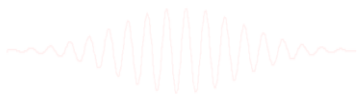


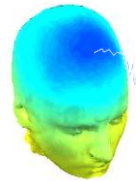
STUDY clustering overview



- 1. Build a STUDY**
- 2. Create STUDY design**
- 3. Precompute data measures**
- 4. Precluster data measures**
- 5. Cluster data measures**
- 6. Plot/edit clusters**



Memory options



Memory options - pop_editoptions()

STUDY options (set these checkboxes if you intend to work with studies)

If set, keep at most one dataset in memory. This allows processing hundreds of datasets within studies. .

If set, save not one but two files for each dataset (header and data). This allows faster data loading in studies. .

If set, write ICA activations to disk. This speeds up loading ICA components when dealing with studies. .

Memory options

If set, use single precision under Matlab 7.x. This saves RAM but can lead to rare numerical imprecisions. .

If set, use memory mapped array under Matlab 7.x. This may slow down some computation. .

ICA options

If set, precompute ICA activations. This requires more RAM but allows faster plotting of component activations. .

If set, scale ICA component activities to RMS (Root Mean Square) in microvolt (recommended). .

Folder options

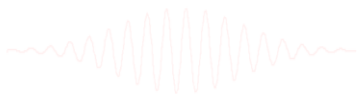
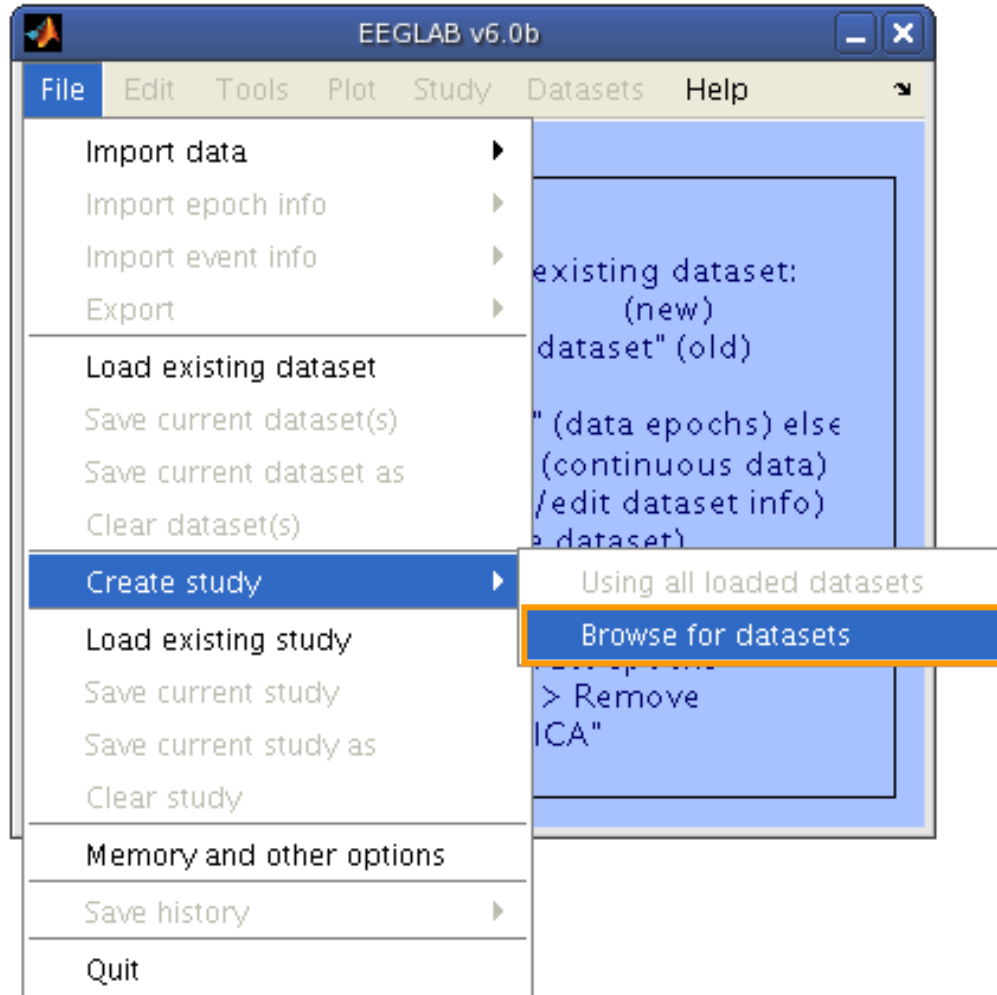
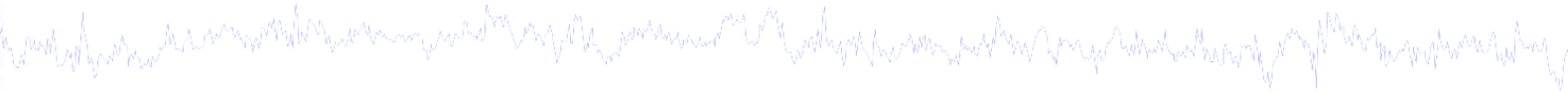
If set, when browsing to open a new dataset assume the folder/directory of previous dataset. .

Option file: C:\Users\julie\Documents\MATLAB\functions\adminfunc\eeeg_options.m

Buttons: Help, Cancel, Ok

Memory options should change when using STUDY vs single dataset

Build a STUDY



Build a STUDY, cont'd



Create a new STUDY set -- pop_study()

Create a new STUDY set

STUDY set name:

STUDY set task name:

STUDY set notes:

	dataset filename	browse	subject	session	condition	group	Select by r.v.	Clear
1	<input type="text"/>	...	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	Clear
2	<input type="text"/>	...	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	Clear
3	<input type="text"/>	...	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
4	<input type="text"/>	...	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
5	<input type="text"/>	...	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
6	<input type="text"/>	...	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
7	<input type="text"/>	...	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
8	<input type="text"/>	...	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
9	<input type="text"/>	...	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
10	<input type="text"/>	...	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	

Important note: Removed datasets will not be saved before being deleted from EEGLAB memory

< Page 1 >

Update dataset info - datasets stored on disk will be overwritten (unset = Keep study info se

Delete cluster information (to allow loading new datasets, set new components for clustering

Help

**Best done by a script
at command line.
Example script in
Tutorial 7 (STUDY
scripting)**

Choose dataset to add to STUDY -- pop_study()

Look in: S01

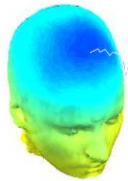
Name	Date modified	Type
Ignore.set	11/8/2009 7:06 PM	SET File
Memorize.set	11/8/2009 7:06 PM	SET File
Probe.set	11/12/2009 10:02 ...	SET File

File name:

Files of type: (*.set, *.SET)

Open Cancel

Edit dataset info



Create a new STUDY set -- pop_study()

Create a new STUDY set

STUDY set name: Sternberg

STUDY set task name: Sternberg

STUDY set notes:

	dataset filename	browse	subject	session	condition	group	Select by r.v.	
1	C:\Users\julie\Documents\Worl	...	S01	1	Memorize	1	All comp.	Clear
2	C:\Users\julie\Documents\Worl	...	S01	1	Ignore	1	All comp.	Clear
3	C:\Users\julie\Documents\Worl	...	S01	1	Probe	1	All comp.	Clear
4	C:\Users\julie\Documents\Worl	...	S02	1	Memorize	1	All comp.	Clear
5	C:\Users\julie\Documents\Worl	...	S02	1	Ignore	1	All comp.	Clear
6	C:\Users\julie\Documents\Worl	...	S02	1	Probe	1	All comp.	Clear
7	C:\Users\julie\Documents\Worl	...	S03	1	Memorize	1	All comp.	Clear
8	C:\Users\julie\Documents\Worl	...	S03	1	Ignore	1	All comp.	Clear
9	C:\Users\julie\Documents\Worl	...	S03	1	Probe	1	All comp.	Clear
10	C:\Users\julie\Documents\Worl	...	S04	1	Memorize	1	All comp.	Clear

Important note: Removed datasets will not be saved before being deleted from EEGLAB memory

< Page 1 >

Update dataset info - datasets stored on disk will be overwritten (unset = Keep study info separate).

Delete cluster information (to allow loading new datasets, set new components for clustering, etc.)

Help Cancel Ok

pop_study(): Pre-select components

Enter maximum residual (topo map - dipole proj.) var. (in %)
NOTE: This will delete any existing component clusters!

15

Keep only in-brain dipoles.

Cancel Help Ok

ICs to cluster



Create a new STUDY set -- pop_study()

Create a new STUDY set

STUDY set name: Sternberg

STUDY set task: Sternberg

STUDY set notes:

dataset filename	condition	group	Select by r.v.	
1 C:\Users\julie\D	Memorize	1	Comp.: 3 5...	Clear
2 C:\Users\julie\D	Ignore	1	Comp.: 3 5...	Clear
3 C:\Users\julie\D	Probe	1	Comp.: 3 5...	Clear
4 C:\Users\julie\D	Memorize	1	Comp.: 5 6...	Clear
5 C:\Users\julie\D	Ignore	1	Comp.: 5 6...	Clear
6 C:\Users\julie\D	Probe	1	Comp.: 5 6...	Clear
7 C:\Users\julie\D	Memorize	1	Comp.: 6 7...	Clear
8 C:\Users\julie\D	Ignore	1	Comp.: 6 7...	Clear
9 C:\Users\julie\D	Probe	1	Comp.: 6 7...	Clear
10 C:\Users\julie\D	Memorize	1	Comp.: 1 2...	Clear

Important note: Removed from EEGLAB memory

Update dataset info - datasets stored on disk will be overwritten (unset = Keep study info separate).

Delete cluster information (to allow loading new datasets, set new components for clustering, etc.)

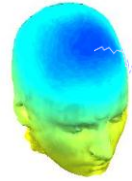
Buttons: Help, Cancel, Ok

select components

- ic 19
- ic 20
- ic 21
- ic 22
- ic 23
- ic 24
- ic 25
- ic 26
- ic 27
- ic 28
- ic 29
- ic 30
- ic 31
- ic 32

Buttons: Cancel, Ok

STUDY structure



STUDY =

```
    name: 'Sternberg'  
    task: 'Sternberg'  
datasetinfo: [1x39 struct]  
    notes: ''  
filename: 'stern.study'  
filepath: 'C:\Users\julie\Documents\Workshops\Mallorca\STUDY'  
    history: [1x7332 char]  
    subject: {1x13 cell}  
    group: {''}  
    session: []  
condition: {'ignore' 'memorize' 'probe'}  
    setind: [3x13 double]  
    etc: [1x1 struct]  
preclust: [1x1 struct]  
    cluster: [1x1 struct]  
changrp: [1x71 struct]  
    saved: 'yes'
```

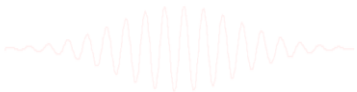
More STUDY structure
details in Tutorial 7

>>

STUDY clustering overview



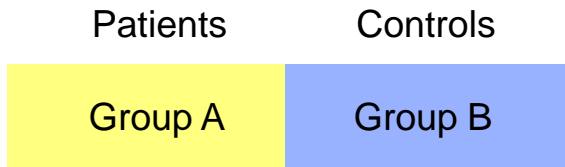
- 1. Build a STUDY**
- 2. Create STUDY design**
- 3. Precompute data measures**
- 4. Precluster data measures**
- 5. Cluster data measures**
- 6. Plot/edit clusters**



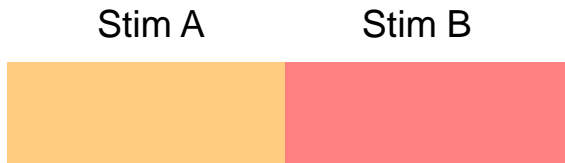
Experimental design



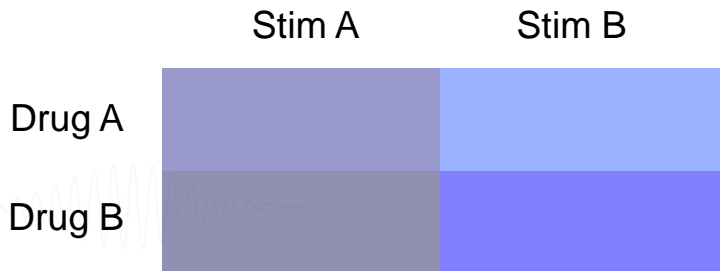
1x2 unpaired



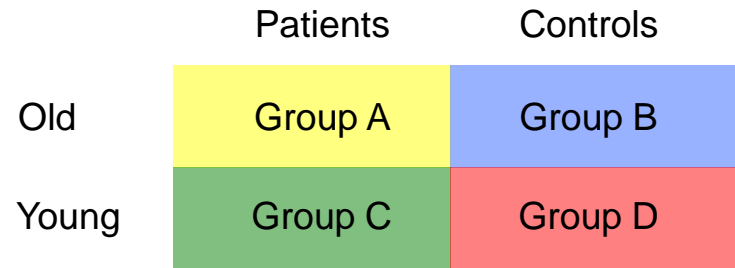
1x2 paired



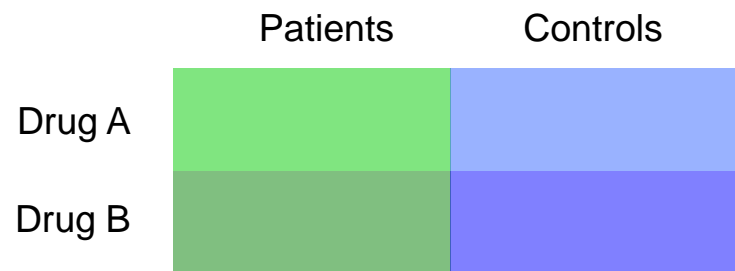
2x2 paired



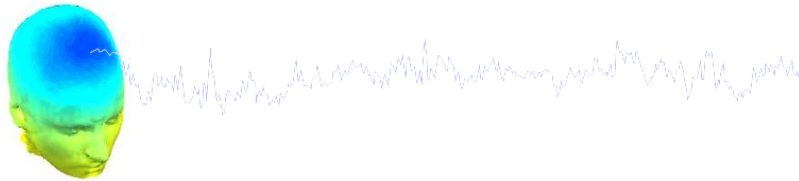
2x2 unpaired



2x2 paired & unpaired



Create design



EEGLAB v9.0.0.0b

File Edit Tools Plot **Study** Datasets Help

STUDY set:

- Study filename: ...s/data
- Study task name
- Nb of subjects
- Nb of conditions
- Nb of sessions
- Nb of groups
- Epoch consistency
- Channels per frame: 61
- Channel locations: yes
- Clusters: 1
- Status: Pre-clustered
- Total size (Mb): 8.2

Edit study info
 Select/Edit study design(s)
 Precompute channel measures
 Plot channel measures
 Precompute component measures
 Measure Product clustering
 PCA clustering (original)
 Edit/plot clusters

Edit STUDY design -- pop_studydesign0

Select STUDY design

STUDY.design 1

Add design
Rename design
Delete design

Subjects

S01
S02
S03
S04
S05
S06
S07
S08
S09
S10
S11
S12
S13

Independent variable 1

condition
duration
init_index
init_time
inset
load ...

Ind. var. 1 values

ignore
memorize
probe

Combine selected values
Paired statistics

Independent variable 2

None
condition
duration
init_index
init_time
inset

Ind. var. 2 values

Combine selected values
Paired statistics

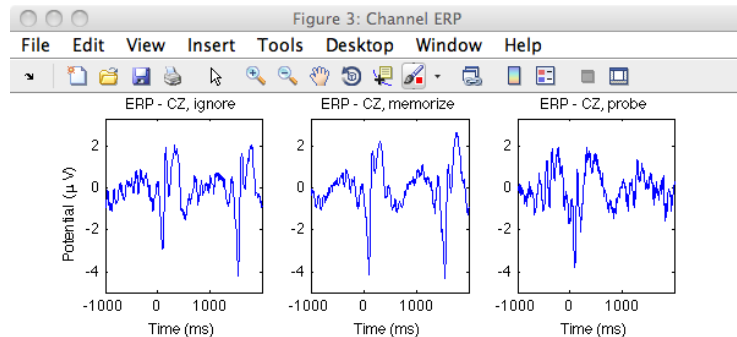
Use only specific datasets/trials

Delete all datafiles associated with this STUDY design

Save the STUDY

Cancel Ok

1x3 design



Create design

EEGLAB v7.1.7.18b

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

Continuous -- Rere...

