



# EEGLAB Processing

Data import/Preprocessing

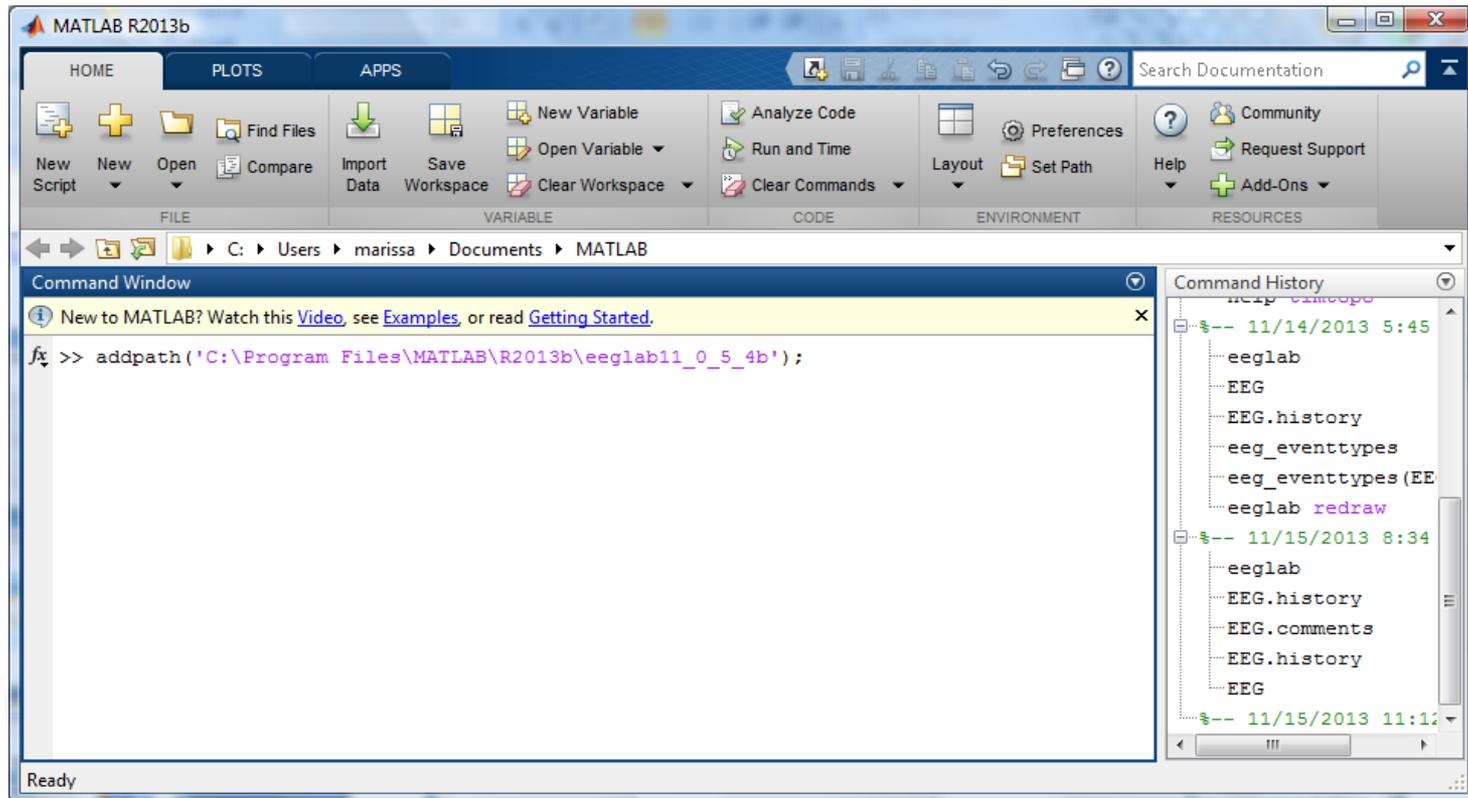
Basic ERP visualization



# Installing EEGLAB and data folder



- Start Matlab
- Add the EEGLAB folder to your Matlab path:



# The EEGLAB Matlab software



## main graphic interface

The screenshot shows the MATLAB R2013b environment. The main window has a ribbon interface with tabs for HOME, PLOTS, and APPS. The Command Window shows the command `fx >> eeglab`. The EEGLAB v11.0.5.4b window is open, displaying a message: "No current dataset". Below the message is a list of instructions:

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

# Sample data: basic P300 paradigm



## File

SimpleOddball.set

## Data

68 channel EEG, 256 Hz sampling rate, Biosemi system, re-referenced during import to averaged left and right mastoid electrodes

## Task

speeded button press response to star shape (no response to circle shape), 100 ms presentation duration, 200 trials



# Pre-processing pipeline



Collect high-density EEG data (>30 chan)

Import into EEGLAB

Import event markers and channel locations

Re-reference/  
down-sample  
(if necessary)

High pass filter  
(~.5 – 1 Hz)

Examine raw data

Identify/reject  
bad channels

Reject large artifact  
time points

Run ICA

# Importing a dataset



EEGLAB v11.0.5.4b

File Edit Tools Plot Study Datasets Help

Import data

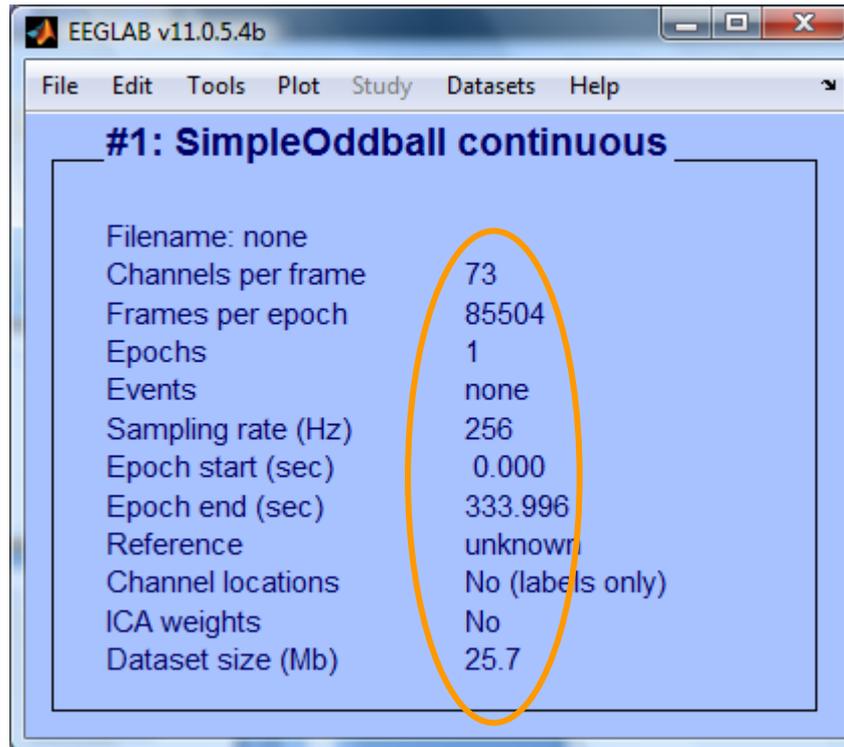
- Using EEGLAB functions and plugins
- Using the FILE-IO interface
- Using the BIOSIG interface
- Troubleshooting data formats...

Load existing dataset

- From ASCII/float file or Matlab array
- From Netstation .mff (FILE-IO toolbox)
- From Netstation binary simple file
- From Multiple seg. Netstation files
- From Netstation Matlab files
- From BCI2000 ASCII file
- From Snapmaster .SMA file
- From Neuroscan .CNT file
- From Neuroscan .EEG file
- From Biosemi BDF file (BIOSIG toolbox)
- From Biosemi BDF and EDF files (BDF plugin)**
- From EDF/EDF+/GDF files (BIOSIG toolbox)
- From ANT EEProbe .CNT file
- From ANT EEProbe .AVR file
- From BCI2000 .DAT file
- From BIOPAC MATLAB files
- From Brain Vis. Rec. .vhdr file
- From Brain Vis. Anal. Matlab file
- From CTF folder (MEG)
- From ERPSS .RAW or .RDF file
- From INStep .ASC file
- From 4D .m4d pdf file
- From Procom Infinity Text File

Tip for Biosemi users:  
Use the 'BDF plugin' version  
of the Biosemi BDF/EDF importer

# Imported EEG data



# Pre-processing pipeline



Collect high-density EEG data (>30 chan)

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Re-reference/  
down-sample  
(if necessary)

High pass filter  
(~.5 – 1 Hz)

Remove line noise  
(if necessary)

Identify/reject  
bad channels

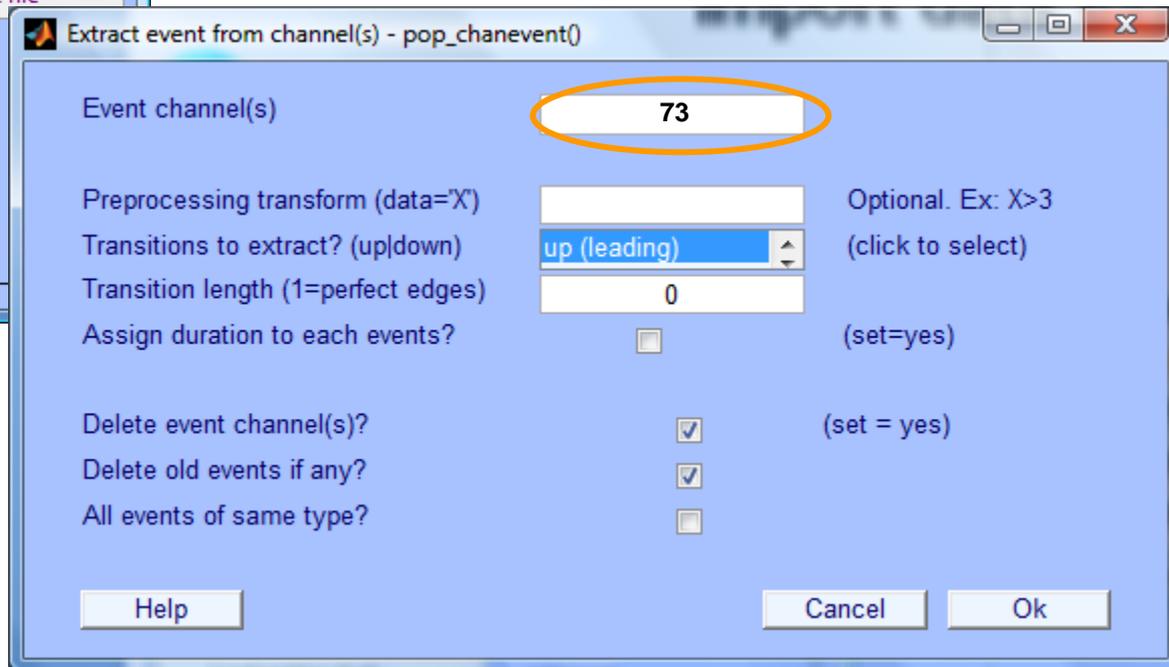
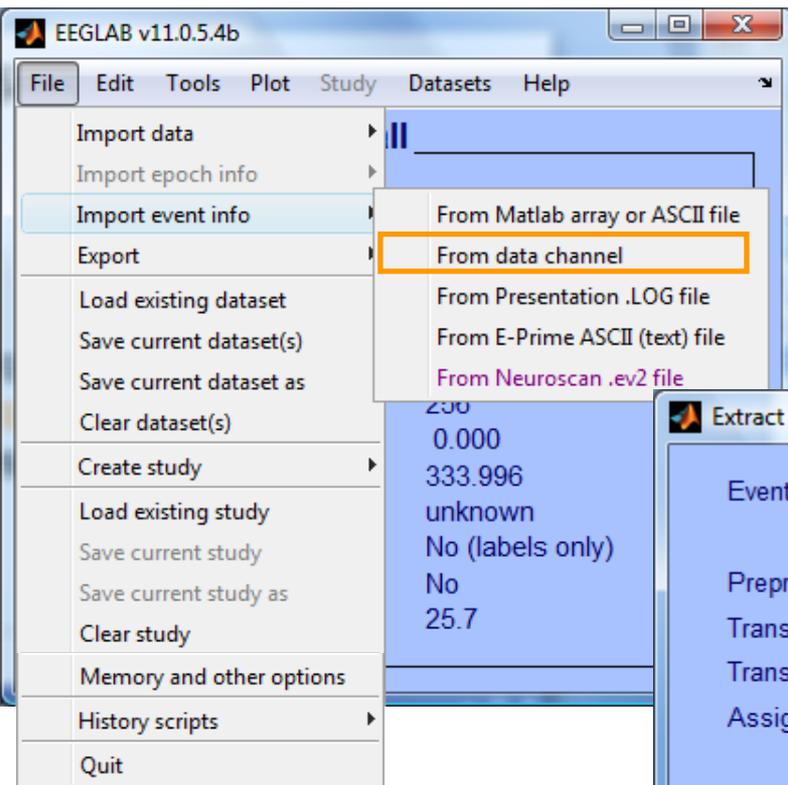
Reject large artifact  
time points

Run ICA

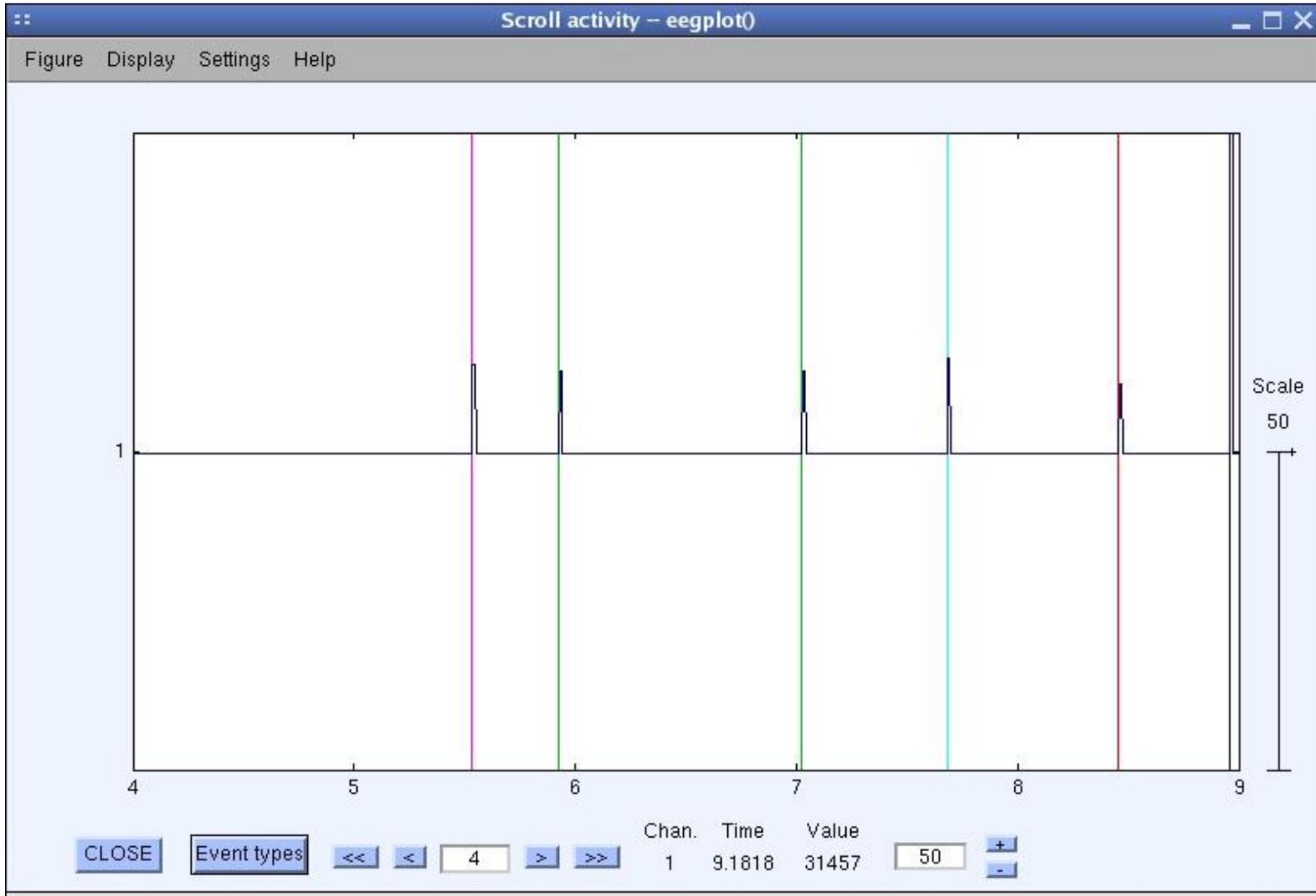
# Import data events



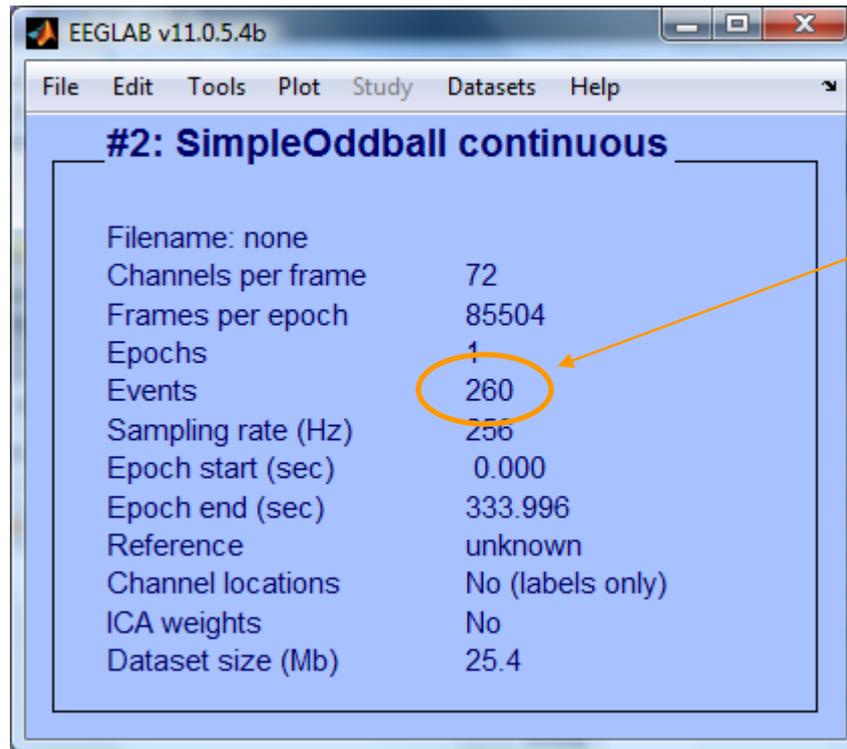
(Often imported automatically during data import)



