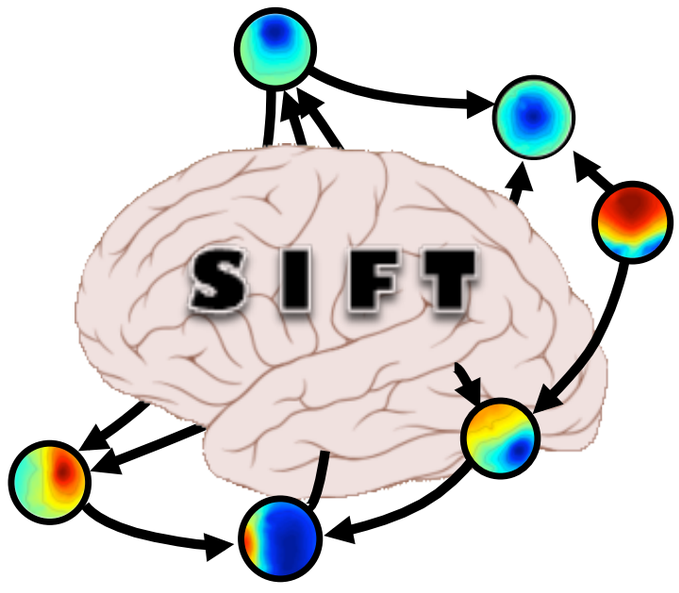
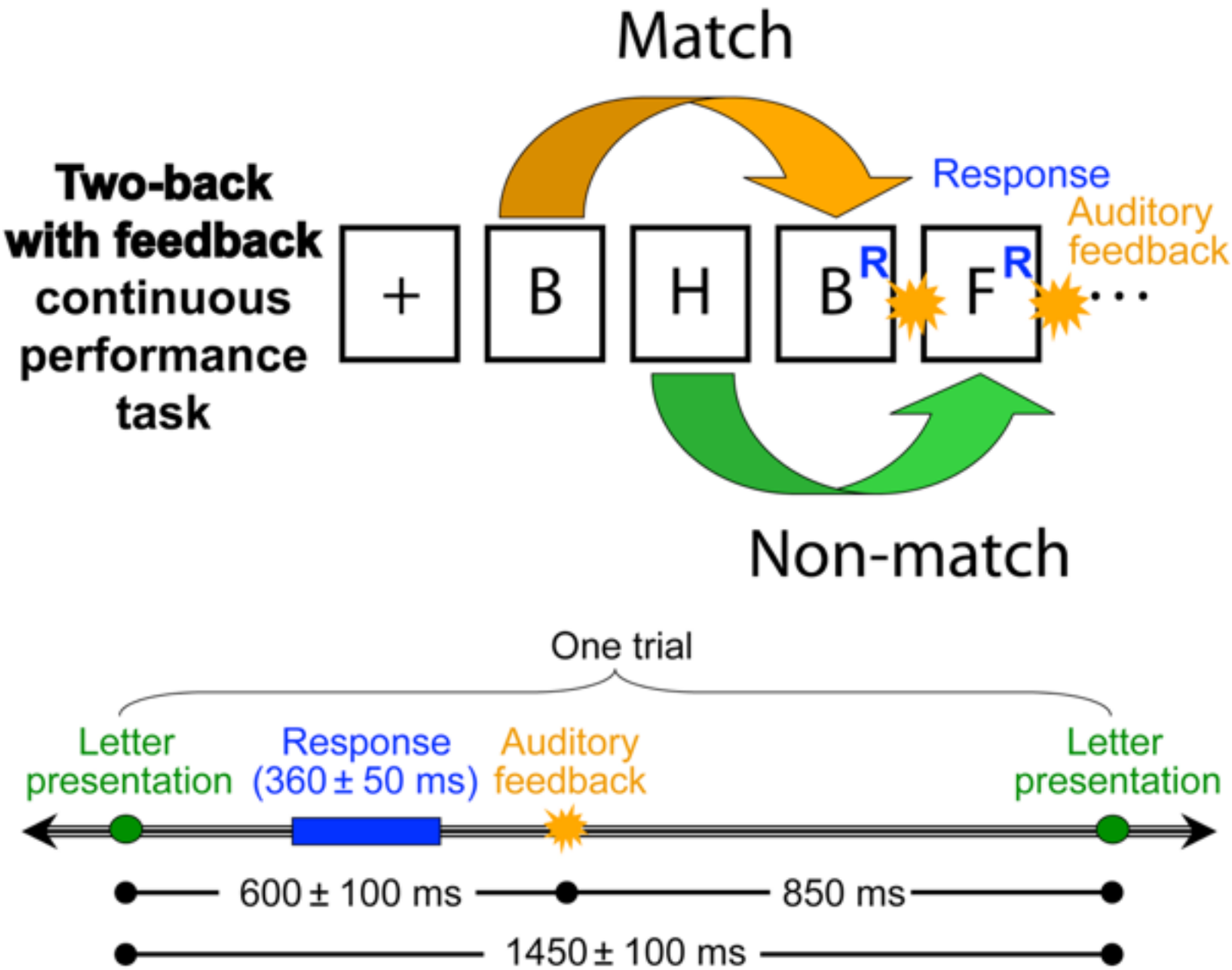
The Source Information Flow Toolbox



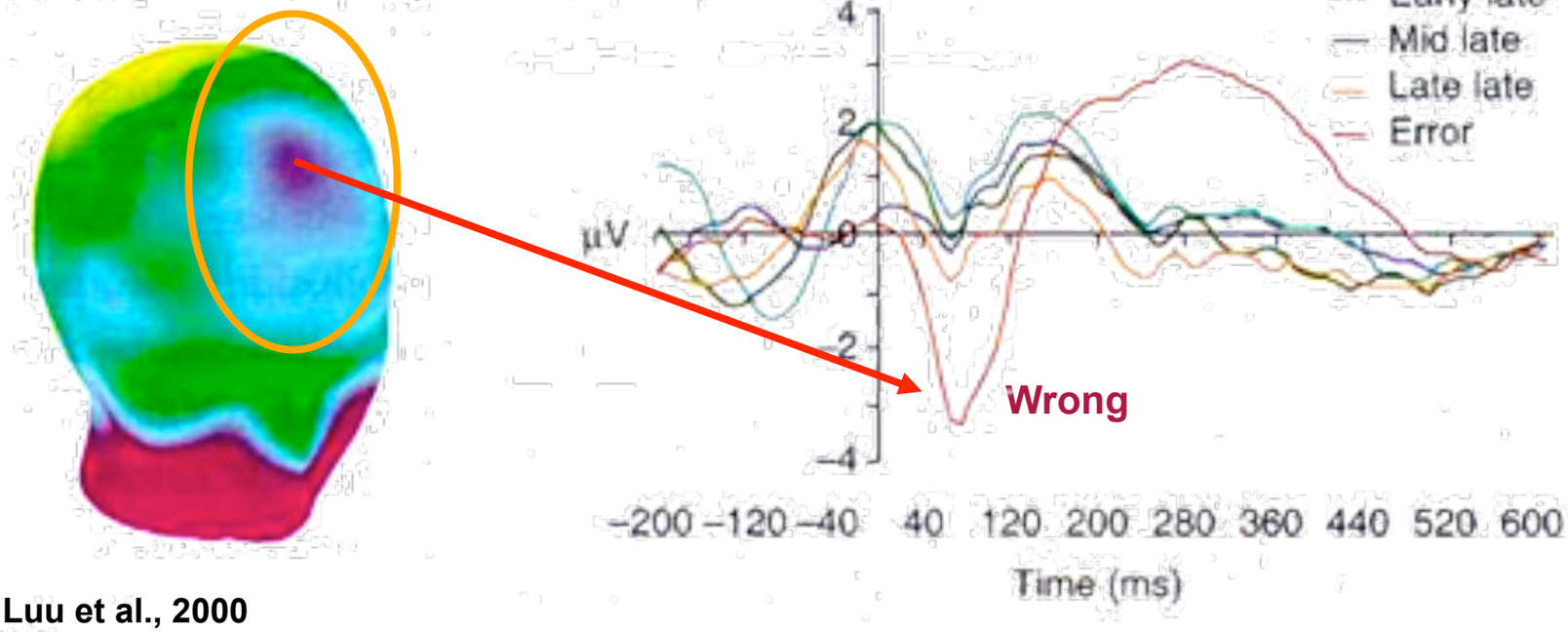
Practicum

Tim Mullen

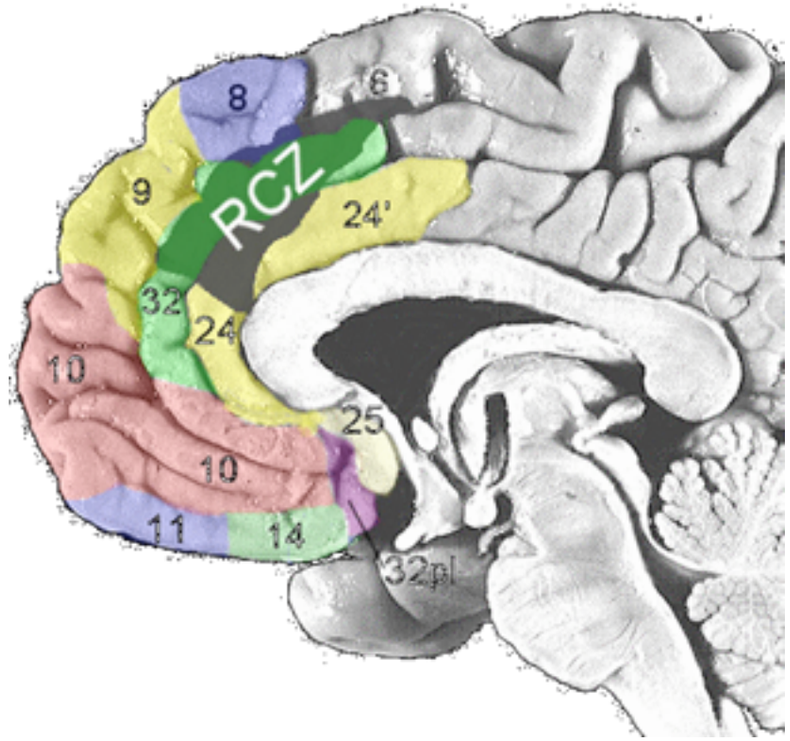
Experimental Data



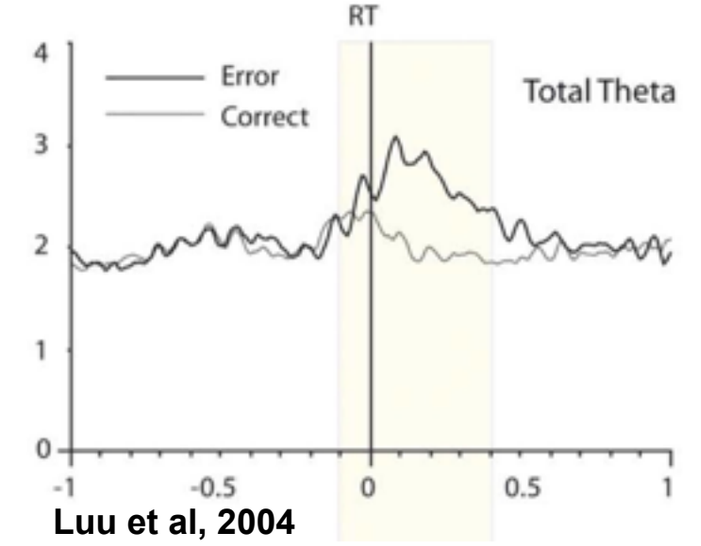
Error-Related Negativity (ERN)



Luu et al., 2000

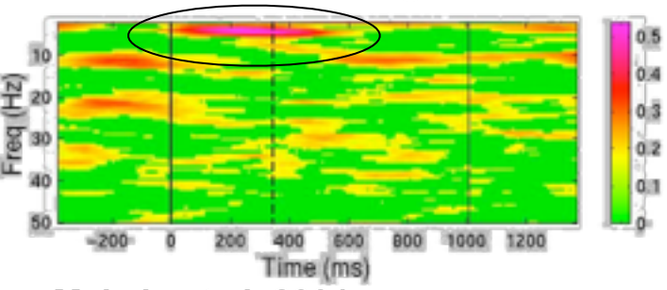


Ridderinkhof et al. 2004



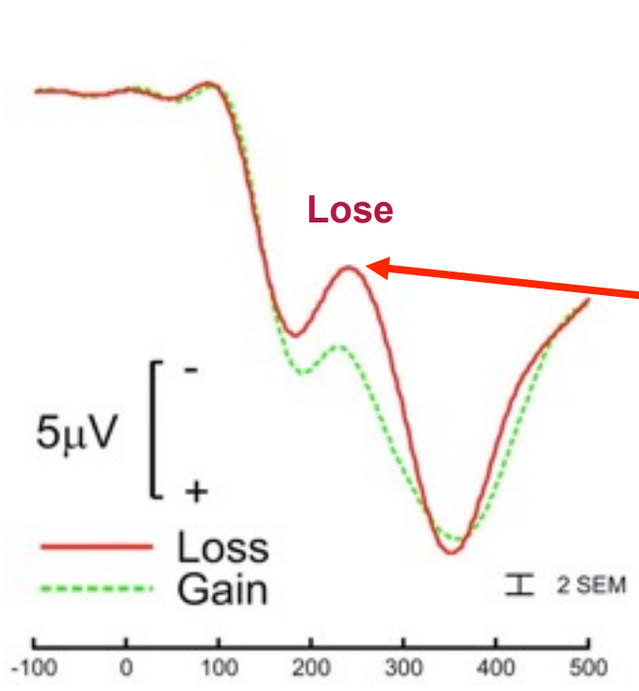
Luu et al, 2004

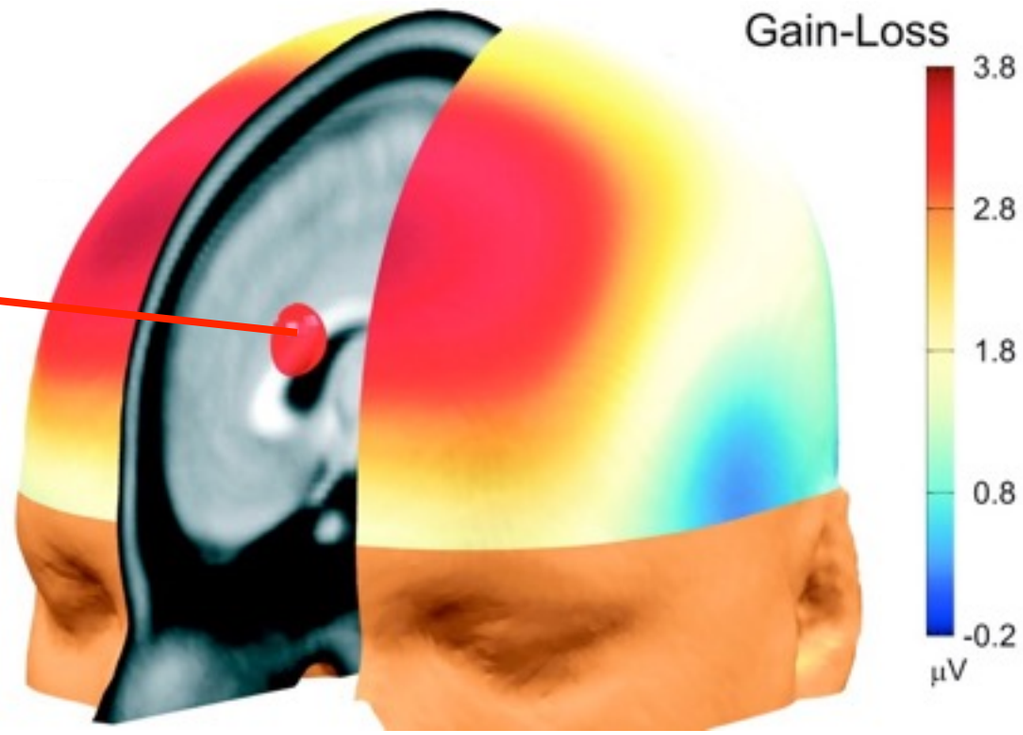
Coherence Magnitude



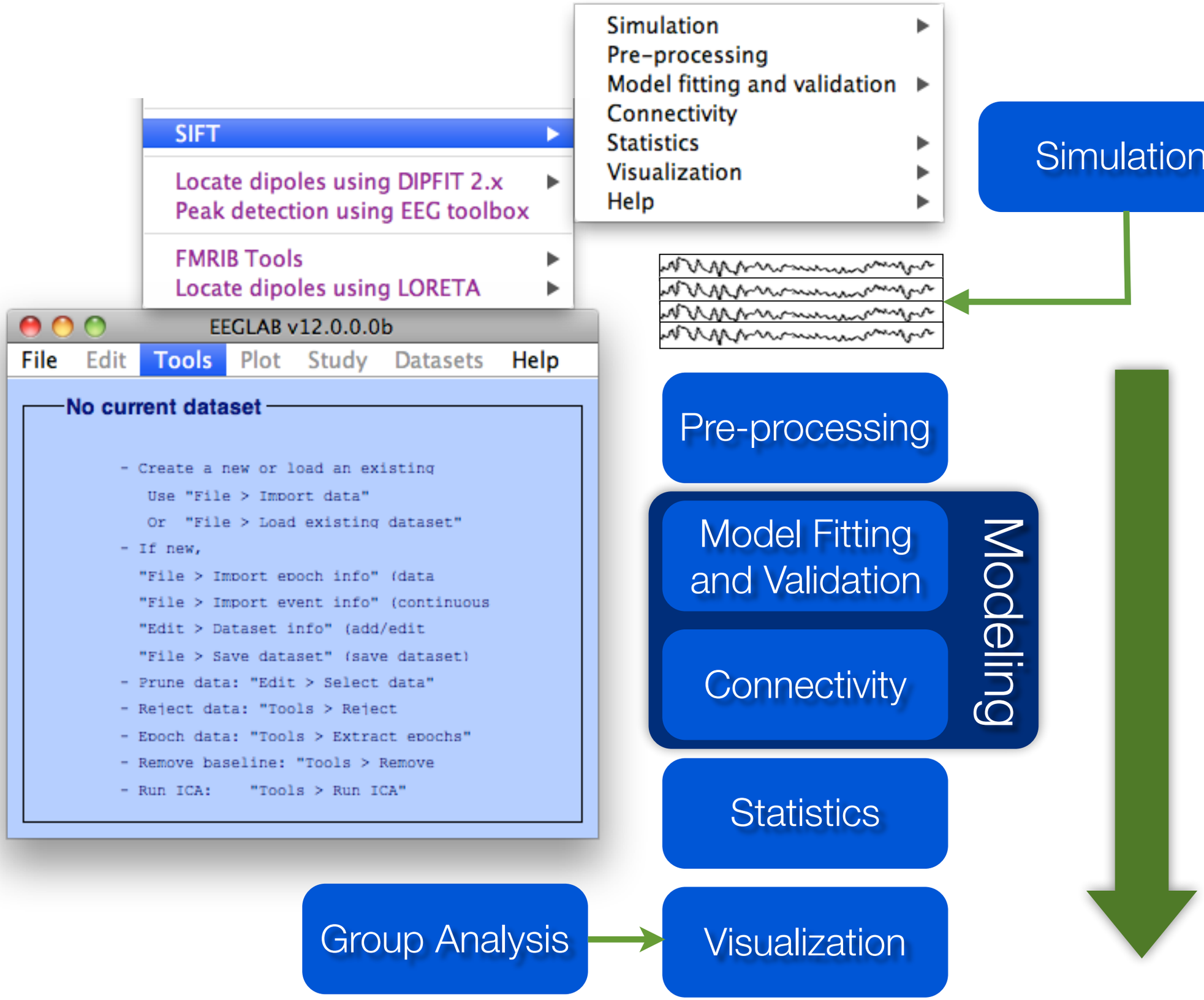
Makeig et al, 2001

Medial-Frontal Negativity (MFN)





