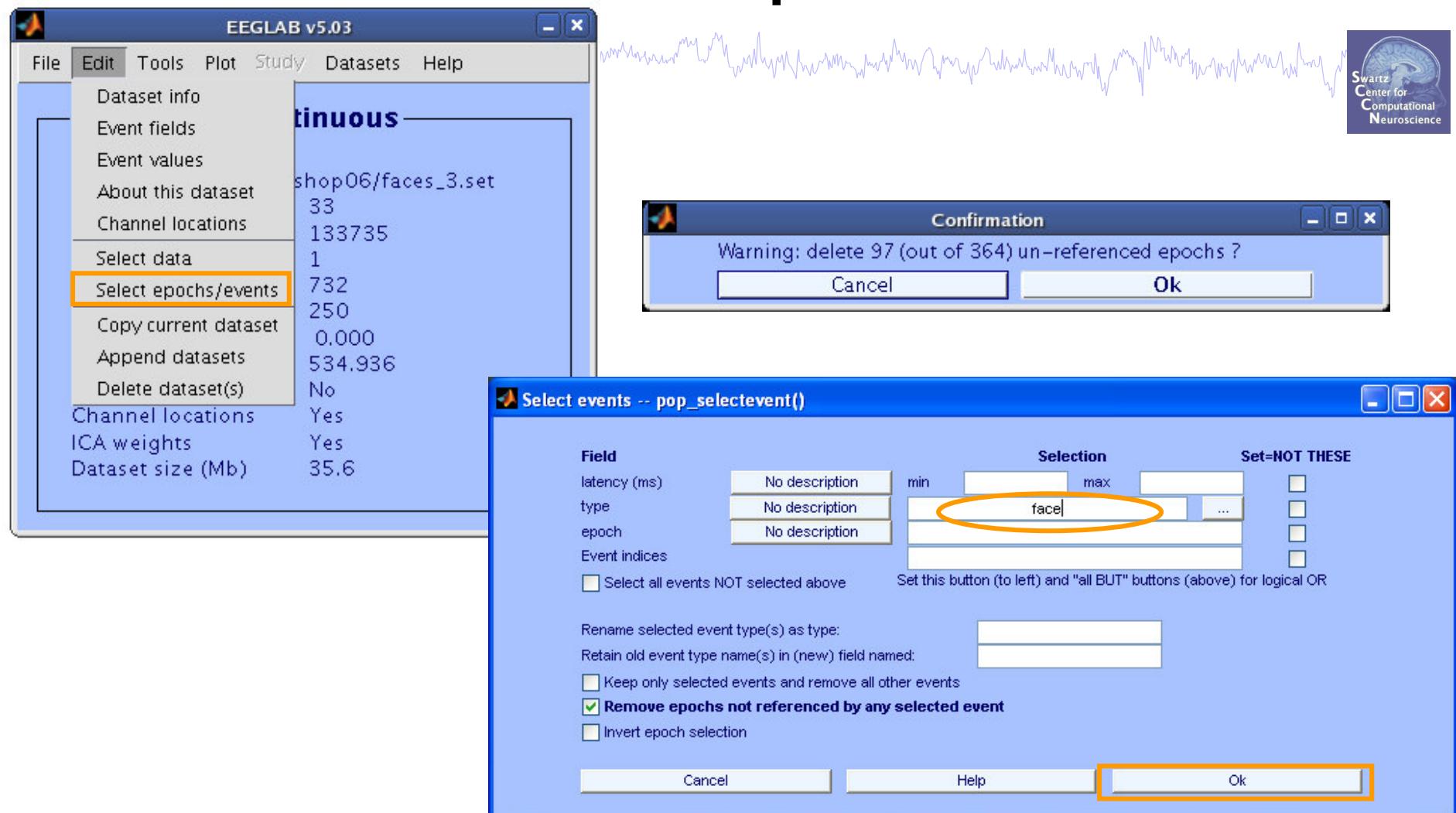
```
>> EEG = pop_epoch(EEG, {'face' 'object'}, [-1 2], ...
    'newname', 'faces_3_chans removed epochs', ...
    'epochinfo', 'yes');
>> EEG = pop_rmbase(EEG, [-1000 0]);
>> [ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, EEG, ...
    CURRENTSET, 'setname', 'faces_3_chans removed epochs');
```

Three windows are overlaid on the command-line session:

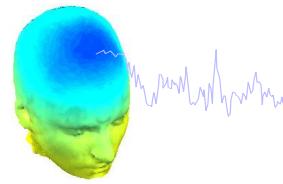
- Epoch baseline removal – pop\_rmbase()**: Shows "Baseline latency range (min\_ms max\_ms) ([] = whole epoch): -1000 0".
- Dataset info – pop\_newset()**: Shows "What do you want to do with the new dataset? Name it: faces\_3\_chans" and "Some changes have not been saved. What do Overwrite it in memory (set=yes; unset=create)".
- EEGLAB v5.03**: Shows dataset parameters:

Filename: none	
Channels per frame	31
Frames per epoch	750
<b>Epochs</b>	<b>364</b>
Events	1500
Sampling rate (Hz)	250
Epoch start (sec)	-1.000
Epoch end (sec)	1.996
Average reference	No
Channel locations	Yes
ICA weights	Yes
Dataset size (Mb)	70.6

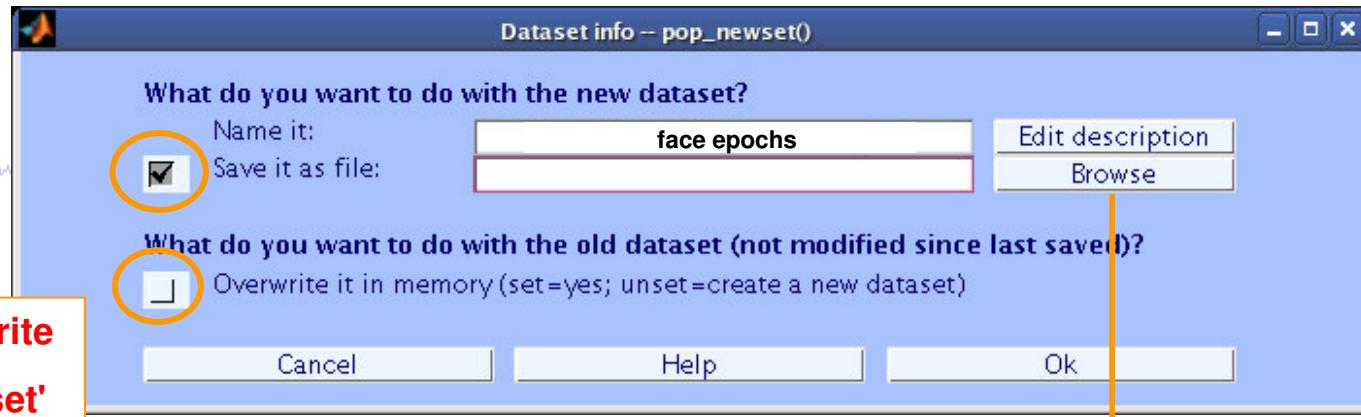
# Select epochs



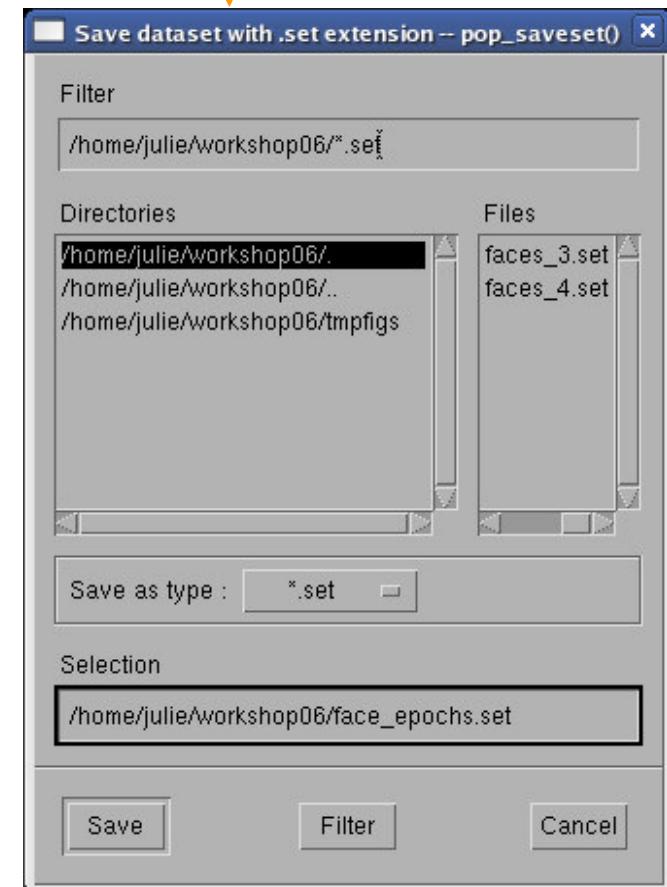
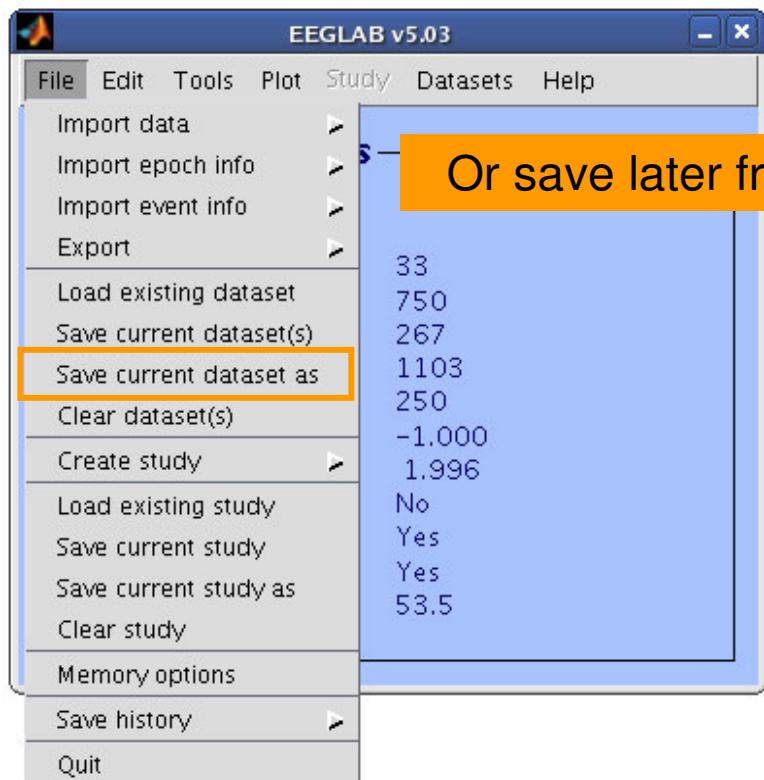
```
>> EEG = pop_selectevent(EEG, 'type', {'face'}, ...
    'deleteevents', 'off', 'deleteepochs', 'on');
>> [ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG, EEG, 4, ...
    'setname', 'faces only epochs');
```

