



Clustering of ICA components

EEGLAB

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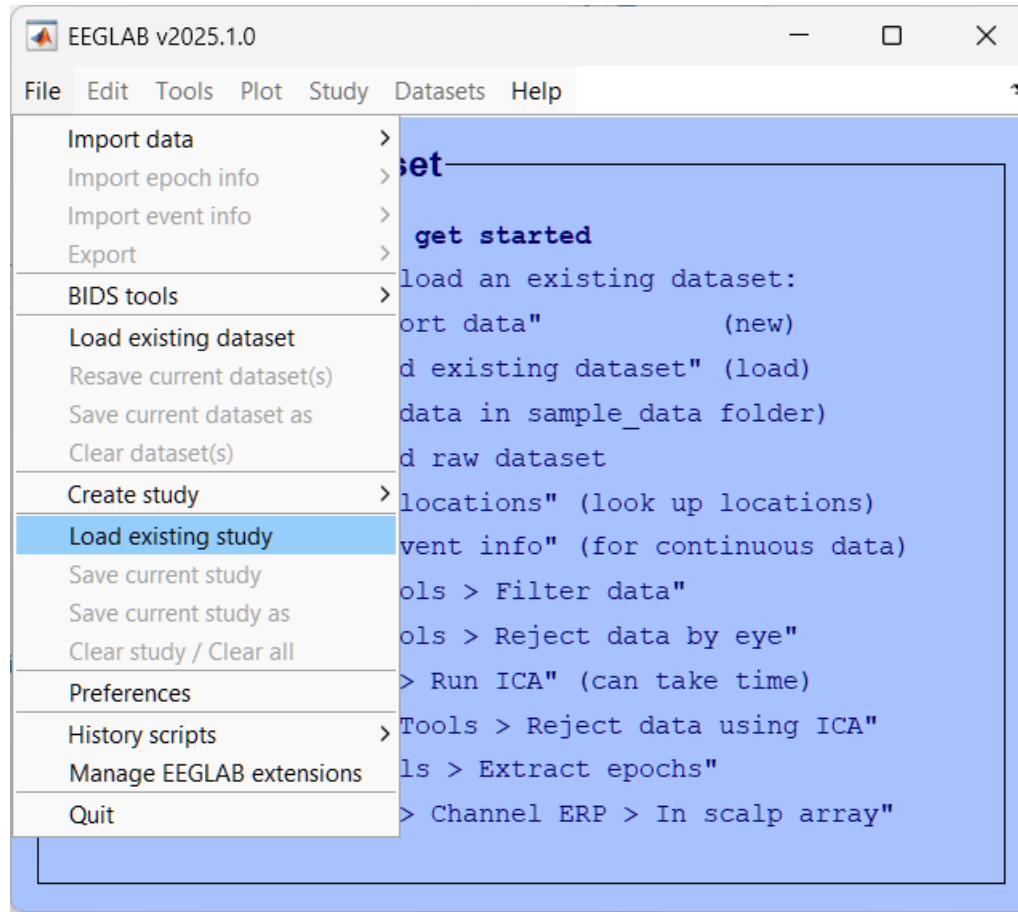
Steps of clustering

1. Select ICA components for clustering
2. Precompute measures of interest
3. Cluster measures
4. Plot clusters and edit them if necessary



Load an existing STUDY

ds002718_processed/Face_detection.study



EEGLAB v2025.1.0

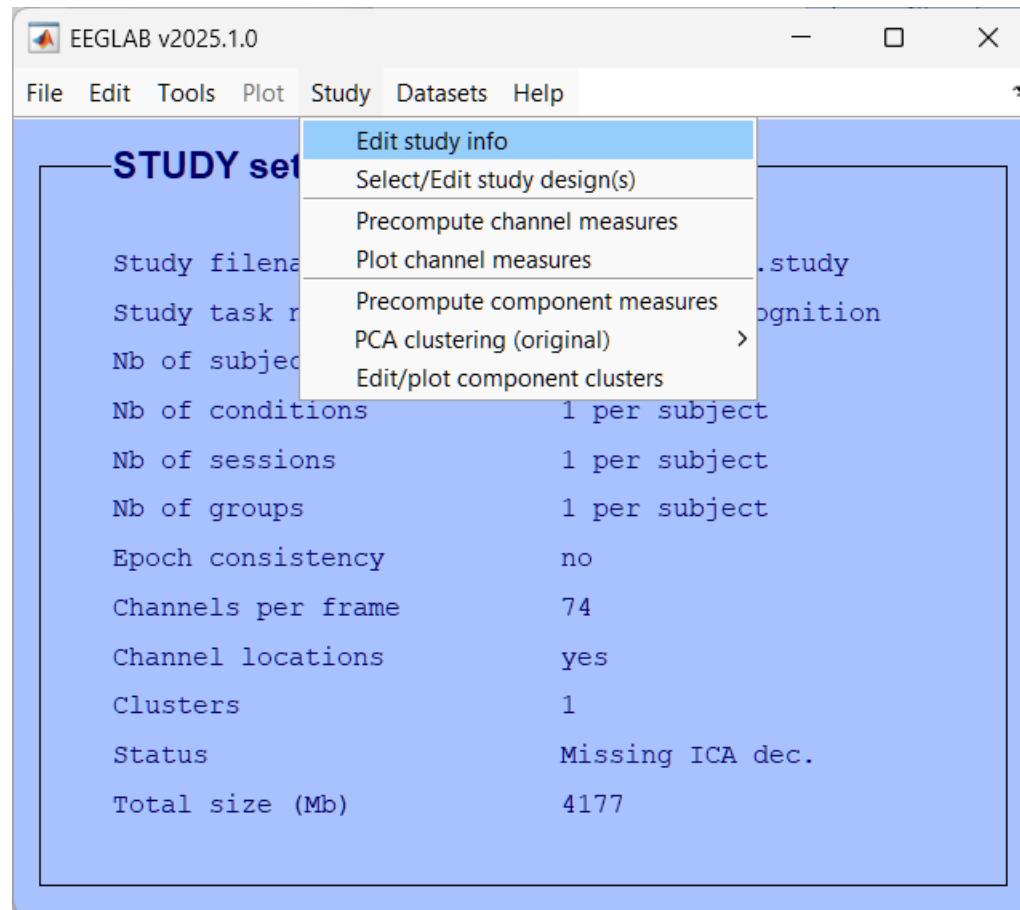
File Edit Tools Plot Study Datasets Help

STUDY set:

Study filename:	...cessed\Face_detection.study
Study task name	
Nb of subjects	18
Nb of conditions	1 per subject
Nb of sessions	1 per subject
Nb of groups	1 per subject
Epoch consistency	yes
Channels per frame	60, 61, 62, 64, 65, 66, 67, 68
Channel locations	yes
Clusters	19
Status	Pre-clustered
Total size (Mb)	2571.8



Study/Edit study info



Edit dataset info

Create a new STUDY set -- pop_study()

Edit STUDY set information - remember to save changes

STUDY set name:

STUDY set task name:

STUDY set notes:

	dataset filename	browse	subject	session	run	condition	group	Select by r.v.	
1	C:\Users\Romain\Workspace\	...	sub-002	1	1			All comp.	Clear
2	C:\Users\Romain\Workspace\	...	sub-003	1	1			All comp.	Clear
3	C:\Users\Romain\Workspace\	...	sub-004	1	1			All comp.	Clear
4	C:\Users\Romain\Workspace\	...	sub-005	1	1			All comp.	Clear
5	C:\Users\Romain\Workspace\	...	sub-006	1	1			All comp.	Clear
6	C:\Users\Romain\Workspace\	...	sub-007	1	1			All comp.	Clear
7	C:\Users\Romain\Workspace\	...	sub-008	1	1			All comp.	Clear
8	C:\Users\Romain\Workspace\	...	sub-009	1	1			All comp.	Clear
9	C:\Users\Romain\Workspace\	...	sub-010	1	1			All comp.	Clear
10	C:\Users\Romain\Workspace\	...	sub-011	1	1			All comp.	Clear

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

< Page 1 >

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!

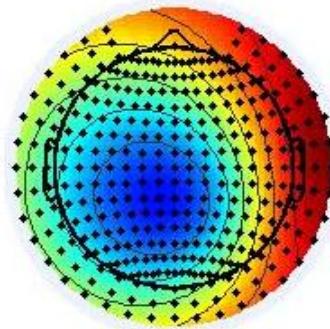
15

Keep only in-brain dipoles.

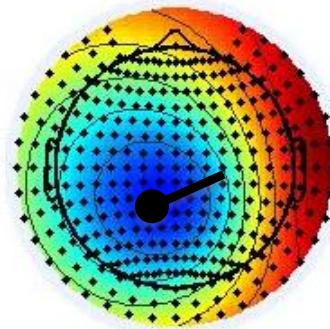
Cancel Help Ok

Computing residual variance (%)

Actual IC map (\mathcal{X}_i)



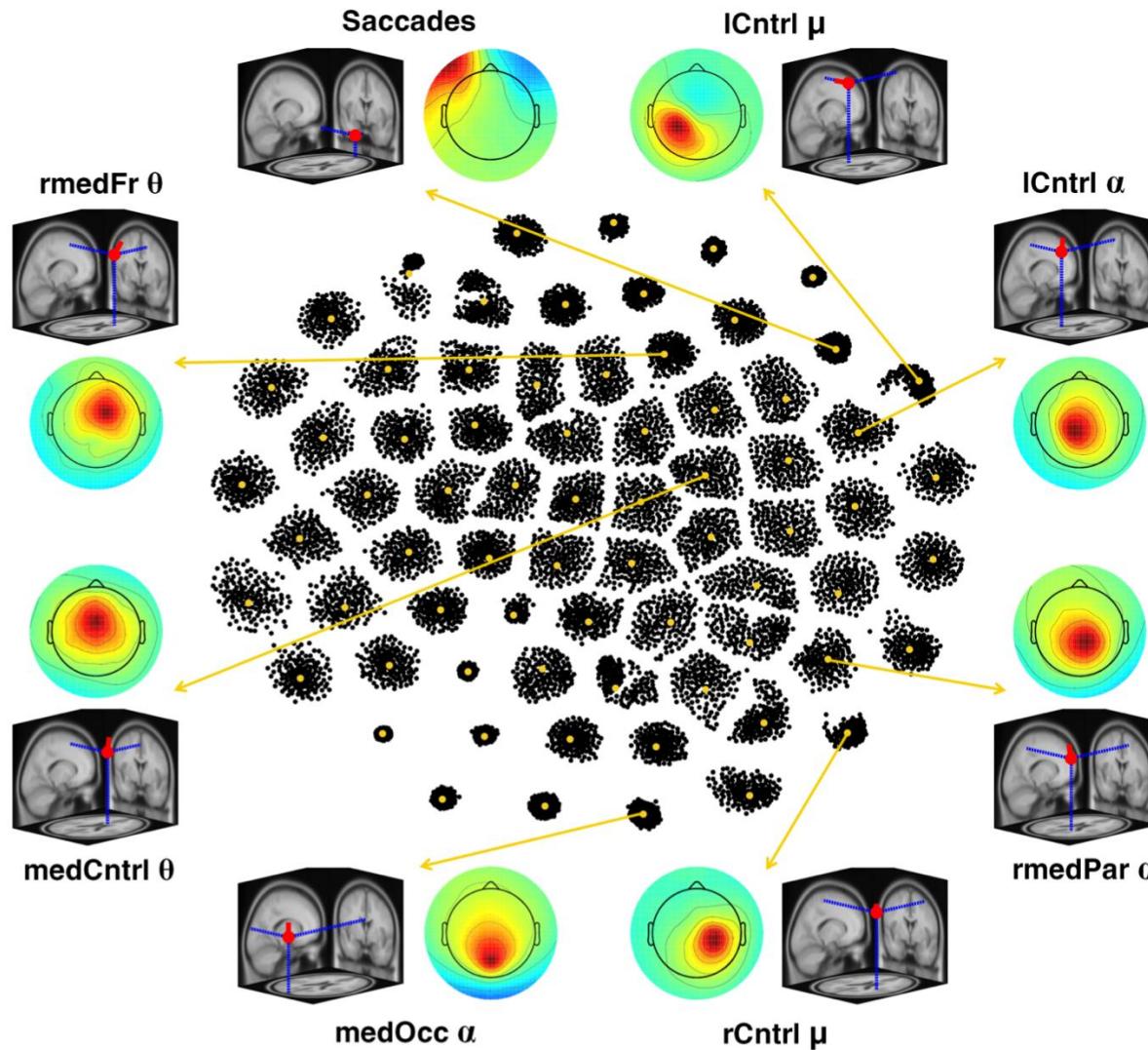
Dipole projection ($\tilde{\mathcal{X}}_i$)



$$rv = \frac{\sum_i (x_i - \tilde{x}_i)^2}{\sum_i x_i^2}$$



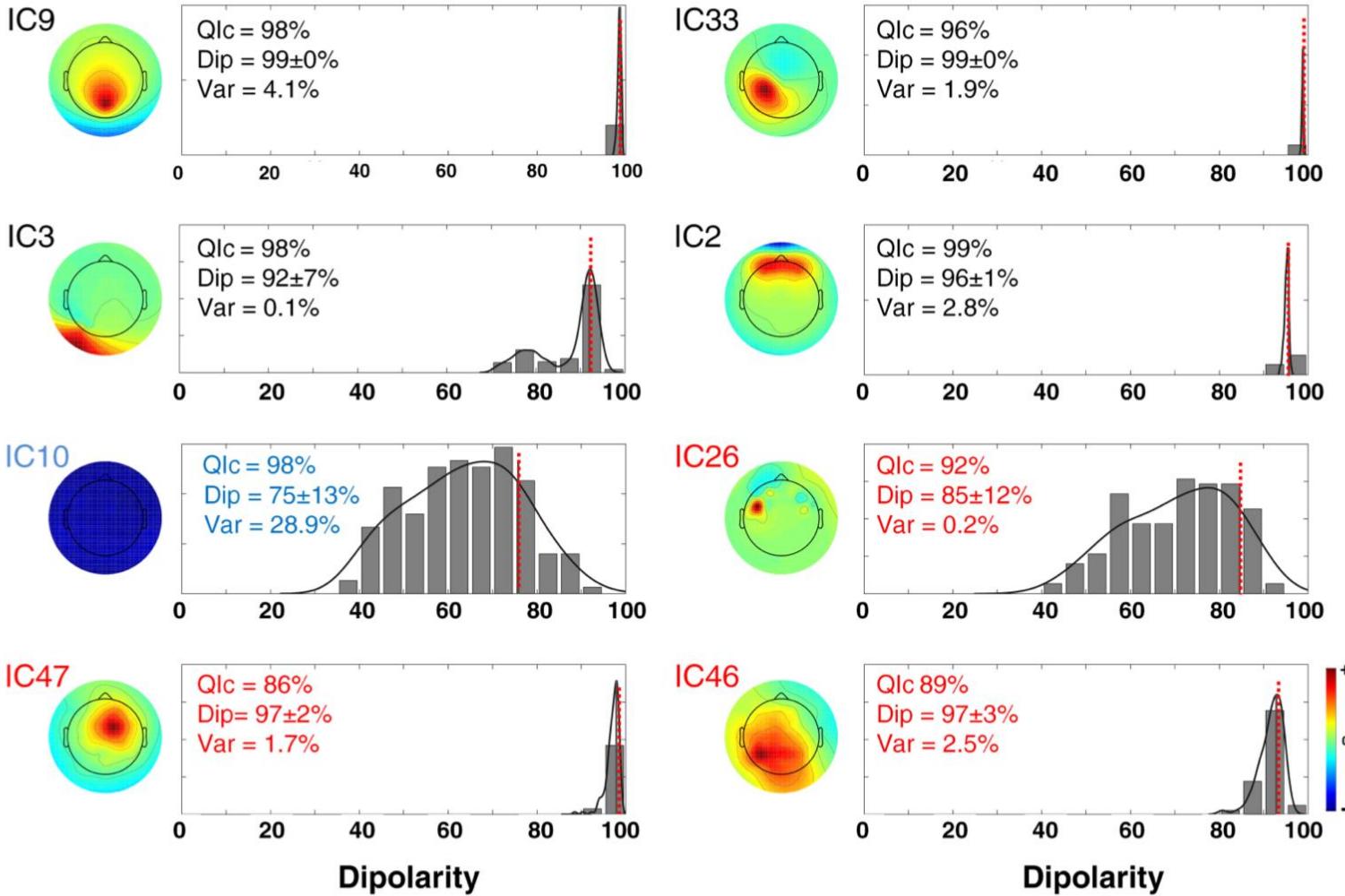
Clustering results example



RELICA: A method for estimating the reliability of independent components

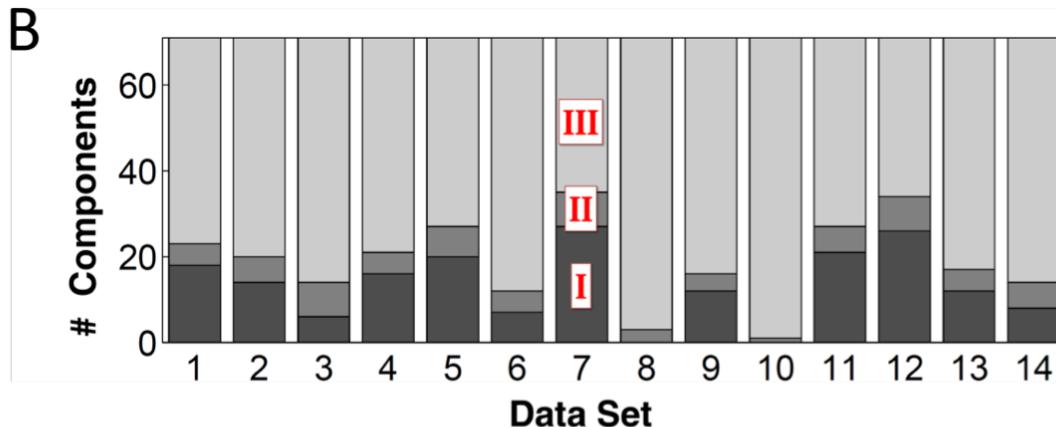
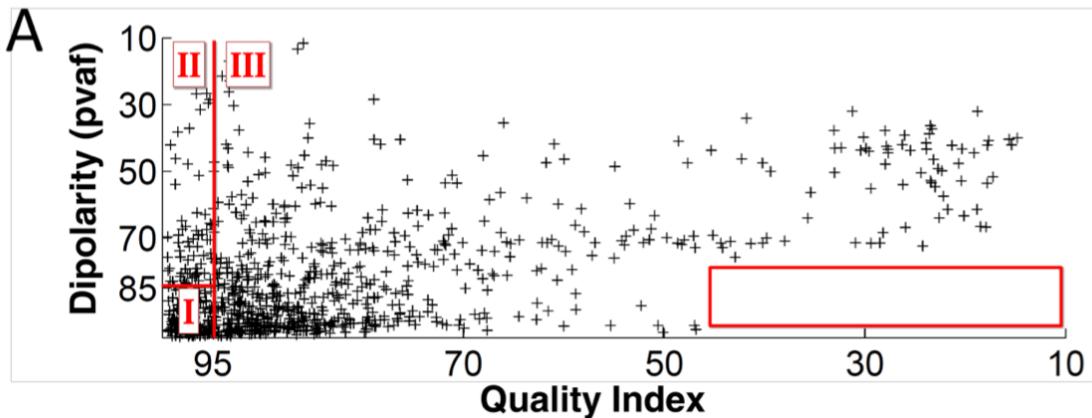
Within-cluster reliability

