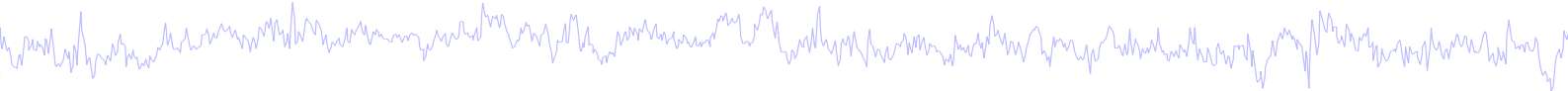


Artifact processing and ERP analysis



Task 1

Reject bad channels

Task 2

Reject continuous data

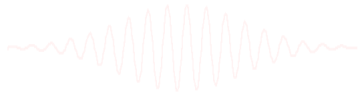
Task 3

Reject data epochs

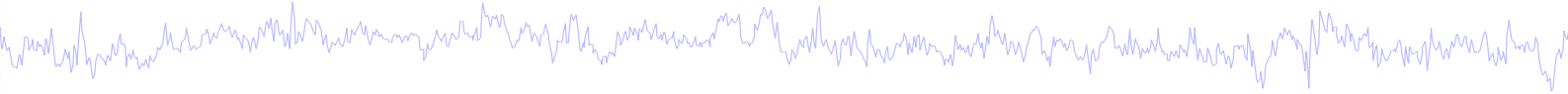
Task 4

Analysis of channel ERPs

Exercise...



Artifact processing and ERP analysis



Task 1

Reject bad channels

Task 2

Reject continuous data

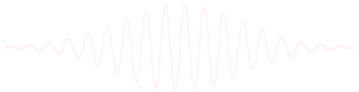
Task 3

Reject data epochs

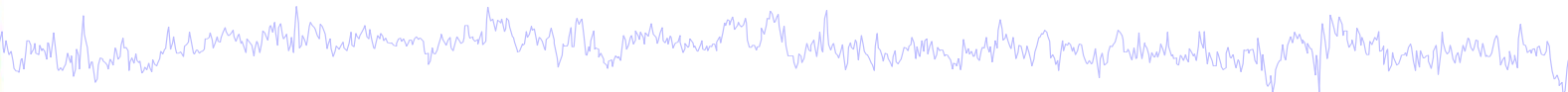
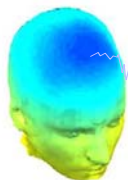
Task 4

Analysis of channel ERPs

Exercise...



The example data: faces vs. objects



File

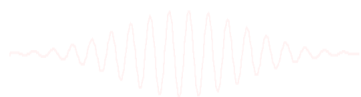
../data/faces_3.set

Data

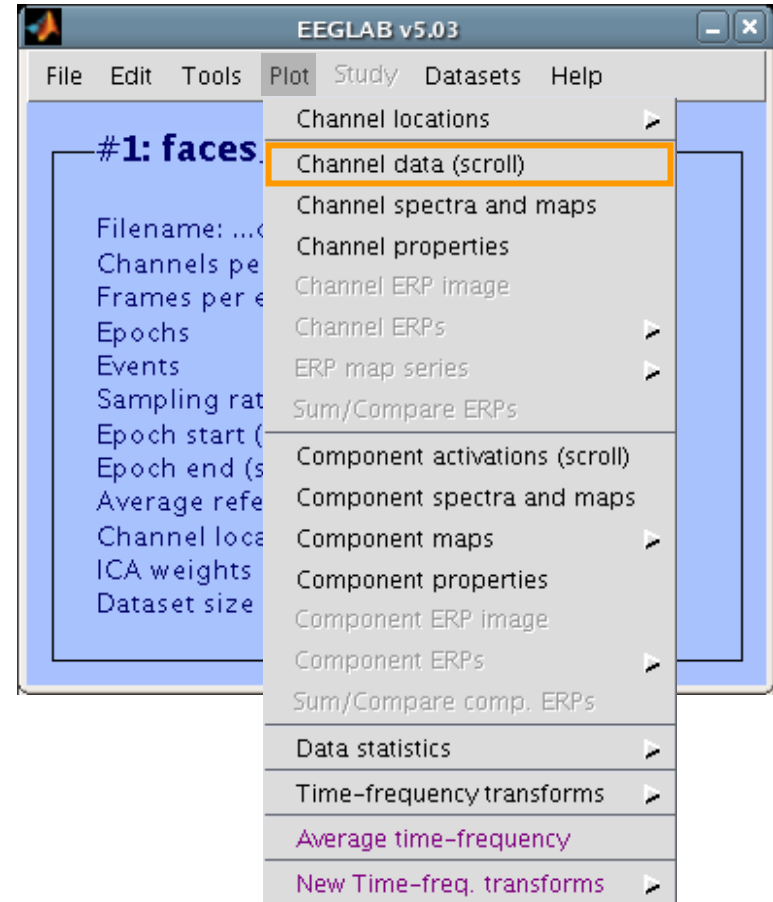
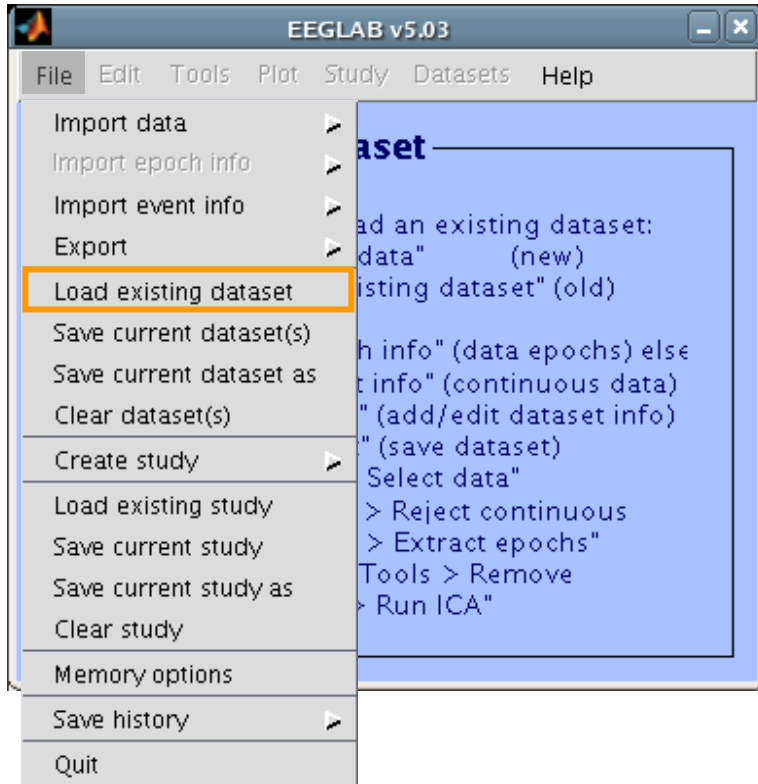
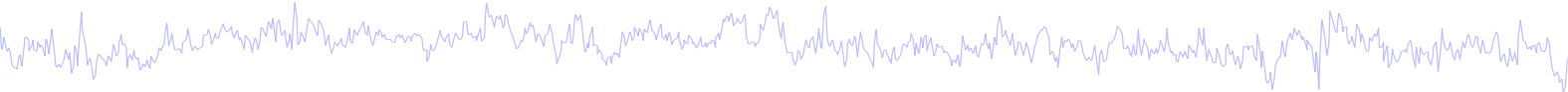
33 channel EEG, nose-tip reference, 250 Hz sampling rate, 0.5-100 Hz, 16 bit, BrainAmps