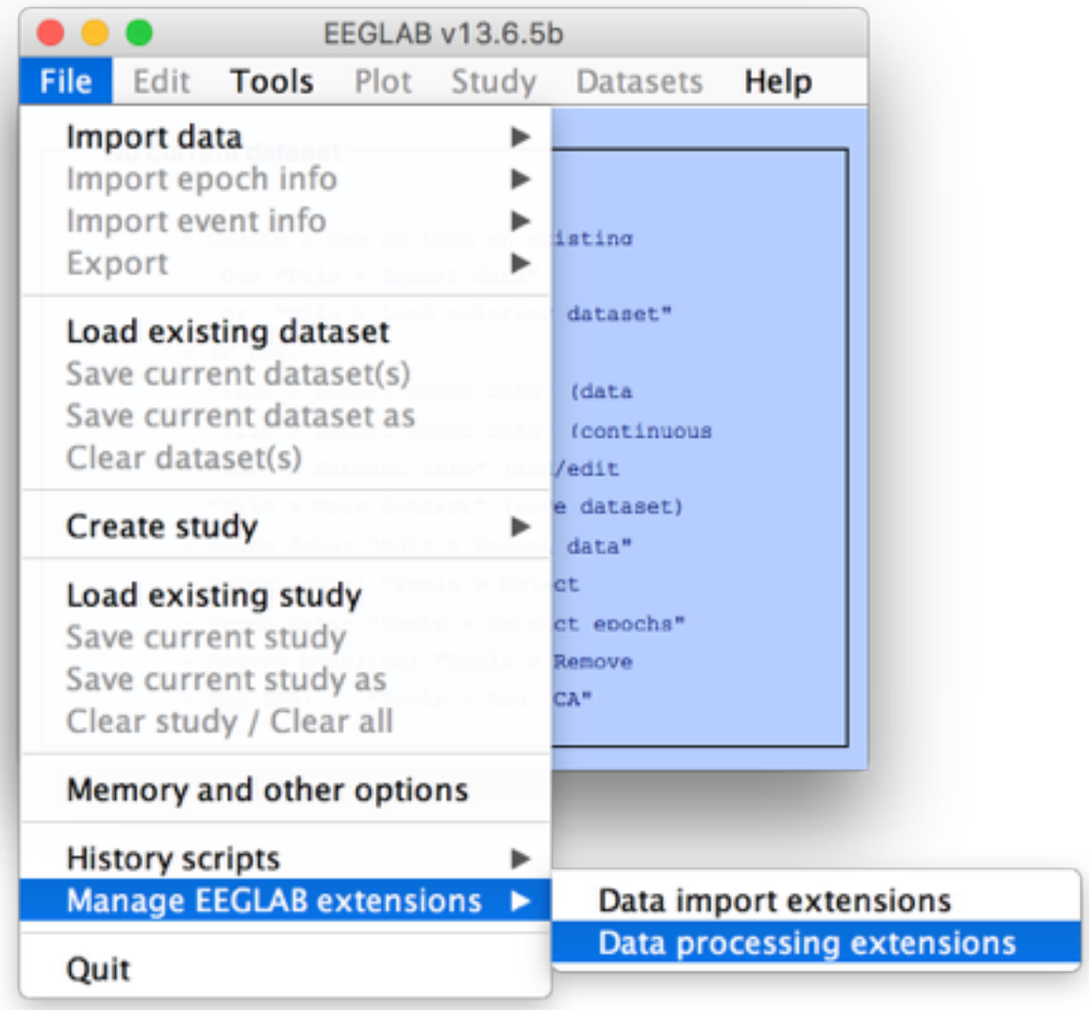
Gehring et al., 2002


Simulation
Pre-processing
Model fitting and validation
Connectivity
Statistics
Visualization
Help
SIFT
Locate dipoles using DIPFIT 2.x
Peak detection using EEG toolbox
FMRIB Tools
Locate dipoles using LORETA
EEGLAB v12.0.0.0b
File Edit Tools Plot Study Datasets Help
No current dataset
- Create a new or load an existing
Use "File > Import data"
Or "File > Load existing dataset"
- If new,
"File > Import epoch info" (data
"File > Import event info" (continuous
"Edit > Dataset info" (add/edit
"File > Save dataset" (save dataset)
- Prune data: "Edit > Select data"
- Reject data: "Tools > Reject
- Epoch data: "Tools > Extract epochs"
- Remove baseline: "Tools > Remove
- Run ICA: "Tools > Run ICA"
Simulation
Pre-processing
Model Fitting and Validation
Connectivity
Modeling
Statistics
Group Analysis
Visualization

I Starting EEGLAB/SIFT

SIFT Requirements:

- **Matlab 2008b** (or greater) *
- Signal Processing Toolbox
- Statistics Toolbox
- EEGLAB
- SIFT 1.5

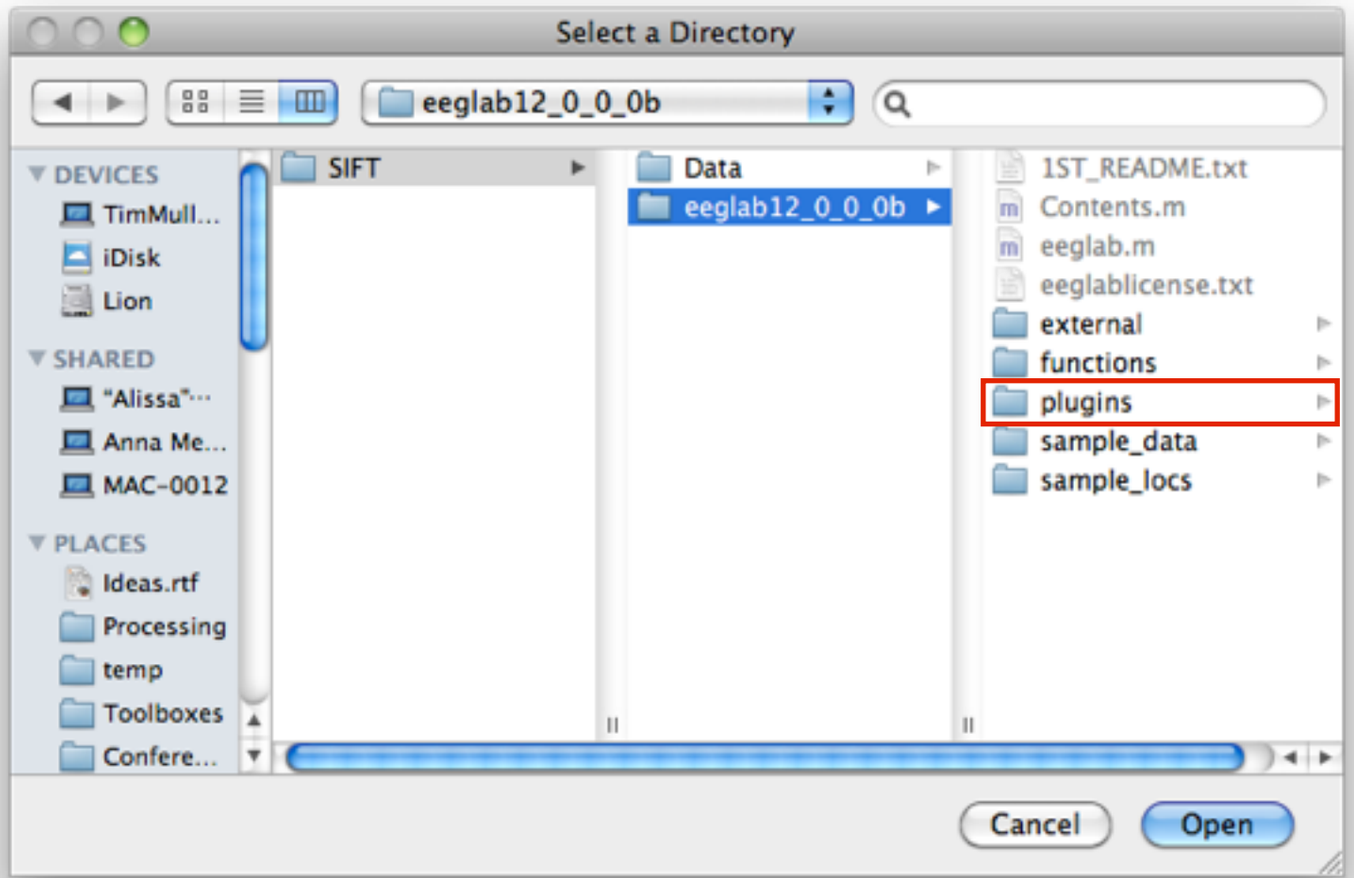


* SIFT 1.5+ required for compatibility with Matlab 2014a or greater

1 Starting EEGLAB/SIFT

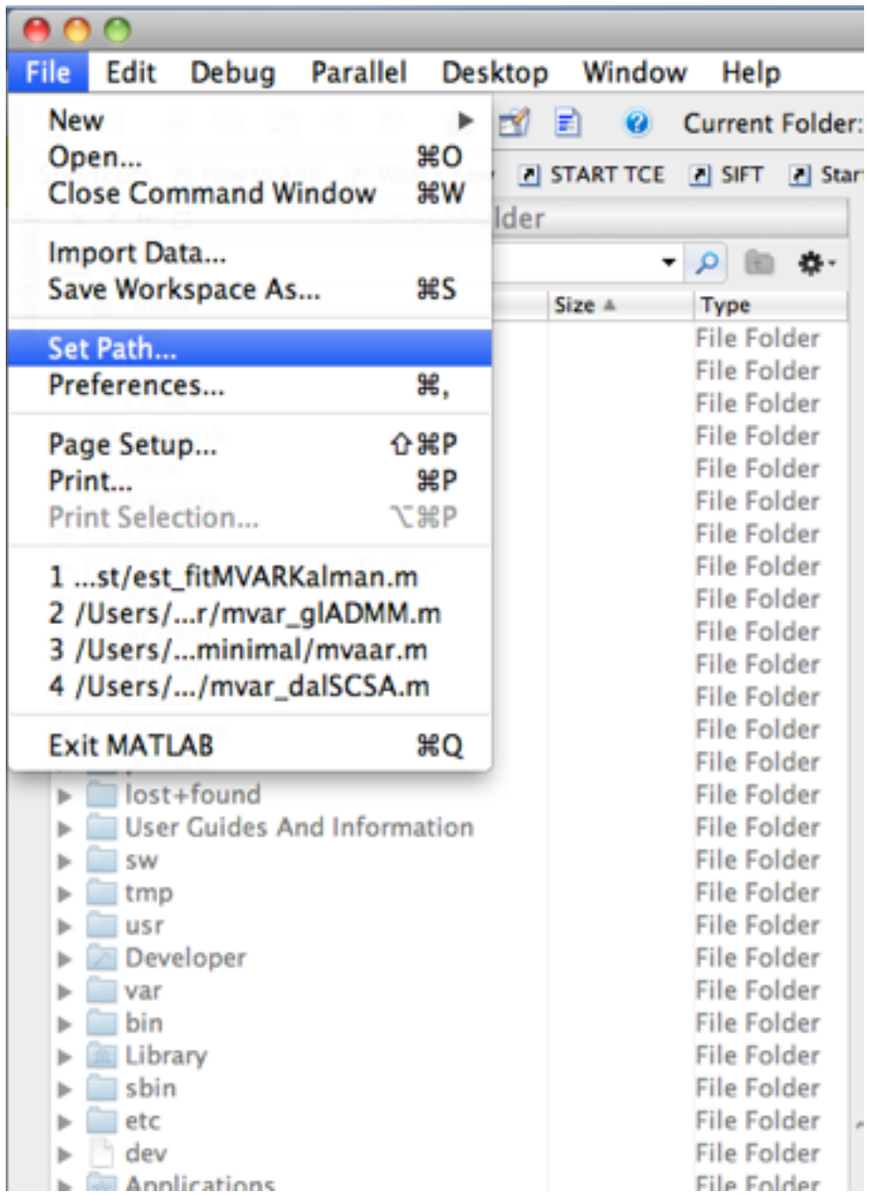
If you can't install SIFT via plugin manager…

Copy <USB-key>/…/SIFT_1.5 to EEGLAB plugins folder (unzipped)