The distribution of dipolarity within the cluster helps assessing the **quality** and characteristics of Independent Components



Reliability criteria and the rv<15%

First justification why we should select an $r.v < 15\%$ for components to include in further analyses: there is a forbidden region underlined in red, that indicates the absence of



CLASS I

Quality Index and Dipolarity above
Retention threshold: **Good**

CLASS II

Quality Index above threshold,
dipolarity below: **artifact** or mixing
of multiple processes

CLASS III

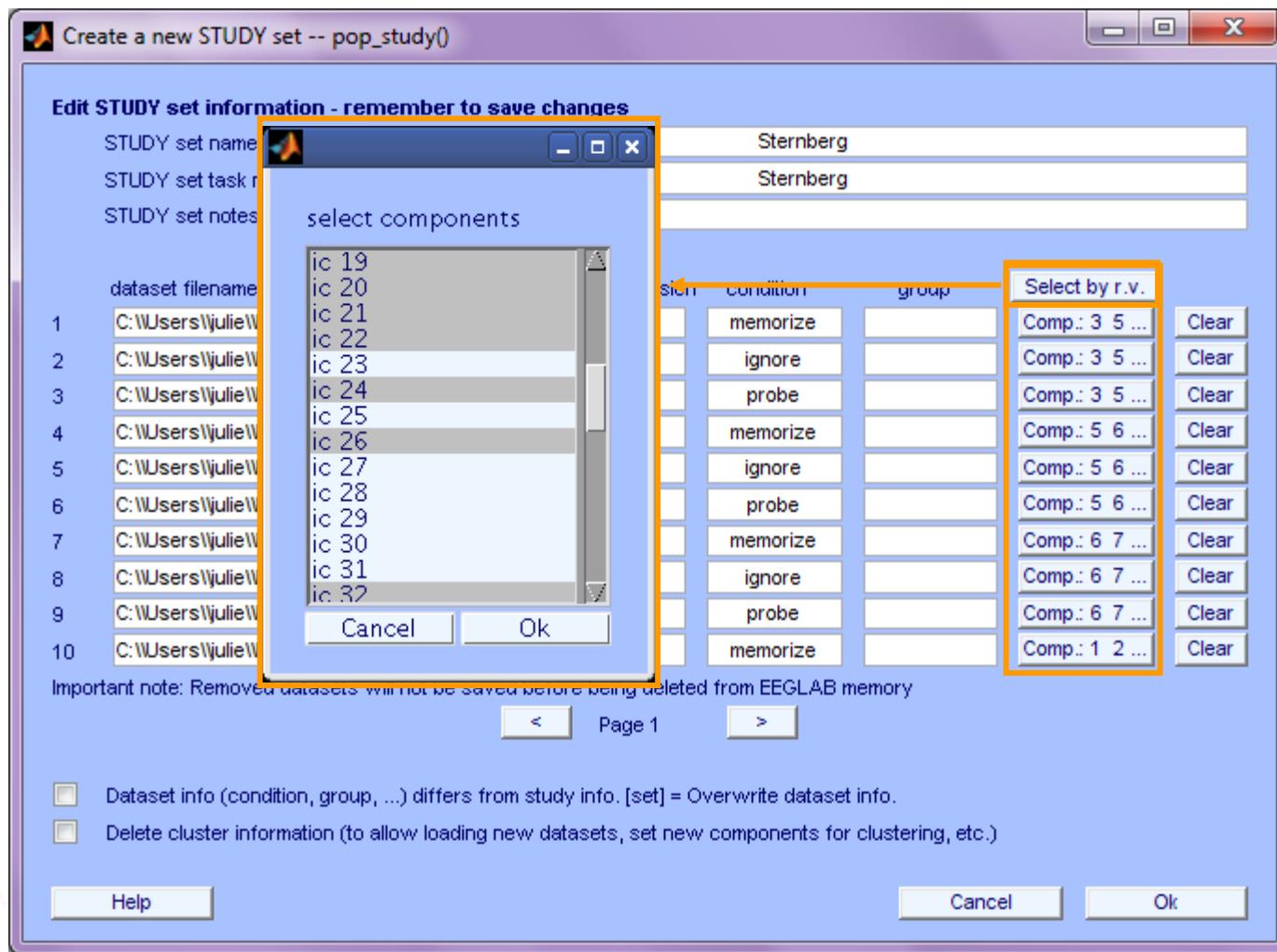
Quality Index below retention
threshold

$dip \pm std > th$

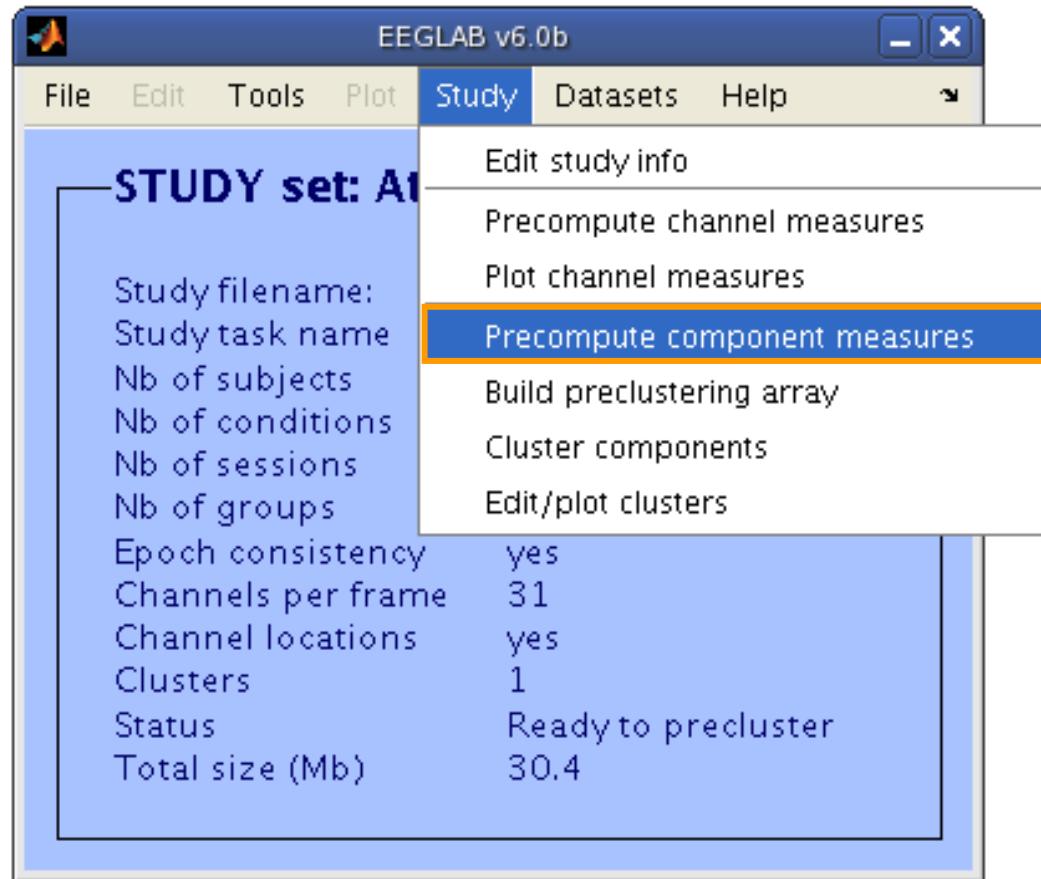
$dip \pm std < th$

Probable Inseparable
noise: variance
explained useful or
multiple subject
Discard

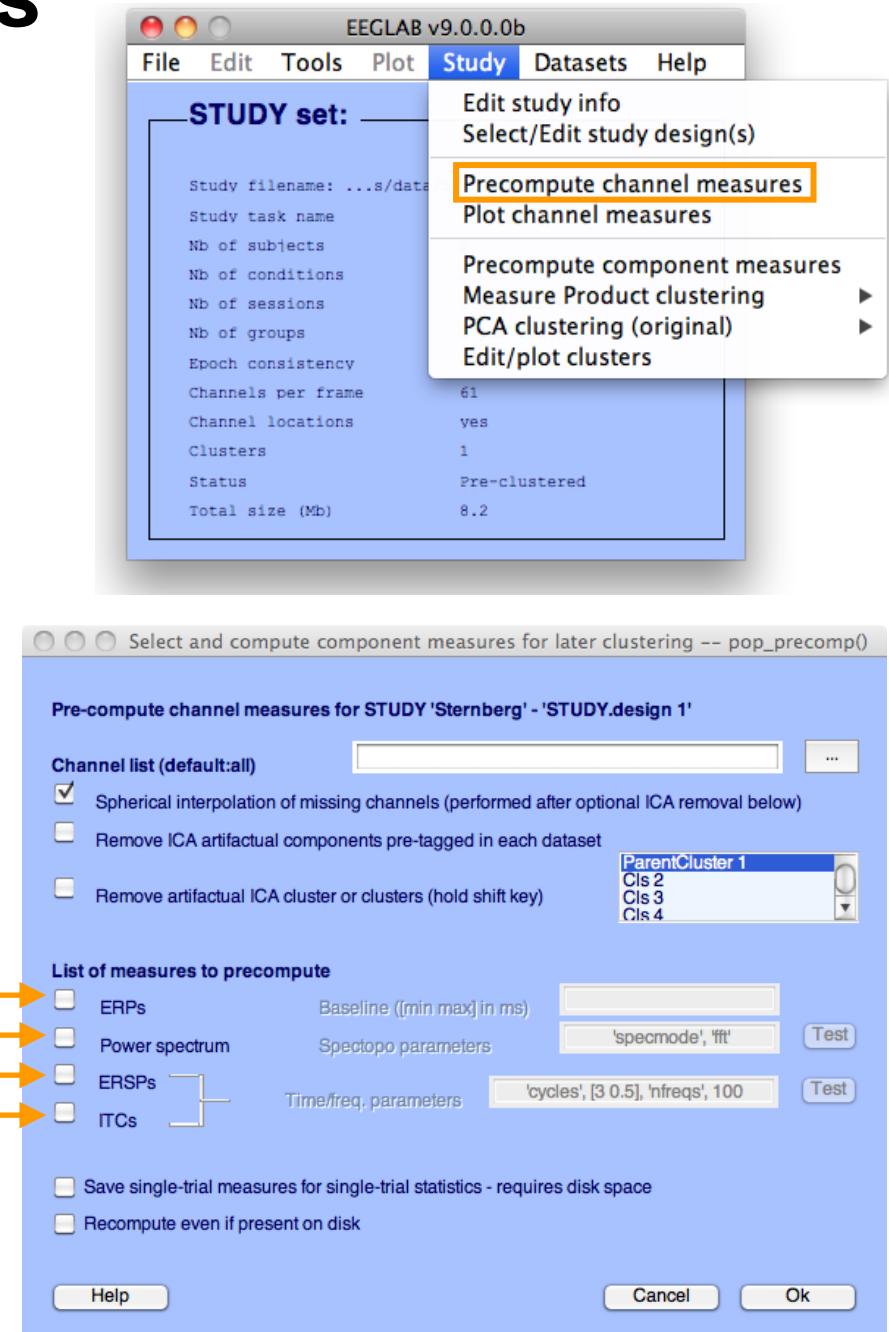
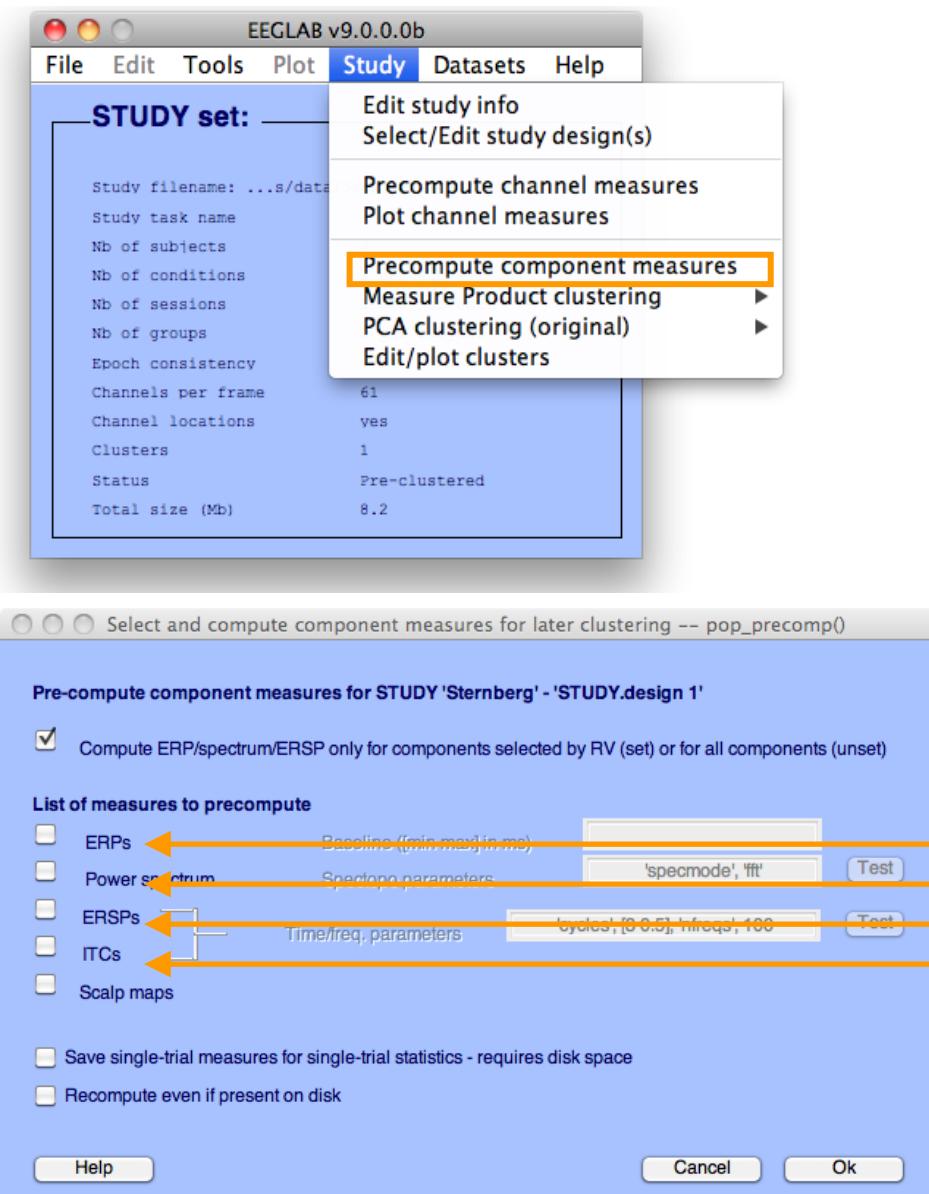
ICs to cluster



Precompute data measures

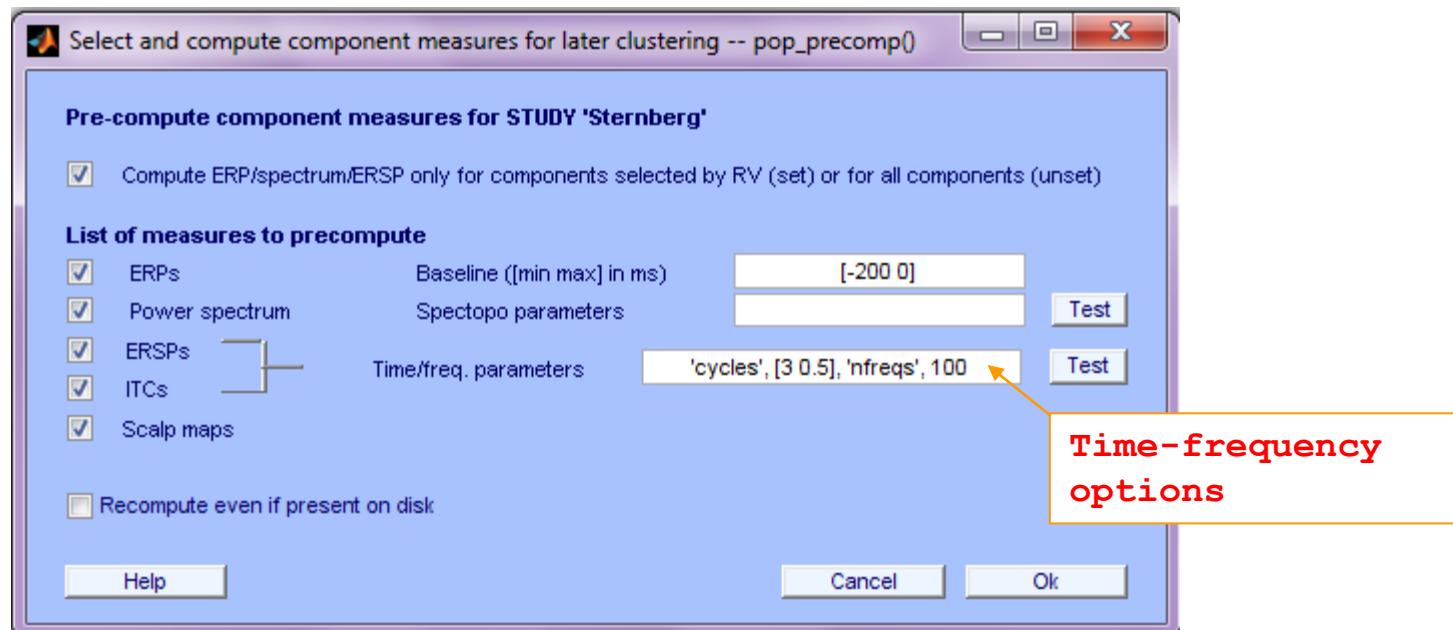


Pre-compute measures



Precompute data measures

**TIP: Compute all measures so you can
test different combinations for clustering**



Cluster components

EEGLAB v15.x (dev)

File Edit Tools Plot Study Datasets Help

STUDY set: Sternberg

Study filename:
Study task name
Nb of subjects
Nb of conditions
Nb of sessions
Nb of groups
Epoch consistency
Channels per frame
Channel locations
Clusters
Status
Total size (Mb)

69.70.71
ves
ves
1
Ready to precluster
229.3

Edit study info
Select/Edit study design(s)
Precompute channel measures
Plot channel measures
Precompute component measures
PCA clustering (original) ► Build preclustering array
Edit/plot clusters
Cluster components

Select and compute component measures for later clustering -- pop_preclust()