Task

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

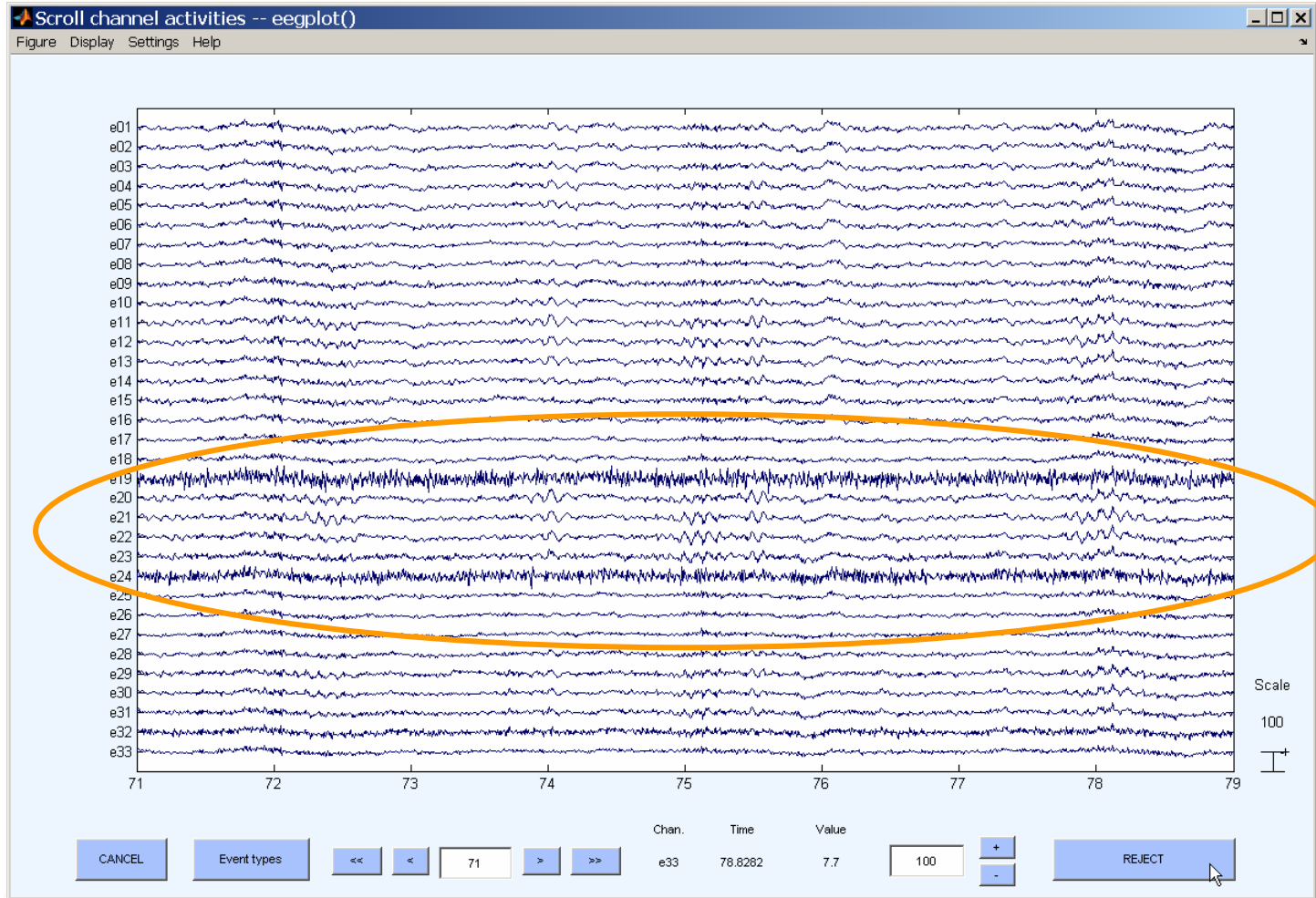


Load/scroll data



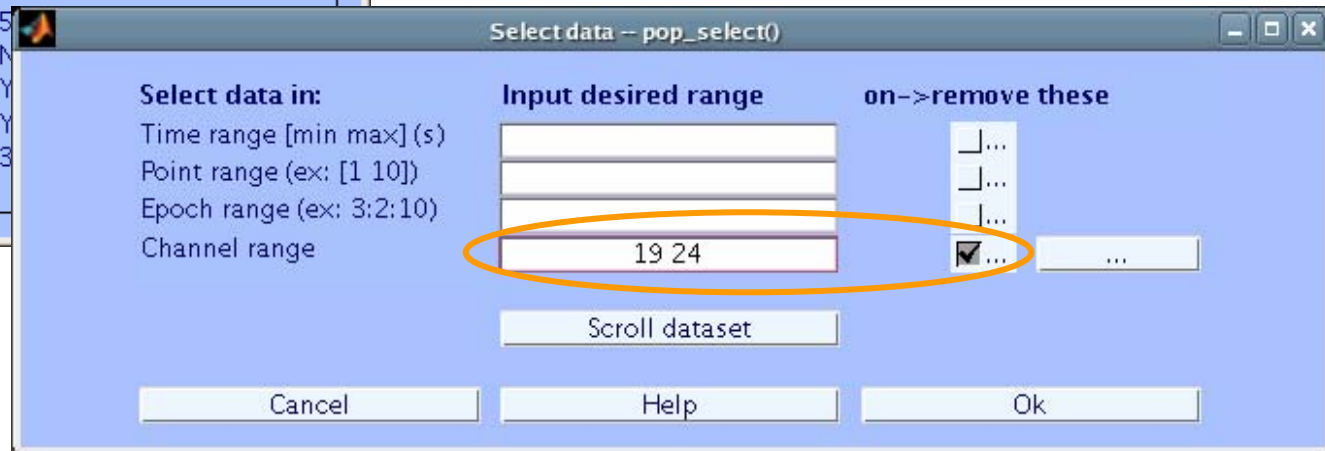
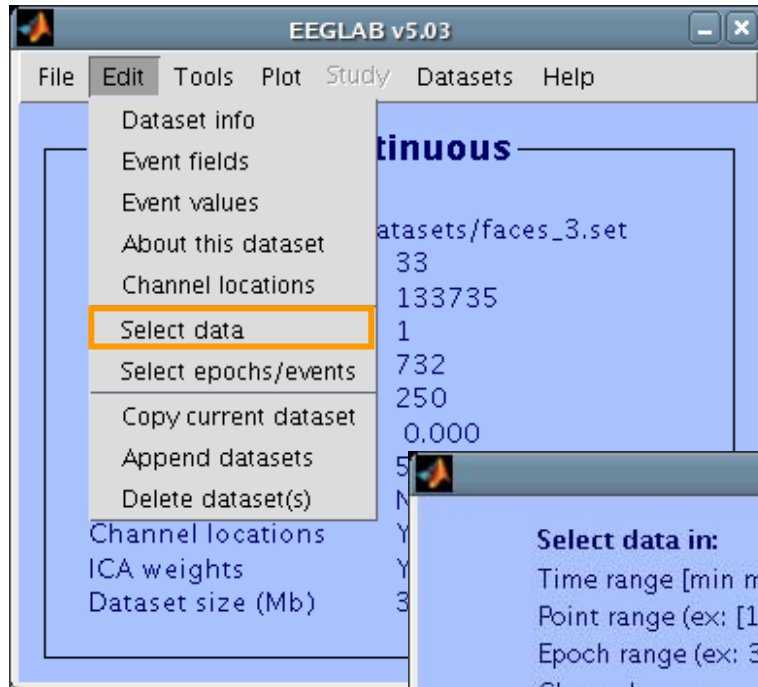
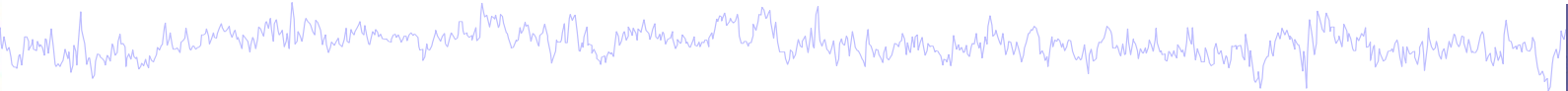
```
>> EEG = pop_loadset('faces_3.set', '...\data\');  
>> [ALLEEG EEG CURRENTSET] = eeg_store(ALLEEG, EEG, 0);
```

Reject bad channels



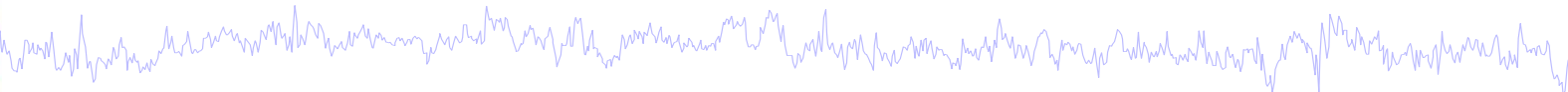
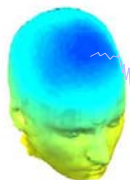
```
>> pop_eegplot(EEG, 1, 1, 1);
```

Reject bad channels



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

Reject bad channels



Dataset info -- pop_newset()

What do you want to do with the new dataset?

Name it:

Save it as file:

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)

EEGLAB v5.03

File Edit Tools Plot Study Datasets Help

#1: faces_3_continuous

Filename: ...ded_cd/Datasets/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

EEGLAB v5.03

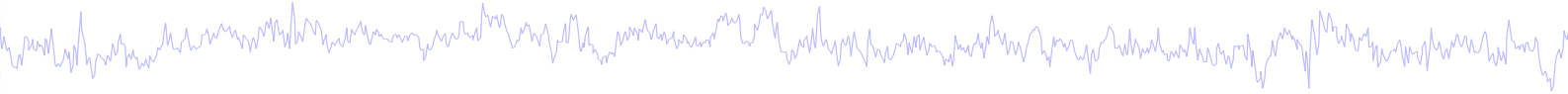
File Edit Tools Plot Study Datasets Help

#2: faces_3_chans removed

Filename: none

Channels per frame	31
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)	34.5

Artifact processing and ERP analysis



Task 1

Reject bad channels

Task 2

Reject continuous data

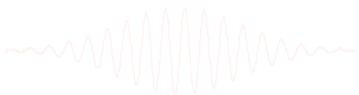
Task 3

Reject data epochs

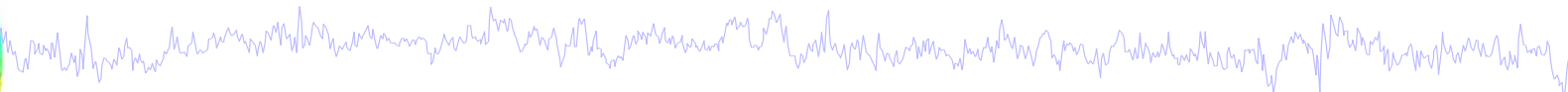
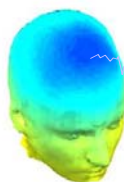
Task 4

Analysis of channel ERPs

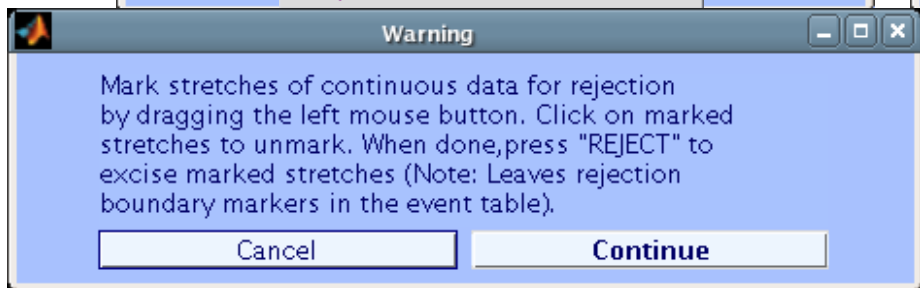
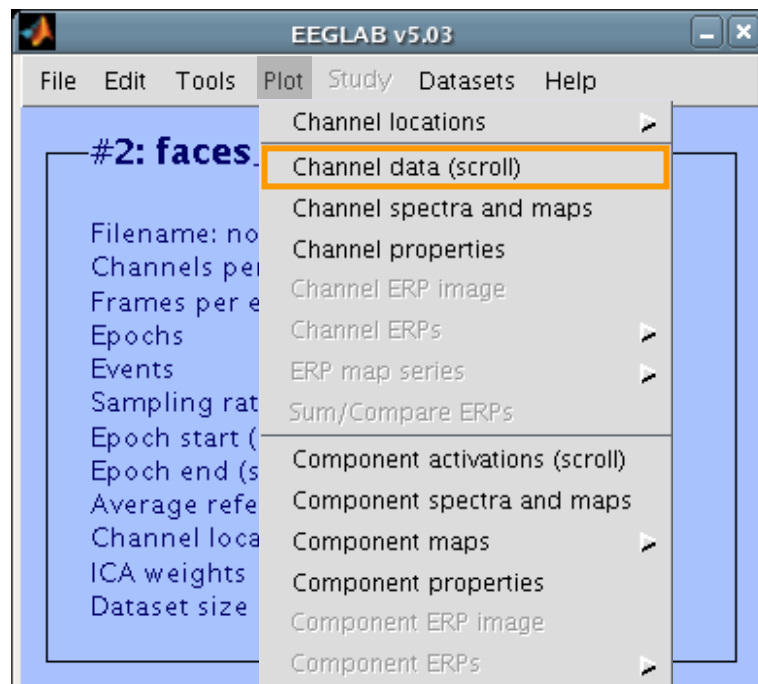
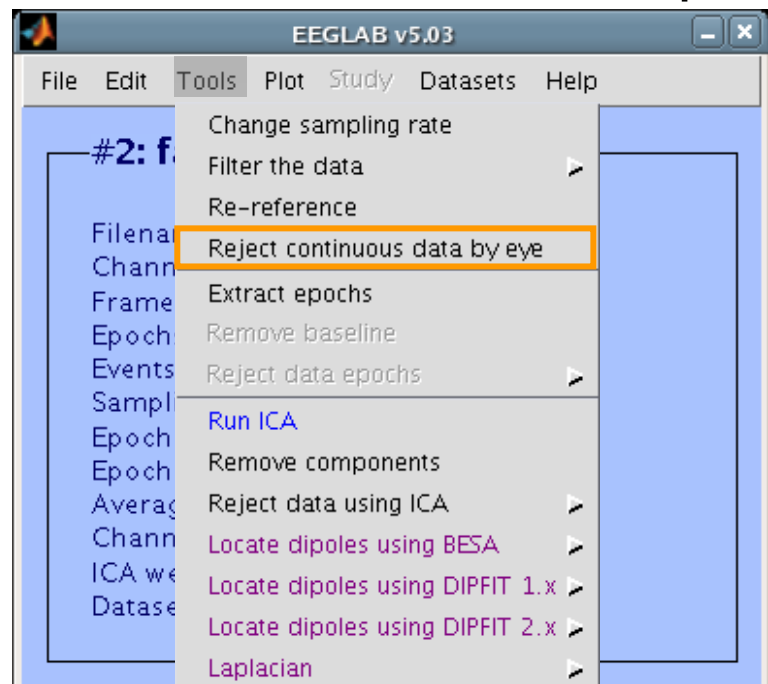
Exercise...



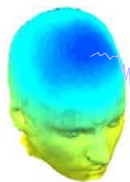
Reject continuous data



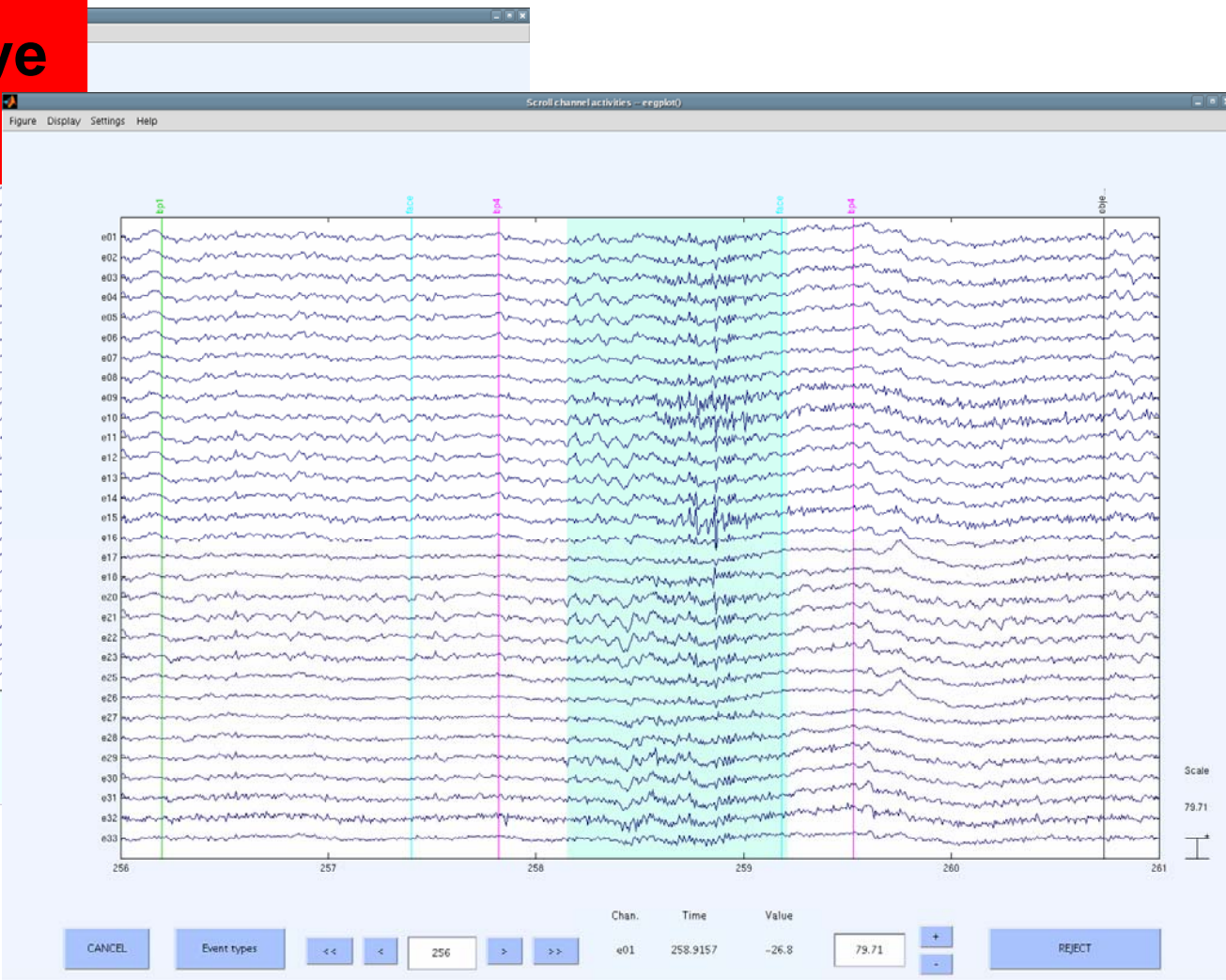
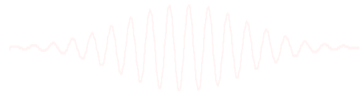
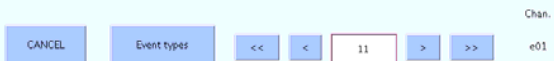
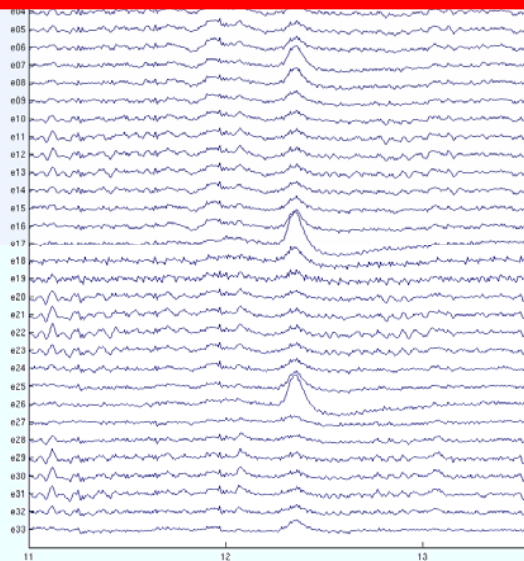
Equivalent!!