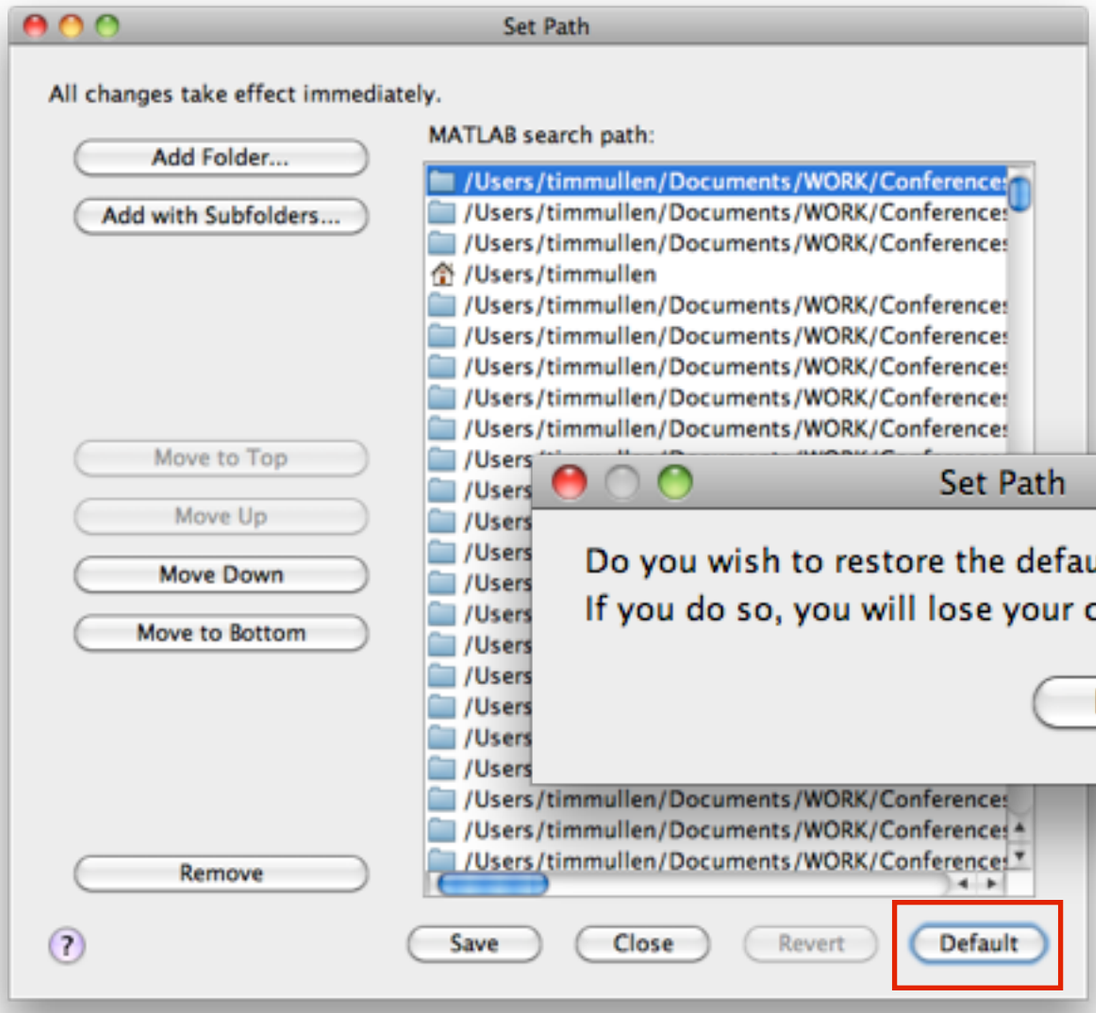


1 Starting EEGLAB/SIFT

If you don't have SIFT Installed

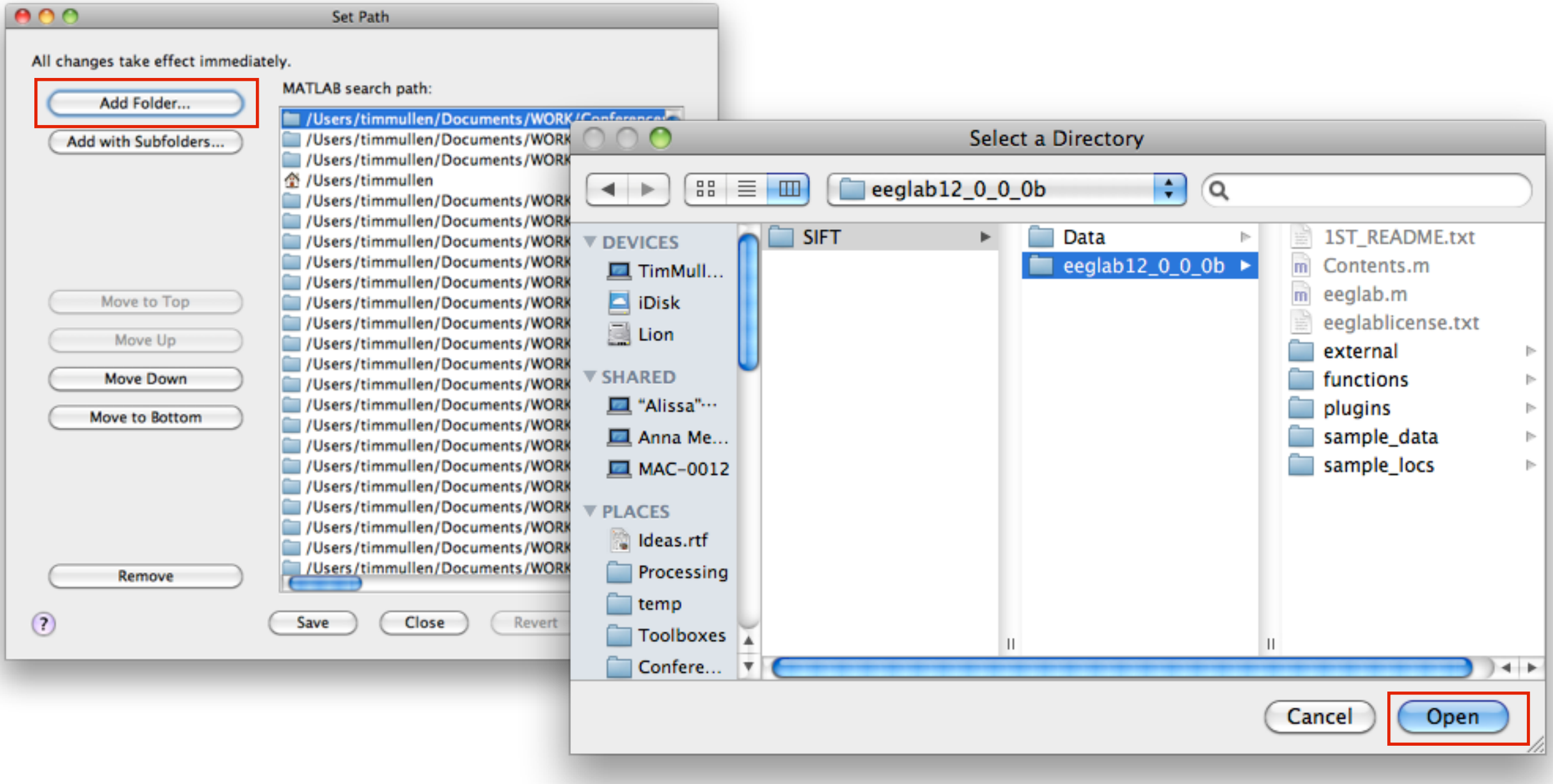


1. Clear the Matlab Path



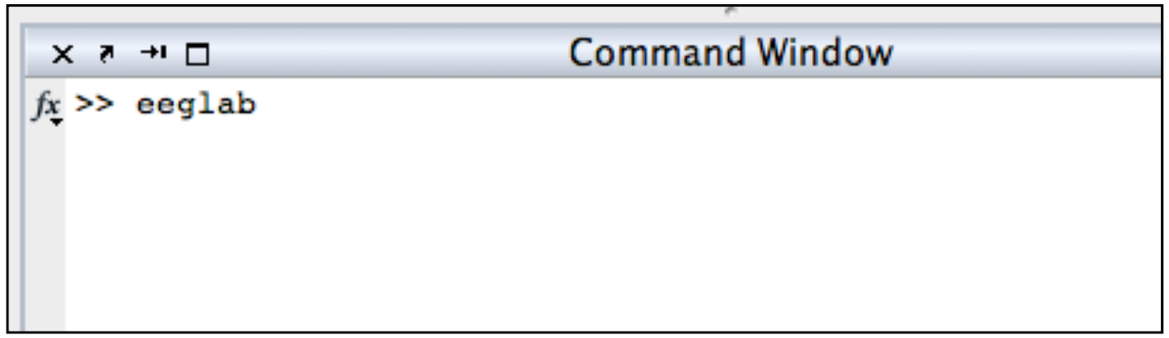
1 Starting EEGLAB/SIFT

2. Add EEGLAB+SIFT to path



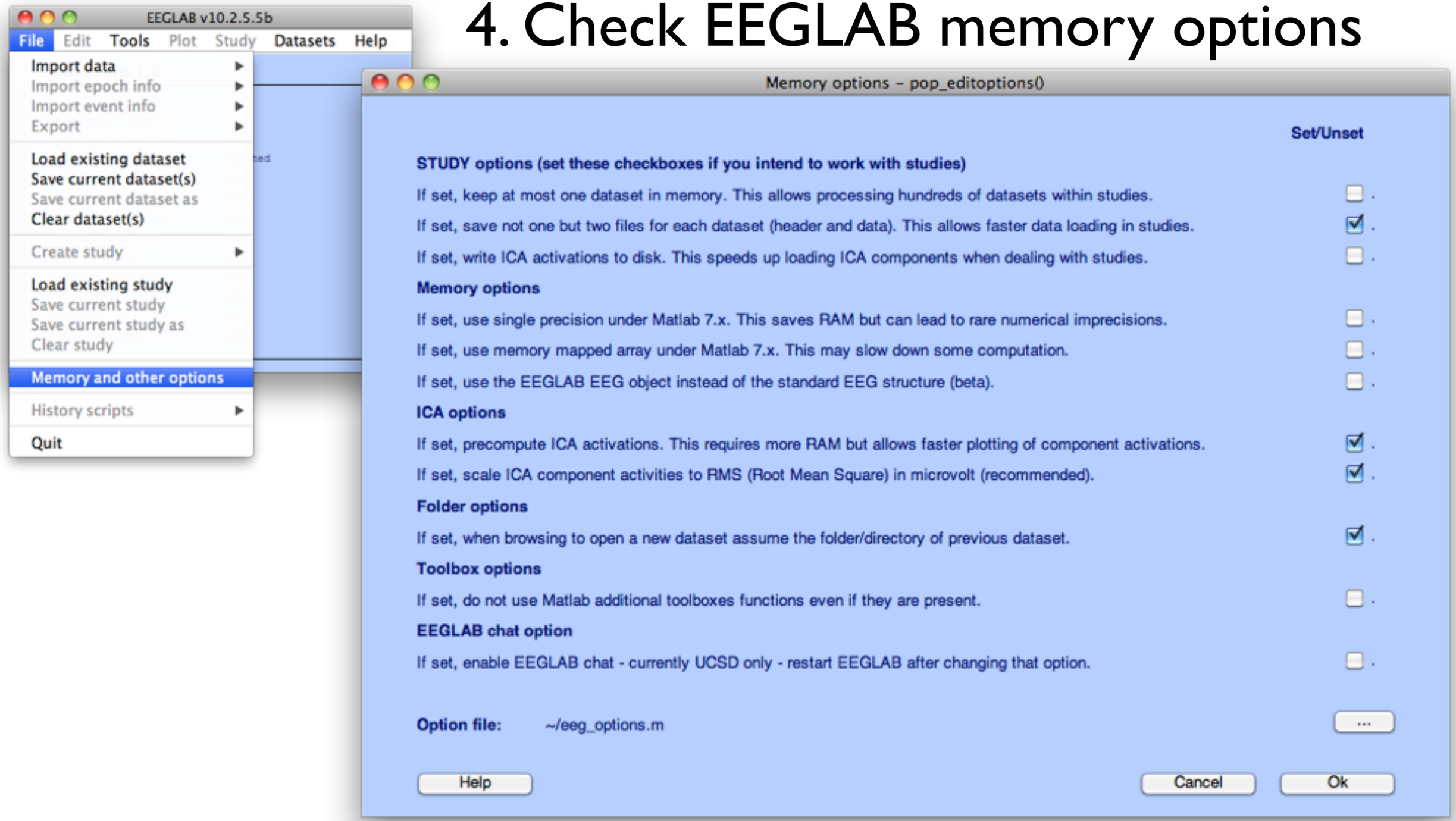
I Starting EEGLAB/SIFT

3. Start EEGLAB



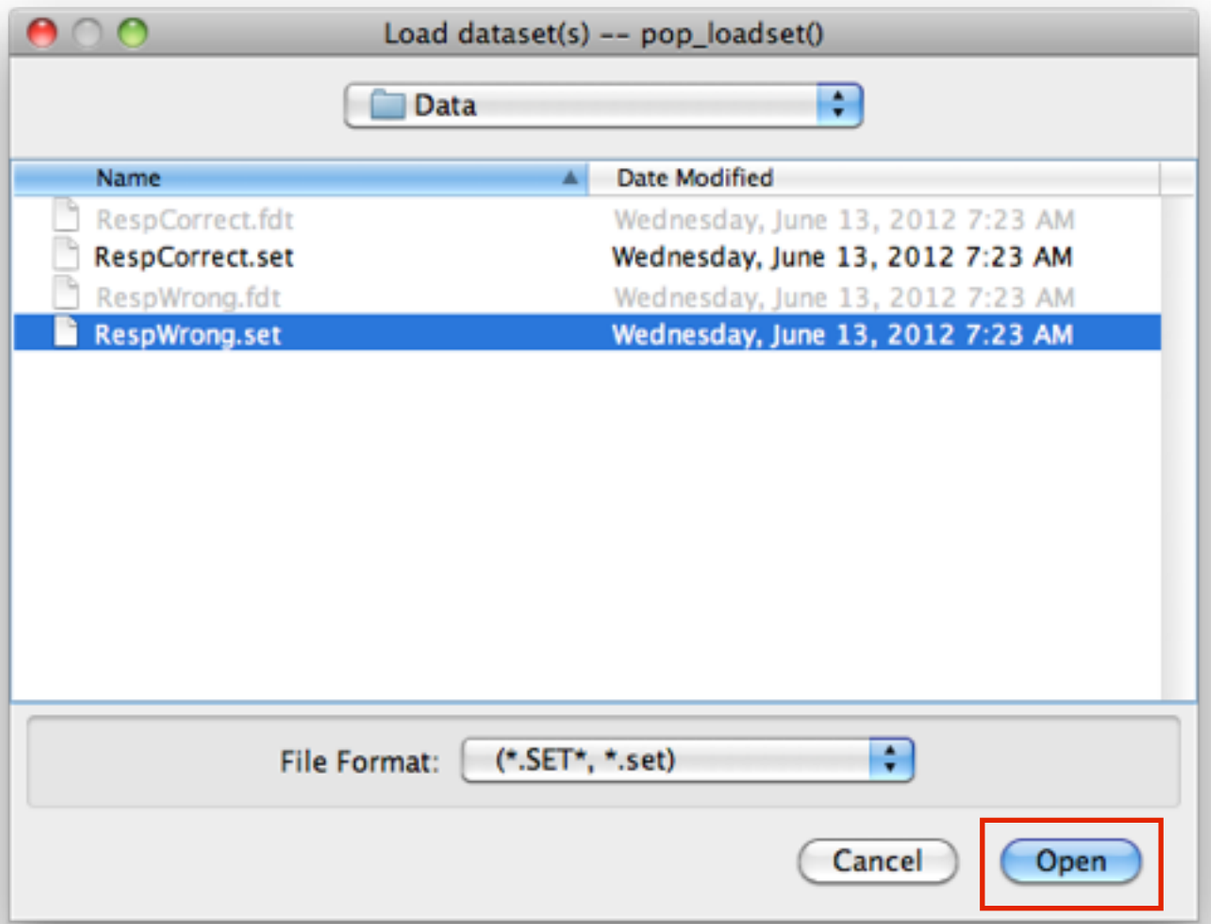
I Starting EEGLAB/SIFT

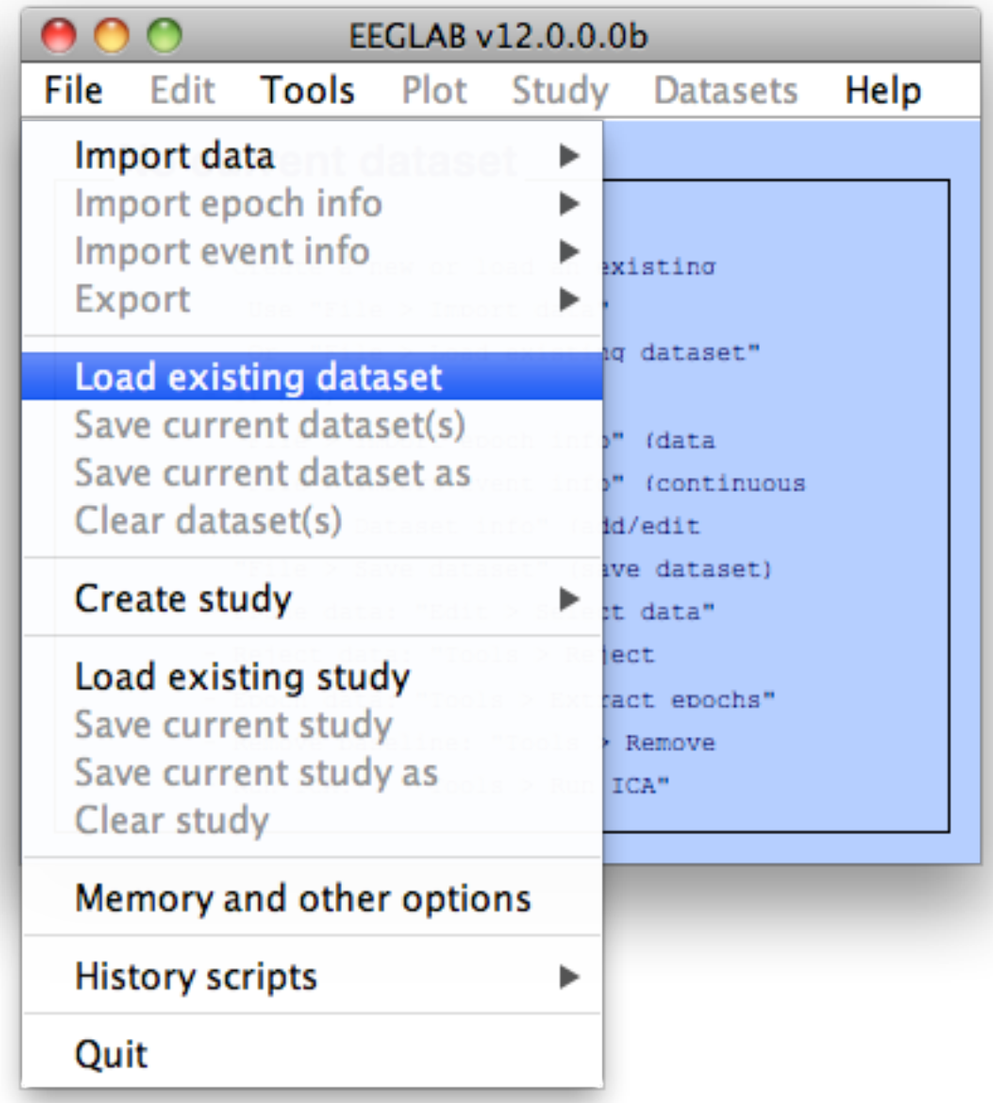
4. Check EEGLAB memory options



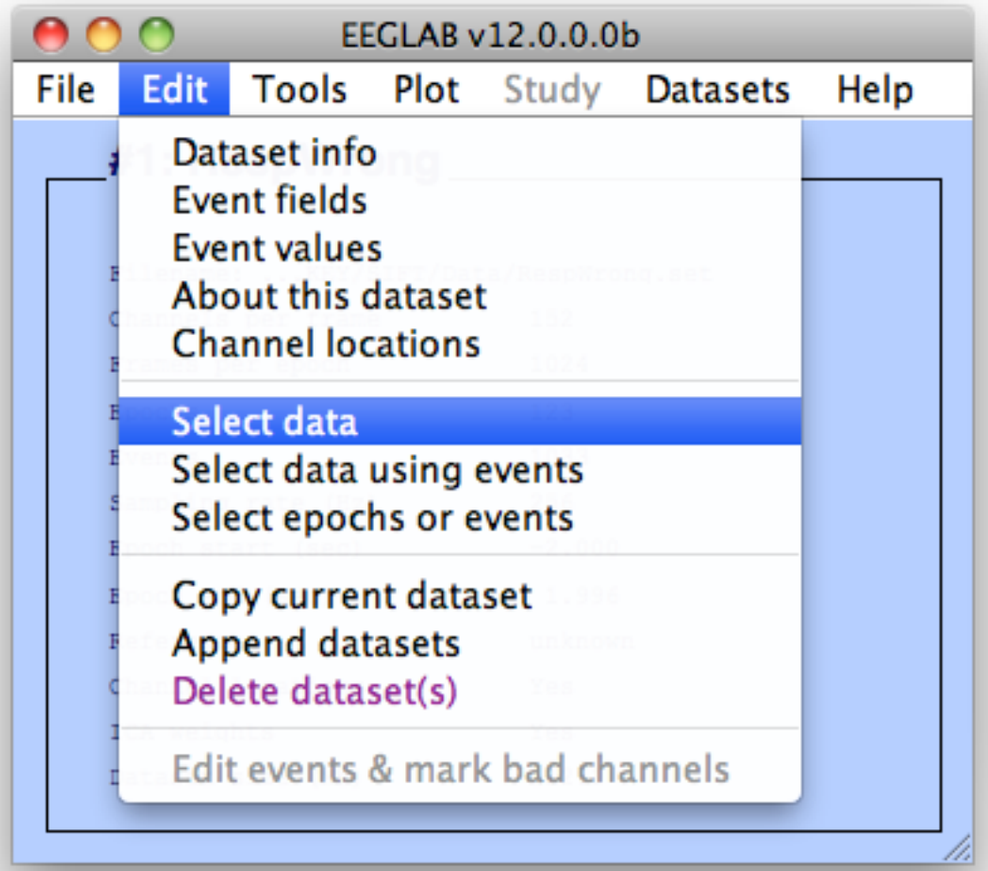
2 Loading Data

