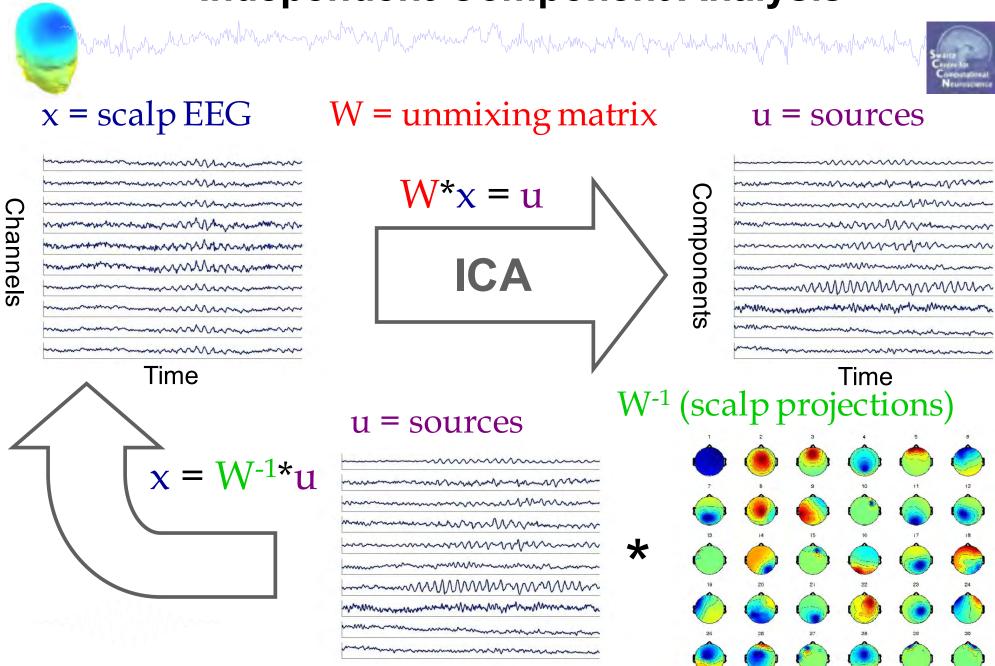


Evaluating ICA Components

EEGLAB Workshop XX Sheffield, England Day 1, 11:45-12:30



Independent Component Analysis



Review: ICA in Plain English

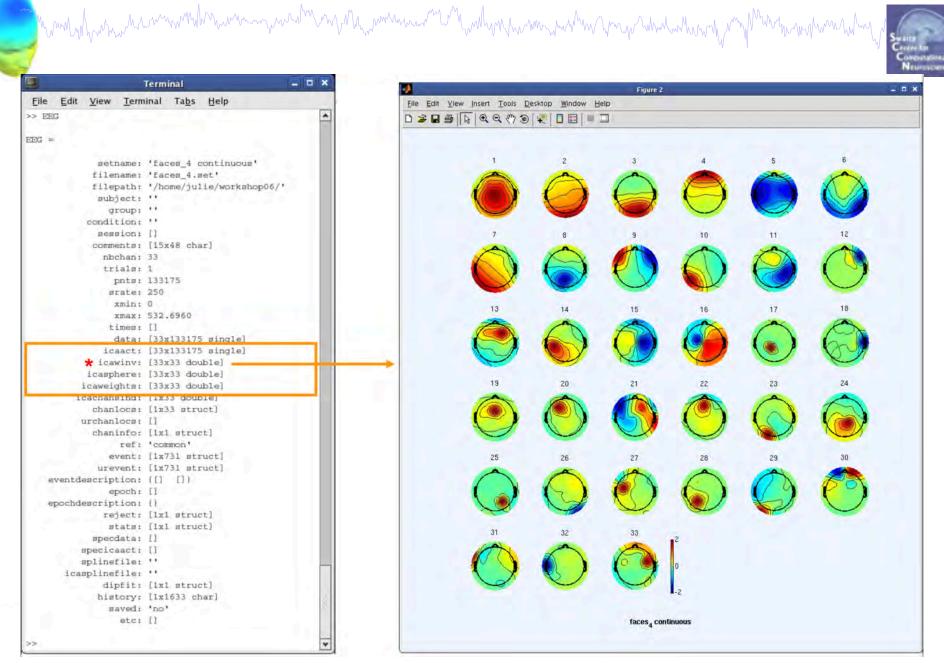


Source activation = unmixing * Channel data

Channel data = mixing (topo) * Source activation



Results of ICA Decomposition in EEG struct



English → MATLAB





Source activation = unmixing * Channel data

Channel data = mixing (topo) * Source activation

```
EEG.icaact = (EEG.icaweights*EEG.icasphere) * EEG.data
         EEG.data = EEG.icawinv * EEG.icaact
```



Now what...?



Part 1

Getting an overview of your ICs

Part 2

Classifying/Evaluating ICs

Part 3

Detailed look at IC properties

ERP

Spectrum

ERP images

ERSP





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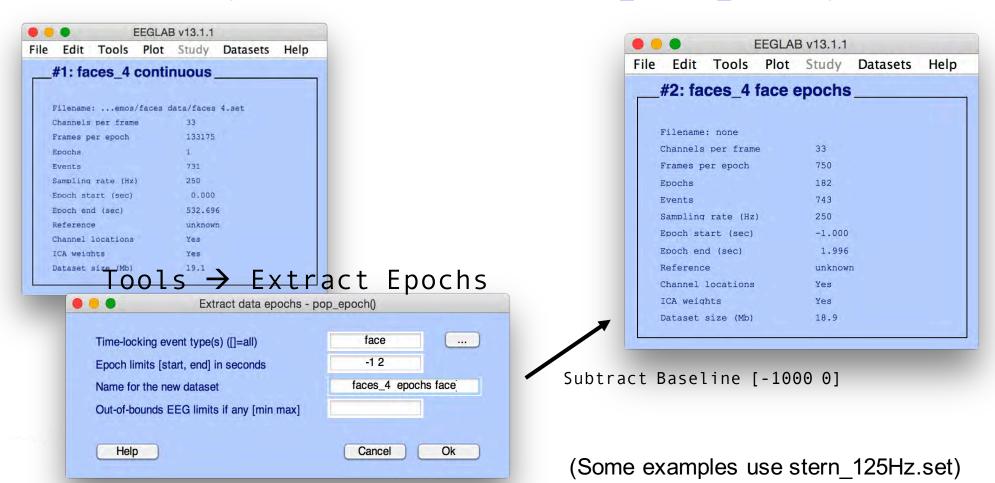
(Example Datasets)



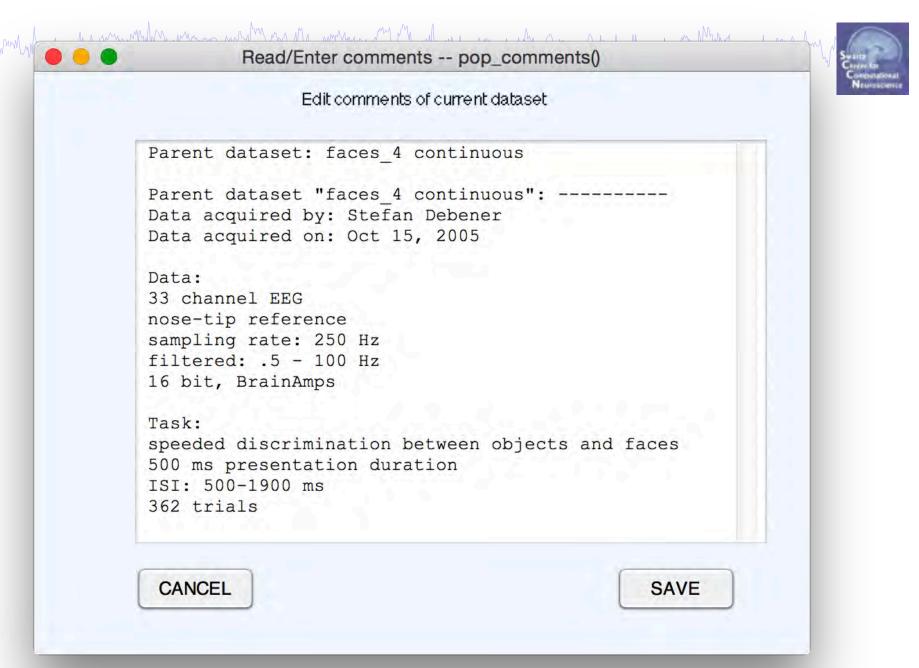


/faces continuous/faces_4.set

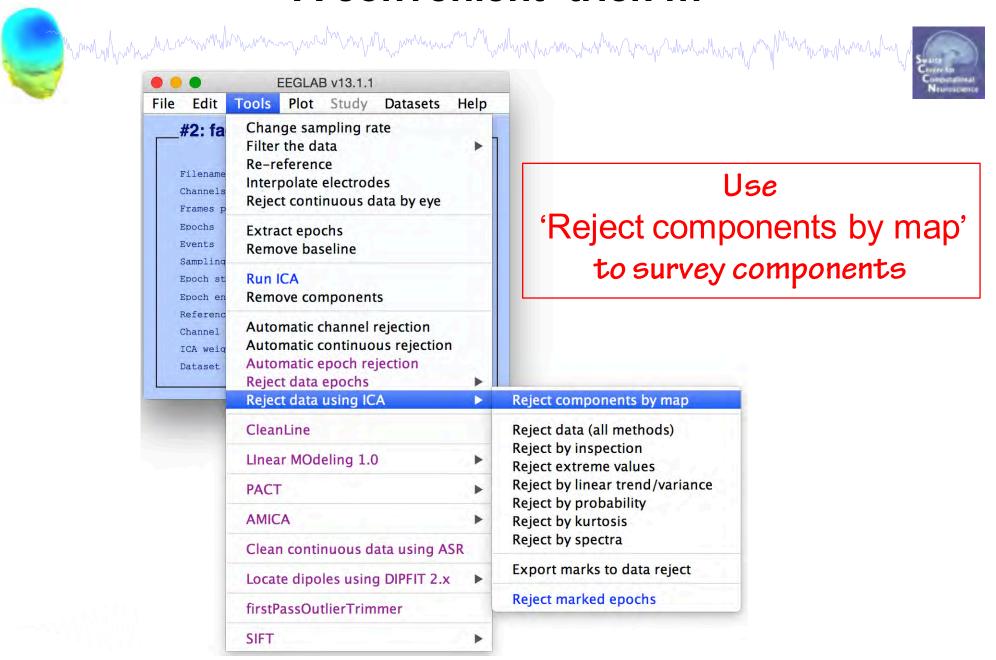
ftp://sccn.ucsd.edu/pub/julie/EEGLAB_Workshop/FacesData.zip
Linked from: http://sccn.ucsd.edu/wiki/Online_EEGLAB_Workshop



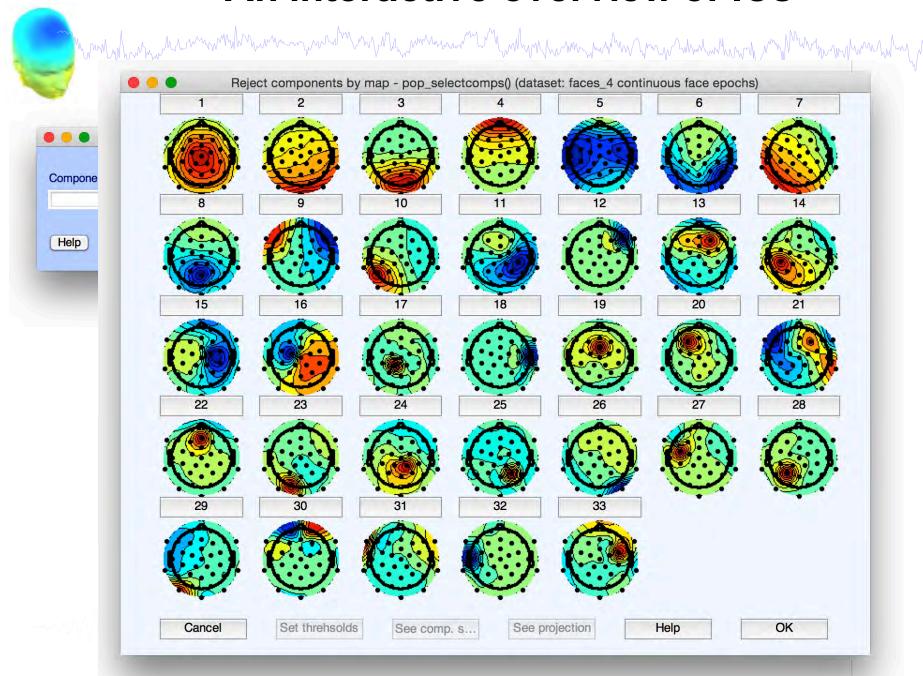
Edit → Dataset Info → Enter Comments



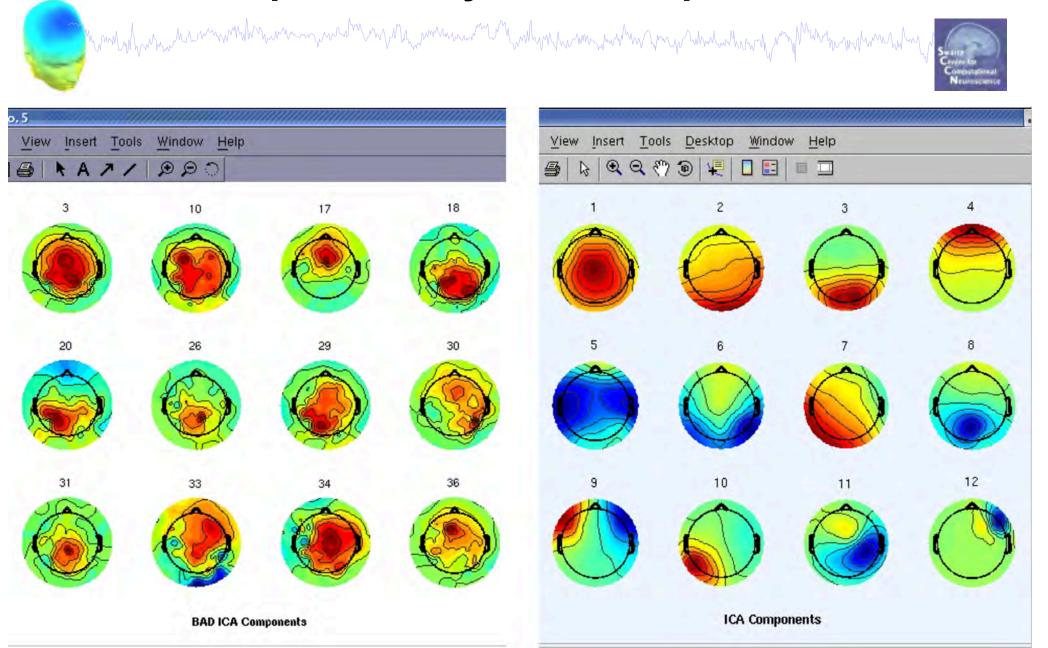
A convenient 'trick'...