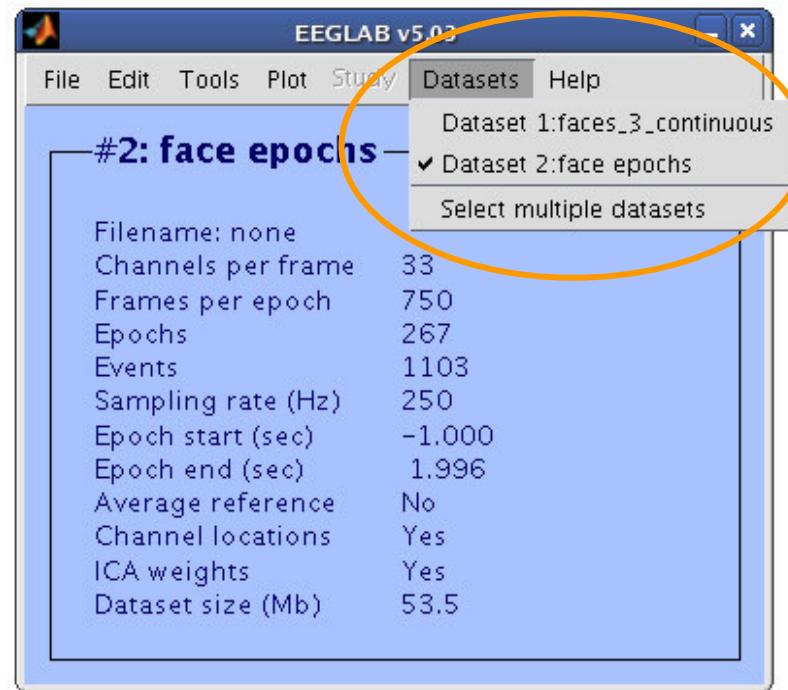


'Do not overwrite  
current dataset'



## Save dataset (optional)

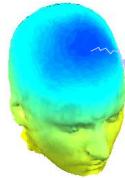




New dataset  
created



# Data import and preprocessing



## 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

- Analysis of ERPs
- Export EEG data

## Task 6

- Reject badchannels

## Task 7

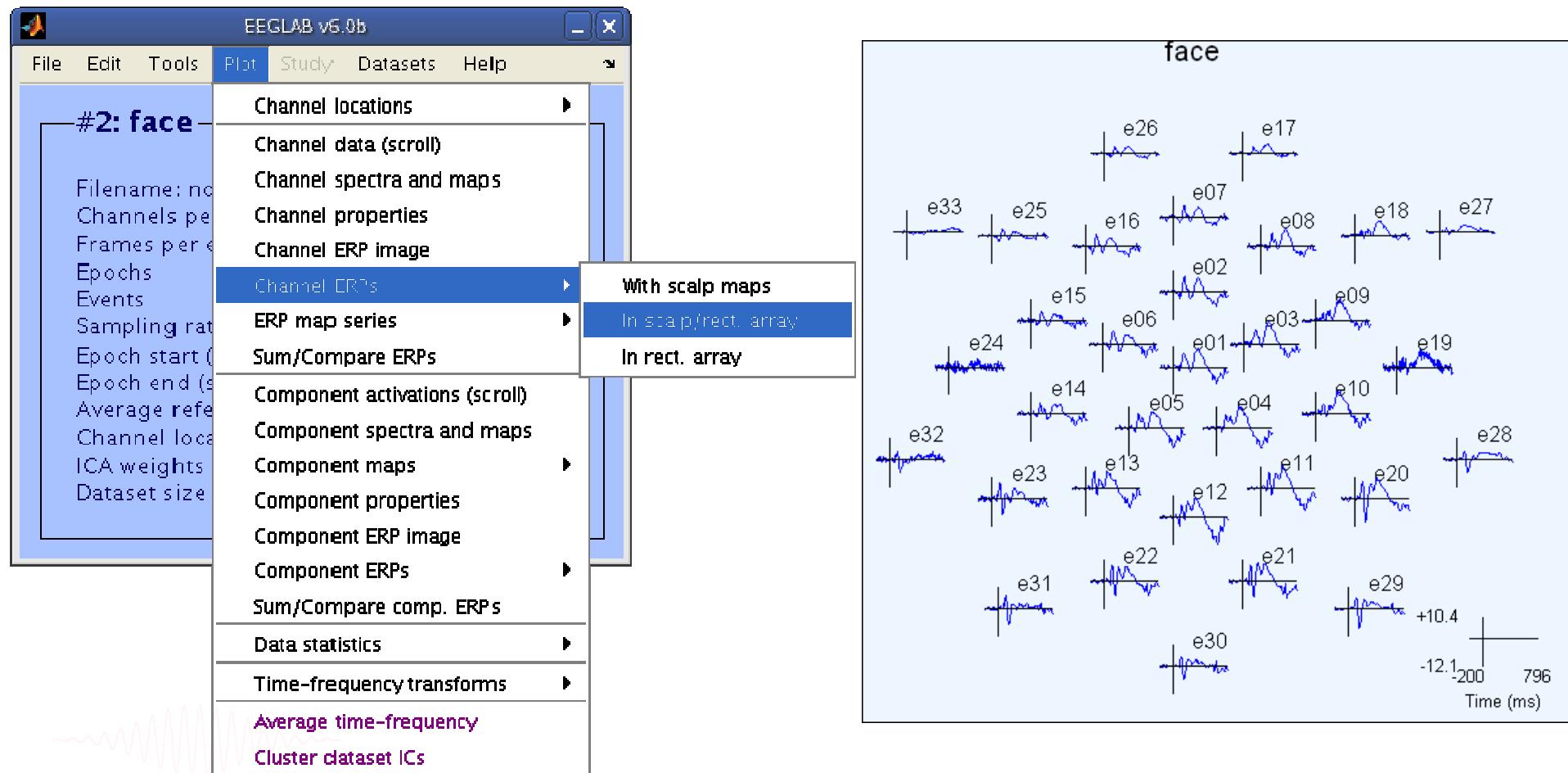
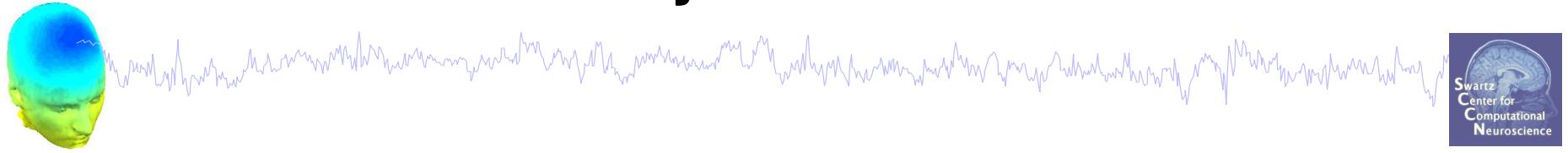
- Reject continuous data