70
610133
1
1303
250
0.000
2440.528
CZ
Yes
Yes
Yes
349

Edit event values -- pop_editeventvals()

Edit event field values (currently 1303 events) Delete event

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

Number of event fields is unlimited

Event Num: 1

Re-order events (for review only)

Main sorting field: No field selected

Secondary sorting field: No field selected

Create a new STUDY set -- pop_study()

Edit STUDY set information - remember to save changes

STUDY set name: Sternberg

STUDY set task name: Sternberg

STUDY set notes:

dataset filename	browse	subject	session	condition	group	Select by r.v.
C:\Users\julie\Documents\Wor...	...	S01		memorize		Comp.: 3 5 ... Clear
C:\Users\julie\Documents\Wor...	...	S01		ignore		Comp.: 3 5 ... Clear
C:\Users\julie\Documents\Wor...	...	S01		probe		Comp.: 3 5 ... Clear
C:\Users\julie\Documents\Wor...	...	S02		memorize		Comp.: 5 6 ... Clear
C:\Users\julie\Documents\Wor...	...	S02		ignore		Comp.: 5 6 ... Clear
C:\Users\julie\Documents\Wor...	...	S02		probe		Comp.: 5 6 ... Clear
C:\Users\julie\Documents\Wor...	...	S03		memorize		Comp.: 6 7 ... Clear
C:\Users\julie\Documents\Wor...	...	S03		ignore		Comp.: 6 7 ... Clear
C:\Users\julie\Documents\Wor...	...	S03		probe		Comp.: 6 7 ... Clear
C:\Users\julie\Documents\Wor...	...	S04		memorize		Comp.: 1 2 ... Clear

Important note: Removed datasets will not be saved before being deleted from EEGLAB memory

Dataset info (condition, group, ...) differs from study info. [set] = Overwrite dataset info.

Delete cluster information (to allow loading new datasets, set new components for clustering, etc.)

Edit STUDY design -- pop_studydesign()

Independent variable 1

- condition
- duration
- init_index
- init_time
- inset
- load

Independent variable 2

- None
- condition
- duration
- init_index
- init_time
- inset

Ind. var. 1 values

- ignore
- memorize
- probe

Ind. var. 2 values

Combine selected values

Paired statistics

Cancel Ok

STUDY design examples



Edit STUDY design -- pop_studydesign()

Select STUDY design

Audio versus light all subjects
All stimulus type - non dual subjects only
Blank versus other stimulus type - non dual subjects only
Audio preceded by different stimulus types
Audio versus light across sessions - non dual subjects only
Audio versus light across presentation - non dual subjects only

Add design
Rename design
Delete design

Subjects

c1
c2
c3
c4
c5
c6
c7
c8
nd1
nd2
nd3
nd4
nd5
nd6
nd7
nd8

Select all subjects

Independent variable 1

None
group
stimulusType
presentation
session
preevent

Ind. var. 1 values

audio
blank
both
light
audio - light

Combine selected values
Unpaired statistics

Independent variable 2

None
group
stimulusType
presentation
session
preevent

Ind. var. 2 values

control
nondual

Combine selected values
Unpaired statistics

Use only specific datasets/trials

Delete all datafiles associated with this STUDY design

Save the STUDY

Cancel Ok

STUDY design examples



Edit STUDY design -- pop_studydesign()

Select STUDY design

Audio versus light all subjects
All stimulus type - non dual subjects only
Blank versus other stimulus type - non dual subjects only
Audio preceded by different stimulus types
Audio versus light across sessions - non dual subjects only
Audio versus light across presentation - non dual subjects only

Add design
Rename design
Delete design

Subjects

c1
c2
c3
c4
c5
c6
c7
c8
nd1
nd2
nd3
nd4
nd5
nd6
nd7
nd8

Select all subjects

Independent variable 1

None
group
stimulusType
presentation
session
preevent

Ind. var. 1 values

audio
blank
both
light
audio - light

Combine selected values
Unpaired statistics

Independent variable 2

None
group
stimulusType
presentation
session
preevent

Ind. var. 2 values

Combine selected values
Unpaired statistics

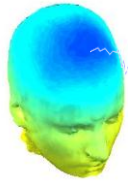
Use only specific datasets/trials

Delete all datafiles associated with this STUDY design

Save the STUDY

Cancel Ok

STUDY design examples



Edit STUDY design -- pop_studydesign()

Select STUDY design

Audio versus light all subjects
All stimulus type - non dual subjects only
Blank versus other stimulus type - non dual subjects only
Audio preceded by different stimulus types
Audio versus light across sessions - non dual subjects only
Audio versus light across presentation - non dual subjects only

Add design
Rename design
Delete design

Subjects

c1
c2
c3
c4
c5
c6
c7
c8
nd1
nd2
nd3
nd4
nd5
nd6
nd7
nd8

Select all subjects

Independent variable 1

None
group
stimulusType
presentation
session
preevent

Ind. var. 1 values

audio
blank
both
light
audio - light

Combine selected values
Unpaired statistics

Independent variable 2

None
group
stimulusType
presentation
session
preevent

Ind. var. 2 values

Combine selected values
Unpaired statistics

Use only specific datasets/trials

Delete all datafiles associated with this STUDY design

Save the STUDY

Cancel Ok

STUDY design examples



Edit STUDY design -- pop_studydesign0

Select STUDY design

Audio versus light all subjects
All stimulus type - non dual subjects only
Blank versus other stimulus type - non dual subjects only
Audio preceded by different stimulus types
Audio versus light across sessions - non dual subjects only
Audio versus light across presentation - non dual subjects only

Add design
Rename design
Delete design

Subjects

c1
c2
c3
c4
c5
c6
c7
c8
nd1
nd2
nd3
nd4
nd5
nd6
nd7
nd8

Select all subjects

Independent variable 1

None
group
stimulusType
presentation
session
preevent

Ind. var. 1 values

audio
blank
both
light

Combine selected values
Unpaired statistics

Independent variable 2

None
group
stimulusType
presentation
session
preevent

Ind. var. 2 values

Combine selected values
Unpaired statistics

Use only specific datasets/trials 'stimulusType',{'audio'}

Delete all datafiles associated with this STUDY design

Save the STUDY

Cancel Ok

STUDY design examples



Edit STUDY design -- pop_studydesign()

Select STUDY design

Audio versus light all subjects
All stimulus type - non dual subjects only
Blank versus other stimulus type - non dual subjects only
Audio preceded by different stimulus types
Audio versus light across sessions - non dual subjects only
Audio versus light across presentation - non dual subjects only

Add design
Rename design
Delete design

Subjects

c1
c2
c3
c4
c5
c6
c7
c8
nd1
nd2
nd3
nd4
nd5
nd6
nd7
nd8

Select all subjects

Independent variable 1

None
group
stimulusType
presentation
session
preevent

Ind. var. 1 values

audio
blank
both
light
audio - light

Combine selected values
Unpaired statistics

Independent variable 2

None
group
stimulusType
presentation
session
preevent

Ind. var. 2 values

1
2

Combine selected values
Unpaired statistics

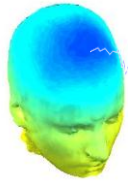
Use only specific datasets/trials

Delete all datafiles associated with this STUDY design

Save the STUDY

Cancel Ok

STUDY design examples



Edit STUDY design -- pop_studydesign()

Select STUDY design

Audio versus light all subjects
All stimulus type - non dual subjects only
Blank versus other stimulus type - non dual subjects only
Audio preceeded by different stimulus types
Audio versus ligh accross sessions - non dual subjects only
Audio versus light accross presentation - non dual subjects only

Add design
Rename design
Delete design

Subjects

c1
c2
c3
c4
c5
c6
c7
c8
nd1
nd2
nd3
nd4
nd5
nd6
nd7
nd8

Select all subjects

Independent variable 1

None
group
stimulusType
presentation
session
prevevent

Ind. var. 1 values

audio
blank
both
light
audio - light

Combine selected values
Unpaired statistics

Independent variable 2

None
group
stimulusType
presentation
session
prevevent

Ind. var. 2 values

evoked
spontaneous

Combine selected values
Unpaired statistics

Use only specific datasets/trials

Delete all datafiles associated with this STUDY design

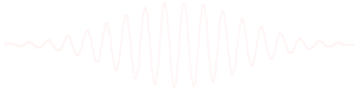
Save the STUDY

Cancel Ok

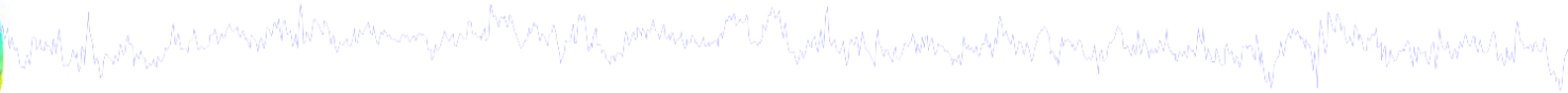
STUDY clustering overview



- 1. Build a STUDY**
- 2. Create STUDY design**
- 3. Precompute data measures**
- 4. Precluster data measures**
- 5. Cluster data measures**
- 6. Plot/edit clusters**



Precompute data measures



EEGLAB v6.0b

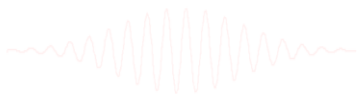
File Edit Tools Plot Study Datasets Help

STUDY set: A1

Study filename:
Study task name
Nb of subjects
Nb of conditions
Nb of sessions
Nb of groups
Epoch consistency yes
Channels per frame 31
Channel locations yes
Clusters 1
Status Ready to precluster
Total size (Mb) 30.4

Study menu options:

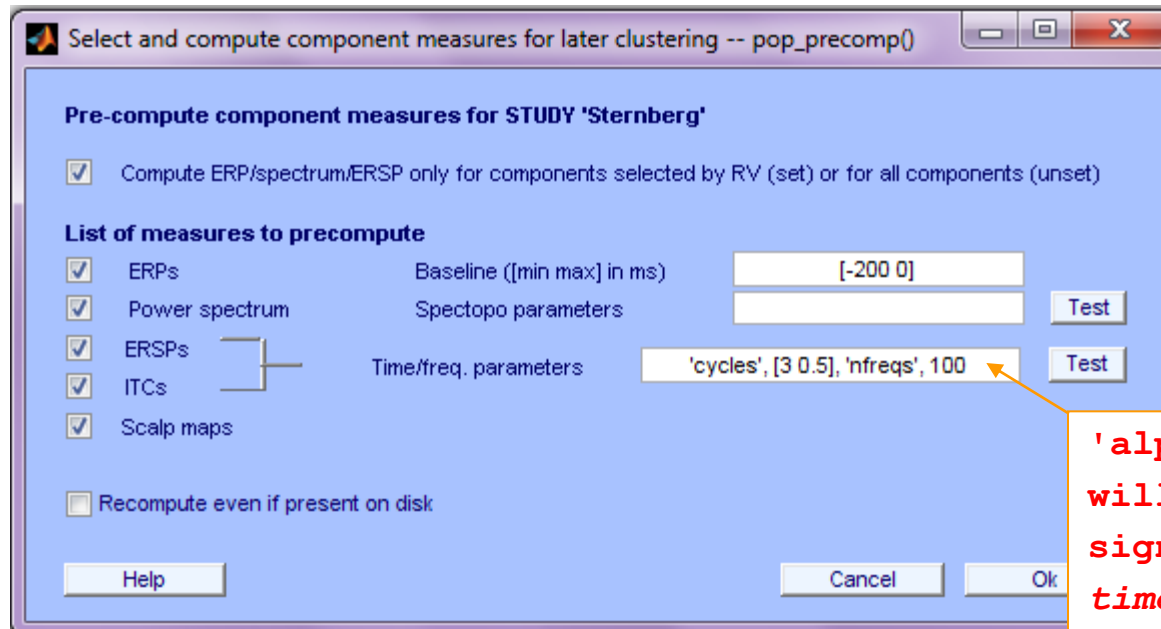
- Edit study info
- Precompute channel measures
- Plot channel measures
- Precompute component measures**
- Build preclustering array
- Cluster components
- Edit/plot clusters



Precompute data measures



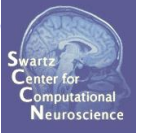
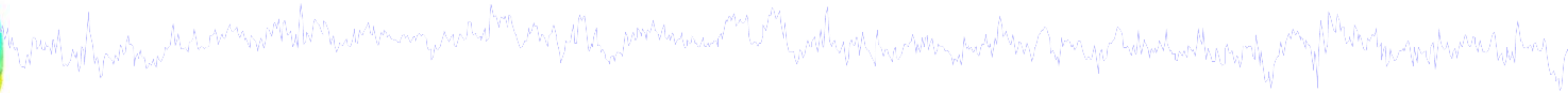
TIP: Compute all measures so you can test different combinations for preclustering later



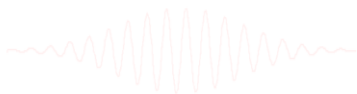
'alpha', .01 will compute significance, but time-consuming

```
[STUDY ALLEEG] = std_precomp(STUDY, ALLEEG, 'components', ...  
'erp', 'on', 'rmbase', [-200 0], 'scalp', 'on', 'spec', ...  
'on', 'specparams', {}, 'ersp', 'on', 'erspparams', ...  
{ 'cycles', [3 0.5], 'nfreqs', 100, 'freqs', [3 70], ...  
'alpha', 0.01}, 'itc', 'on');
```

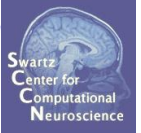
STUDY clustering overview



- 1. Build a STUDY**
- 2. Create STUDY design**
- 3. Precompute data measures**
- 4. Precluster data measures**
- 5. Cluster data measures**
- 6. Plot/edit clusters**



Precluster the data



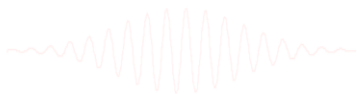
EEGLAB v6.0b

File Edit Tools Plot Study Datasets Help

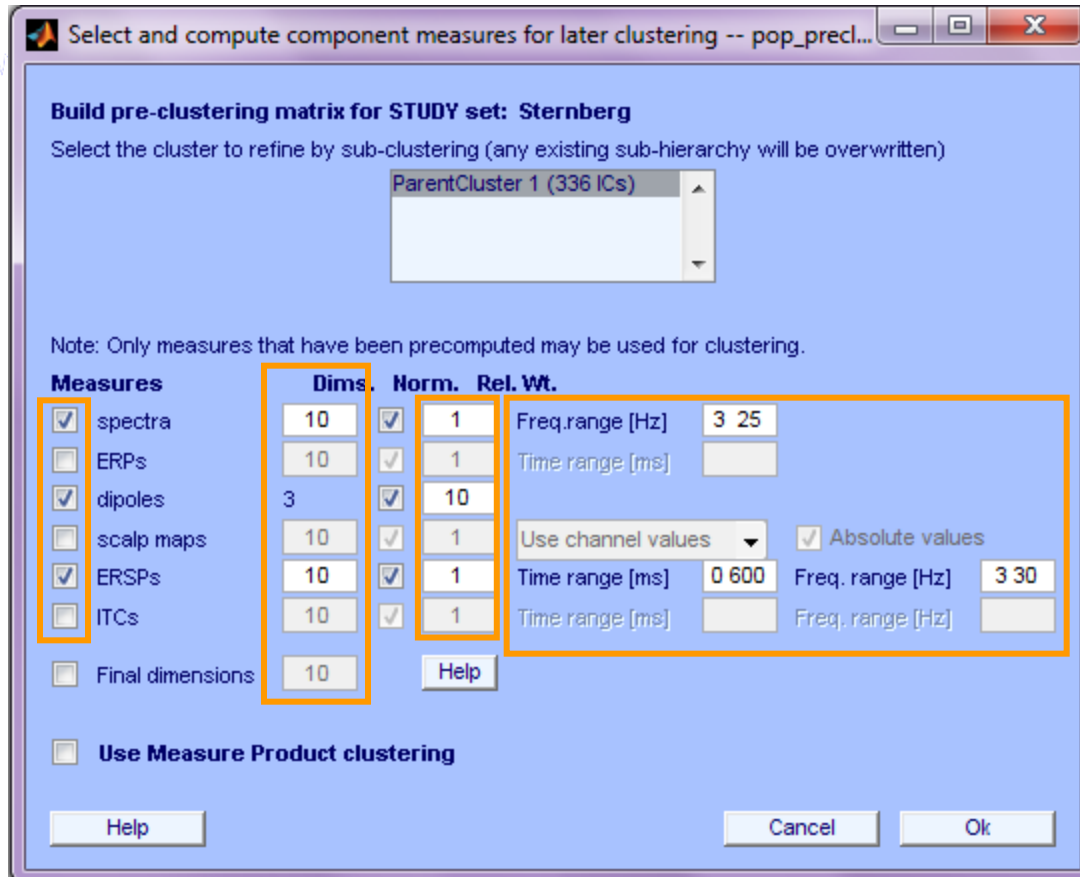
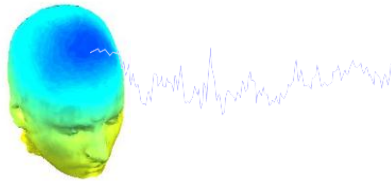
STUDY set: A

Study filename:
Study task name
Nb of subjects
Nb of conditions
Nb of sessions
Nb of groups
Epoch consistency yes
Channels per frame 31
Channel locations yes
Clusters 1
Status Pre-clustered
Total size (Mb) 32.4

- Edit study info
- Precompute channel measures
- Plot channel measures
- Precompute component measures
- Build preclustering array**
- Cluster components
- Edit/plot clusters



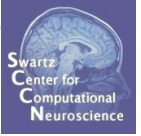
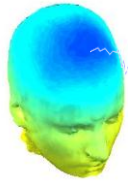
Precluster the data



```
parentclust = 1; % cluster 1 is always full parent cluster
```

```
[STUDY ALLEEG] = std_preclust(STUDY, ALLEEG, parentclust, {'spec', 'npca', 5, ...
    'norm', 1, 'weight', 1, 'freqrange', [3 25]}, {'erp', 'npca', 6, 'norm', 1, ...
    'weight', 1, 'timewindow', [0 400]}, {'scalp', 'npca', 10, 'norm', 1, 'weight', 1, ...
    'abso', 1}, {'dipoles', 'norm', 1, 'weight', 10}, {'ersp', 'npca', 20, ...
    'freqrange', [3 30], 'timewindow', [0 600], 'norm', 1, 'weight', 1}, {'itc', ...
    'npca', 6, 'freqrange', [3 30], 'timewindow', [0 400], 'norm', 1, 'weight', 1});
```


Choosing data measures



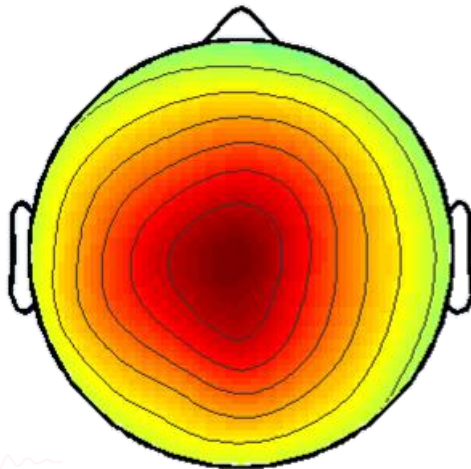
What measure(s) should you use?