# Appearance of an event channel in raw data



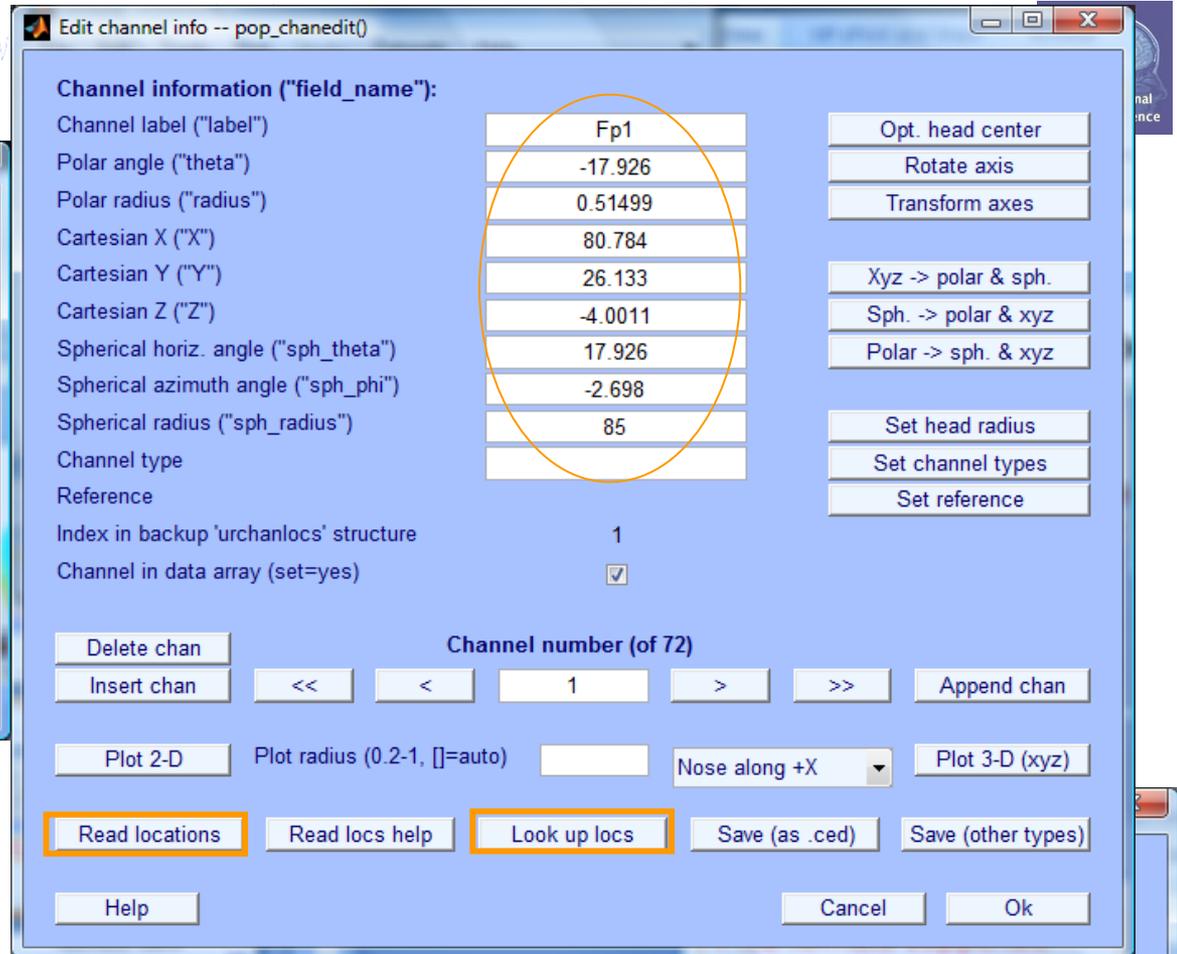
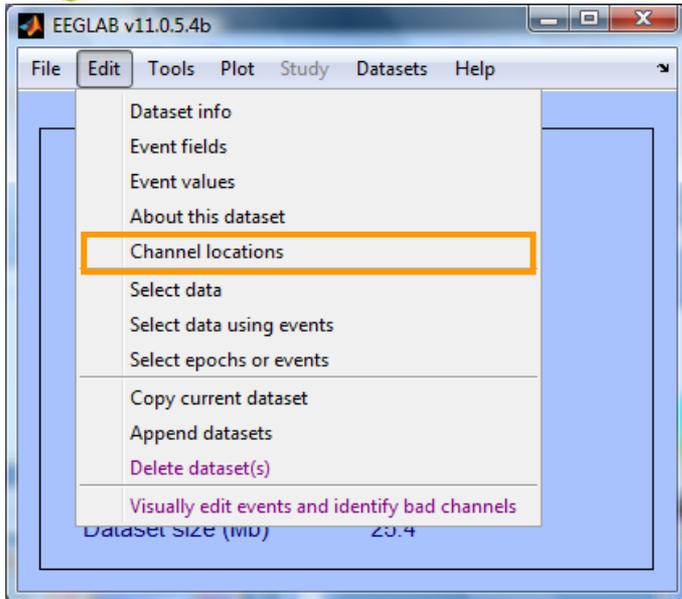
# Imported data events



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

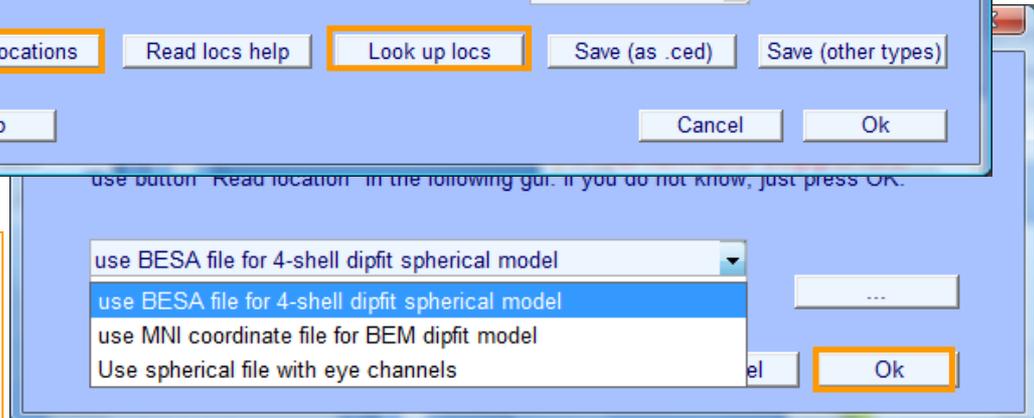


# Import channel locations



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

Standard locations offered  
if you do not have locations  
and labels are standard



# Import channel locations



**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	EEG
Reference	
Index in backup 'urchanlocs' structure	
Channel in data array (set=yes)	<input checked="" type="checkbox"/>

Buttons: Delete chan, Insert chan, Plot 2-D, Read locations, Help, Channel number (of 71): 1, Append chan, Plot 3-D (xyz), Save (as .ced), Save (other types), Cancel, Ok

Buttons: Opt. head center, Rotate axis, Transform axes, Set head radius, Set channel types, Set reference, Xyz -> polar & sph., Sph. -> polar & xyz, Polar -> sph. & xyz

**Convert channel locations -- pop\_chancenter()**

Optimize center location  or specify center

Channel indices to ignore for best-sphere matching

Buttons: Help, Browse, Cancel, Ok

**Force electrode location -- forclocs()**

XY value	Coordinate	Electrode list
<input type="text" value="0"/>	X (rotate X-Z plane)	<input type="text" value="Cz"/>

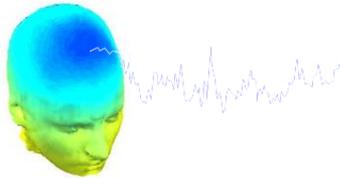
Buttons: Help, Pick, Cancel, Ok

**Set channel ...**

Channel indices

Type (e.g. EEG)

Buttons: Help, Cancel, Ok



**Edit channel info -- pop\_chanedit()**

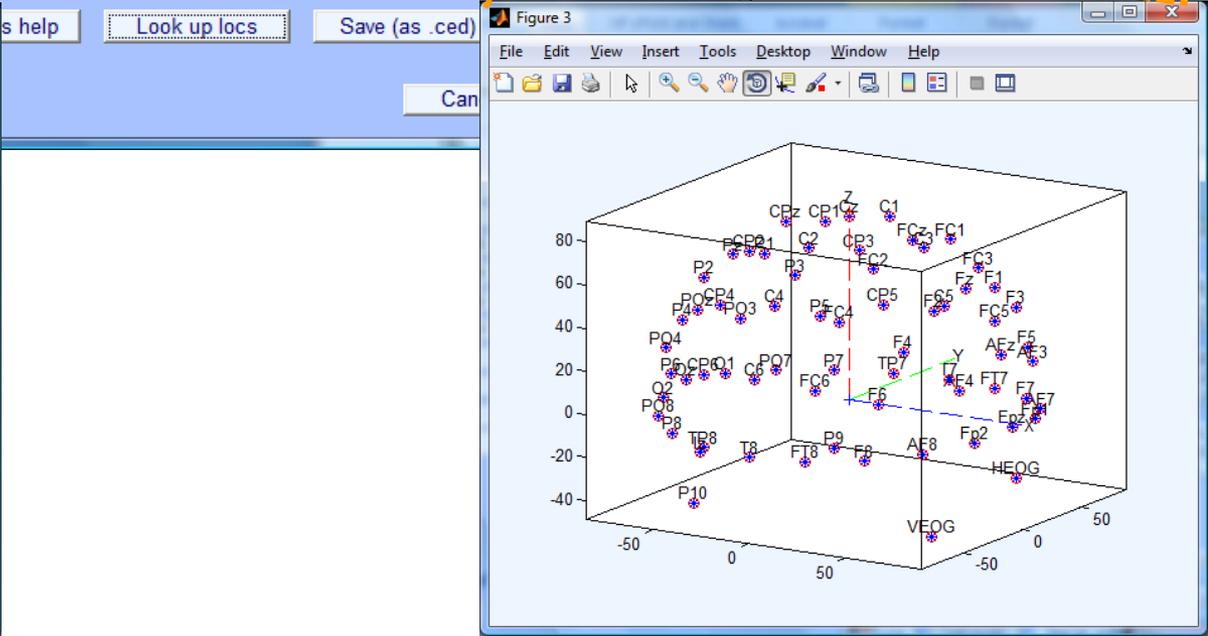
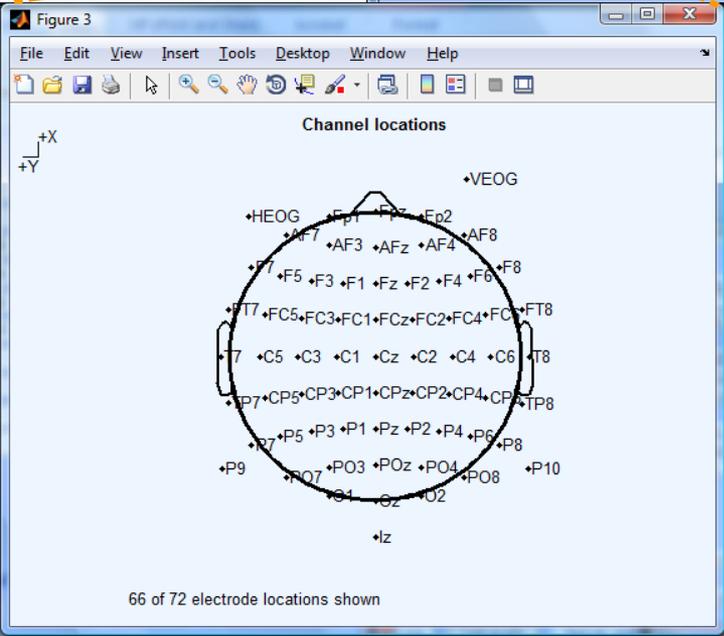
**Channel information ("field\_name"):**

Channel label ("label")	HEOG	Opt. head center
Polar angle ("theta")	-42	Rotate axis
Polar radius ("radius")	0.65556	Transform axes
Cartesian X ("X")	55.7734	XYZ -> polar & sph.
Cartesian Y ("Y")	50.2186	Sph. -> polar & xyz
Cartesian Z ("Z")	-39.9051	Polar -> sph. & xyz
Spherical horiz. angle ("sph_theta")	42	Set head radius
Spherical azimuth angle ("sph_phi")	-28	Set channel types
Spherical radius ("sph_radius")	85	Set reference
Channel type		
Reference		
Index in backup 'urchanlocs' structure	68	
Channel in data array (set=yes)	<input checked="" type="checkbox"/>	

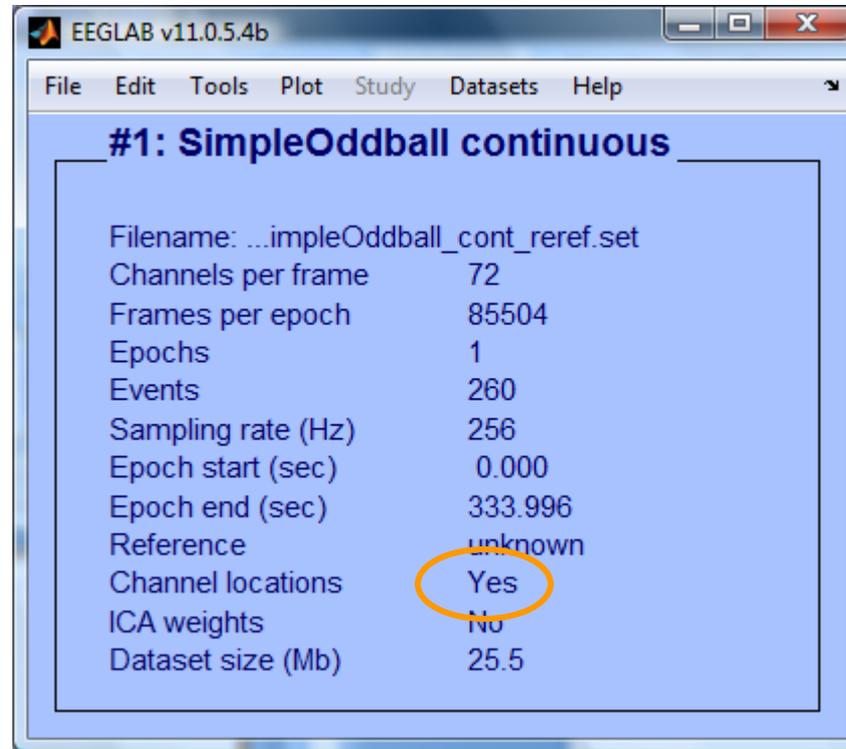
Channel number (of 72): 68

Buttons: Delete chan, Insert chan, Append chan

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



# Imported channel locations



# Pre-processing pipeline



Collect high-density EEG data (>30 chan)

Import into EEGLAB

Import event markers and channel locations

Re-reference/  
down-sample  
(if necessary)

High pass filter  
(~.5 – 1 Hz)

Remove line noise  
(if necessary)

Identify/reject  
bad channels

Reject large artifact  
time points

Run ICA

# Re-reference data (if necessary/desired)



For example,  
average reference

EEGLAB v10.2.2.1b

File Edit **Tools** Plot Study Datasets Help

#1

Change sampling rate  
Filter the data  
**Re-reference**  
Interpolate electrodes  
Reject continuous data

Extract epochs  
Remove baseline  
Run ICA  
Remove components

Automatic channel selection  
Automatic epoch rejection  
Reject data epochs  
Reject data using ICA

NFT plugin  
SIFT

Locate dipoles using...  
Peak detection using EEG toolbox

FMRIB Tools  
Locate dipoles using LORETA

pop\_reref - average reference or re-reference data

Current data reference state is: unknown

Compute average reference

Re-reference data to channel(s):

Retain old reference channels in data

Exclude channel indices (EMG, EOG) optional **LEYE REYE**

Add current reference channel back to the data

Help Cancel Ok

(use shift|ctrl to select several)

- 1 - LEYE
- 2 - REYE
- 3 - OZ
- 4 - O2
- 5 - FP1
- 6 - FPZ
- 7 - FP2
- 8 - AF7
- 9 - AF3
- 10 - AFZ
- 11 - AF4
- 12 - AF8
- 13 - F9
- 14 - F7
- 15 - F5
- 16 - F3
- 17 - F1
- 18 - FZ
- 19 - F2
- 20 - F4
- 21 - F6
- 22 - F8
- 23 - F10
- 24 - FT9
- 25 - FT7
- 26 - FC5

Cancel Ok

# Re-reference data (if necessary/desired)



OR, re-reference to  
(i.e.) 'linked mastoids'

EEGLAB v10.2.2.1b

File Edit **Tools** Plot Study Datasets Help

#1

Change sampling rate

Filter the data

**Re-reference**

Interpolate electrodes

Reject continuous

Extract epochs

Remove baseline

Run ICA

Remove component

Automatic channel selection

Automatic epoch selection

Reject data epochs

Reject data using

NFT plugin

SIFT

Locate dipoles using

Peak detection using

FMRIB Tools

Locate dipoles using LORETA

pop\_reref - average reference or re-reference data

Current data reference state is: unknown

Compute average reference

Re-reference data to channel(s): RMAS LMAS

Retain old reference channels in data

Exclude channel indices (EMG, EOG)

Add current reference channel back to the data

Help Cancel Ok

(use shift|ctrl to select several)