## Task 8

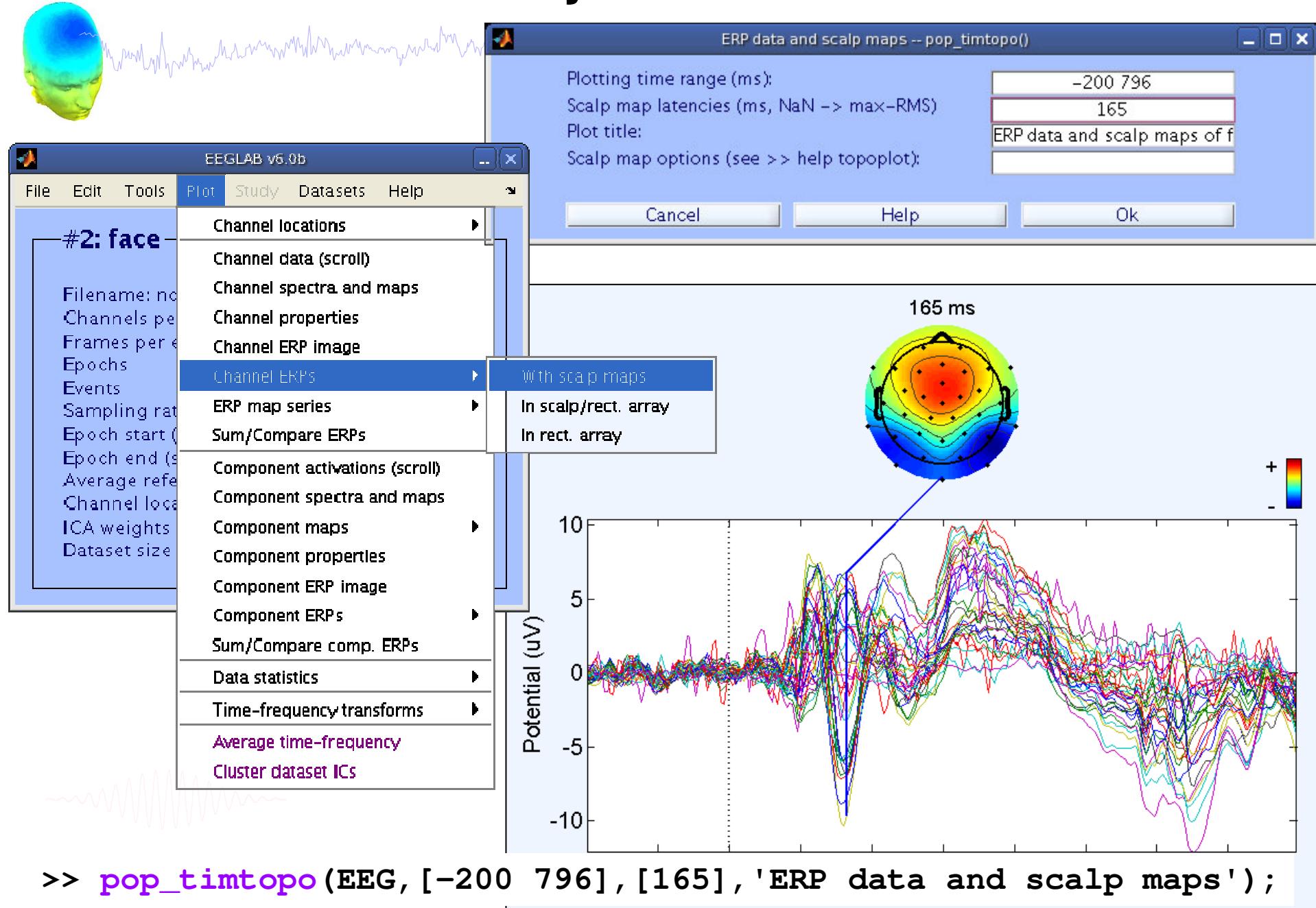
- Reject data epochs

Exercise...