- It depends on your final cluster criteria...
 - If for example, your priority is dipole location, then cluster only based on dipole location...

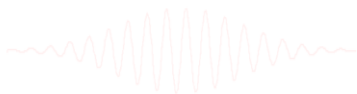
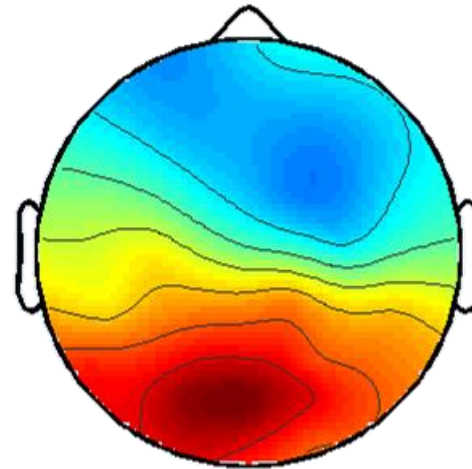
But consider:

- What is the difference between these two components?

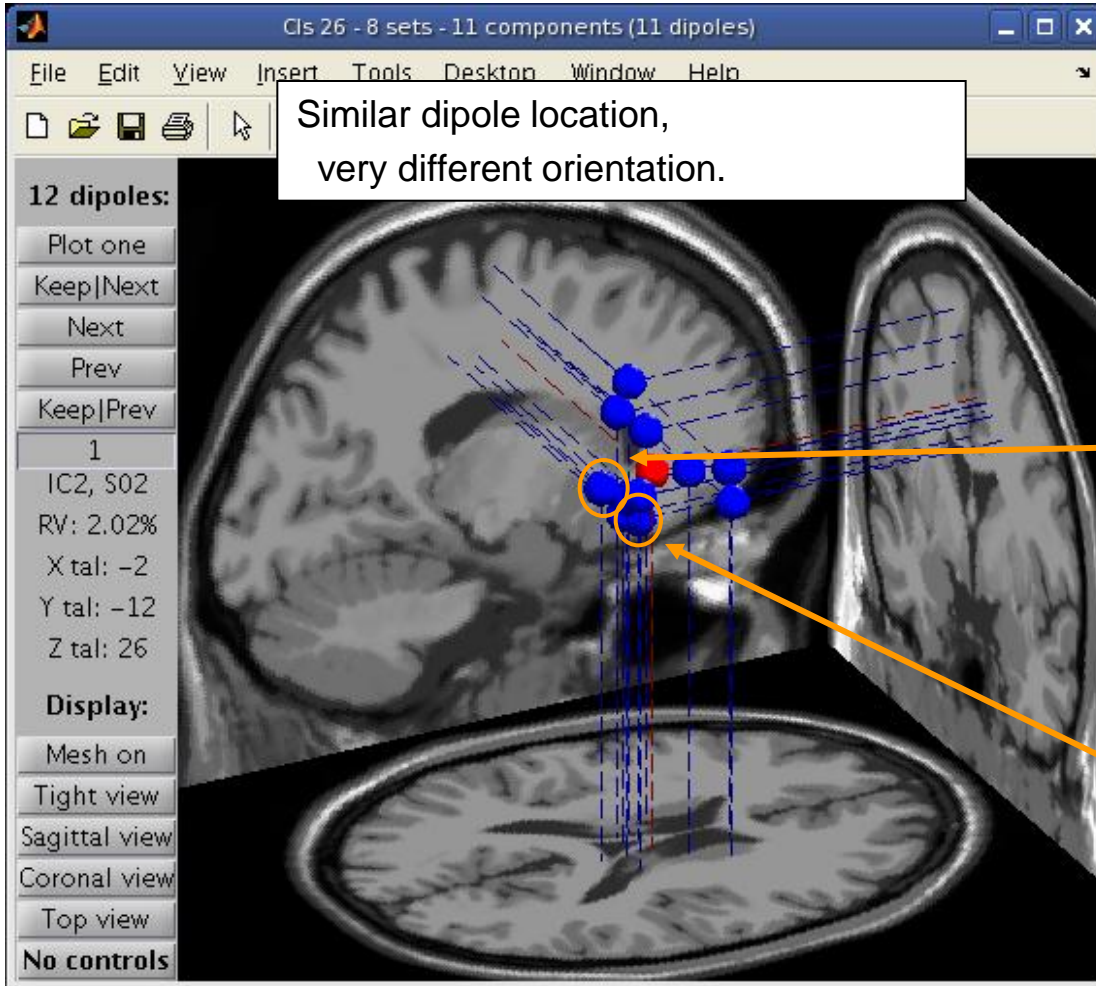
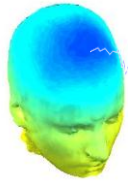
IC2 / S02, Cls 26



IC5 / S05, Cls 26

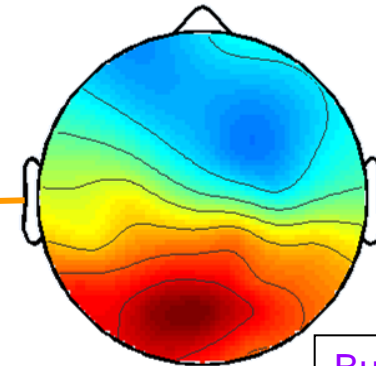


Choosing data measures

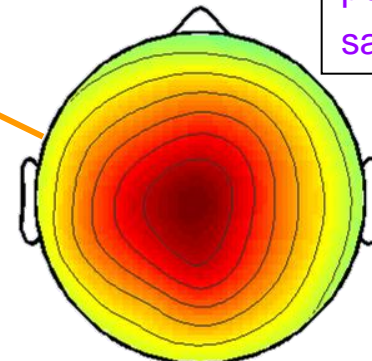


Obvious dramatic effect on scalp map topography:

IC5 / S05, Cis 26

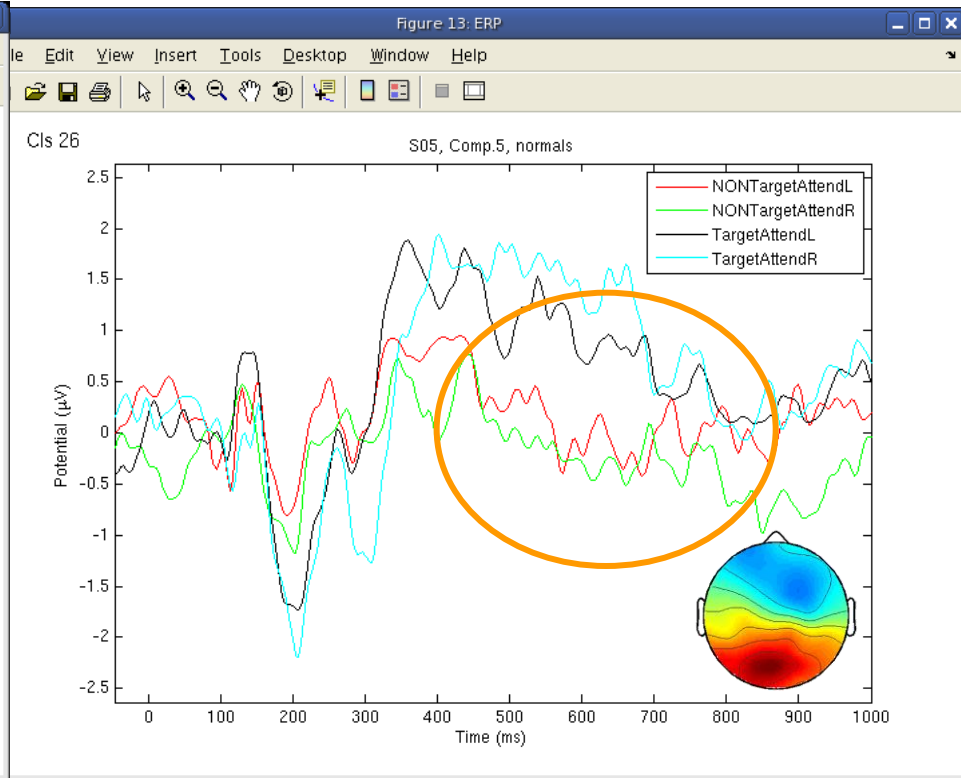
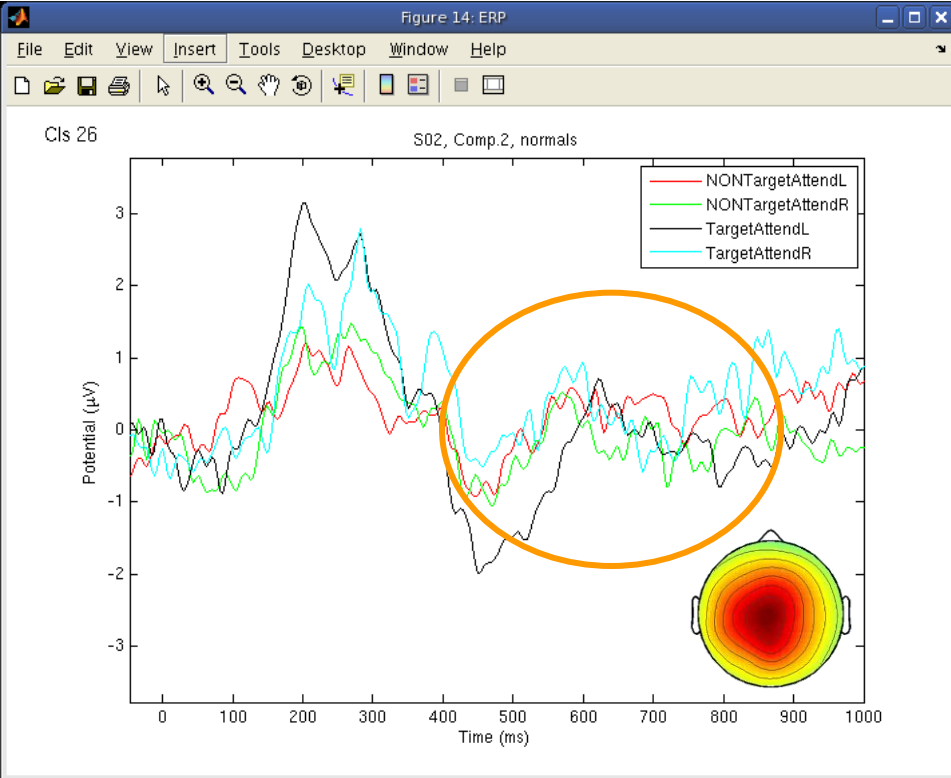


IC2 / S02, Cis 26

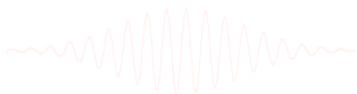


But, do they perform the same functions?

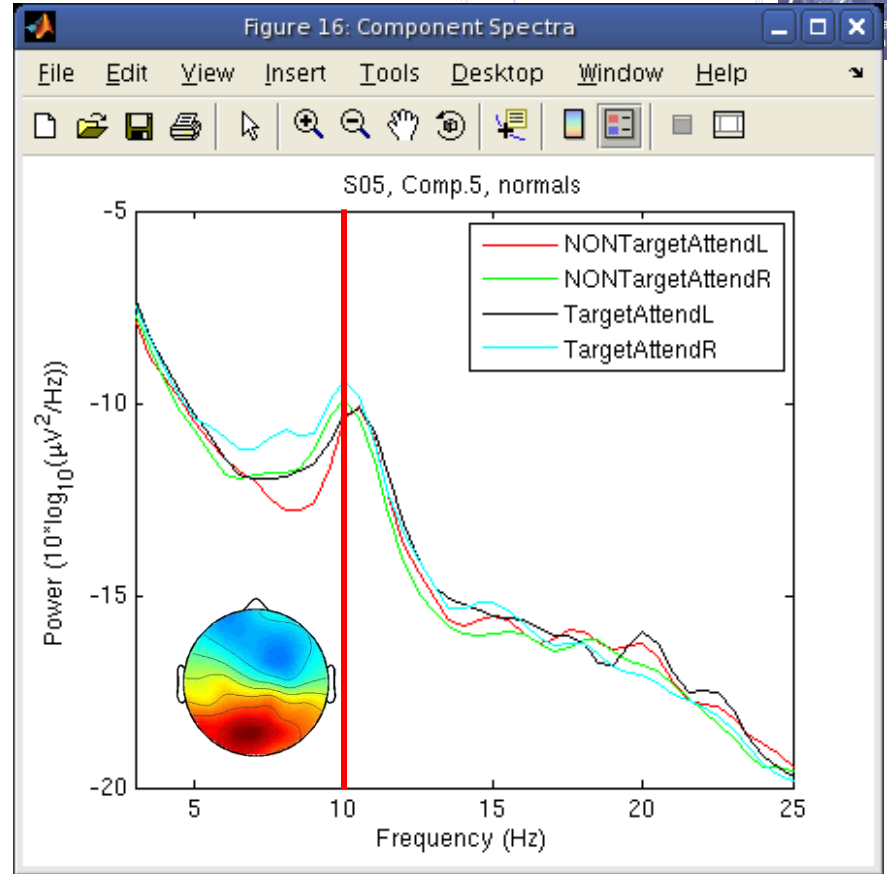
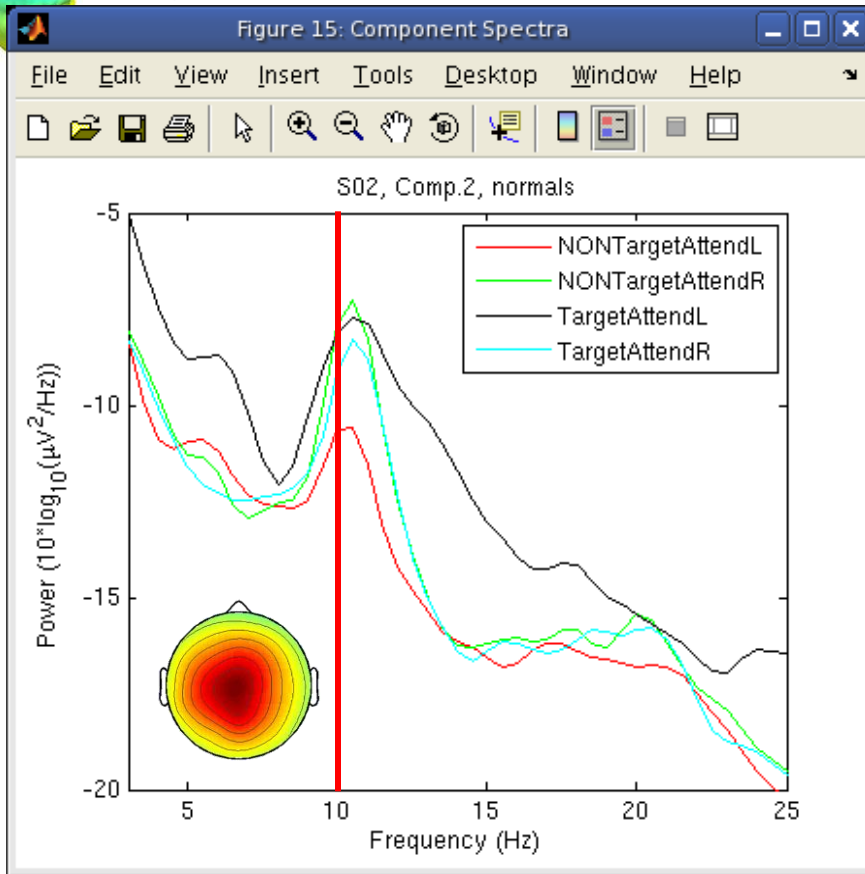
Choosing data measures



ERPs seem different...