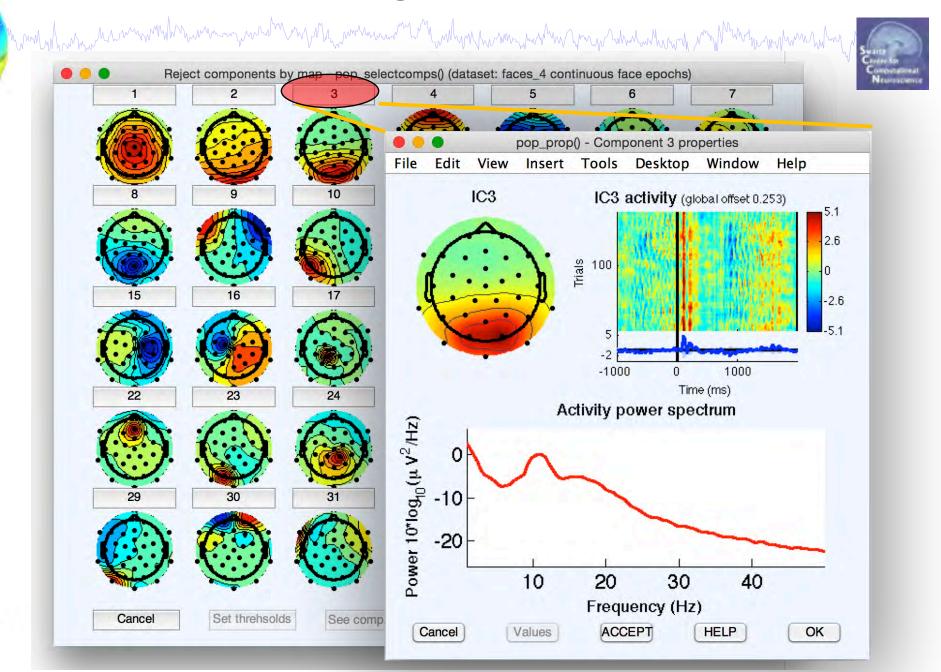
An interactive overview of ICs

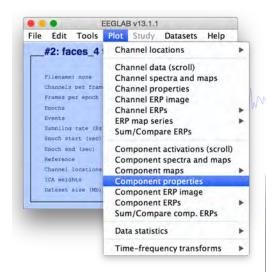


Step 0: Quality of Decomposition



Examining IC Properties



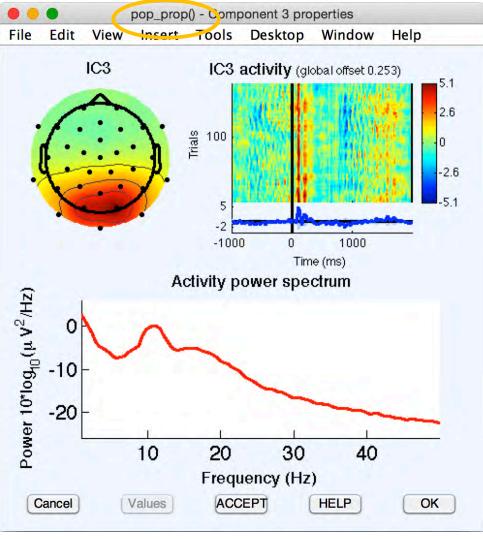


IC Topography topoplot()

IC Properties

Manner of the second se

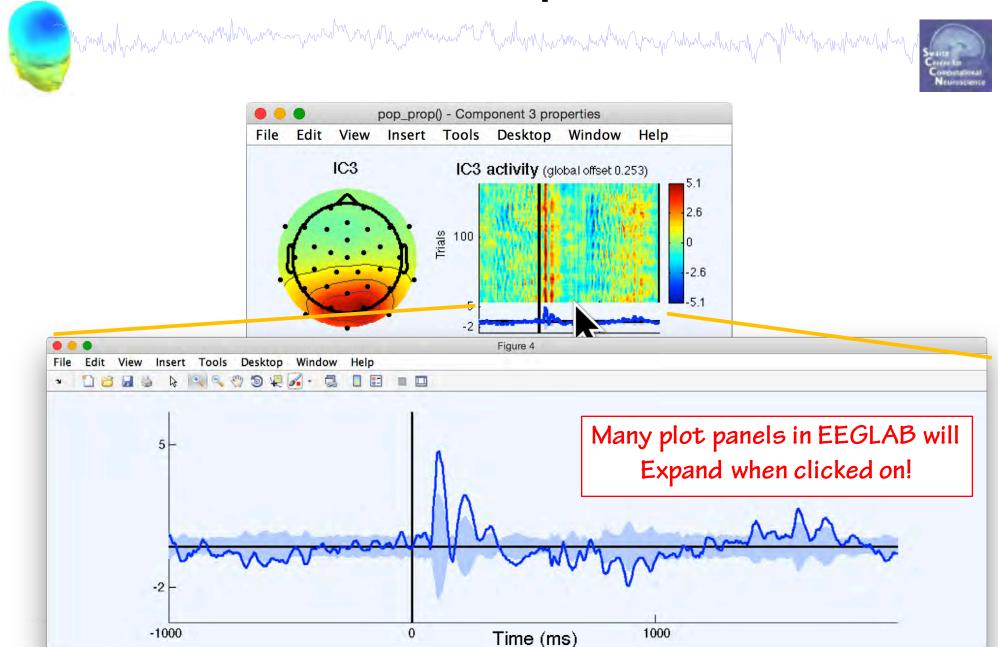




ERP Image & ERP erpimage()

Power Spectrum spectopo()

Click to expand...





Part 1

Getting an overview of your ICs

Part 2

Classifying/Evaluating ICs

Eye Artifacts

Muscle Artifacts

Other Artifacts

Brain ICs

Part 3

Detailed look at IC properties

FRP

Spectrum

ERP images

ERSP



Evaluating ICs





Over time, most EEGLAB users develop a heuristic sense of which ICs might be brain vs. artifact.

Heuristics are generally based on:

Topography

Component Activities (scroll)

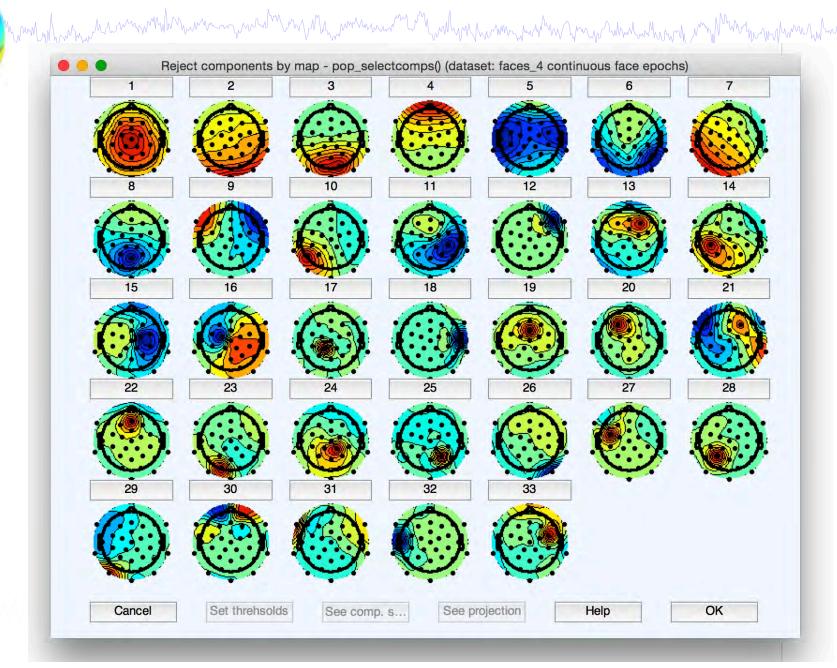
ERP

Power Spectrum

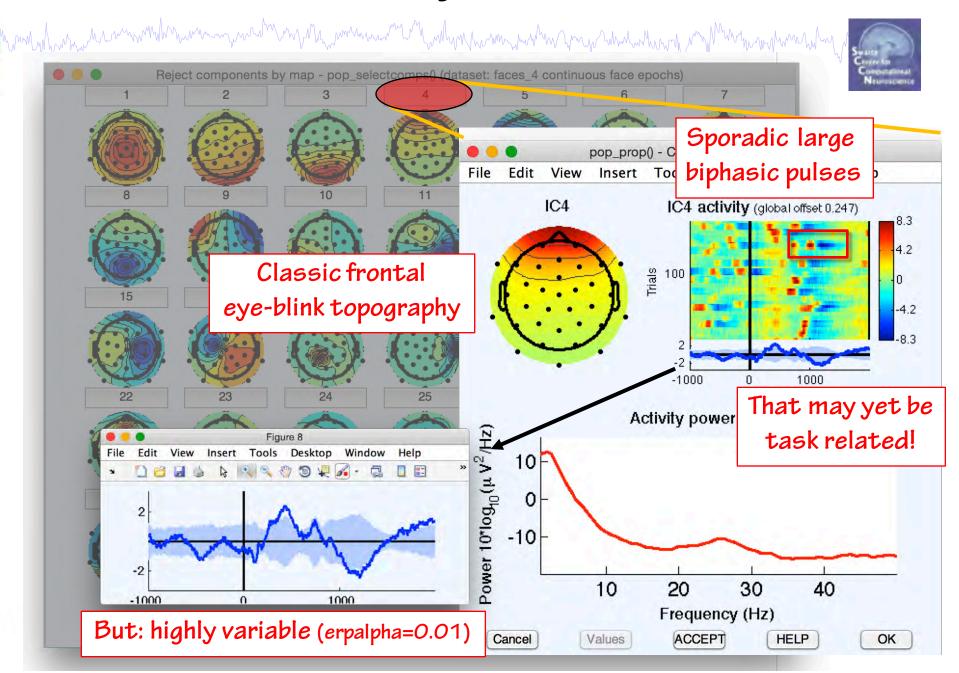
IC Classification is typically used to 'clean' data—study likely brain activity without artifacts

There are some efforts to automate this process, but doing it by hand is a good place to start to build intuition

Topography



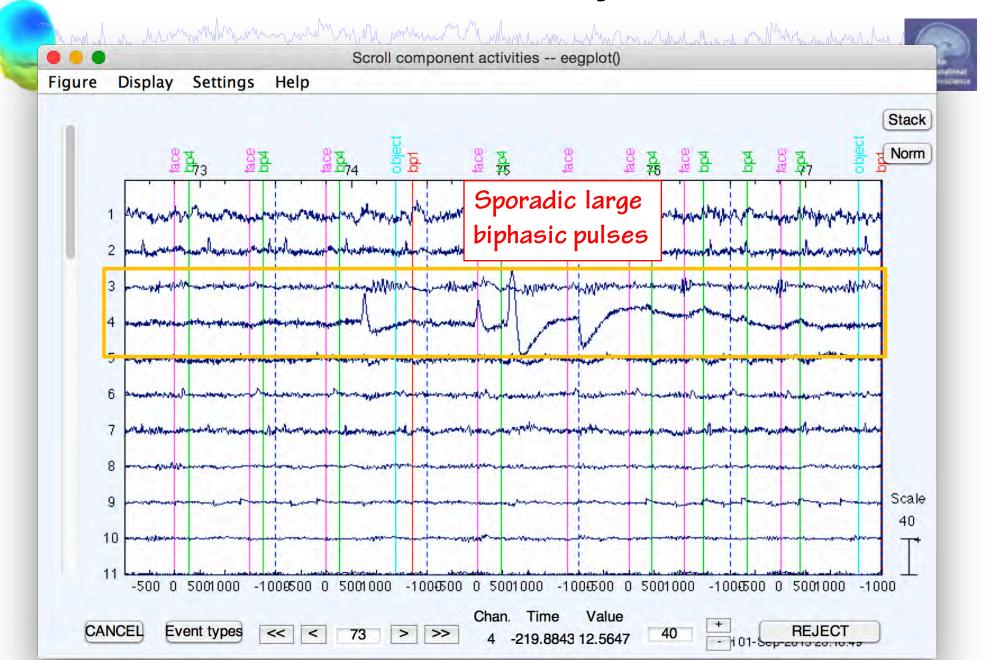
IC 4 – eyeblink



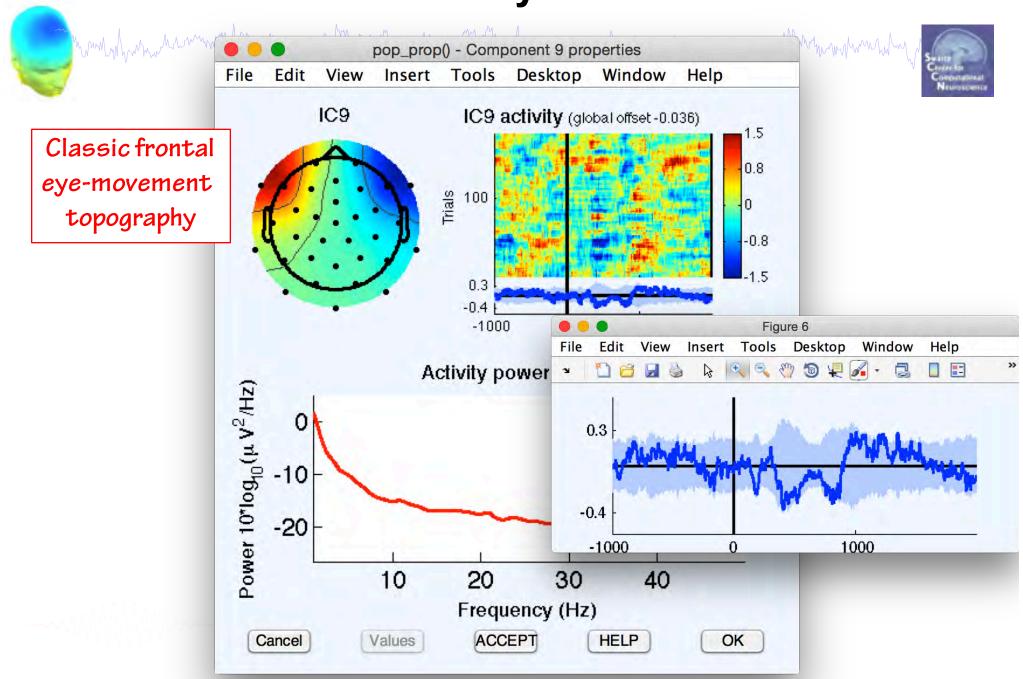
Plot → Component Activations (scroll)