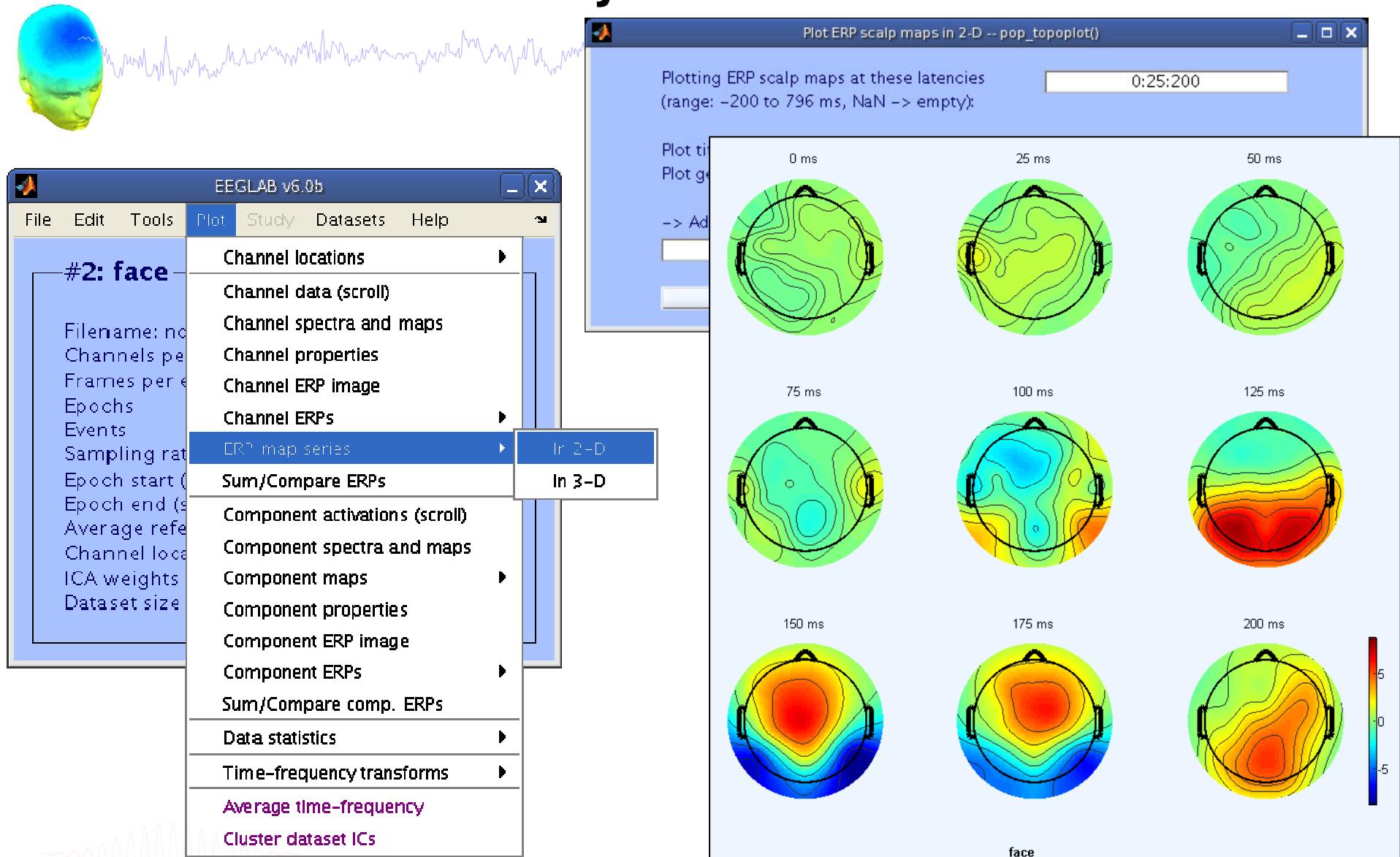
# Analysis of ERPs



# Analysis of ERPs

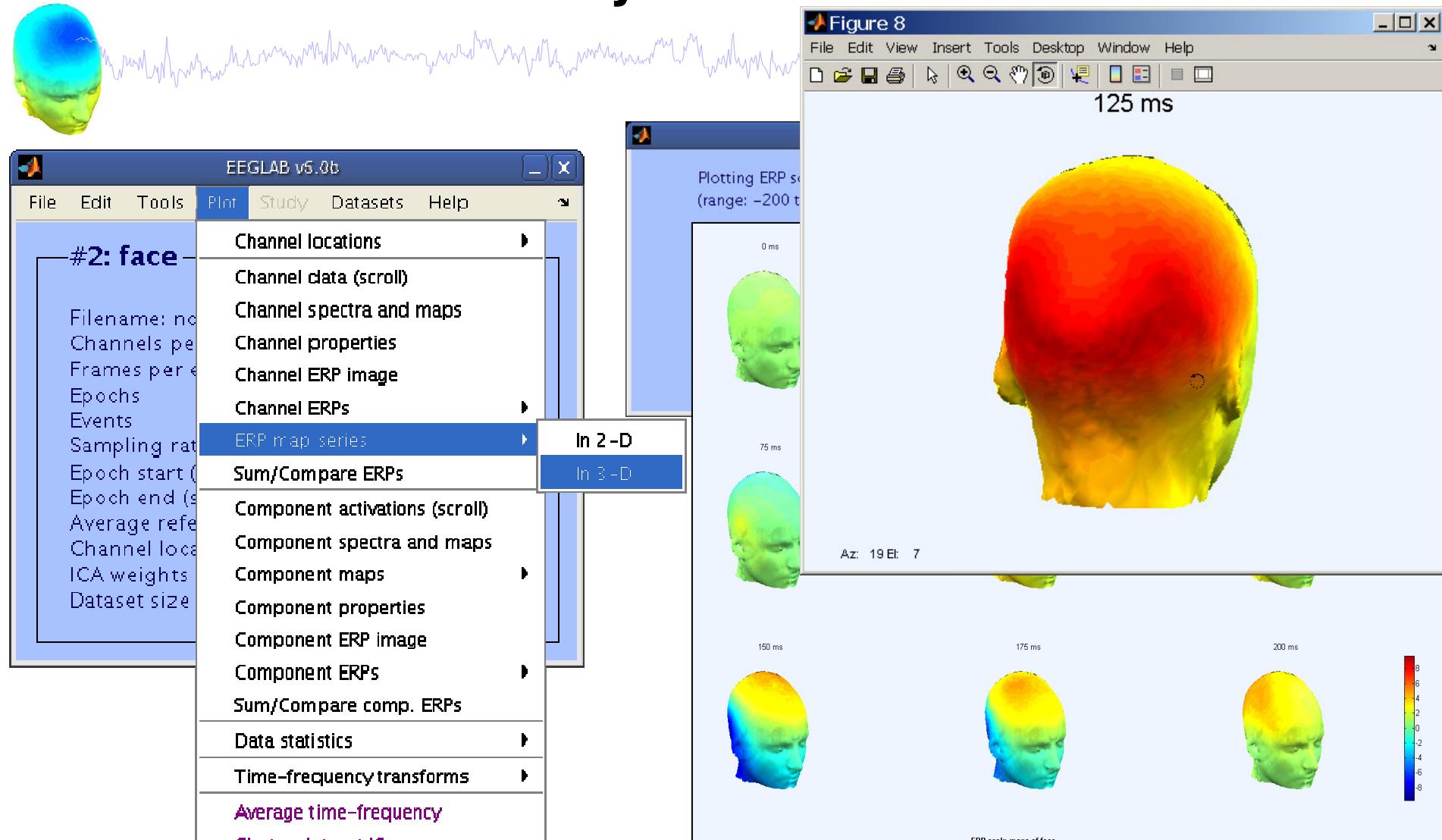


# Analysis of ERPs



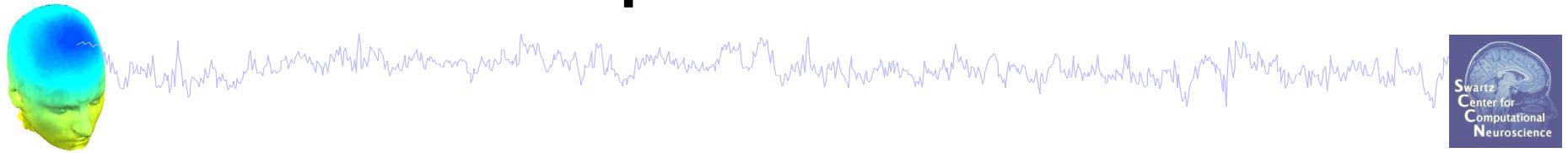
```
>>pop_topoplot(EEG,1,[0:25:200],'face',[3 3],0,'electrodes','off');
```

# Analysis of ERPs



```
>> pop_headplot(EEG,1,[0:25:200],'ERP scalp maps',[3 3],...  
    'electrodes','off');
```

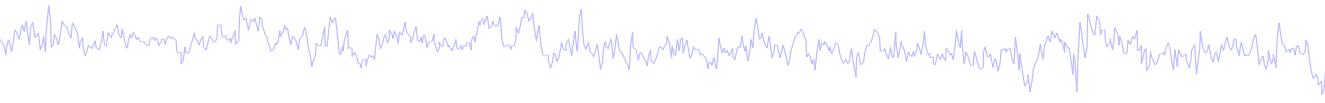
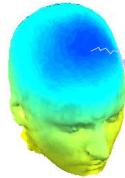
# Export EEG data



e01	e02	e03	e04	e05	e06	e07	e08	e09	e10	e11	e12	e13
-0.7021	-0.6395	-0.5491	-0.3844	-0.4730	-0.5075	-0.						
-0.7116	-0.7245	-0.4236	-0.2221	-0.4850	-0.7165	-0.						
-0.5483	-0.6298	-0.2757	-0.0396	-0.3252	-0.7949	-0.						
-0.4038	-0.4629	-0.1161	-0.1454	-0.3393	-0.7880	-0.						
-0.3721	-0.3333	-0.1556	-0.3324	-0.4109	-0.7188	-0.						
-0.2317	-0.1290	-0.2646	-0.2754	-0.2334	-0.4372	-0.						
0.0962	0.2113	-0.0913	-0.1361	0.0039	0.0085	0.1						
0.5633	0.6851	0.3850	0.0617	0.2508	0.4841	0.5						
0.7854	0.9445	0.7090	0.2071	0.3589	0.6747	0.6						
0.3744	0.5905	0.2864	-0.1259	0.0329	0.3895	0.3						
-0.0672	0.1176	-0.2224	-0.4370	-0.1789	0.0444	-0.						
-0.0826	-0.0019	-0.1886	-0.2928	-0.0028	-0.1215	-0.						
-0.0582	-0.0889	-0.1299	-0.1322	0.1167	-0.2183	-0.						
-0.1189	-0.2618	-0.2840	-0.1262	0.1378	-0.2262	-0.						
-0.0765	-0.2820	-0.4683	-0.0749	0.2594	-0.1621	-0.						
0.1603	-0.0609	-0.3273	0.1355	0.4519	0.0595	-0.						
0.3770	0.2577	0.0617	0.3868	0.5652	0.3752	-0.						

```
>> pop_export(EEG, 'D:\tmp\faces.dat', 'erp', 'on', ...
    'transpose', 'on', 'time', 'off');
```

# Data import and preprocessing



## 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

- Analysis of ERPs
- Export EEG data

## Task 6

- Reject badchannels

## Task 7

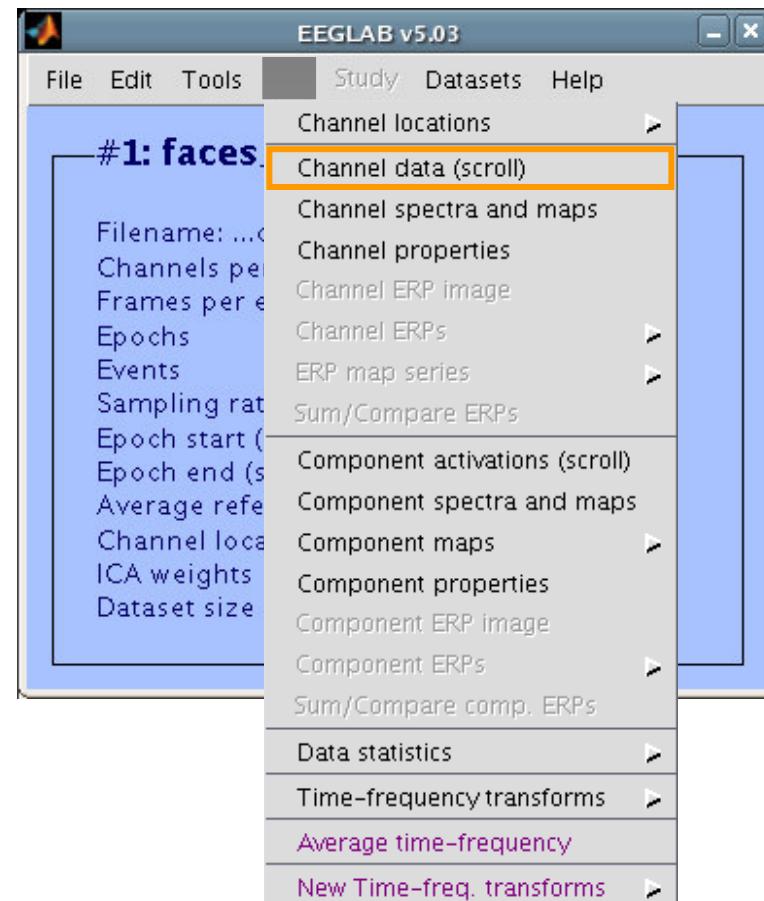
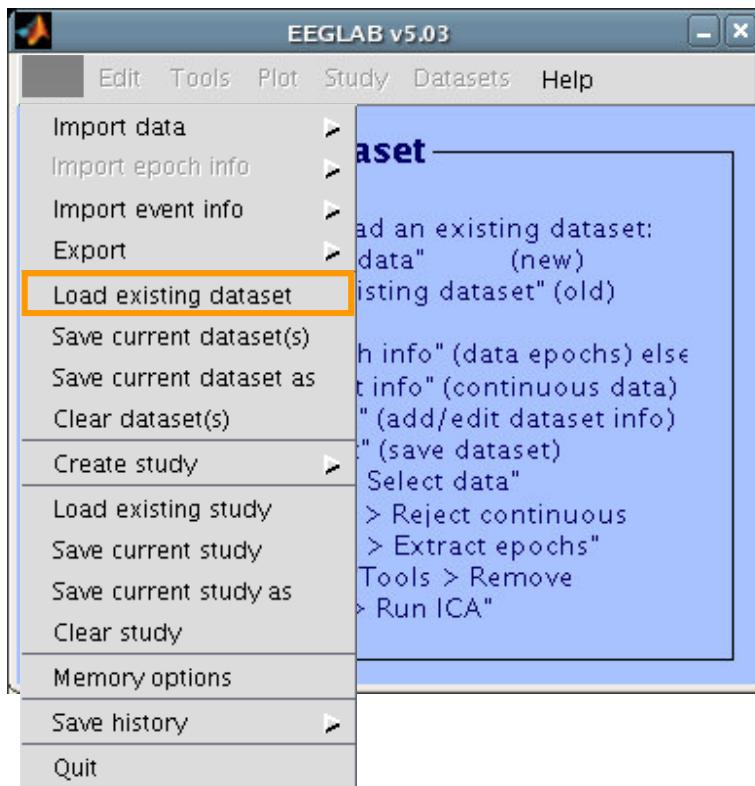
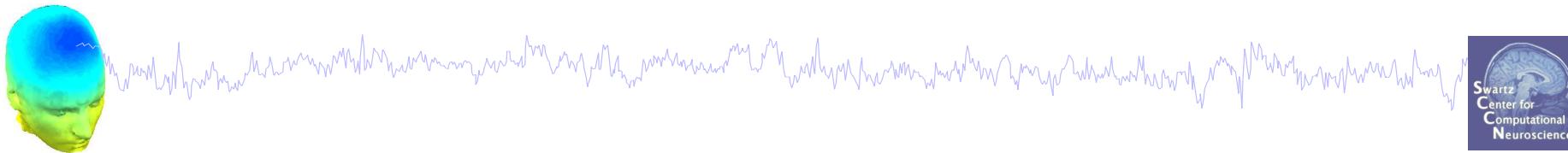
- Reject continuous data