Reject continuous data



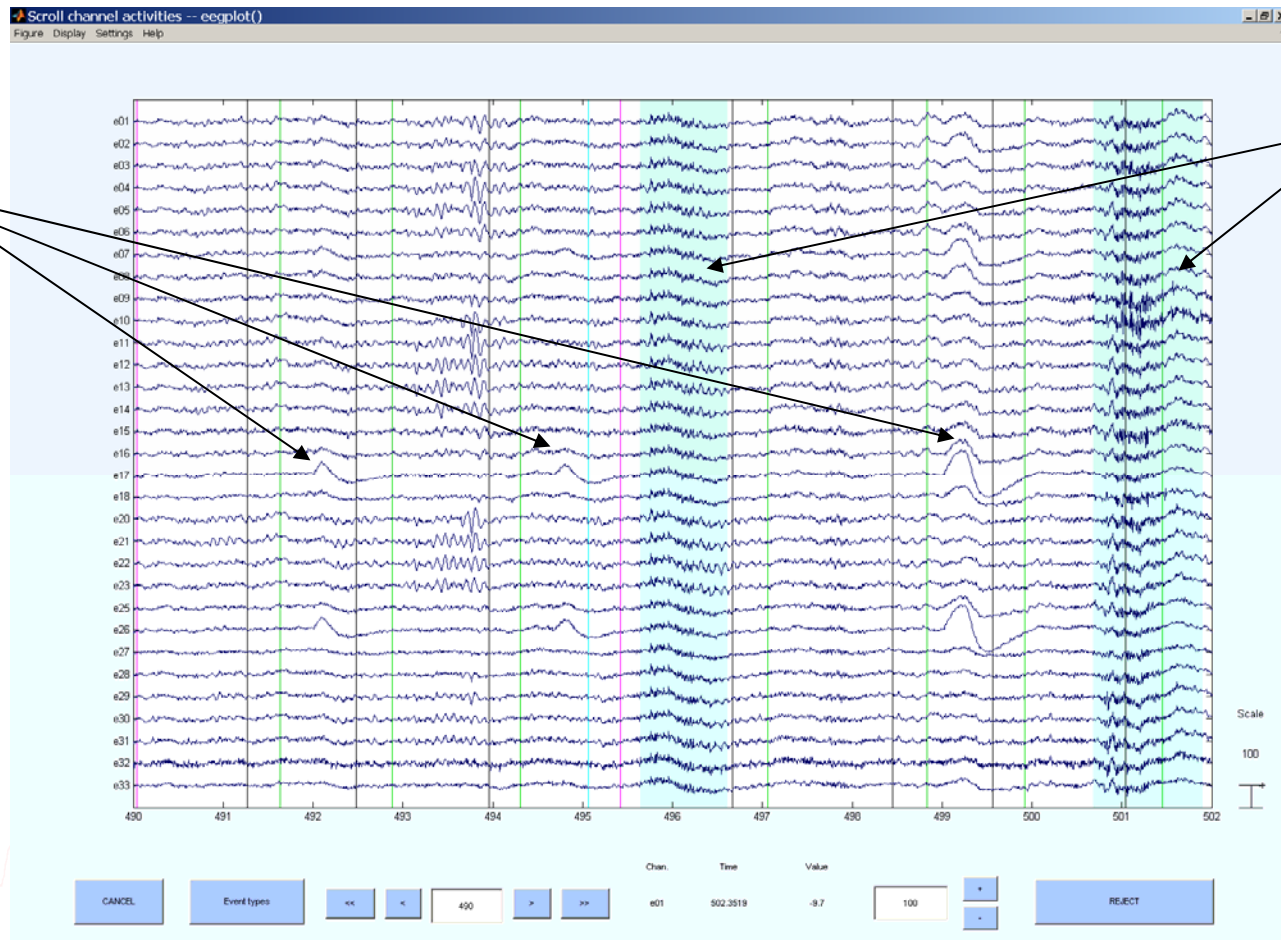
**TIP: use ICA for eye
blink correction**



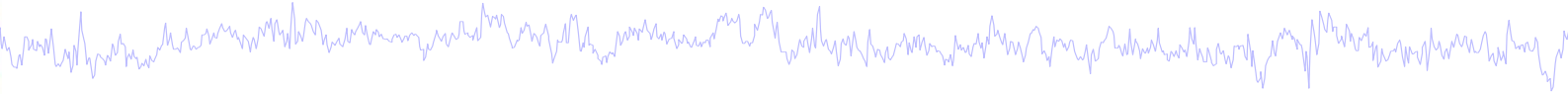
Reject continuous data



To prepare data for ICA, reject odd artifacts and keep stereotyped artifacts



Artifact processing and ERP analysis



Task 1

Reject bad channels

Task 2

Reject continuous data

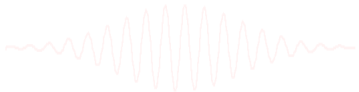
Task 3

Reject data epochs

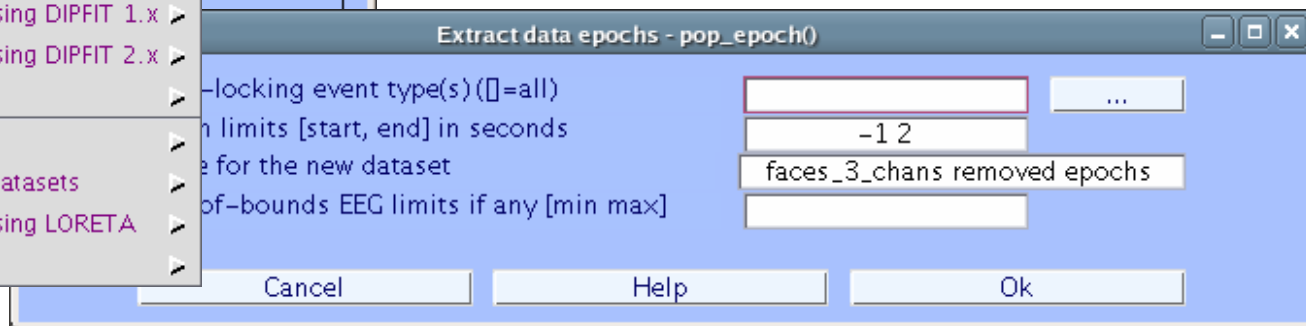
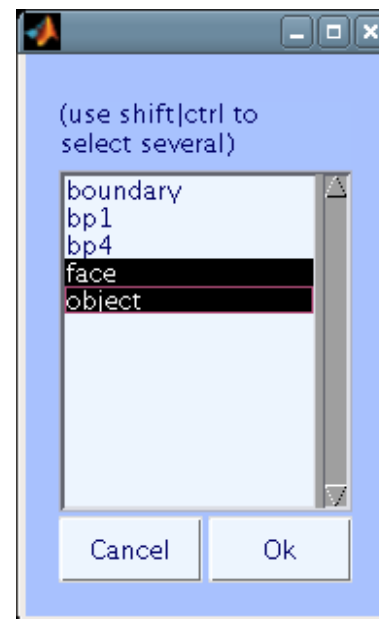
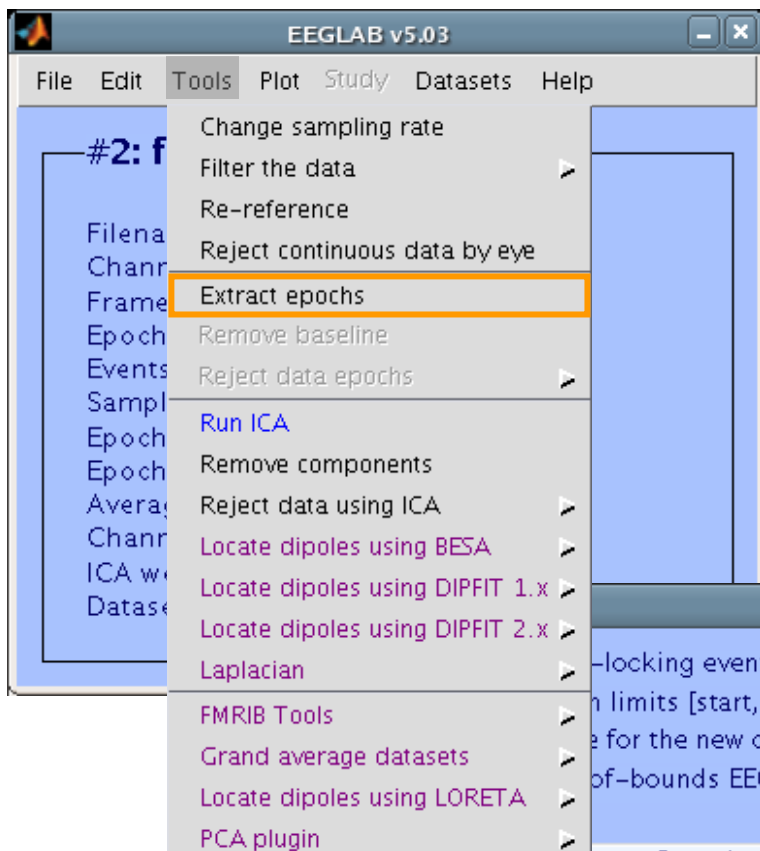
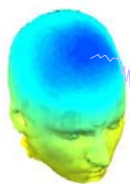
Task 4