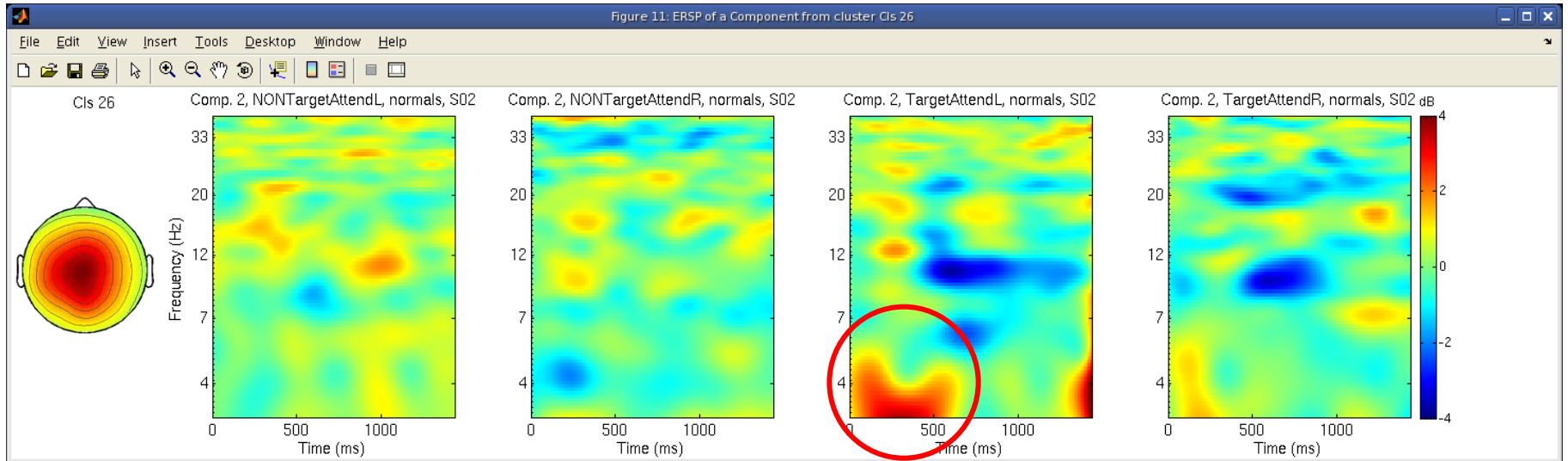


Choosing data measures

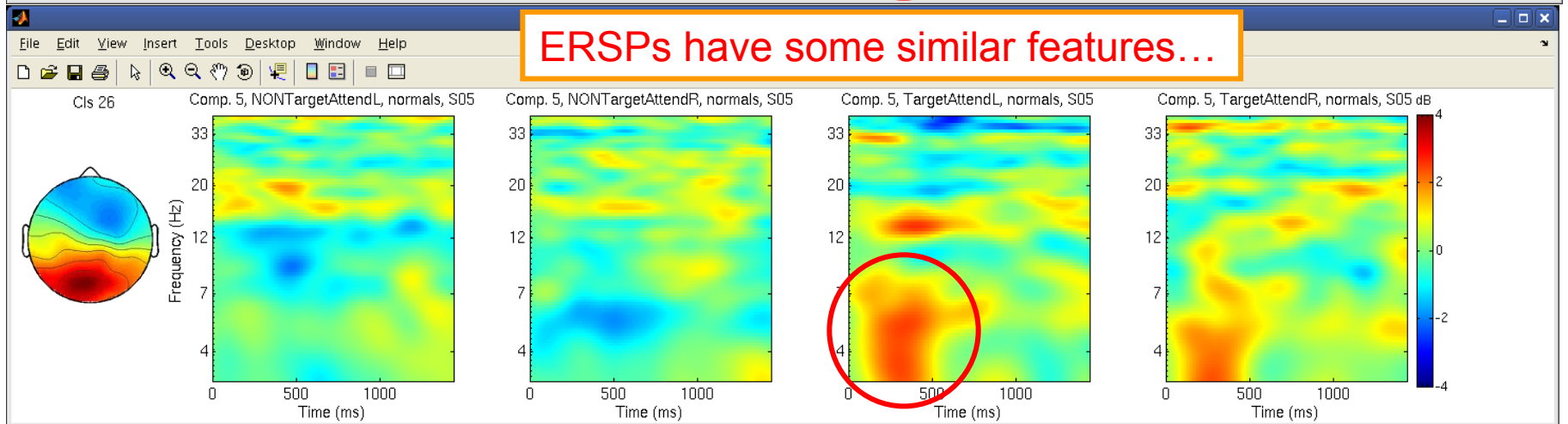


Spectra are similar, but they have variable responses to different conditions...

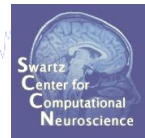
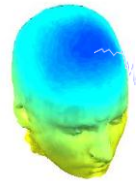
Choosing data measures



ERSPs have some similar features...



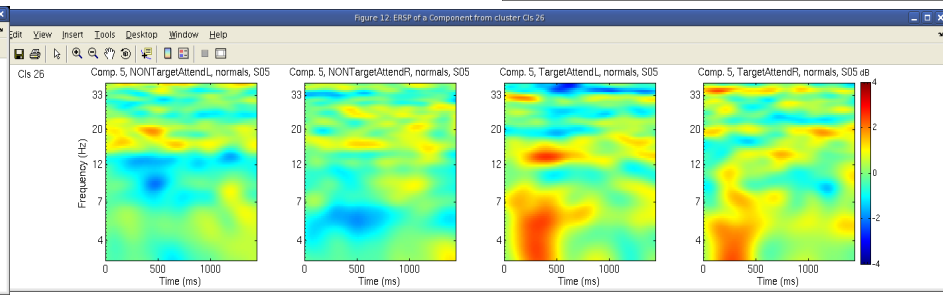
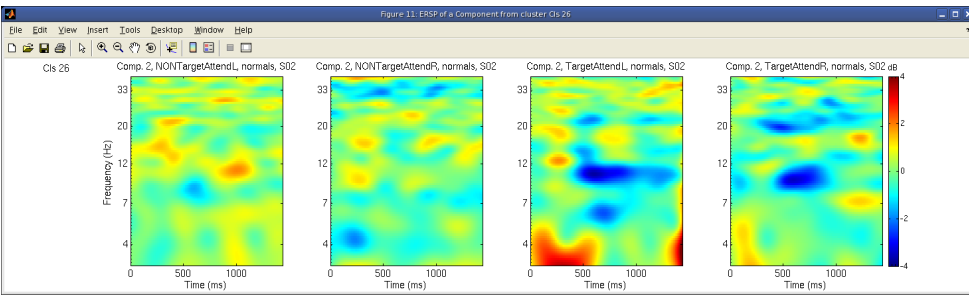
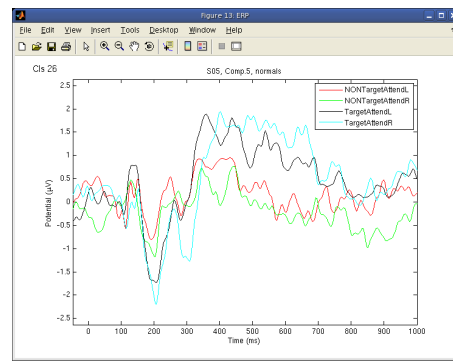
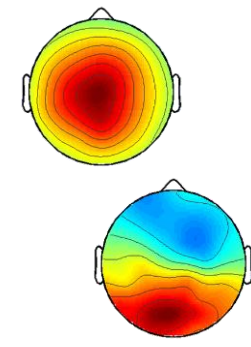
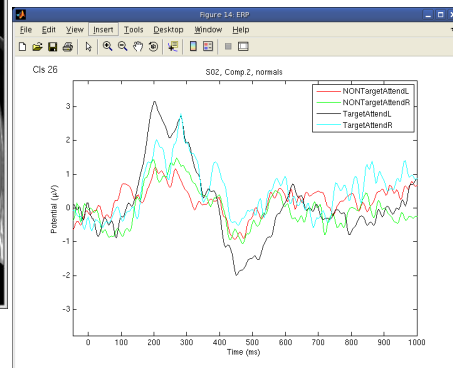
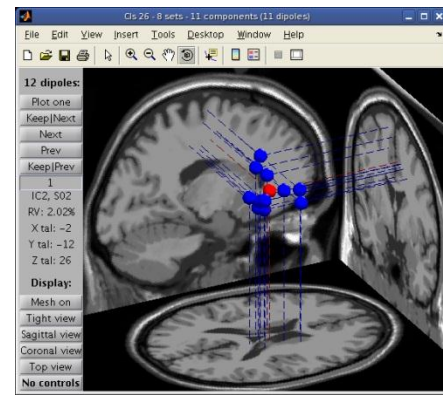
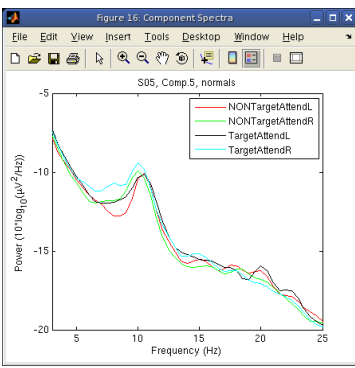
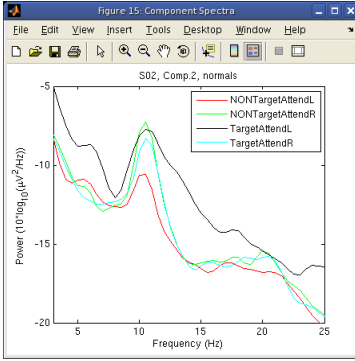
Choosing data measures



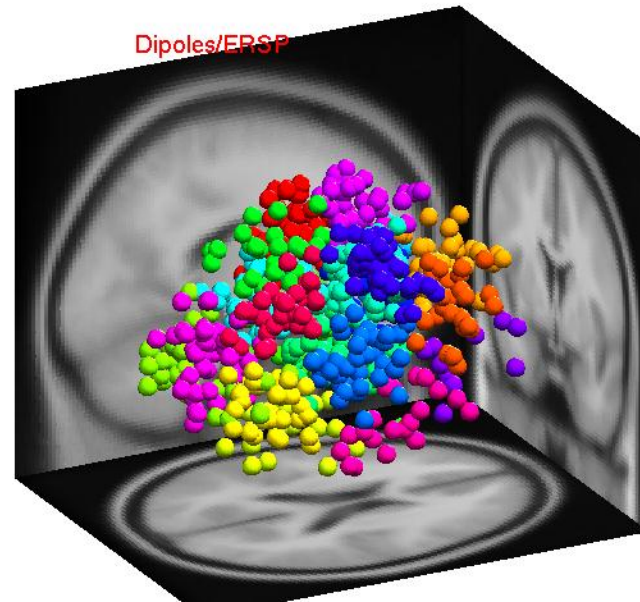
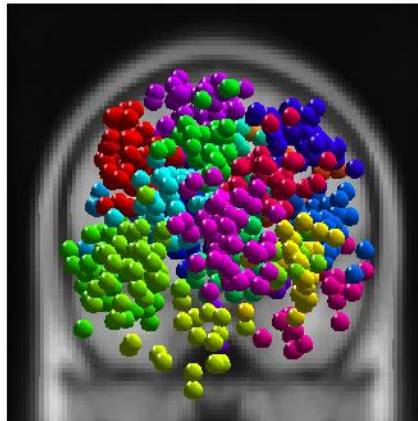
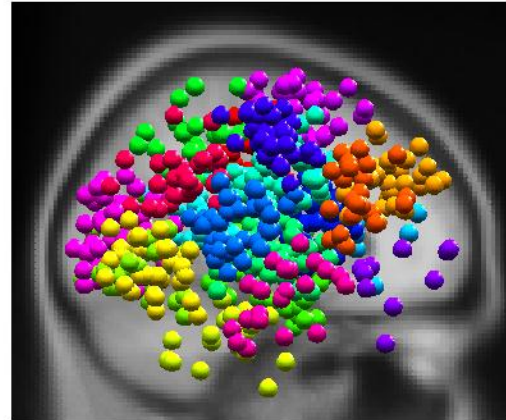
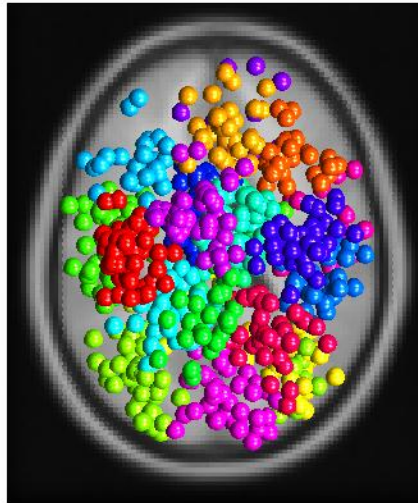
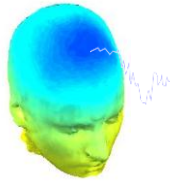
What data measures should you use?

It depends...

- broadly-matched ICs: use many/all of the measures.
- specifically-matched ICs: use one/few of the measures.



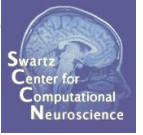
What should clusters look like?



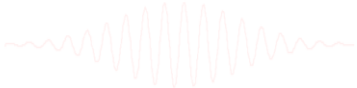
ICs clustered
by dipole
location and
ERSP activity



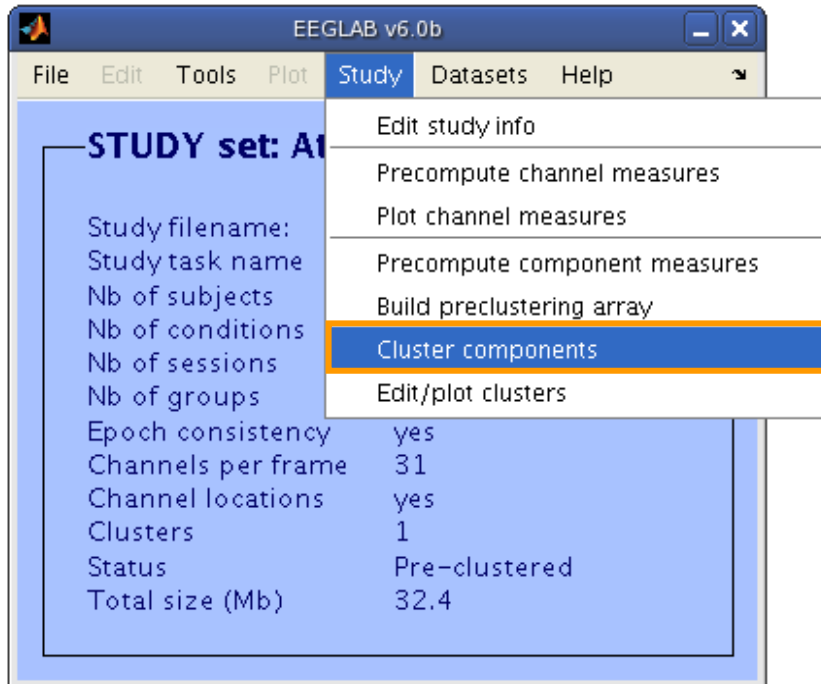
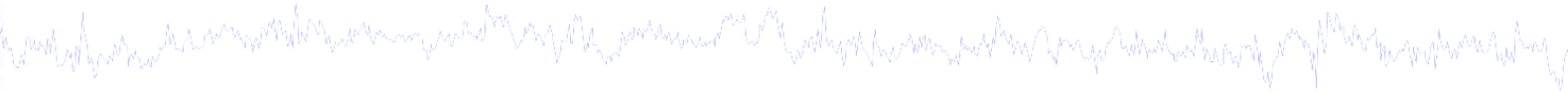
STUDY clustering overview



- 1. Build a STUDY**
- 2. Create STUDY design**
- 3. Precompute data measures**
- 4. Precluster data measures**
- 5. Cluster data measures**
- 6. Plot/edit clusters**



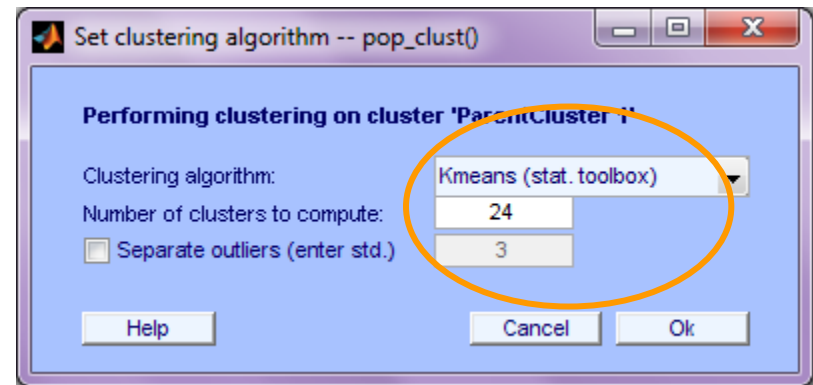
Cluster components



How to determine number of clusters?

Try the average number of ICs per subject.

Then adjust up or down from there.