Build pre-clustering matrix for STUDY set: Sternberg

Only measures that have been precomputed may be used for clustering

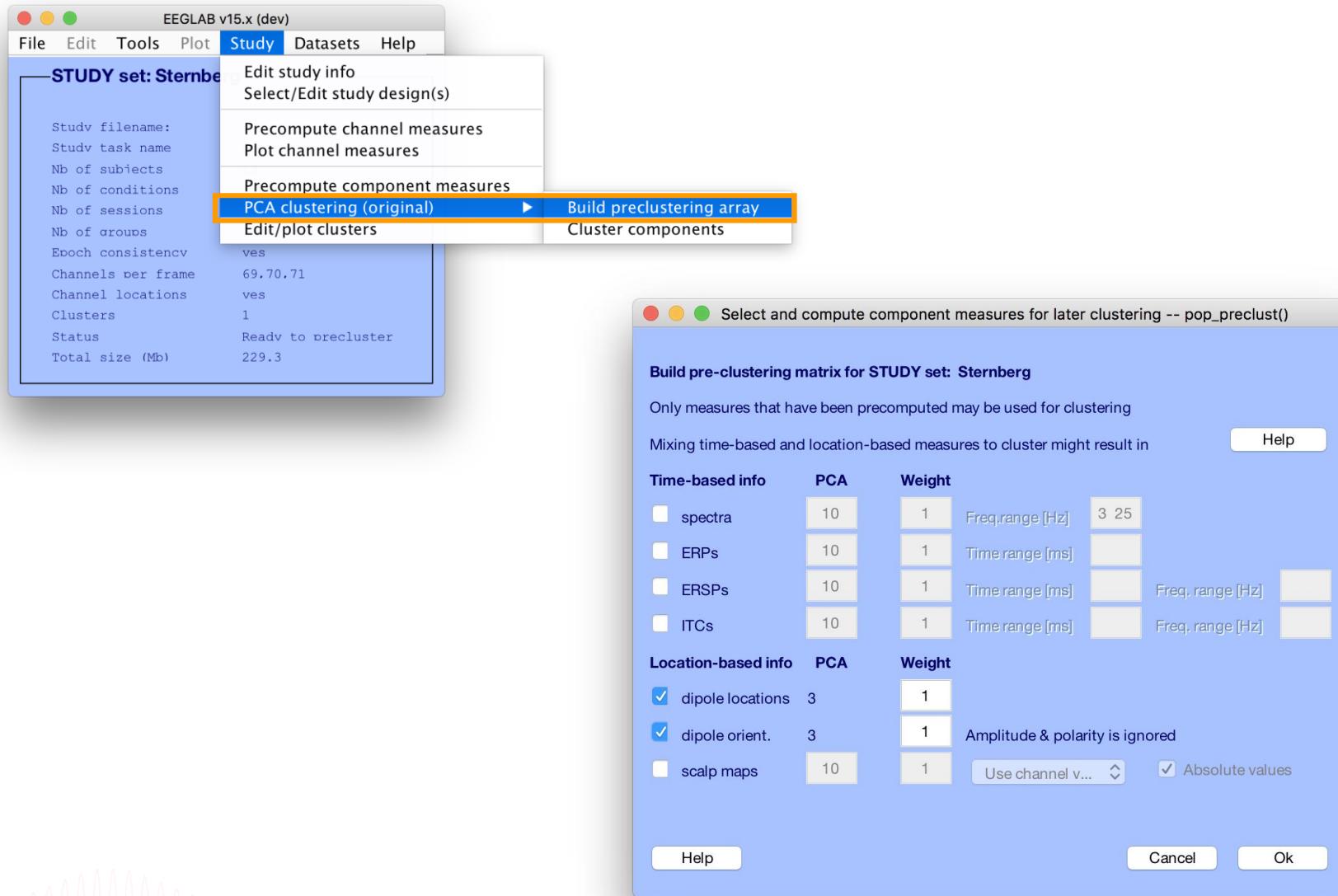
Mixing time-based and location-based measures to cluster might result in

Help

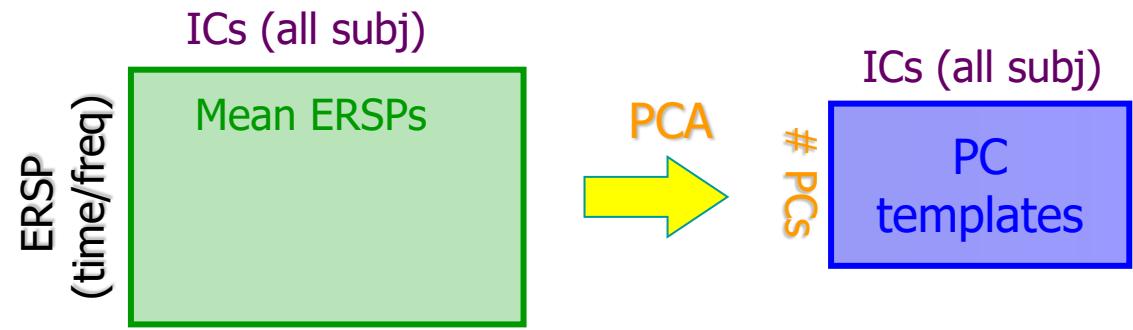
Time-based info	PCA	Weight	
<input type="checkbox"/> spectra	10	1	Freq.range [Hz] 3.25
<input type="checkbox"/> ERPs	10	1	Time range [ms]
<input type="checkbox"/> ERSPs	10	1	Time range [ms]
<input type="checkbox"/> ITCs	10	1	Time range [ms]
			Freq. range [Hz]

Location-based info	PCA	Weight	
<input checked="" type="checkbox"/> dipole locations	3	1	
<input checked="" type="checkbox"/> dipole orient.	3	1	Amplitude & polarity is ignored
<input type="checkbox"/> scalp maps	10	1	<input type="checkbox"/> Use channel v... <input type="checkbox"/> Absolute values

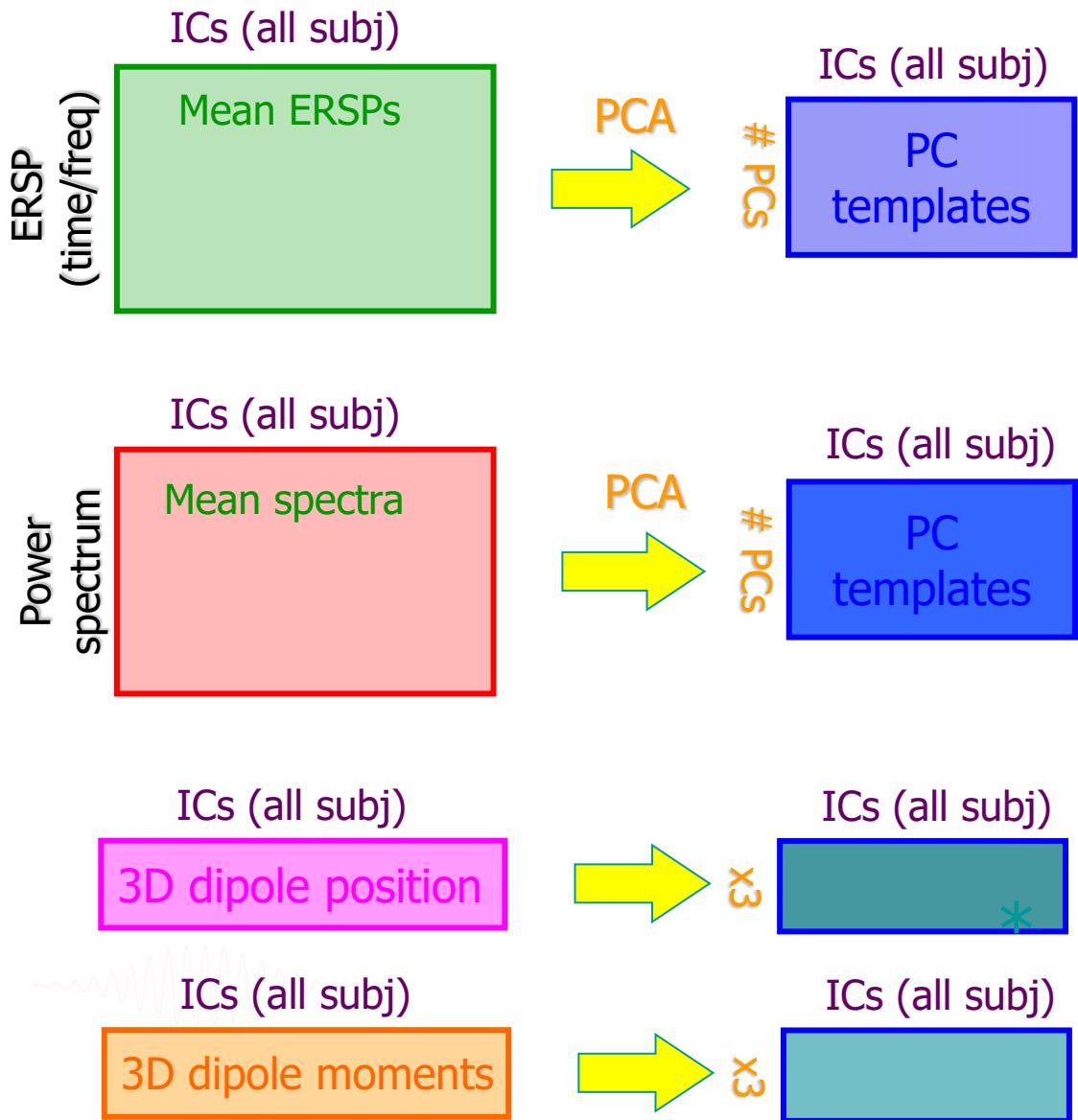
Help Cancel Ok



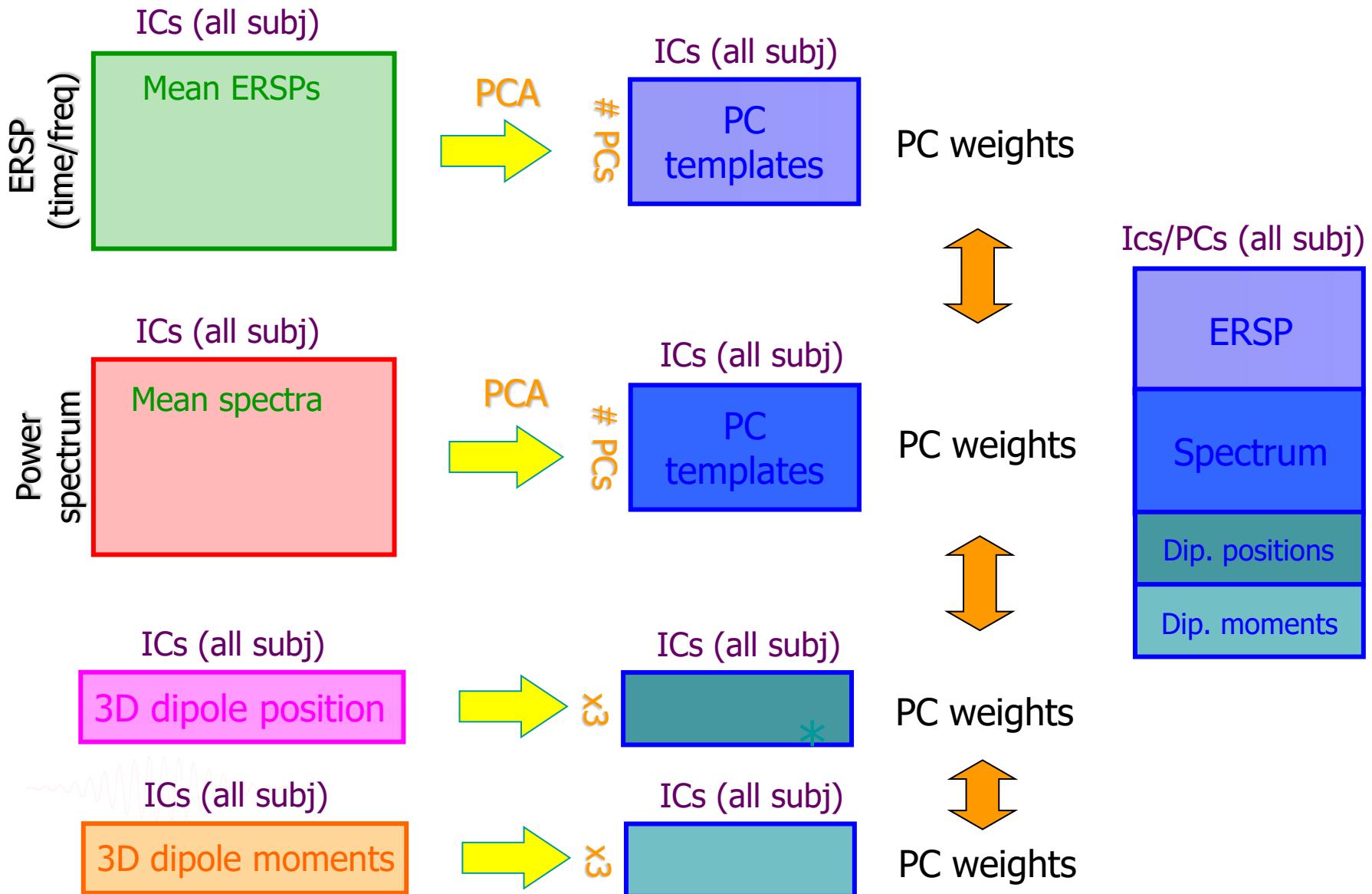
Precluster schematic



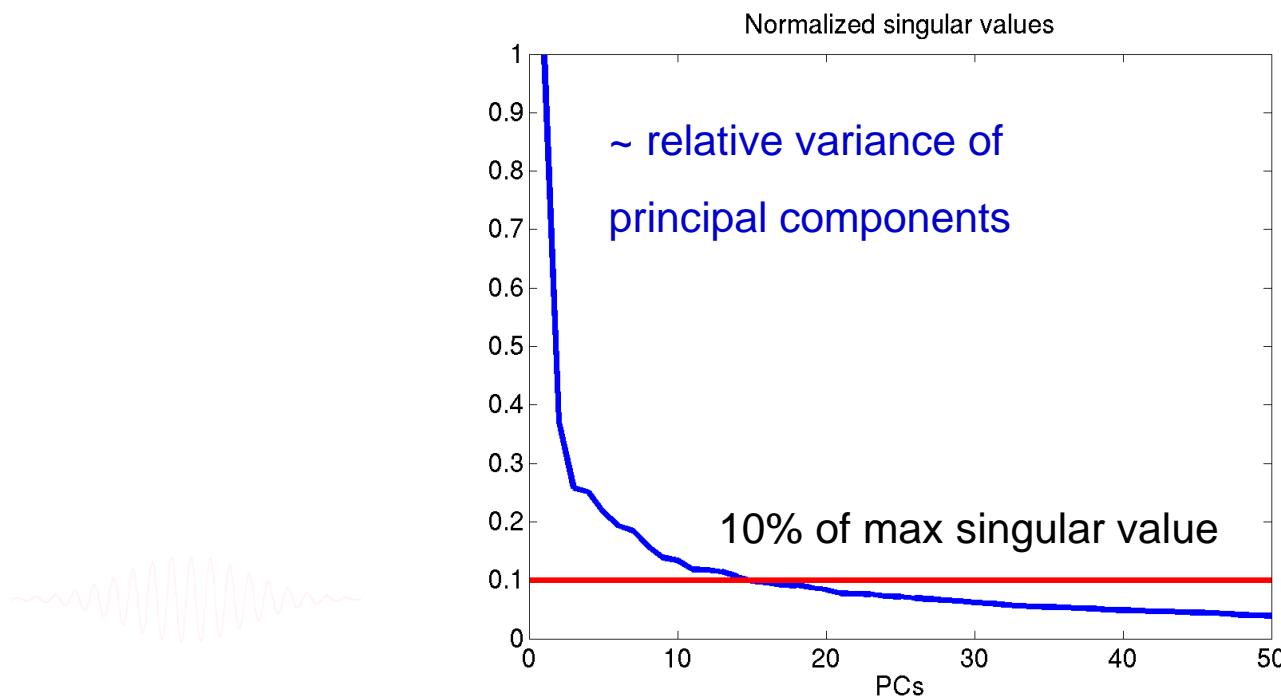
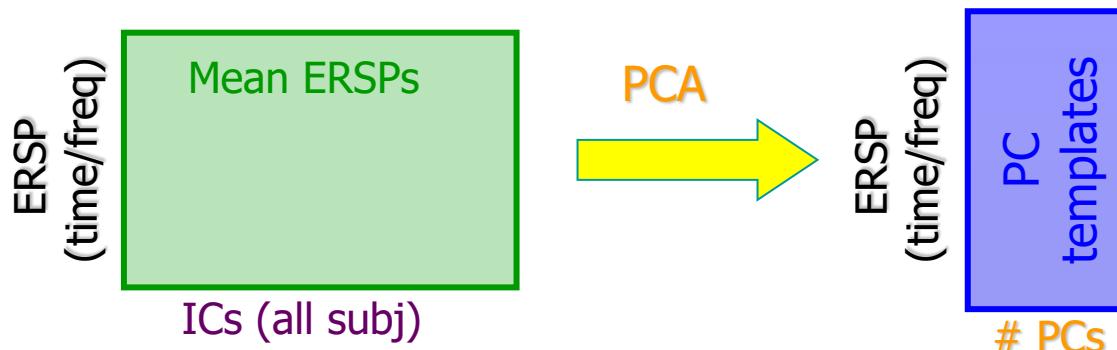
Precluster schematic