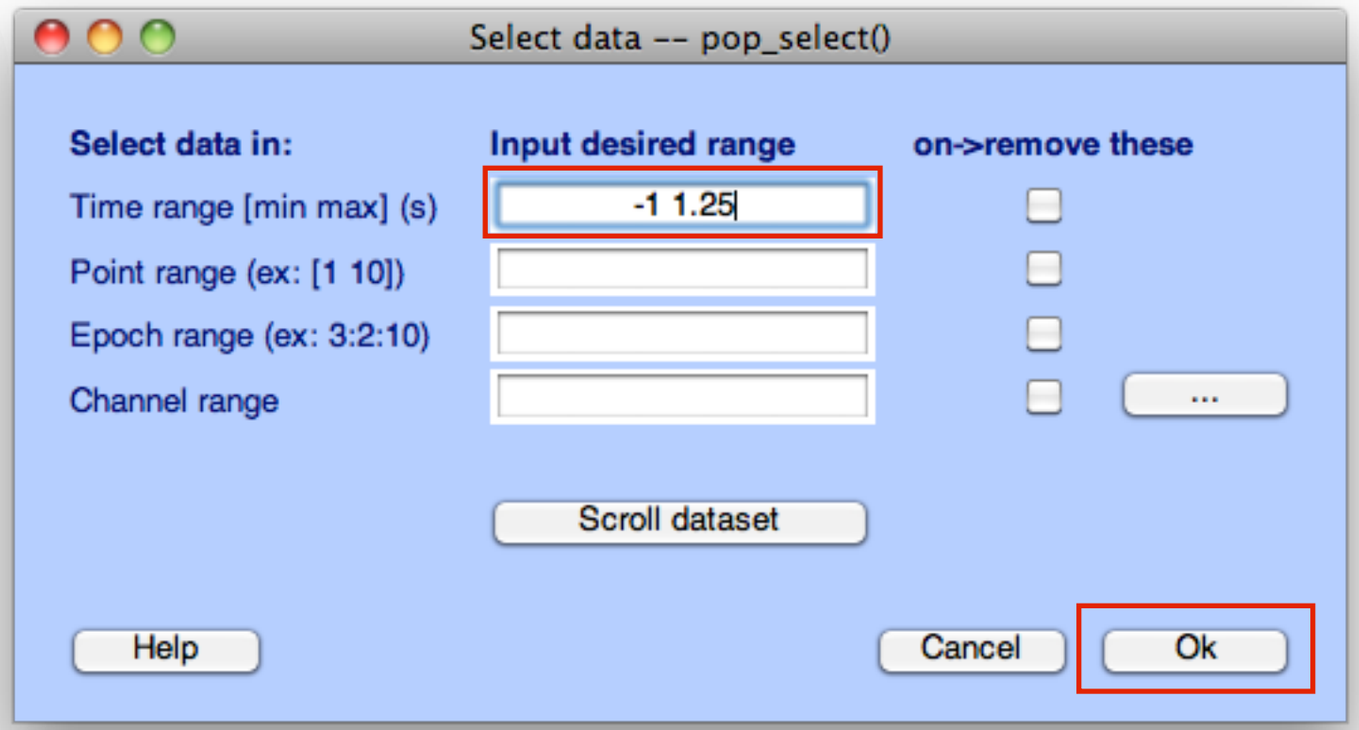
<USB Key>/SIFT/Data/

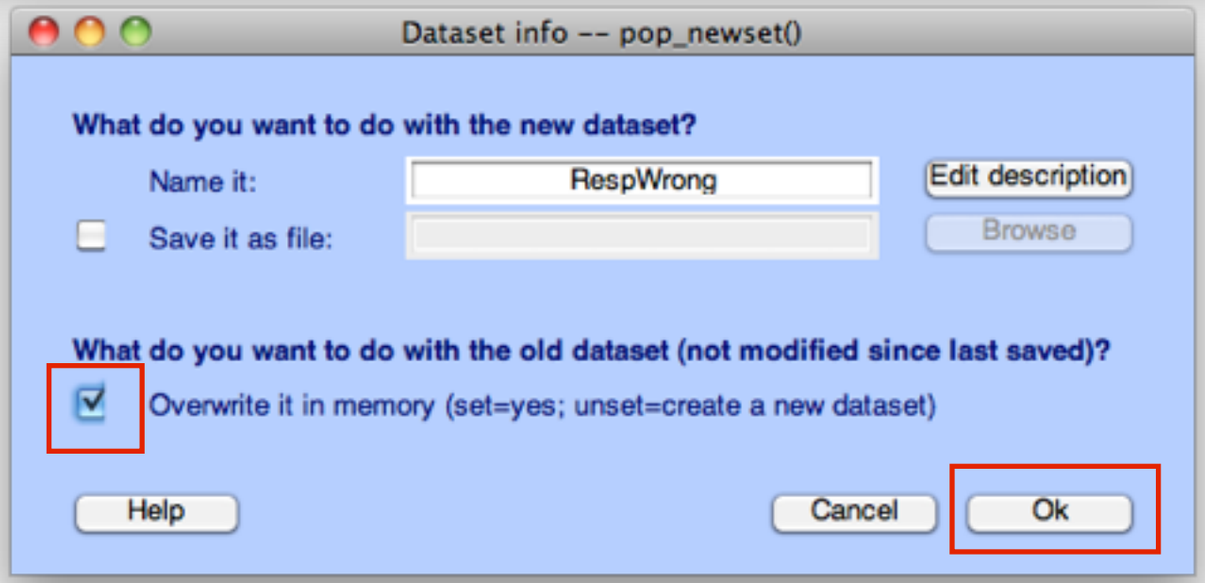




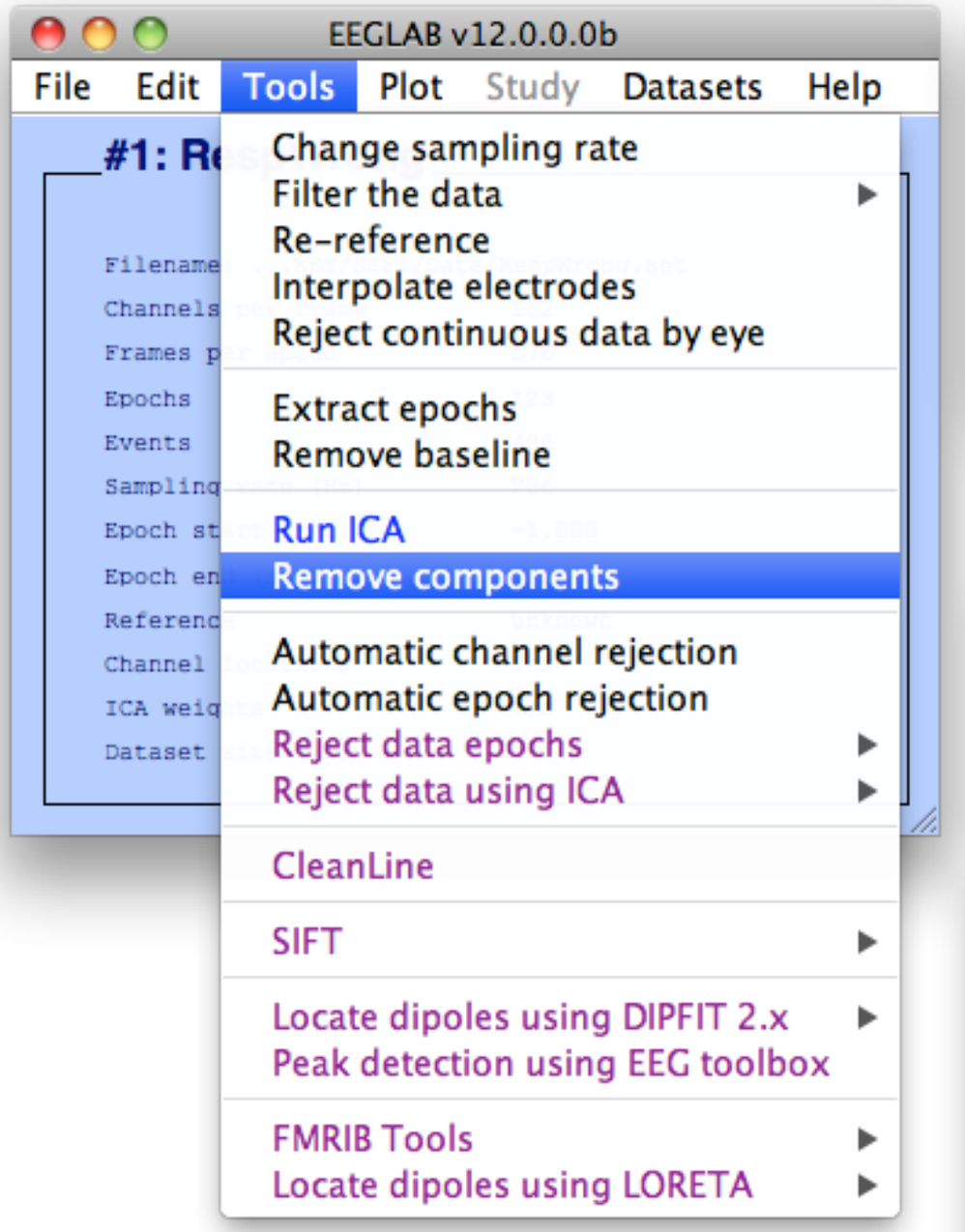
3 Preprocessing: Select Data Range

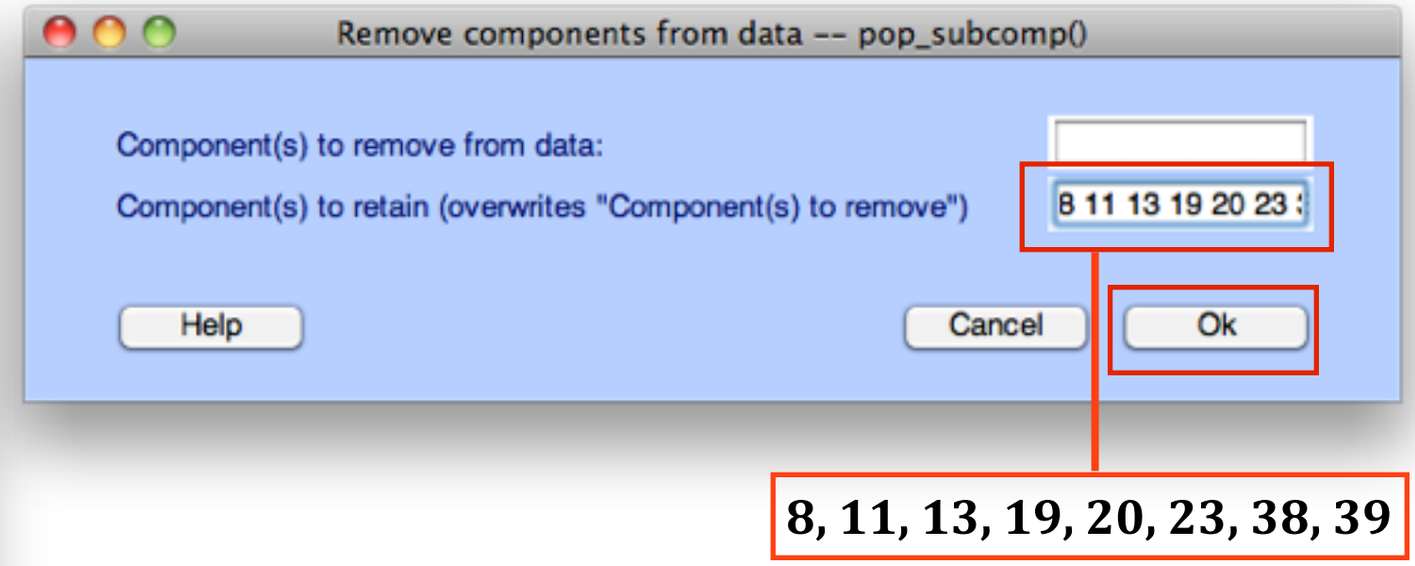




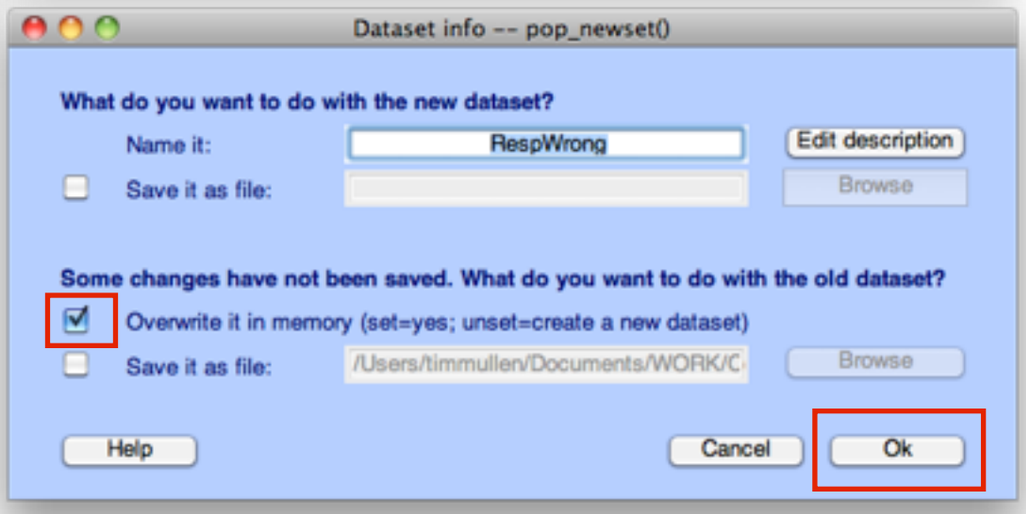


3 Preprocessing: Select Components

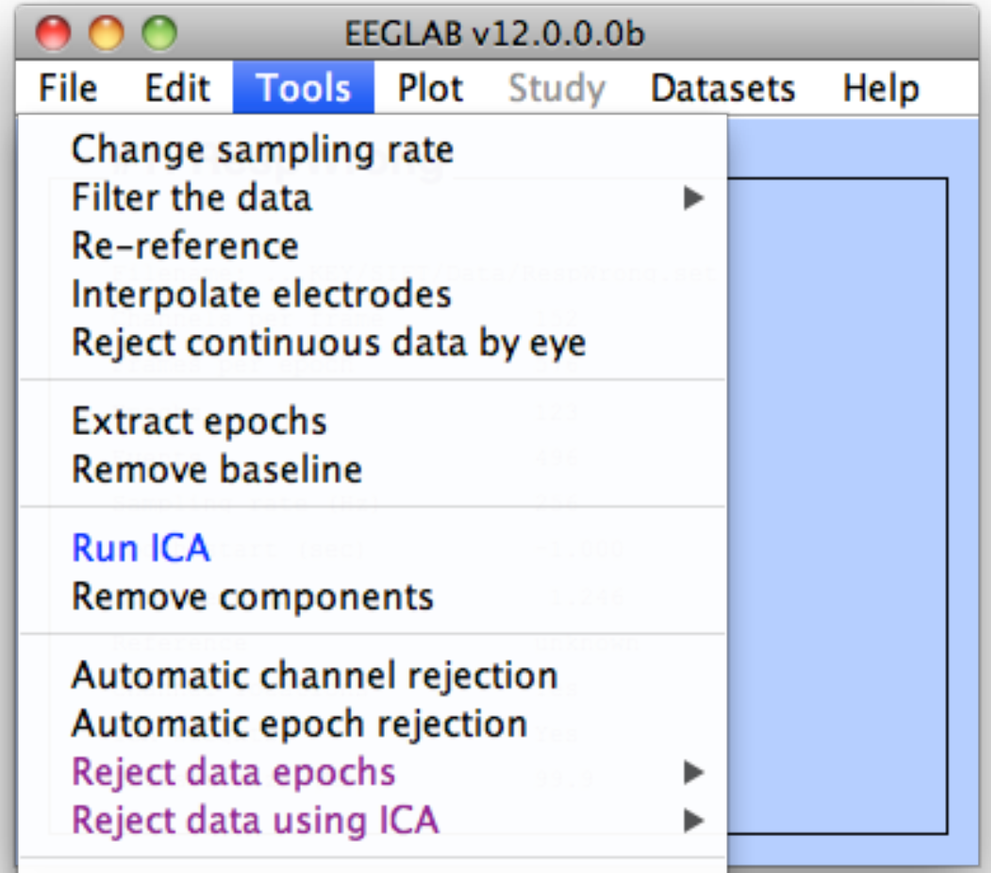


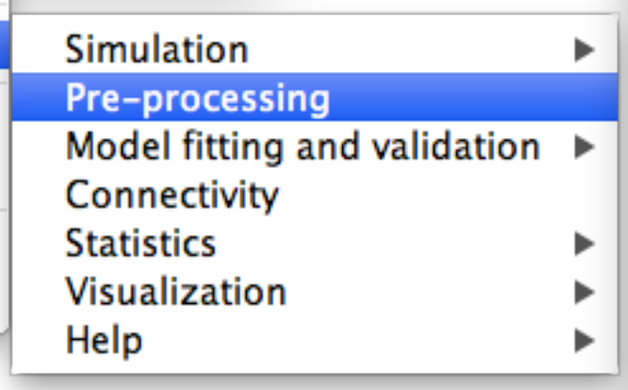


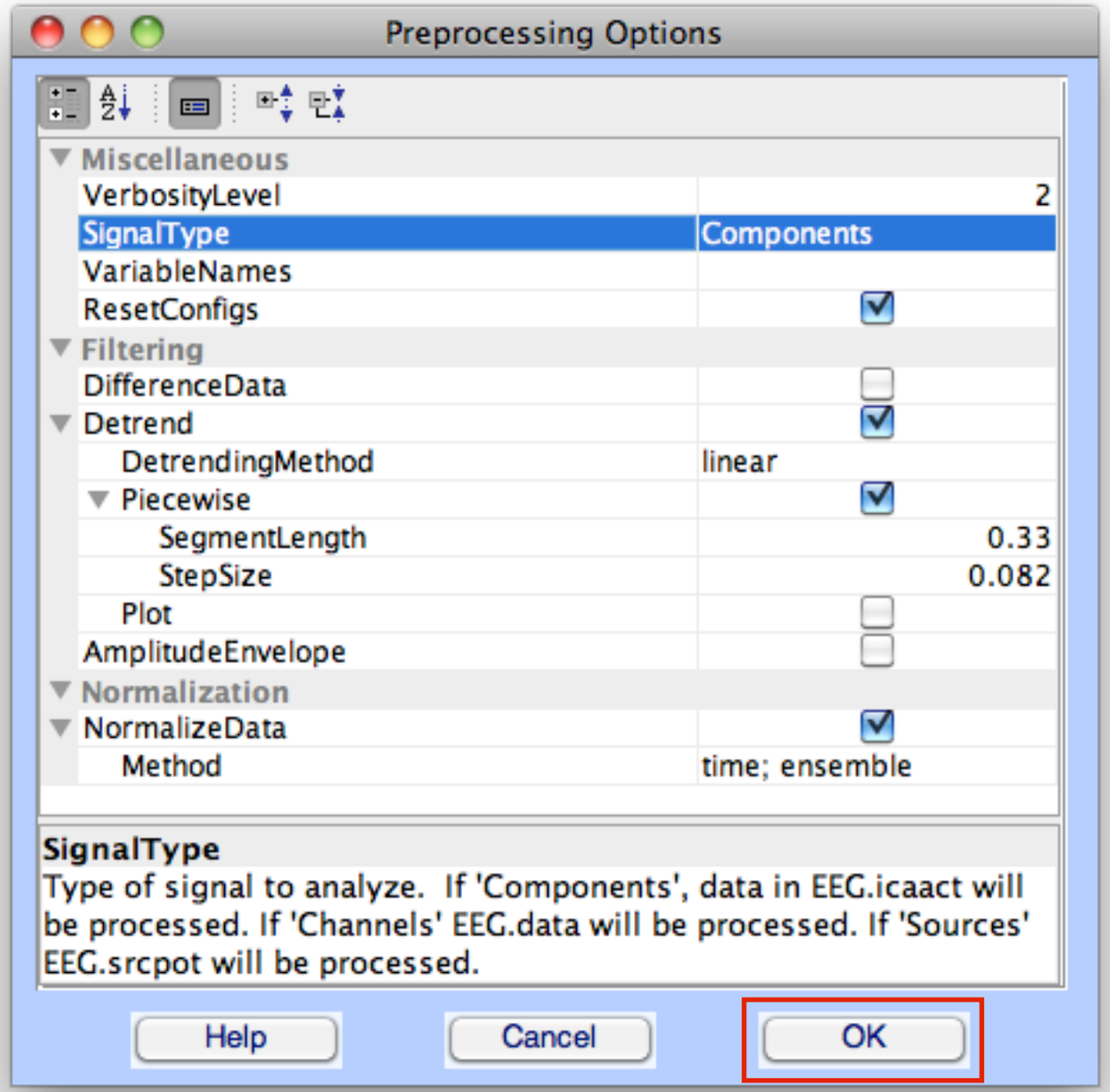
8, 11, 13, 19, 20, 23, 38, 39

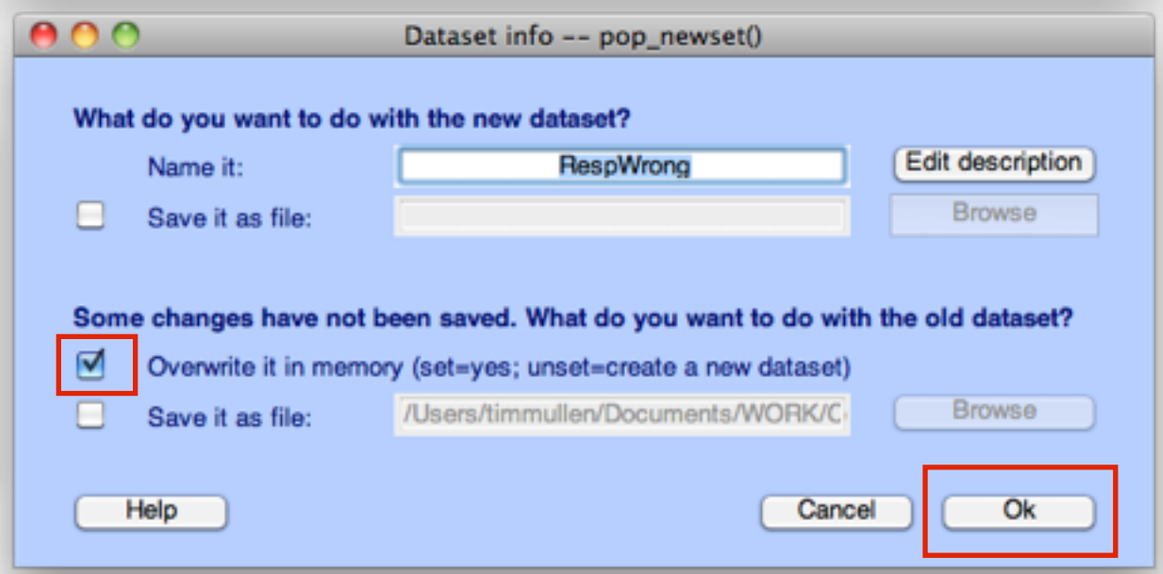


3 Preprocessing: SIFT