## Task 8

- Reject data epochs

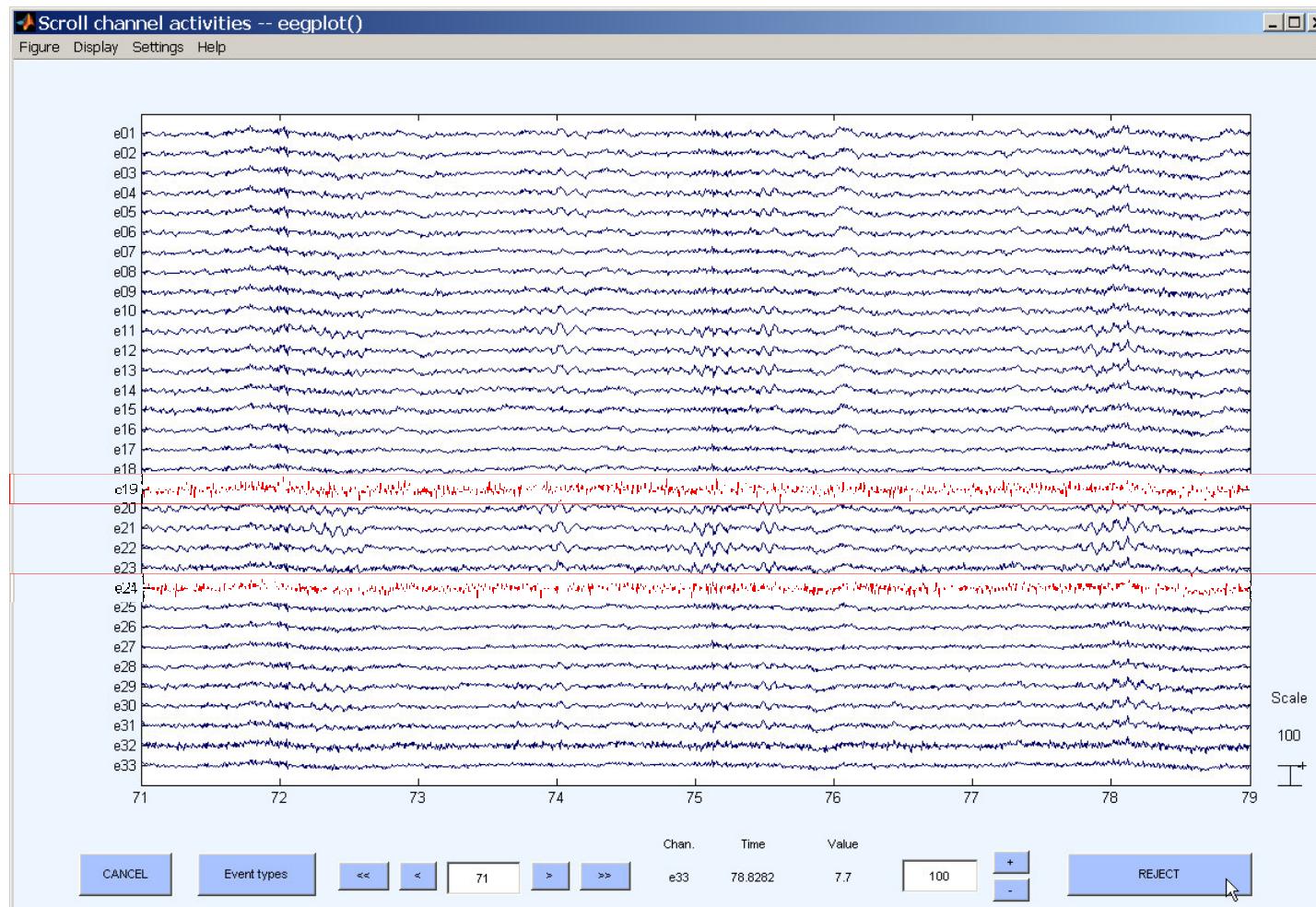
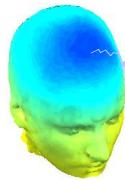
Exercise...

# Load/scroll data

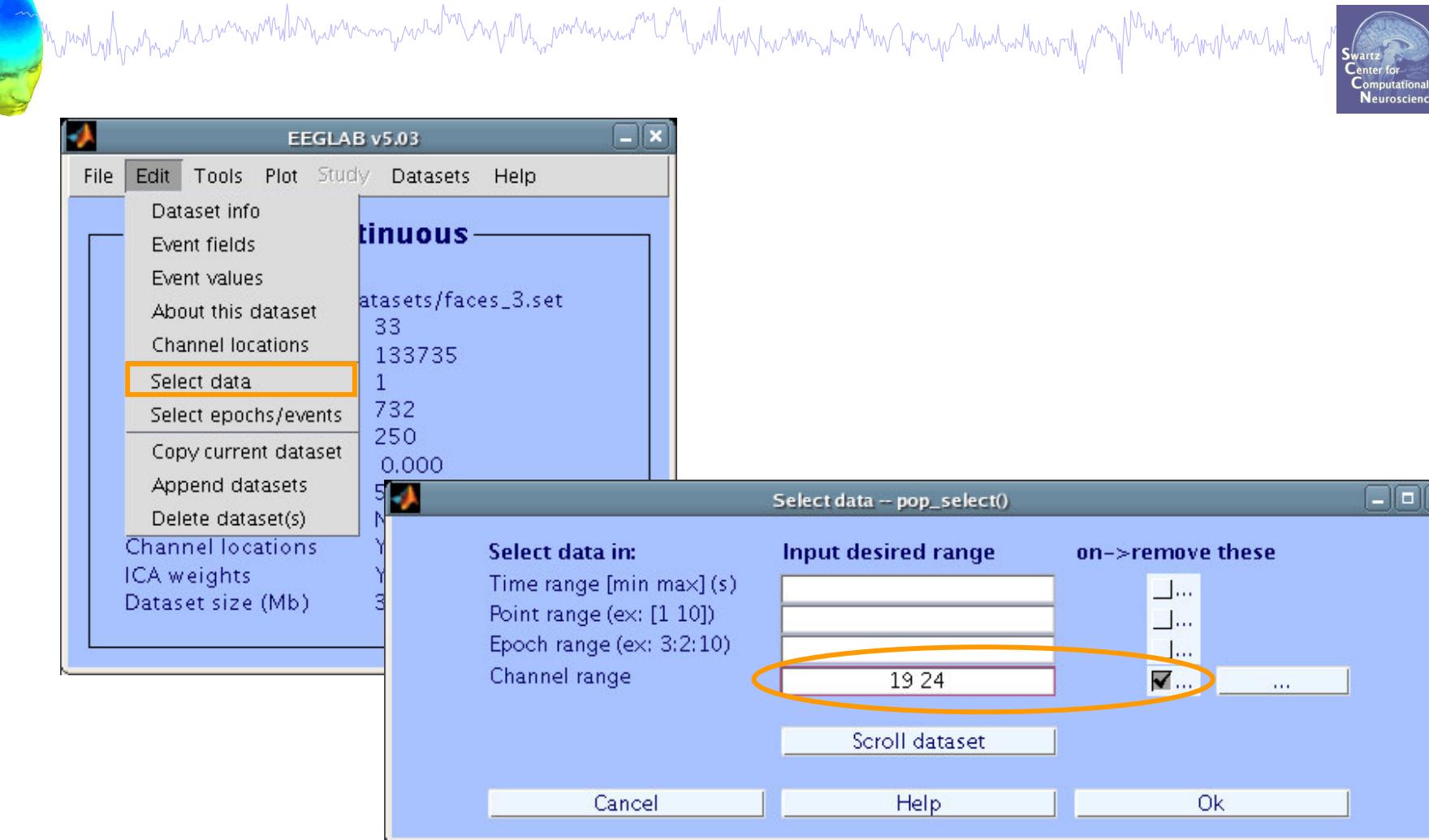
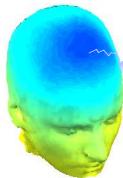


```
>> EEG = pop_loadset('faces_3.set', '...\\data\\');
>> [ALLEEG EEG CURRENTSET] = eeg_store(ALLEEG, EEG, 0);
```