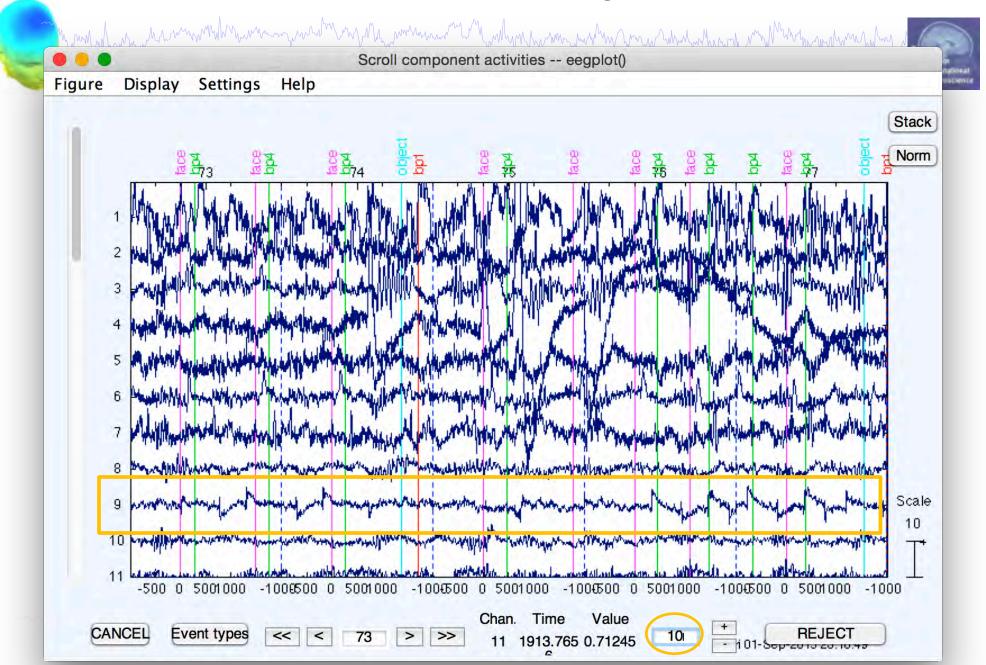
IC 4 Activation – eyeblink



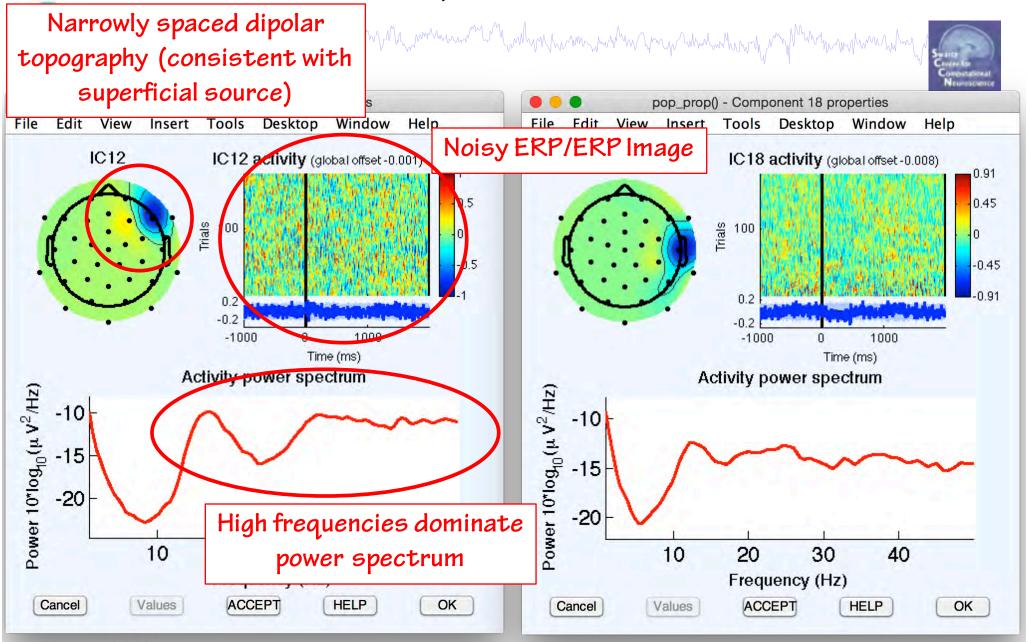
IC 9 – lateral eye movement



IC 9 Activation – lateral eye movement



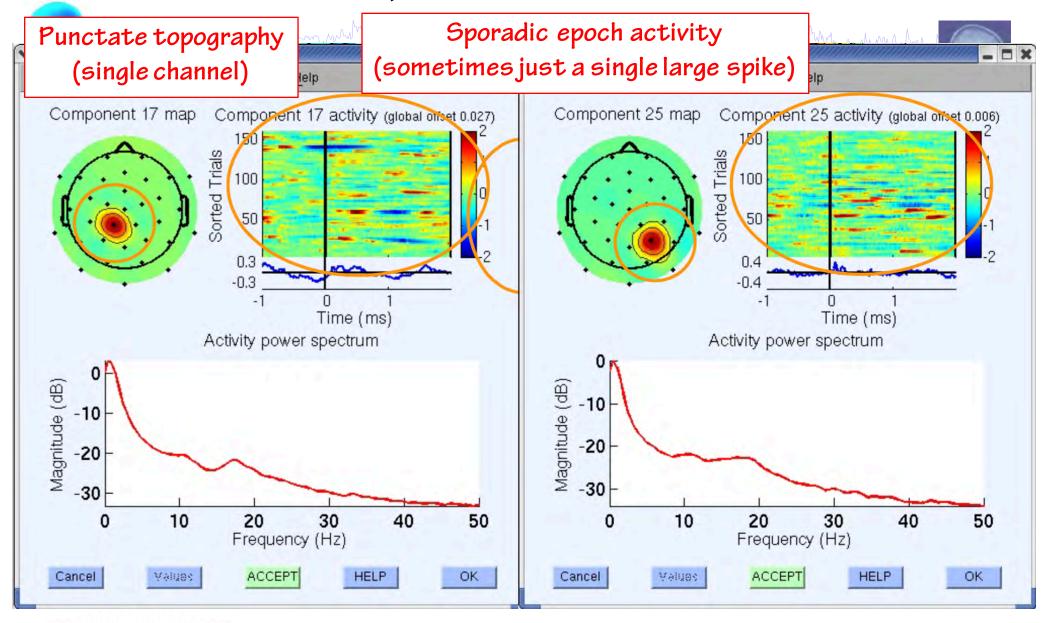
IC 12, 18 - Muscle



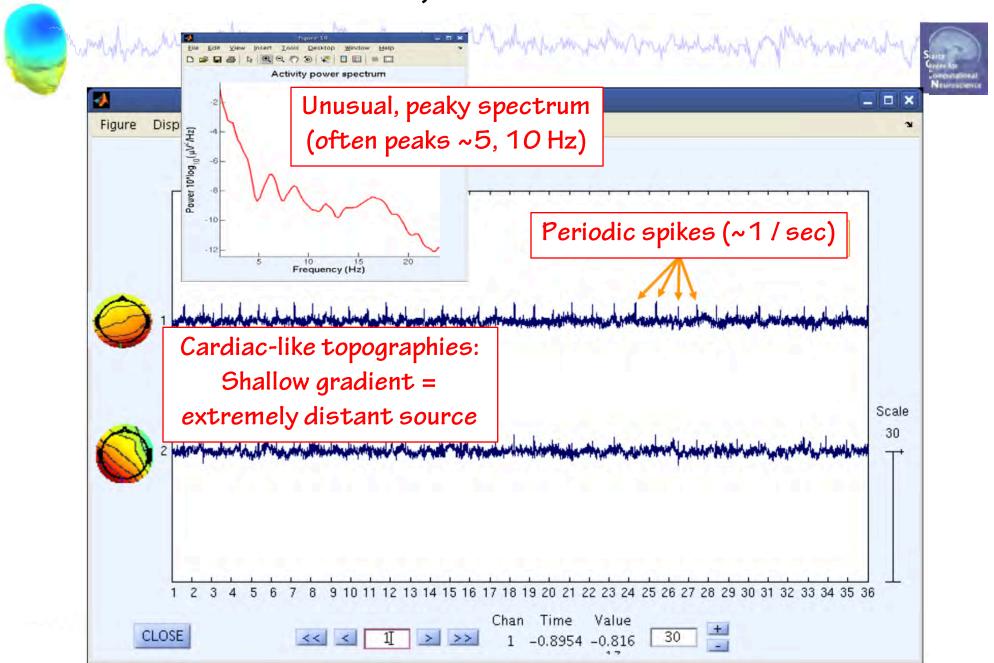
IC 12, 18 Activation – Muscle



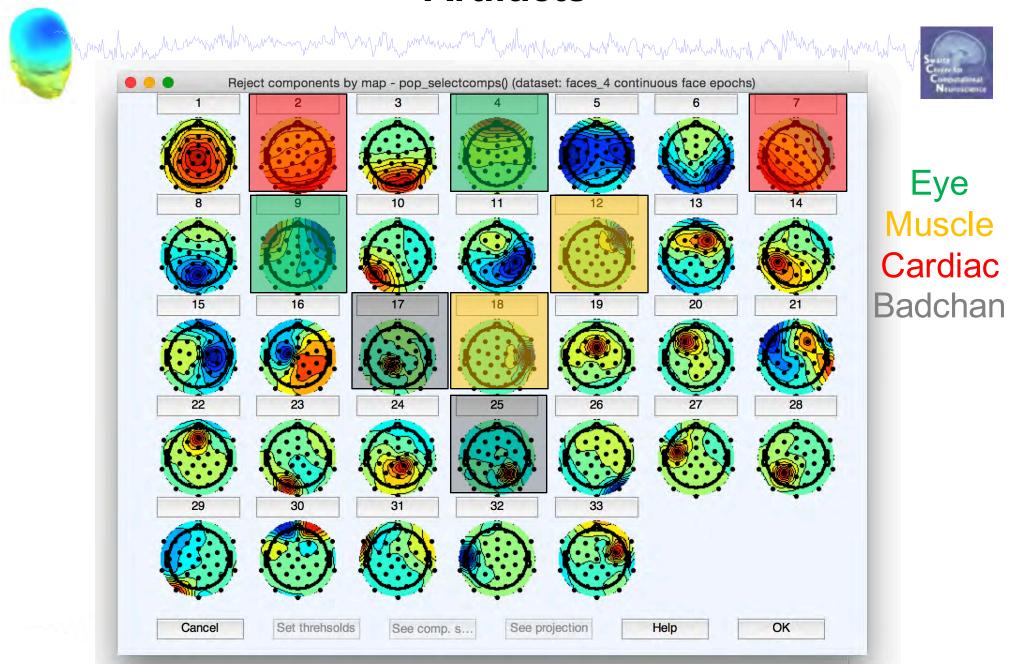
IC 17, 25 – Bad channels



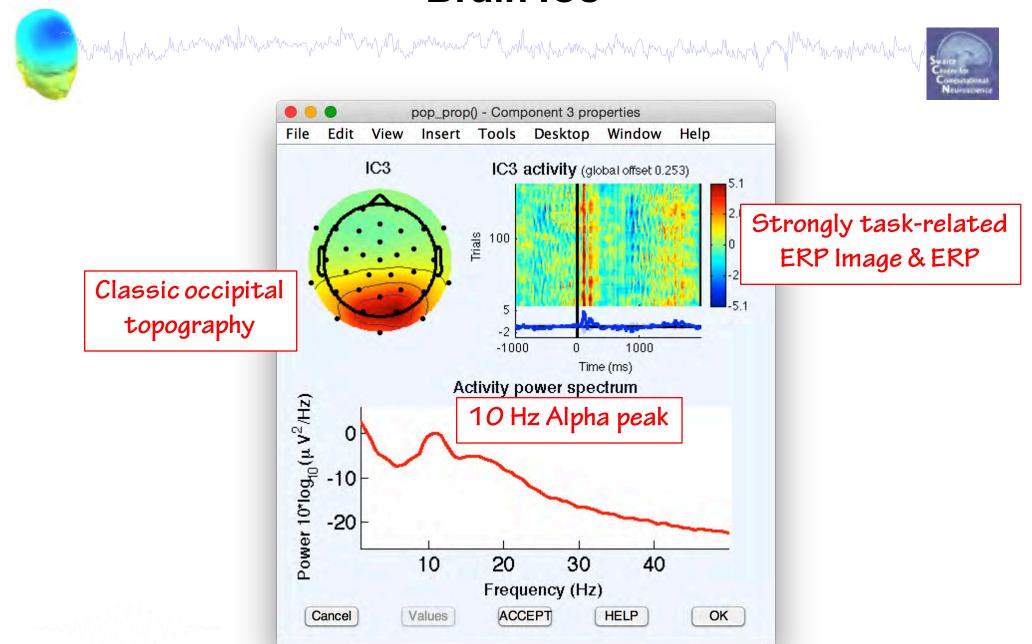
IC 2, 7 – Cardiac



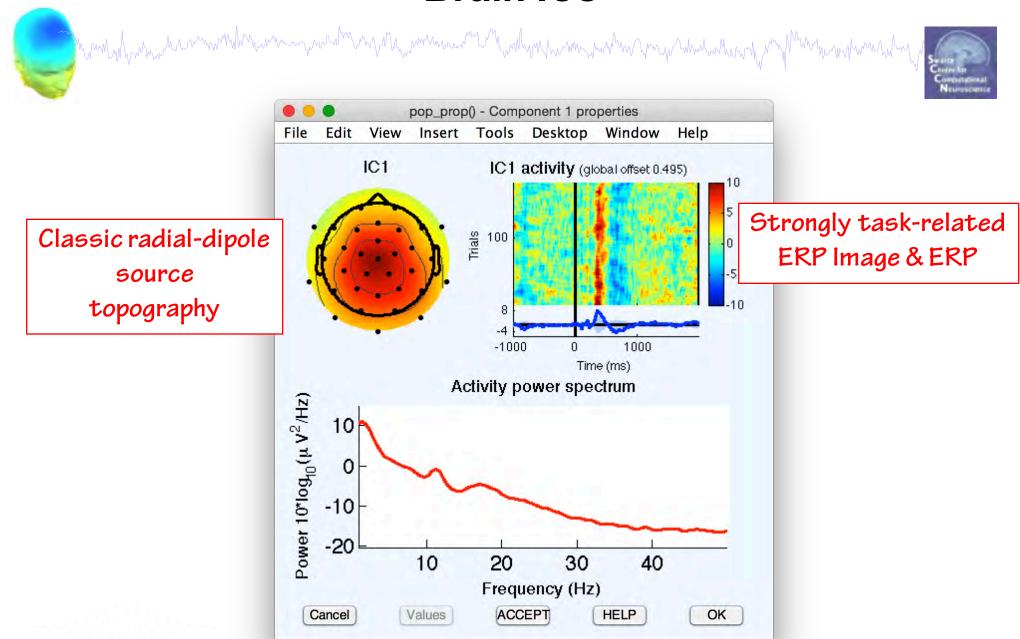
Artifacts



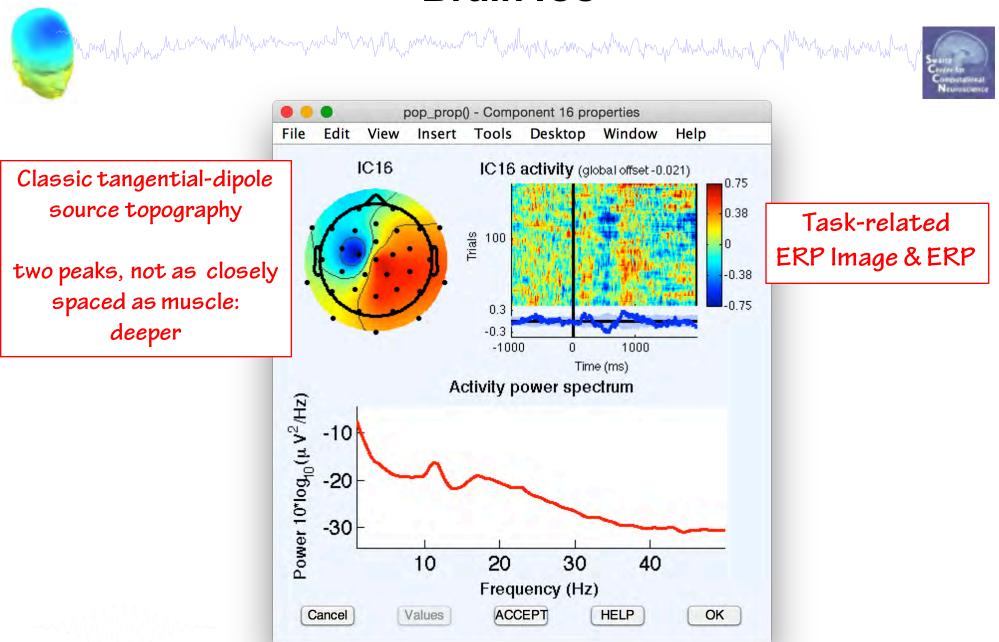
Brain ICs



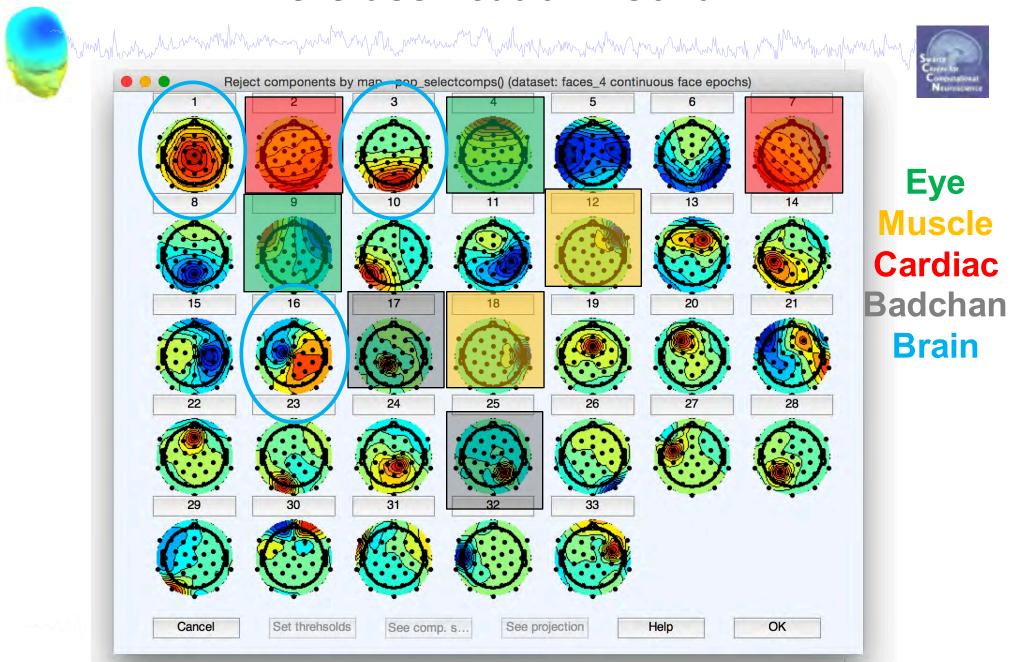