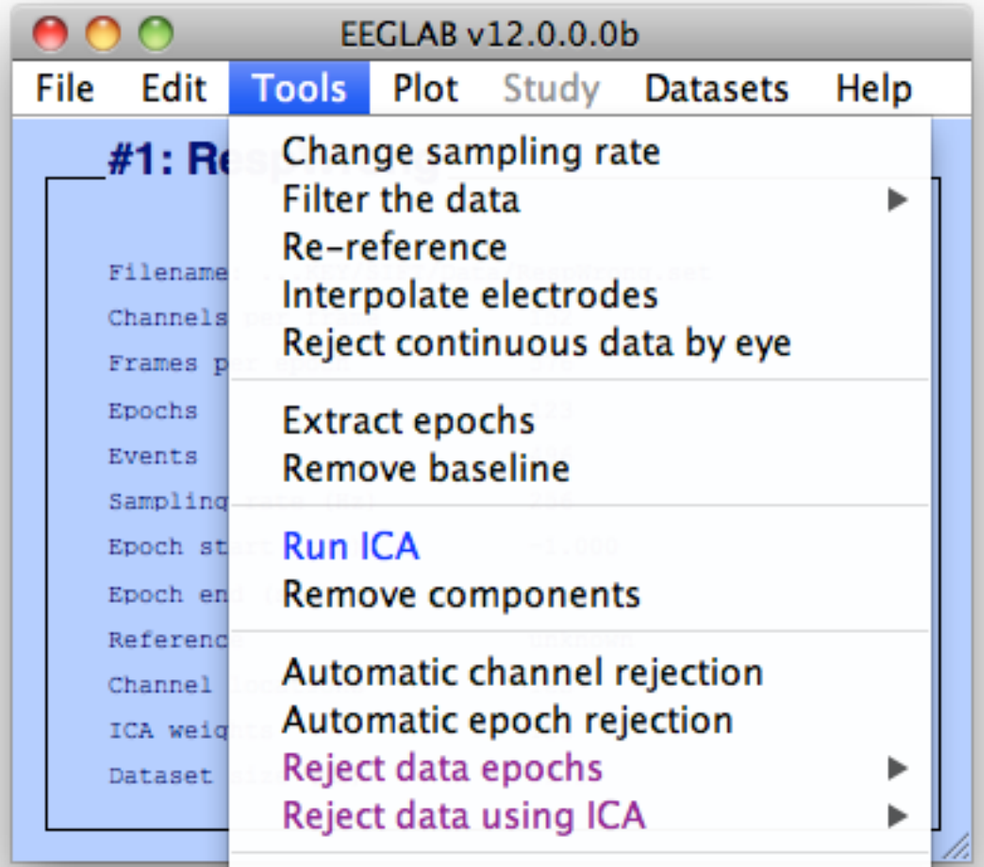


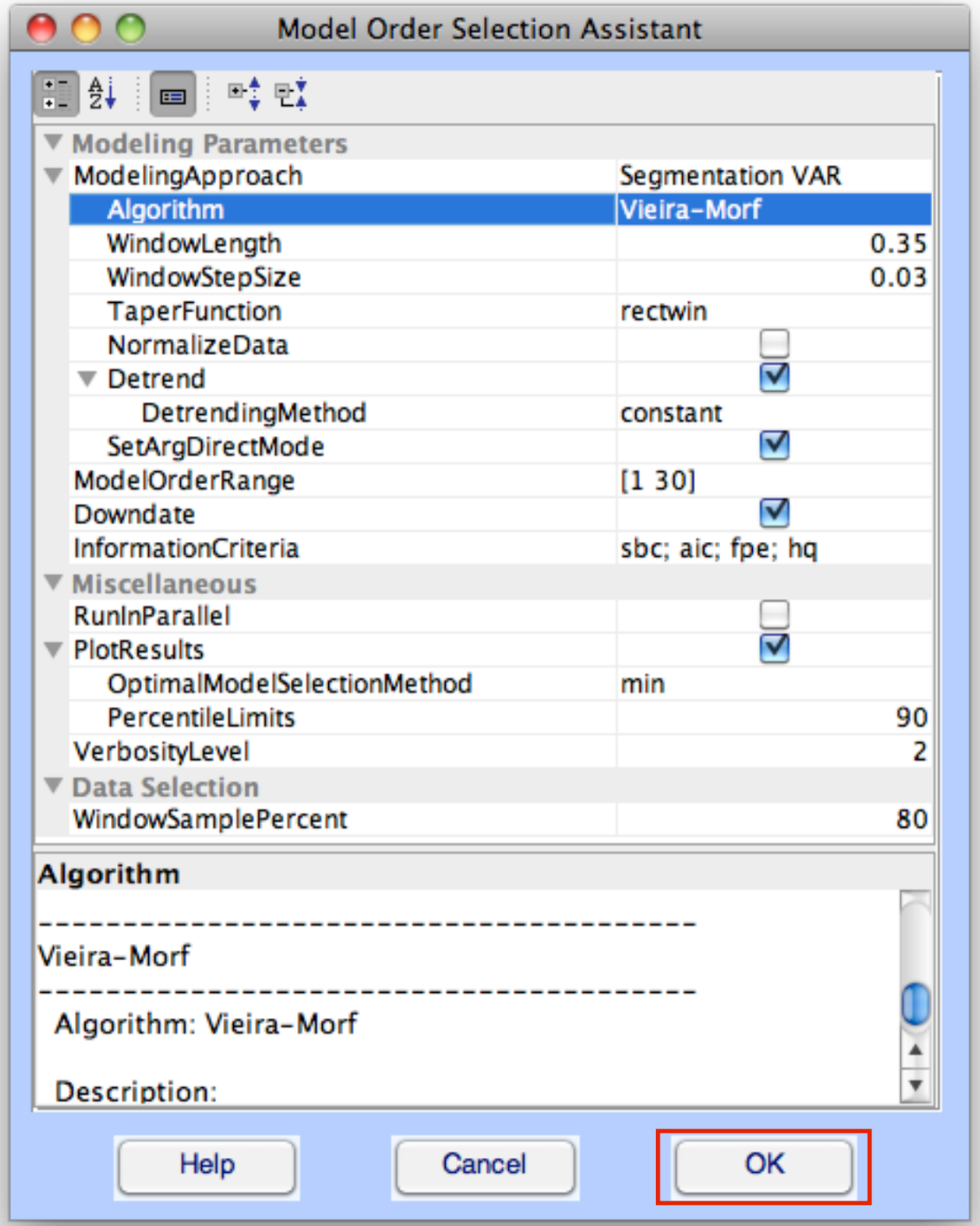




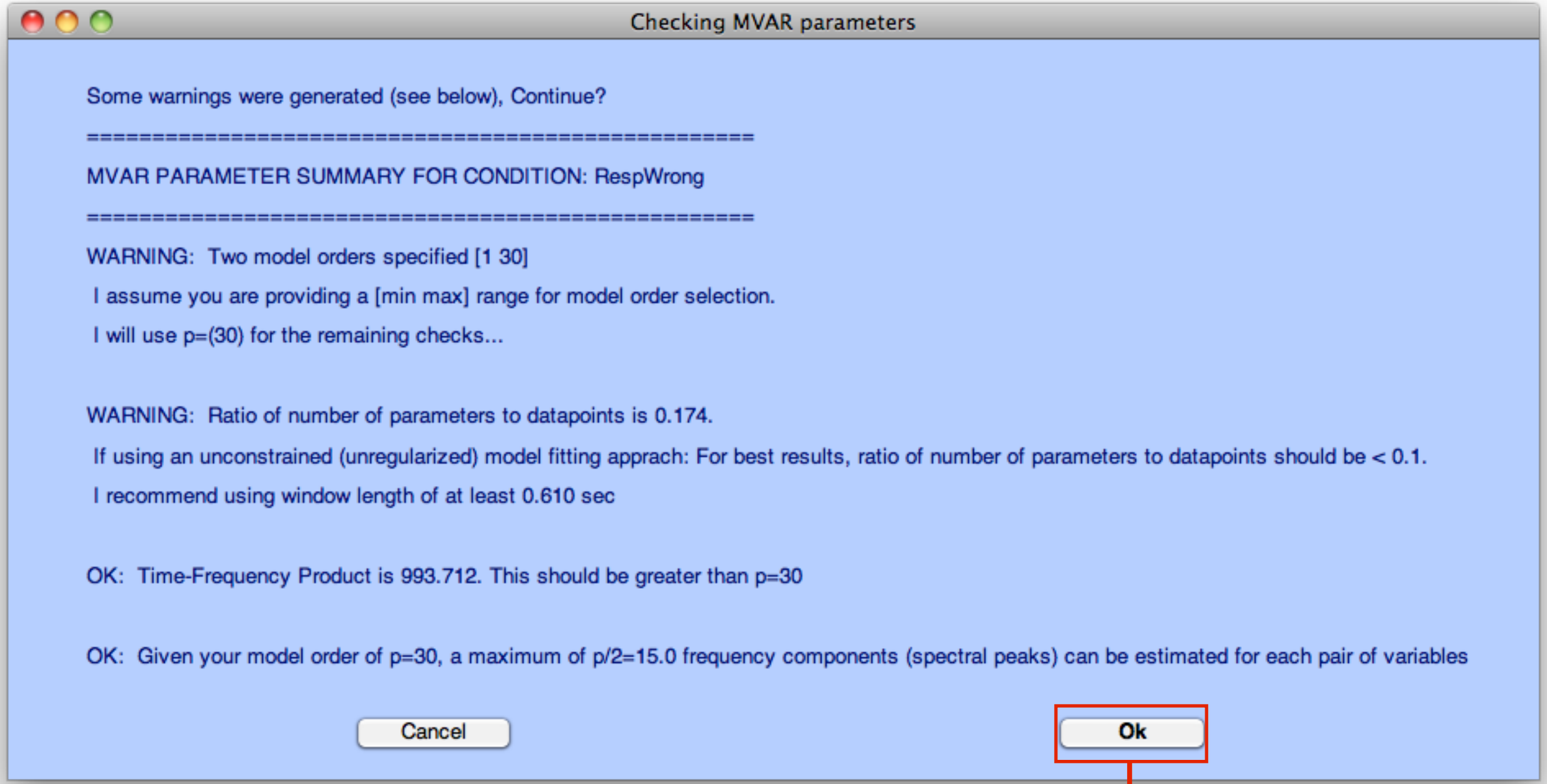


4 Model Order Selection





4 Model Order Selection



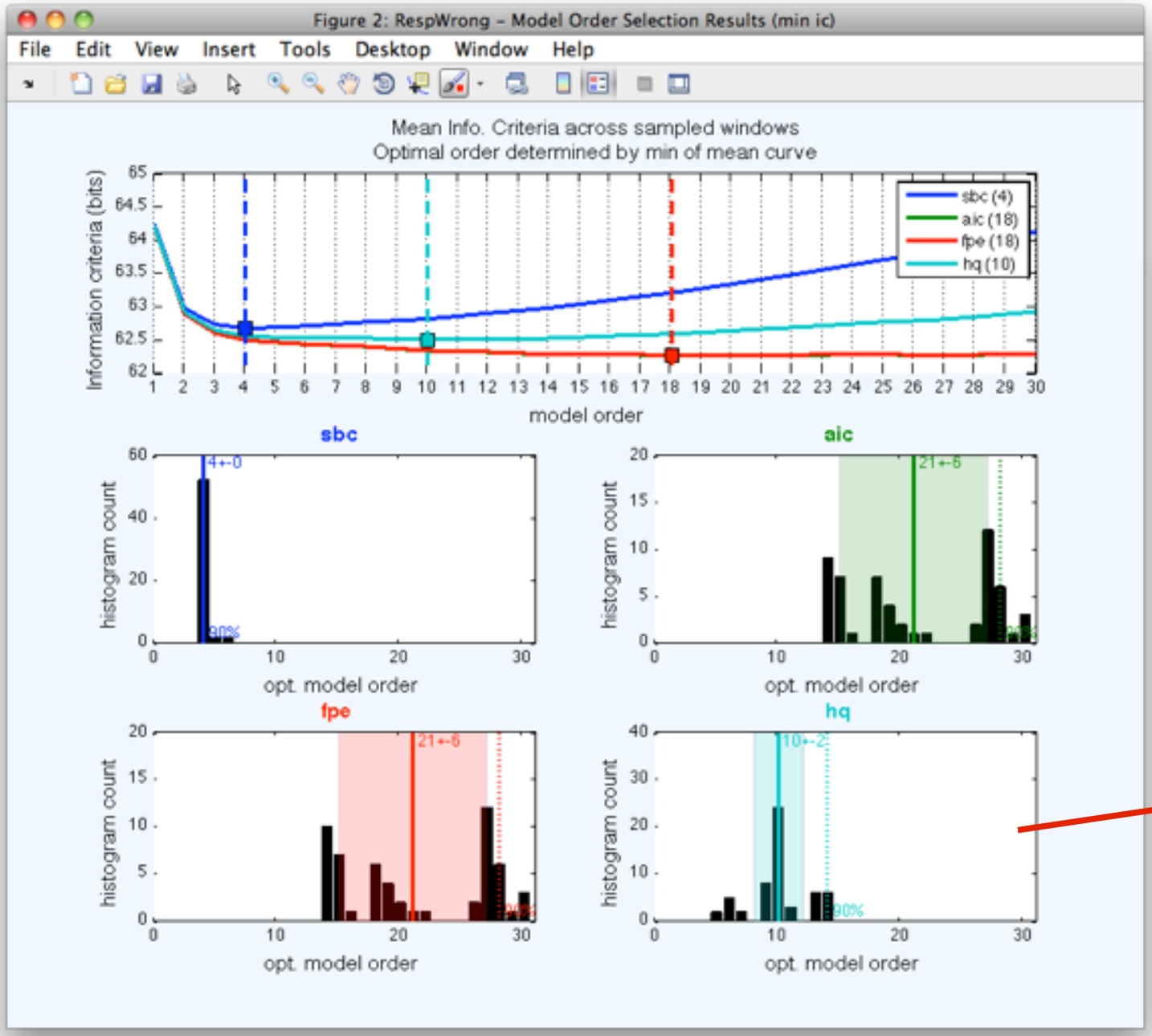


Figure 2: RespWrong - Model Order Selection Results (min ic)
File Edit View Insert Tools Desktop Window Help
Mean Info. Criteria across sampled windows
Optimal order determined by min of mean curve
Information criteria (bits)
model order
sbc (4)
aic (18)
fpe (18)
hq (10)
sbc
aic
fpe
hq
histogram count
opt. model order
4+-0
21+-6
10+-2
90%