# Reject bad channels

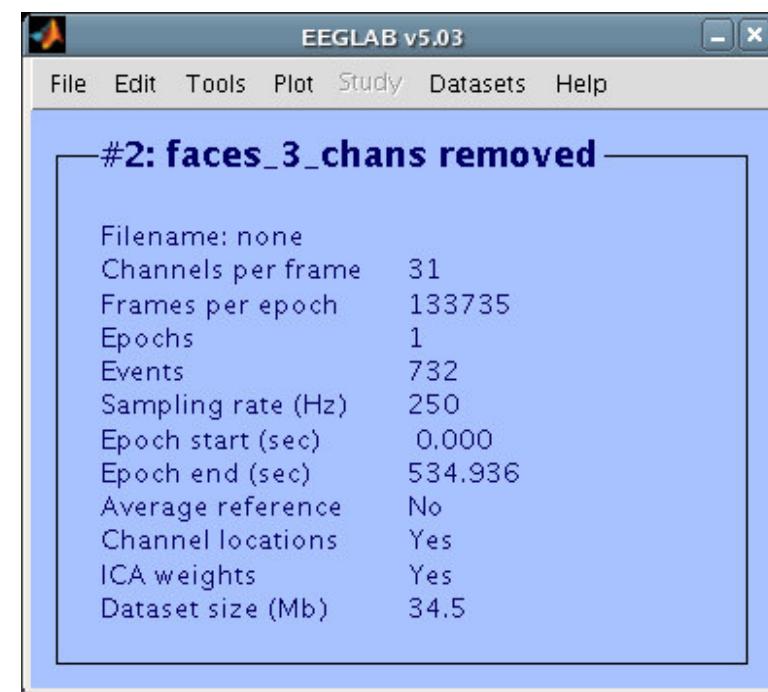
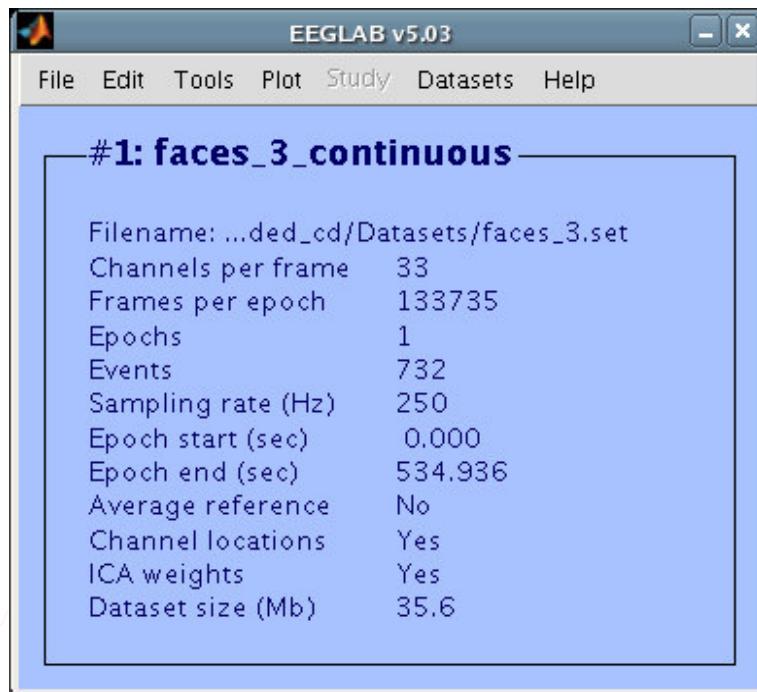
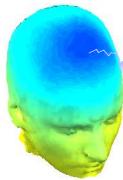


# Reject bad channels

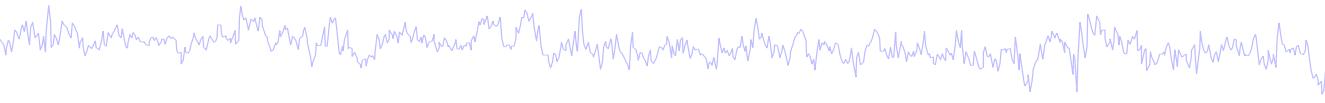
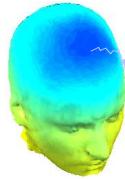


```
EEG = pop_select(EEG, 'nochannel', [19 24]);
```

# Reject bad channels



# Data import and preprocessing



## 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

- Analysis of ERPs
- Export EEG data

## Task 6

- Reject badchannels

## Task 7

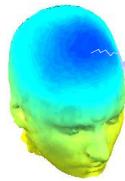
- Reject continuous data

## Task 8

- Reject data epochs

Exercise...

# Reject continuous data



Equivalent!!

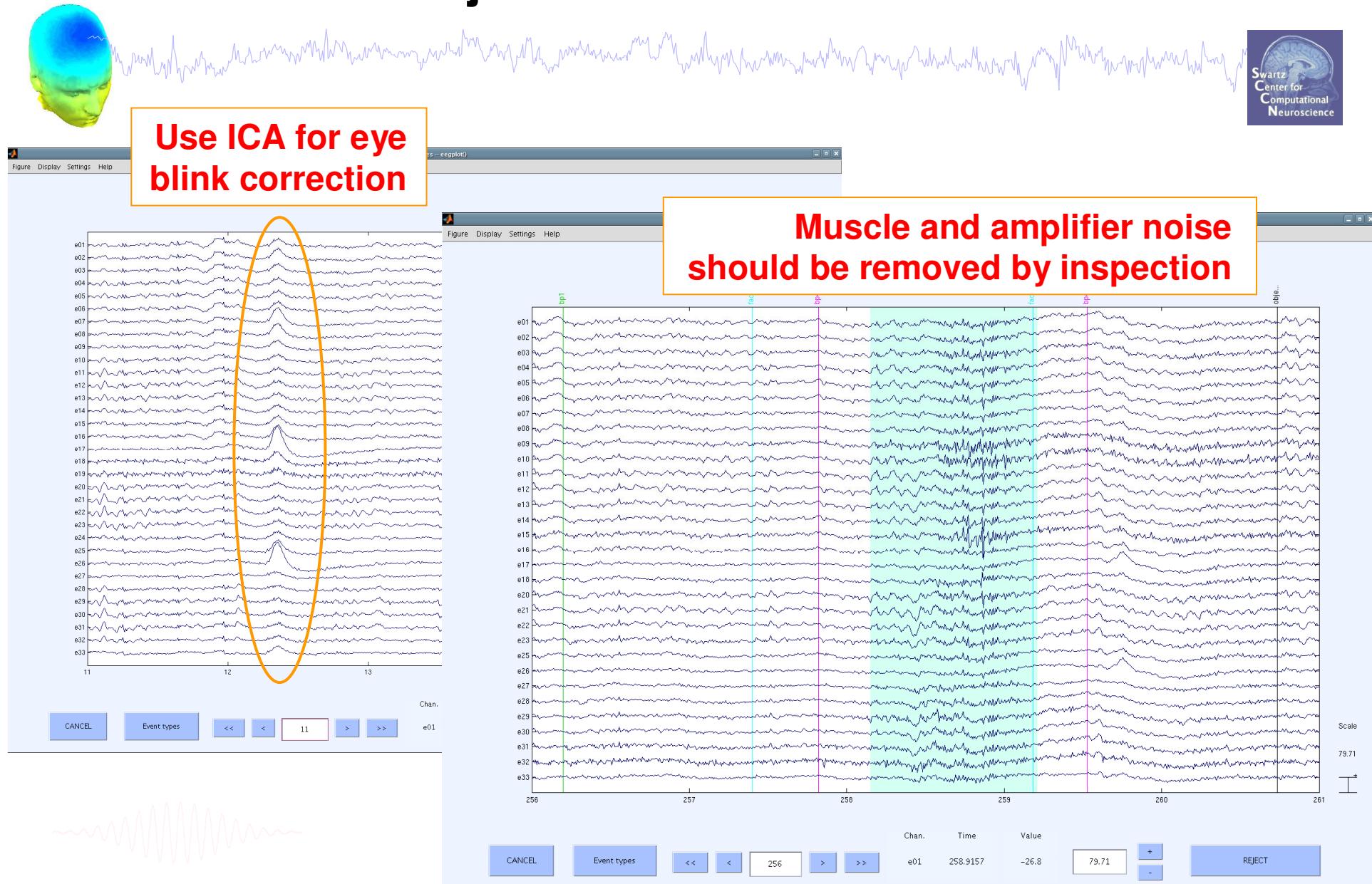
The screenshot shows two EEGLAB windows and a warning dialog.

**EEGLAB v5.03 Window 1:** The menu bar includes File, Edit, Plot, Study, Datasets, and Help. The "Plot" menu is open, showing options like Change sampling rate, Filter the data, Re-reference, Reject continuous data by eye (which is highlighted with a red box), Extract epochs, Remove baseline, Reject data epochs, Run ICA, Remove components, Reject data using ICA, Locate dipoles using BESA, Locate dipoles using DIPFIT 1.x, Locate dipoles using DIPFIT 2.x, and Laplacian.

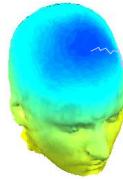
**EEGLAB v5.03 Window 2:** The menu bar includes File, Edit, Tools, Study, Datasets, and Help. The "Study" menu is open, showing options like Channel locations, Channel data (scroll) (which is highlighted with a red box), Channel spectra and maps, Channel properties, Channel ERP image, Channel ERPs, ERP map series, Sum/Compare ERPs, Component activations (scroll), Component spectra and maps, Component maps, Component properties, Component ERP image, Component ERPs, Sum/Compare comp. ERPs, Data statistics, Time-frequency transforms, Average time-frequency, and New Time-freq. transforms.

**Warning Dialog:** A modal dialog titled "Warning" contains the text: "Mark stretches of continuous data for rejection by dragging the left mouse button. Click on marked stretches to unmark. When done, press 'REJECT' to excise marked stretches (Note: Leaves rejection boundary markers in the event table)." It has "Cancel" and "Continue" buttons.