Brain ICs



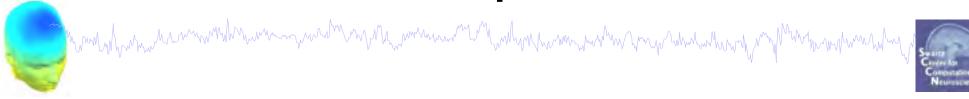
Brain ICs



IC Classification...so far



IC Properties





Part 1

Getting an overview of your ICs

Part 2

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Part 3

Detailed look at IC properties

ERP

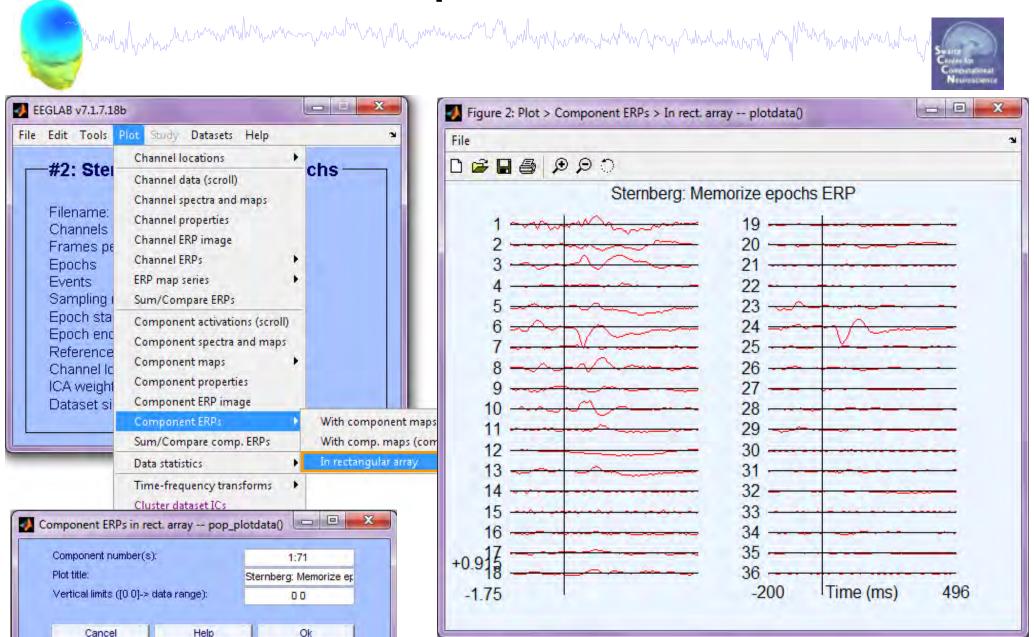
Spectrum

ERP images

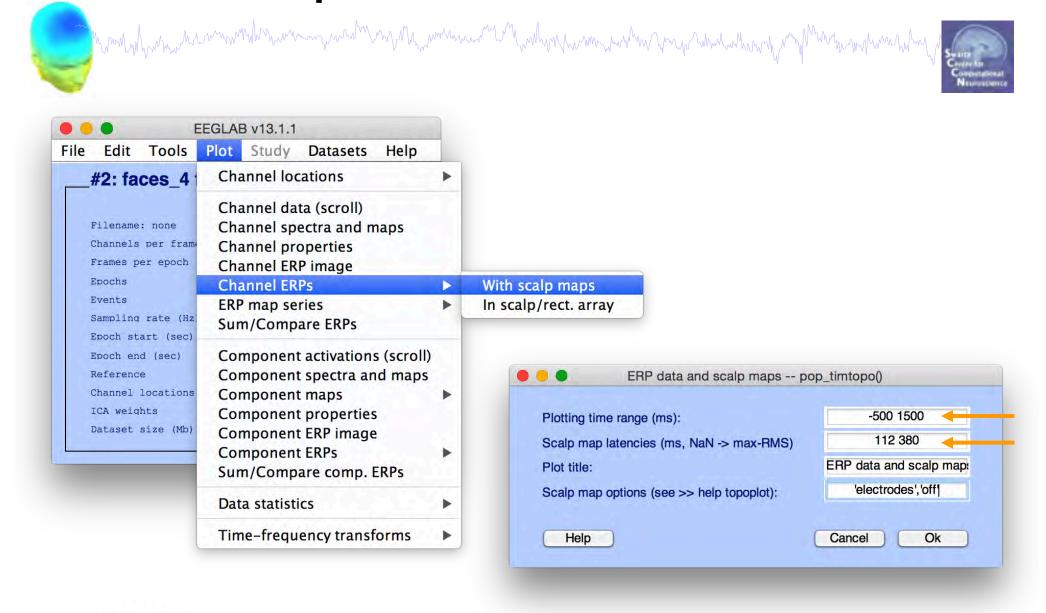
ERSP



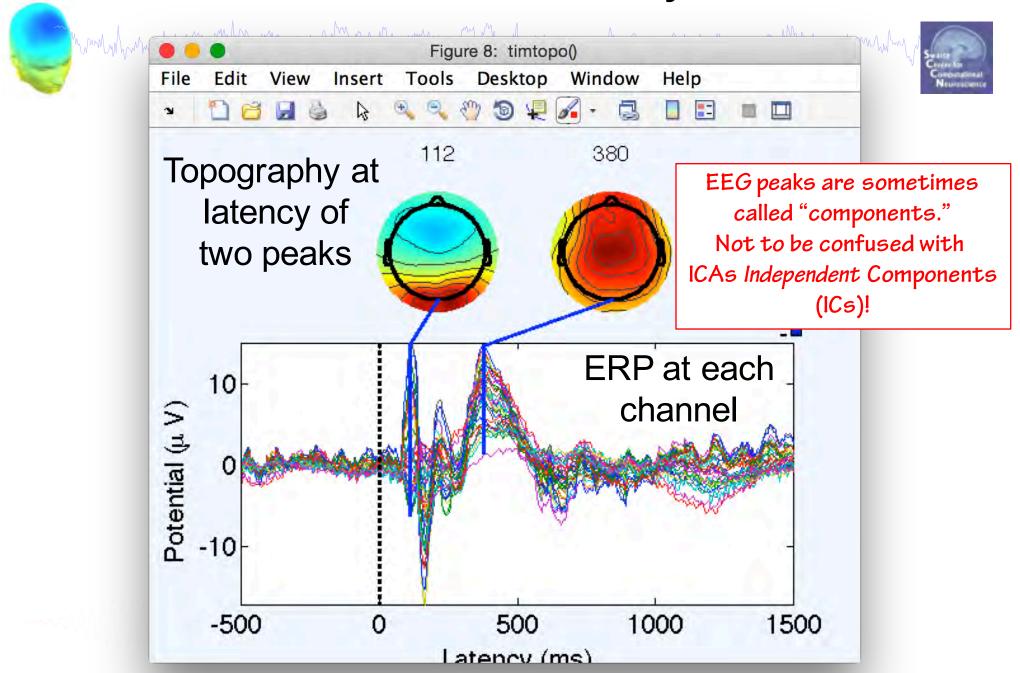
Component ERPs



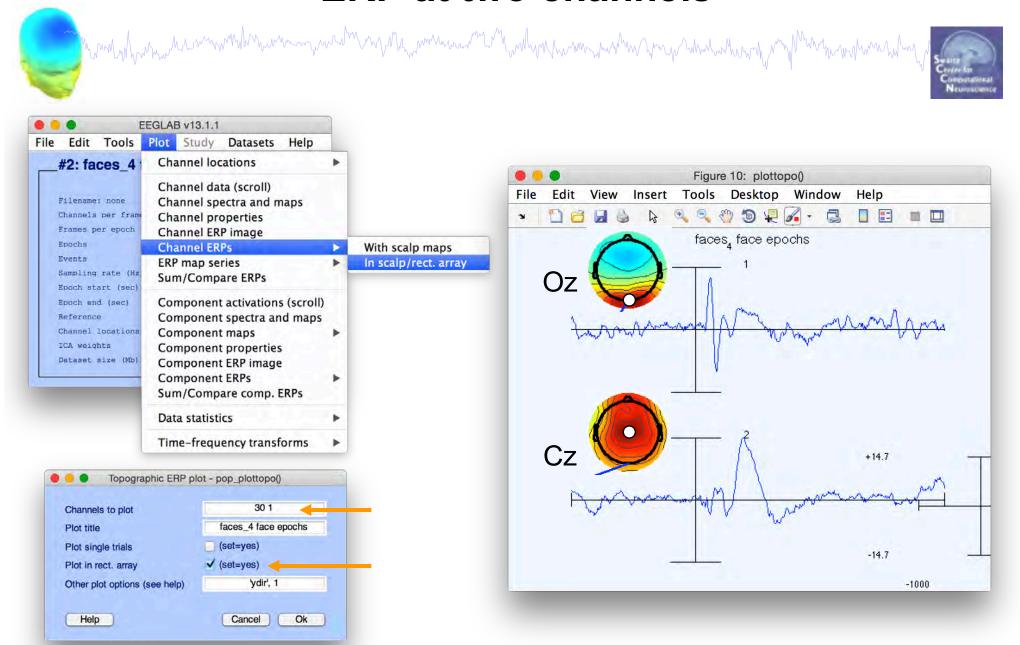
A step back: Electrode-level ERP



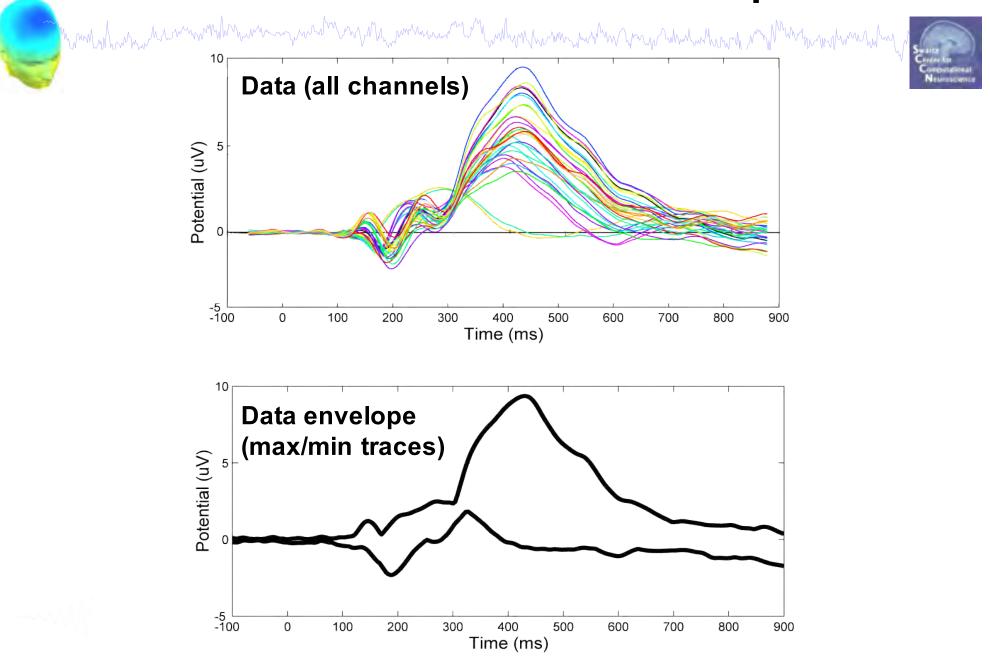
Traditional ERP: Time-locked activity at each channel