47 - FCz

48 - Cz

49 - C2

50 - C4

51 - C6

52 - T8

53 - TP8

54 - CP6

55 - CP4

56 - CP2

57 - P2

58 - P4

59 - P6

60 - P8

61 - P10

62 - PO8

63 - PO4

64 - O2

**65 - RMAS**

**66 - LMAS**

67 - VEOG

68 - HEOG

69 - EXG5

70 - EXG6

71 - EXG7

72 - EXG8

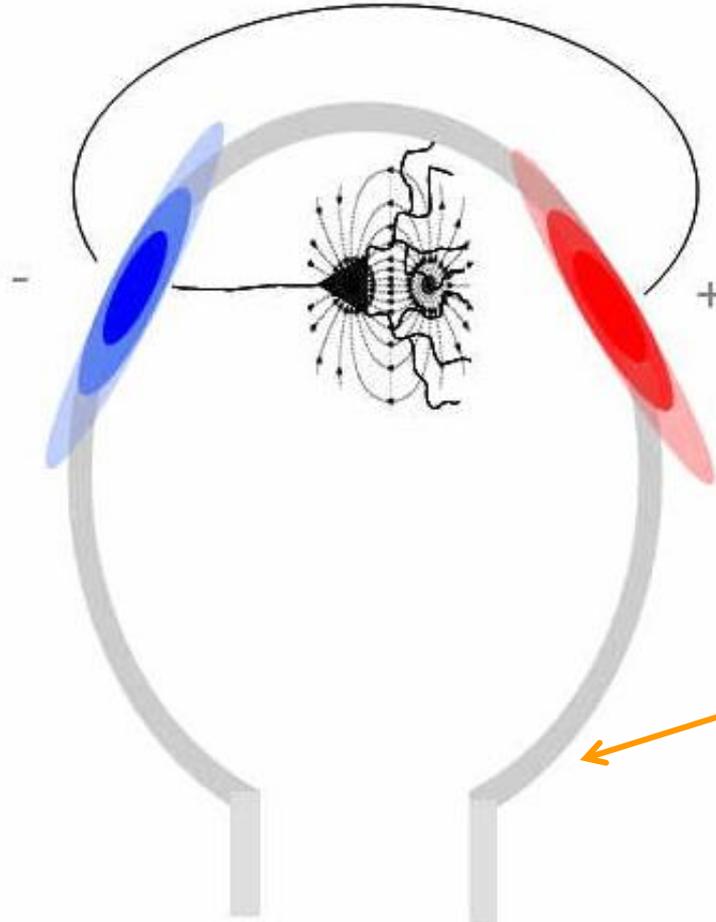
Cancel Ok

# Choice of reference

The “perfect” reference is probably impossible to find



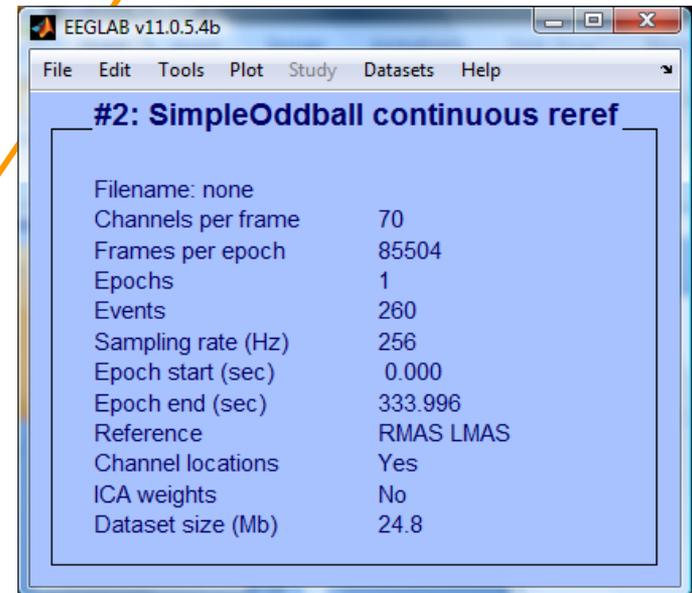
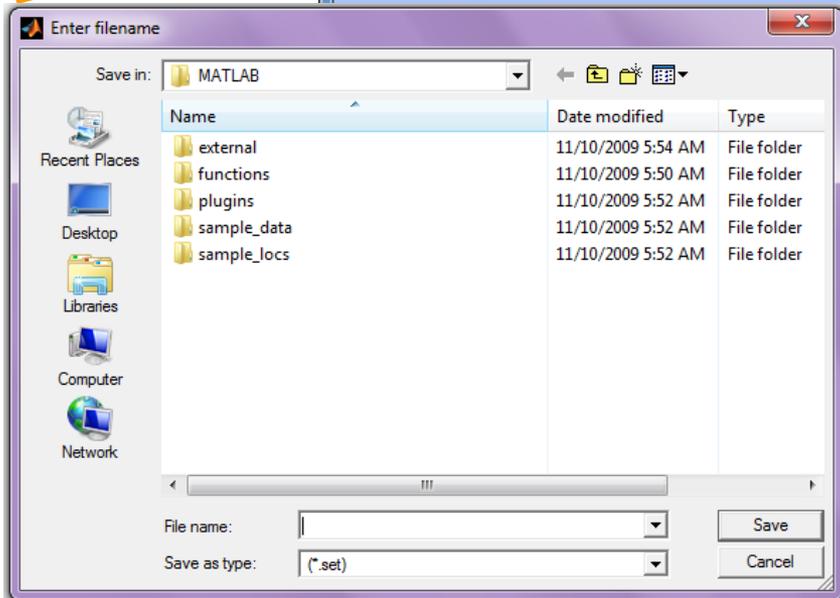
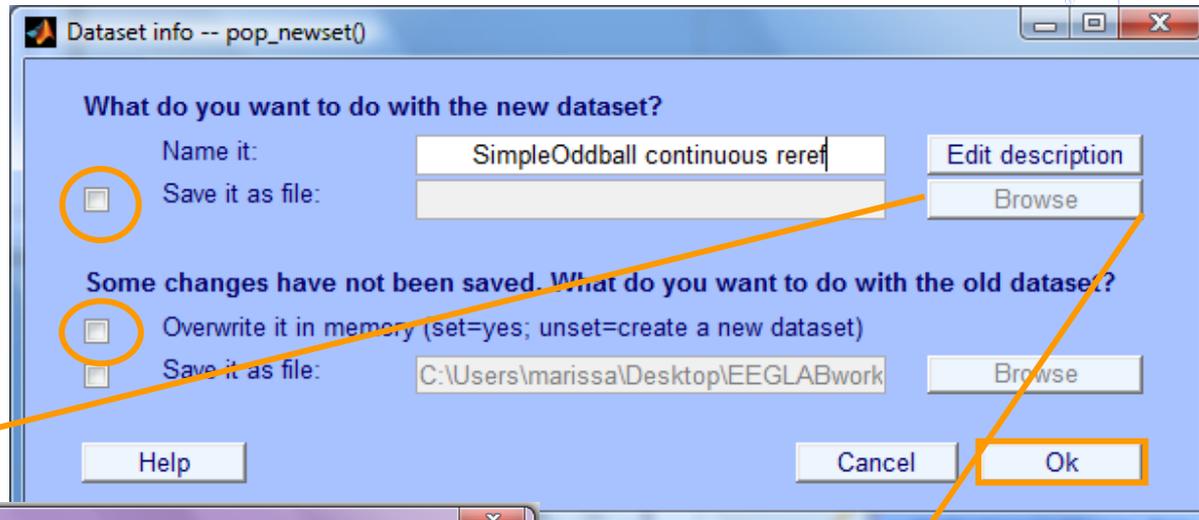
True average reference requires **even electrode distribution over the head**



Typical montages have **fewer (if any) on the lower half of the head surface**

**Rationale for average reference:** outward positive and negative currents, summed across an entire (electrically isolated) sphere, will sum to 0 (by Ohm's law)

# Save new dataset, keep old one



# Multiple active datasets (ALLEEG)



EEGLAB v11.0.5.4b

File Edit Tools Plot Study Datasets Help

**#1: SimpleOddball continuous**

Filename:	...impleOddball_cont_reref.set
Channels per frame	72
Frames per epoch	85504
Epochs	1
Events	260
Sampling rate (Hz)	256
Epoch start (sec)	0.000
Epoch end (sec)	333.996
Reference	unknown
Channel locations	Yes
ICA weights	No
Dataset size (Mb)	25.5

EEGLAB v11.0.5.4b

File Edit Tools Plot Study Datasets Help

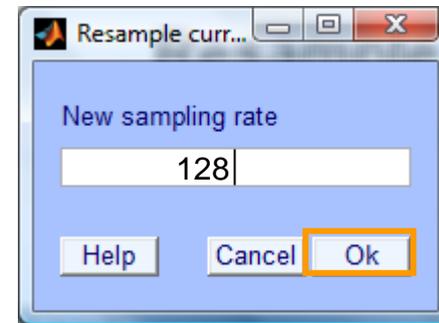
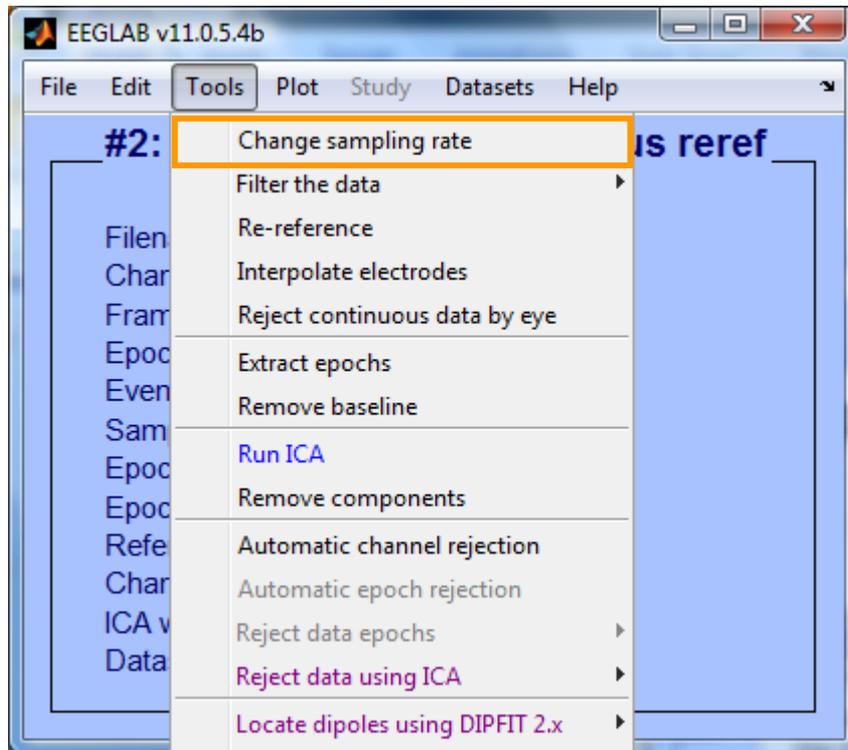
**#2: SimpleOddball continuous**

Filename:	none
Channels per frame	
Frames per epoch	85504
Epochs	1
Events	260
Sampling rate (Hz)	256
Epoch start (sec)	0.000
Epoch end (sec)	333.996
Reference	RMAS LMAS
Channel locations	Yes
ICA weights	No
Dataset size (Mb)	24.8

Dataset 1: SimpleOddball continuous  
 Dataset 2: SimpleOddball continuous  
-----  
Select multiple datasets



# Resample data (if necessary)



# Pre-processing pipeline



Collect high-density EEG data (>30 chan)

Import into EEGLAB

Import event markers and channel locations

Re-reference/  
down-sample  
(if necessary)

High pass filter  
(~.5 – 1 Hz)

Remove line noise  
(if necessary)

Identify/reject  
bad channels

Reject large artifact  
time points

Run ICA

# Filter the data (if necessary/desired)



Lower cut off frequencies require longer stretches of continuous data

EEGLAB v11.0.5.4b

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 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

CleanLine

Basic FIR filter

ERPLAB Butterworth

ERPLAB Polynomial

Short non-linear IIR

Filter the data -- pop\_eegfilt()

Lower edge of the frequency pass band (Hz) 0.5

Higher edge of the frequency pass band (Hz)

FIR Filter order (default is automatic)

Notch filter the data instead of pass band

Use (sharper) FFT linear filter instead of FIR filtering (Use the option above if you do not have the Signal Processing Toolbox)

Use causal filter (useful when performing causal analysis)

Plot the filter frequency response

Use fir1 (check, recommended) or firls (uncheck, legacy)

Help Cancel Ok

High-pass needed for ICA

Dataset info -- pop\_newset()

What do you want to do with the new dataset?

Name it: SimpleOddball hipass0.5 Edit description

Save it as file: Browse

What do you want to do with the old dataset (not modified since last saved)?

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

Help Cancel Ok

# Pre-processing pipeline



Collect high-density EEG data (>30 chan)

Import into EEGLAB

Import event markers and channel locations

Re-reference/  
down-sample  
(if necessary)

High pass filter  
(~.5 – 1 Hz)

Remove line noise  
(if necessary)

Identify/reject  
bad channels

Reject large artifact  
time points

Run ICA



EEGLAB v12.0.2.1b

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
- Memory and other options
- History scripts
- Manage plugins**
  - Manage data import plugins
  - Manage data processing plugins**
  - Manage deactivated plugins
- Quit

Plutings available for install on the internet

Install	Plugin	Version	Description	
<input type="checkbox"/>	ERPLABfilters	1.00	Interface ERPLAB filters (requires seperate ERPLAB instalati...	Doc
<input type="checkbox"/>	<b>Cleanline</b>	1.21	Automatic artifact rejection	Doc
<input type="checkbox"/>	BERGEN	1.1	Removal of fMRI-related gradient artifacts from simultaneous...	Doc

Update Deactivate

**Installed plutings**

Update	Deactivate	Plugin	Version	Description	
<input type="checkbox"/>	<input type="checkbox"/>	brainmovie	0.1	Brainmovies (command line only)	Doc
<input type="checkbox"/>	<input type="checkbox"/>	coormap	2.00	New version 1.03 available. Click update to install.	Doc
<input type="checkbox"/>	<input type="checkbox"/>	eeg_toolbox	1.0	Interface EEG toolbox functions for ERP peak detection	Doc
<input type="checkbox"/>	<input type="checkbox"/>	fMRIfb	1.21	Remove fMRI artifacts from EEG	Doc
<input type="checkbox"/>	<input type="checkbox"/>	MP_clustering	1.00	Measure projection clustering of ICA components	Doc
<input type="checkbox"/>	<input type="checkbox"/>	MutualInfoClustering	1.00	Mutual information clustering	Doc
<input type="checkbox"/>	<input type="checkbox"/>	StudyEnvtopo	0.9	Add envtopo capabilities to STUDY	Doc
<input checked="" type="checkbox"/>	<input type="checkbox"/>	VisEd	1.05	New version 1.04 available. Click update to install.	Doc
<input type="checkbox"/>	<input type="checkbox"/>	iirfilt	1.02	Non linear filtering	Doc
<input type="checkbox"/>	<input type="checkbox"/>	loreta	1.1	New version 1.0 available. Click update to install.	Doc

Cancel Ok



# Remove line noise (Cleanline)



EEGLAB v11.0.5.4b

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 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

**CleanLine**

CleanLine Options

Line noise frequencies to remove [60 120]

Scan for line noise  (set)

p-value for detection of significant sinusoid 0.01

Bandwidth (Hz) 2

Type of signal to clean Channels

Indices of Channels/Components to clean '1:66'

Sliding window length (sec) 4

Sliding window step size (sec) 2

Window overlap smoothing factor 100

FFT padding factor 2

Visualize Original and Cleaned Spectra  (set)

Normalize log spectrum by detrending  (set)

Produce verbose output  (set)

Plot Individual Figures  (set)

uncheck

Help Cancel Ok

# Plot channel spectra



EEGLAB v11.0.5.4b

File Edit Tools **Plot** Study Datasets Help

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

Component properties - pop\_prop0

Channel index(ices) to plot:

Spectral options (see spectopo() help):

Help Cancel Ok



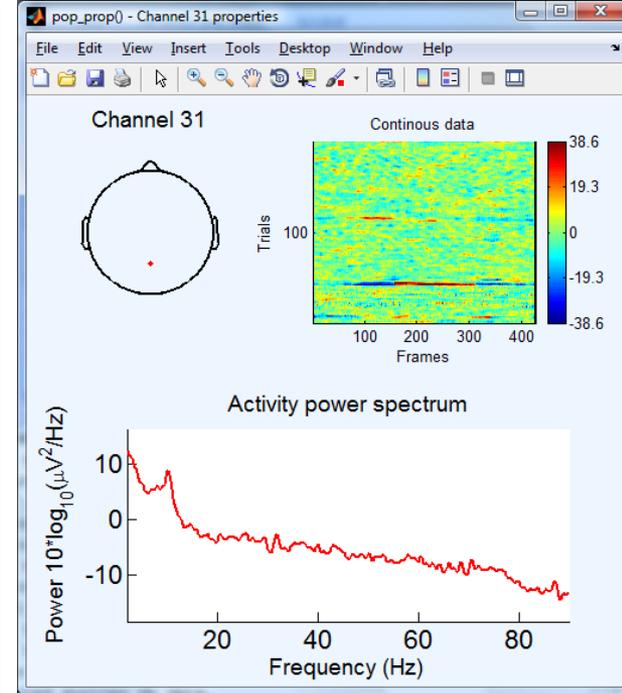
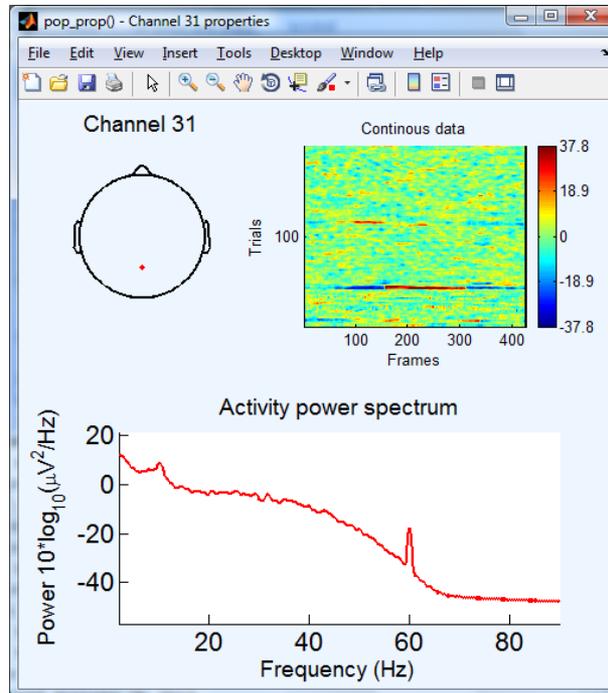
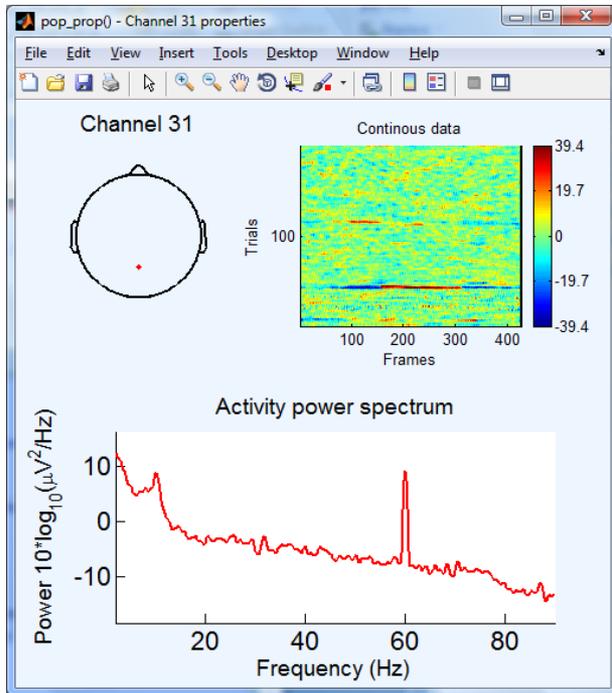
# Filter comparisons



0.5 Hz high-pass filter

0.5 Hz high-pass filter  
50 Hz low-pass filter

0.5 Hz high-pass filter  
Cleanline: 60 Hz



# Pre-processing pipeline



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Re-reference/  
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(if necessary)

High pass filter  
(~.5 – 1 Hz)