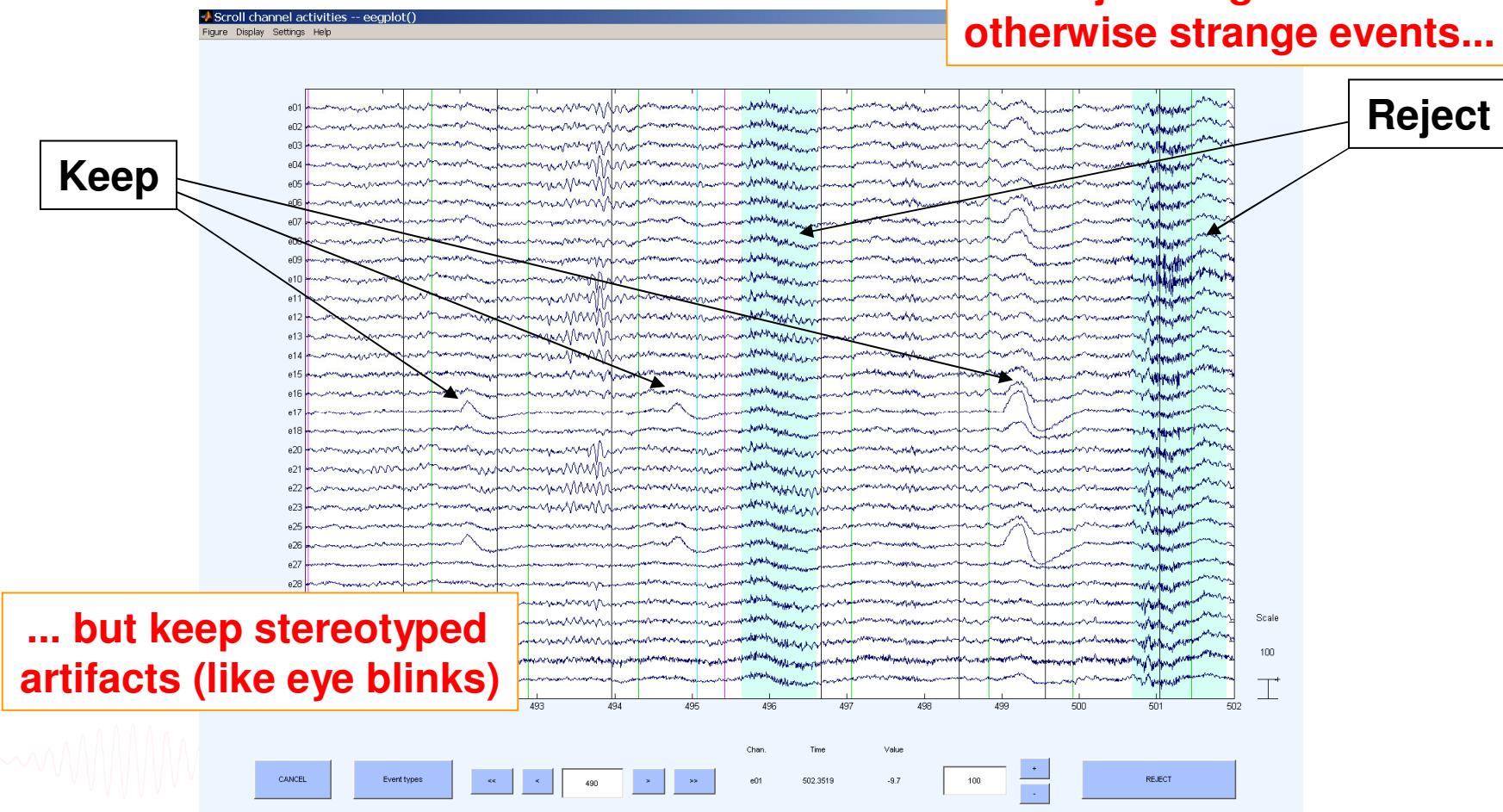
# Reject continuous data



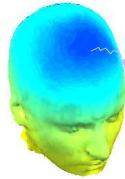
# Reject continuous data



To prepare data for ICA:



# Data import and preprocessing



## 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

- Analysis of ERPs
- Export EEG data

## Task 6

- Reject badchannels

## Task 7

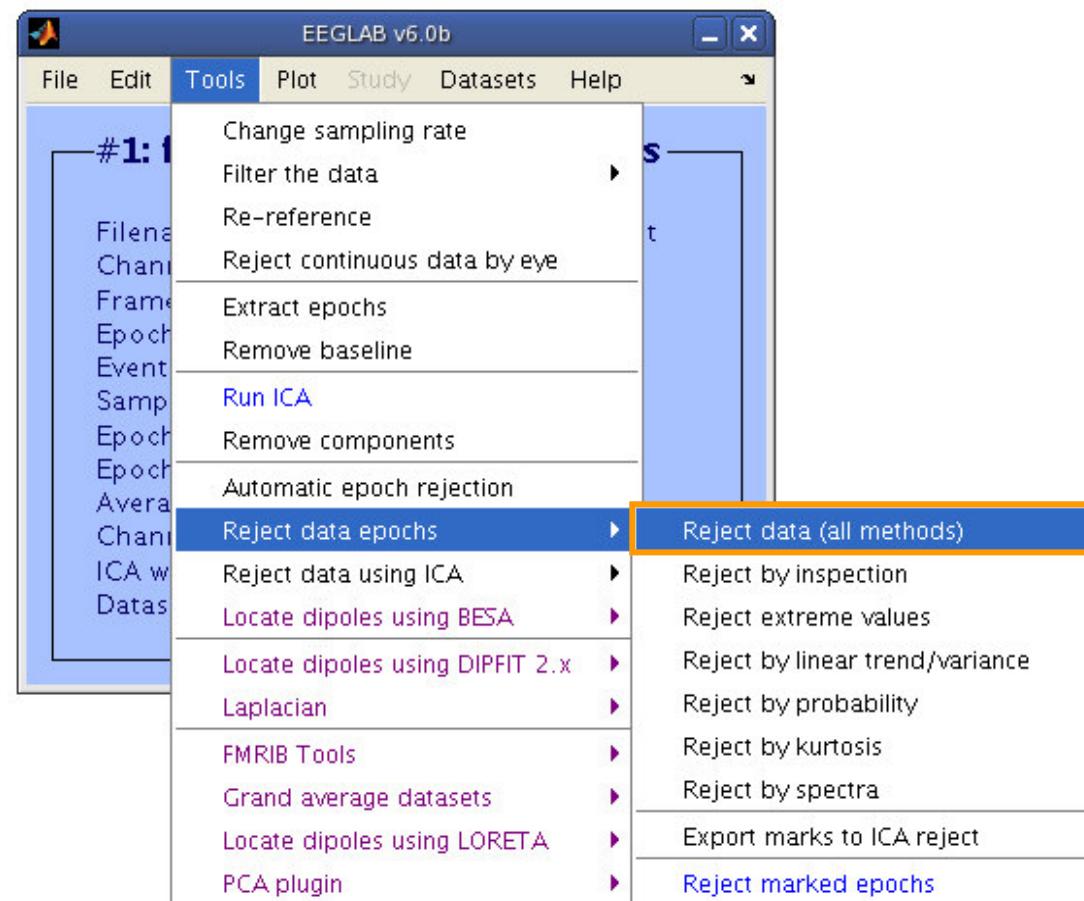
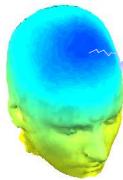
- Reject continuous data

## Task 8

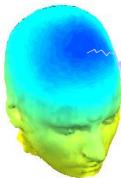
- Reject data epochs

Exercise...

# Reject data epochs



# Reject data epochs



visual inspection

probability

Reject trials using data statistics - pop\_rejmenu()