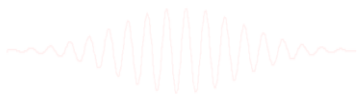
```
nclusters = 24; % choose # of clusters to create (no 'right' answer)
```

```
[STUDY] = pop_clust(STUDY, ALLEEG, 'algorithm', 'kmeans', 'clus_num', nclusters);
```

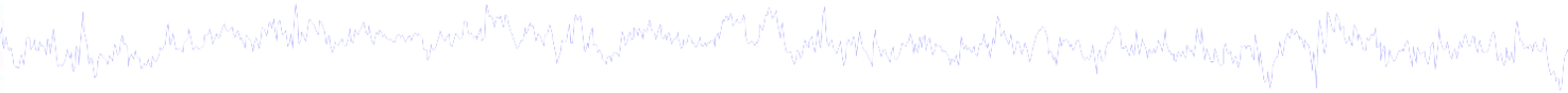

STUDY clustering overview



- 1. Build a STUDY**
- 2. Create STUDY design**
- 3. Precompute data measures**
- 4. Precluster data measures**
- 5. Cluster data measures**
- 6. Plot/edit clusters**



Plot/edit clusters

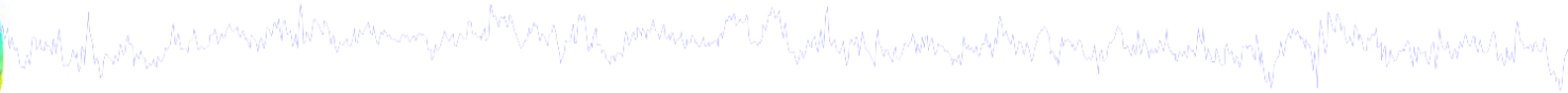


View and edit current component clusters -- pop_clustedit()

Study name: 'Sternberg' (336 of 336 components clustered)

Select cluster to plot		Select component(s) to plot
All cluster centroids		'Cls 2' comp. 1 (S01 IC21)
ParentCluster 1 (336 ICs)		'Cls 2' comp. 2 (S03 IC21)
Cls 2 (17 ICs)		'Cls 2' comp. 3 (S03 IC25)
Cls 3 (6 ICs)		'Cls 2' comp. 4 (S04 IC19)
Plot scalp maps		Plot scalp map(s)
Plot dipoles		Plot dipole(s)
Plot ERPs	Params	Plot ERP(s)
Plot spectra	Params	Plot spectra
Plot ERSPs		Plot ERSP(s)
Plot ITCs	Params	Plot ITC(s)
Plot cluster properties		Plot component properties
Create new cluster		Reassign selected component(s)
Rename selected cluster		Remove selected outlier comps.
Merge clusters		Auto-reject outlier components
Help		Cancel Ok

Plot cluster data



View and edit current component clusters -- pop_clustedit()

Study name: 'Sternberg' (336 of 336 components clustered)

Select cluster to plot

- All cluster centroids
- ParentCluster 1 (336 ICs)
- Clus 2 (17 ICs)
- Clus 3 (6 ICs)

Select component(s) to plot

- 'Clus 2' comp. 1 (S01 IC21)
- 'Clus 2' comp. 2 (S03 IC21)
- 'Clus 2' comp. 3 (S03 IC25)
- 'Clus 2' comp. 4 (S04 IC19)

Plot scalp maps

Plot dipoles

Plot ERPs

Plot spectra

Plot ERSPs

Plot ITCs

Plot cluster properties

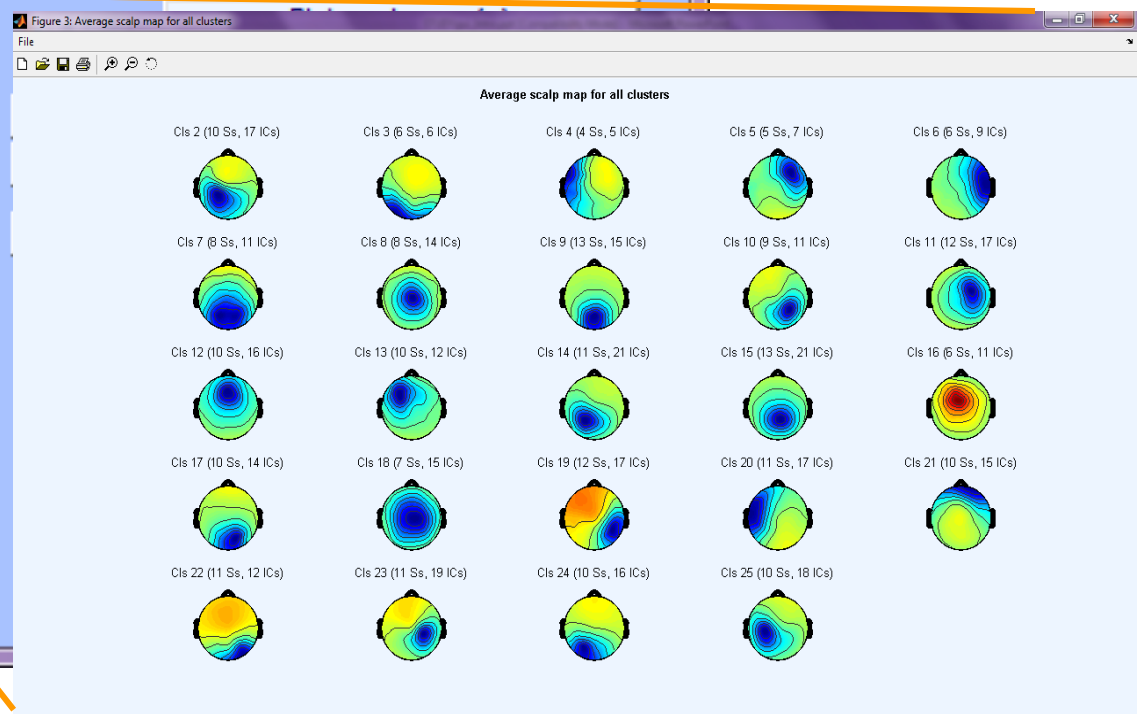
Create new cluster

Rename selected cluster

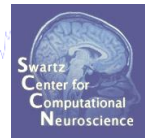
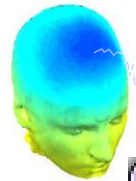
Merge clusters

Help

Plot mean scalp maps for easy reference



Plot cluster data



View and edit current component clusters -- pop_clustedit()

Study name: 'Sternberg' (336 of 336 components clustered)

Select cluster to plot

- Cls 9 (14 ICs)
- Cls 10 (10 ICs)
- Cls 11 (17 ICs)
- Cls 12 (13 ICs)

Select component(s) to plot

- All components
- S01 IC13
- S01 IC20
- S02 IC5

Plot scalp maps
Plot dipoles
Plot ERPs
Plot spectra
Plot ERSPs
Plot ITCs
Plot cluster properties

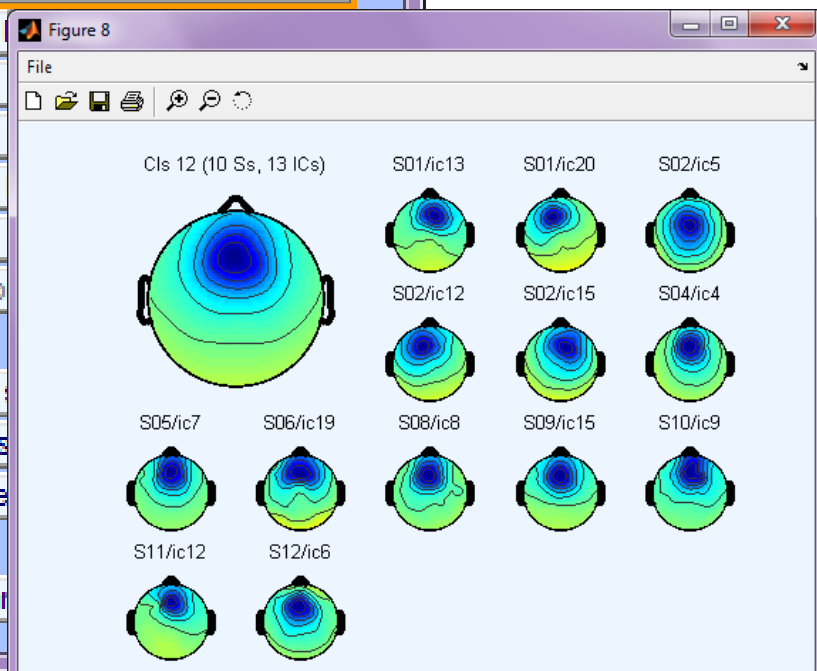
Params
Params
Params

Create new cluster
Rename selected cluster
Merge clusters

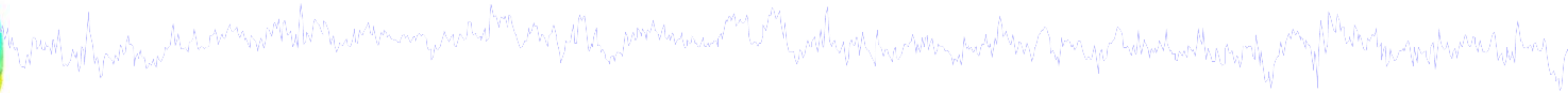
Help

Choose a cluster

Choose which components



Plot clusters



View and edit current component clusters -- pop_clustedit()

Study name: 'Sternberg' (336 of 336 components clustered)

Select cluster to plot

- Cls 11 (17 ICs)
- Cls 12 (13 ICs)

Select component(s) to plot

- All components
- S01 IC13
- S01 IC20
- S02 IC5

Plot scalp map(s)

Plot dipole(s)

Plot ERP(s)

Plot spectra

Plot ERSP(s)

Plot ITC(s)

Plot component properties

Reassign selected component(s)

Remove selected outlier comps.

Auto-reject outlier components

Cancel Ok

Cls 12 - 10 sets - 13 components (13 dipoles)

File

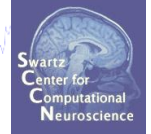
14 dipoles:

- Plot one
- Keep|Next
- Next
- Prev
- Keep|Prev
- 1
- S01, IC13
- RV: 1.58%
- X tal: 12
- Y tal: 31
- Z tal: 38

Display:

- Mesh on
- Tight view
- Sagittal view
- Coronal view
- Top view
- No controls

Plot ERPs



View and edit current component clusters -- pop_clustedit()

Study name: 'Sternberg' (336 of 336 components clustered)

Select cluster to plot

- Cls 11 (17 ICs)
- Cls 12 (13 ICs)
- Cls 13 (12 ICs)
- Cls 14 (17 ICs)

Plot scalp maps

Plot dipoles

Plot ERPs

Plot spectra

Plot ERSPs

Plot ITCs

Plot cluster properties

Create new cluster

Rename selected cluster

Merge clusters

Help

Select component(s) to plot

- All components
- S01 IC13
- S01 IC20
- S02 IC5

Plot scalp map(s)

Plot dipole(s)

Plot ERP(s)

Plot spectra

Params

Params

Set parameters for plotting ERPs -- pop_erpparams()

Time range in ms [low high]

Plot scalp map at latency [ms]

Plot limits in uV [low high]

Display filter in Hz [high]

Plot conditions on the same panel

Plot groups on the same panel

Statistical method to use

Statistical threshold (p<)

Compute condition statistics

Compute group statistics

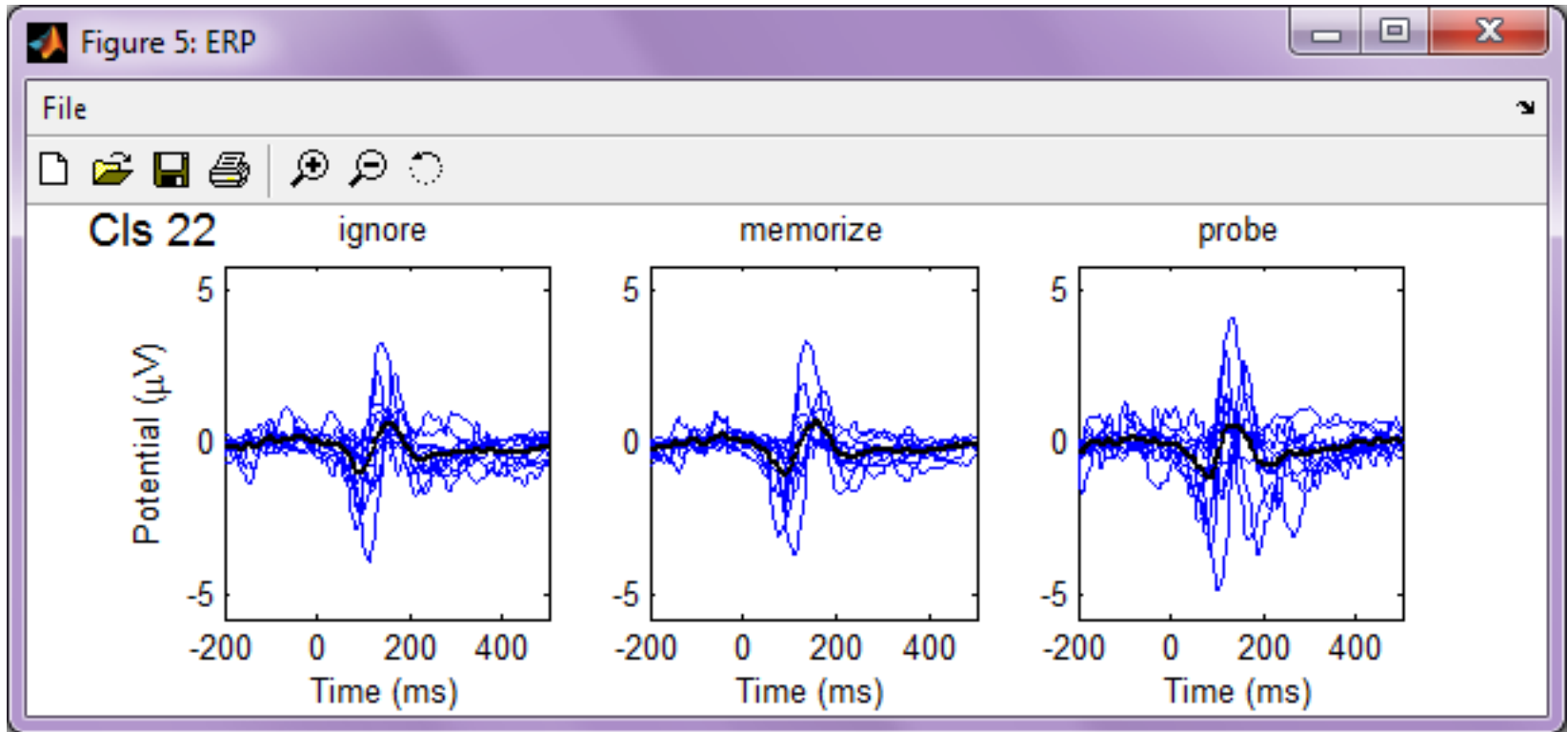
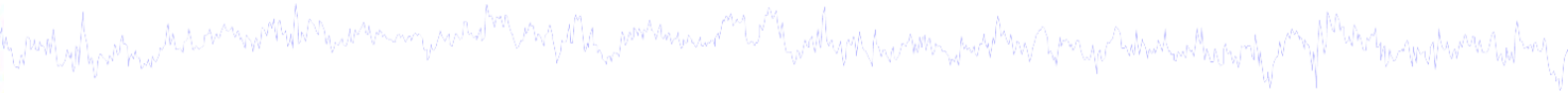
Use False Discovery Rate to correct for multiple comparisons

Help

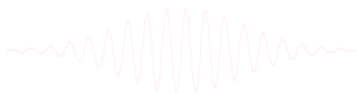
Cancel

Ok

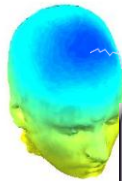
Plot cluster ERP



Each blue trace is the ERP of a different component



Plot cluster spectra



View and edit current component clusters -- pop_clustedit()

Study name: 'Sternberg' (336 of 336 components clustered)

Select cluster to plot

- Cls 11 (17 ICs)
- Cls 12 (13 ICs)
- Cls 13 (12 ICs)
- Cls 14 (17 ICs)

Select component(s) to plot

- All components
- S01 IC13
- S01 IC20
- S02 IC5

Buttons: Plot scalp maps, Plot dipoles, Plot ERPs, Plot spectra, Plot ERSPs, Plot ITCs, Plot cluster properties, Create new cluster, Rename selected cluster, Merge clusters, Help

Buttons: Plot scalp map(s), Plot dipole(s), Plot ERP(s), Plot spectra

Buttons: Params, Params

Set parameters for plotting specs -- pop_specparams()

Frequency [low_Hz high_Hz] Plot limits [low high]

Plot scalp map at freq. [Hz]

Subtract individual subject mean spectrum

Plot conditions on the same panel

Plot groups on the same panel

Statistical method to use Statistical threshold (p<)