Precluster schematic

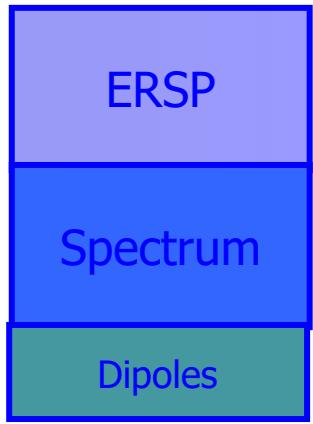


Precluster: Use singular values from PCA

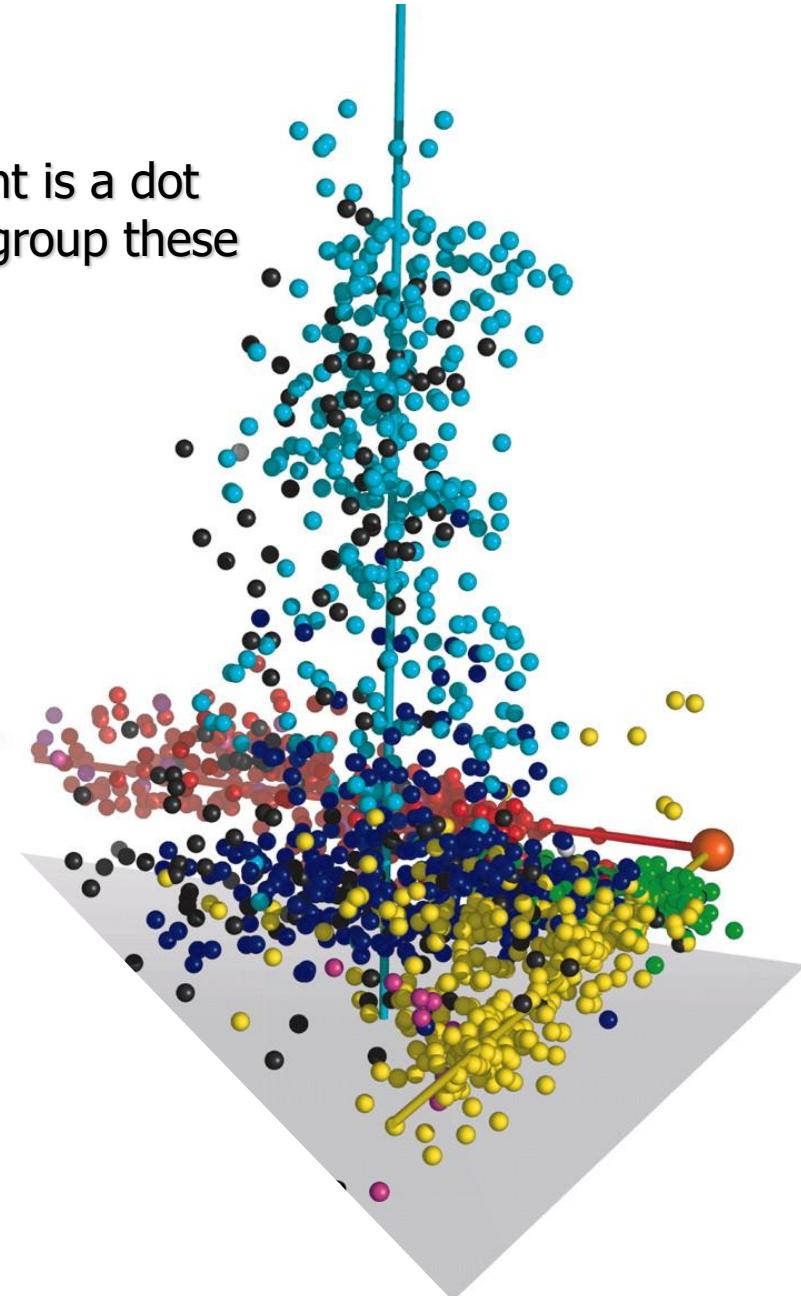


Precluster schematic

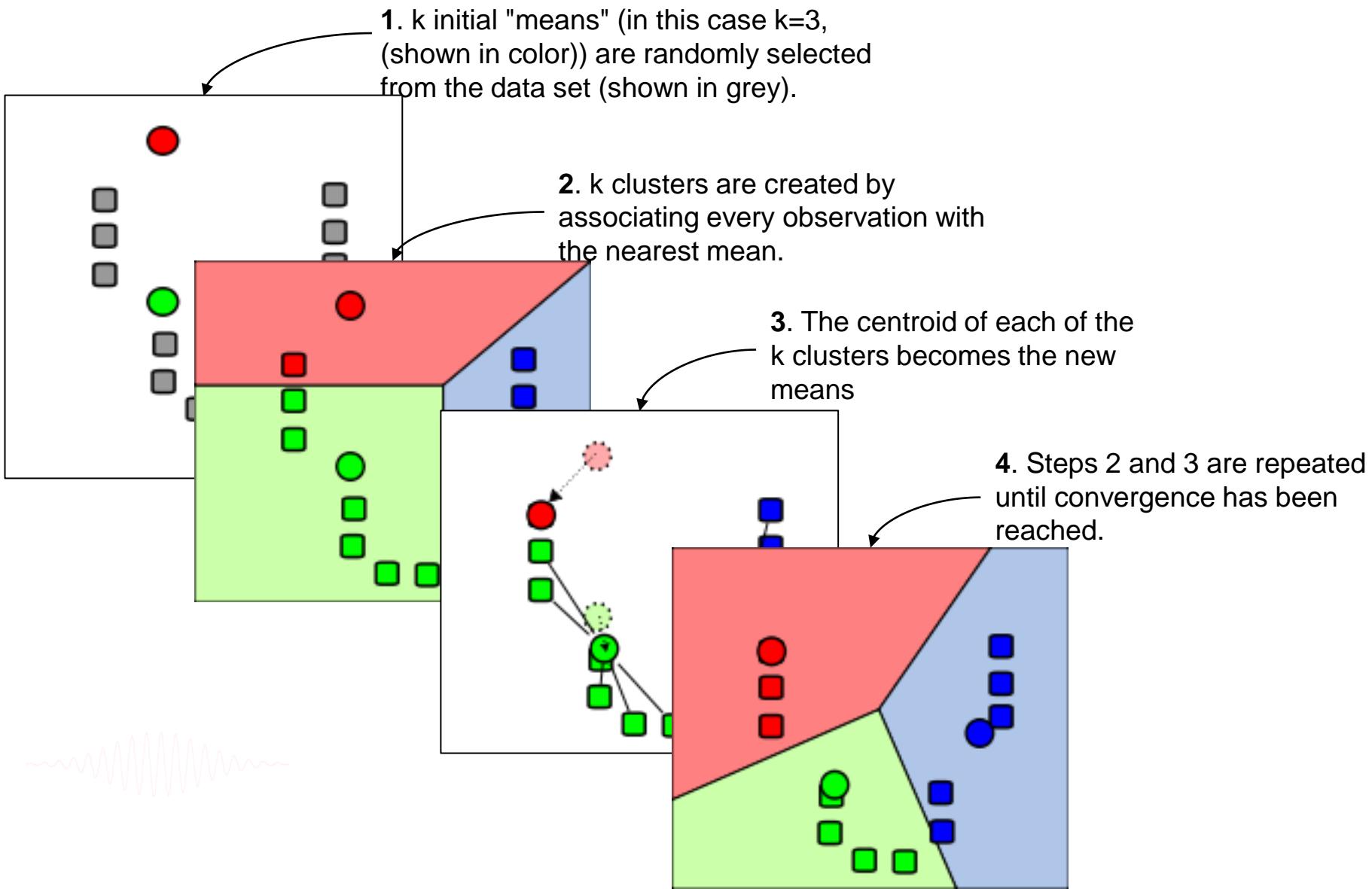
ICs (all subj)



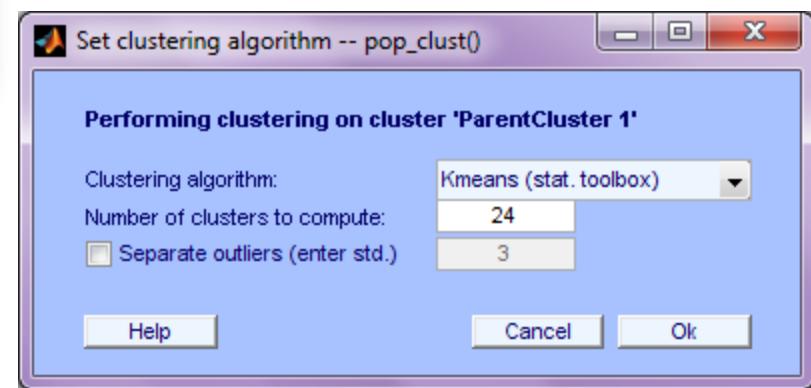
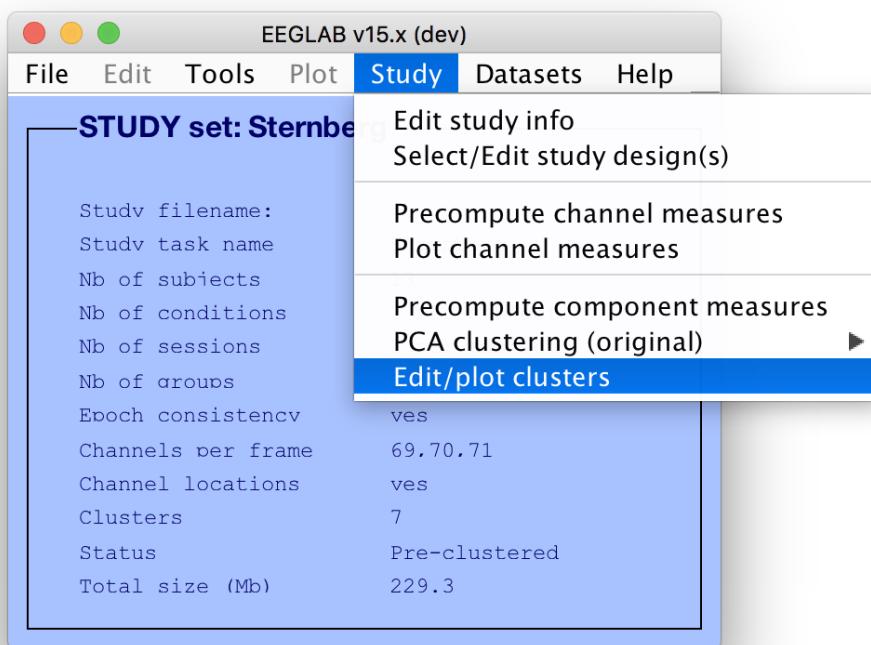
Each component is a dot
Clustering will group these dots



Standard Kmean Clustering



Cluster components



Choosing data measures

What measure(s) should you use?

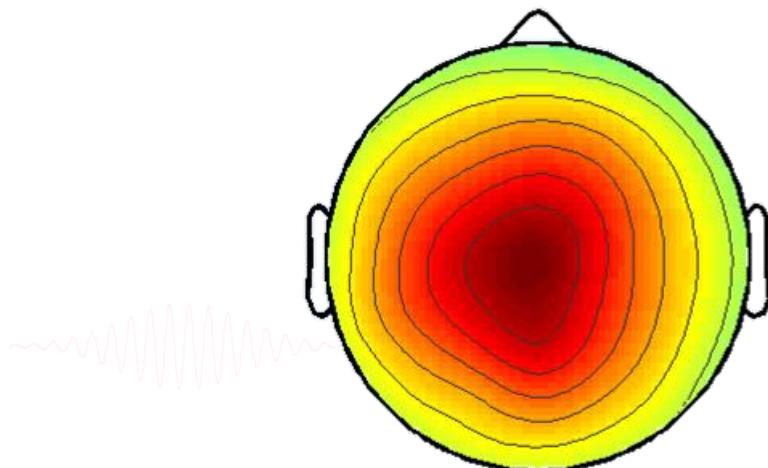
It depends on your final cluster criteria...

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

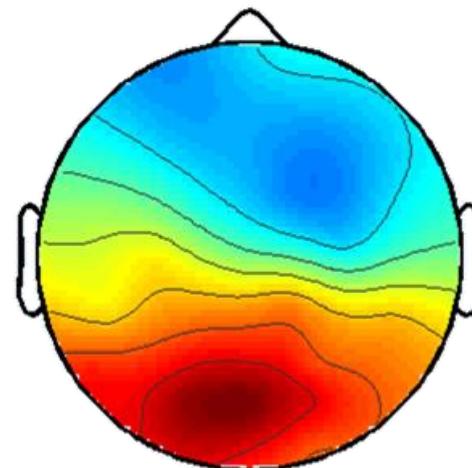
But consider:

- What is the difference between these two components?

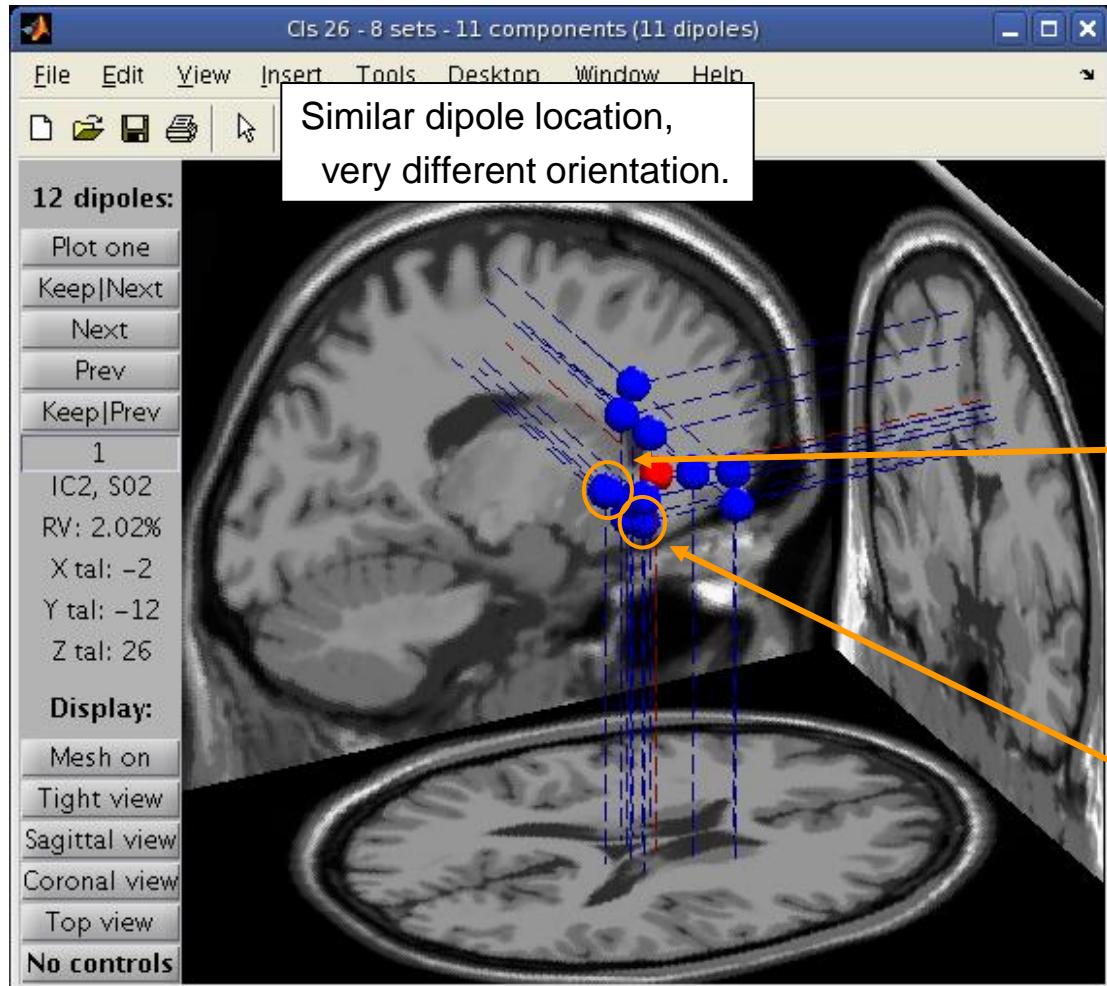
IC2 / S02, Cls 26



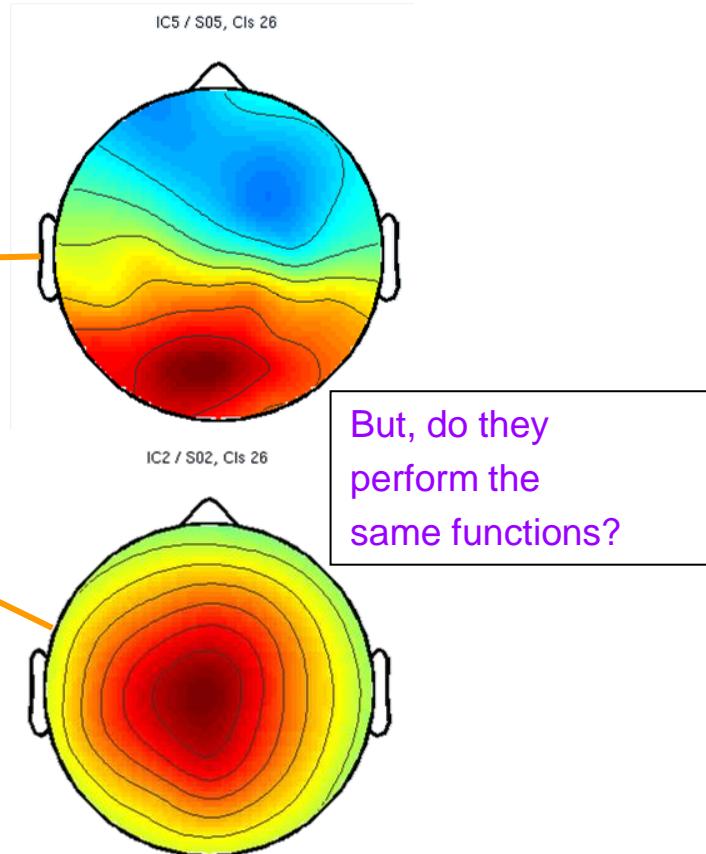
IC5 / S05, Cls 26



Choosing data measures

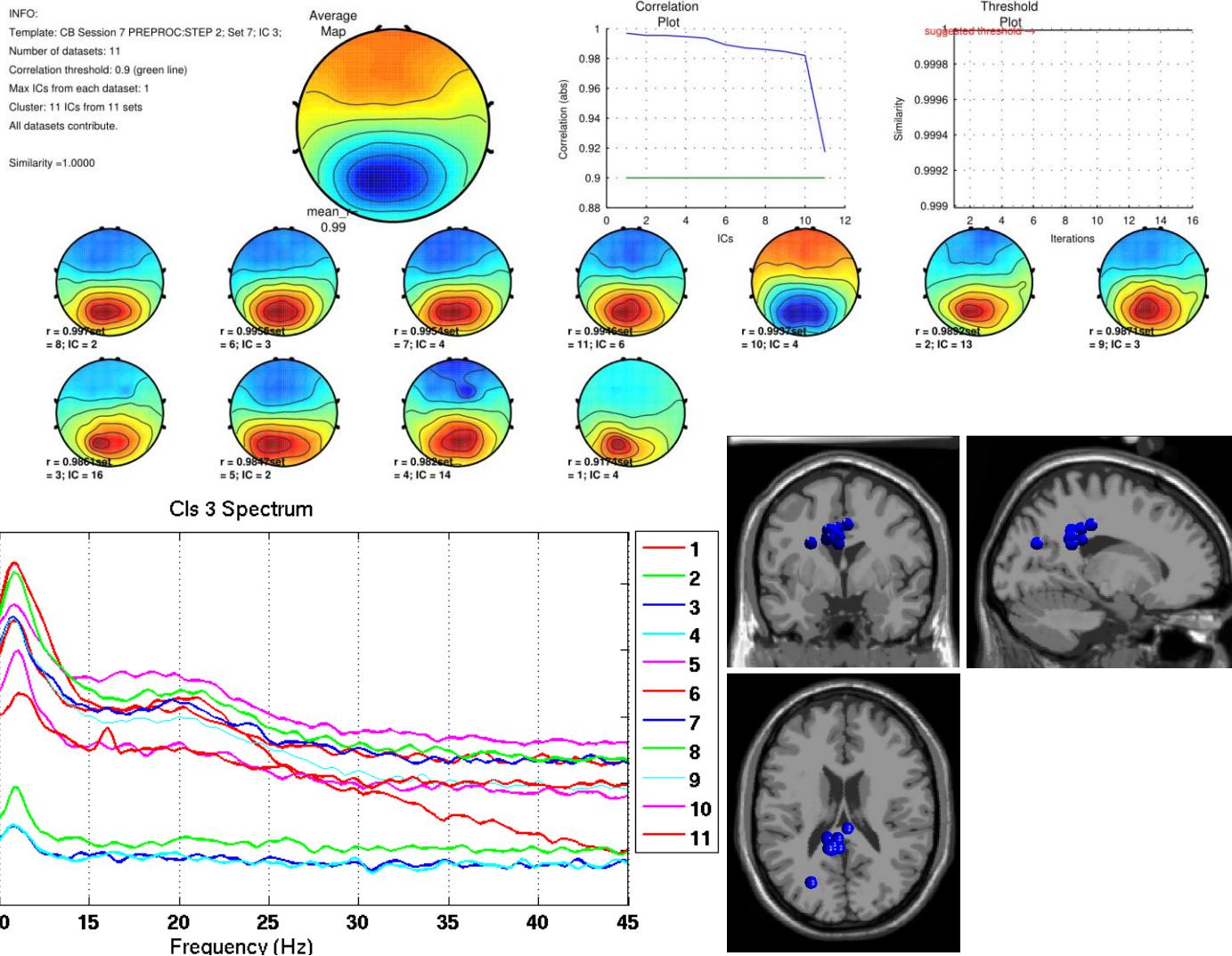


Obvious dramatic effect on
scalp map topography:



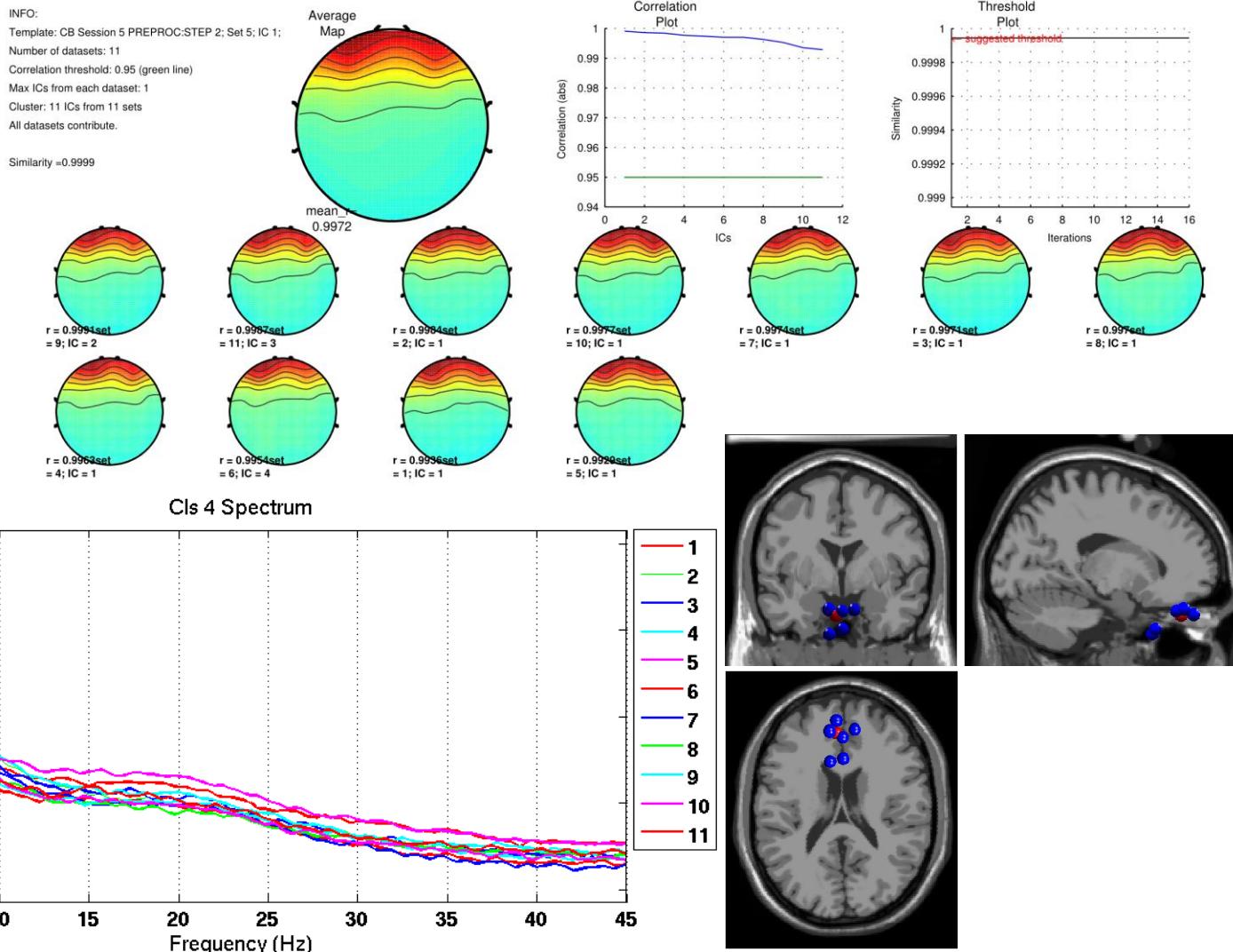
Results (Cluster 1 within subject)

100 % Sessions contribute



Results (Cluster 2 within subject)

100 % Sessions contribute



Results (Cluster 8 within subject)

100 % Sessions contribute

INFO:

Template: CB Session 7 PREPROC:STEP 2; Set 7; IC 11;

Number of datasets: 11

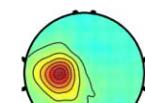
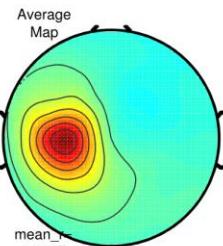
Correlation threshold: 0.83 (green line)

Max ICs from each dataset: 1

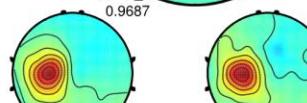
Cluster: 11 ICs from 11 sets

All datasets contribute.

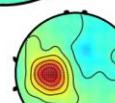
Similarity = 0.9998



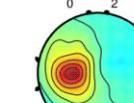
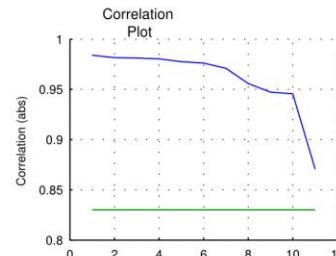
$r = 0.9841$ set
= 8; IC = 15



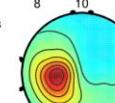
$r = 0.9817$ set
= 11; IC = 12



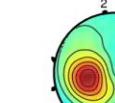
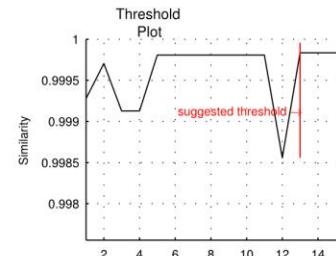
$r = 0.9812$ set
= 7; IC = 11



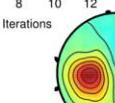
$r = 0.9808$ set
= 2; IC = 12



$r = 0.9777$ set
= 5; IC = 10

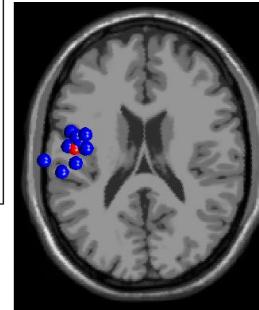
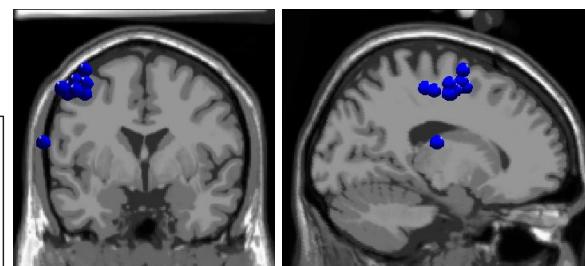
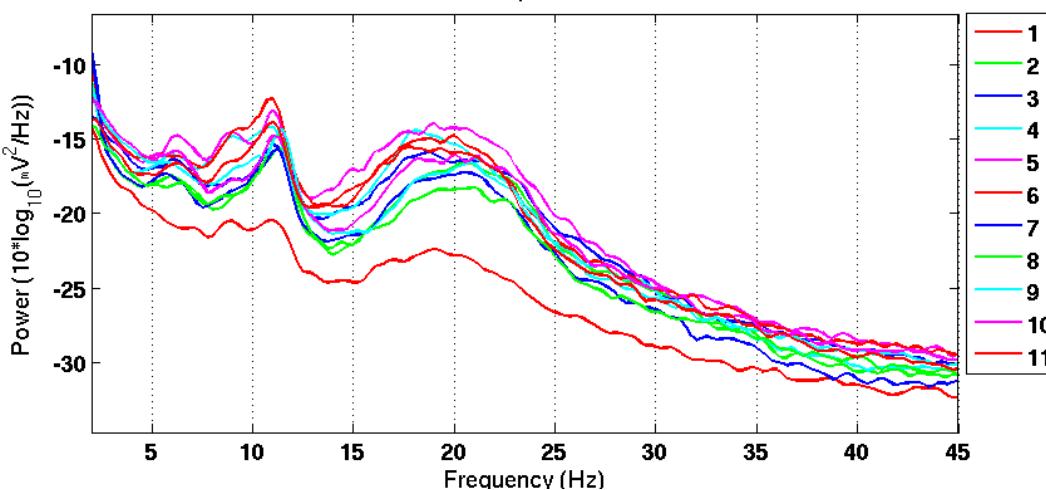


$r = 0.9761$ set
= 4; IC = 13



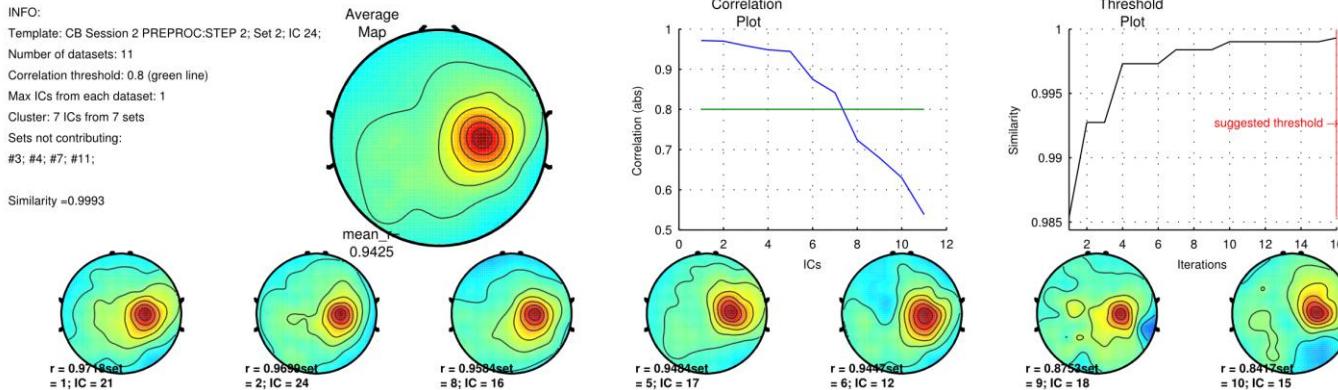
$r = 0.9760$ set
= 6; IC = 10

Cls 8 Spectrum

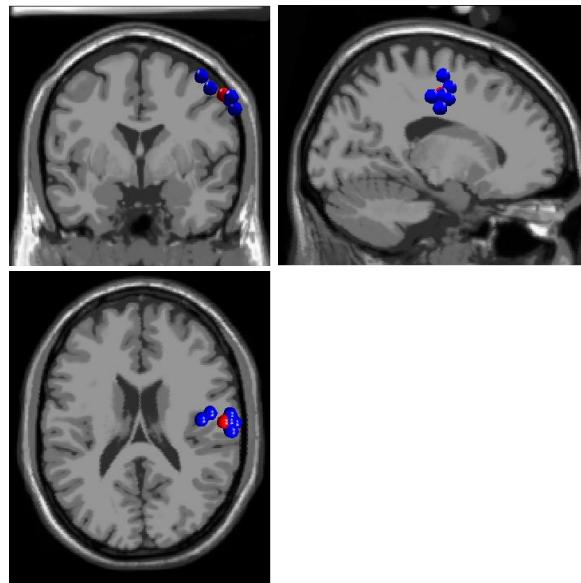
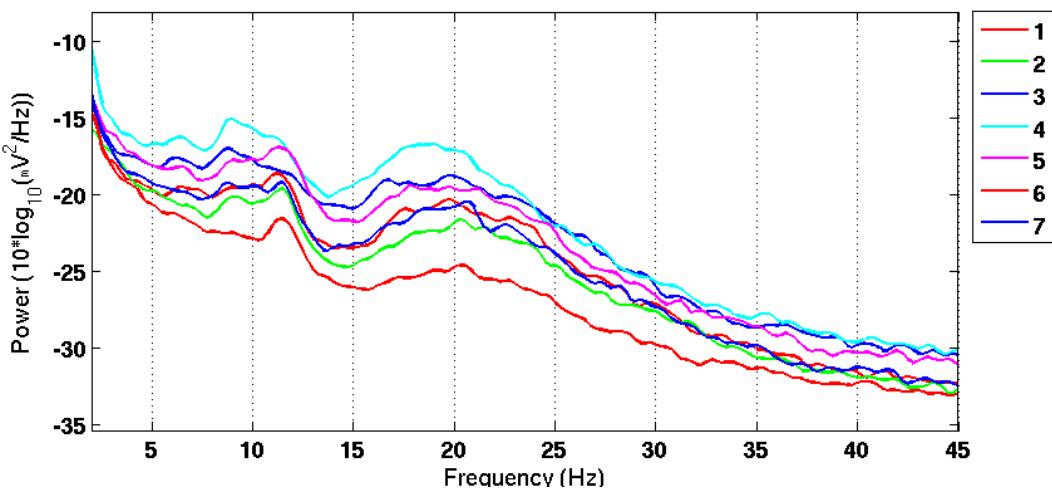


Results (Cluster 13 within subject)

63.64% Sessions contribute

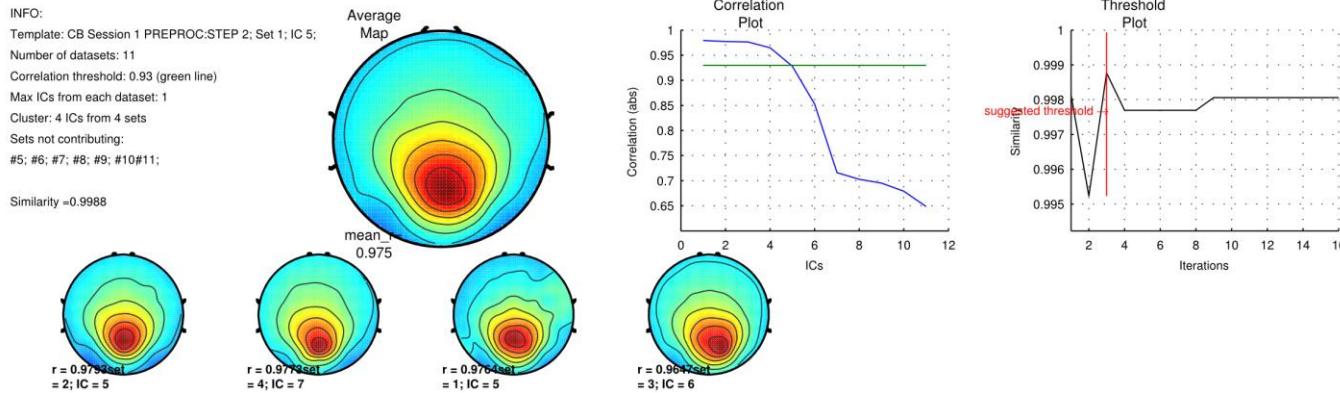


Cl 13 Spectrum

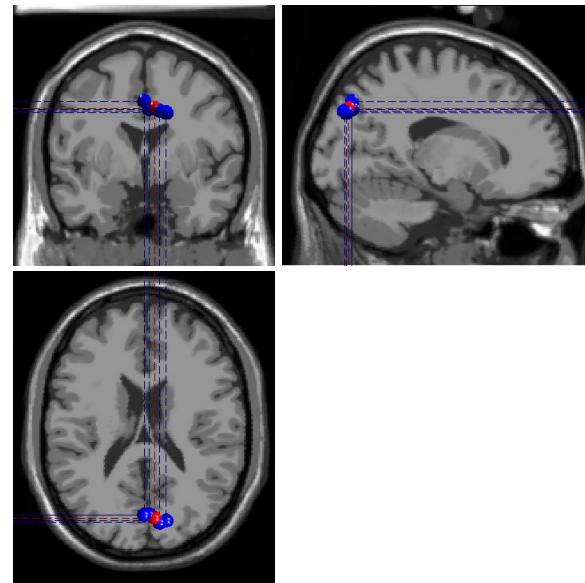
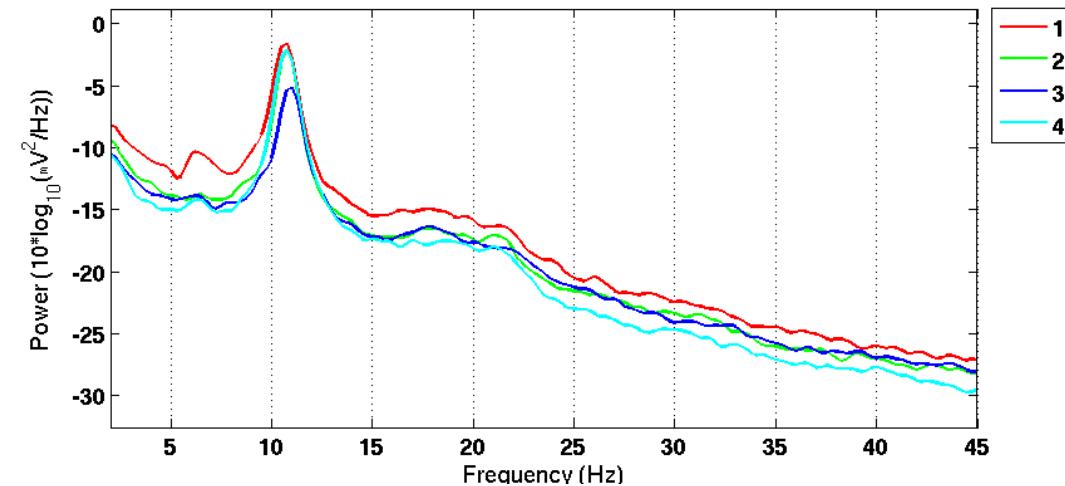


Results (Cluster 14 within subject)