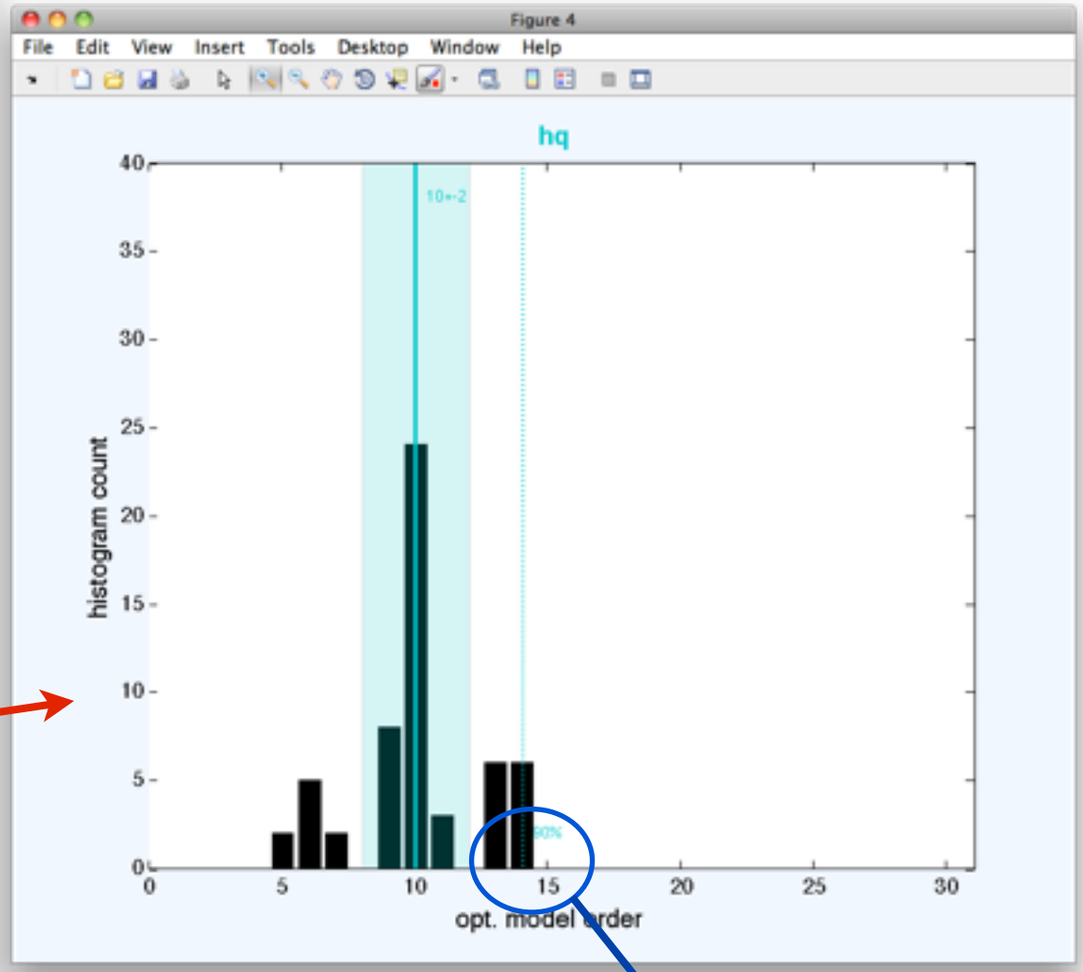
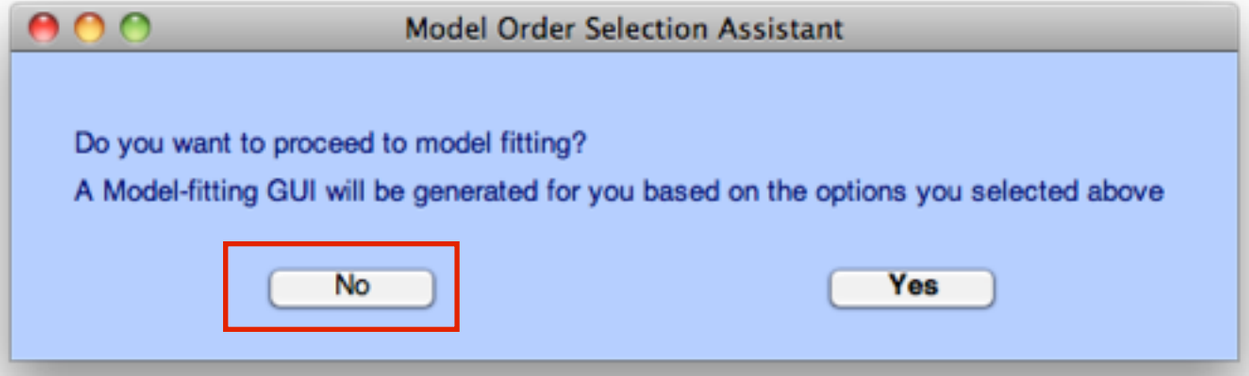
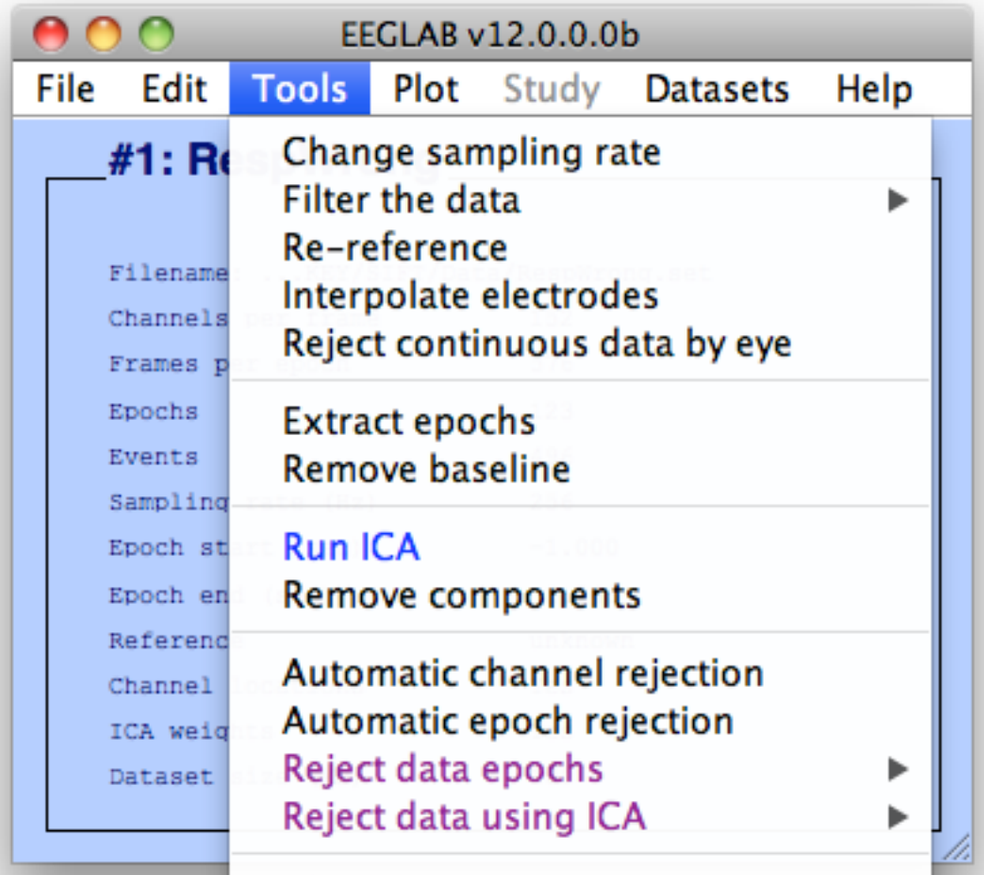


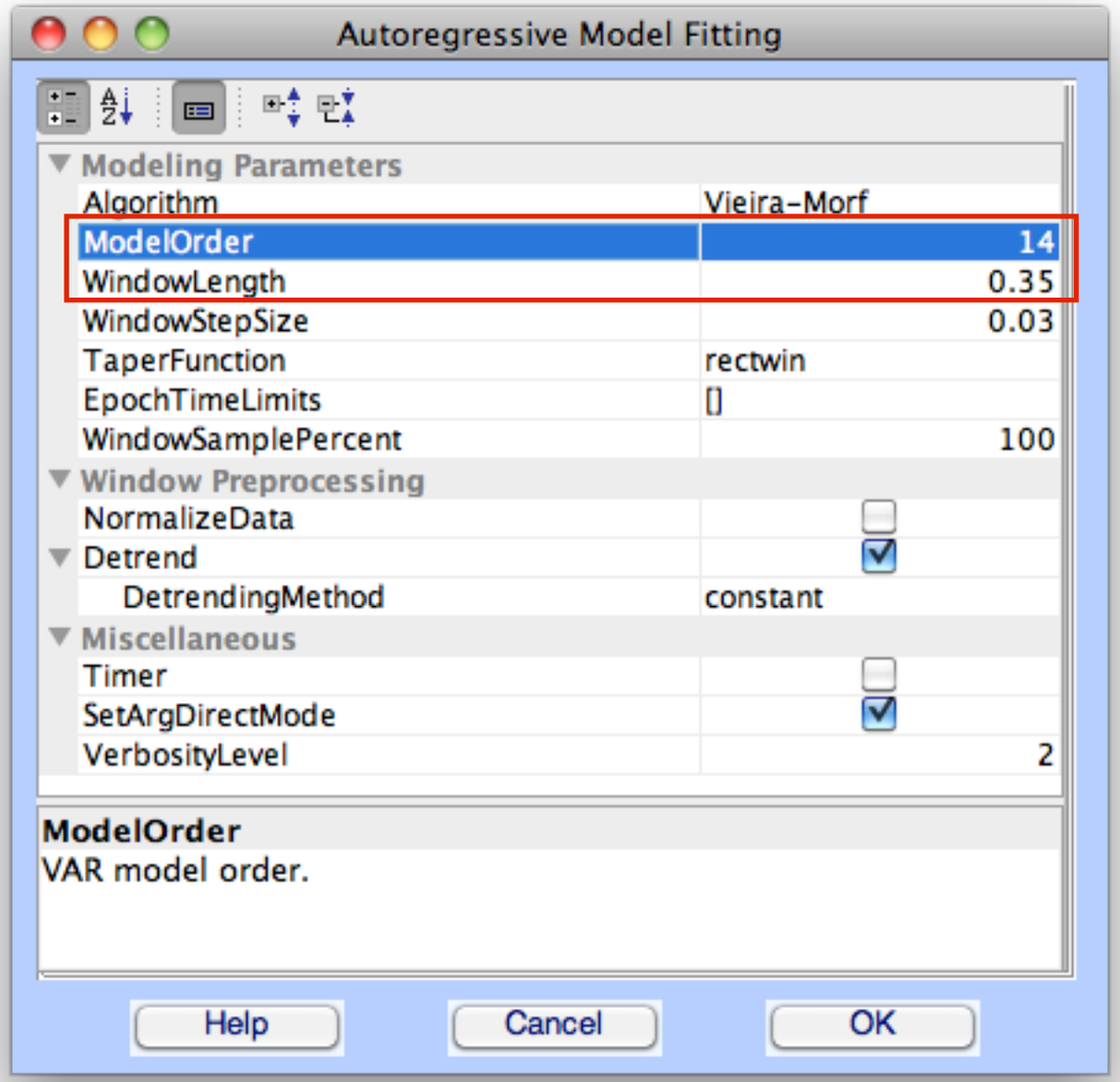
Figure 4
File Edit View Insert Tools Desktop Window Help
hq
histogram count
opt. model order
10+-2
90%

Order: 14

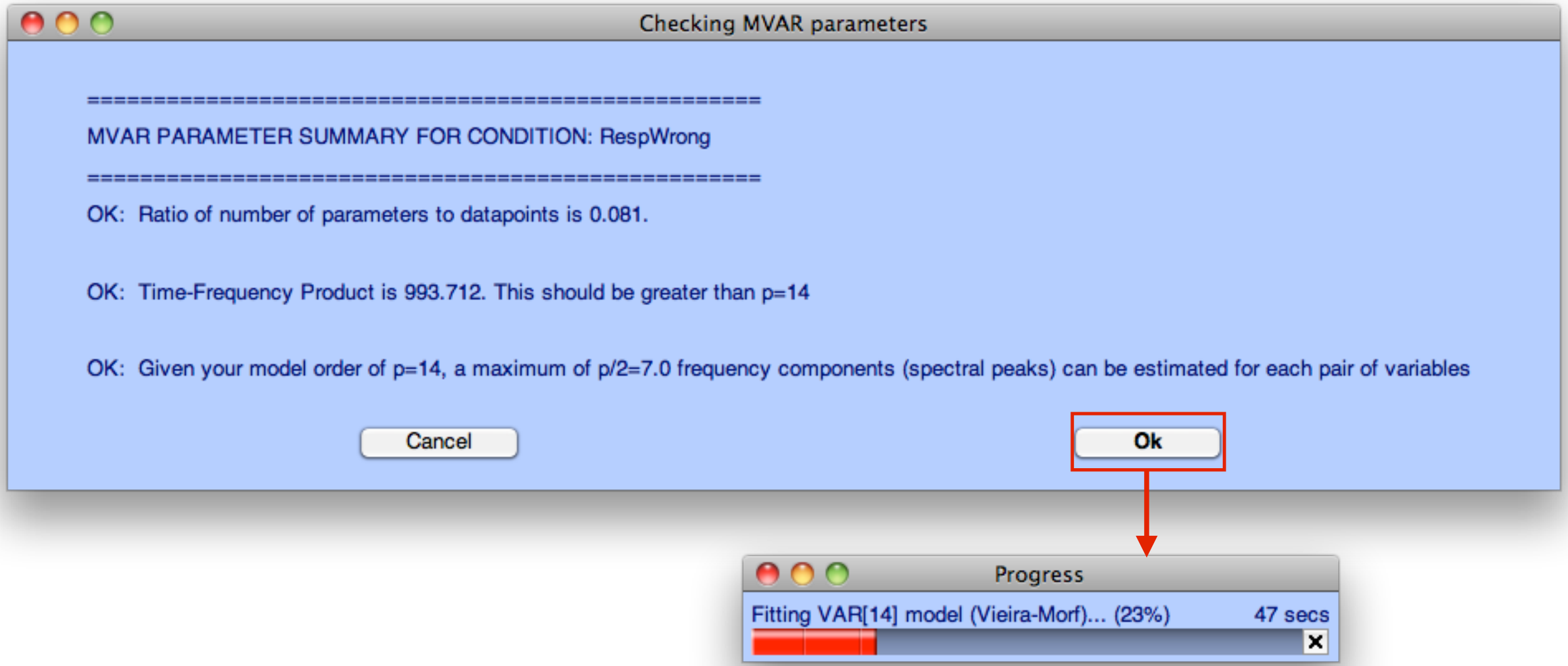

Model Order Selection Assistant
Do you want to proceed to model fitting?
A Model-fitting GUI will be generated for you based on the options you selected above
No
Yes