Analysis of channel ERPs

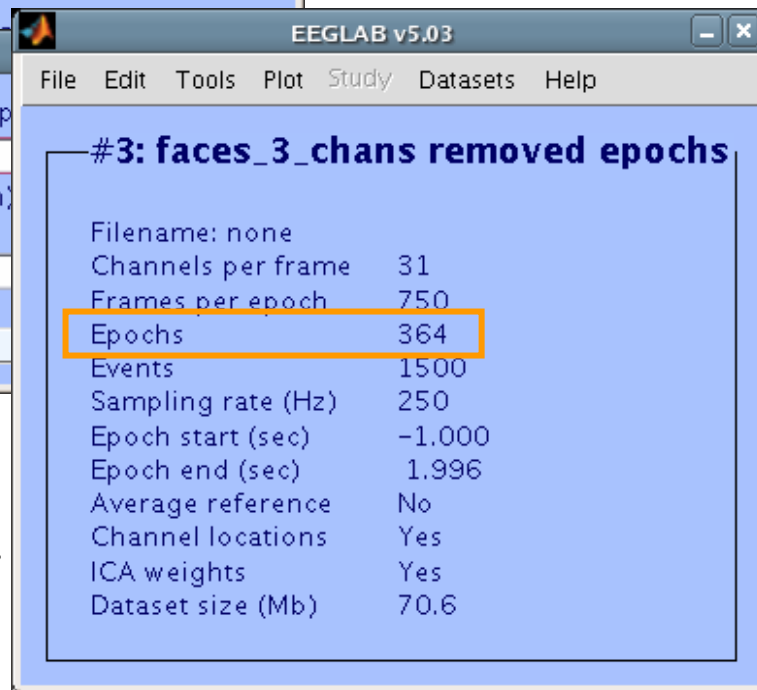
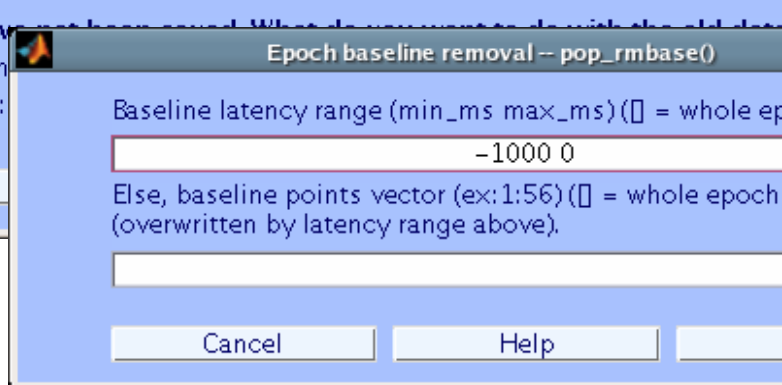
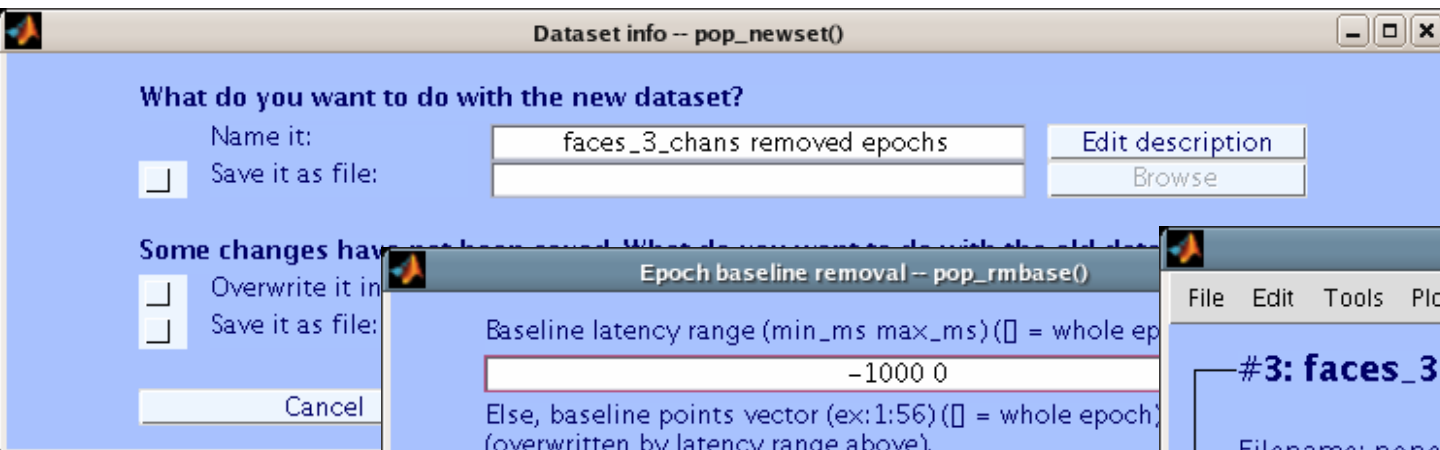
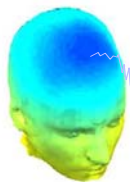
Exercise...



Extract Epochs (review)

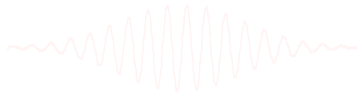
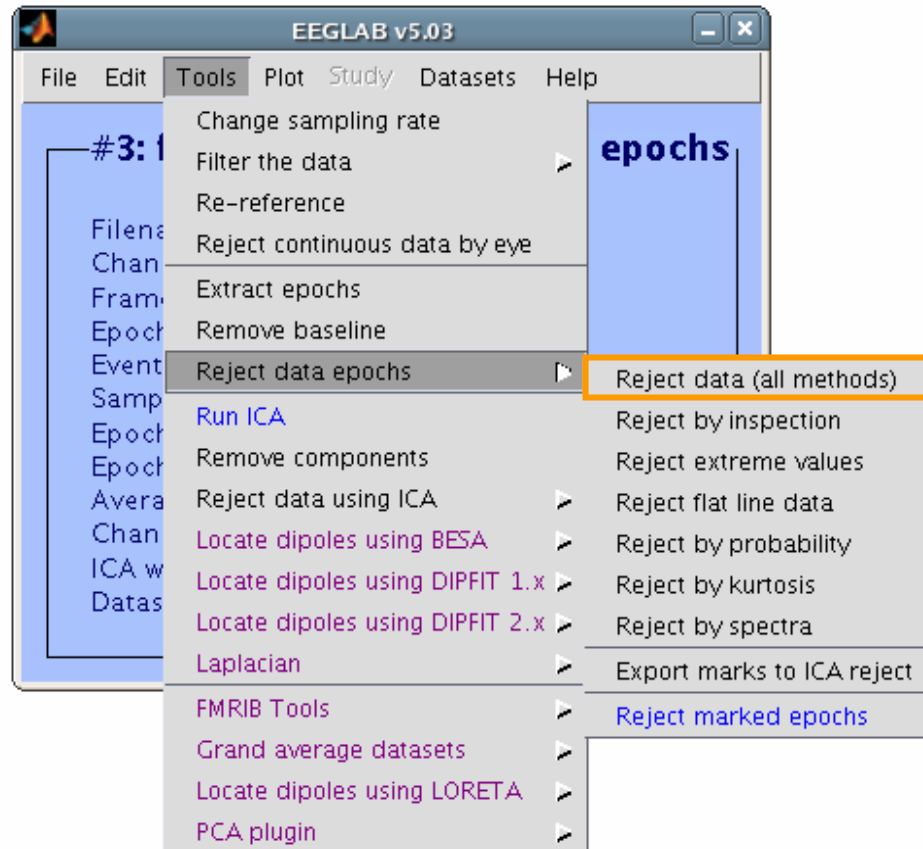
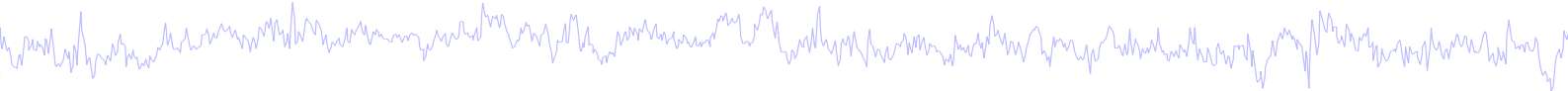


Extract Epochs (review)



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


Reject data epochs



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 | /

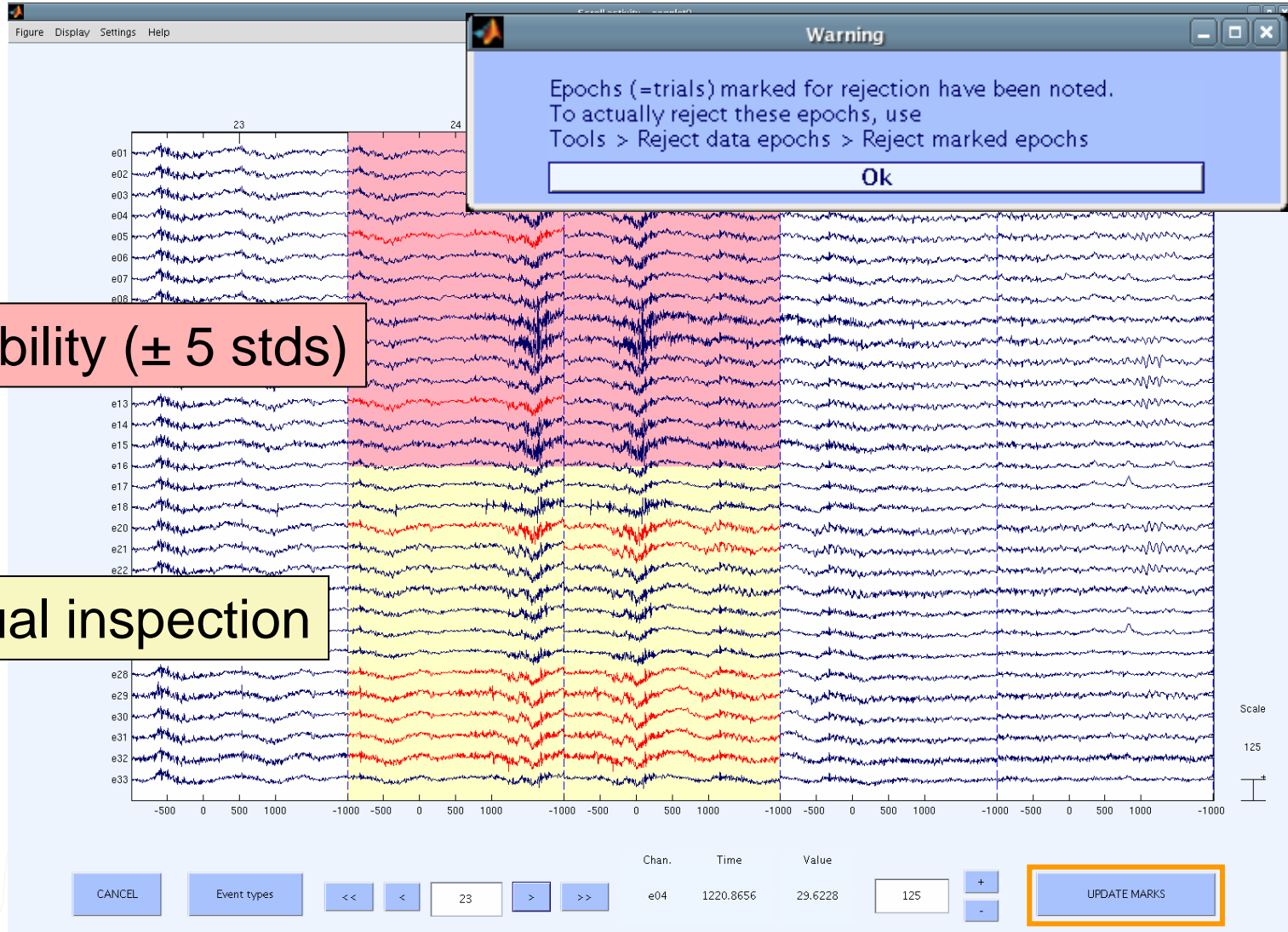
<input checked="" type="checkbox"/> Abnormal appearance	<input checked="" type="checkbox"/> Abnormal values	<input checked="" type="checkbox"/> Abnormal trends
<input checked="" type="checkbox"/> Improbable epochs	<input checked="" type="checkbox"/> Abnormal distributions	<input checked="" type="checkbox"/>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