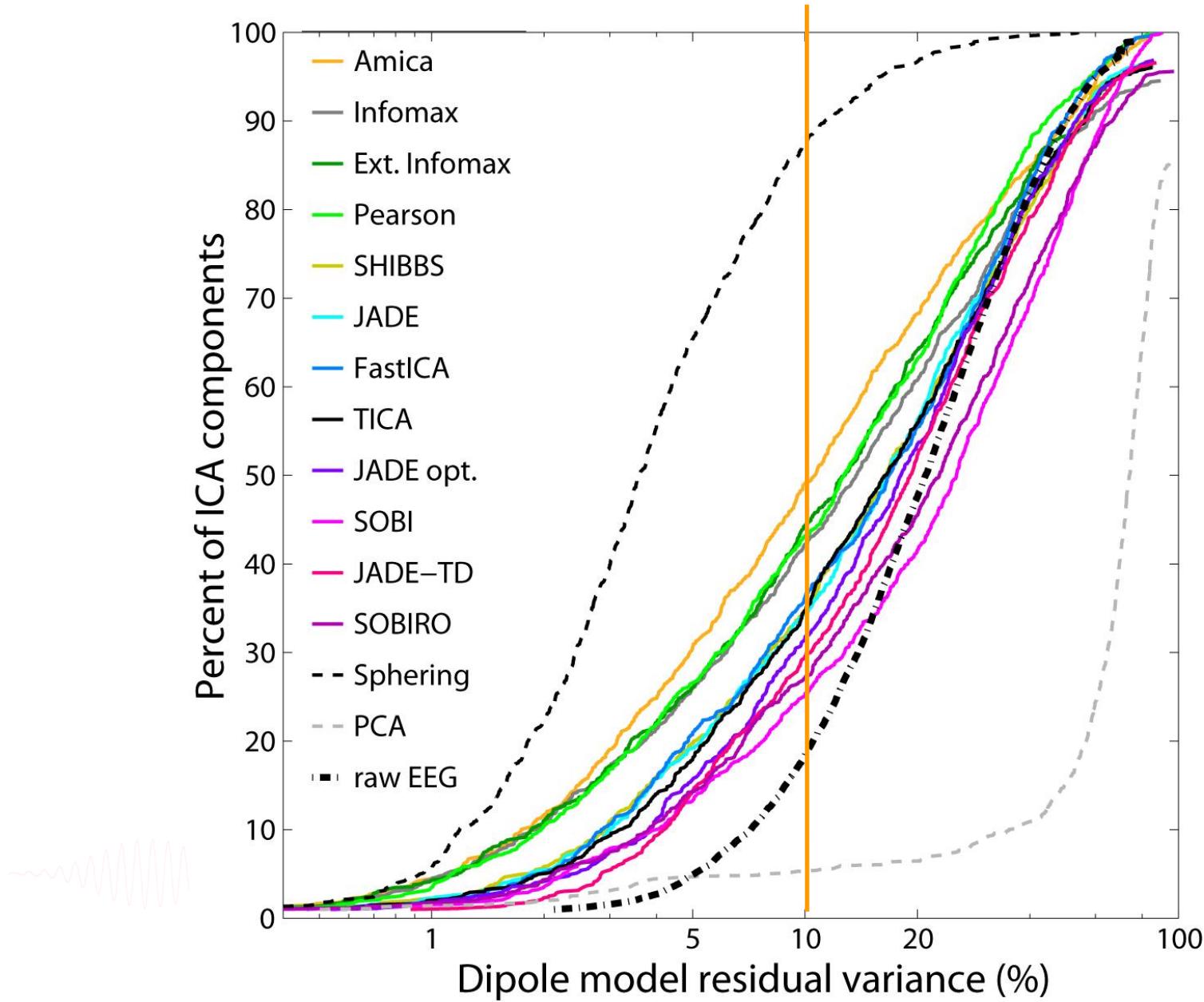
36.36% Sessions contribute



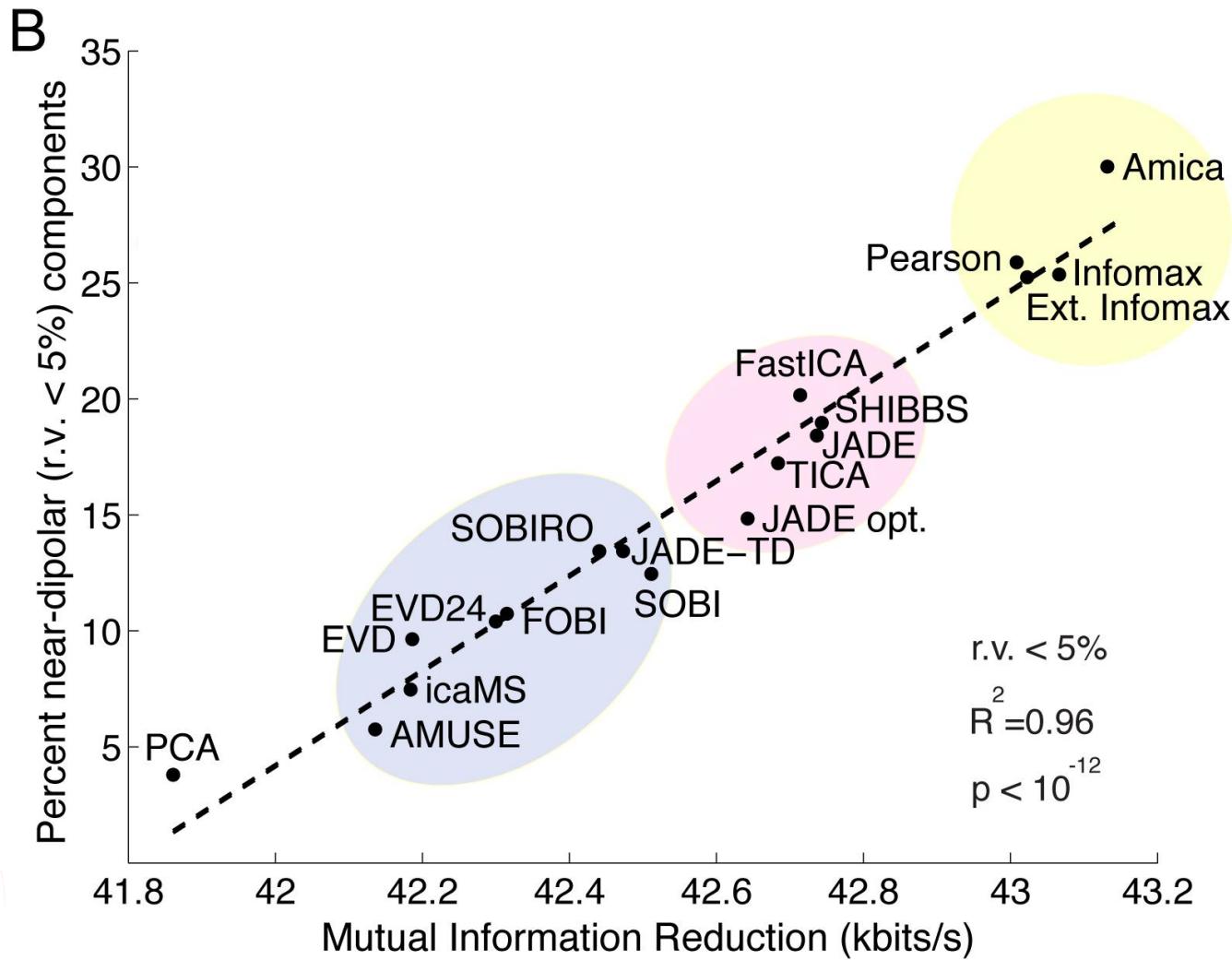
Cl 14 Spectrum

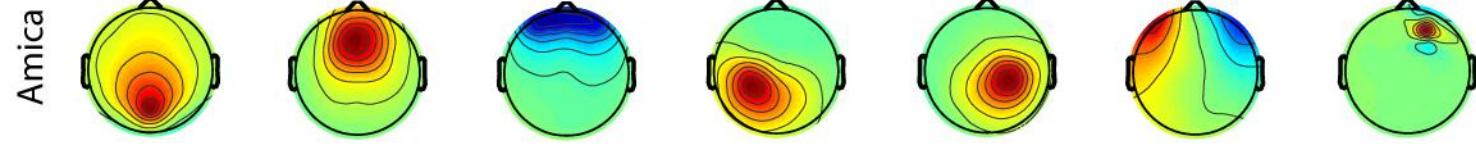
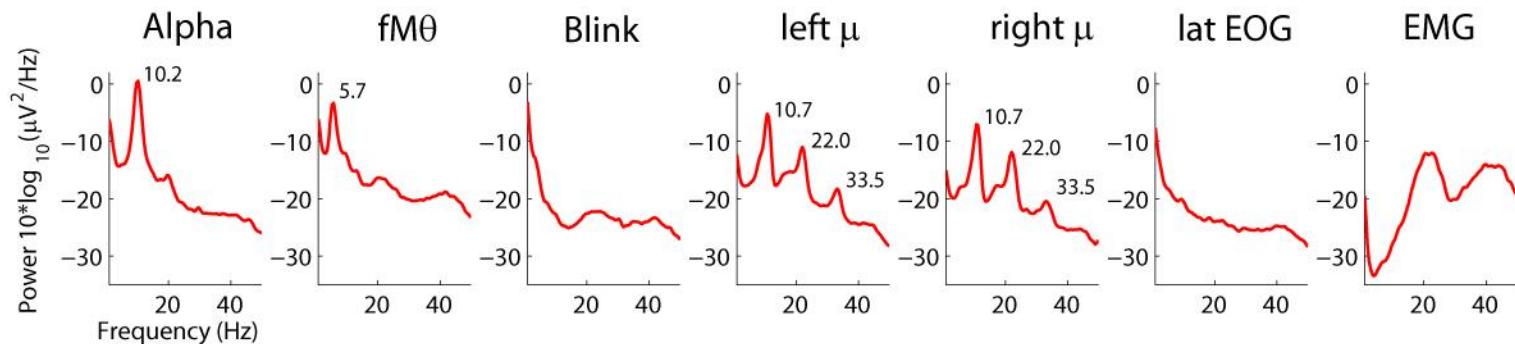


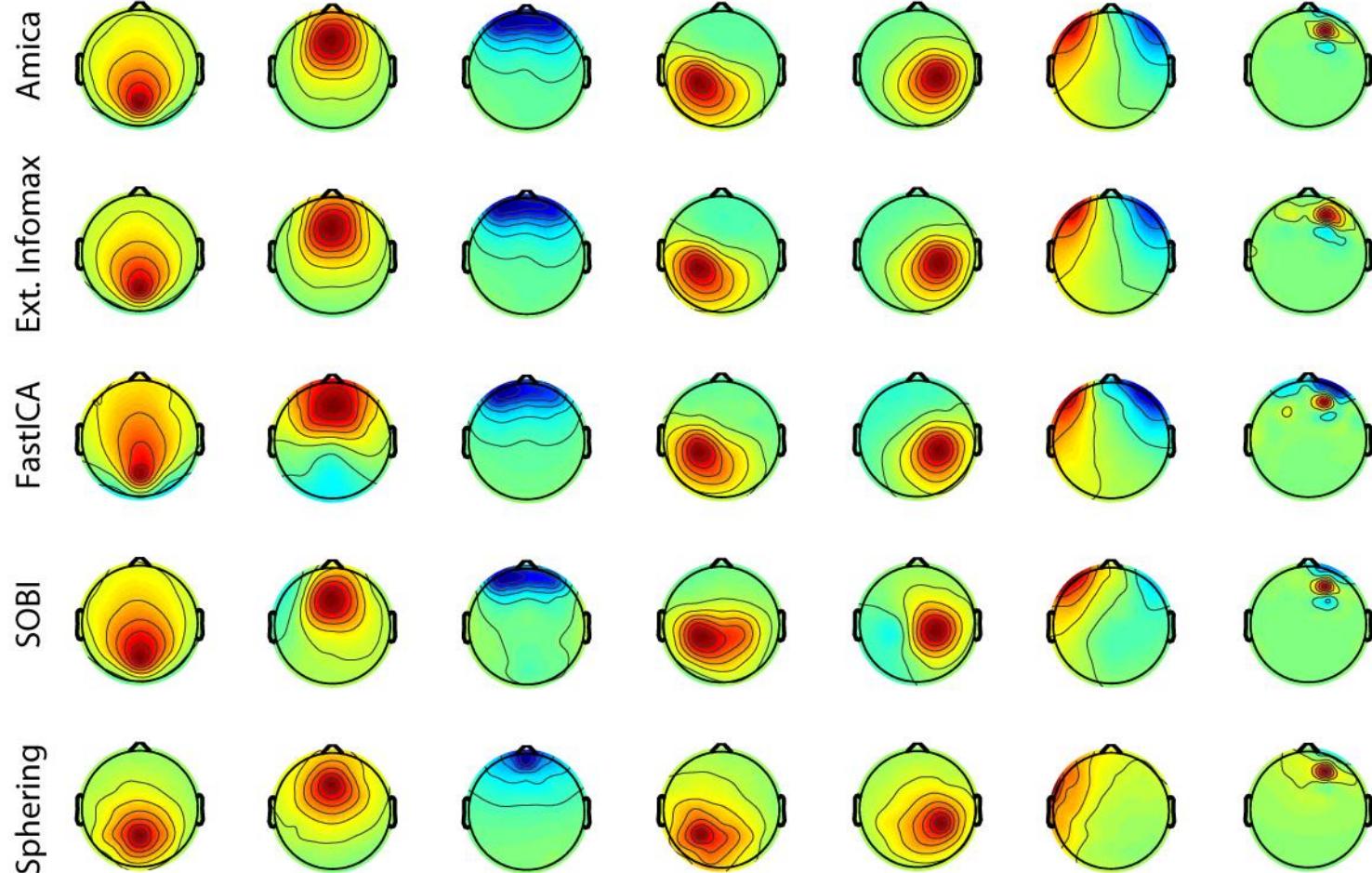
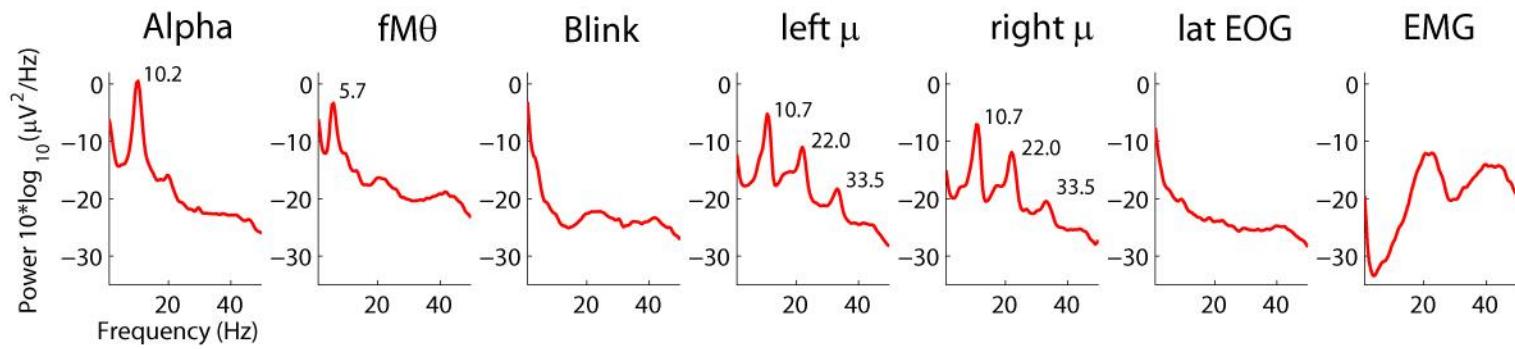
Number of components with residual variance lower than a specific threshold



More independence -> more biological components

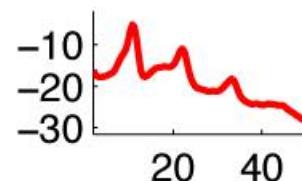




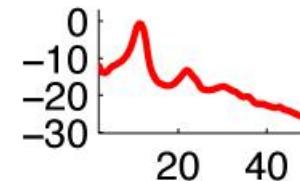
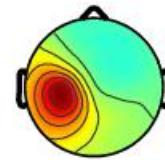


Left μ cluster (across subjects)

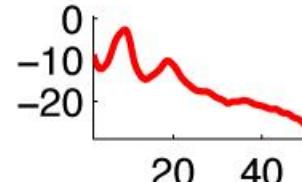
S2 IC47



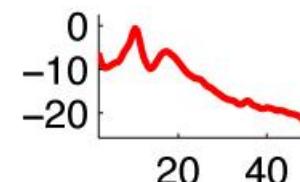
S3 IC47



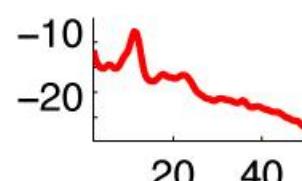
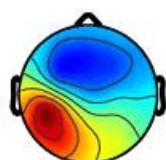
S4 IC37



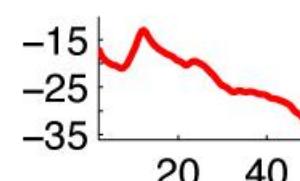
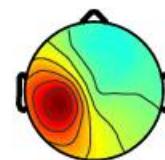
S5 IC48



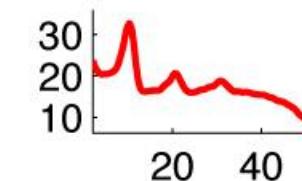
S6 IC46



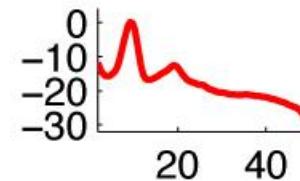
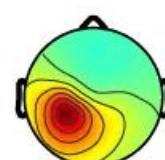
S7 IC35



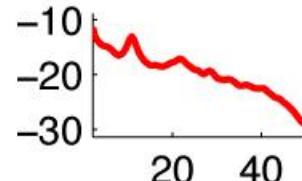
S9 IC7



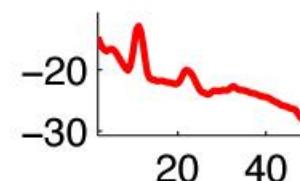
S11 IC45



S12 IC45

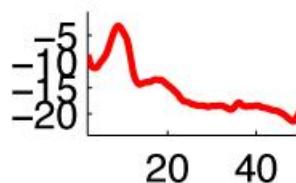


S14 IC45

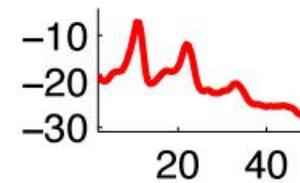


Right μ cluster

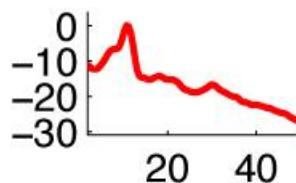
S1 IC51



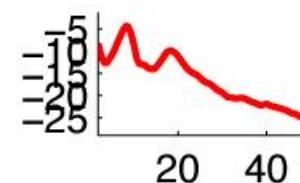
S2 IC41



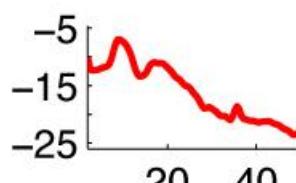
S3 IC41



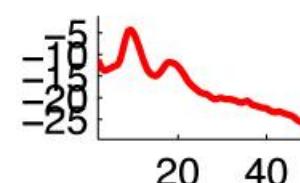
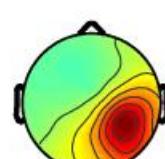
S4 IC50