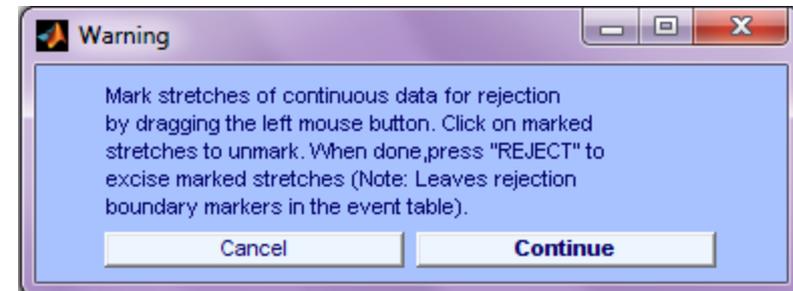
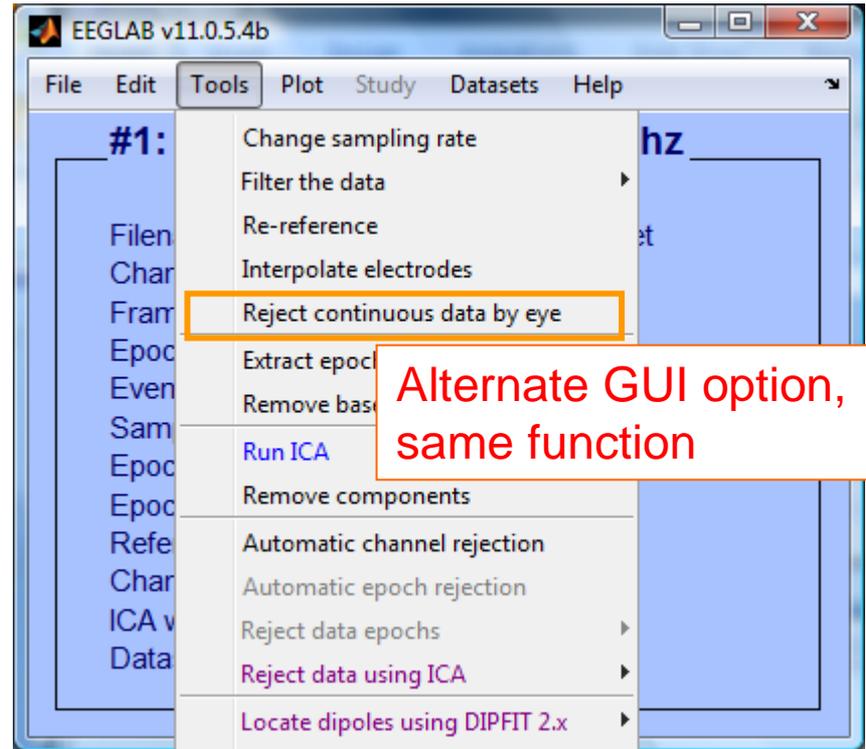
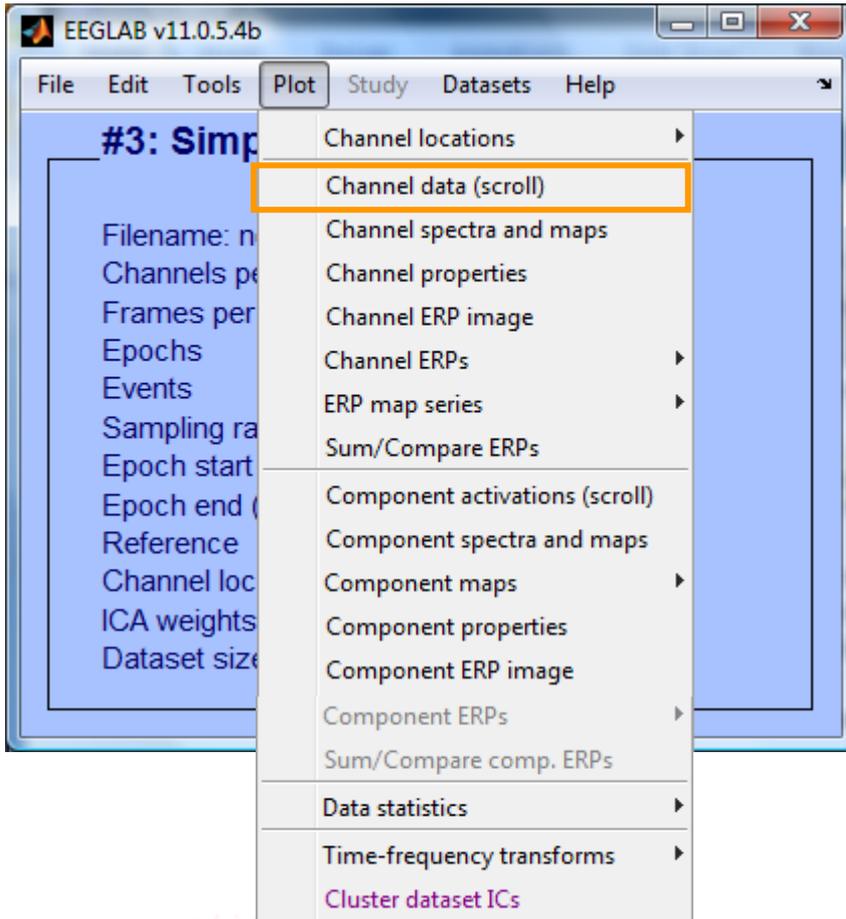
Remove line noise  
(if necessary)

Identify/reject  
bad channels

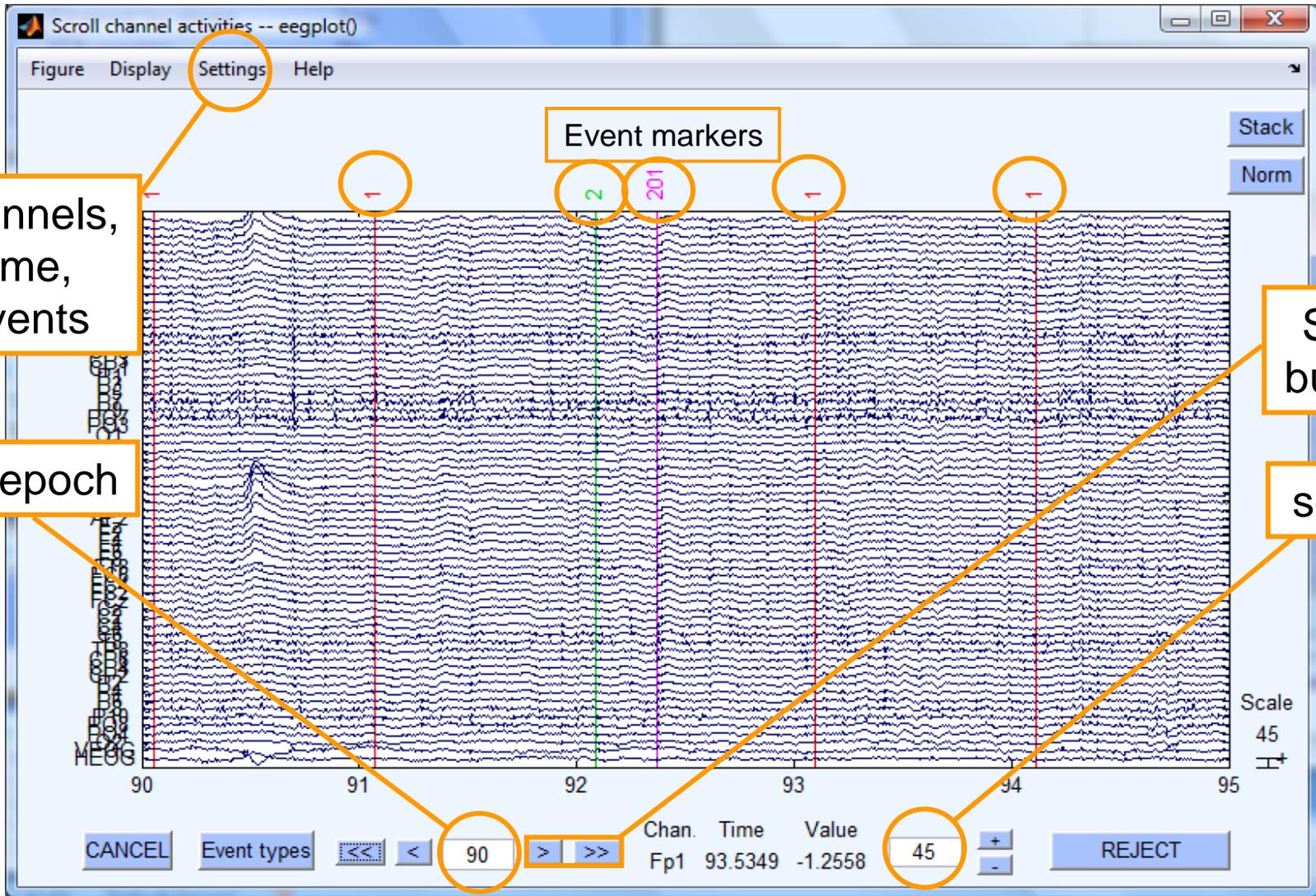
Reject large artifact  
time points

Run ICA

# Scroll channel data



# Scroll channel data



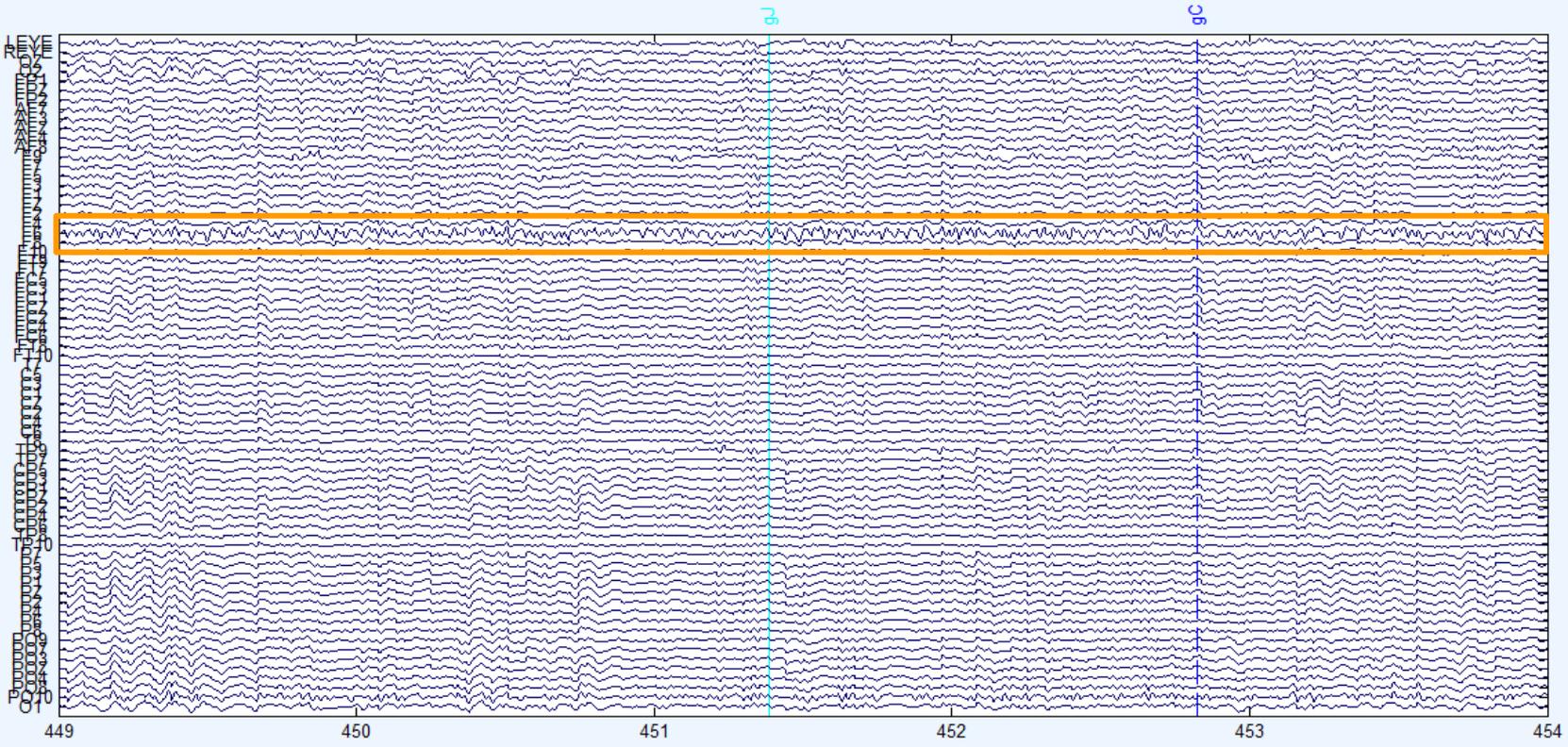
# Manually identifying bad channels



Scroll channel activities -- eegplot()

Figure Display Settings Help

Identify bad channel

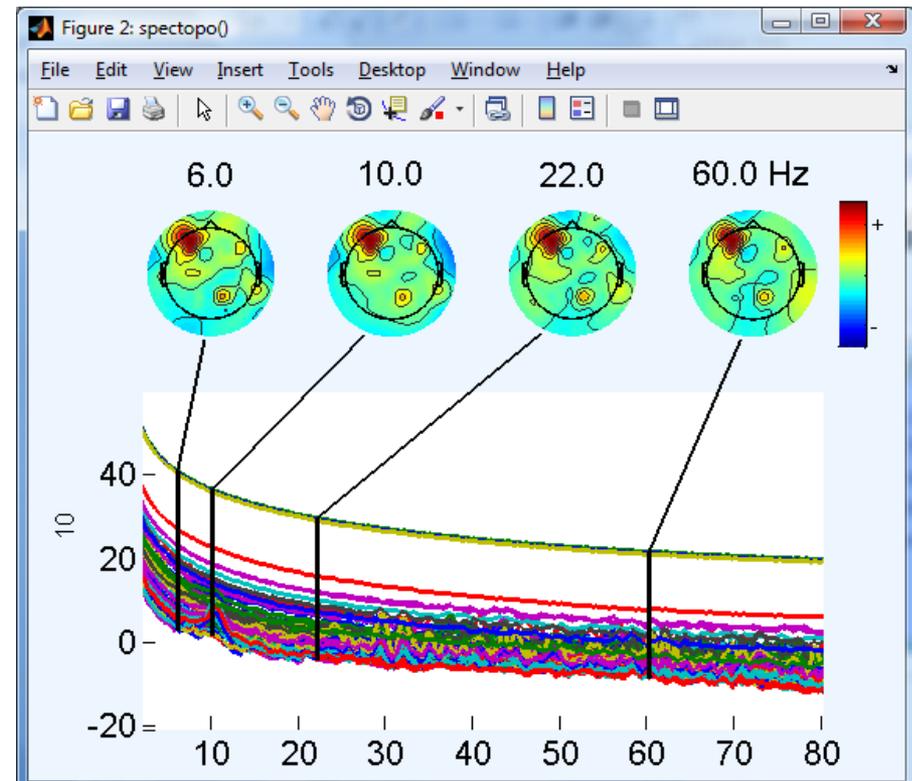
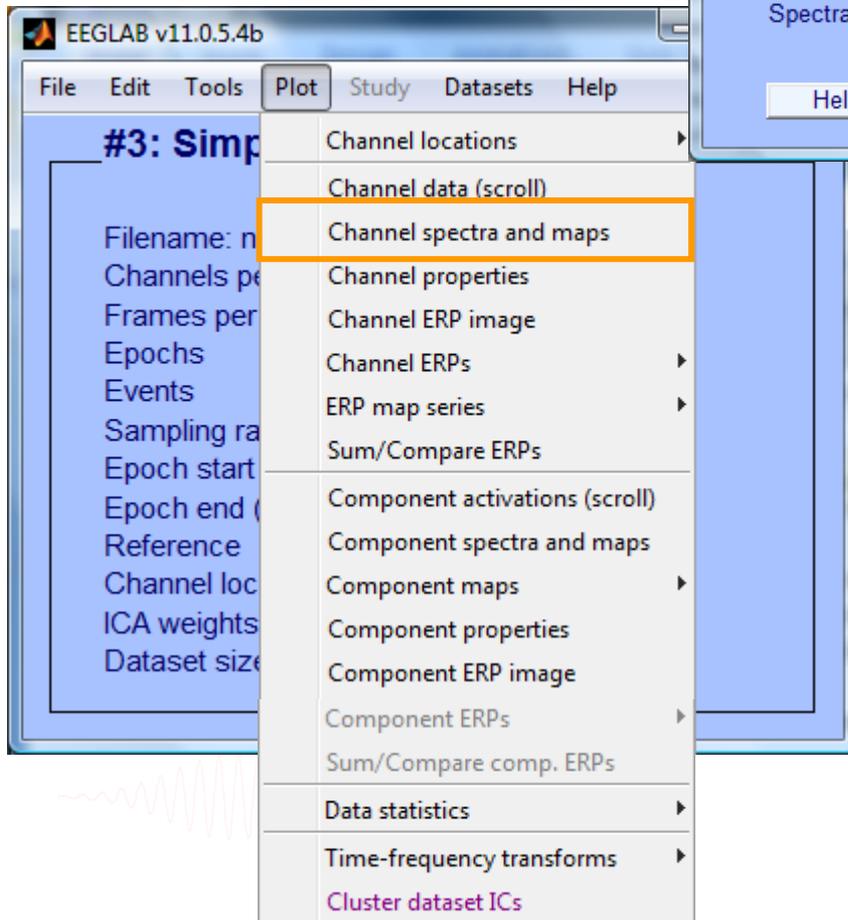
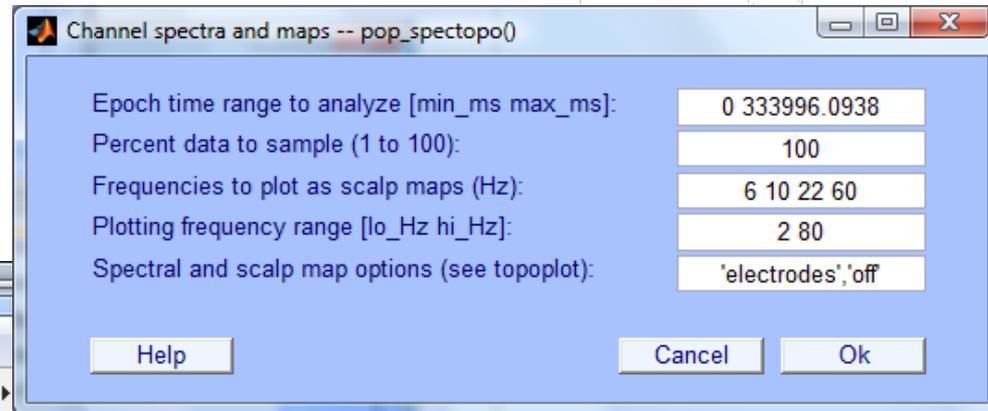


Scale  
35

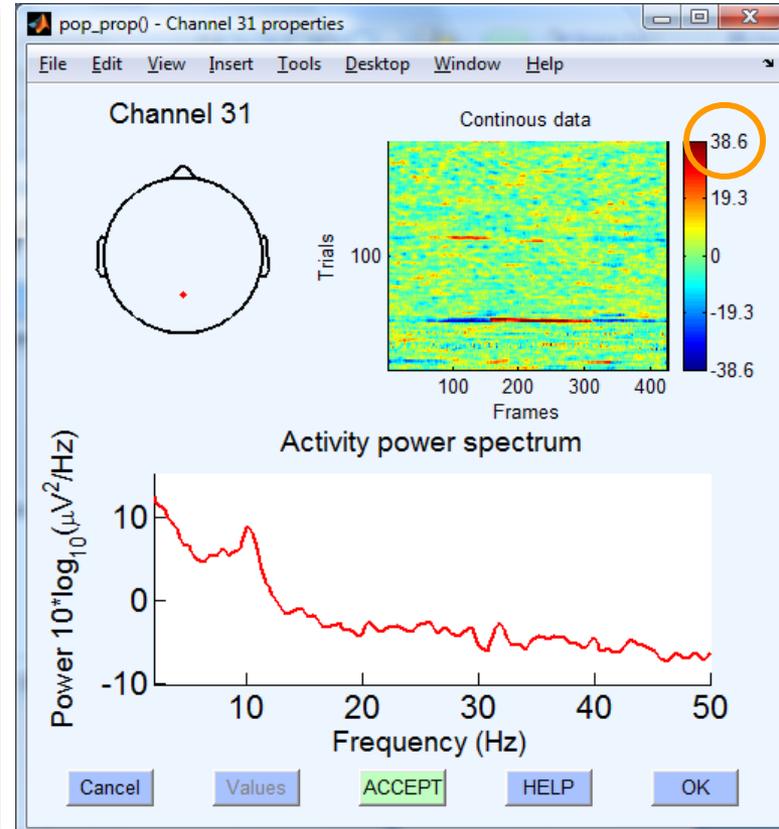
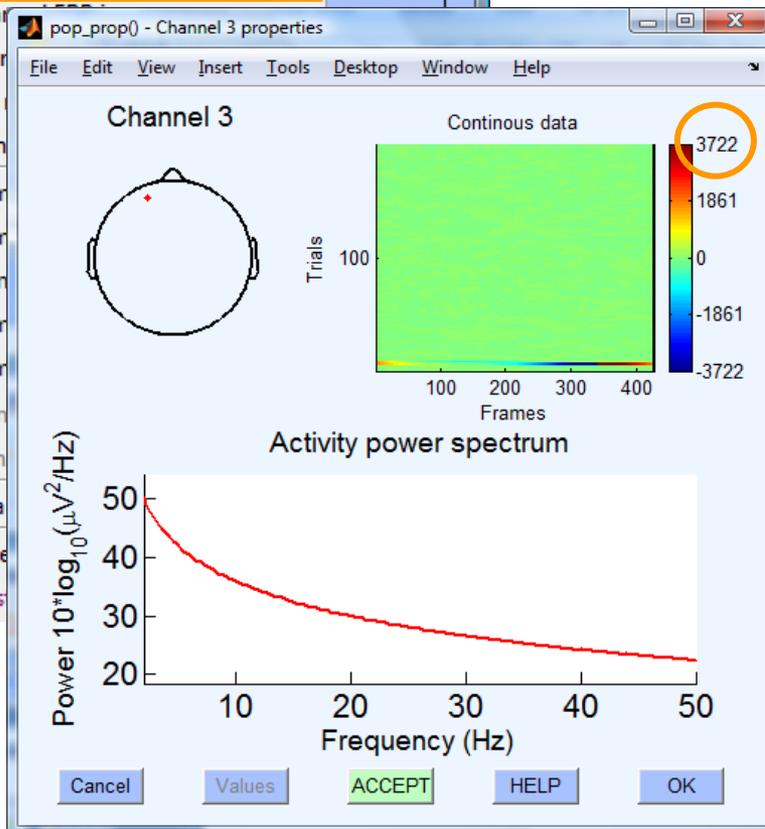
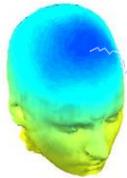
CANCEL    Event types    <<    <    449    >    >>    Chan.    Time    Value    35    +    -    REJECT