Close (keep marks) Clear all marks Reject marked trials

visual inspection

probability

Reject data epochs



Plot channel measures over time



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

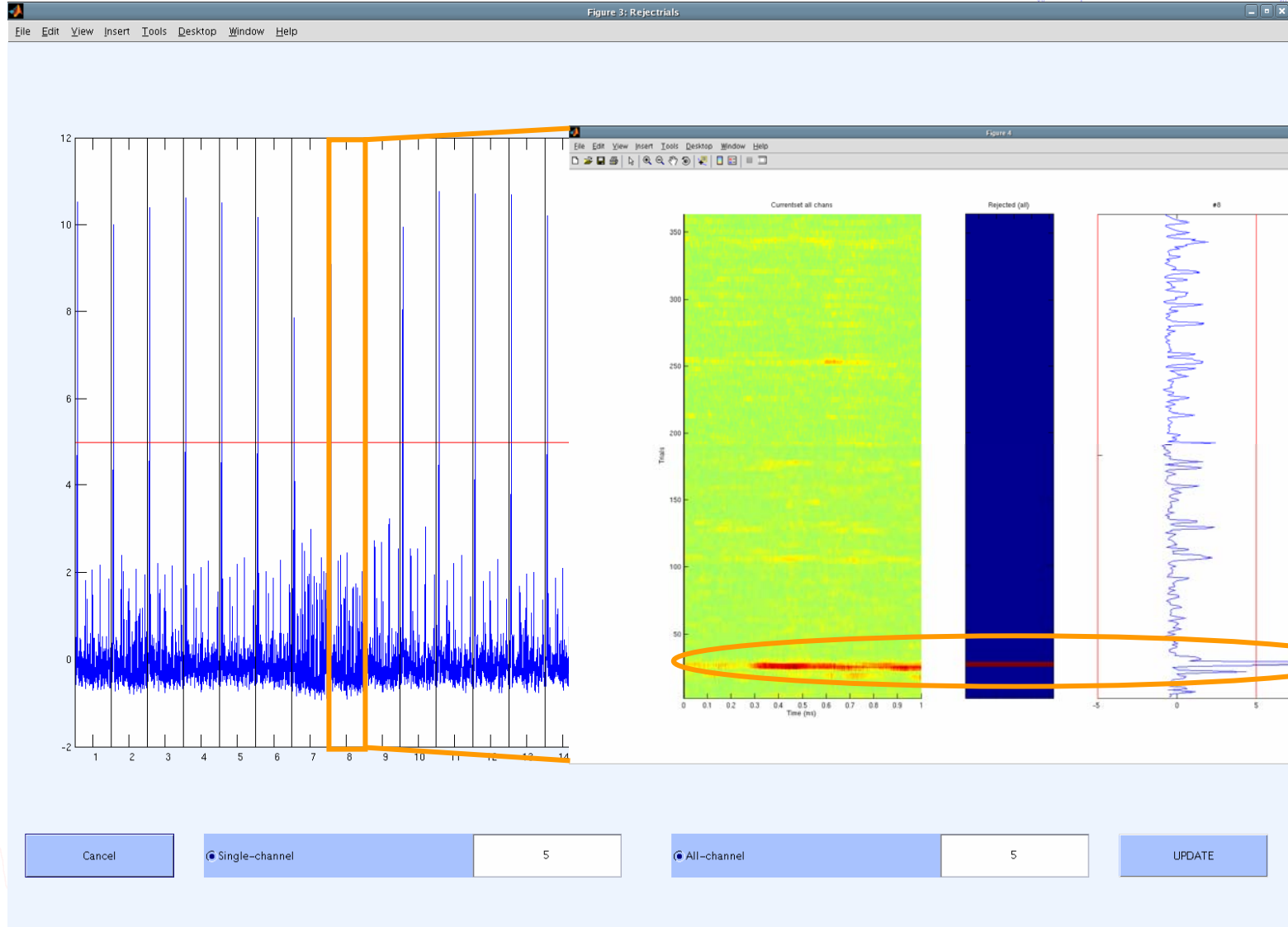
Plotting options

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

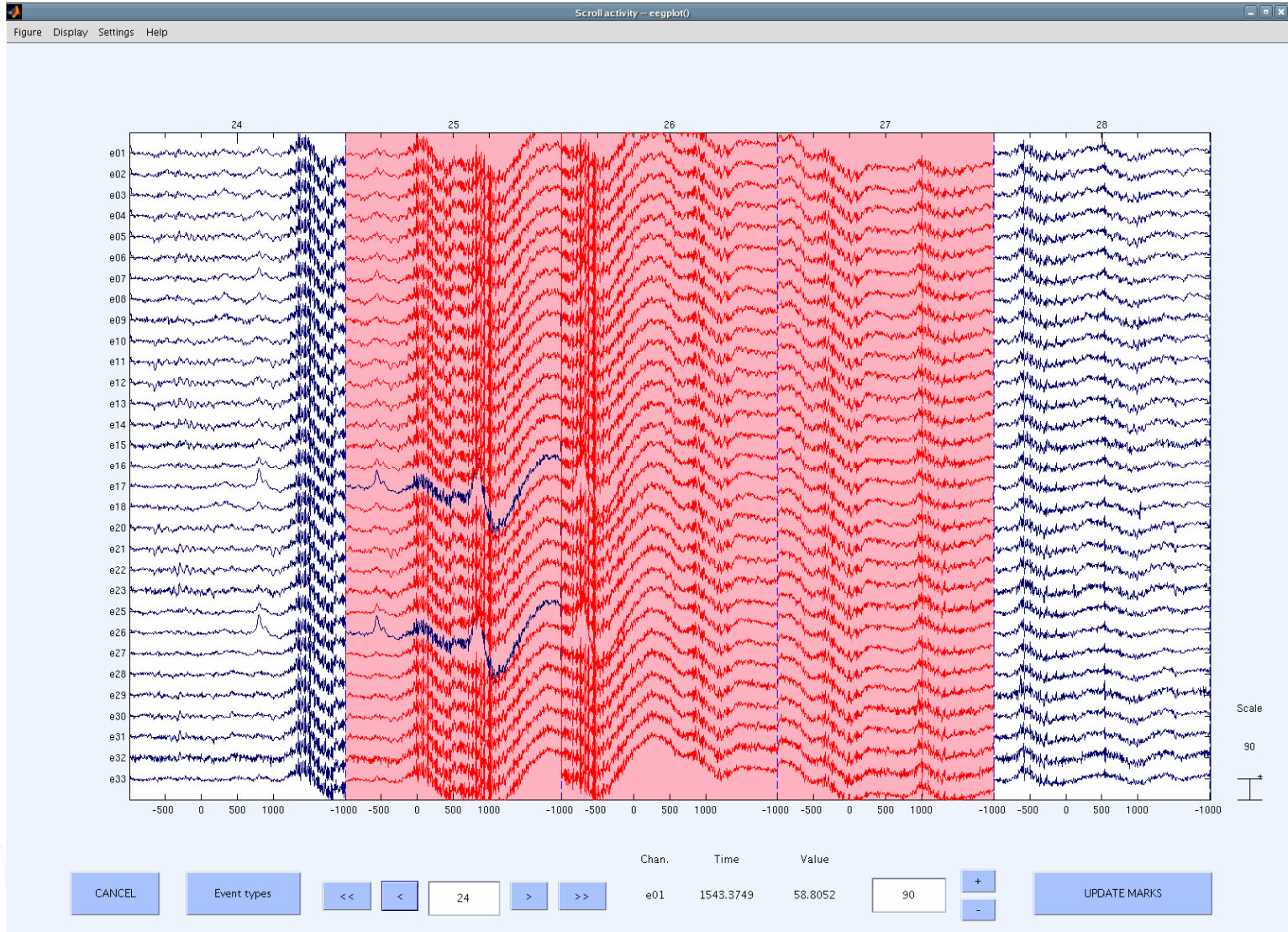
<input checked="" type="checkbox"/> Abnormal appearance	<input checked="" type="checkbox"/> Abnormal values	<input checked="" type="checkbox"/> Abnormal trends
<input checked="" type="checkbox"/> Improbable epochs	<input checked="" type="checkbox"/> Abnormal distributions	<input checked="" type="checkbox"/>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

Close (keep marks) Clear all marks Reject marked trials

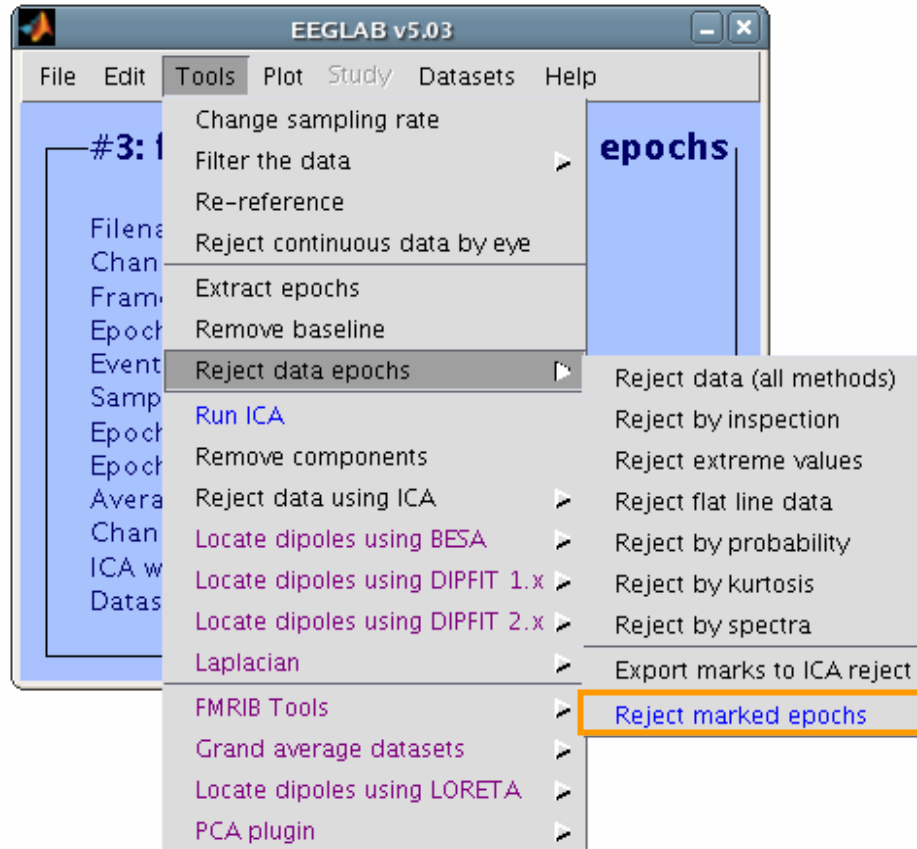
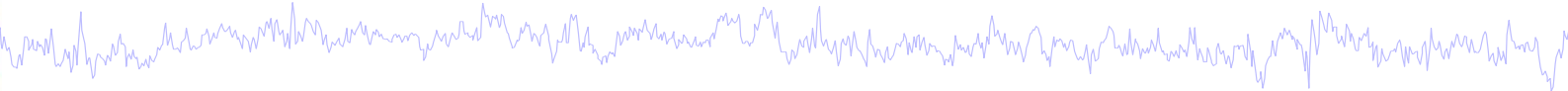
Reject data epochs



Reject data epochs

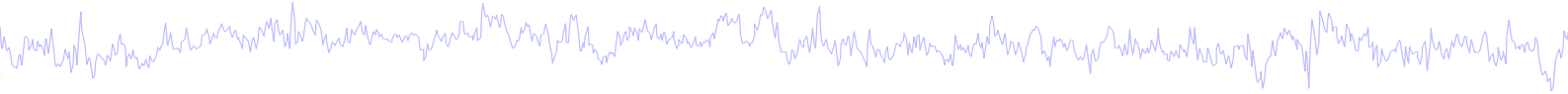


Reject data epochs



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

Artifact processing and ERP analysis



Task 1

Reject bad channels

Task 2

Reject continuous data

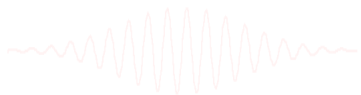
Task 3

Reject data epochs

Task 4

Analysis of channel ERPs

Exercise...



Select epochs (review)

Create separate data sets for face and object trials



Selection	Field Descriptions	Selection (value, list or real range "min<=max")	If set, select all BUT these
Field	To edit: Edit > Event fields	Ex: "Target" or 2;4,5 or 4.5 <= 13	
Event indices			<input type="checkbox"/>
latency (ms)	No description		<input type="checkbox"/>
type	No description	face	<input type="checkbox"/>
epoch	No description		<input type="checkbox"/>

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:

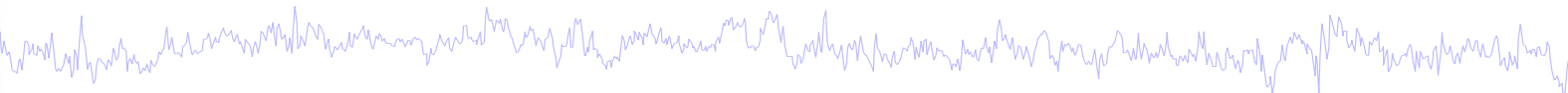
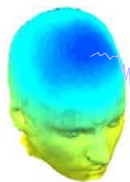
Keep only selected events and remove all other events