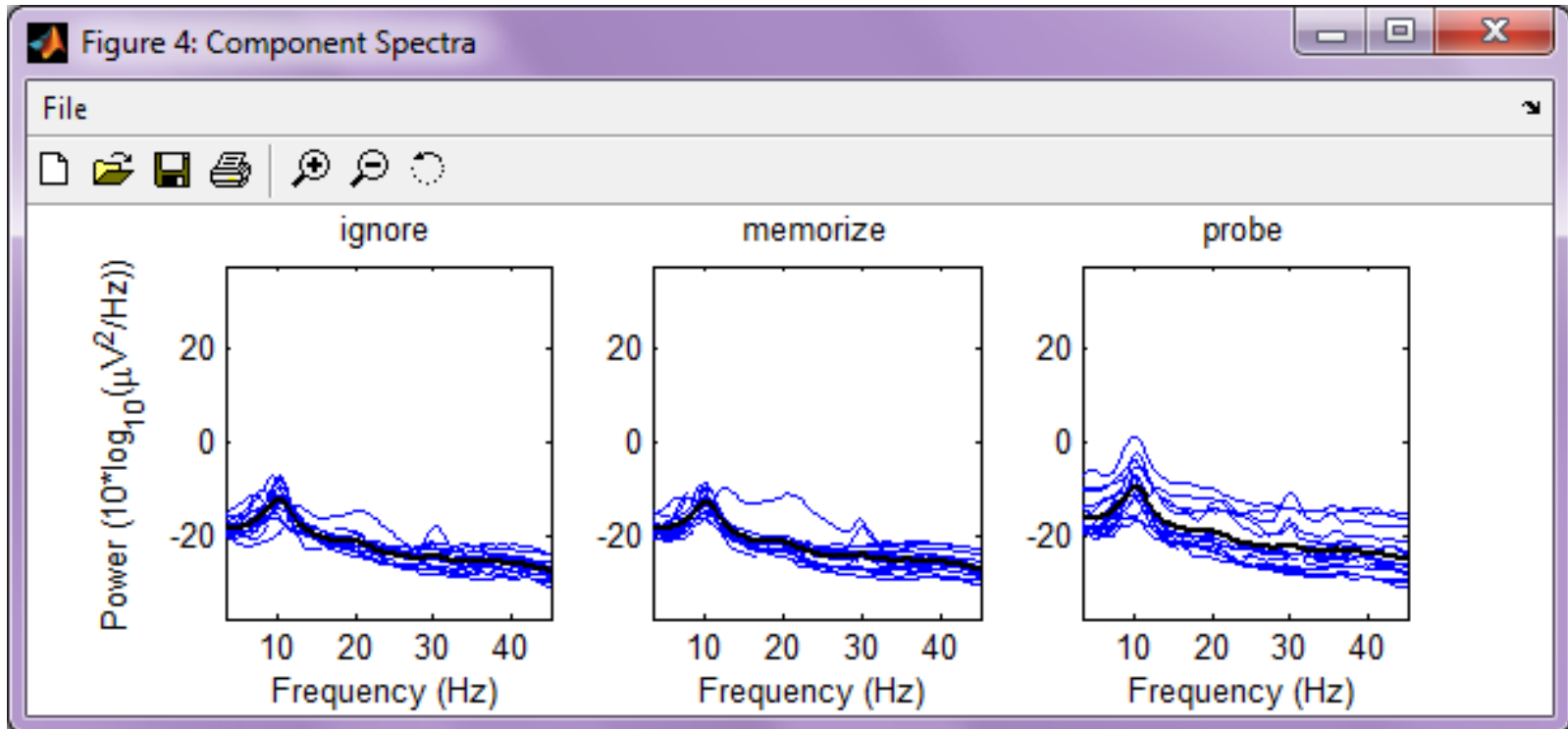
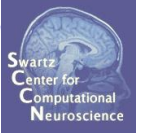
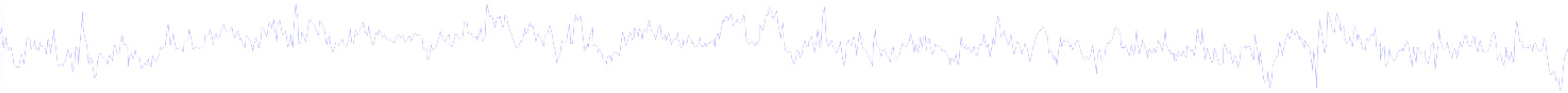
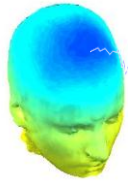
Compute condition statistics

Compute group statistics

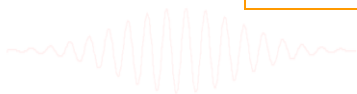
Use False Discovery Rate to correct for multiple comparisons

Buttons: Help, Cancel, Ok

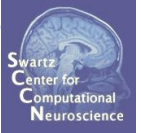
Plot cluster spectra



Each blue trace is the power spectrum of a different component



Plot cluster ERSPs



View and edit current component clusters -- pop_clustedit()

Study name: 'Sternberg' (336 of 336 components clustered)

Select cluster to plot

- Cls 11 (17 ICs)
- Cls 12 (13 ICs)
- Cls 13 (12 ICs)
- Cls 14 (17 ICs)

Plot scalp maps

Plot dipoles

Plot ERPs

Plot spectra

Plot ERSPs

Plot ITCs

Plot cluster properties

Create new cluster

Rename selected cluster

Merge clusters

Help

Select component(s) to plot

- All components
- S01 IC13
- S01 IC20
- S02 IC5

Plot scalp map(s)

Plot dipole(s)

Plot ERP(s)

Plot spectra

Plot ERSP(s)

Plot ITC(s)

Params

Params

Params

Set ERSP|ITC plotting parameters -- pop_erspparams()

Time range in ms [Low High] -200 1200

Freq. range in Hz [Low High] 3 30

Power limits in dB [Low High] [] ITC limit (0-1) [High] []

Compute ERSP baseline across conditions

Statistical method to use Permutation Statistical threshold (p<) []

Compute condition statistics

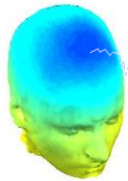
Compute group statistics

Mask non-significant data (only when threshold is set)

Use False Discovery Rate to correct for multiple comparisons

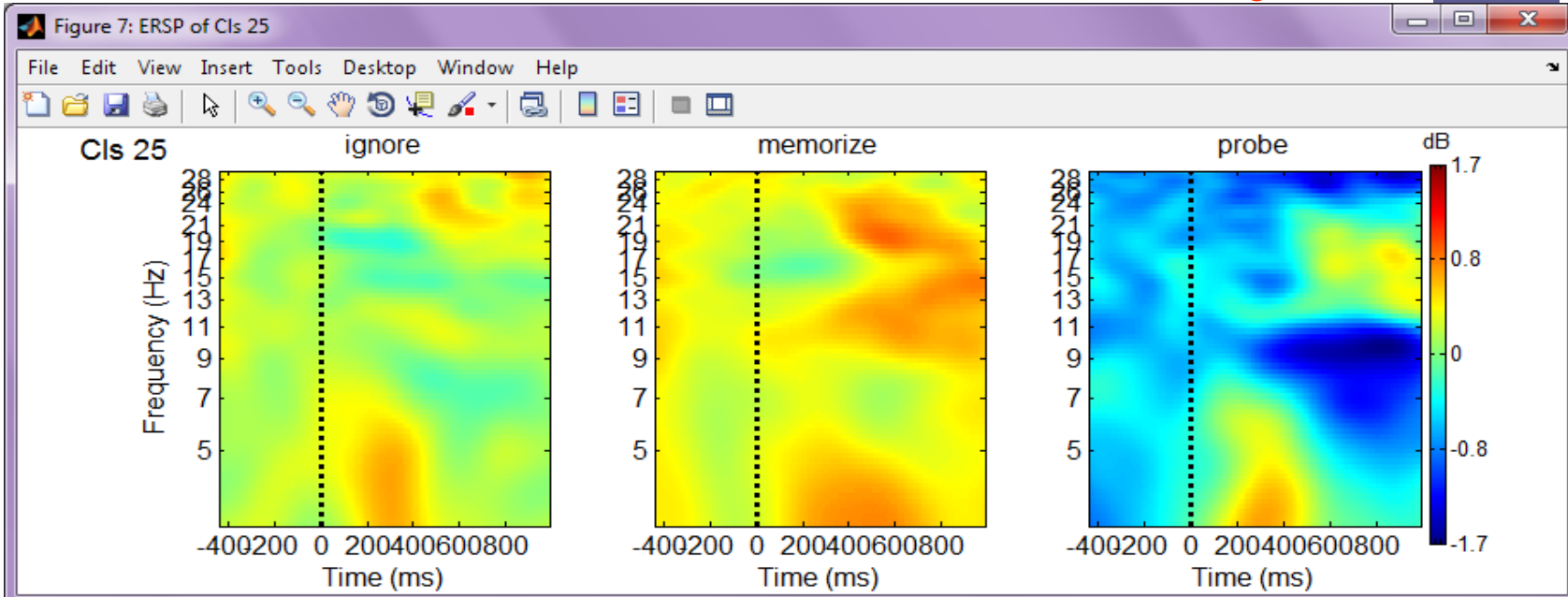
Help Cancel Ok

Plot cluster ERSPs and ITC

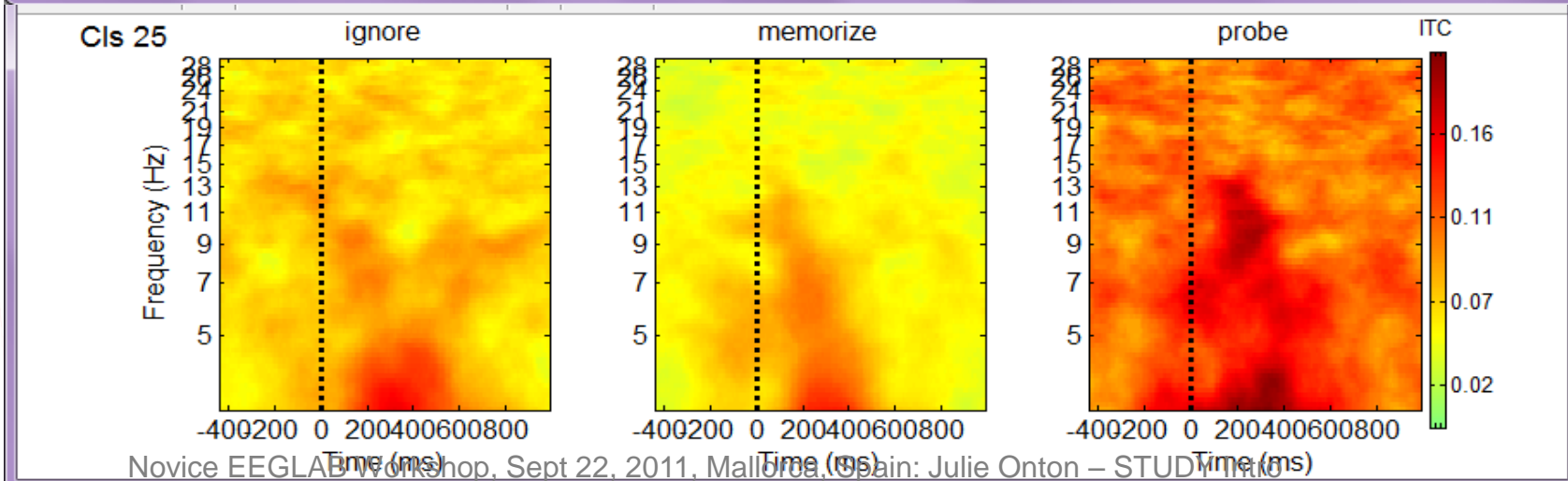


Not masked for significance

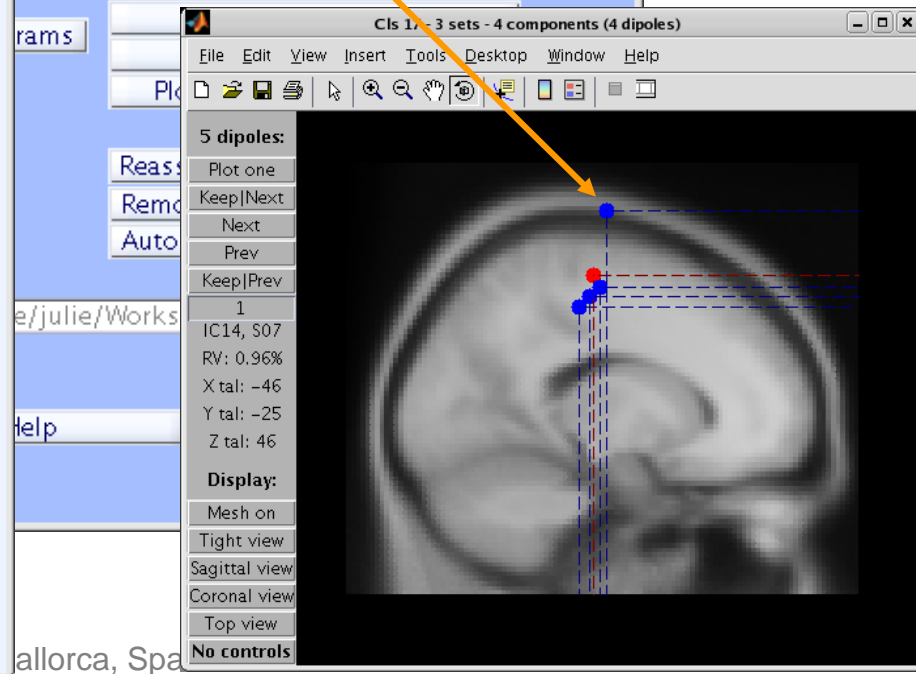
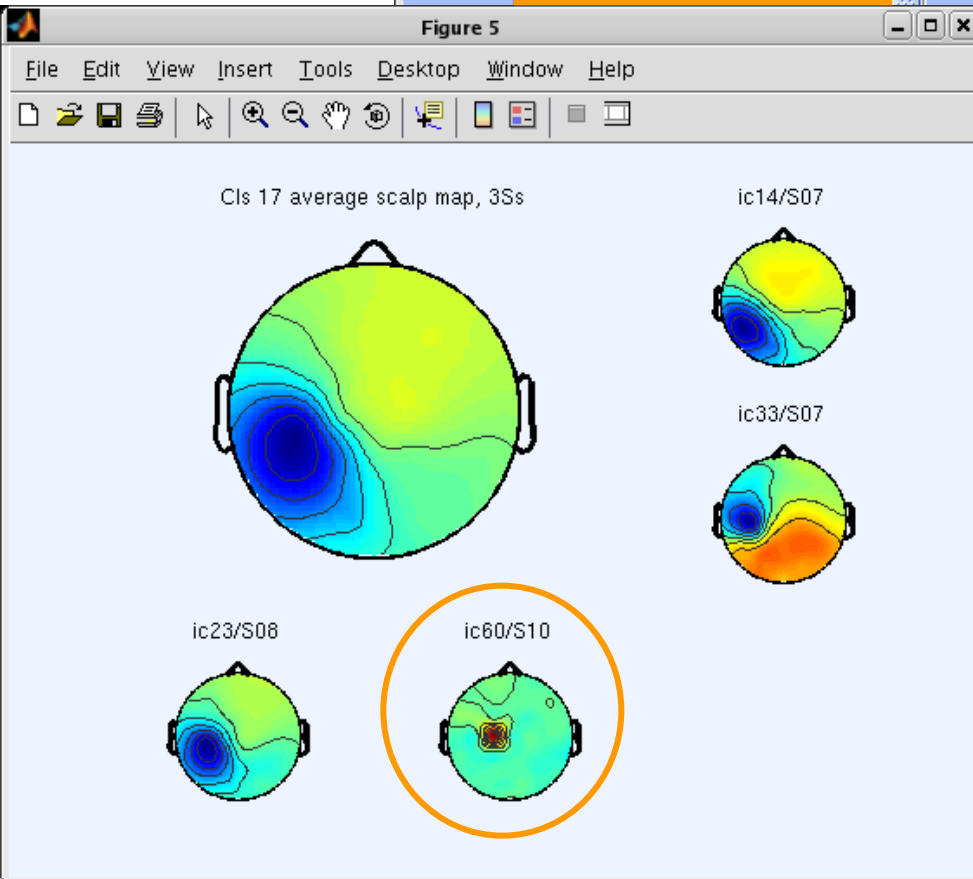
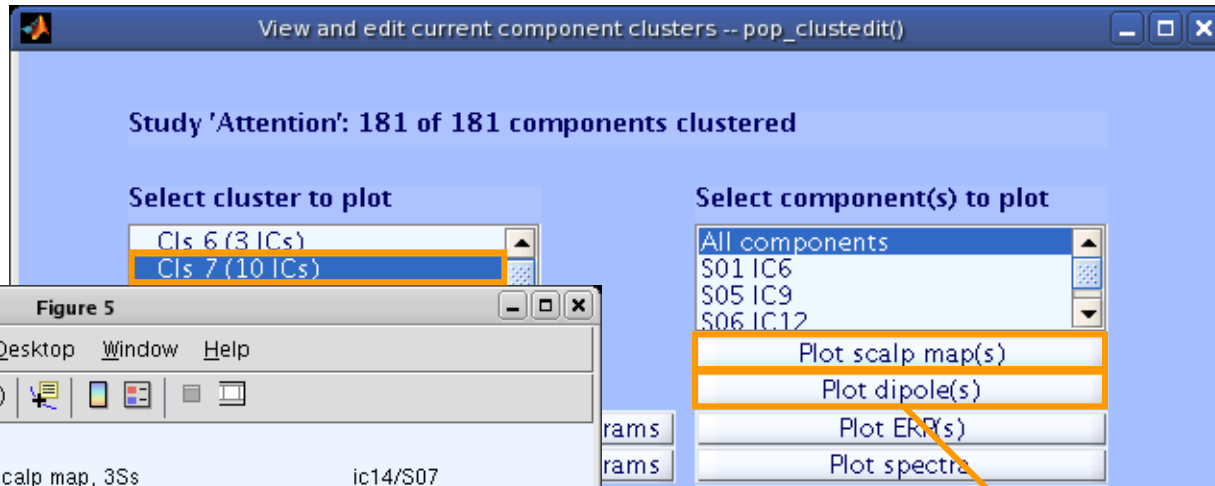
ERSP



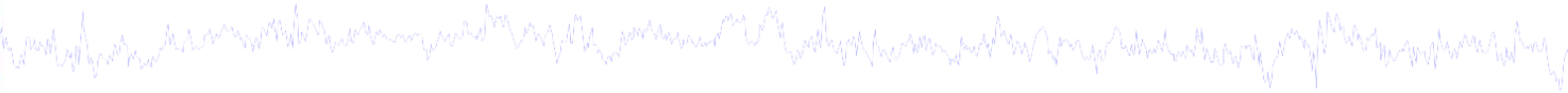
ITC



Remove outlier components



Remove outlier components



View and edit current component clusters -- pop_clustedit()

Study #: 151 of 151 components clustered

Select cluster to plot

- Cls 13 (5 ICs)
- Cls 14 (11 ICs)
- Cls 15 (8 ICs)
- Cls 16 (6 ICs)
- Cls 17 (4 ICs)

Select component(s) to plot

- All components
- S07 IC14
- S07 IC33
- S08 IC23
- S10 IC60

Plot scalp maps

Plot dipoles

Plot ERPs

Plot spectra

Plot ERSPs

Plot ITCs

Plot cluster properties

Create new cluster

Rename selected cluster

Merge clusters

Save STUDY set to disk /home/julie/workshop06/5subjects/WSstudy.study ...