Chan.	Time	Value
01	451.0988	3.6619

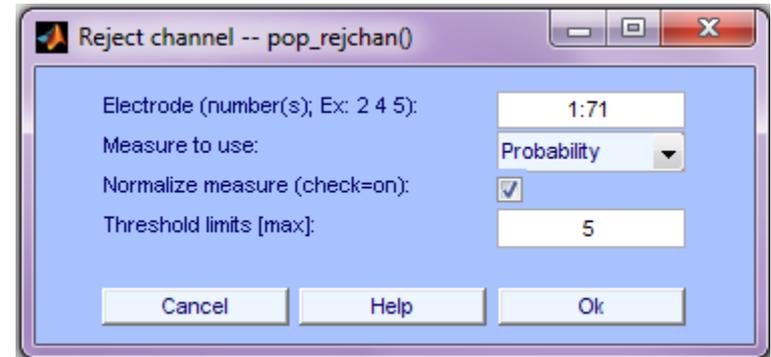
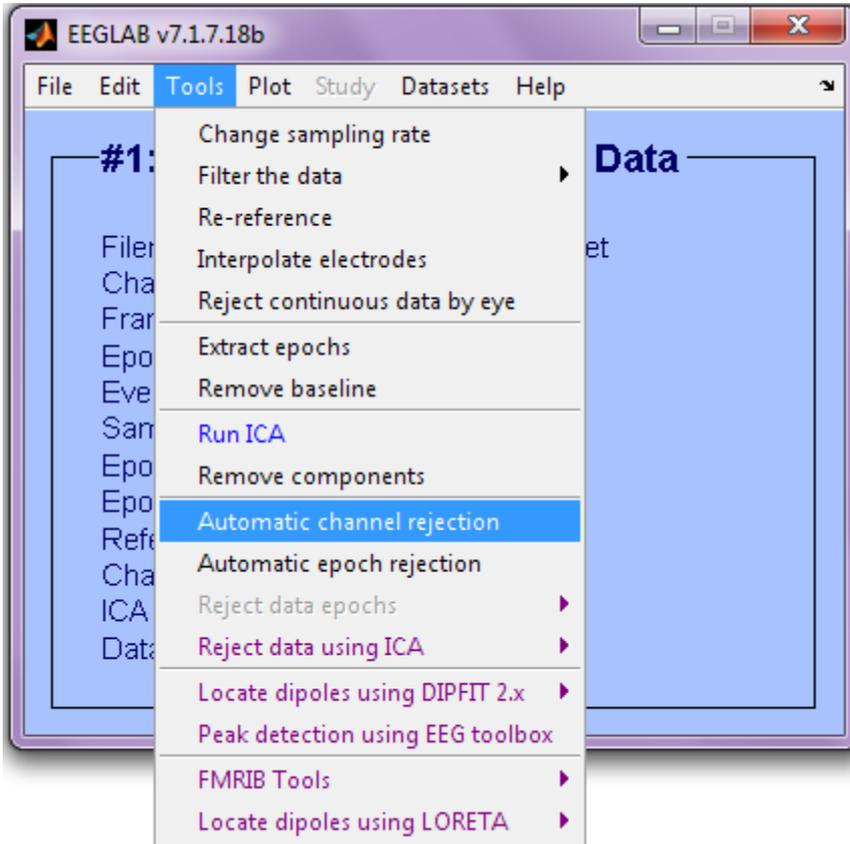
# Manually identifying bad channels



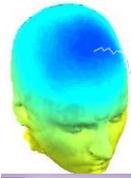
# Manually identifying bad channels



# Auto-detection of noisy channels

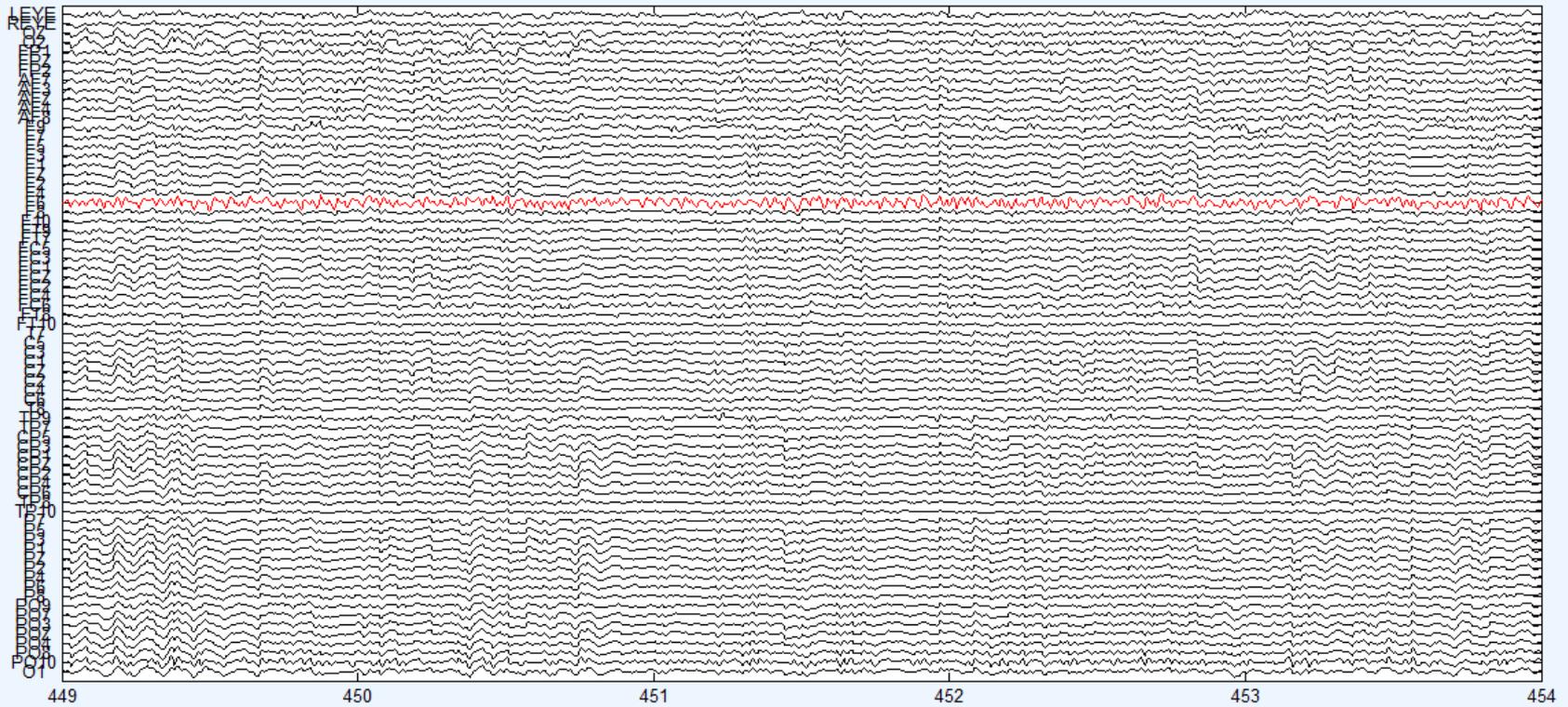


# Auto-detected noisy channel



Scroll component activities -- eegplot()

Figure Display Settings Help



Scale  
35  
↑

CANCEL

<< < 449 > >>

Chan.	Time	Value
TP8	452.1146	-2.6647

35  
+  
-

REJECT

# Removing channel(s)



EEGLAB v11.0.5.4b

File Edit Tools Plot Study Datasets Help

Dataset info  
Event fields  
Event values  
About this dataset  
Channel locations  
**Select data**  
Select data using e  
Select epochs or ev  
Copy current datas  
Append datasets  
Delete dataset(s)  
Visually edit events  
Dataset size (MB)

If not checked, will result in dataset with one channel

Select data -- pop\_select()

Select data in:      Input desired range      on->remove these

Time range [min max] (s)             ...

Point range (ex: [1 10])             ...

Epoch range (ex: 3:2:10)             ...

Channel range      F6       ...

Scroll dataset

Cancel

(use shift|ctrl to select several)

- 45 - FC4
- 46 - FC2
- 47 - FCz
- 48 - Cz
- 49 - C2
- 50 - C4
- 51 - C6
- 52 - T8
- 53 - TP8
- 54 - CP6
- 55 - CP4
- 56 - CP2
- 57 - P2
- 58 - P4
- 59 - P6
- 60 - P8
- 61 - P10
- 62 - PO8
- 63 - PO4
- 64 - PO2

Dataset info -- pop\_newset()

What do you want to do with the new dataset?

Name it:      SimpleOddball hipass0.5 CL - F6      Edit description

Save it as file:            Browse

What do you want to do with the old dataset (not modified since last saved)?

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

Help      Cancel      Ok



# Pre-processing pipeline



Collect high-density EEG data (>30 chan)

Import into EEGLAB

Import event markers and channel locations

Re-reference/down-sample (if necessary)

High pass filter (5 – 1 Hz)

Remove line noise (if necessary)

**STOP!**  
Save your dataset here; you will import ICA weights to this dataset later

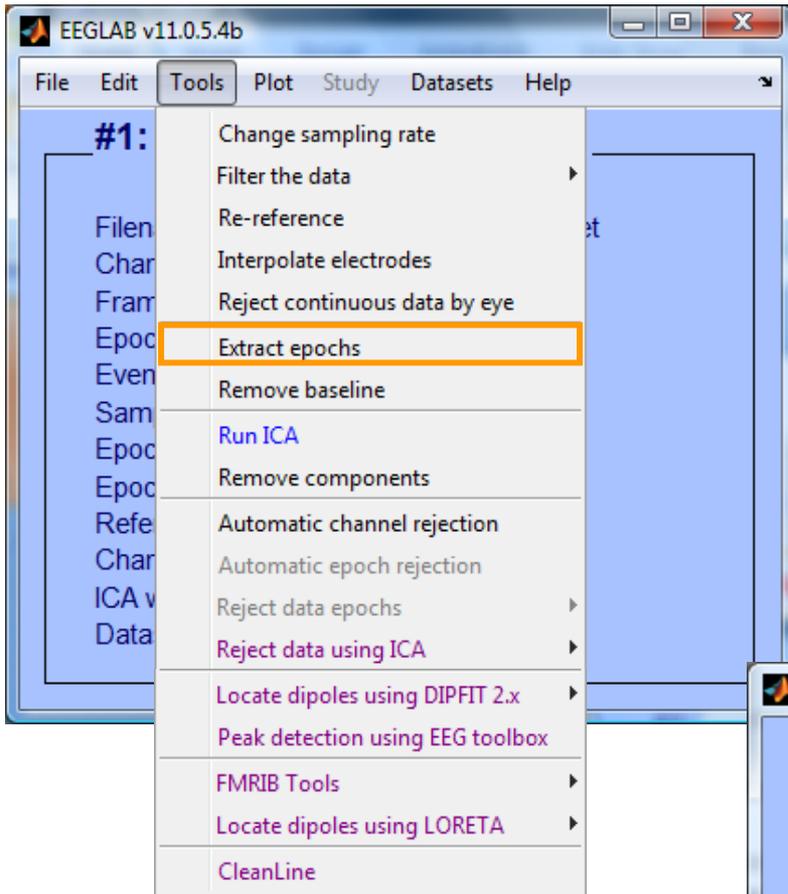
Identify/reject bad channels

Reject large artifact time points

Plot data

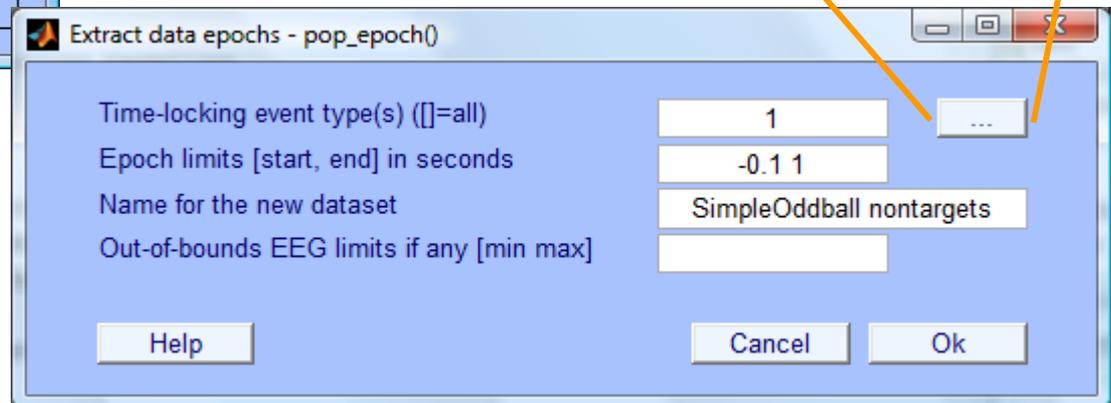
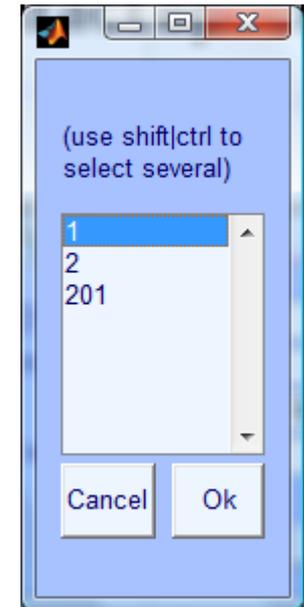
Run ICA

# Extract epochs



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

1	140	star
2	60	circle
201	60	button press



# Extract epochs



Dataset info -- pop\_newset()

What do you want to do with the new dataset?

Name it:

Save it as file:

Some changes have not been saved

Overwrite it in memory (set=)

Save it as file:

Epoch baseline removal -- pop\_rmbase()

Baseline latency range (min\_ms max\_ms) ([] = whole epoch)

Else, baseline points vector (ex:1:56) ([] = whole epoch) (overwritten by latency range above).

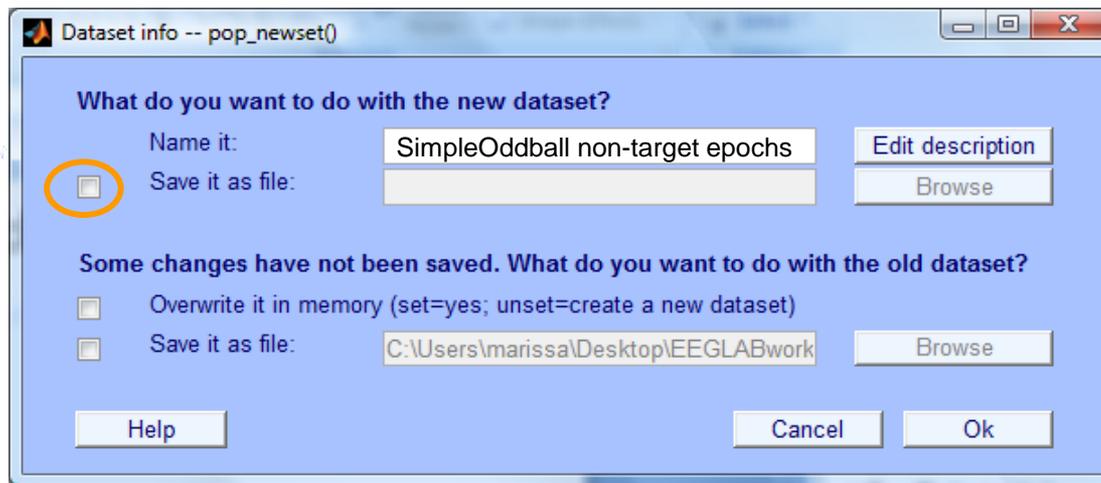
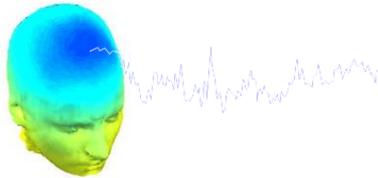
EEGLAB v11.0.5.4b