Remove epochs not referenced by any selected event

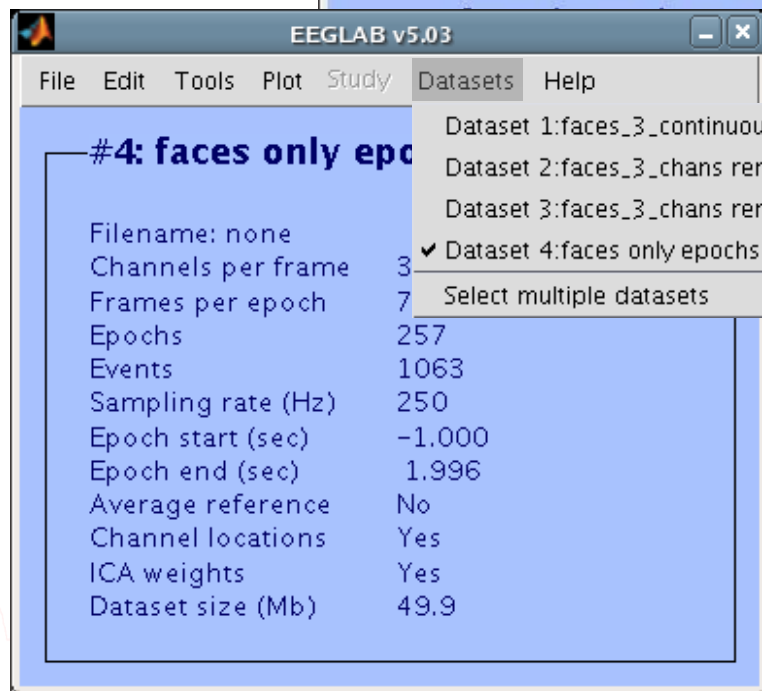
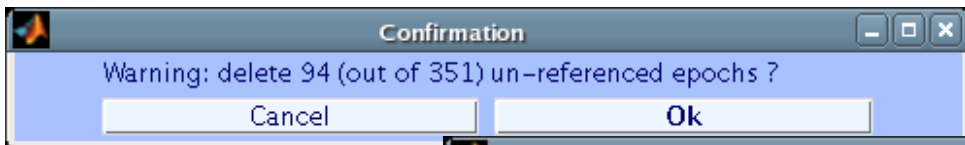
Cancel Help Ok

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

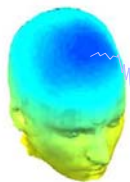
Select epochs (review)



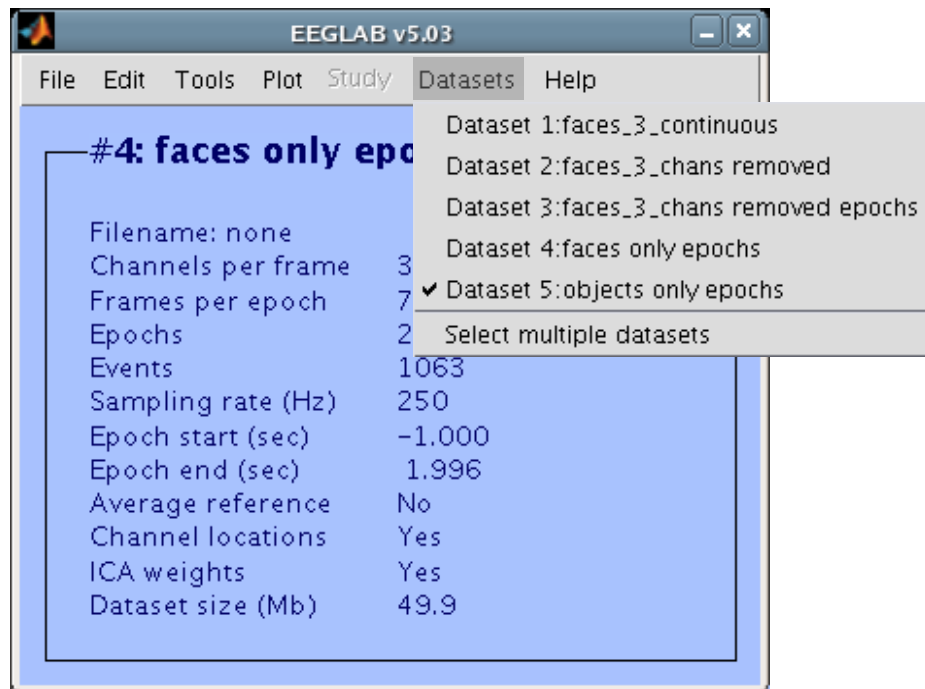
Create a new dataset



Select epochs (review)



Do the same
thing for 'object'
epochs



```
>> [EEG,ALLEEG,CURRENTSET]=pop_newset(ALLEEG,EEG,4, ...  
'retrieve',3,'study',0);  
>> EEG=pop_selectevent(EEG,'type',{'object'},'deleteevents', ...  
'off','deleteepochs','on');  
>> [ALLEEG EEG CURRENTSET]=pop_newset(ALLEEG,EEG,5, ...  
'setname','object only epochs');
```

Analysis of ERPs



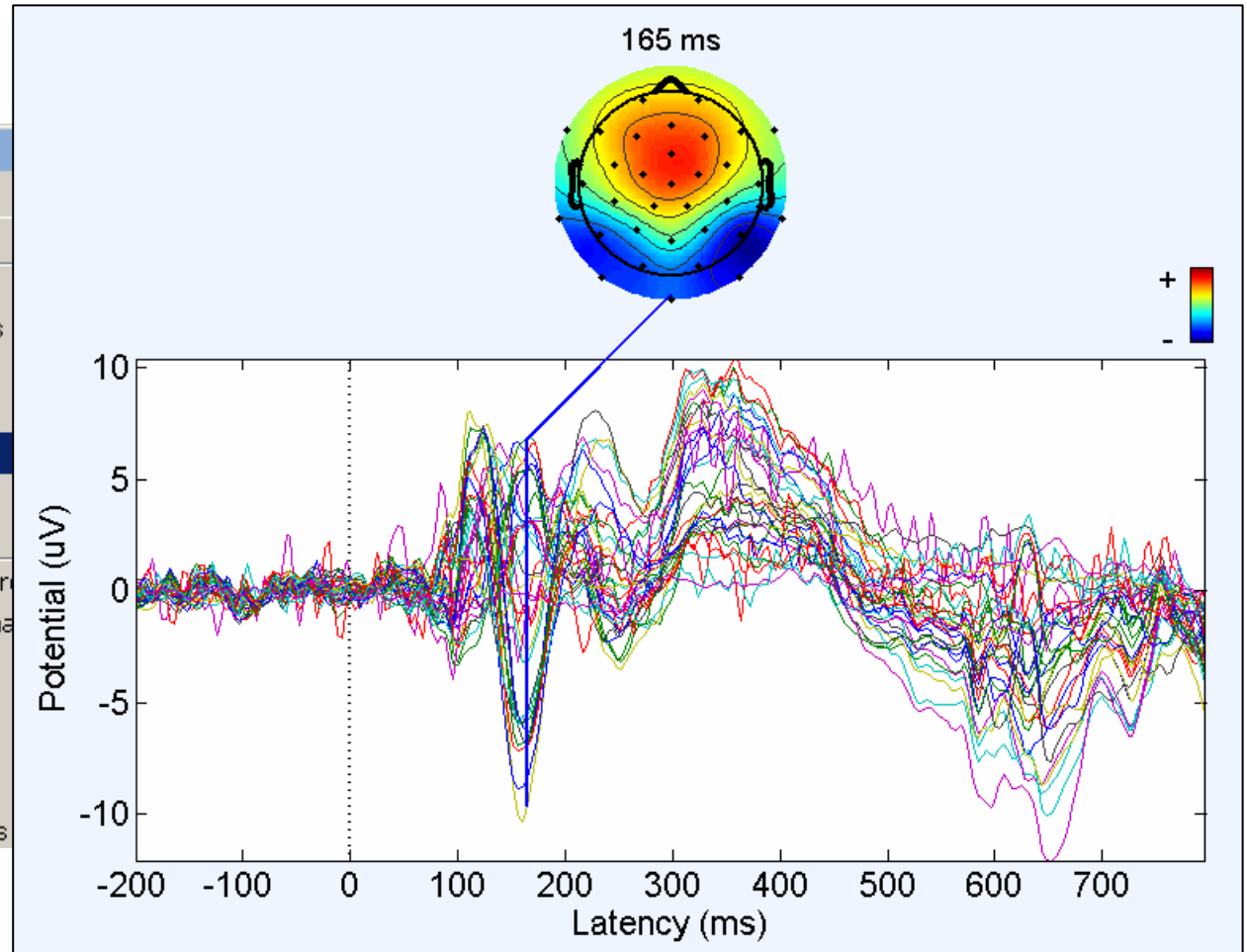
EEGLAB v4.512

File Edit Tools Plot Datasets Help

#3: face

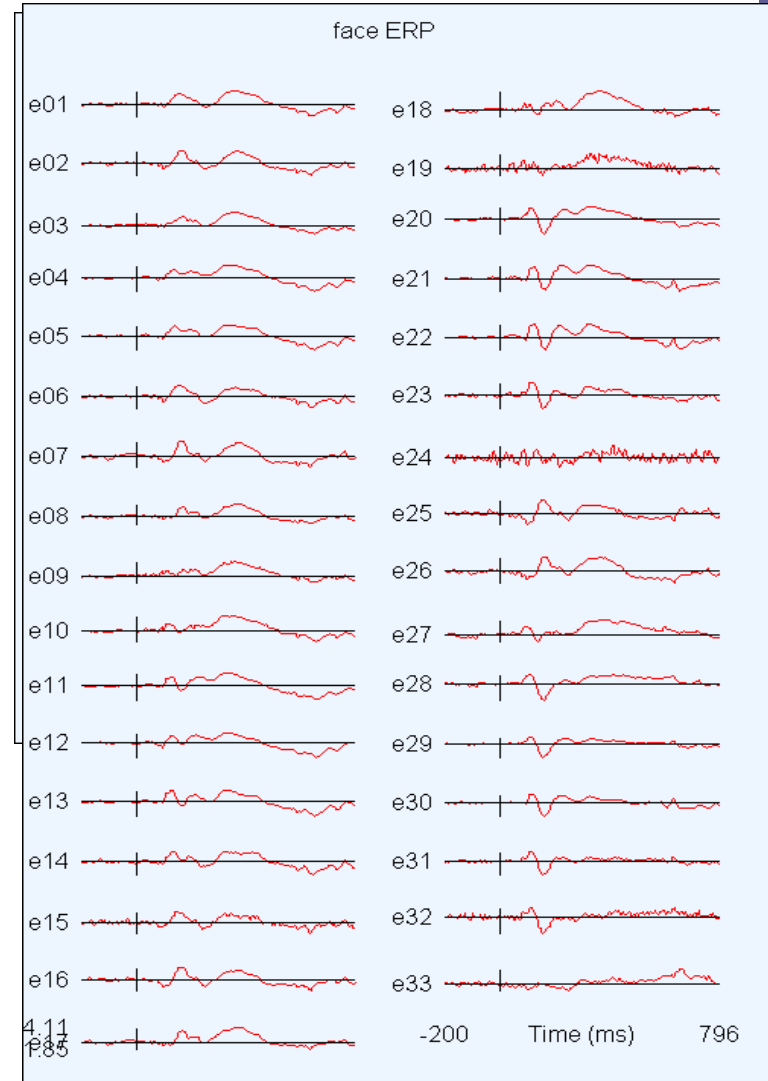
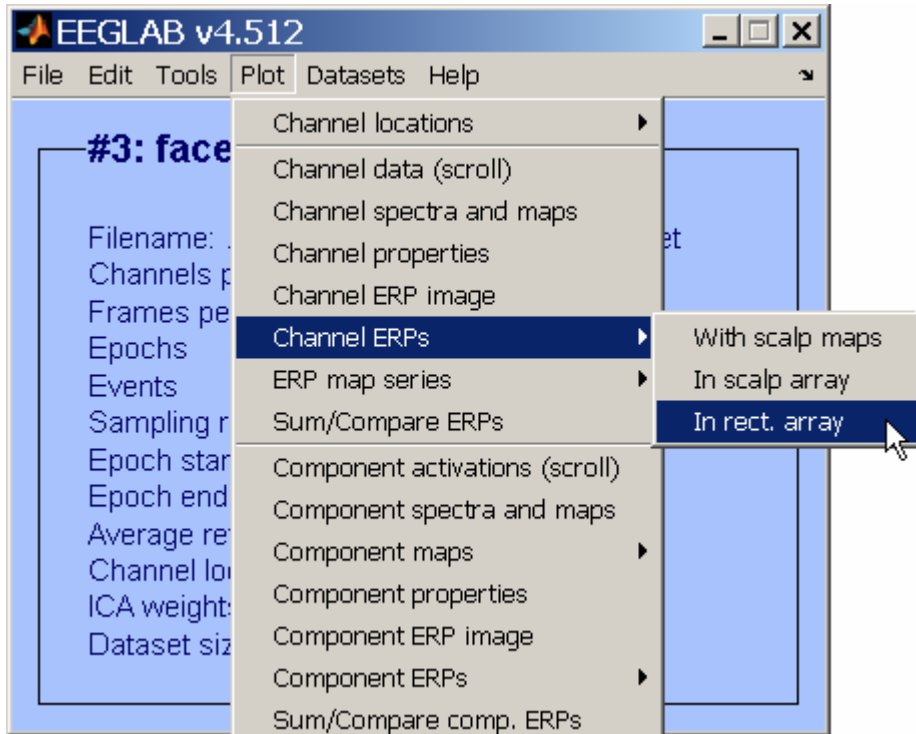
- Channel locations
- Channel data (scroll)
- Channel spectra and maps
- Channel properties
- Channel ERP image
- Channel ERPs**
- ERP map series
- Sum/Compare ERPs
- Component activations (scr
- Component spectra and ma
- Component maps
- Component properties
- Component ERP image
- Component ERPs
- Sum/Compare comp. ERPs