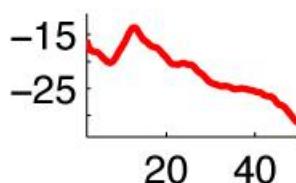
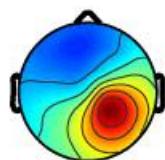
S5 IC51



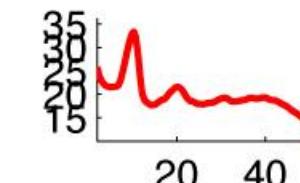
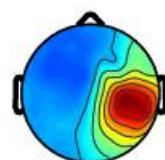
S6 IC 6^0



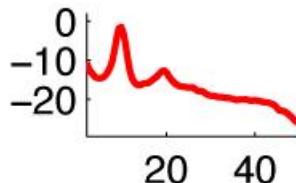
S7 IC48



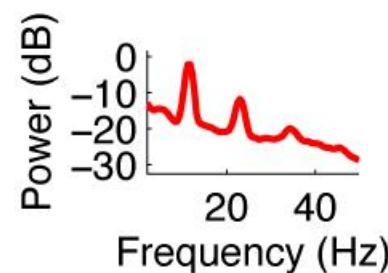
S9 IC39



S11 IC49

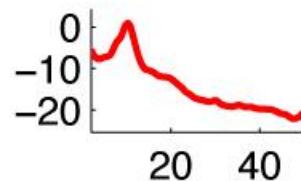


S14 IC49

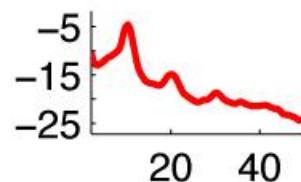


Occipital α cluster

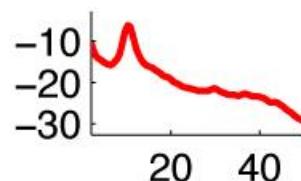
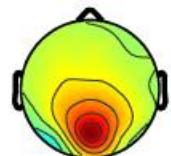
S1 IC67



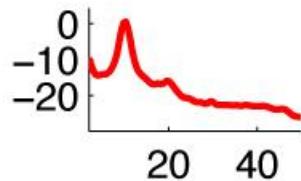
S3 IC51



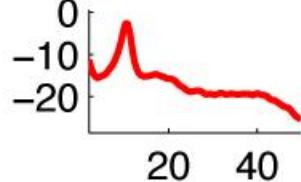
S12 IC3⁸



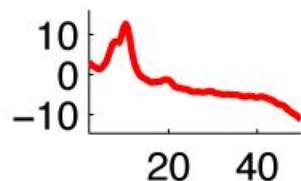
S2 IC67



S11 IC65

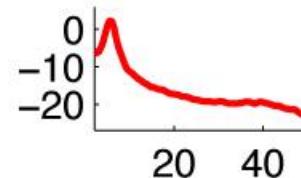


S13 IC65

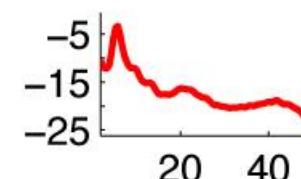


Frontal Midline θ cluster

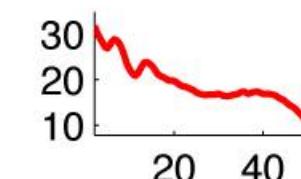
S1 IC63



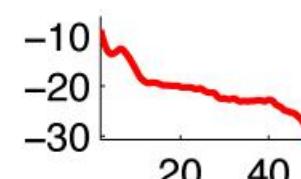
S2 IC18



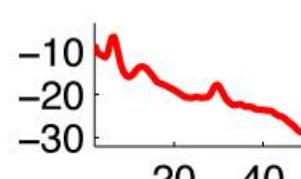
S9 IC16



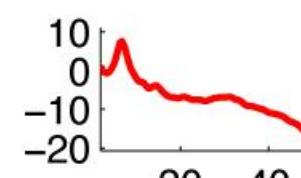
S11 IC16



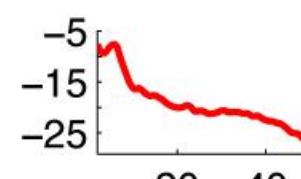
S12 IC15



S13 IC15



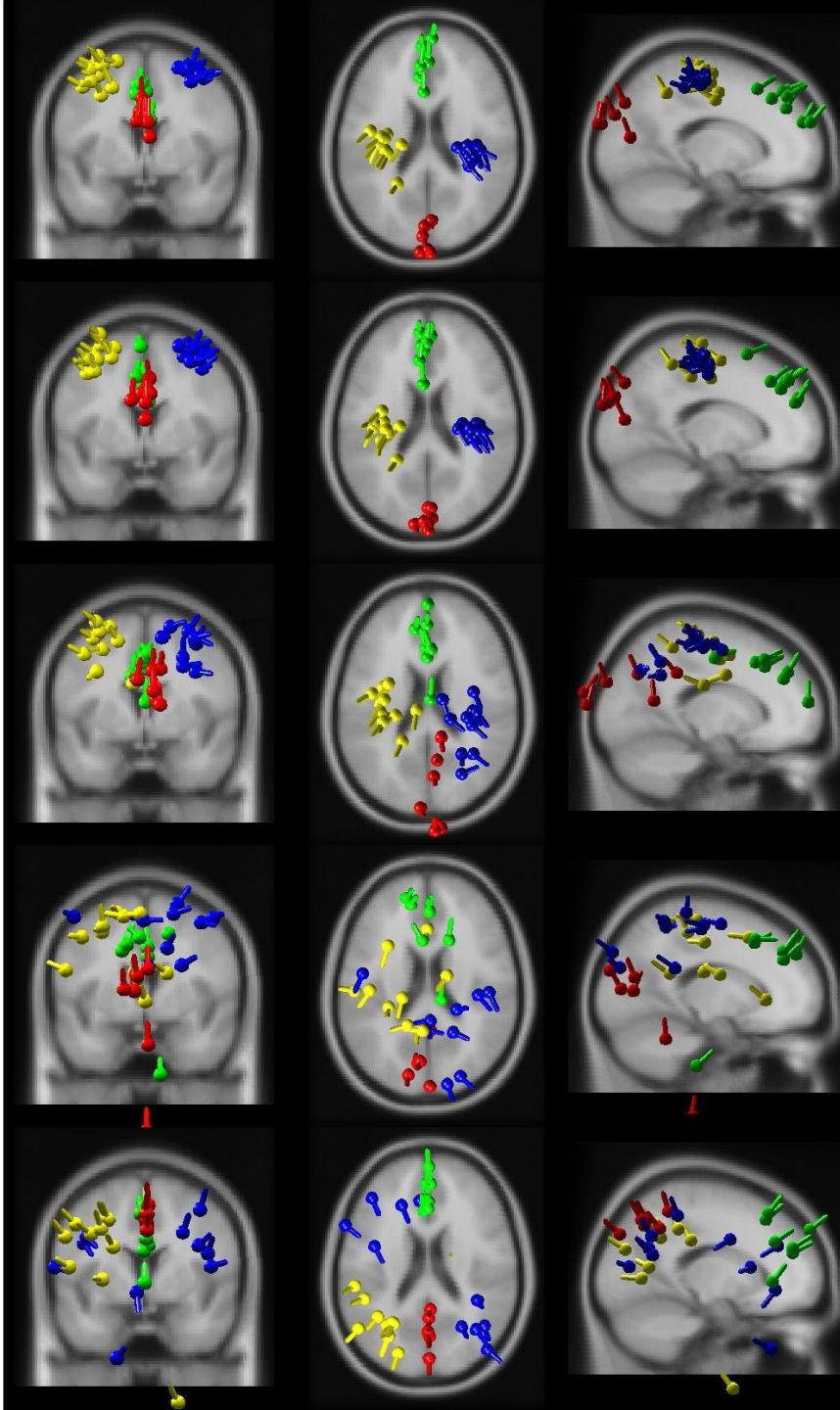
S14 IC16





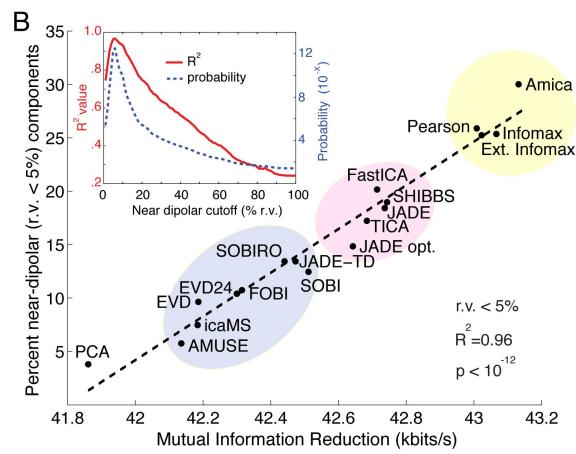
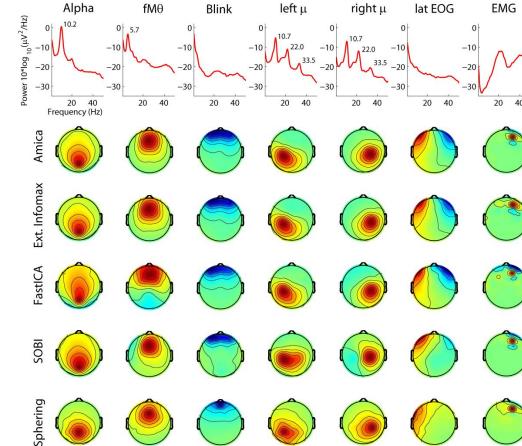
Sphering

SOBI FASTICA Ext. Infomax AMICA



ICA reliability across subjects

- Different ICA algorithms return similar solutions
- The ICA algorithms that return the most biologically plausible solutions are also the one that return the most independent decompositions



View and edit clusters

The screenshot shows the EEGLAB v15.x (dev) application window. The title bar reads "EEGLAB v15.x (dev)". The menu bar includes "File", "Edit", "Tools", "Plot", "Study" (which is highlighted in blue), "Datasets", and "Help". A sub-menu for "Study" is displayed, containing the following items:

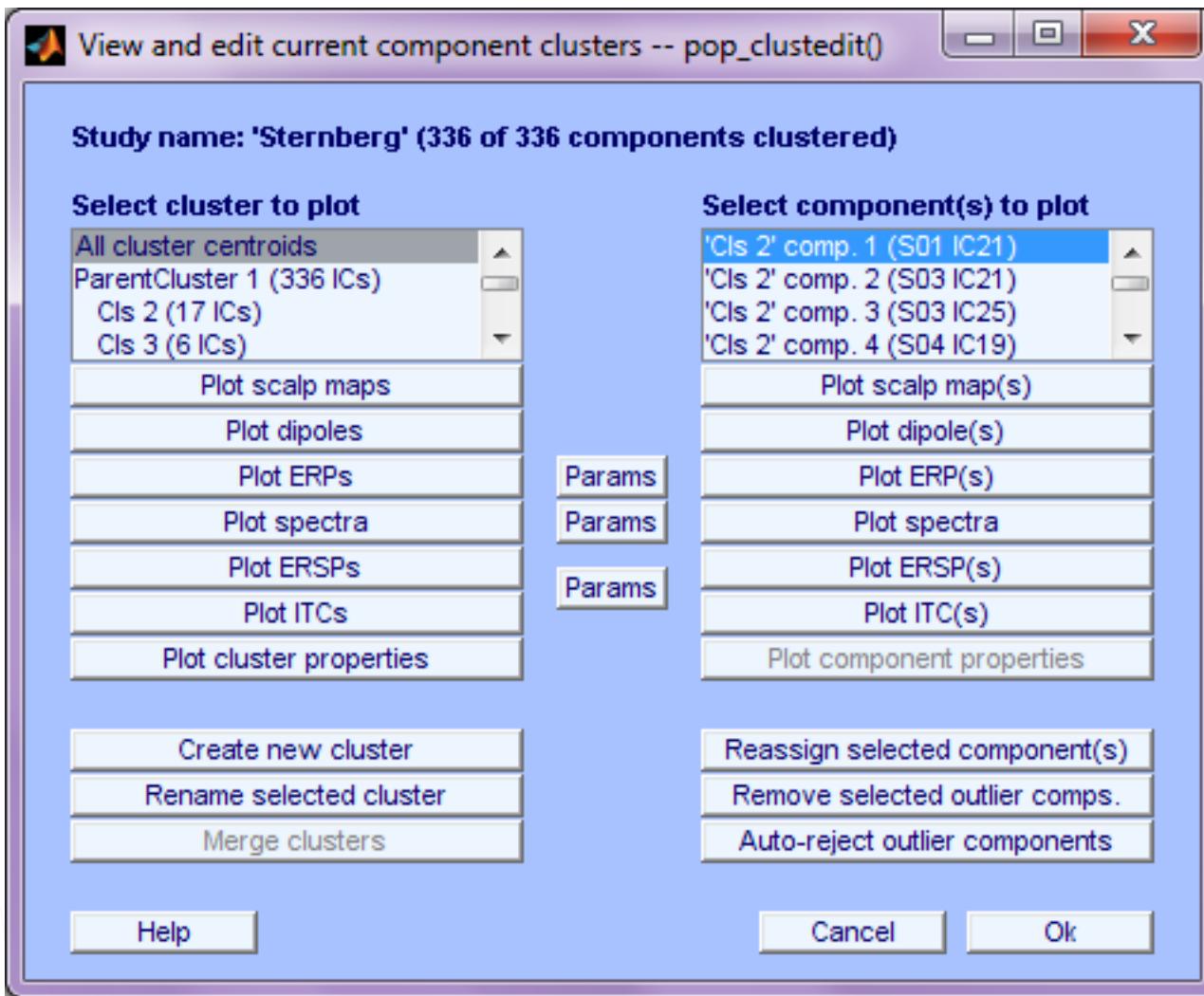
- Edit study info
- Select/Edit study design(s)
- Precompute channel measures
- Plot channel measures
- Precompute component measures
- PCA clustering (original) ►
- Edit/plot clusters** (this item is highlighted with a blue background)

To the left of the sub-menu, there is a sidebar titled "STUDY set: Sternbe" (partially visible). The sidebar lists various study parameters with their values:

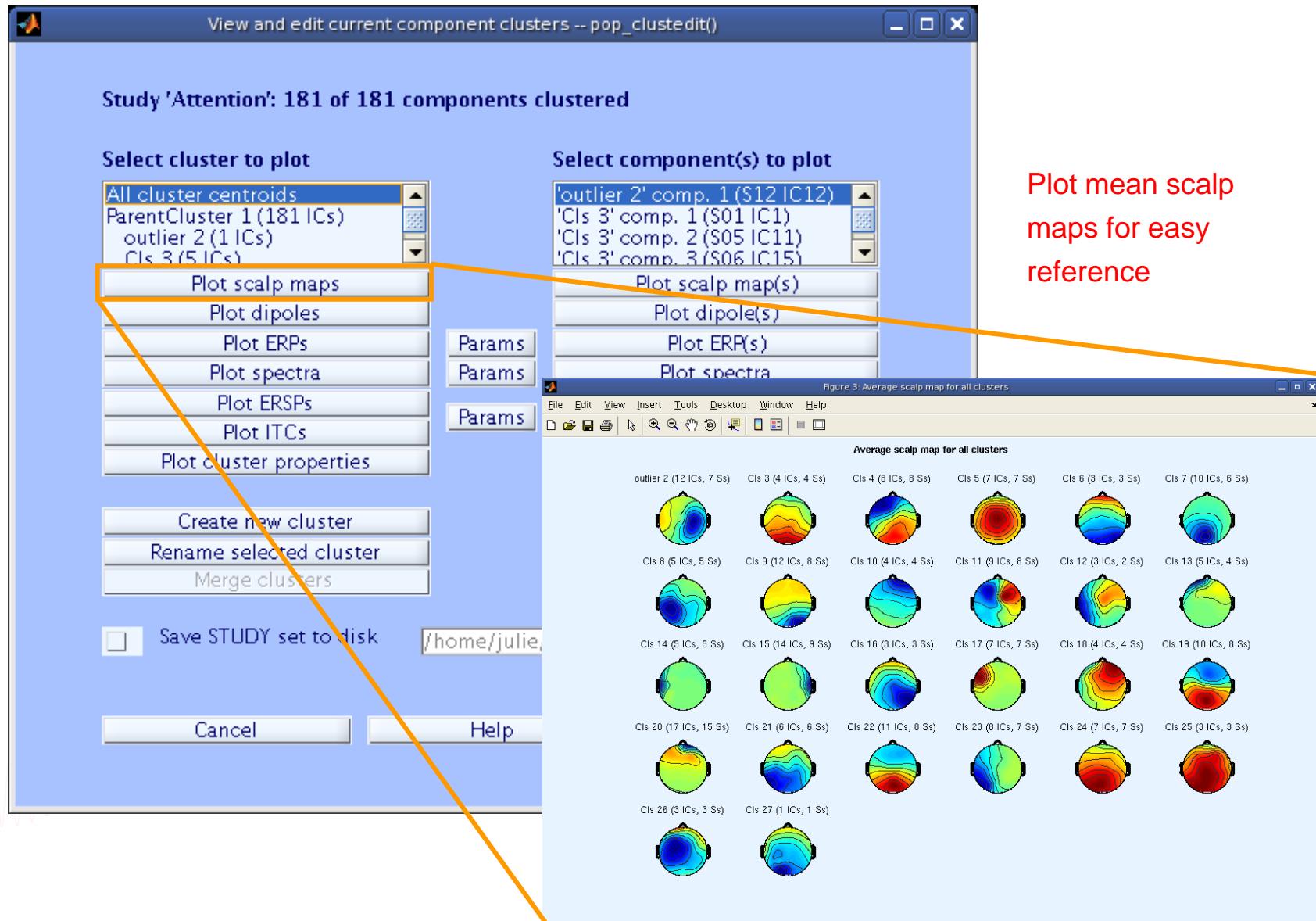
Study filename:	ves
Study task name:	69.70.71
Nb of subjects:	ves
Nb of conditions:	7
Nb of sessions:	Pre-clustered
Nb of groups:	229.3
Epoch consistency:	
Channels per frame:	
Channel locations:	
Clusters:	
Status:	
Total size (Mb):	



Plot/edit clusters



Plot cluster data



Plot cluster data

View and edit current component clusters -- pop_clustedit()

Study 'Attention': 181 of 181 components clustered

Choose which cluster

Select cluster to plot

- Cl 6 (3 ICs)
- Cl 7 (10 ICs)**
- Cl 8 (5 ICs)
- Cl 9 (12 ICs)

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

Save STUDY set to disk /home/julie/WorkshopSD2

Choose which components

Select component(s) to plot

- All components
- S01 IC6
- S05 IC9
- S06 IC12

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

Figure 4

File Edit View Insert Tools Desktop Window Help

Cl 21 (7 ICs, 7 Ss)