5 Model Fitting

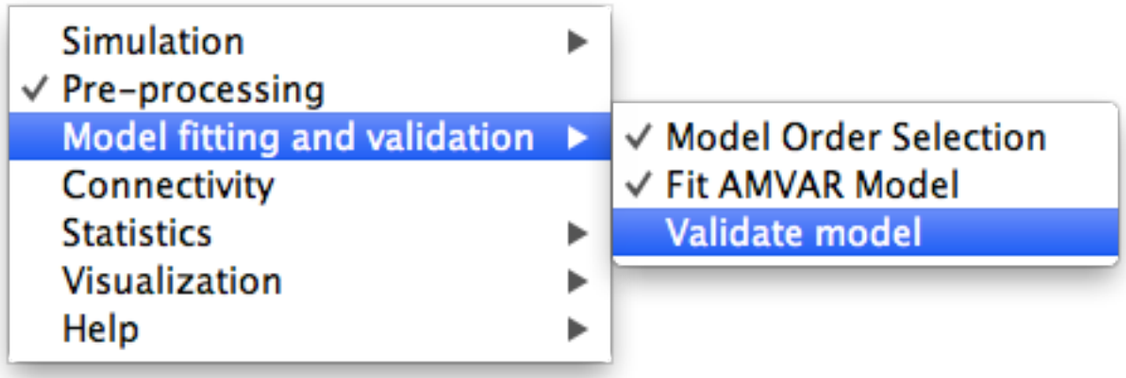


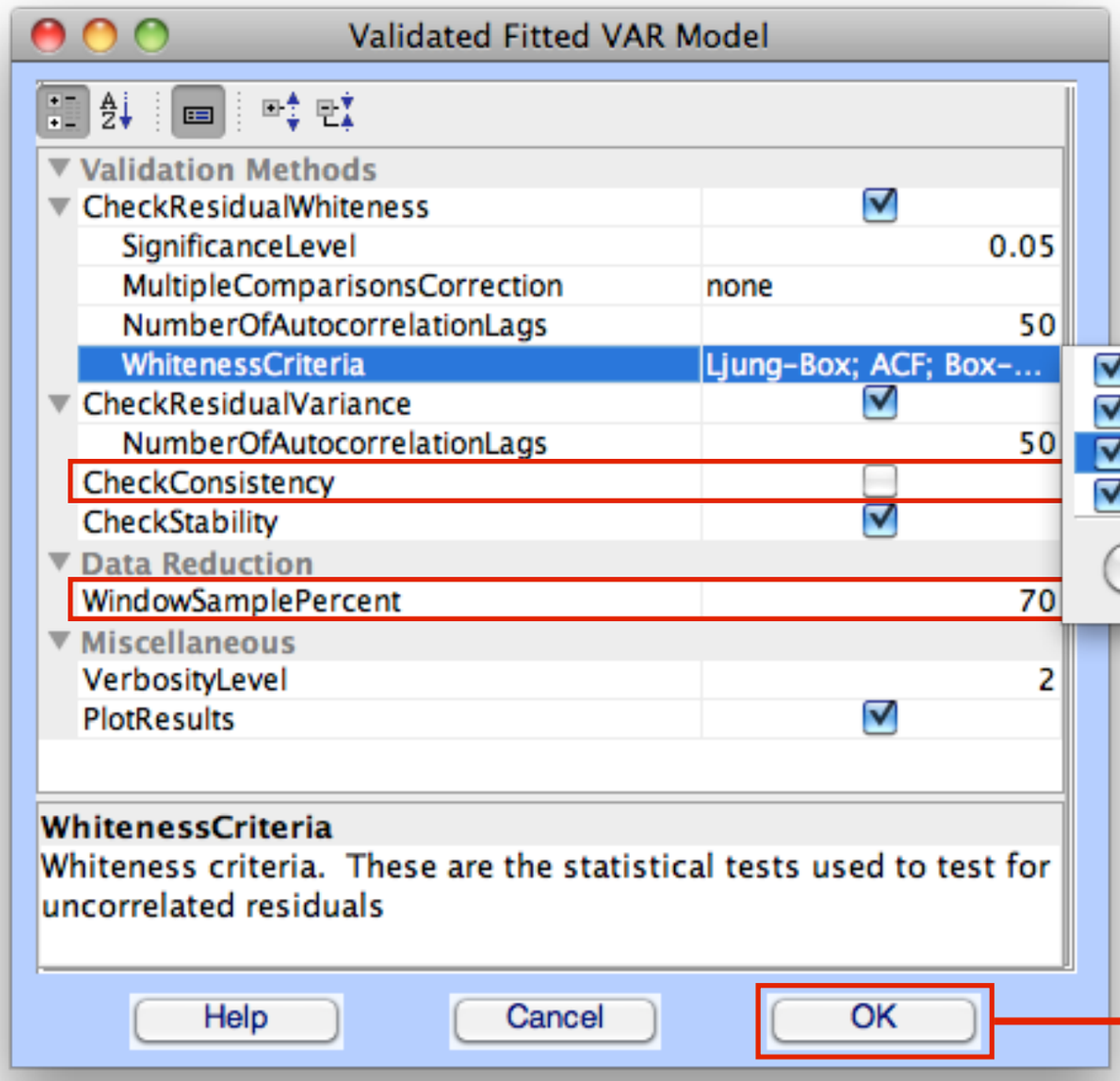


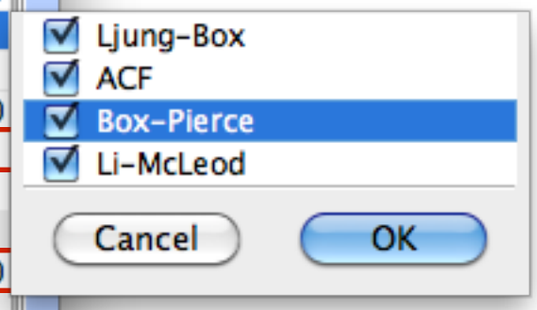
5 Model Fitting

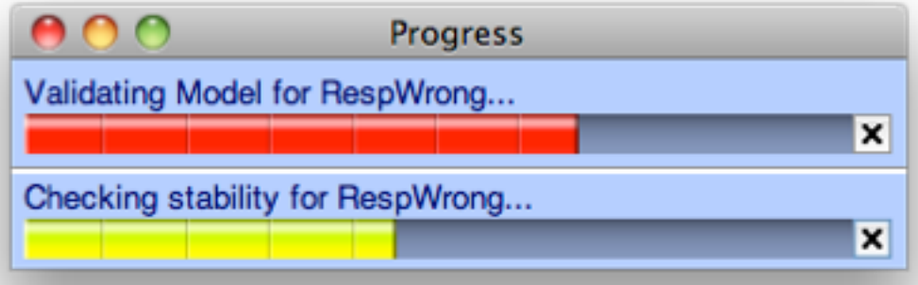


6 Model Validation

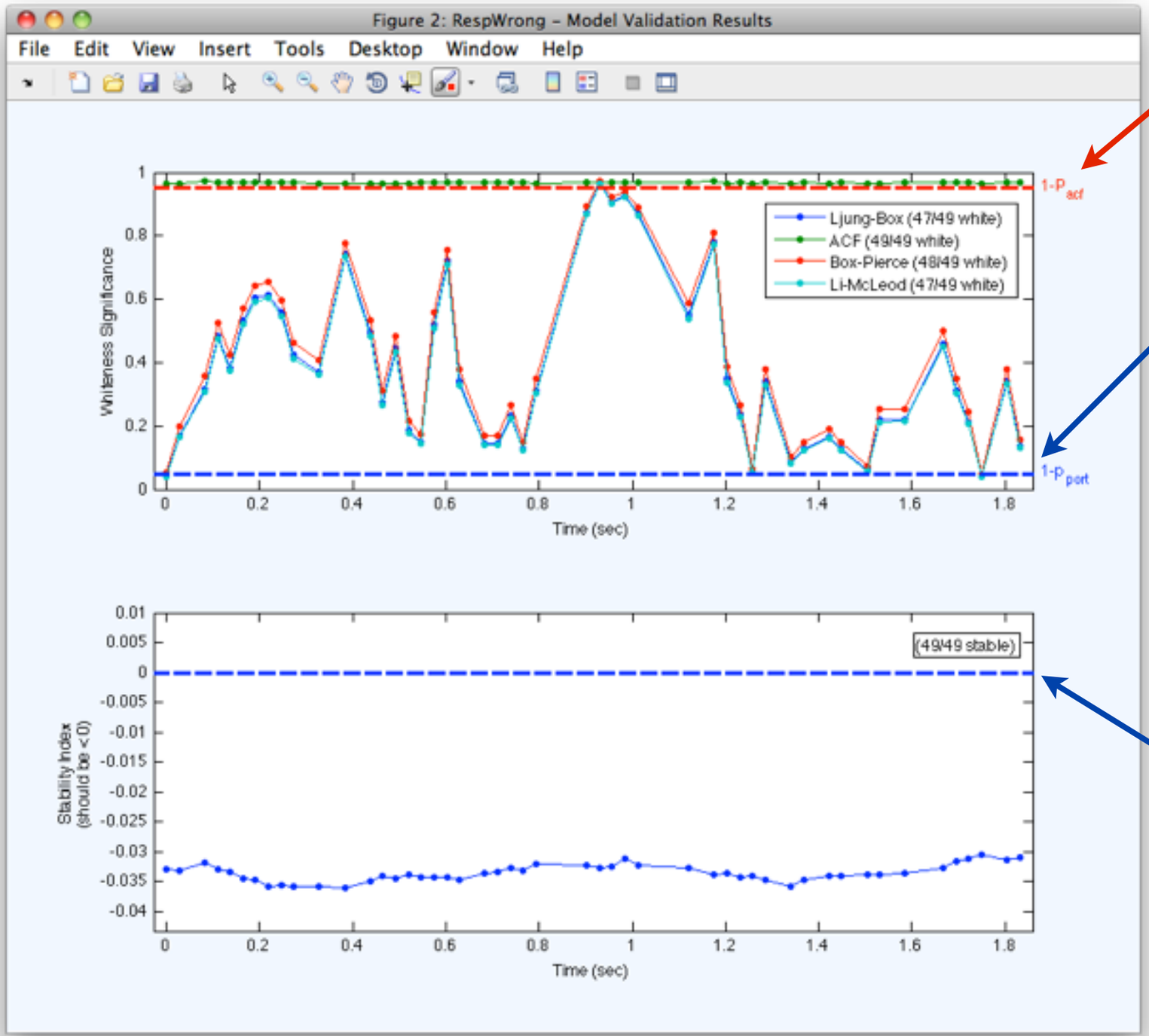








6 Model Validation

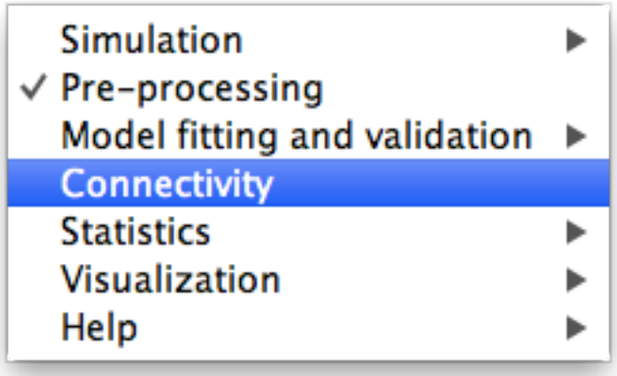


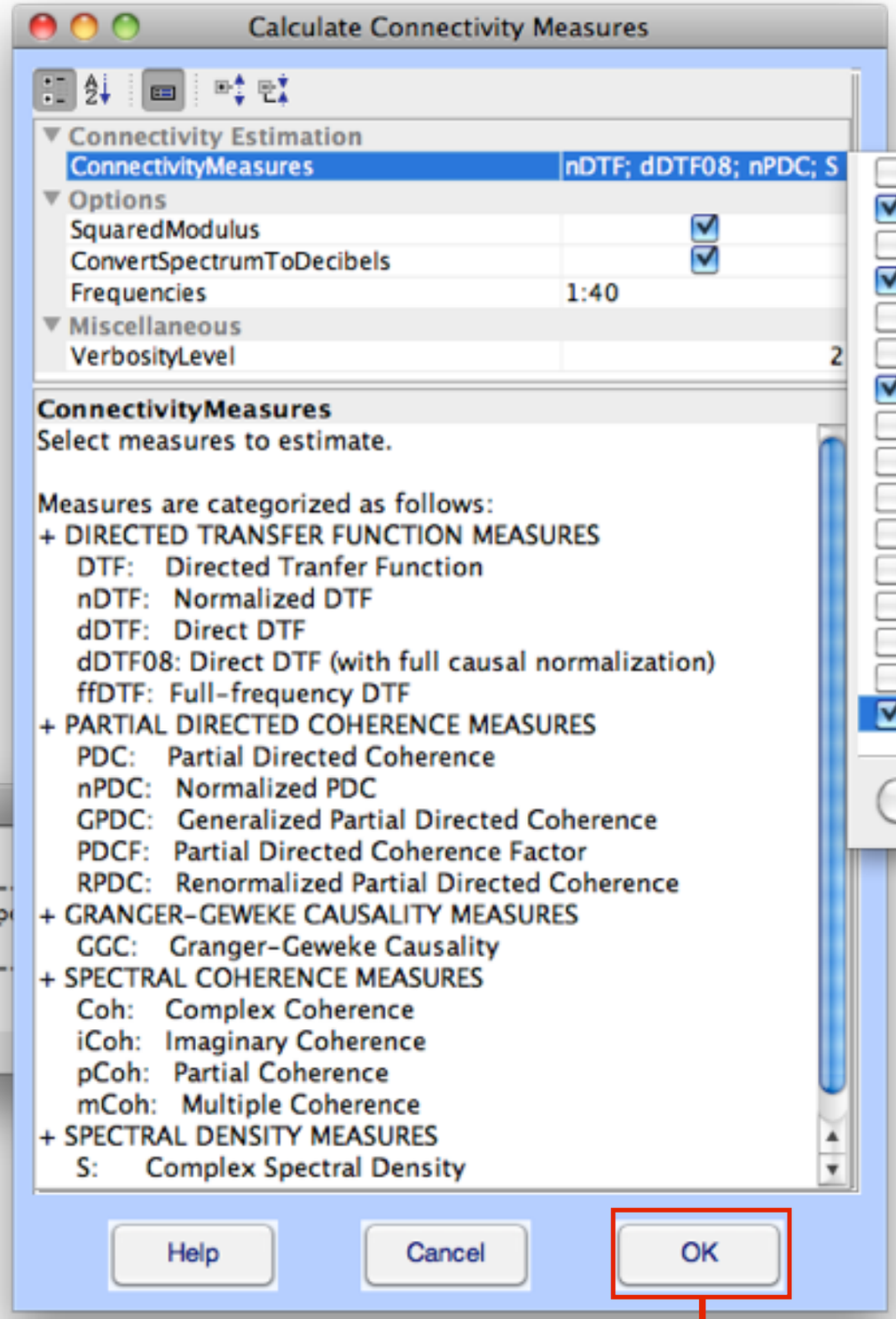
ACF statistic should be above this line

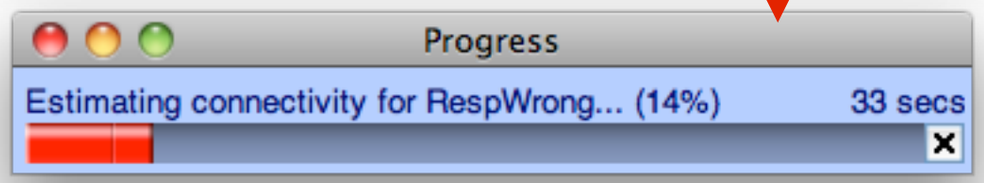
Portmanteau statistics should be above this line

Stability index should be < 0

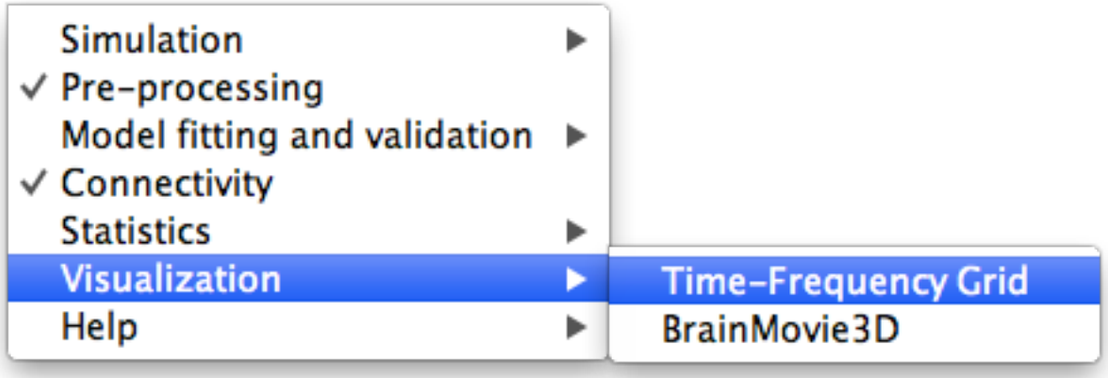
7 Connectivity







8 Visualization: Time-Frequency Grid



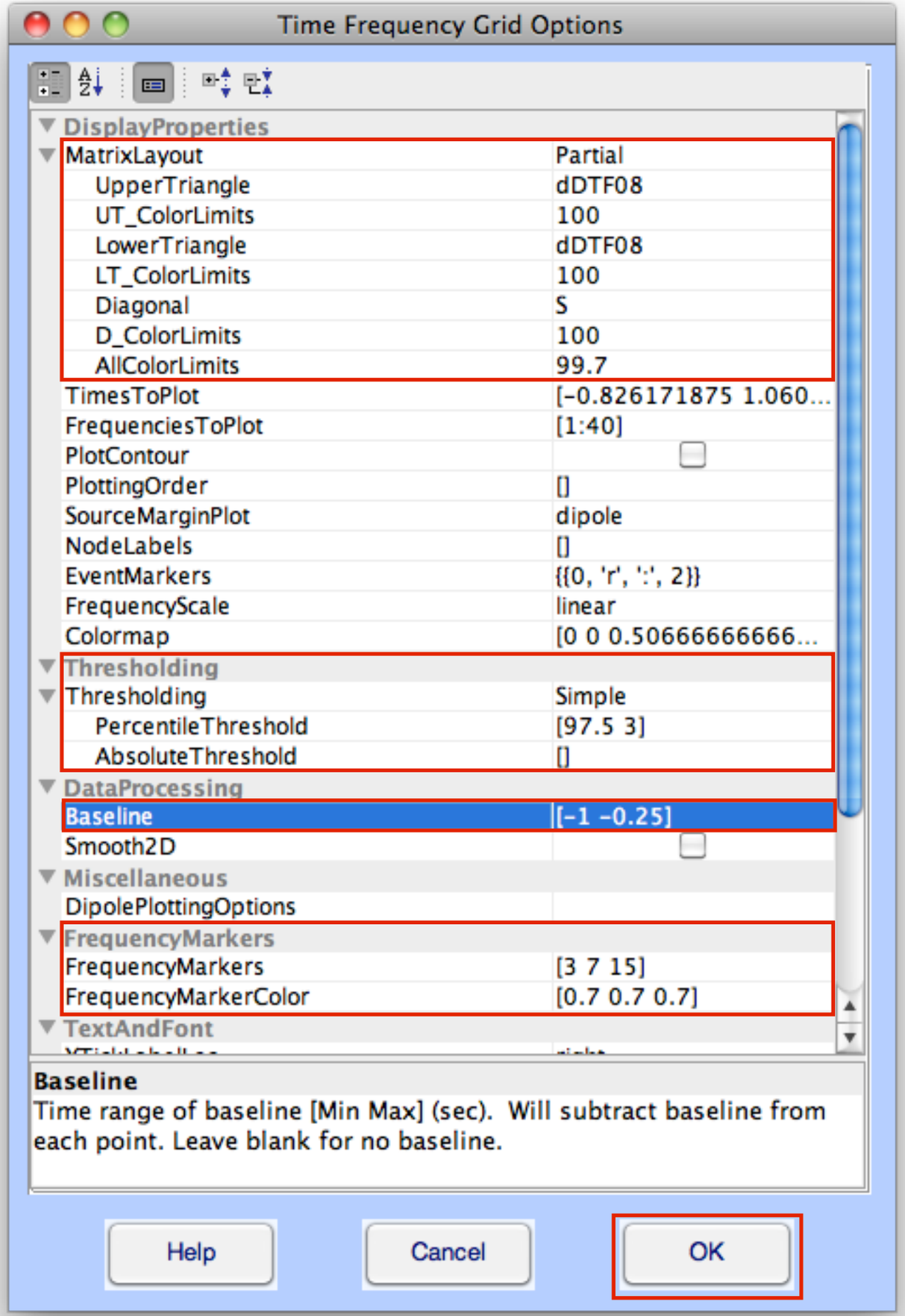
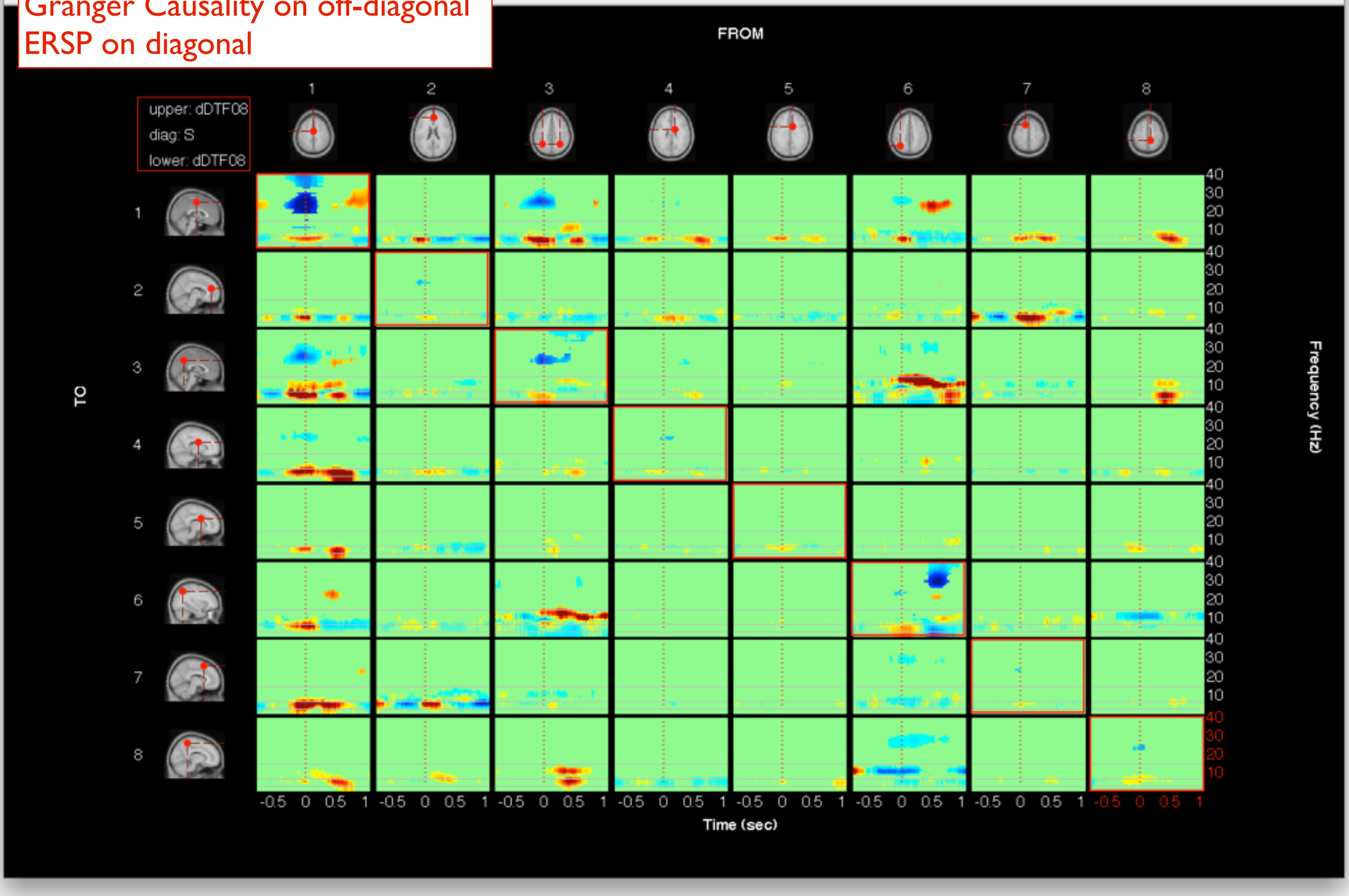