Cancel Help Ok

Remove outliers - from pop_clustedit()

Remove currently selected component below from Cls 17 to its outlier cluster?

- S10 IC60

Cancel Ok

Remove selected outlier comps.

Auto-reject outlier components

Remove outlier components



View and edit current component clusters -- pop_clustedit()

Study #: 151 of 151 components clustered

Select cluster to plot

- Cls 16 (6 ICs)
- Cls 17 (3 ICs)
- Cls 18 (14 ICs)
- Cls 19 (14 ICs)
- Outliers Cls 17 20 (1 ICs)

Select component(s) to plot

- All components
- S10 IC60

Plot scalp maps

Plot dipoles

Plot ERPs

Plot spectra

Plot ERSPs

Plot ITCs

Plot cluster properties

Params

Params

Params

Plot scalp map(s)

Plot dipole(s)

Plot ERP(s)

Plot spectra

Plot ERSP(s)

Plot ITC(s)

Plot component properties

Create new cluster

Rename selected cluster

Merge clusters

Reassign selected component(s)

Remove selected outlier comps.

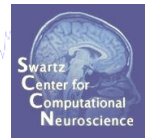
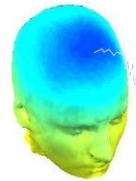
Auto-reject outlier components

Save STUDY set to disk

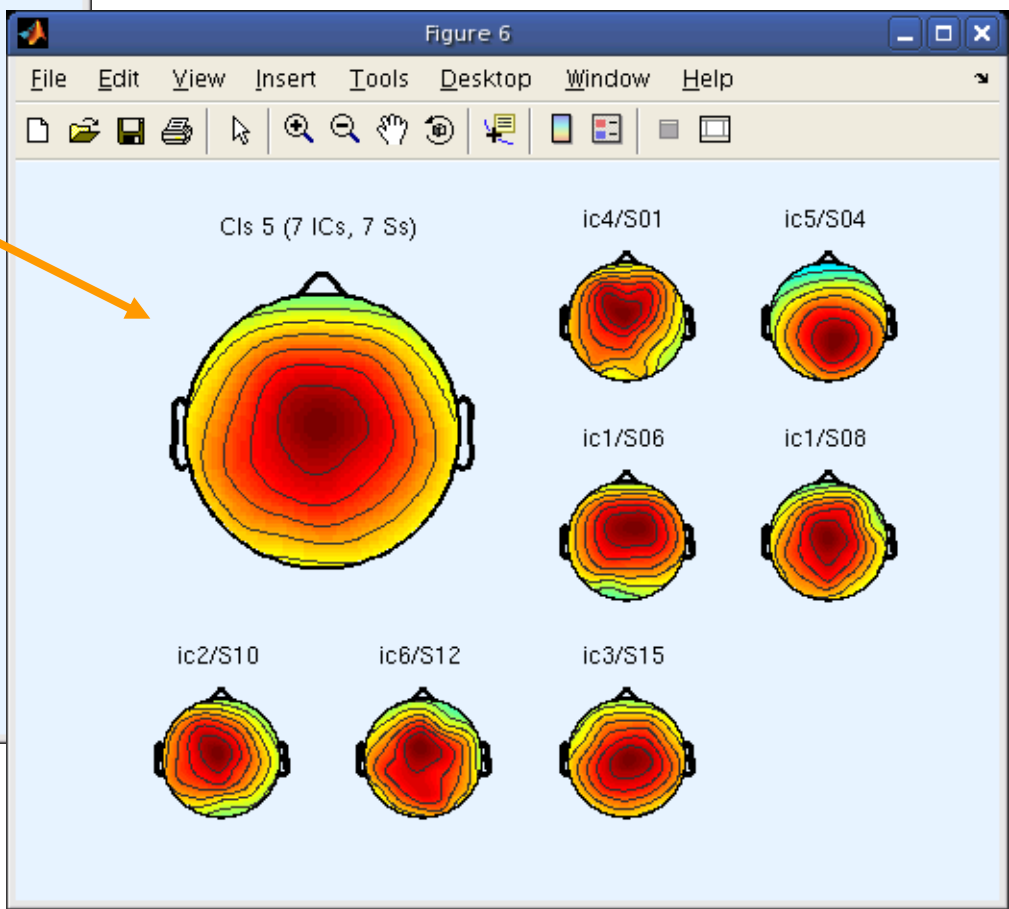
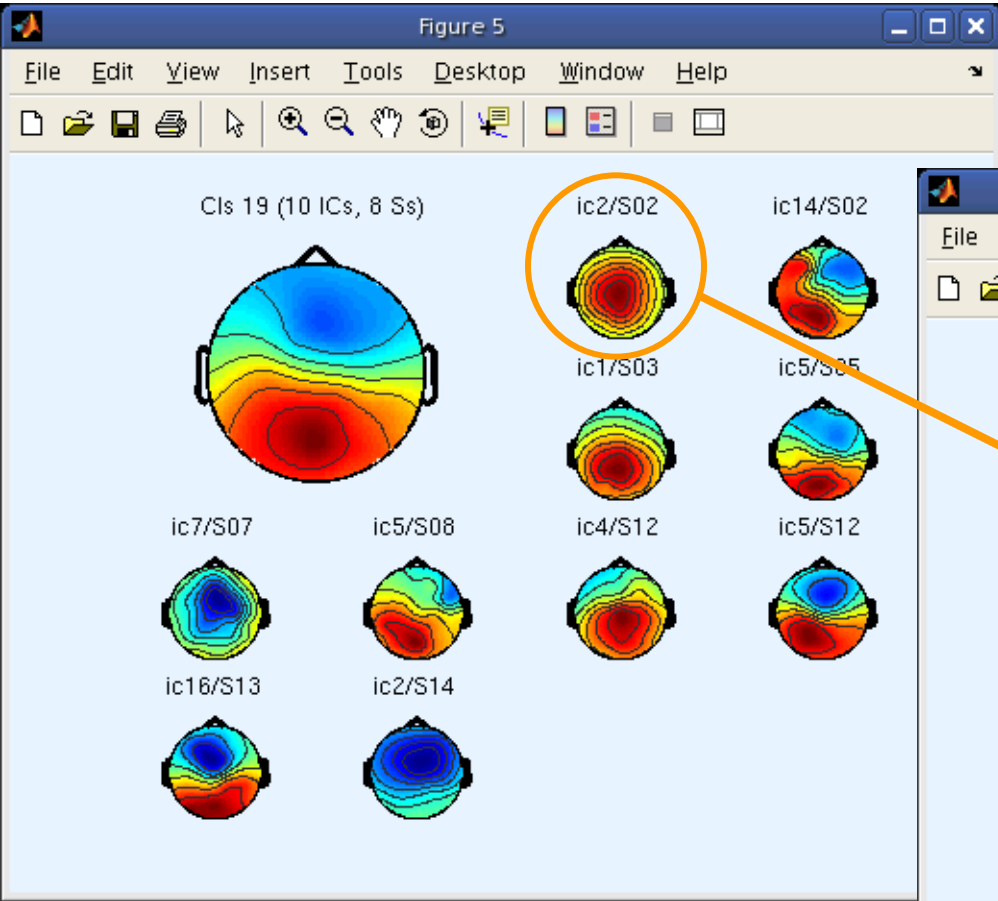
/home/julie/workshop06/5subjects/WSstudy.study

Cancel Help Ok

Reassign component



If you want to manually reassign a component to another cluster...



Reassign component



View and edit current component clusters -- pop_clustedit()

Study 'Attention': 181 of 181 components clustered

Select cluster to plot

- Cls 18 (4 ICs)
- Cls 19 (10 ICs)
- Cls 20 (17 ICs)
- Cls 21 (6 ICs)

Plot scalp maps

Plot dipoles

Plot ERPs

Plot spectra

Plot ERSPs

Plot ITCs

Plot cluster properties

Params

Create new cluster

Rename selected cluster

Merge clusters

Save STUDY set to disk /home/julie/WorkshopSD2007/STUDY ...

Cancel Help Ok

Select component(s) to plot

- All components
- S02 IC2
- S02 IC14
- S03 IC1

Plot scalp map(s)

Plot dipole(s)

Plot ERP(s)

Plot spectra

Plot ERSP(s)

Plot ITC(s)

Plot component properties

Reassign selected component(s)

Remove selected outlier comps.

Auto-reject outlier components

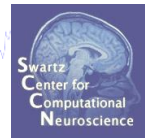
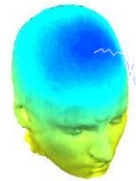
Reassign cluster - from pop_clustedit()

Reassign currently selected component from Cls 19 to the cluster selected below

- Cls 4
- Cls 5
- Cls 6
- Cls 7

Cancel Ok

Reassign component



Successful reassignment

View and edit current component clusters -- pop_clustedit()

Study 'Attention': 181 of 181 components clustered

Select cluster to plot

- Cls 4 (8 ICs)
- Cls 5 (8 ICs)
- Cls 6 (3 ICs)
- Cls 7 (10 ICs)

Plot scalp maps

Plot dipoles

Plot ERPs

Plot spectra

Plot ERSPs

Plot ITCs

Plot cluster properties

Create new cluster

Rename selected cluster

Merge clusters

Save STUDY set to disk /home/julie/WorkshopSD2007/

Cancel Help

Select component

- All components
- S01 IC4
- S02 IC2
- S04 IC5

Plot scalp maps

Plot dipoles

Plot ERPs

Plot spectra

Plot ERSPs

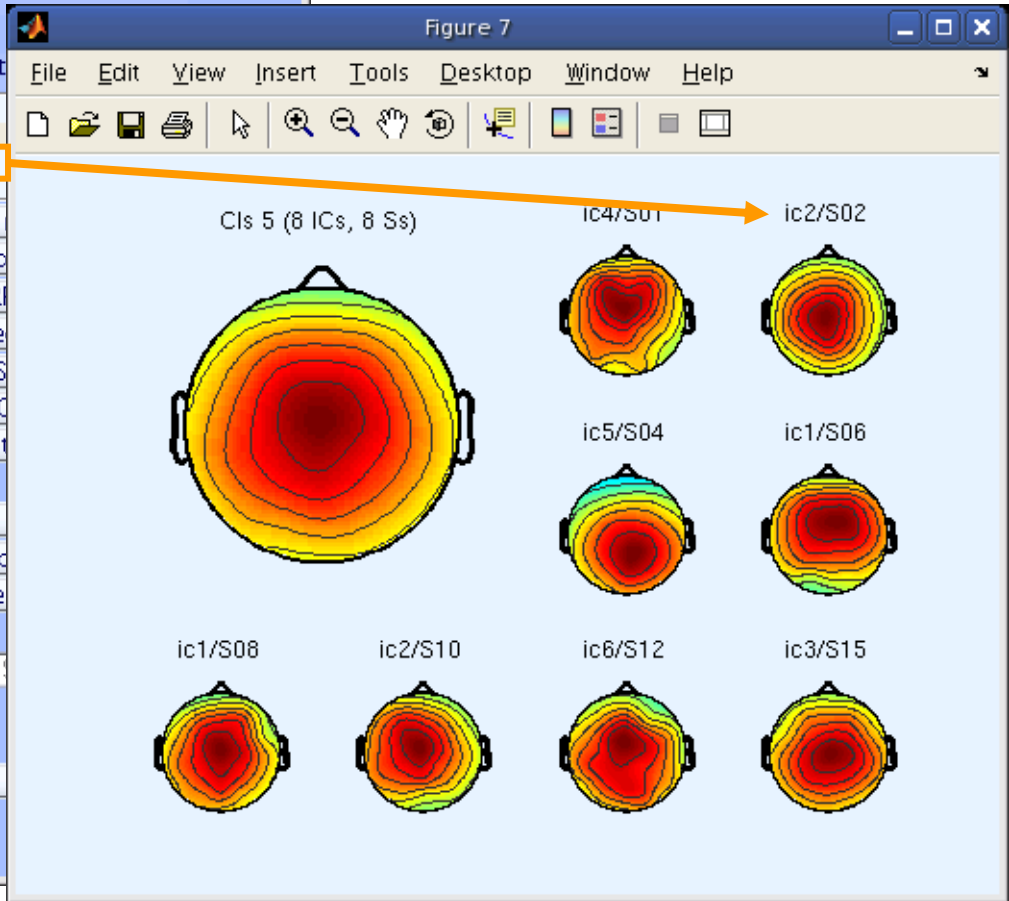
Plot ITCs

Plot component properties

Reassign selected cluster

Remove selected cluster

Auto-reject outliers



Rename a cluster



Name your cluster of interest

View and edit current component clusters -- pop_clustedit()

Study 'Attention': 181 of 181 components clustered

Select cluster to plot

- Cls 4 (8 ICs)
- Cls 5 (8 ICs)**
- Cls 6 (3 ICs)
- Cls 7 (10 ICs)

Plot scalp maps

Plot dipoles

Plot ERPs

Plot spectra

Plot ERSPs

Plot ITCs

Plot cluster properties

Create new cluster

Rename selected cluster

Merge clusters

Save STUDY set to disk /home/julie/WorkshopSD2007/

Cancel Help

Figure 7

File Edit View Insert Tools Desktop Window Help

Cls 5 (8 ICs, 8 Ss)

ic4/S01

ic2/S02

ic5/S04

ic1/S06

ic1/S08

ic2/S10

ic6/S12

ic3/S15

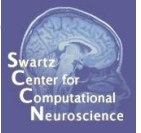
Rename cluster

Rename Cls 5

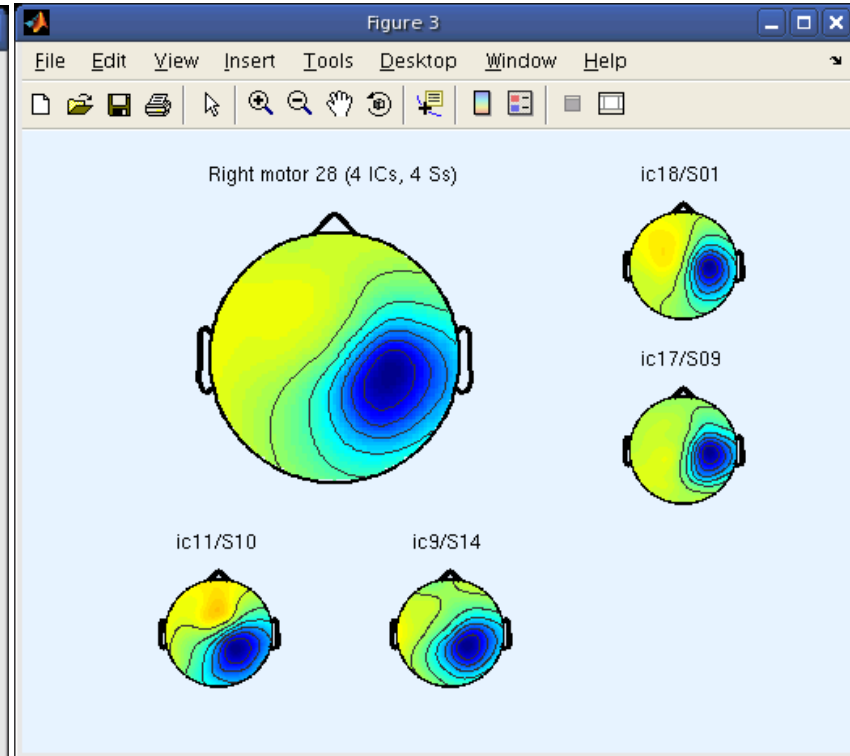
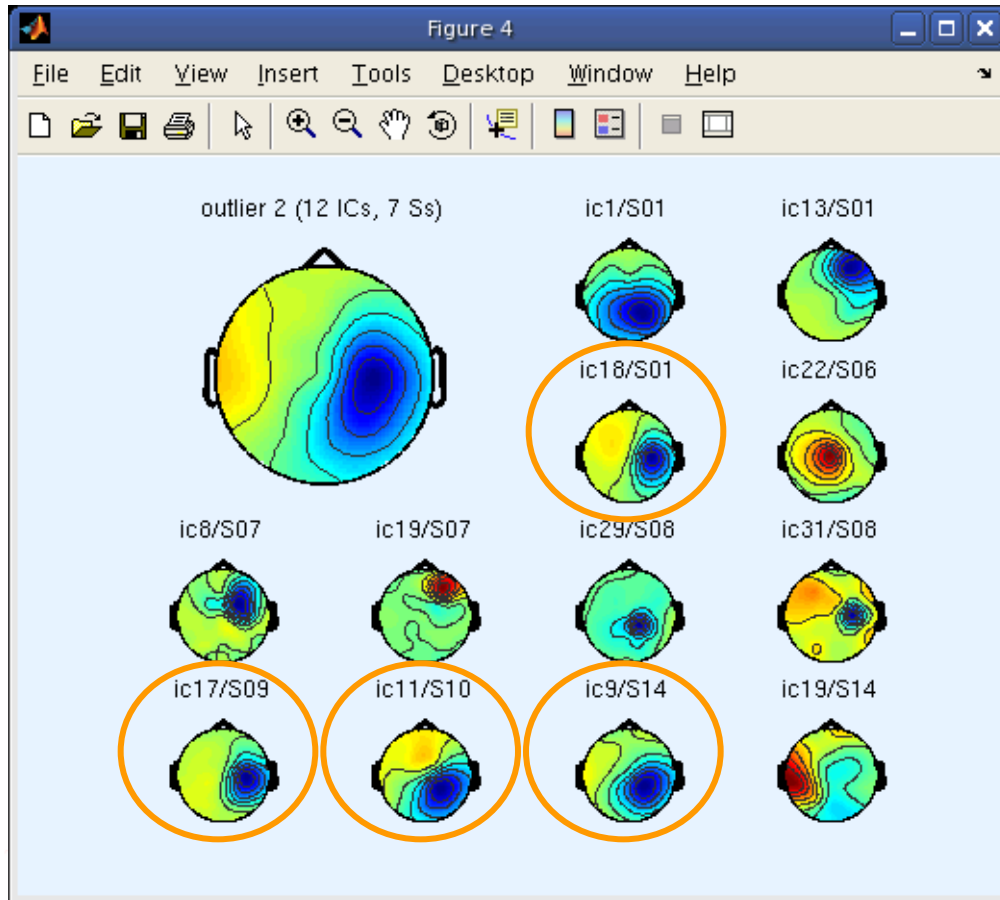
Mid-central