ERP at two channels



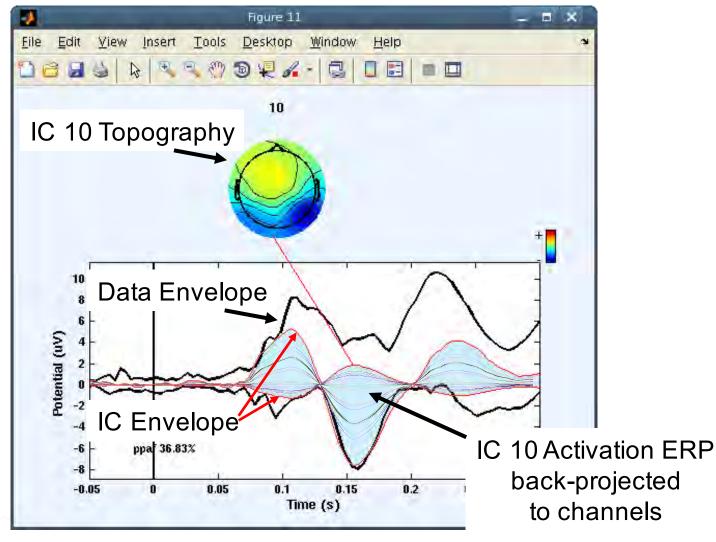
Definition: The data envelope

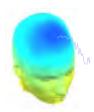


Definition: IC Envelope



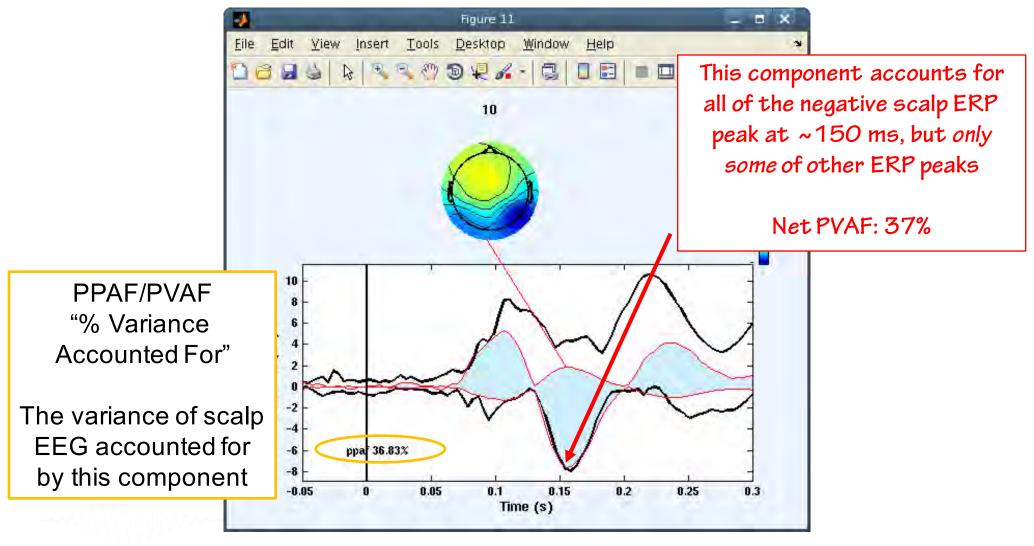




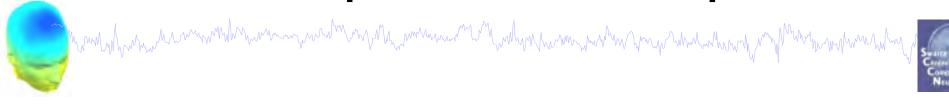


Key: Scalp ERP peaks are often the sum of multiple independent source processes

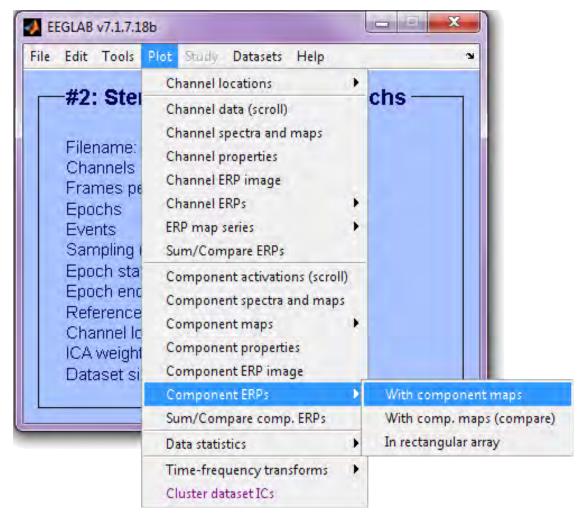




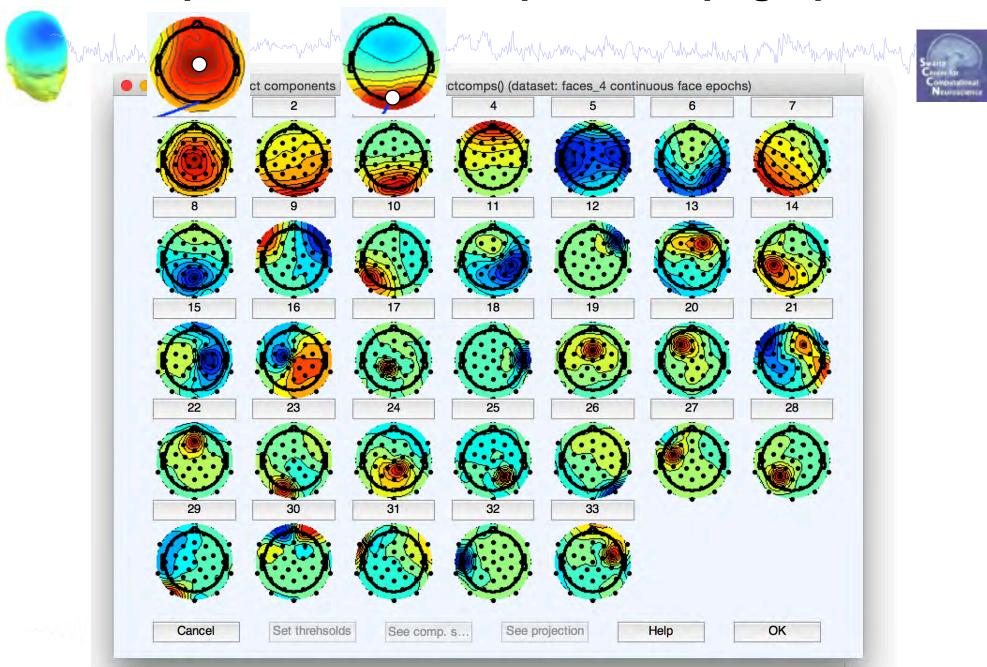
Component ERP envelope



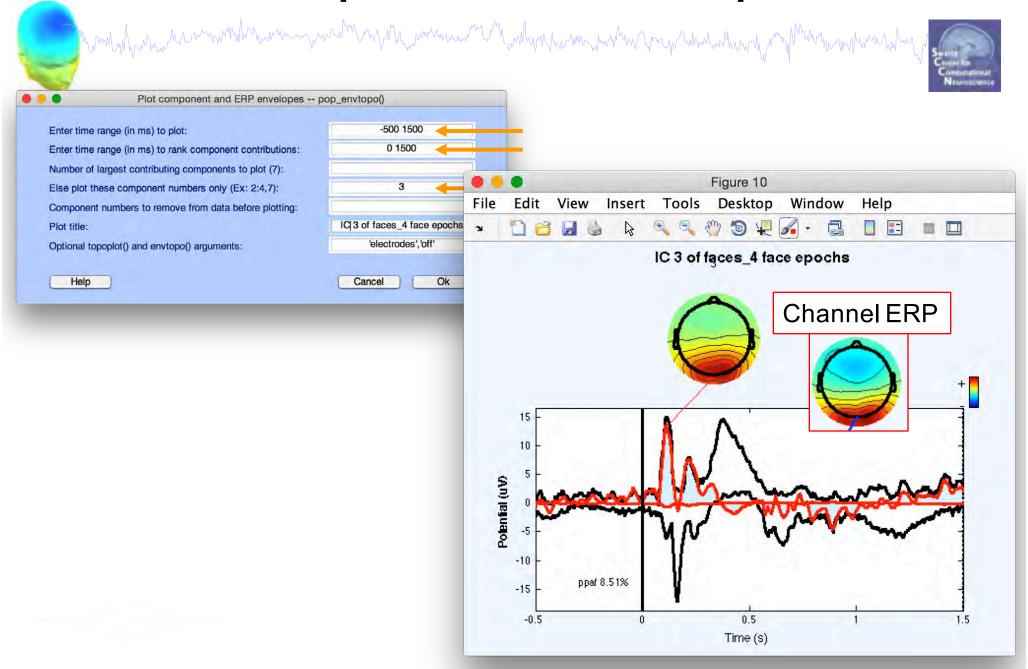




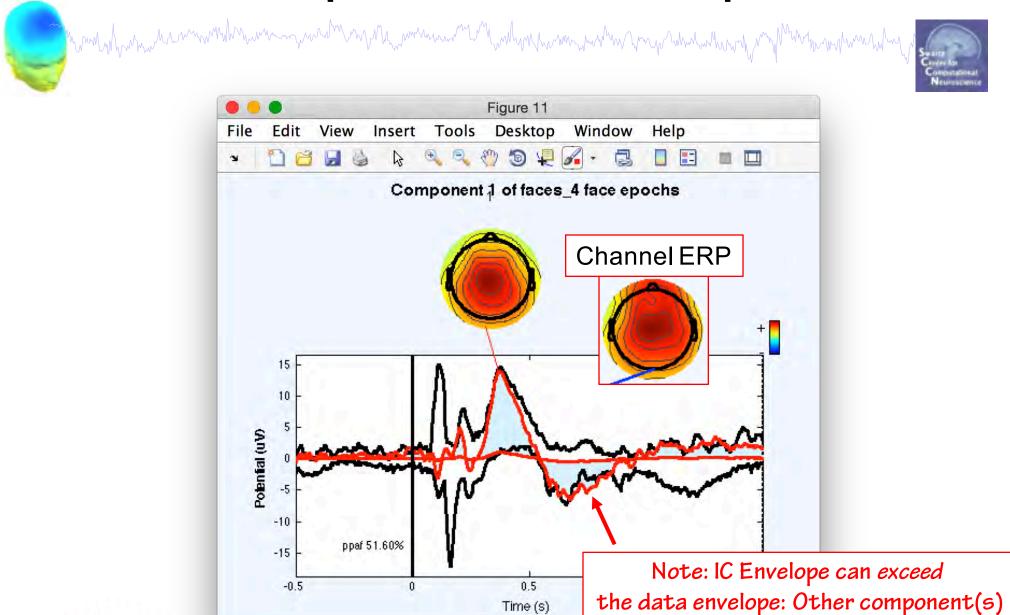
ERP peak- and IC Component-topographies



Component 3 ERP envelope

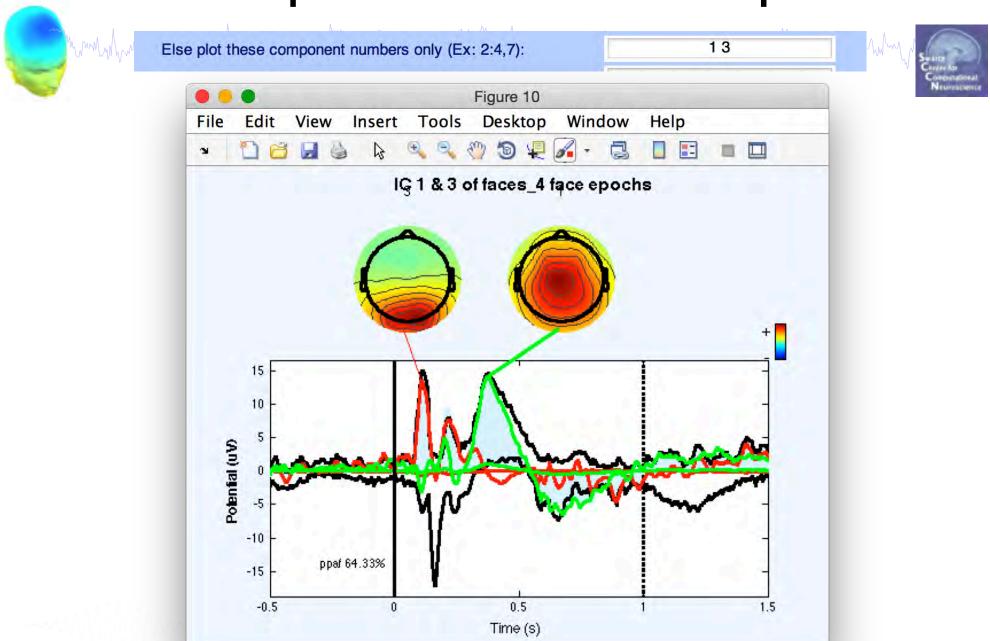


Component 1 ERP envelope

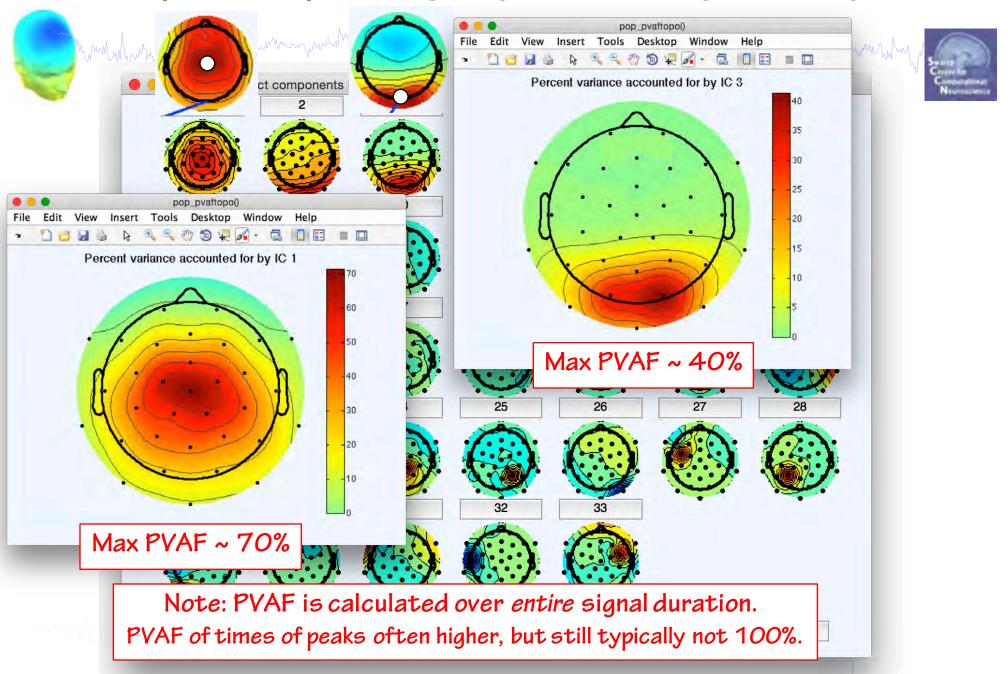


have opposite sign at this latency.