Filename: .
Channels p
Frames pe
Epochs
Events
Sampling r
Epoch star
Epoch end
Average re
Channel lo
ICA weight
Dataset siz

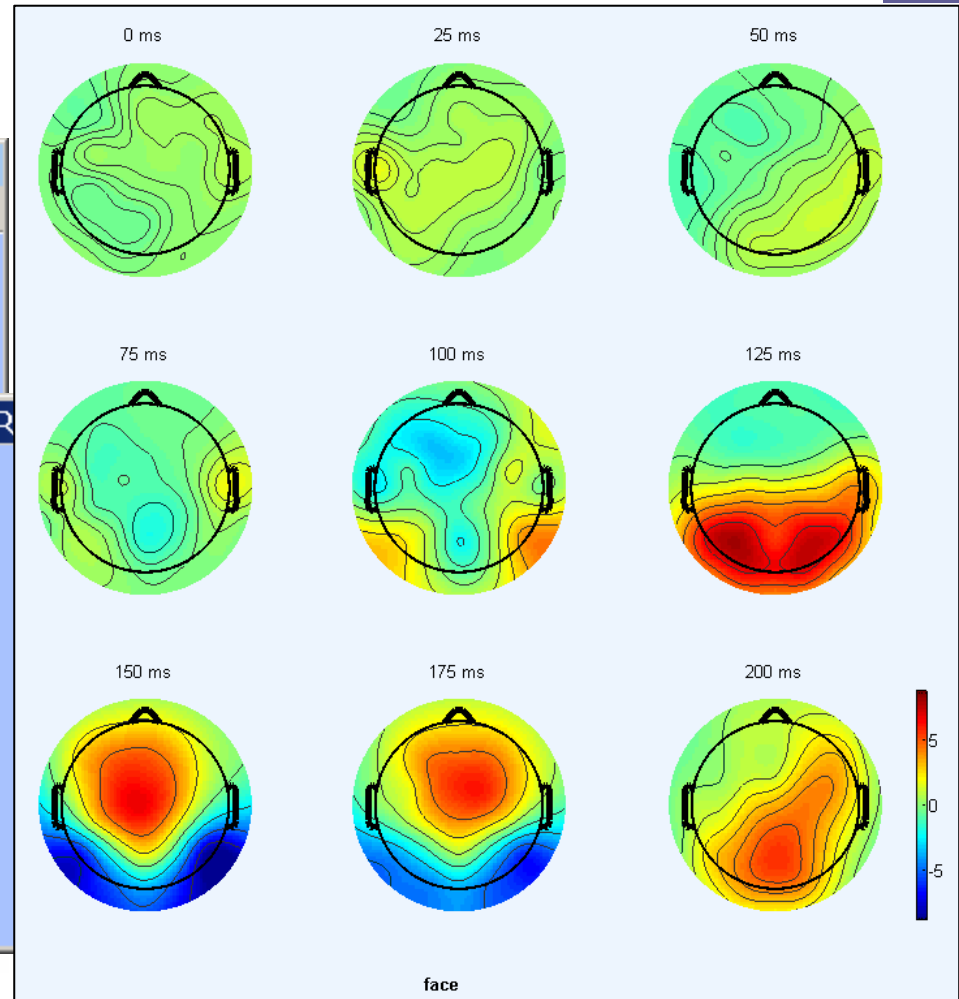
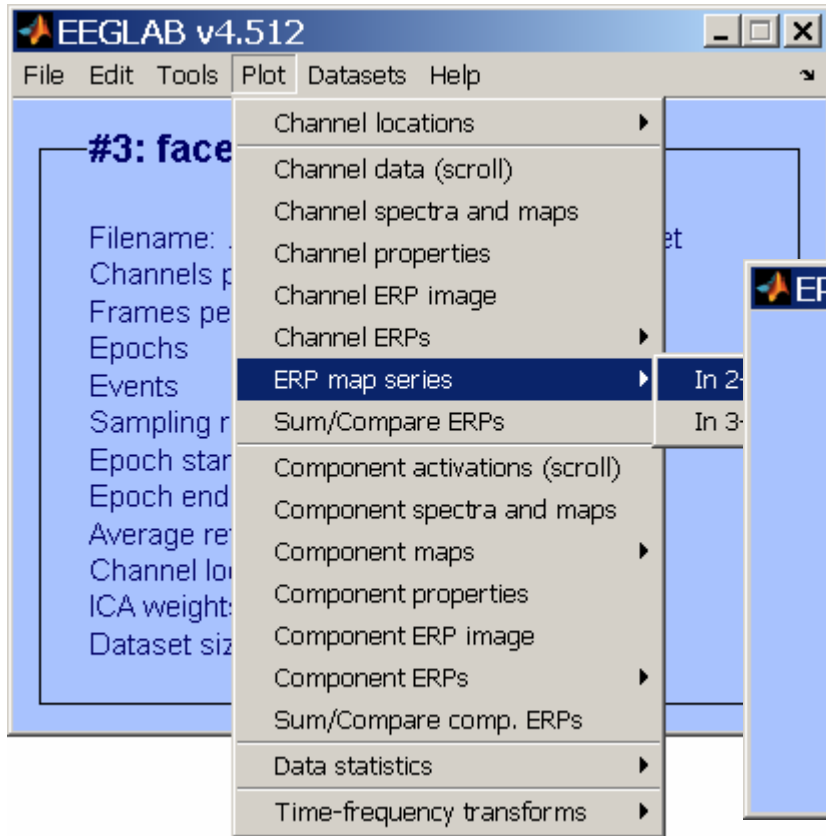


```
>> pop_timtopo(EEG,[-200 796],[165],'ERP data and scalp maps');
```

Analysis of ERPs

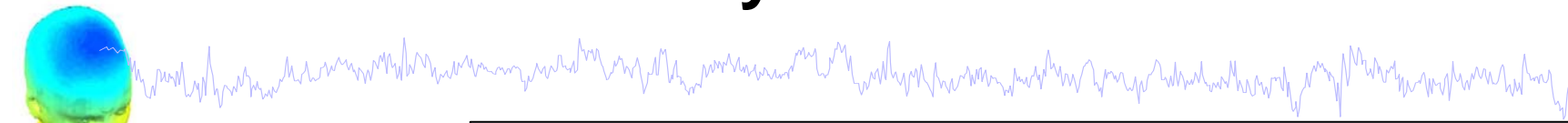


Analysis of ERPs



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

Analysis of ERPs



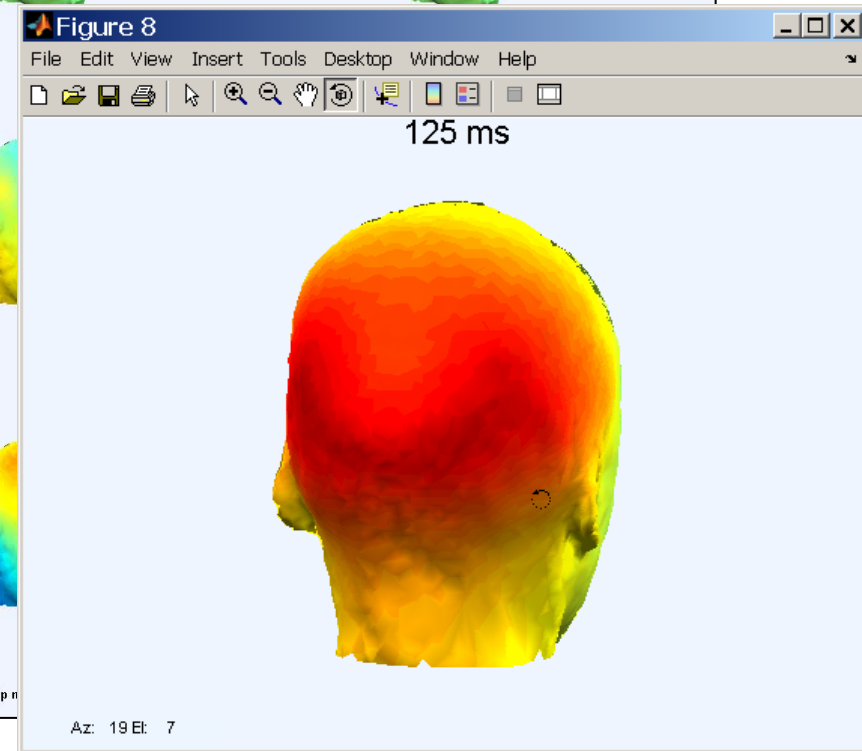
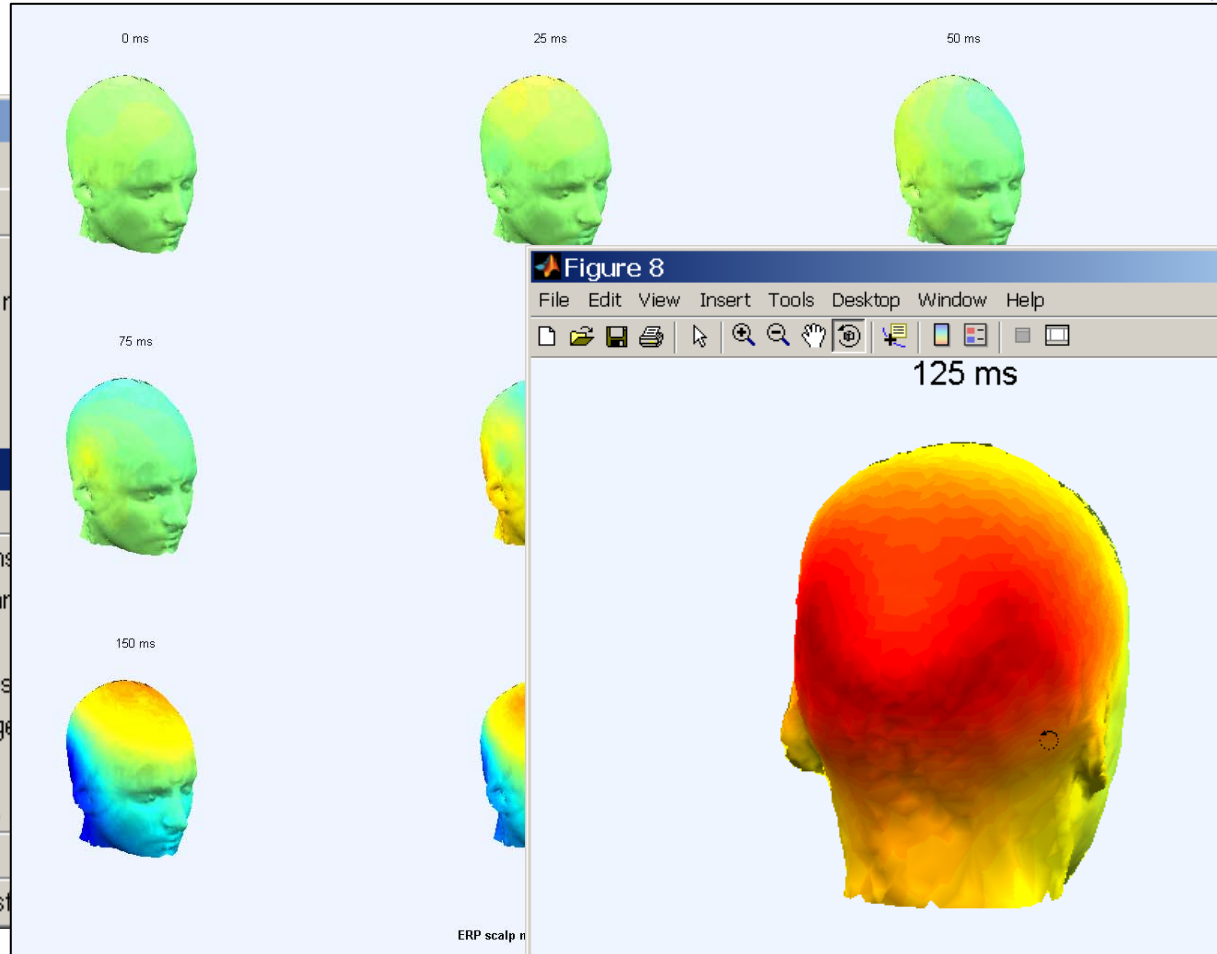
EEGLAB v4.512

File Edit Tools Plot Datasets Help

#1: (no ...)