File Edit Tools Plot Study Datasets Help

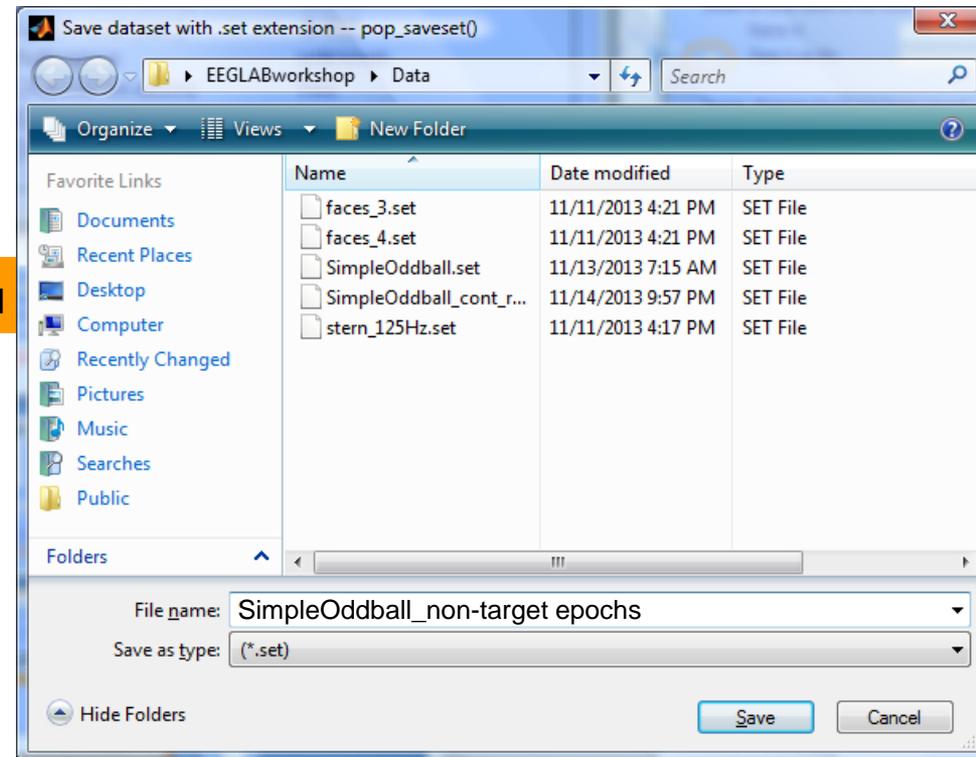
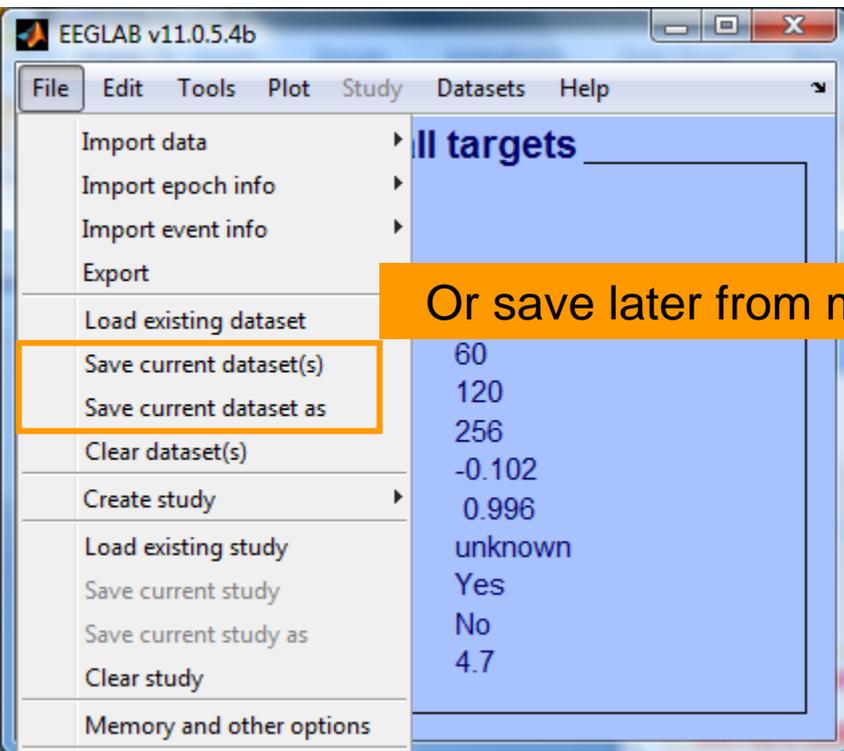
**#2: SimpleOddball nontargets**

Filename:	none
Channels per frame	66
<b>Frames per epoch</b>	<b>282</b>
<b>Epochs</b>	<b>140</b>
Events	140
Sampling rate (Hz)	256
Epoch start (sec)	-0.102
Epoch end (sec)	0.996
Reference	unknown
Channel locations	Yes
ICA weights	No
Dataset size (Mb)	10.6

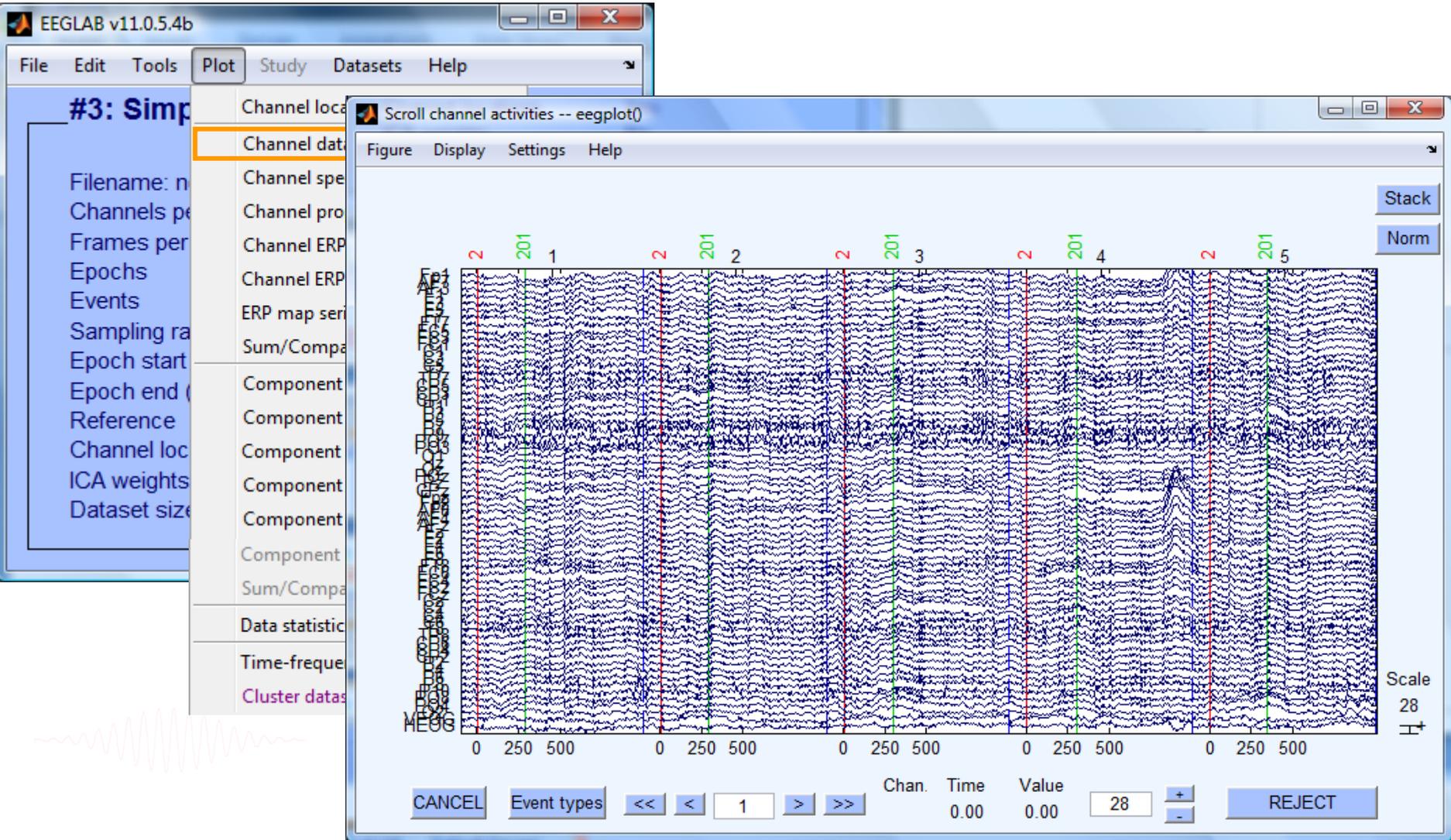




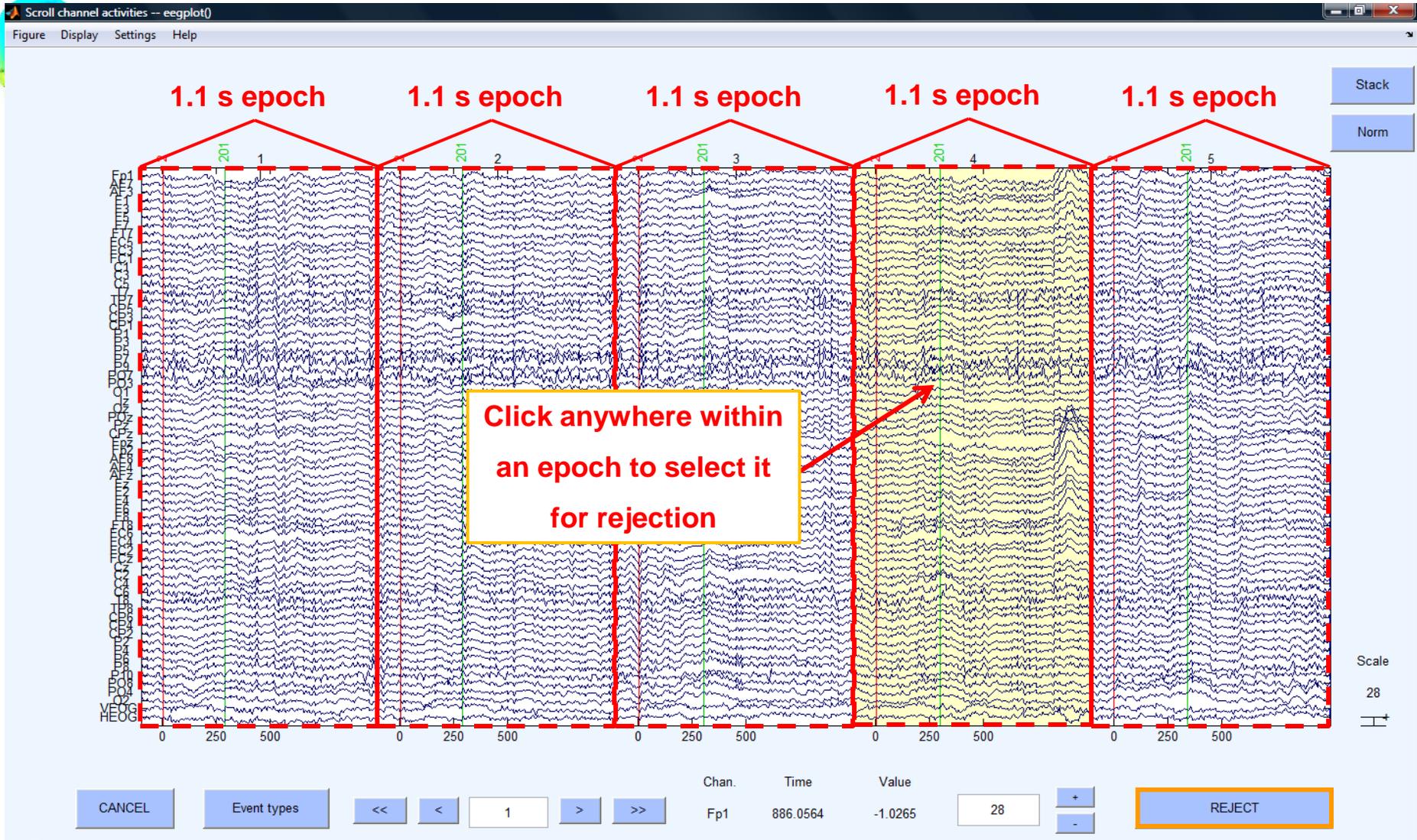
## Save dataset (optional)



# Scroll (epoched) channel data



# Reject epochs with artifact



# Reject data epochs



EEGLAB v6.0b

File Edit **Tools** Plot Study Datasets Help

- Change sampling rate
- Filter the data
- Re-reference
- Reject continuous data by eye
- Extract epochs
- Remove baseline
- Run ICA
- Remove components
- Automatic epoch rejection
- Reject data epochs**
  - 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 ICA reject
  - Reject marked epochs
- Reject data using ICA
- Locate dipoles using BESA
- Locate dipoles using DIPFIT 2.x
- Laplacian
- FMRIB Tools
- Grand average datasets
- Locate dipoles using LORETA
- PCA plugin



# Reject data epochs



Reject trials using data statistics - pop\_rejmenu()

Mark trials by appearance  Scroll Data Marked trials 0

**Find abnormal values**

Upper limit(s) (uV)	25	Lower limit(s) (uV)	-25
Start time(s) (ms)	-1000	Ending time(s) (ms)	1996
Electrode(s)	1:31	Currently marked trials	0

Calc / Plot Help

**Find abnormal trends**

Max slope (uV/epoch)	50	R-squared limit (0 to 1)	0.3
Electrode(s)	1:31	Currently marked trials	0

Calc / Plot Help

**Find improbable data**

Single-channel limit (std. dev.)	5	All channels limit (std. dev.)	5
Electrode(s)	1:31	Currently marked trials	0

Calculate Scroll Data Plot Help

**Find abnormal distributions**

Single-channel limit (std. dev.)	5	All channels limit (std. dev.)	5
Electrode(s)	1:31	Currently marked trials	0

Calculate Scroll Data Plot Help

**Find abnormal spectra (slow)**

Upper limit(s) (dB)	25	Lower limit(s) (dB)	-25
Low frequency(s) (Hz)	0	High frequency(s) (Hz)	50
Electrode(s)	1:31	Currently marked trials	0

Calc / Plot Help

**Plotting options**

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

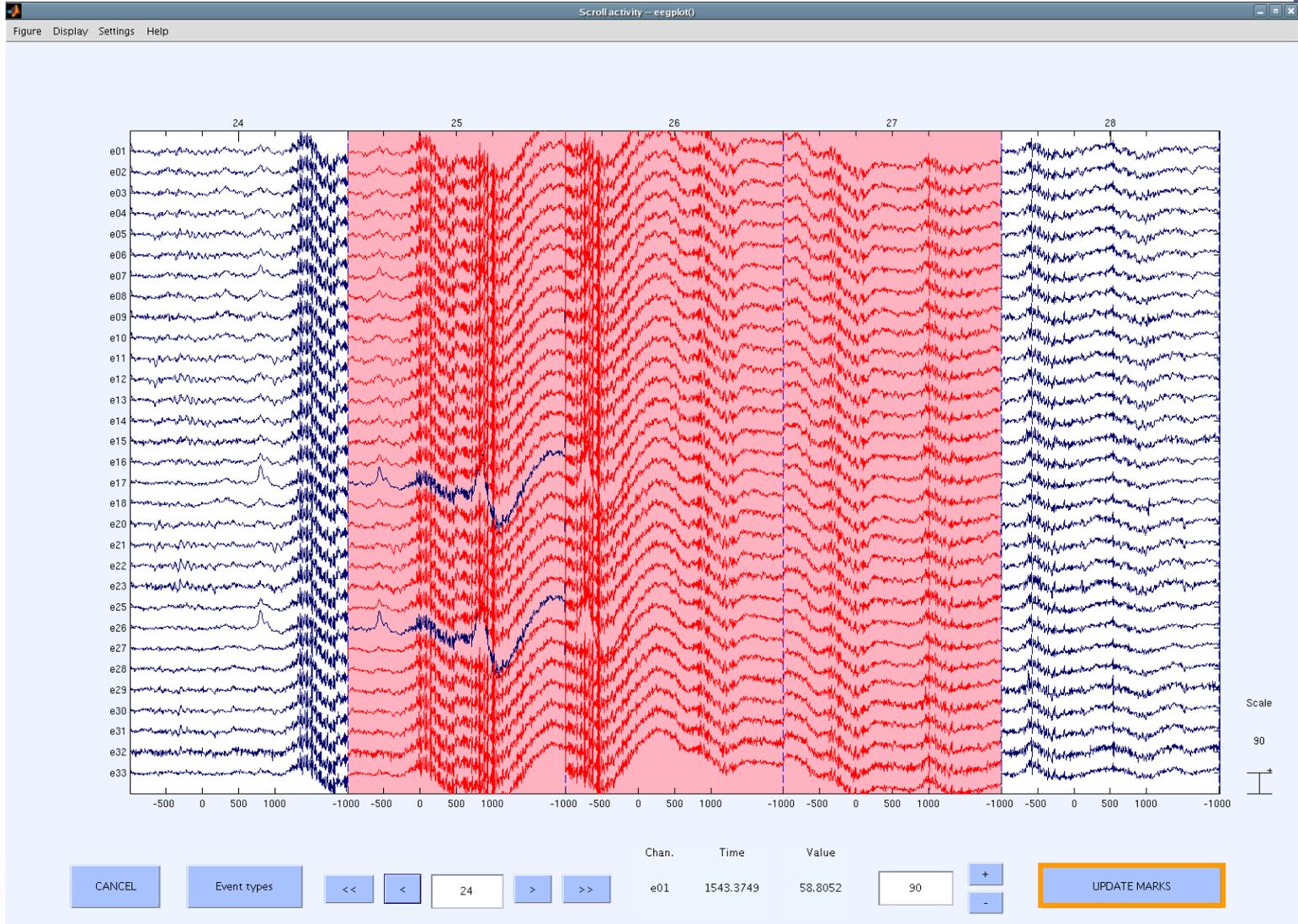
<input checked="" type="checkbox"/> Abnormal appearance	<input checked="" type="checkbox"/> Abnormal values	<input checked="" type="checkbox"/> Abnormal trends
<input checked="" type="checkbox"/> Improbable epochs	<input checked="" type="checkbox"/> Abnormal distributions	<input checked="" type="checkbox"/> Abnormal spectra

Close (keep marks) Clear all marks Reject marked trials

visual inspection

probability

# Reject data epochs



# Reject data epochs



Reject trials using data statistics - pop\_rejmenu()

Mark trials by appearance   Marked trials 0

**Find abnormal values**

Upper limit(s) (uV)	<input type="text" value="25"/>	Lower limit(s) (uV)	<input type="text" value="-25"/>
Start time(s) (ms)	<input type="text" value="-1000"/>	Ending time(s) (ms)	<input type="text" value="1996"/>
Electrode(s)	<input type="text" value="1:31"/>	Currently marked trials	<input type="text" value="0"/>

**Find abnormal trends**

Max slope (uV/epoch)	<input type="text" value="50"/>	R-squared limit (0 to 1)	<input type="text" value="0.3"/>
Electrode(s)	<input type="text" value="1:31"/>	Currently marked trials	<input type="text" value="0"/>

**Find improbable data**

Single-channel limit (std. dev.)	<input type="text" value="5"/>	All channels limit (std. dev.)	<input type="text" value="5"/>
Electrode(s)	<input type="text" value="1:31"/>	Currently marked trials	<input type="text" value="0"/>

**Find abnormal distributions**

Single-channel limit (std. dev.)	<input type="text" value="5"/>	All channels limit (std. dev.)	<input type="text" value="5"/>
Electrode(s)	<input type="text" value="1:31"/>	Currently marked trials	<input type="text" value="0"/>

**Find abnormal spectra (slow)**

Upper limit(s) (dB)	<input type="text" value="25"/>	Lower limit(s) (dB)	<input type="text" value="-25"/>
Low frequency(s) (Hz)	<input type="text" value="0"/>	High frequency(s) (Hz)	<input type="text" value="50"/>
Electrode(s)	<input type="text" value="1:31"/>	Currently marked trials	<input type="text" value="0"/>

**Plotting options**

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

<input checked="" type="checkbox"/> Abnormal appearance	<input checked="" type="checkbox"/> Abnormal values	<input checked="" type="checkbox"/> Abnormal trends
<input checked="" type="checkbox"/> Improbable epochs	<input checked="" type="checkbox"/> Abnormal distributions	<input checked="" type="checkbox"/> Abnormal spectra

# Reject data epochs



EEGLAB v6.0b

File Edit **Tools** Plot Study Datasets Help

- #1: t
- File name
- Change sampling rate
- Frame
- Epoch
- Event
- Sample
- Epoch
- Epoch
- Average
- Change
- ICA w
- Datas