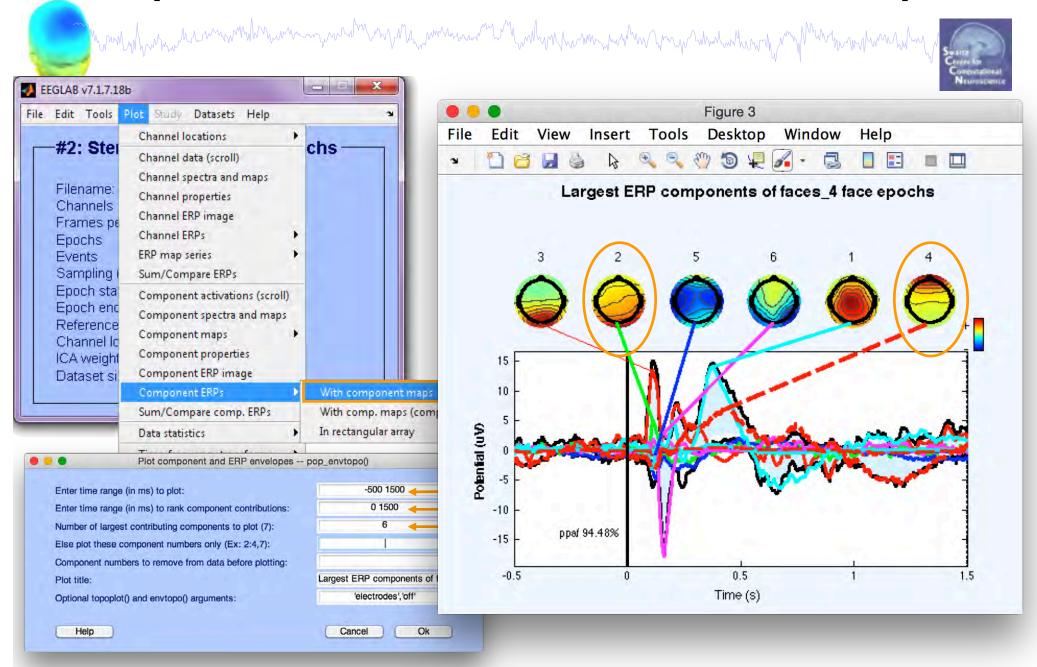
Component 1 & 3 ERP envelope



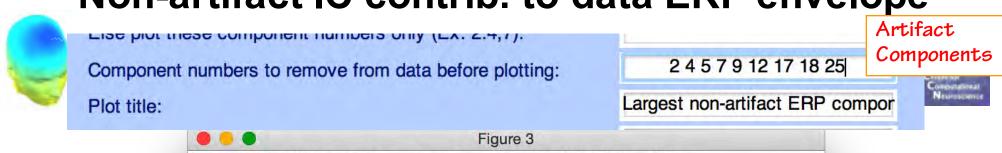
pvaftopo plugin (Makoto Miyakoshi)

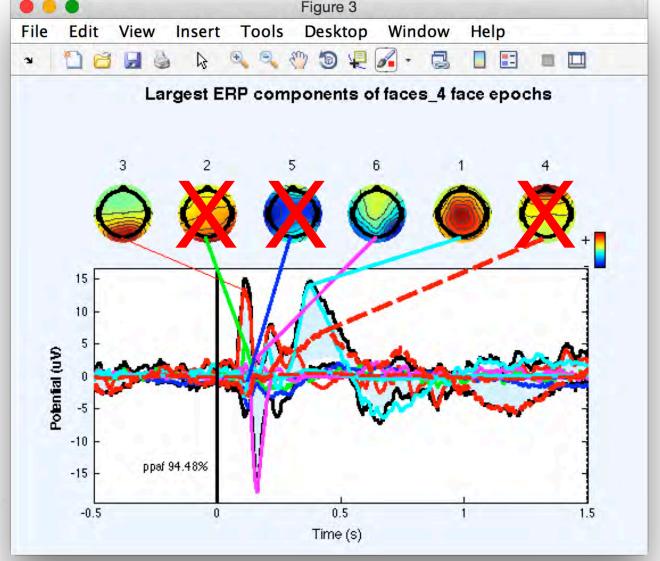


Top 6 IC contributions to data ERP envelope

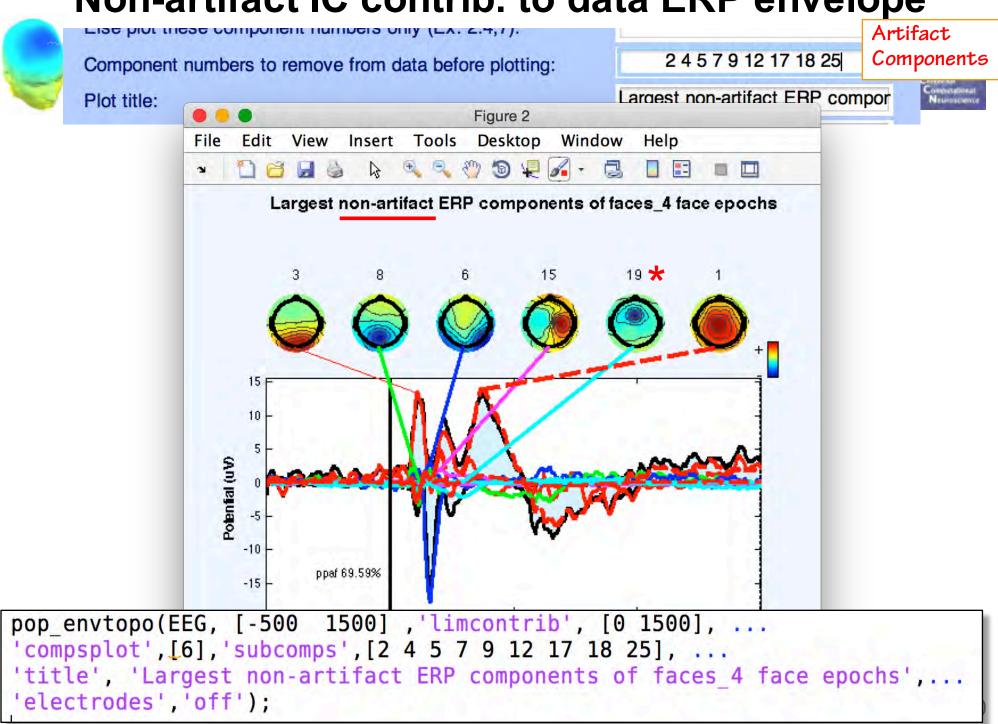


Non-artifact IC contrib. to data ERP envelope





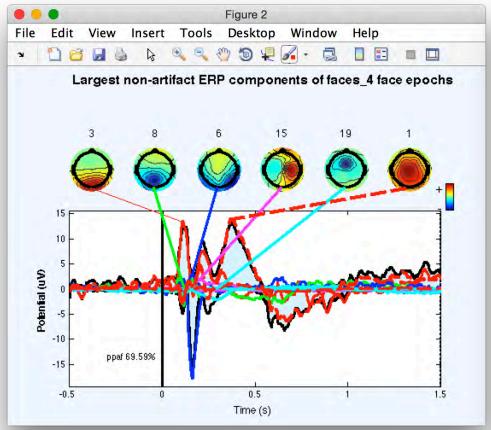
Non-artifact IC contrib. to data ERP envelope

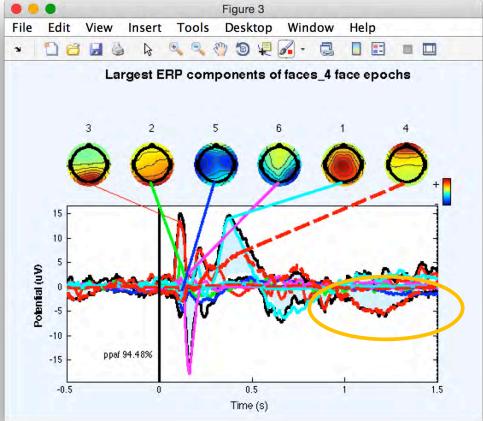


Compare: Effect of removing artifacts







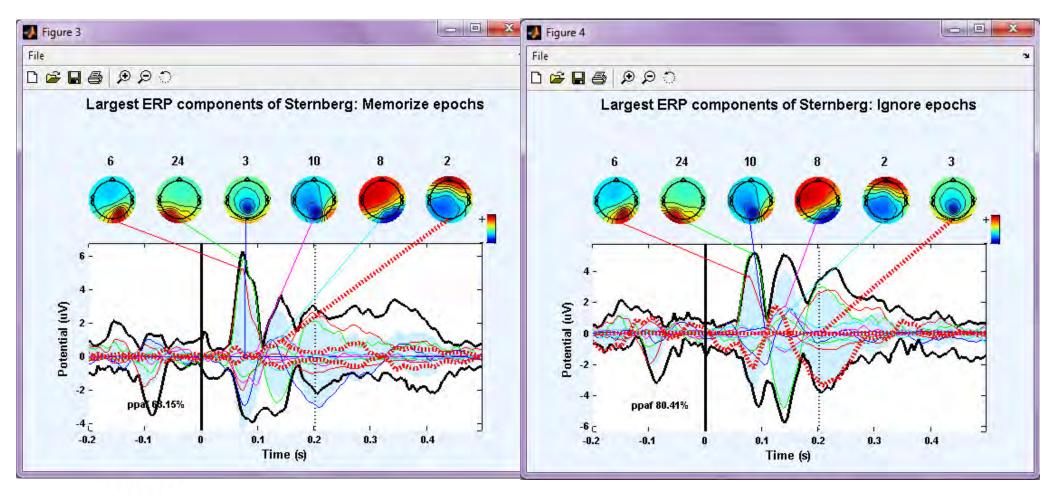


IC ERP difference



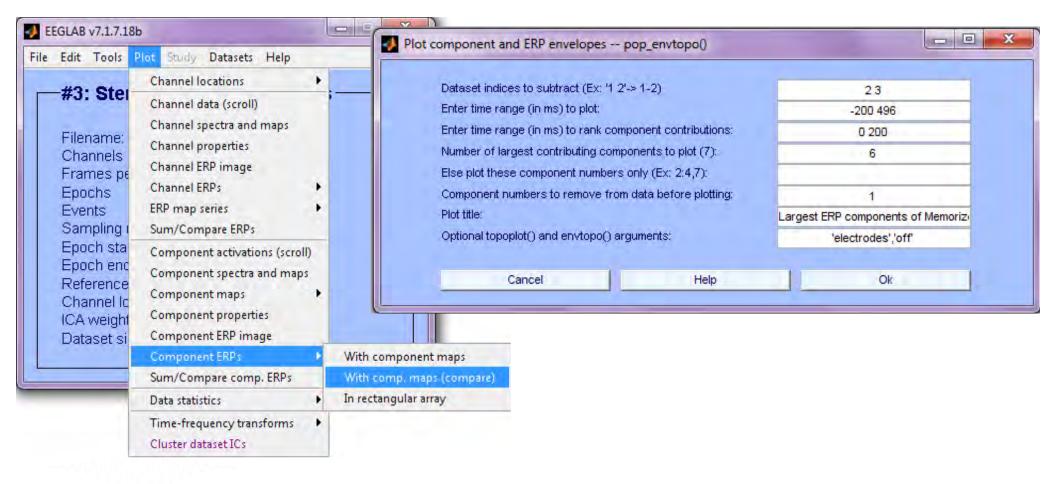


What is the IC ERP difference between these 2 conditions?



IC ERP difference

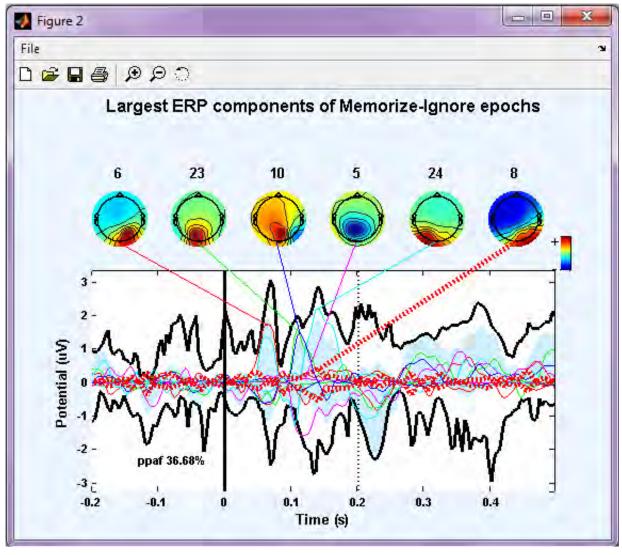




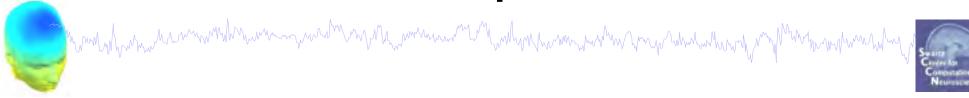
IC ERP difference







IC Properties





Part 1

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Detailed look at IC properties