Cancel Ok

Create a new cluster

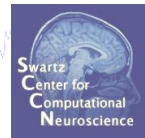
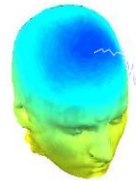


You found a bunch of 'outliers' that seem well-matched



Create a new cluster...

Create a new cluster



View and edit current component clusters -- pop_clustedit()

Study 'Attention': 181 of 181 components clustered

Select cluster to plot

- All cluster centroids
- ParentCluster 1 (181 ICs)
- outlier 2 (9 ICs)**
- Cls 3 (4 ICs)

Plot scalp maps
Plot dipoles
Plot ERPs
Plot spectra
Plot ERSPs
Plot ITCs
Plot cluster properties

Select component(s) to plot

- S01 IC18
- S06 IC22
- S07 IC8
- S07 IC19

Plot scalp map(s)
Plot dipole(s)
Plot ERP(s)
Plot spectra
Plot ERSP(s)
Plot ITC(s)

Params
Params
Params

Create new cluster
Rename selected cluster
Merge clusters

Save STUDY set to disk

Cancel Help Ok

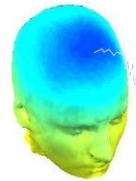
Create new empty cluster - from pop_clustedit()

Create new empty cluster

Enter cluster name:

Cancel Ok

Create a new cluster



View and edit current component clusters -- pop_clustedit()

Study 'Attention': 181 of 181 components clustered

Select cluster to plot

- All cluster centroids
- ParentCluster 1 (181 ICs)
- outlier 2 (9 ICs)
- Cls 3 (4 ICs)

Plot scalp maps

Plot dipoles

Select component(s) to plot

- S01 IC18
- S06 IC22
- S07 IC8
- S07 IC19

Plot scalp map(s)

Plot dipole(s)

Plot ERP(s)

Plot spectra

Plot ERSP(s)

Plot ITC(s)

Plot component properties

Params

Params

Params

Reassign selected component(s)

Remove selected outlier comps.

Aut...

Figure 4

File Edit View Insert Tools Desktop Window Help

outlier 2 (12 ICs, 7 Ss)

ic1/S01 ic13/S01

ic18/S01 ic22/S06

ic8/S07 ic19/S07 ic29/S08 ic31/S08

ic17/S09 ic11/S10 ic9/S14 ic19/S14

Reassign cluster - from pop_clustedit()

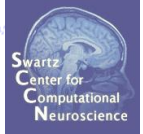
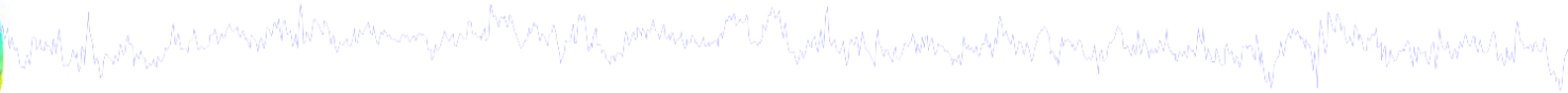
Reassign currently selected component from outlier 2 to the cluster selected below

- Cls 25
- Cls 26
- Cls 27
- Right motor 28

Cancel

Ok

Exercise



- **Novice**

- Open stern.study and practice plotting the existing clusters
- Try removing outliers ICs or moving to another cluster
- Rename clusters; change plotting parameters... etc

- **Intermediate / Advanced**

- Precluster (using existing design) and cluster components using measures of your choice.

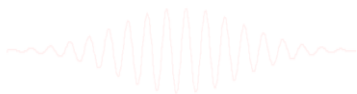
- > How does the number of dimensions and the weighting for each measure affect the results?

- Choose a STUDY design of your choice and recompute measures (dipoles, scalp maps, ERPs are fastest; ERSPs will take several days)

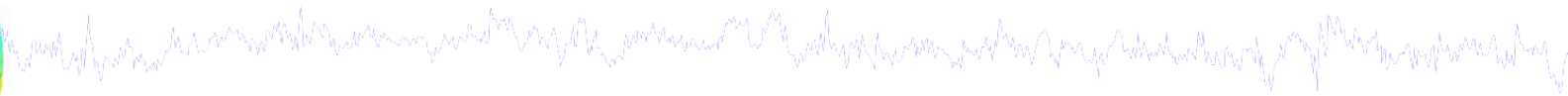
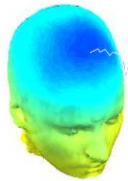
- What are your criteria for a 'good' cluster? Can you imagine a study design that would change your criteria?

- Are all subjects in all clusters? Is this crucial?

Supplementary lessons



Plot STUDY dipoles



```
% std_dipoleclusters() variables:
```

```
clusters = [3:length(STUDY.cluster)]; % clusters to plot
```

```
title = 'Cluster Dipoles'; % figure title
```

```
plot_params = [2,2,1]; % [nrows,ncols,subplot]
```

```
views = [1,2,3,4]; % 1=top,2=side,3=rear,4=oblique
```

```
cols = hsv(length(clusters));
```

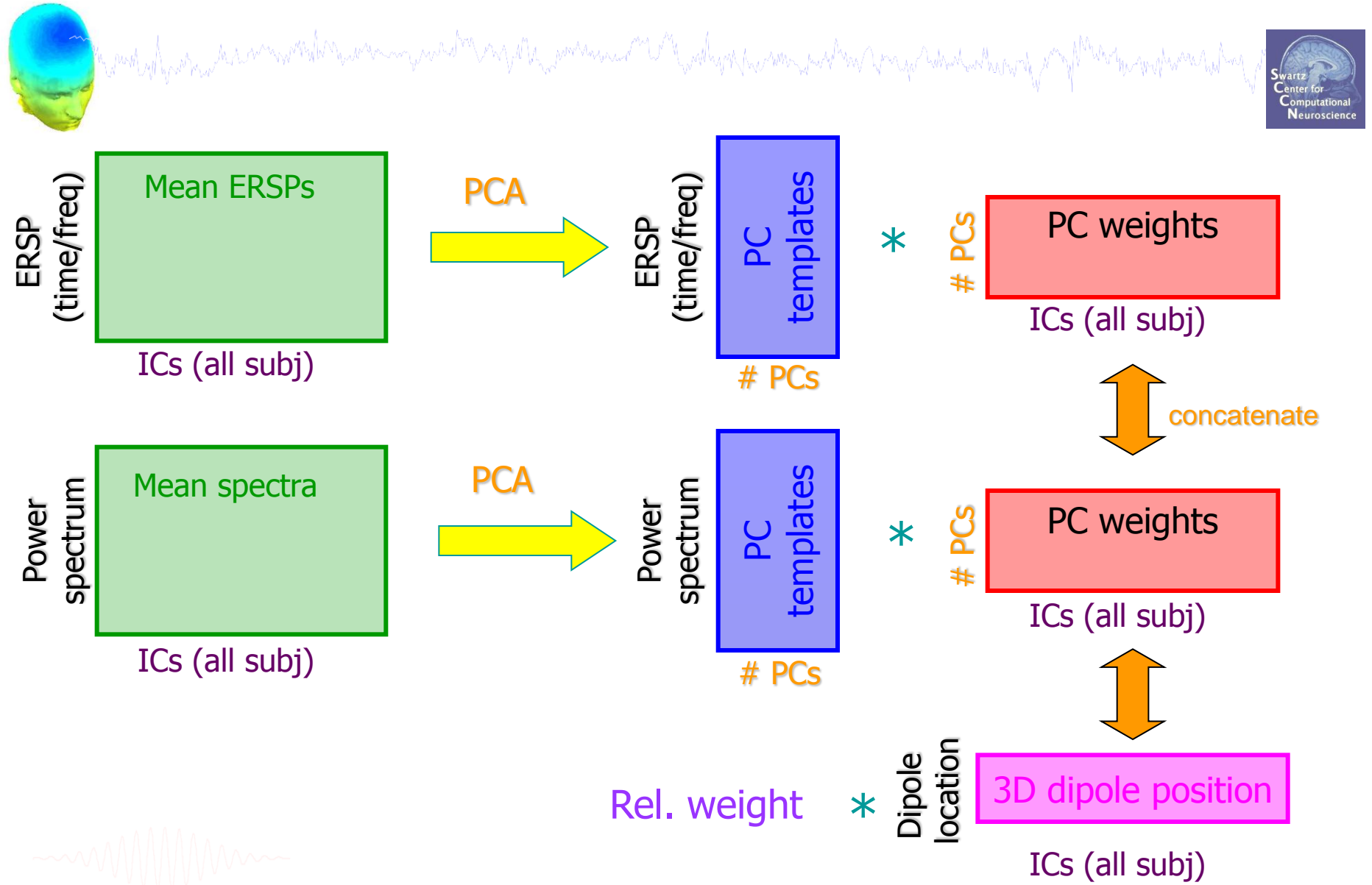
```
% std_dipoleclusters function call:
```

```
std_dipoleclusters(STUDY,ALLEEG,'clusters',clusters,...
```

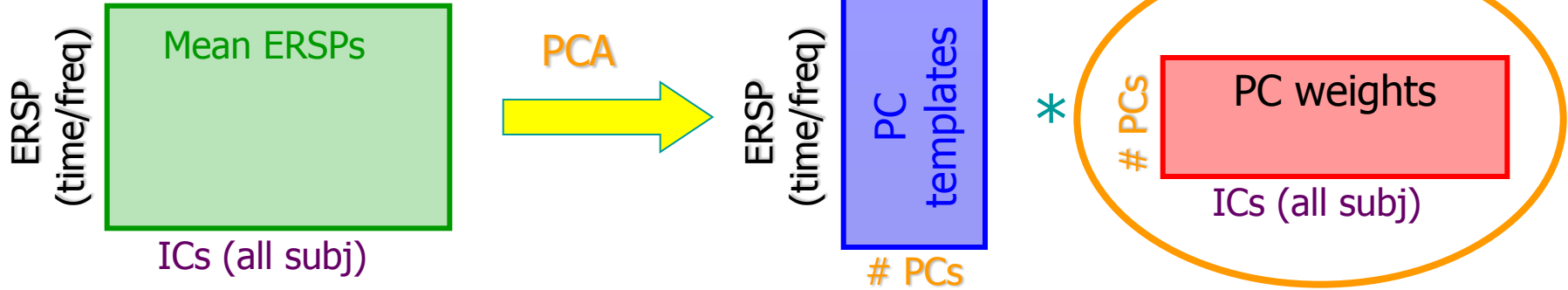
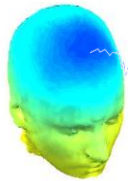
```
'title',title,'viewnum',views,'rowcolplace',plot_param,...
```

```
'centroid','off','colors',cols);
```

Precluster schematic

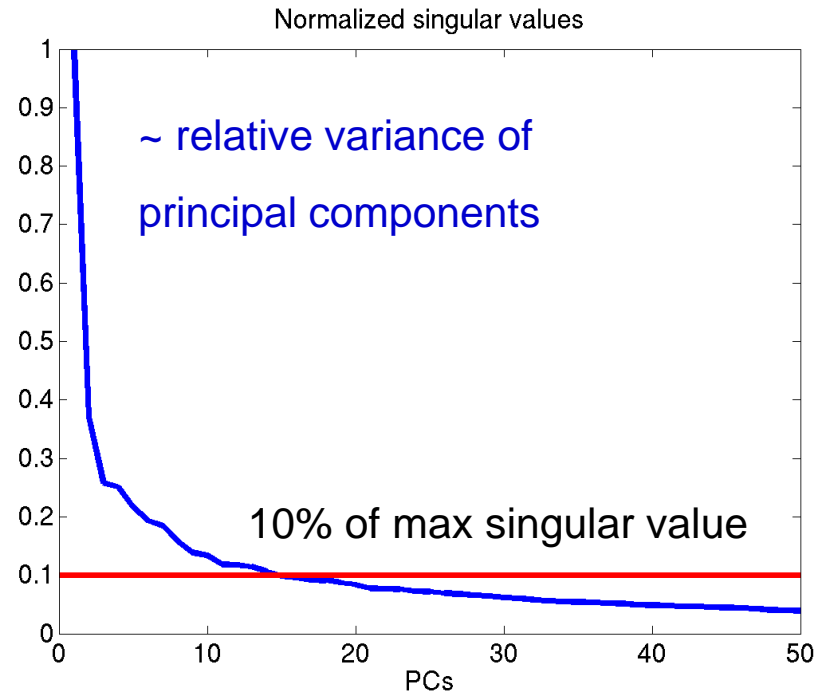
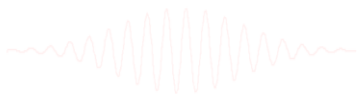


Precluster: Use singular values from PCA

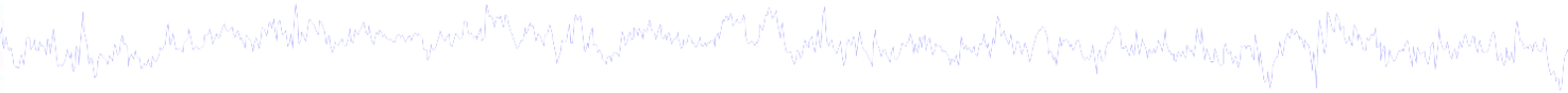
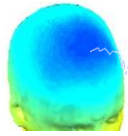


Do it yourself:

- Load all ERSP data
- Decompose with PCA
- Plot singular values



Find variance of ERSP PCA dimensions



```
% Call in raw data and run PCA, then plot singular values:
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cond = 1; % experimental condition (corresponds to STUDY.condition)

clear logersp
for ic = 1:size(STUDY.cluster(1).sets,2)
    [logersp(:, :, ic), logfreqs, timevals, params, baseersp] = ...
    std_readersp(ALLEEG, STUDY.cluster(1).sets(cond, ic), STUDY.cluster(1).comps(ic), [0 1000], [0 40] );
end;
ersp2d = reshape(logersp, size(logersp, 1) * size(logersp, 2), size(logersp, 3));

npcs = 50; % limit the number and speed up PCA
[pc, eigvec, sv] = runpca(double(ersp2d), npc); % decompose ERSP x ICs

% PLOT the singular values:
figure; subplot(2, 2, 1); plot(max(sv)); set(gca, 'xlim', [1 size(sv, 1)]);
title('Raw singular values'); xlabel('PCs');

subplot(2, 2, 2); plot(max(sv) / max(sv(:))); hold on;
set(gca, 'xlim', [1 size(sv, 1)]);
title('Normalized singular values'); xlabel('PCs');
plot([get(gca, 'xlim')], [.1 .1], 'r-'); % line showing 10% of max

subplot(2, 2, 3); imagesc(eigvec); xlabel('PCs'); title('ERSP templates');
ylabel('ERSP time/freq points'); cbar;

subplot(2, 2, 4); imagesc(pc); title('Component weightings');
ylabel('PCs'); xlabel('Trials'); cbar;
textsc('ERSP PCA dimensions', 'title');
```