Change sampling rate

Filter the data

Re-reference

Reject continuous data by eye

Extract epochs

Remove baseline

Run ICA

Remove components

Automatic epoch rejection

**Reject data epochs**

Reject data using ICA

Locate dipoles using BESA

Locate dipoles using DIPFIT 2.x

Laplacian

FMRIB Tools

Grand average datasets

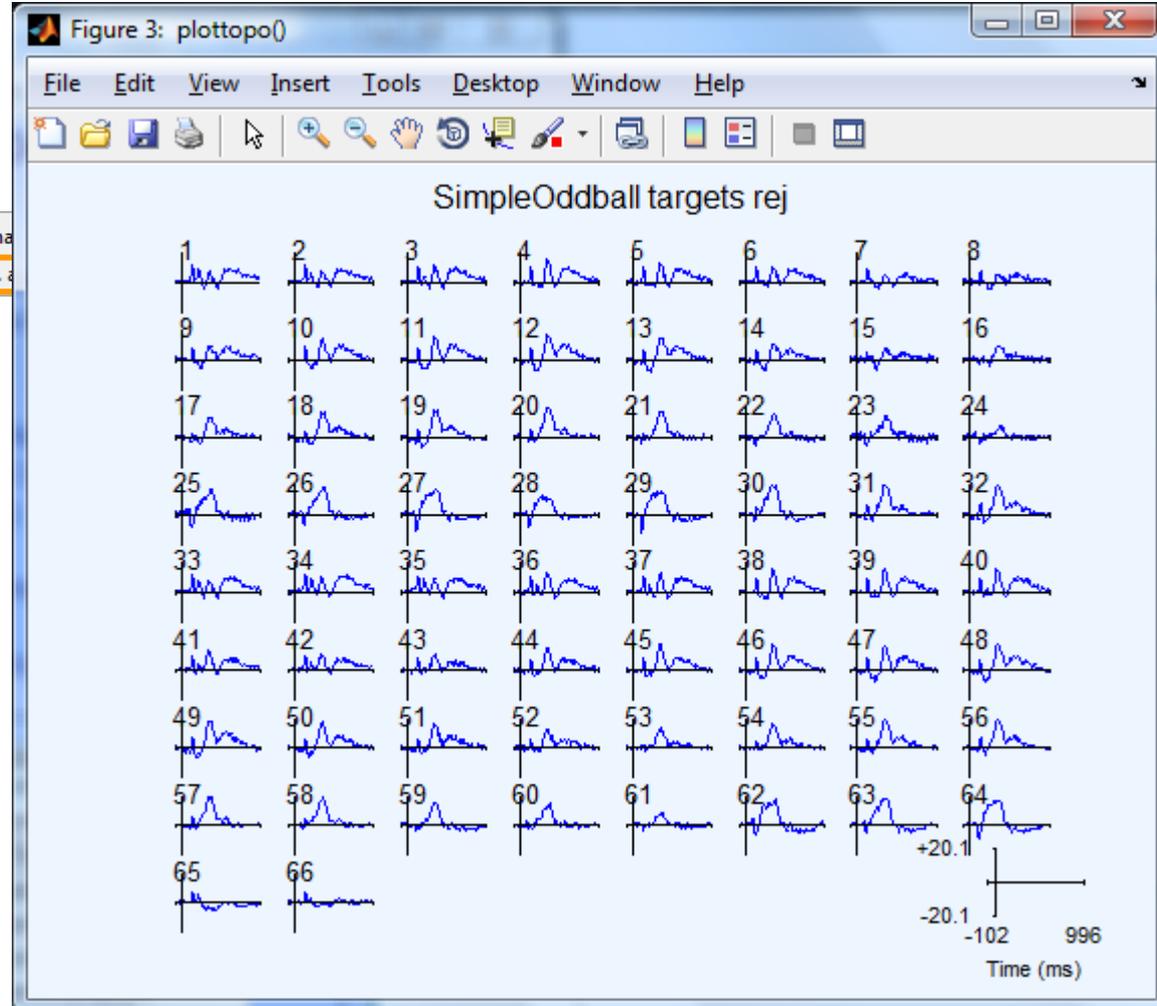
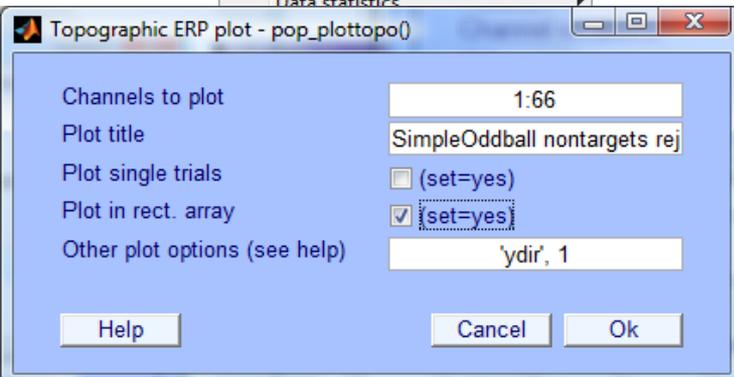
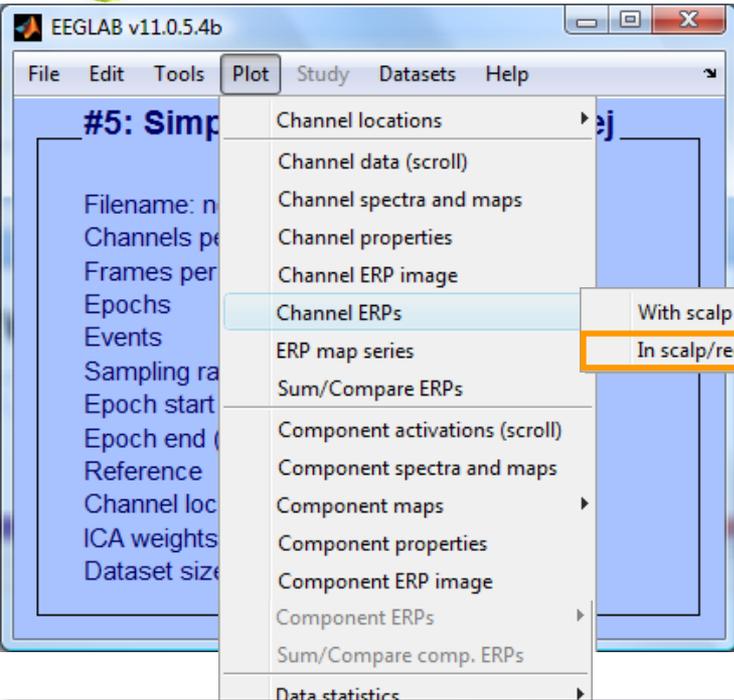
Locate dipoles using LORETA

PCA plugin

- 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 ICA reject
- Reject marked epochs**



# Visualize ERP in rectangular array



# Visualize ERP in topographic array



EEGLAB v11.0.5.4b

File Edit Tools Plot Study Datasets Help

#5: SimpleOddball targets rej

Filename: n...  
Channels per...  
Frames per...  
Epochs  
Events  
Sampling ra...  
Epoch start...  
Epoch end (...)  
Reference  
Channel loc...  
ICA weights  
Dataset size

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

With scalp map  
In scalp/rect. array

Topographic ERP plot - pop\_plottopo()

Channels to plot: 1:66

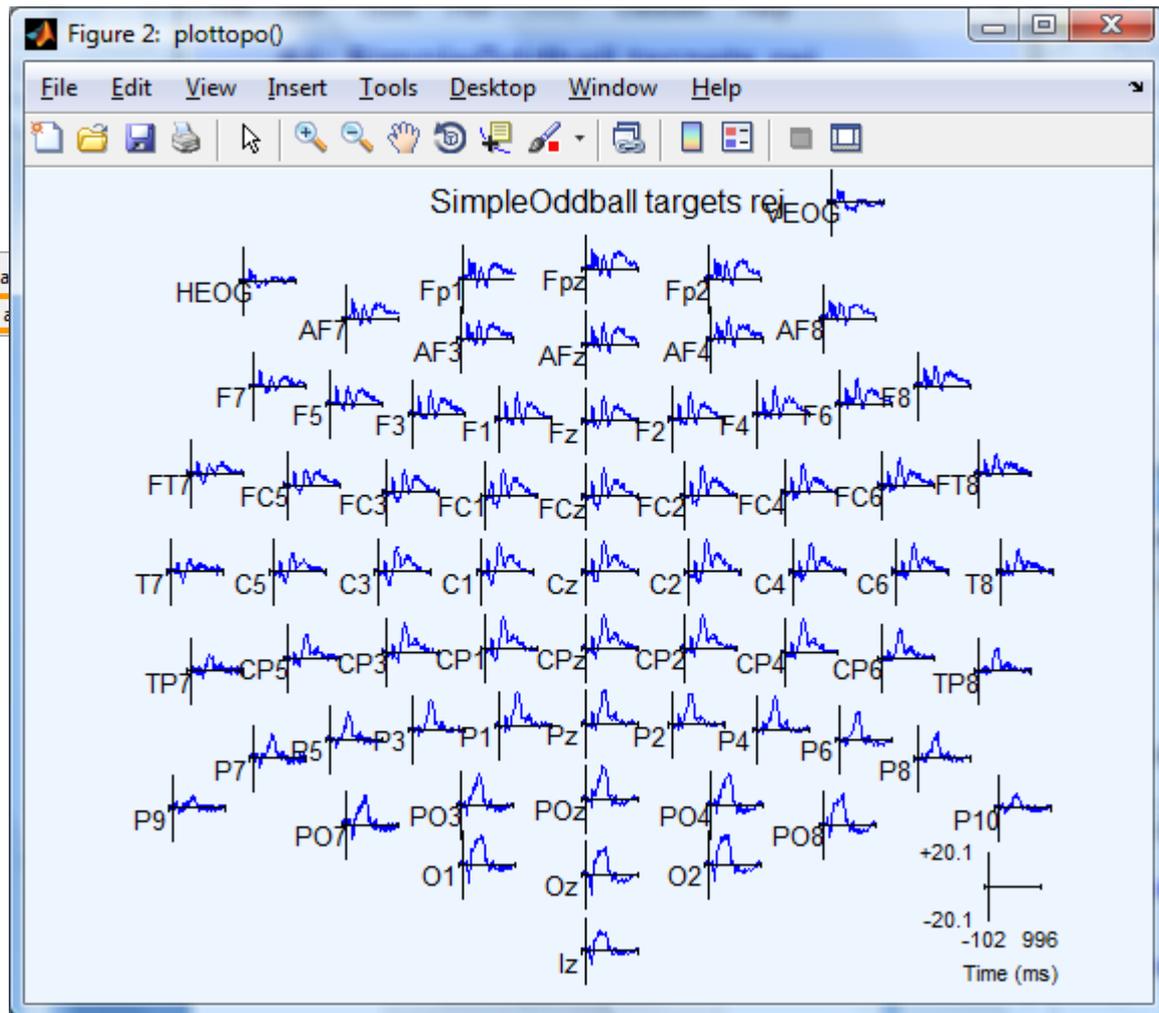
Plot title: SimpleOddball nontargets rej

Plot single trials:  (set=yes)

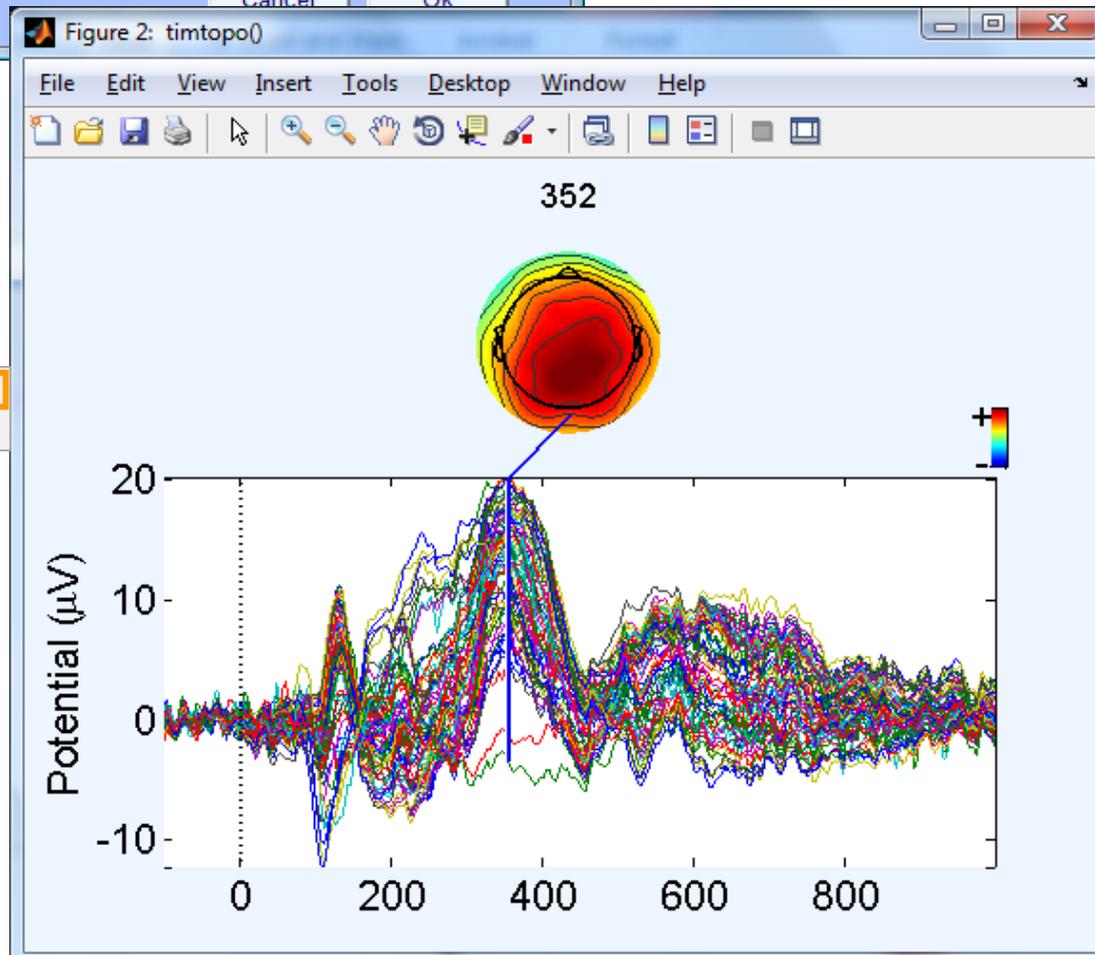
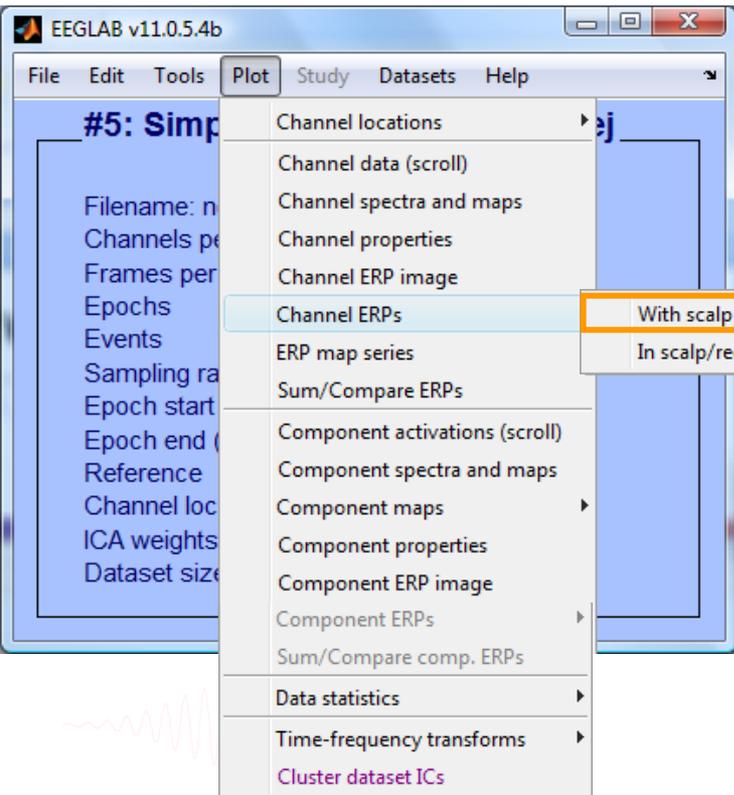
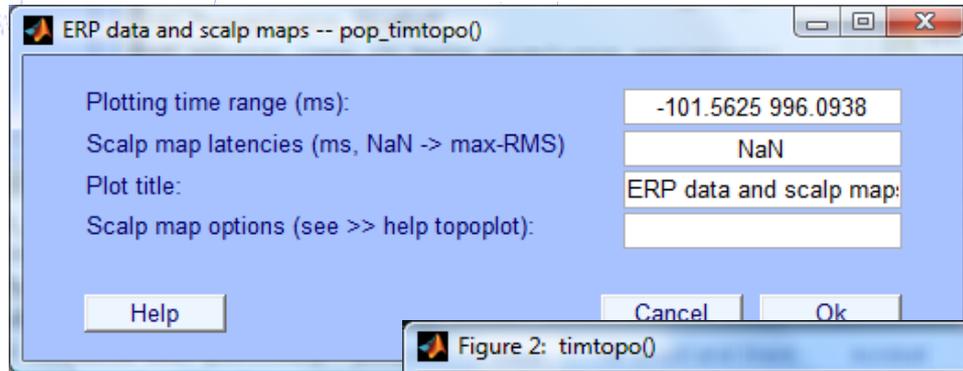
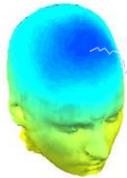
Plot in rect. array:  (set=yes)