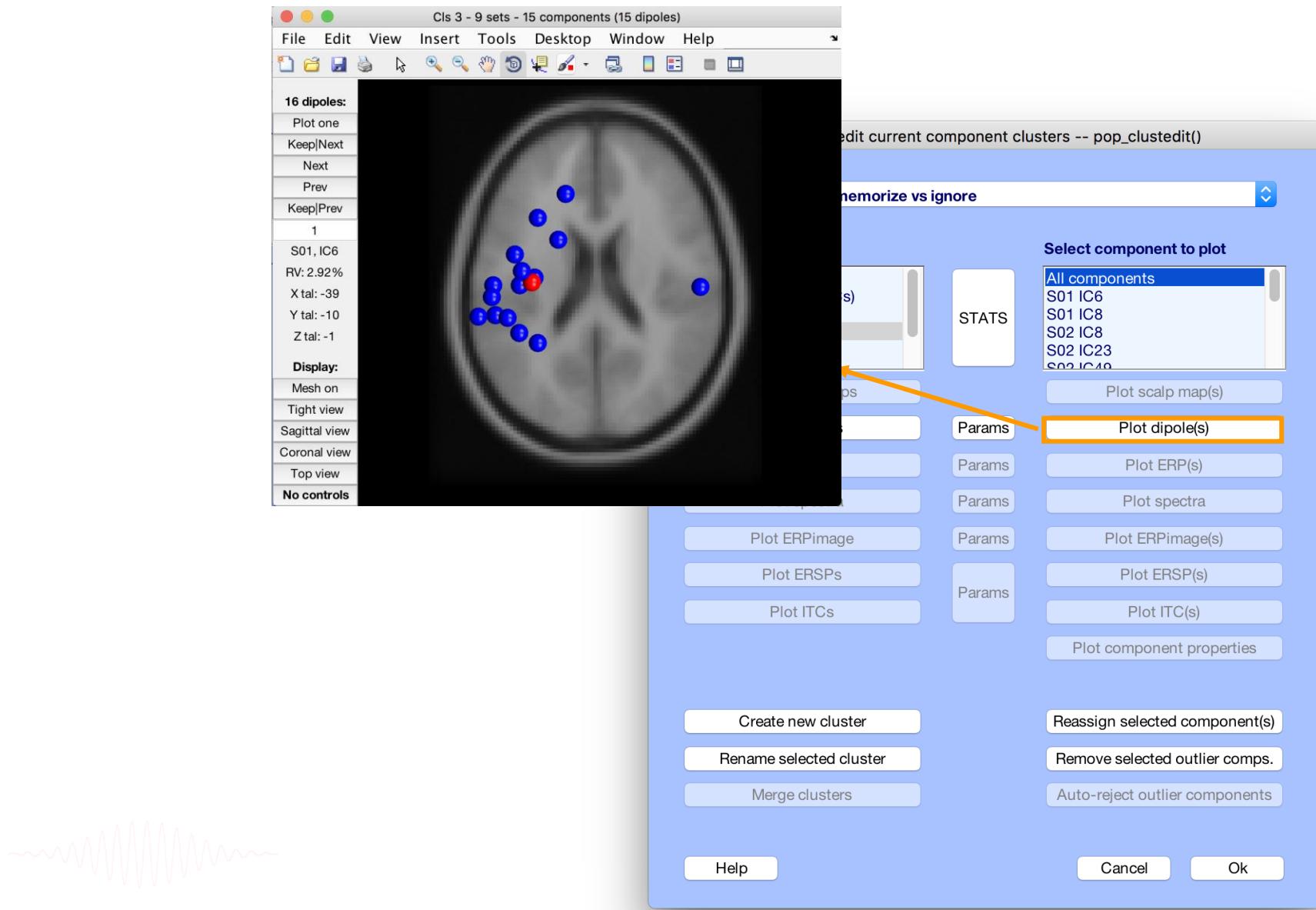
ic4/S01 ic11/S02

ic1/S06 ic1/S08

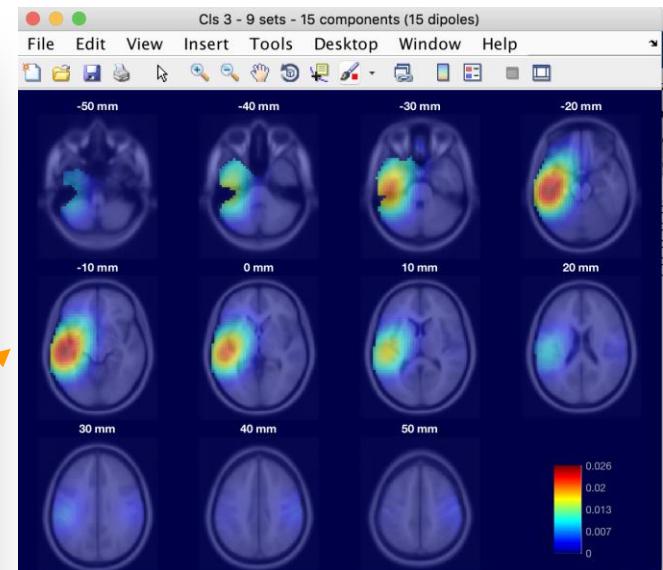
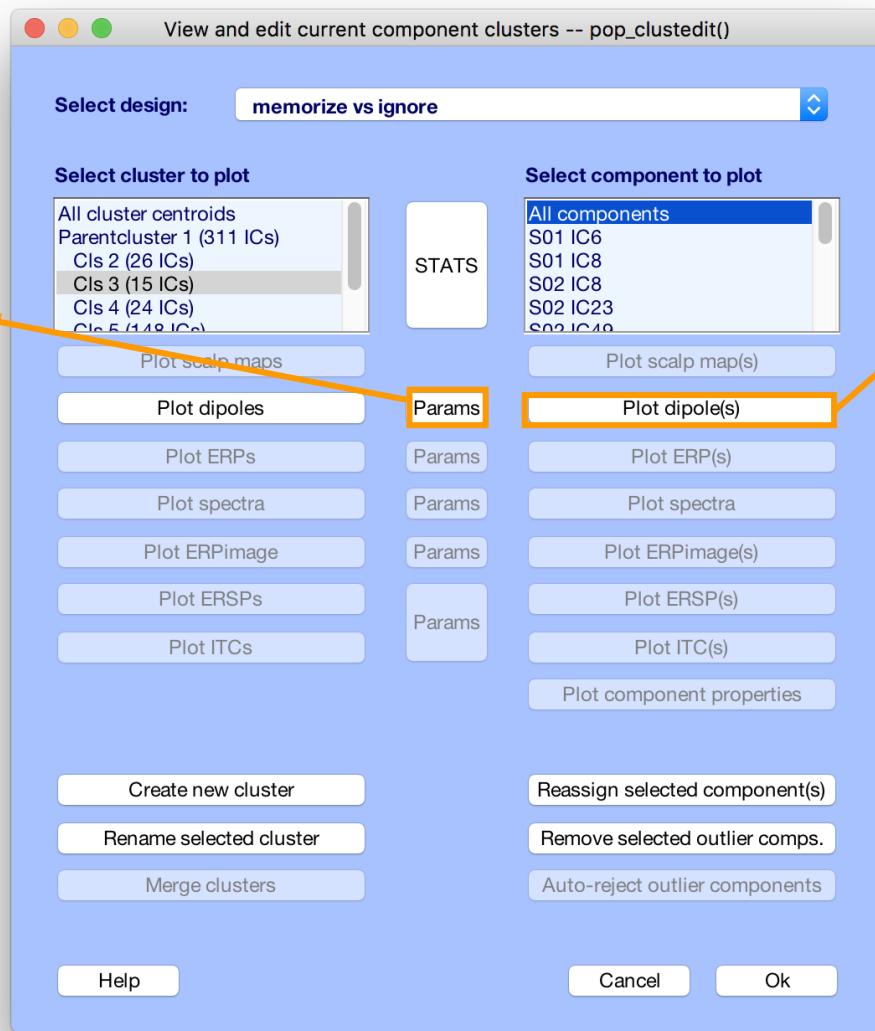
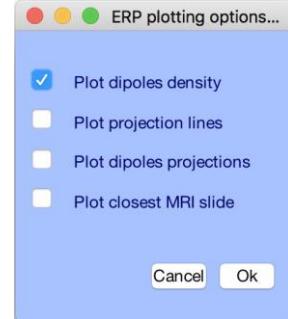
ic2/S10 ic6/S12 ic3/S15

Cancel Help

Plot cluster data

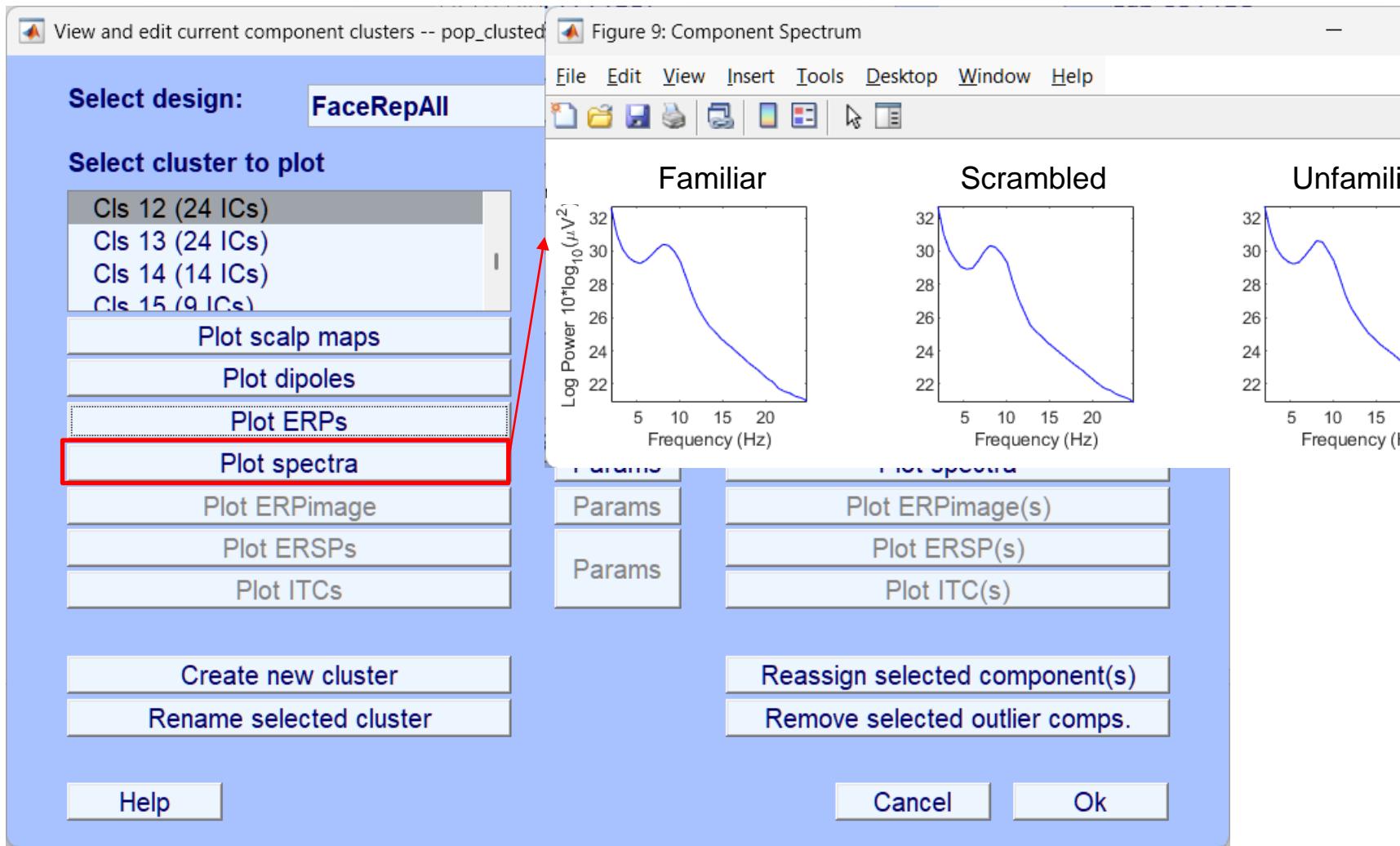


Plot cluster data



Plot cluster data



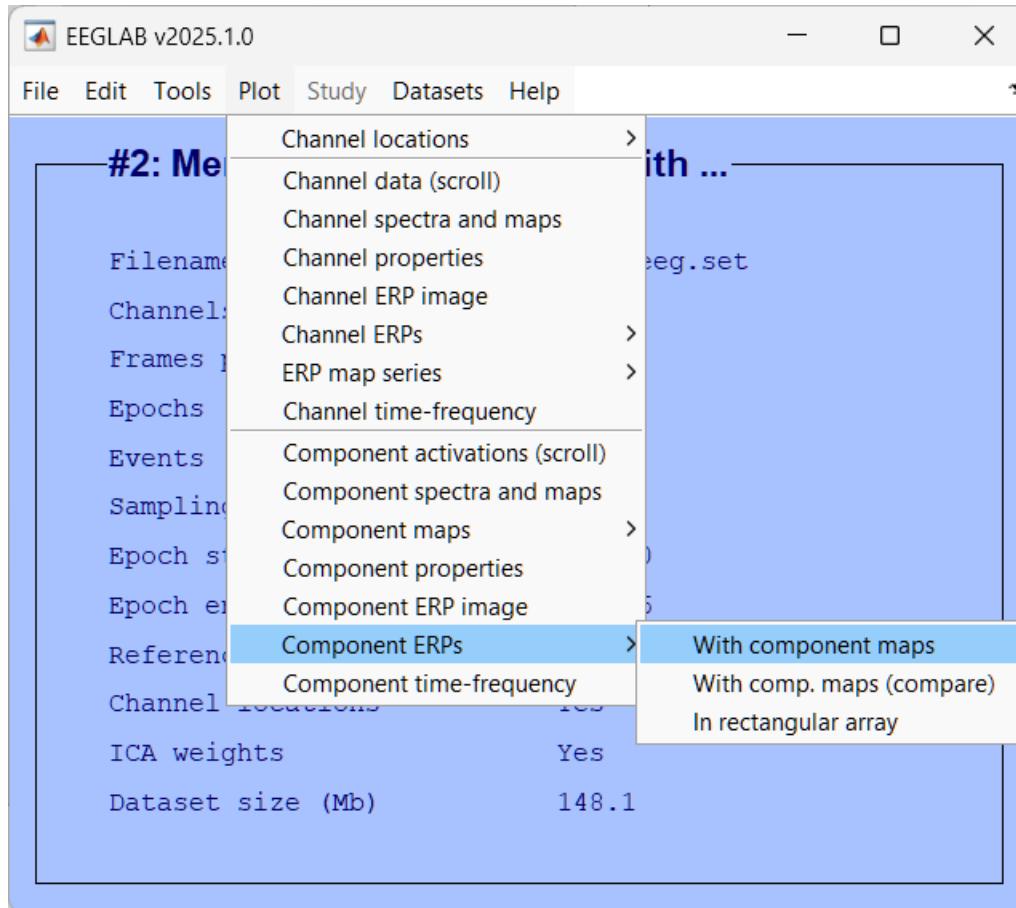


Exercise

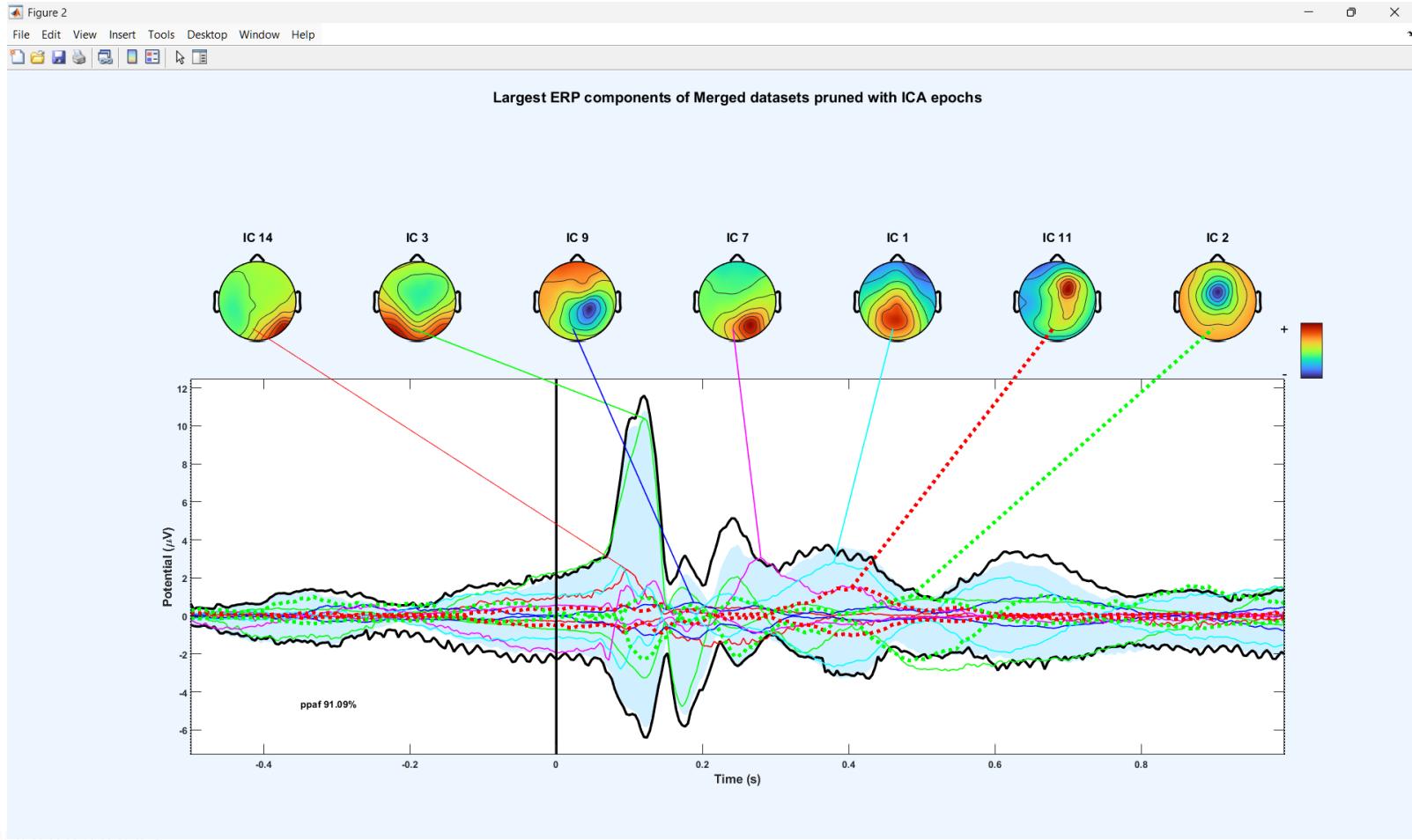
- Load the STUDY Face_detection.study
- Precompute **spectrum** for components, scalp topo.
- Precluster and cluster components using **dipole locations** and **dipole moments** (KMean)
- Look at your clusters. Identify frontal midline theta cluster(s) and occipital alpha cluster(s)
- Look for a cluster generating a N170 and check dipoles location
- Remove outliers if any



IC contributions to ERP envelope



IC contributions to ERP envelope



Exercise

- Display IC contribution to ERP for a selected subject



Update BIDS plugin



Create a STUDY from a BIDS folder