ERP

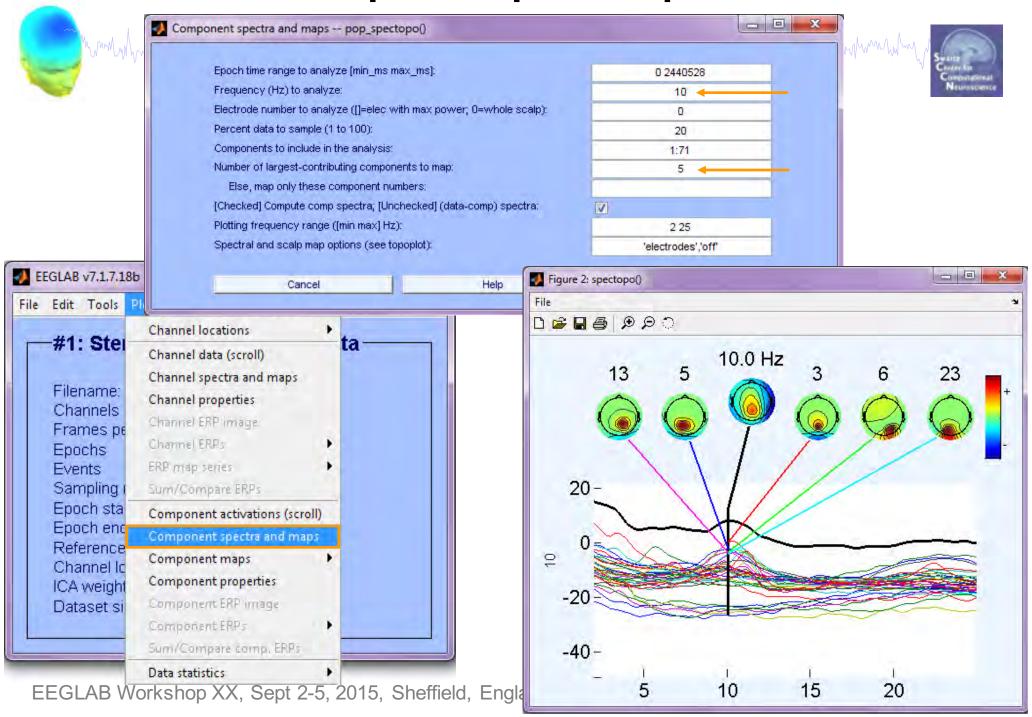
Spectrum

ERP images

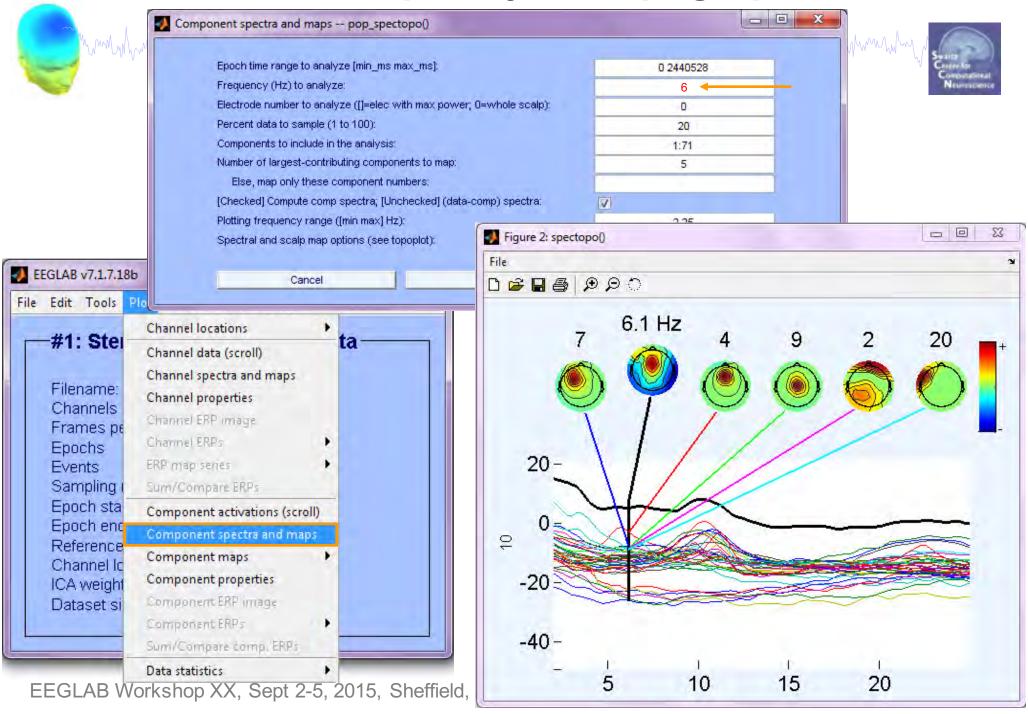
ERSP



Plot component power spectrum



Different frequency for topographies



IC Properties





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ERP

Spectrum

ERP images

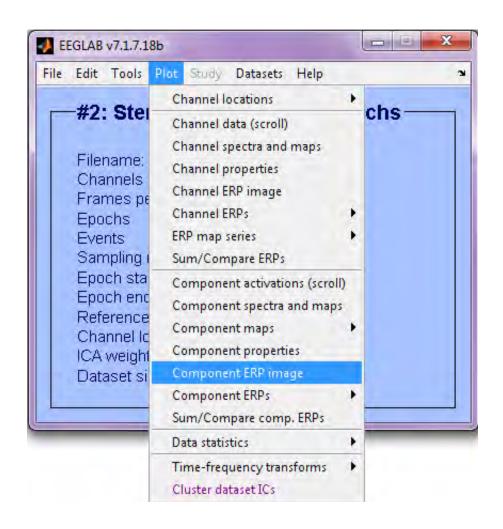
ERSP



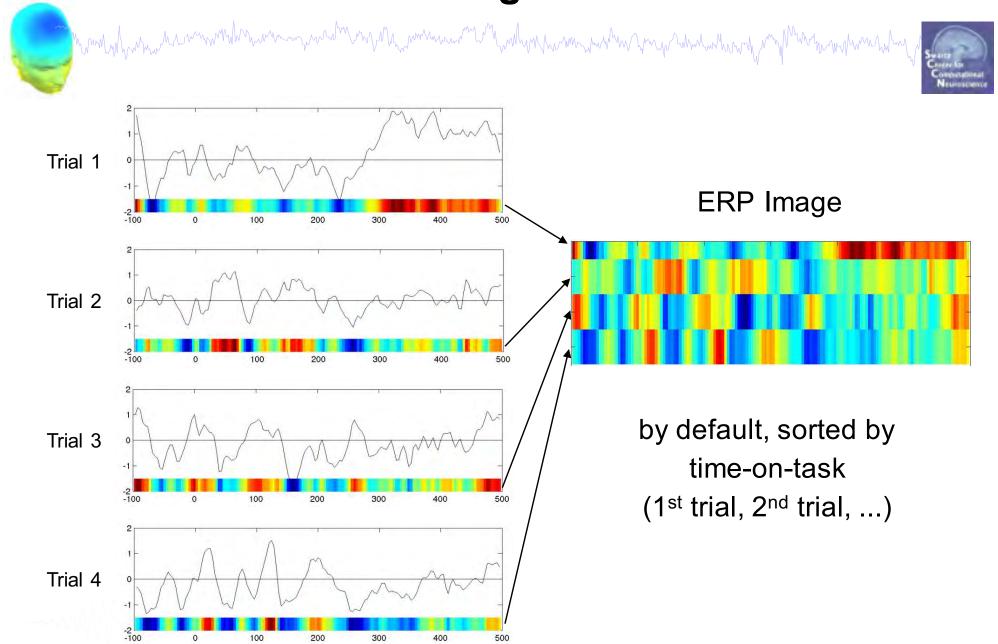
Component ERP image



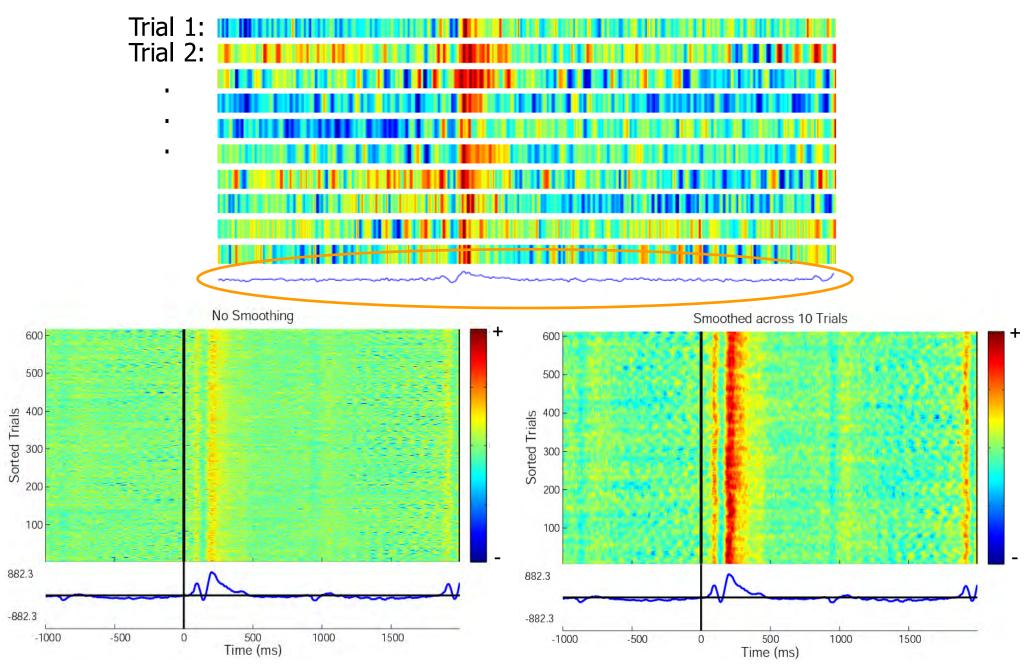




ERP Image basics



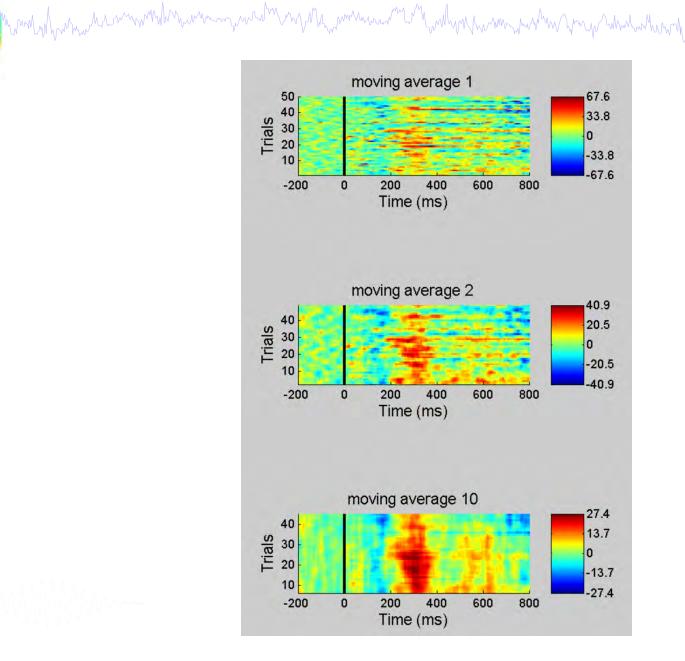
ERP Image basics



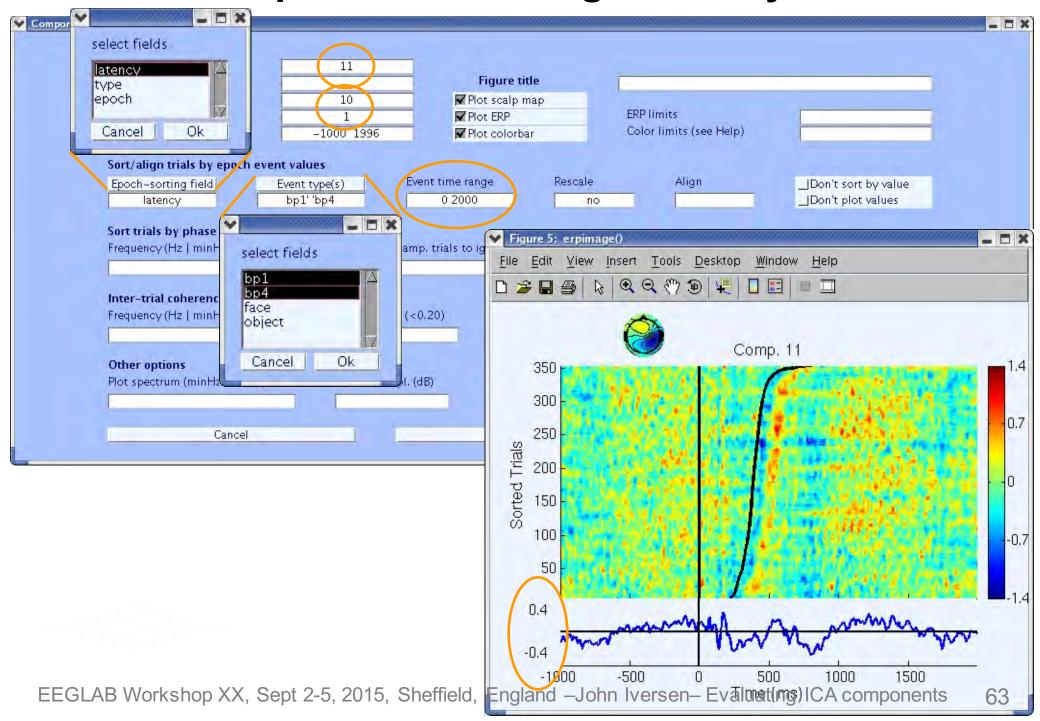
EEGLAB Workshop XX, Sept 2-5, 2015, Sheffield, England –John Iversen– Evaluating ICA components