Other plot options (see help): 'ydir', 1

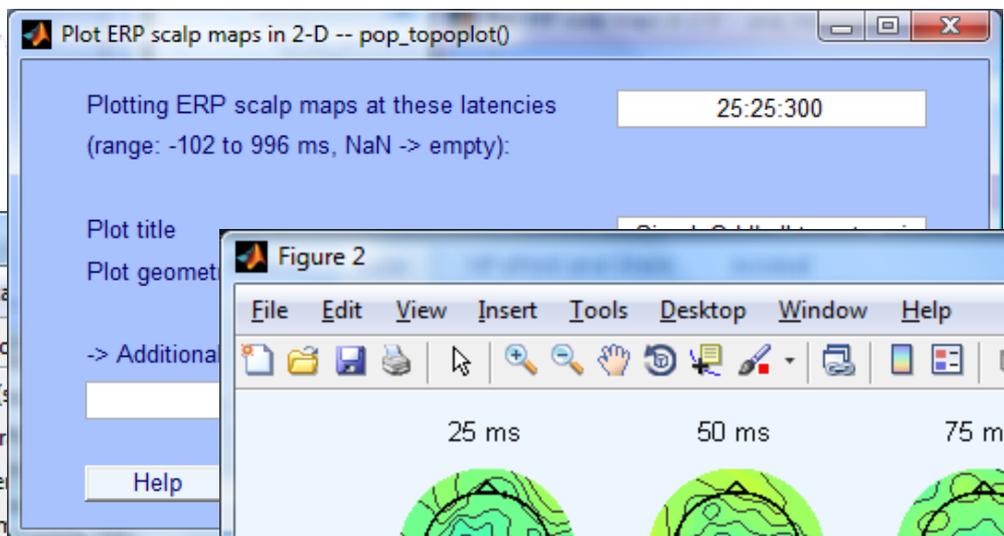
Help Cancel Ok



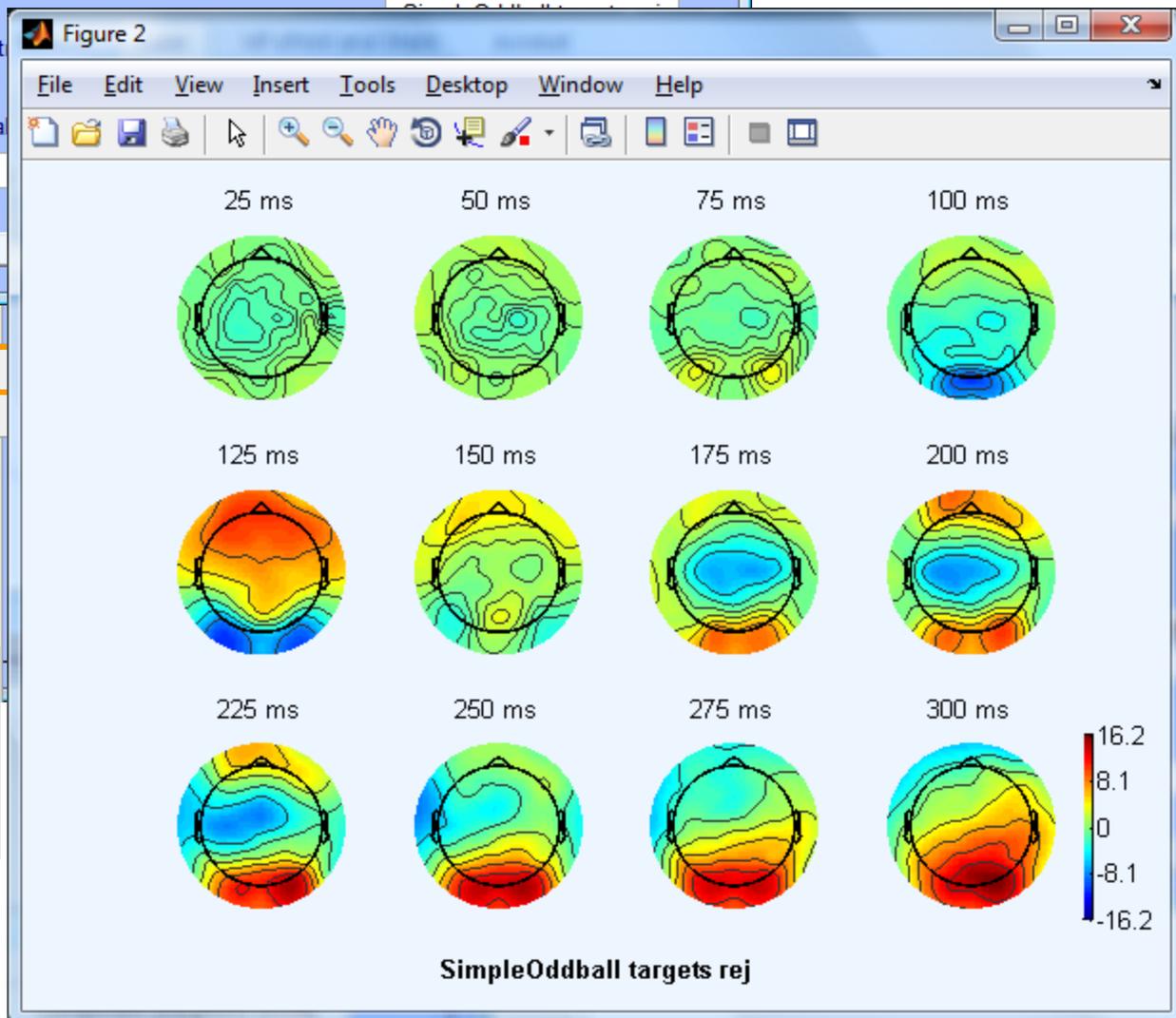
# Visualize ERP scalp distribution



# Visualize channel ERPs in 2D



The EEGLAB v11.0.5.4b menu structure. The "Plot" menu is open, showing options like "Channel location", "Channel data", "Channel spectra", "Channel properties", "Channel ERP images", "Channel ERPs", "ERP map series", "Sum/Compare ERPs", "Component activations", "Component spectra and maps", "Component maps", "Component properties", "Component ERP image", "Component ERPs", "Sum/Compare comp. ERPs", "Data statistics", "Time-frequency transforms", and "Cluster dataset ICs".



# Visualize channel ERPs in 3D



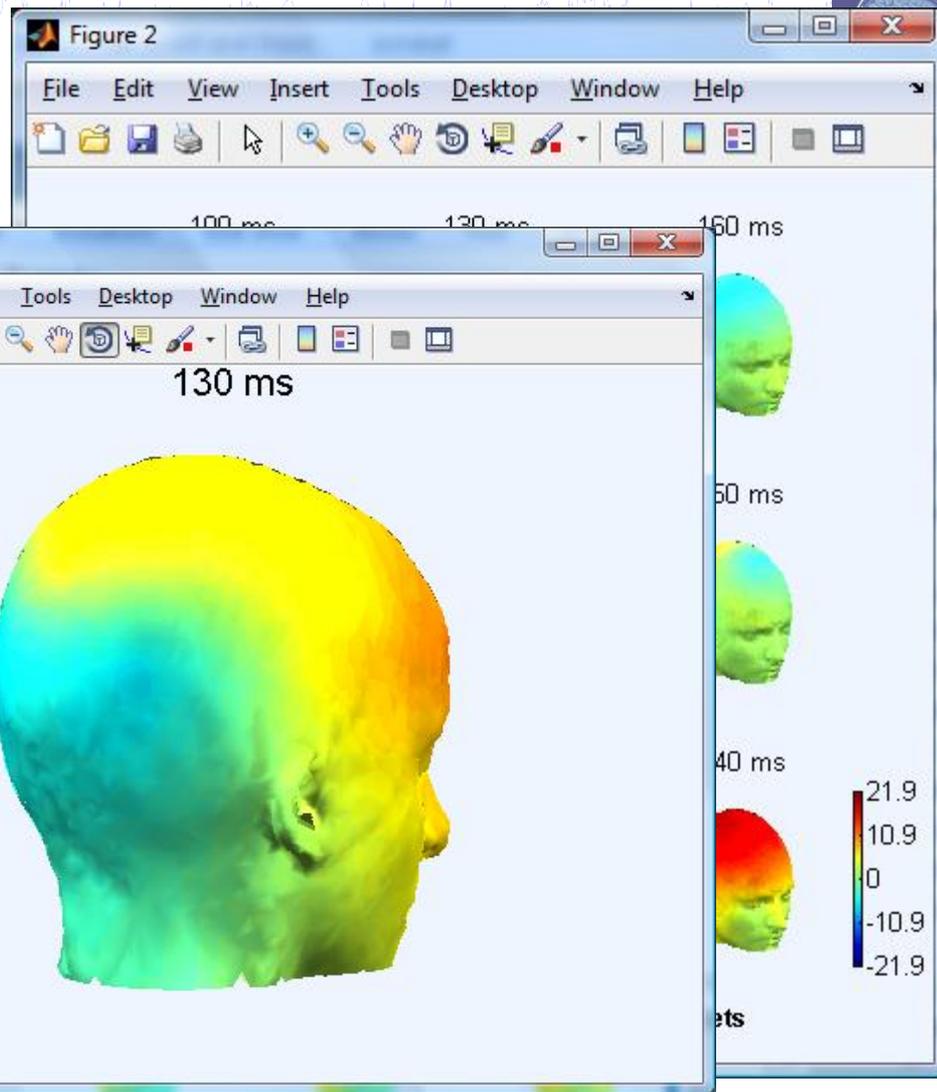
EEGLAB v11.0.5.4b

File Edit Tools **Plot** Study Datasets Help

**#4: Simple**

Filename: n  
Channels pe  
Frames per  
Epochs  
Events  
Sampling ra  
Epoch start  
Epoch end  
Reference  
Channel loc  
ICA weights  
Dataset size

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



# Exercises (continuous data)



- Load SimpleOddball.set
- Re-reference data to average reference
- Hi-pass filter the continuous data, then save
- Epoch the data on circles (event type 1)
- Scroll the epoched data and perform visual rejection of epochs
- Explore the automated artifact rejection tools
- Save 'clean' epoched datasets for circles (targets)

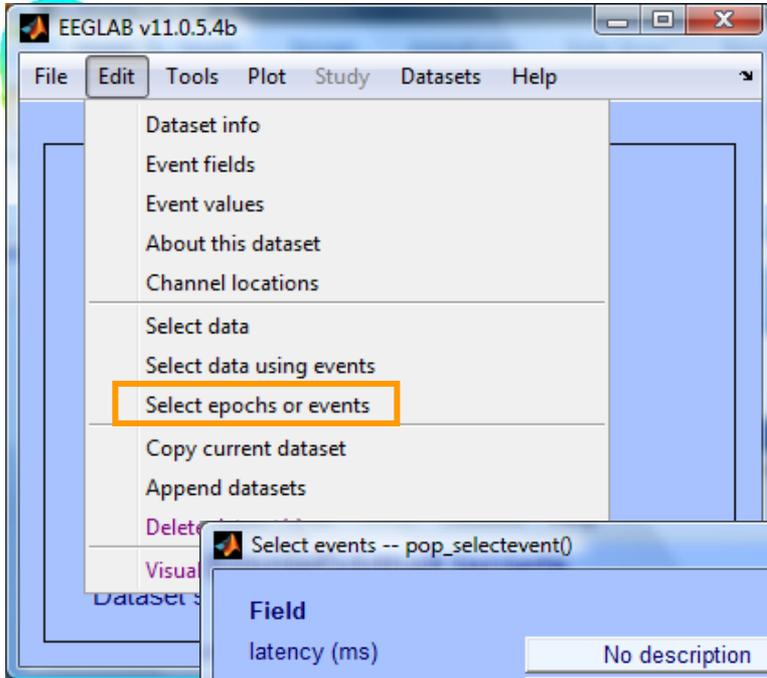




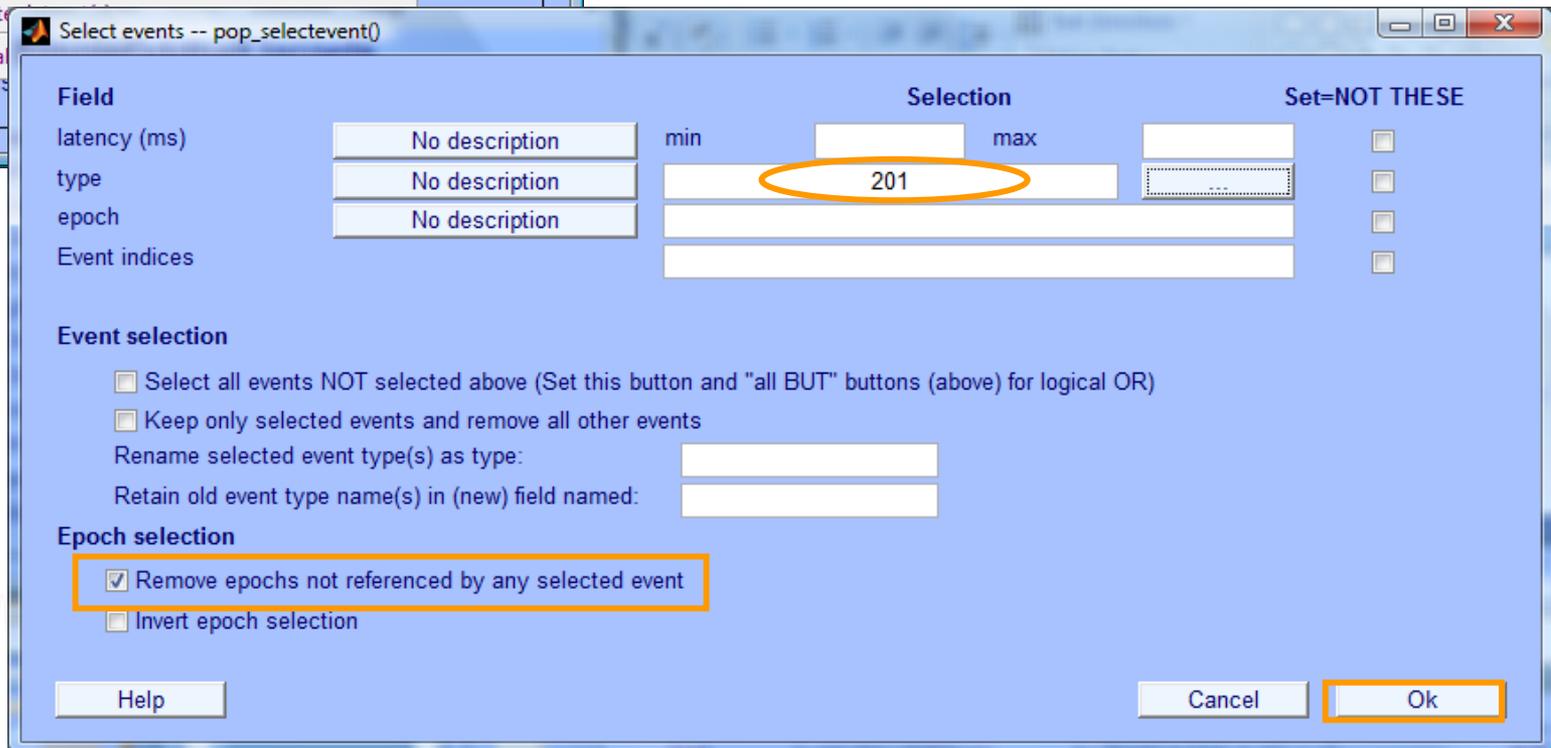
# Supplementary material



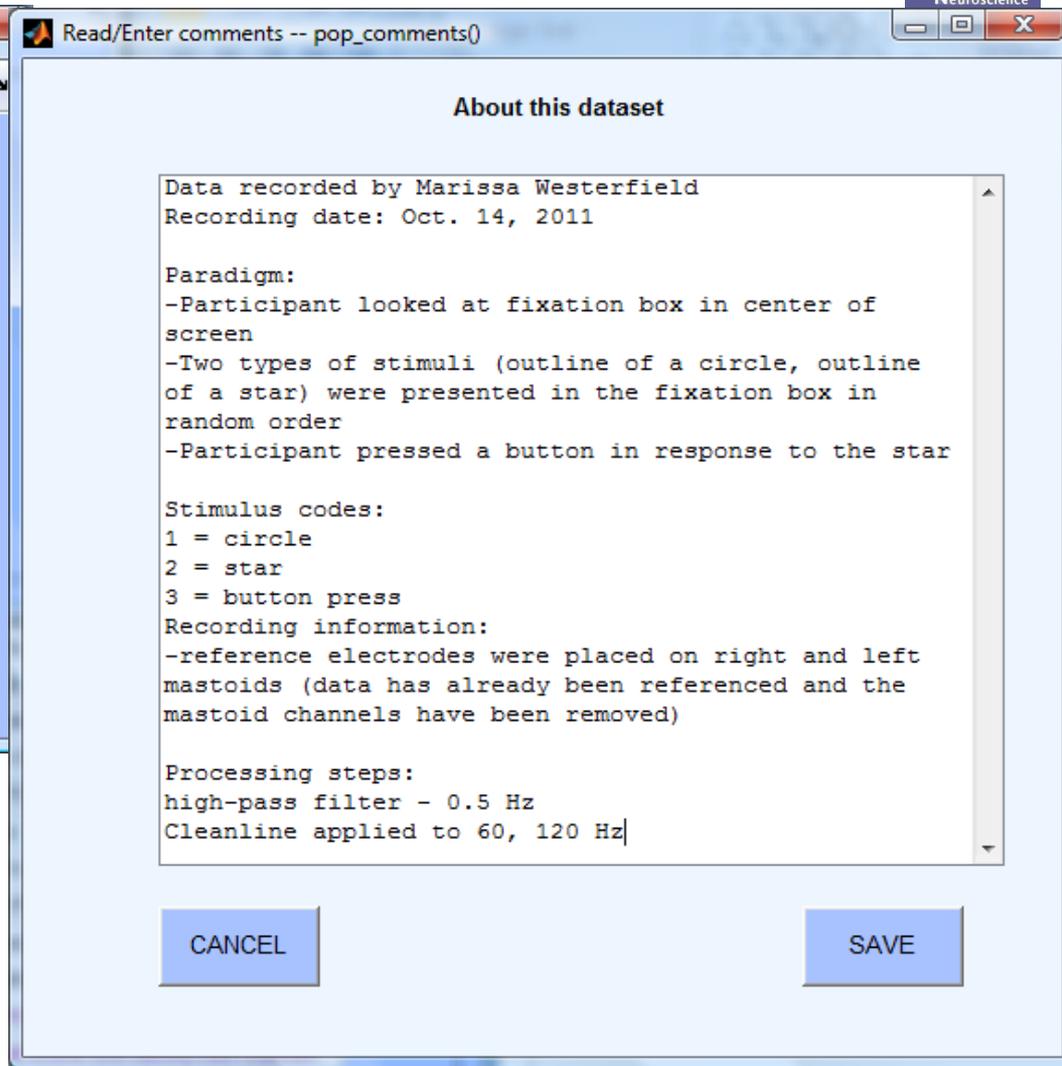
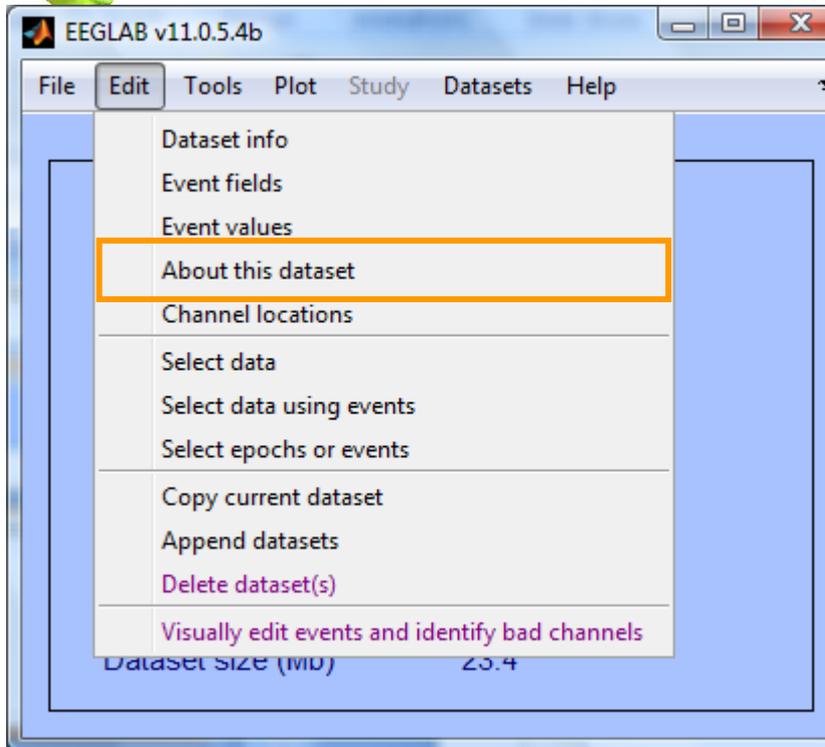
# Select a subset of epochs



Keep only epochs with a 201 (button press) event



# Comments and dataset history



Also:

>> EEG.comments

or

>> EEG.history

# Removing channel(s)



- You may prefer to interpolate bad channels rather than remove them altogether
- The loss in dimensionality will affect the ICA decomposition
- Usual solution:
  - Delete the bad channels before running ICA
  - STUDY tools will do much of this automatically (interpolate missing channels, etc)