Filename: ...
Channels p ...
Frames pe ...
Epochs ...
Events ...
Sampling r ...
Epoch star ...
Epoch end ...
Average re ...
Channel lo ...
ICA weight ...
Dataset siz ...

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



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

Analysis of ERPs



EEGLAB v4.512

File Edit Tools Plot Datasets Help

#3: face

- Filename: ...
- Channels p...
- Frames pe...
- Epochs
- Events
- Sampling r...
- Epoch star...
- Epoch end...
- Average re...
- Channel lo...
- ICA weight...
- Dataset siz...

Channel locations

Channel data (scroll)

Channel spectra and maps

Channel properties

Channel ERP image

Channel ERPs

ERP map series

Sum/Compare ERPs

Component activations (scro...

Component spectra and map...

Component maps

Component properties

Component ERP image

Component ERPs

Sum/Compare comp. ERPs

Data statistics ▶

Time-frequency transforms ▶

ERP grand average/RMS - pop_comperp()

Datasets to add (ex: 1 3 4):

Datasets to subtract (ex: 5 6 7):

Plot difference

	avg.	std.	all ERPs
Datasets to add	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Datasets to subtract	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Plot difference	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Channels subset ([]=all):

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

Use RMS instead of average (check):

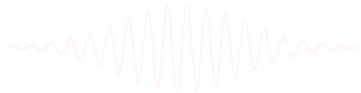
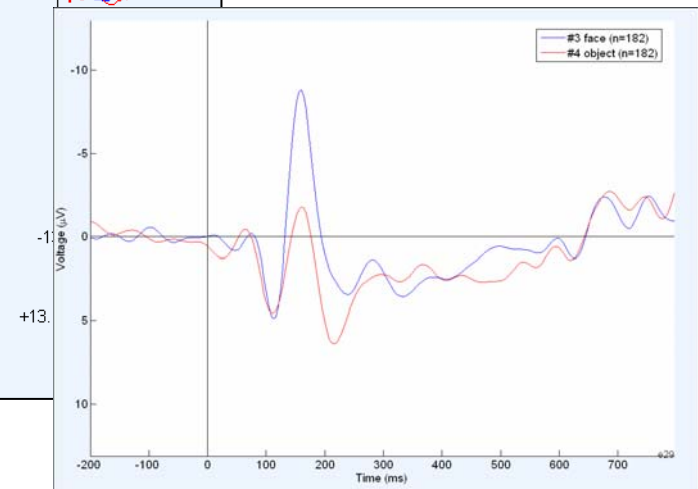
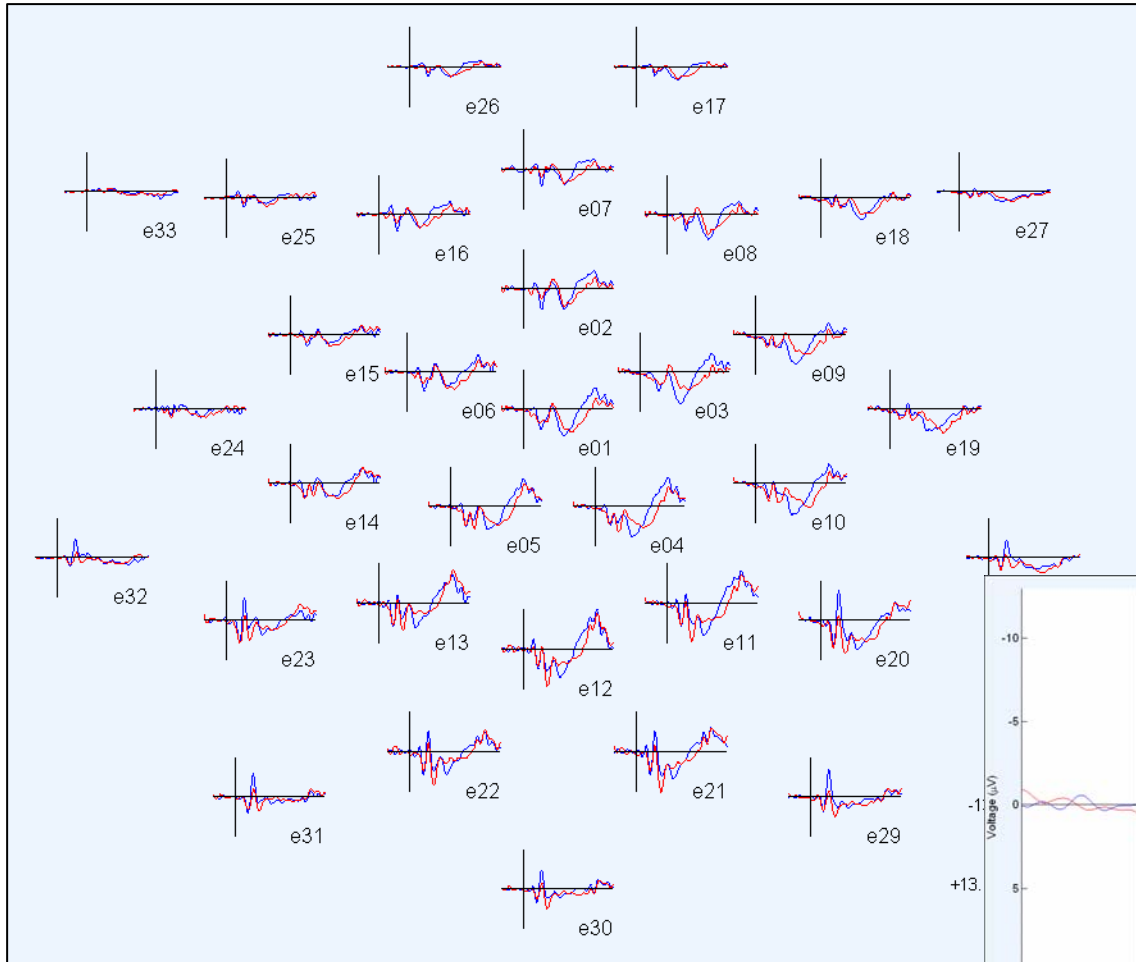
Low pass (Hz) (for display only)

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

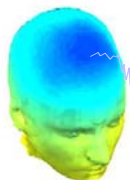
Cancel Help Ok

```
>>pop_comperp(ALLEEG,1,[4 5],[],'addavg','off','addstd','off',...  
'addall','on','diffavg','off','diffstd','off','lowpass',20,...  
'tplotopt',{'ydir',-1});
```

Analysis of ERPs



Analysis of ERP differences



ERP grand average/RMS - pop_comperp()

		avg.	std.	all ERPs
Datasets to add (ex: 1 3 4):	<input type="text" value="4"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Datasets to subtract (ex: 5 6 7):	<input type="text" value="5"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Plot difference		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

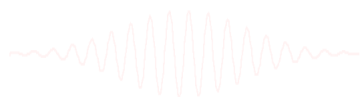
Channels subset ([])=all:

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

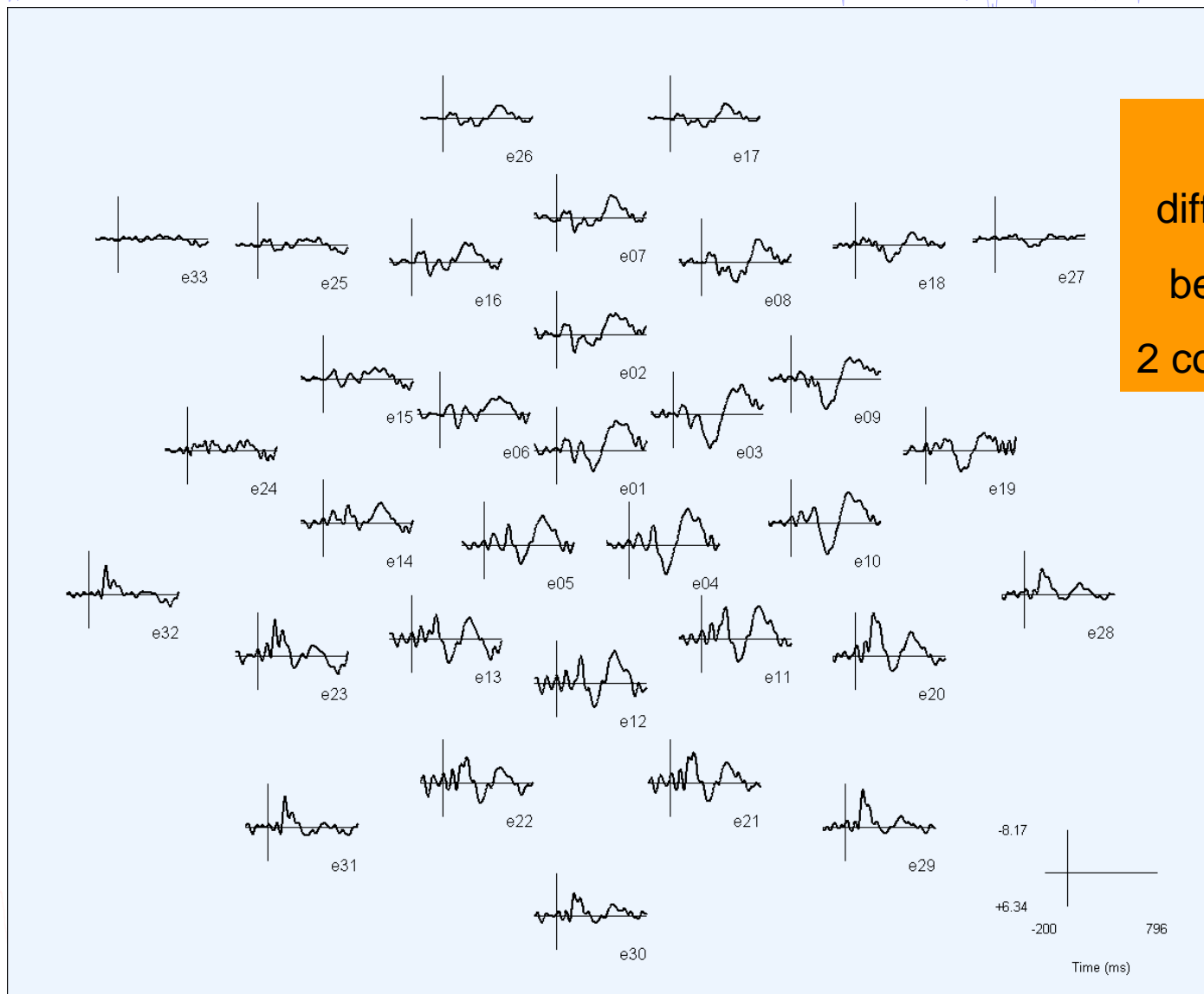
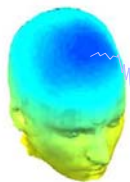
Use RMS instead of average (check):

Low pass (Hz) (for display only)

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



Analysis of ERP differences



ERP
difference
between
2 conditions

Export EEG data



The screenshot shows the EEGLAB v4.512 interface. The 'Export' menu is open, showing options like 'Export', 'Load existing dataset', 'Save current dataset', etc. A sub-menu is visible under 'Export' with 'ICA weights' and 'Dataset size (Mb)'. In the background, a window titled 'SpeedProject's SpeedEdit - [faces]' displays a table of data.

	e01	e02	e03	e04	e05	e06	e07	e08	e09	e10	e11	e12	e13
Out	-0.7021	-0.6395	-0.5491	-0.3844	-0.4730	-0.5075	-0.						
Exp	-0.7116	-0.7245	-0.4236	-0.2221	-0.4850	-0.7165	-0.						
Exp	-0.5483	-0.6298	-0.2757	-0.0396	-0.3252	-0.7949	-0.						
Tr	-0.4038	-0.4629	-0.1161	-0.1454	-0.3393	-0.7880	-0.						
Exp	-0.3721	-0.3333	-0.1556	-0.3324	-0.4109	-0.7188	-0.						
Exp	-0.2317	-0.1290	-0.2646	-0.2754	-0.2334	-0.4372	-0.						
Exp	0.0962	0.2113	-0.0913	-0.1361	0.0039	0.0085	0.1						
Nu	0.5633	0.6851	0.3850	0.0617	0.2508	0.4841	0.5						
Ap	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');
```

Exercise



- Load dataset '**faces_3.set**' from '**.../data/**' directory
- Reject noisy channels
- (optional: reject continuous data stretches)
- Epoch dataset on all 'face' and 'object' events
- Explore 1 or more of the following:
 - Reject noisy epochs by hand or use auto-rejection
 - Compare rejection methods and thresholds
 - Select 'face' and 'object' epochs separately
 - Plot ERPs
 - superimposed ERP envelopes
 - rectangular/scalp array
 - Compare 'face' vs 'object' ERPs
 - Export 'face' ERPs into an ascii file