**Mark trials by appearance**

**Find abnormal values**  
Upper limit(s) (uV): 25  
Start time(s) (ms): -1000  
Electrode(s): 1:31  
Calc / Plot

**Find abnormal trends**  
Max slope (uV/epoch): 50  
Electrode(s): 1:31  
Calc / Plot

**Find improbable data**  
Single-channel limit (std. dev.): 5  
Electrode(s): 1:31  
Calculate

All channels limit (std. dev.): 5  
Currently marked trials: 0  
Plot

**Find abnormal distributions**  
Single-channel limit (std. dev.): 5  
Electrode(s): 1:31  
Calculate

All channels limit (std. dev.): 5  
Currently marked trials: 0  
Plot

**Find abnormal spectra (slow)**  
Upper limit(s) (dB): 25  
Low frequency(s) (Hz): 0  
Electrode(s): 1:31  
Calc / Plot

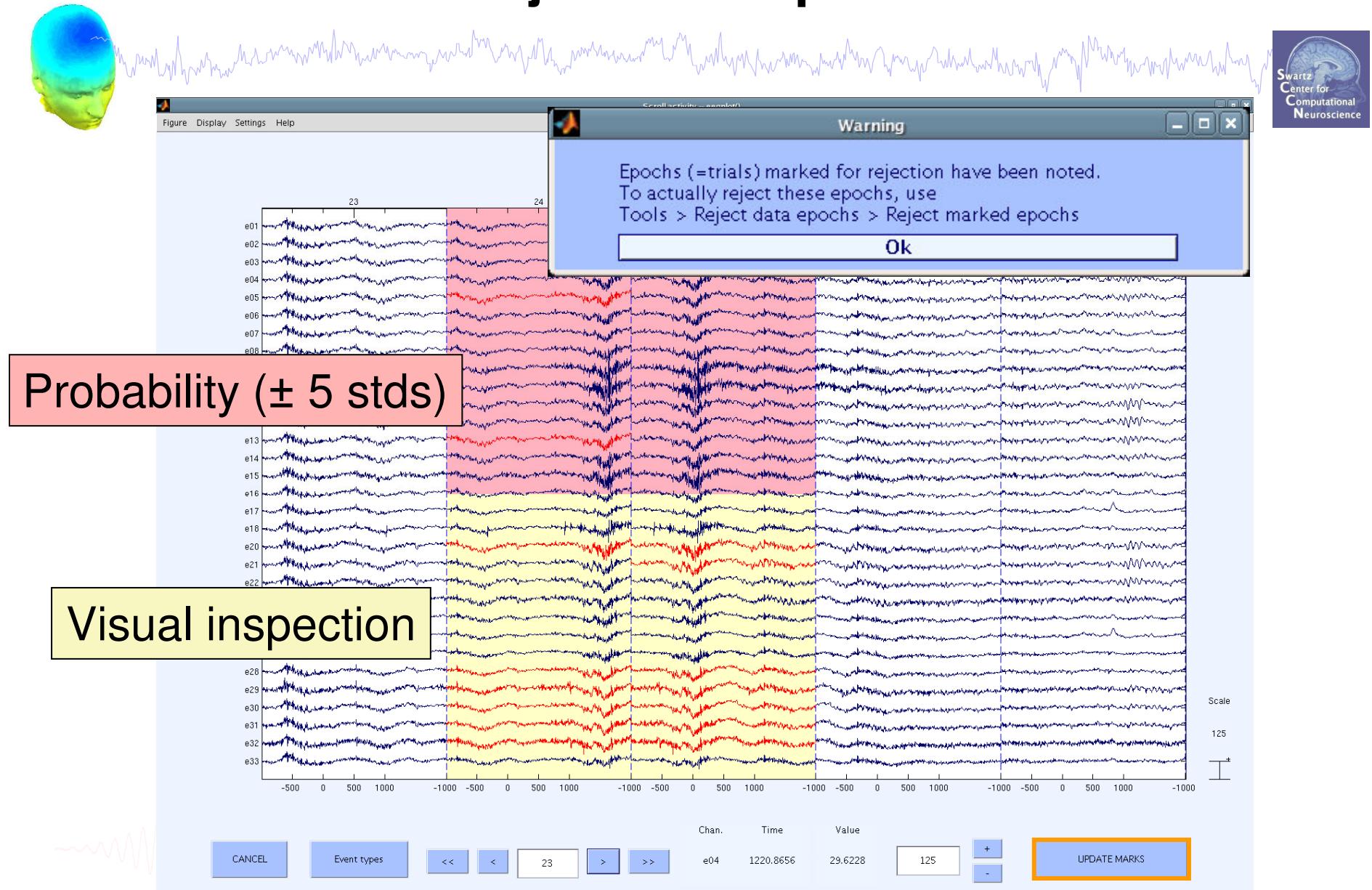
Lower limit(s) (dB): -25  
High frequency(s) (Hz): 50  
Currently marked trials: 0  
Plot

**Plotting options**  
Show all trials marked for rejection by the measure selected above or checked below  
 Abnormal appearance    Abnormal values    Abnormal trends  
 Improbable epochs    Abnormal distributions    Abnormal spectra

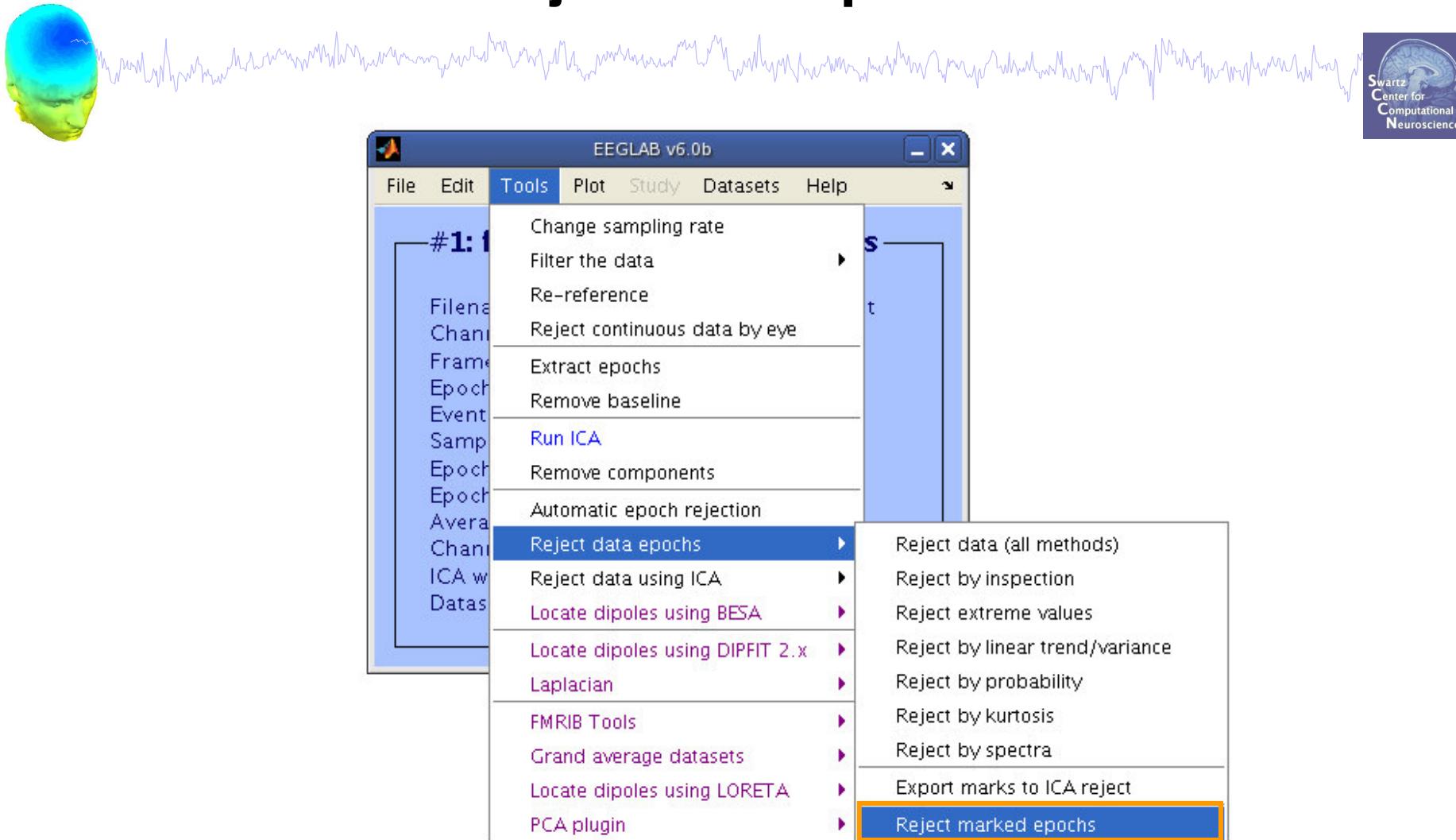
**Buttons:** Close (keep marks), Clear all marks, Reject marked trials



# Reject data epochs

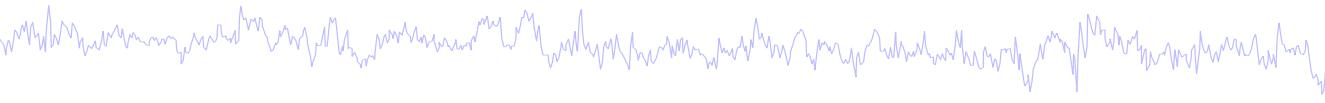
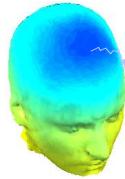


# Reject data epochs



```
>> EEG = pop_jointprob(EEG, 1, [1:31], 5, 5, 0, 0);  
>> EEG = pop_rejepoch(EEG, find(EEG.reject.rejglobal), 0);
```

# Data import and preprocessing



## Task 1

- Import raw data
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- Scroll channel data

## Task 2

- Import channel location file

## Task 3

- Import data events

## Task 4

- Extract data epochs
- Select epochs/events



## Task 5

- Analysis of ERPs
- Export EEG data

## Task 6

- Reject badchannels

## Task 7

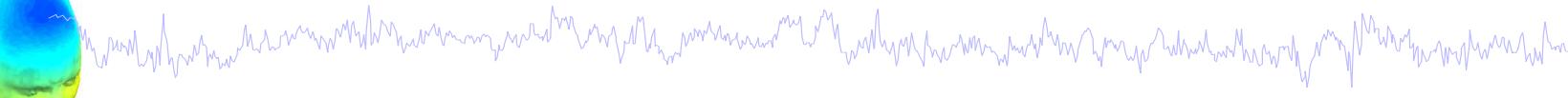
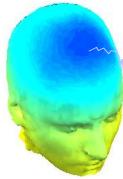
- Reject continuous data

## Task 8

- Reject data epochs

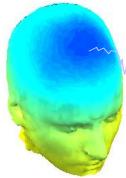
## Exercise...

# Exercise 1



- **ALL**
  - Load faces\_3.set
  - Do not save your changes under the same name!
- **Novice**
  - Rerefence the data to Cz.
  - Scroll data and explore plotting options under 'Settings'.
- **Intermediate**
  - Load channel locations from .locs file in 'data' folder, explore options to transform axes.
  - Review events in Edit->Event values, rename an event in Select epochs/events.
  - Create a new event field in Edit->Event fields.
- **Advanced**
  - Epoch the data on faces and objects separately, then use pop\_comperp to compare ERPs between conditions.
  - Explore other menu options.

# Exercise 2



- **ALL**

- Load faces\_3.set or faces\_4.set
- Epoch the data on faces and objects
- From Reject data epochs->All methods menu
- Scroll the data and perform visual rejection
- Try other rejection protocols and compare
- Explore channel probability and abnormal distribution plots