ERP Images: smoothing across trials

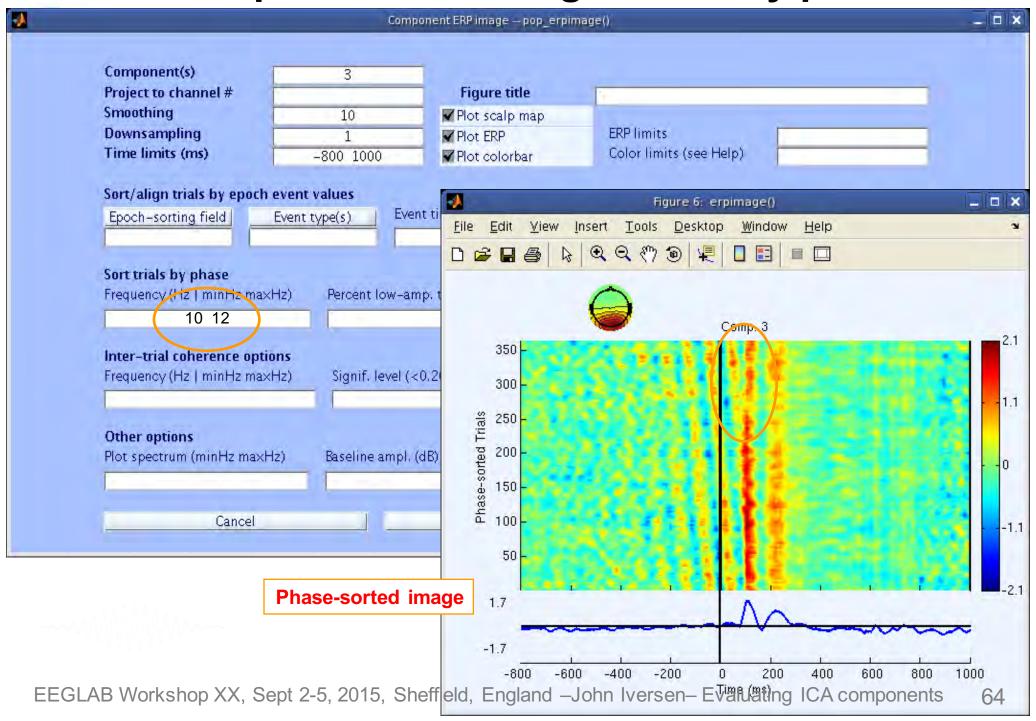




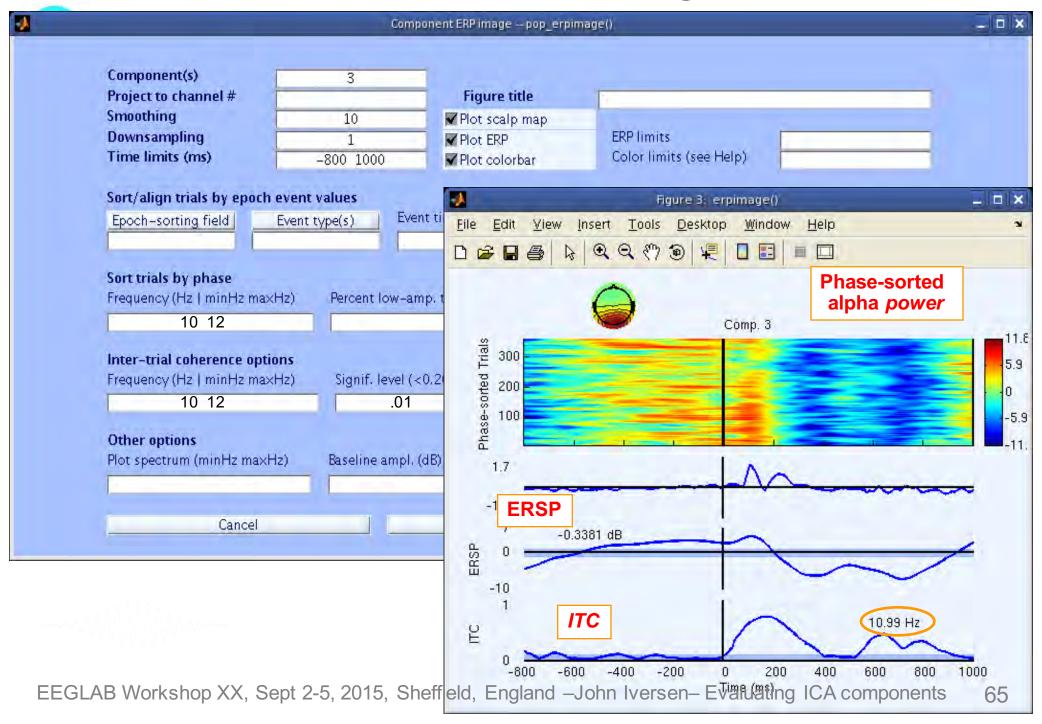
Component ERP Image: Sort by RT



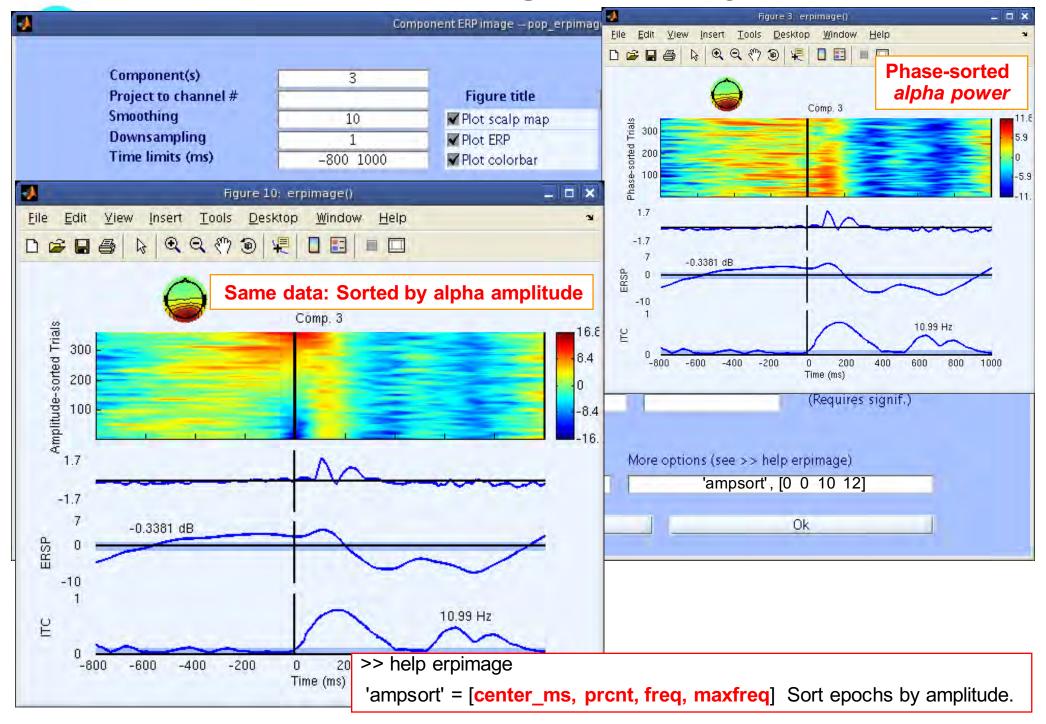
Component ERP Images: Sort by phase



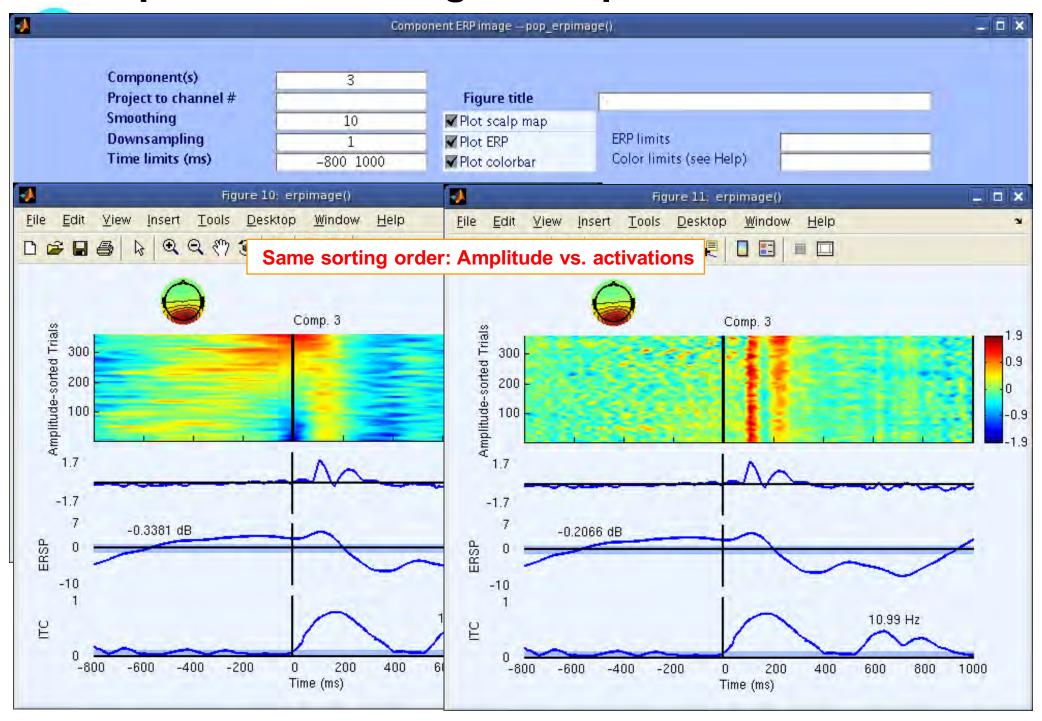
Component ERP Images: ITC



Component ERP Images: Sort by amplitude



Component ERP Images: Amplitude vs. Activations



IC Properties





Part 1

Getting an overview of your ICs

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ERP

Spectrum

ERP images

ERSP



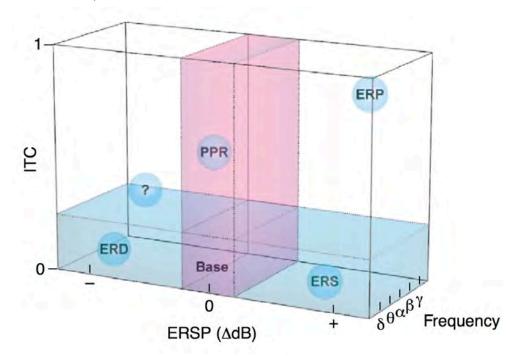
Definition: ERSP



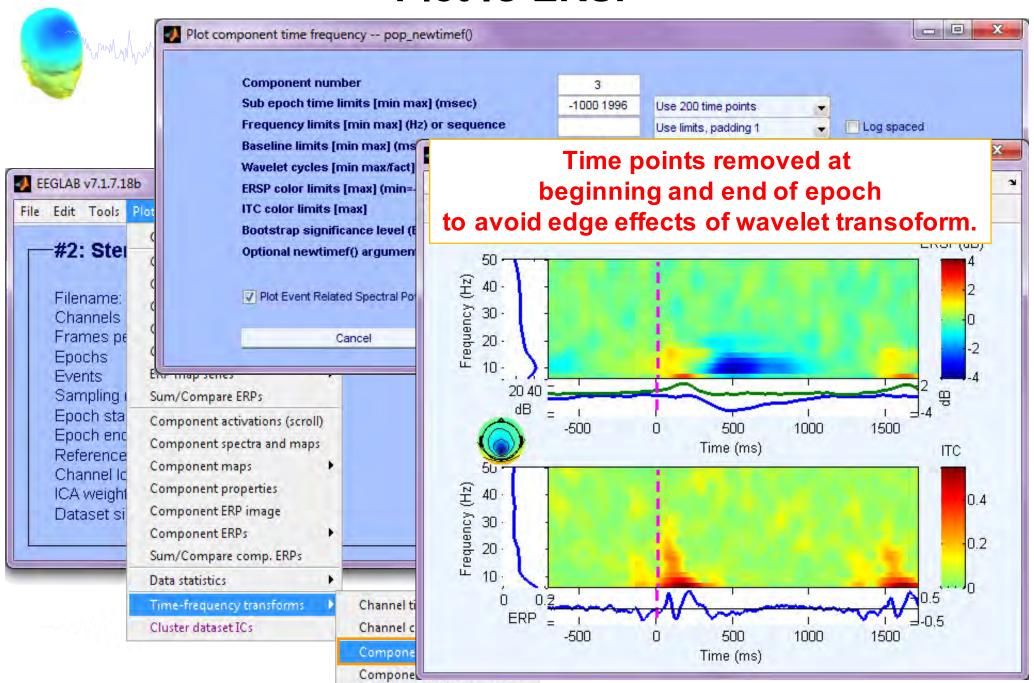


Event Related Spectral Perturbation

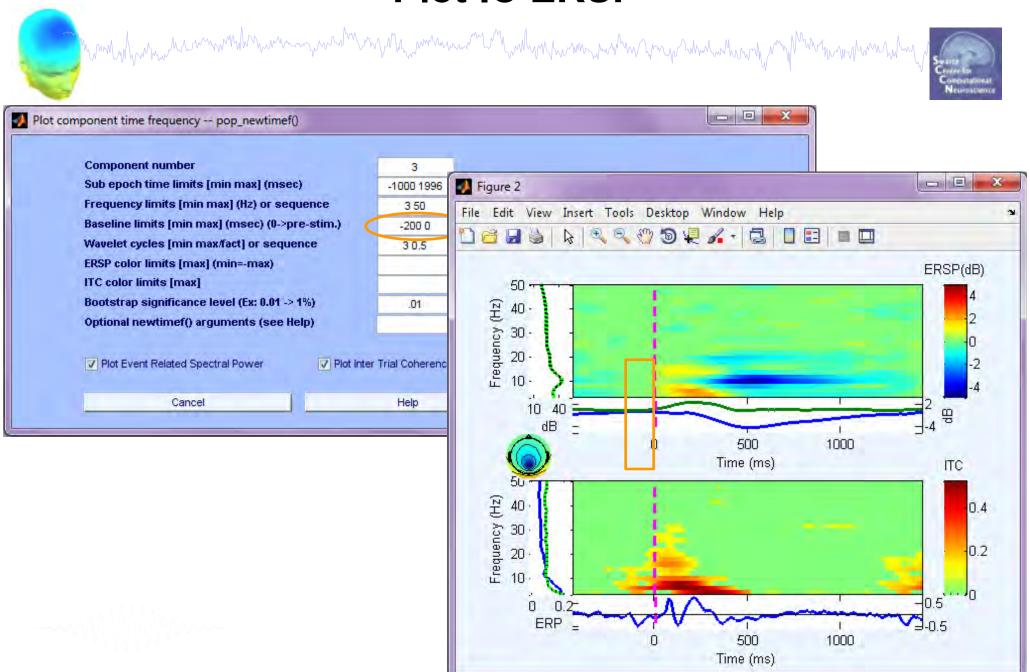
Change in power in different frequency bands relative to a baseline. ERS, ERD



Plot IC ERSP



Plot IC ERSP



Further Resources



Some attempts to automate the IC classification:

"Automatic Classification of Artifactual ICA-Components for Artifact Removal in EEG Signals"

Irene Winkler, Stefan Haufe and Michael Tangermann (2011)

http://www.behavioralandbrainfunctions.com/content/7/1/30

Bigdely-Shamlo's EyeCatch (2013)

https://www.researchgate.net/publication/257602145 EyeCatch Datamining over half a million EEG independent components to construct a fullyautomated eye-component detector



Practicum (15:45 – 17:00 today)



"MyMana ALL

- Download then load faces_4.set, epoch on face



Novice, Intermediate

- From the GUI, open the 'Reject component by map' interface
- Explore and classify several additional ICs: muscle, channel, brain
 - ~ Justify your classification
- Redo the "Plot → Component ERPs → With component maps" excluding your additional artifacts. What change do you observe?
- Pick a brain IC. Plot an ERP Image
 - ~ Try sorting by phase, is there any relationship to the IC activation pattern? What about power in a frequency band of choice?

Intermediate

- Plot ERP Image sorted by response latency
- 'Align') Figure out how to realign trials to response latency instead

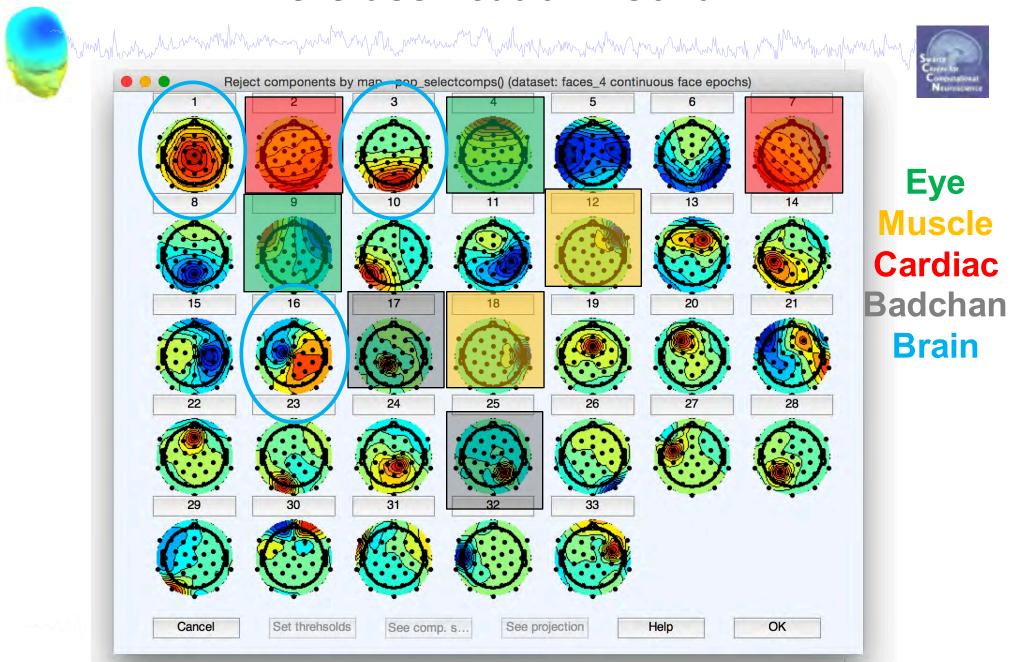
(Hint

- Plot ERSPs for selected ICs
 - ~ Explore parameter options. Why is each useful?
- Plot component cross-coherence for pairs of ICs

ALL (Time permitting)

- Create second dataset, epoched on object
- Examine ERP differences between the conditions using "Plot → Component ERPs → With component maps (compare)"
- For ICs most different between conditions, compare ERP Image, ERSP

IC Classification...so far



Realigning Trials: Stimulus vs. Response