Figure 2: Subj eb79. Cond (RespWrong).

File Edit View Insert Tools Desktop Window Help

Granger Causality on off-diagonal
ERSP on diagonal



Granger Causality on off-diagonal
ERSP on diagonal

Figure 2: Subj eb79. Cond (RespWrong).

File Edit View Insert Tools Desktop Window Help

FROM

upper: dDTF08
diag: S
lower: dDTF08

TO

Figure 3: Subj eb79. Cond (RespWrong).

File Edit View Insert Tools Desktop Window Help

Subj eb79. Cond (RespWrong).

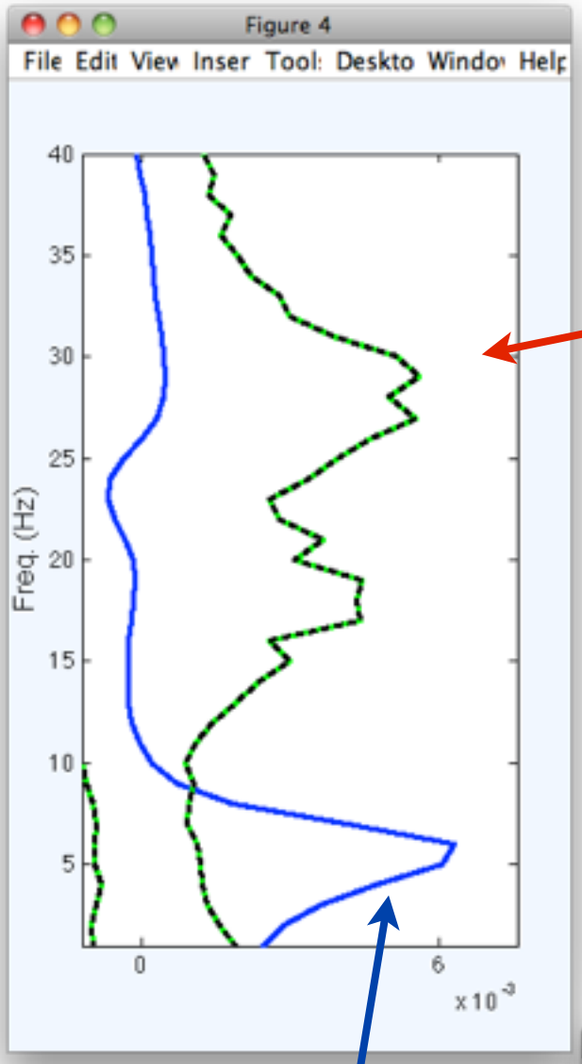
IC1 -> IC4

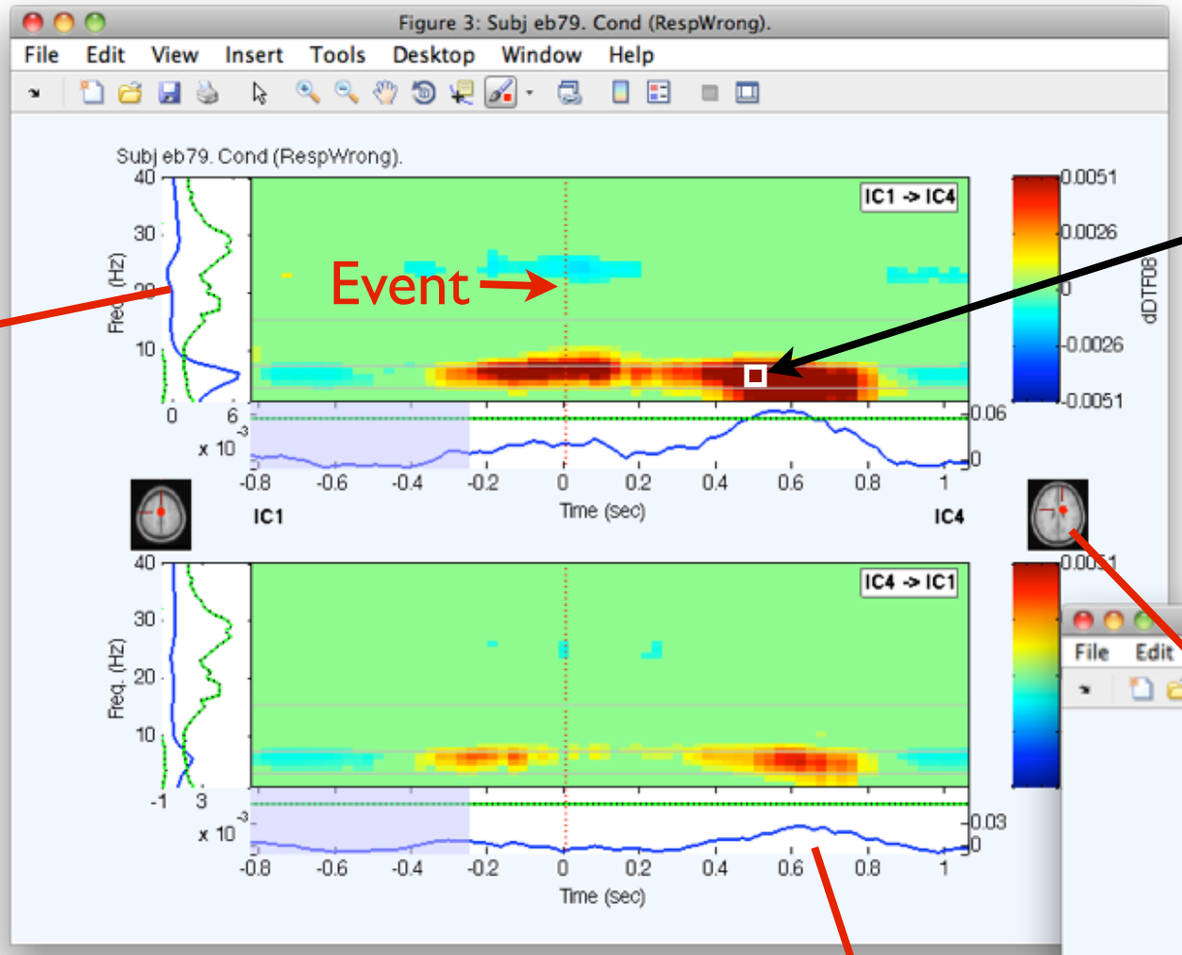
IC4 -> IC1

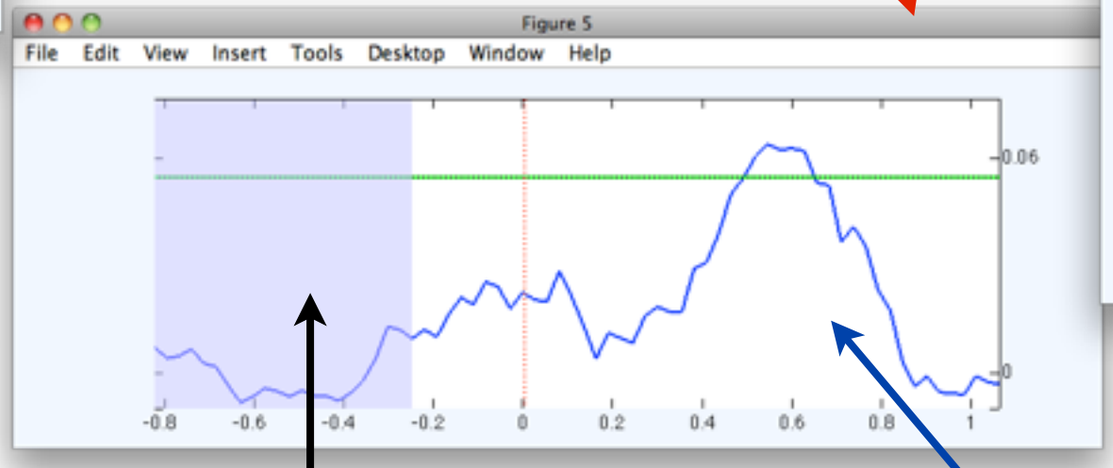
Freq. (Hz)

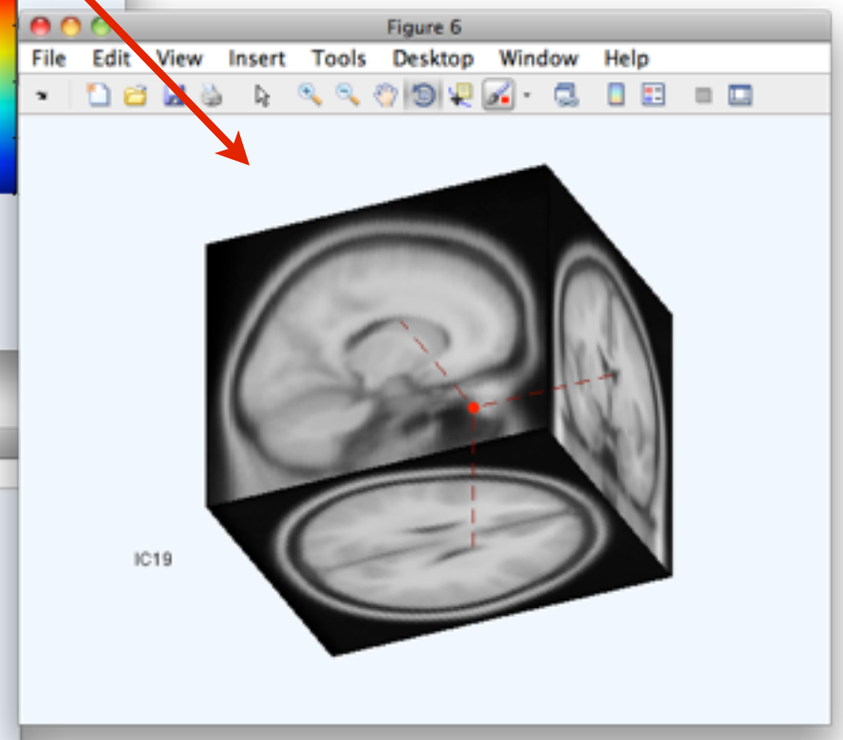
Time (sec)

dDTF08









Increase in event-related information flow from IC1 --> IC4 relative to baseline. This pixel indicates increased dDTF at 5 Hz and 0.5 seconds following the event

Frequency-varying net GC (integrated over time)

Baseline

Time-varying net Granger causality (integrated over frequency)

Figure 2: Subj eb79. Cond (RespWrong).

File Edit View Insert Tools Desktop Window Help

FROM

upper: dDTF08
diag: S
lower: dDTF08

TO

Figure 3: Subj eb79. Cond (RespWrong).

File Edit View Insert Tools Desktop Window Help

Subj eb79. Cond (RespWrong).

IC1

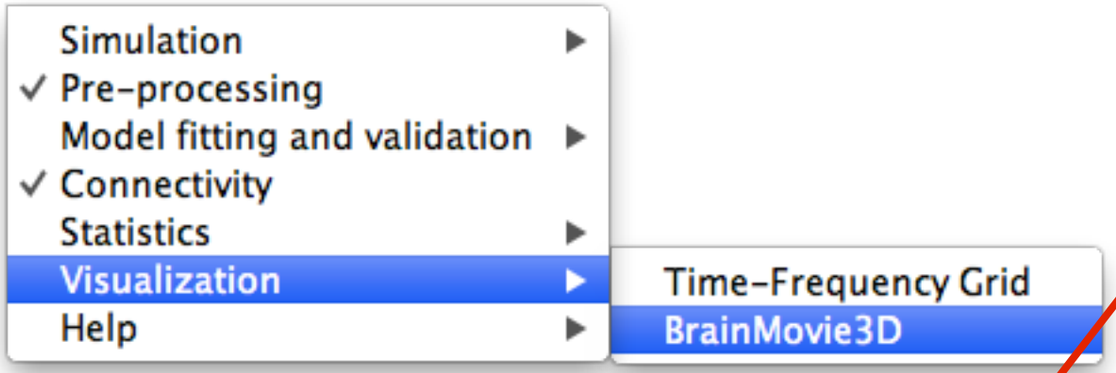
Freq. (Hz)

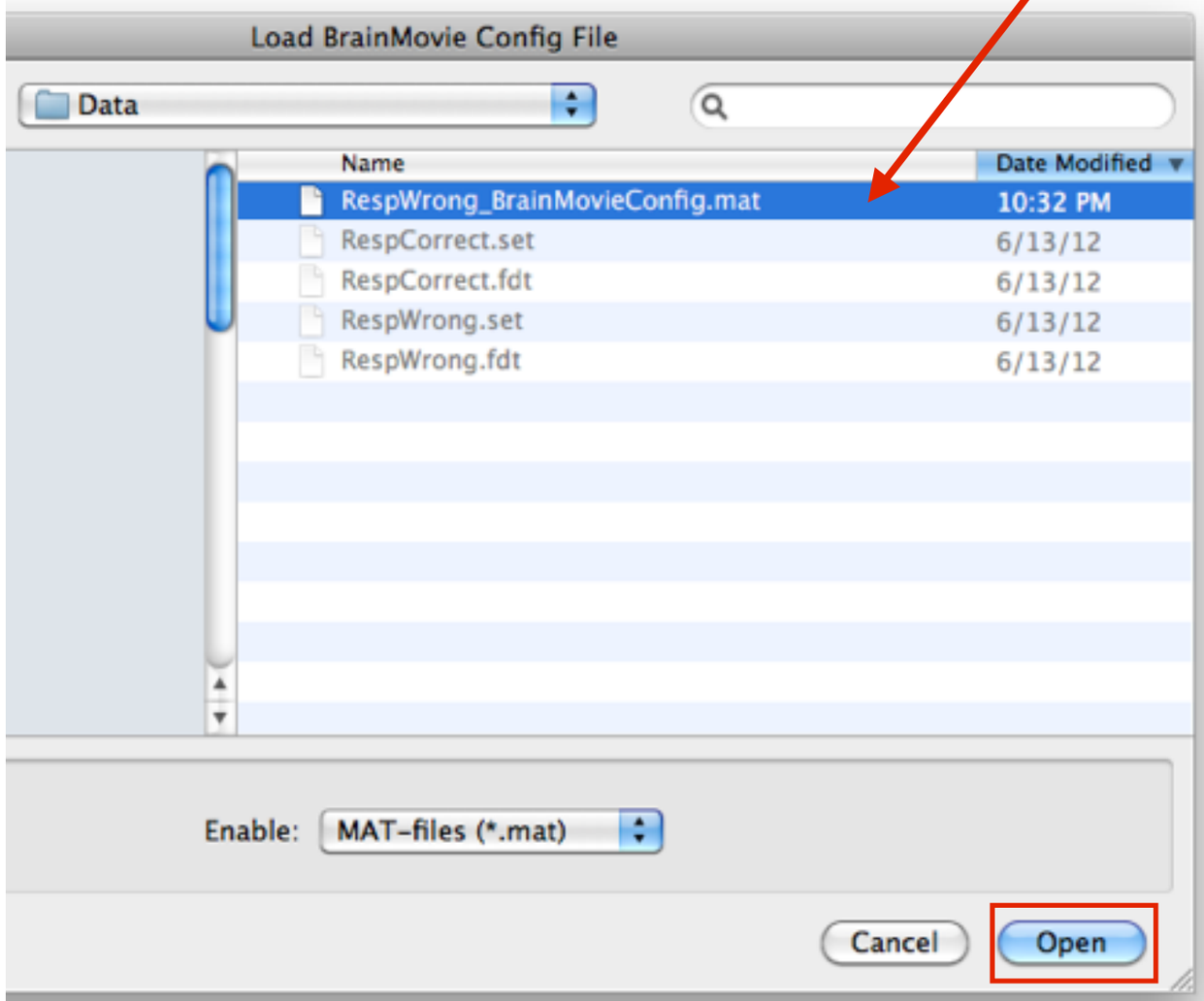
Time (sec)

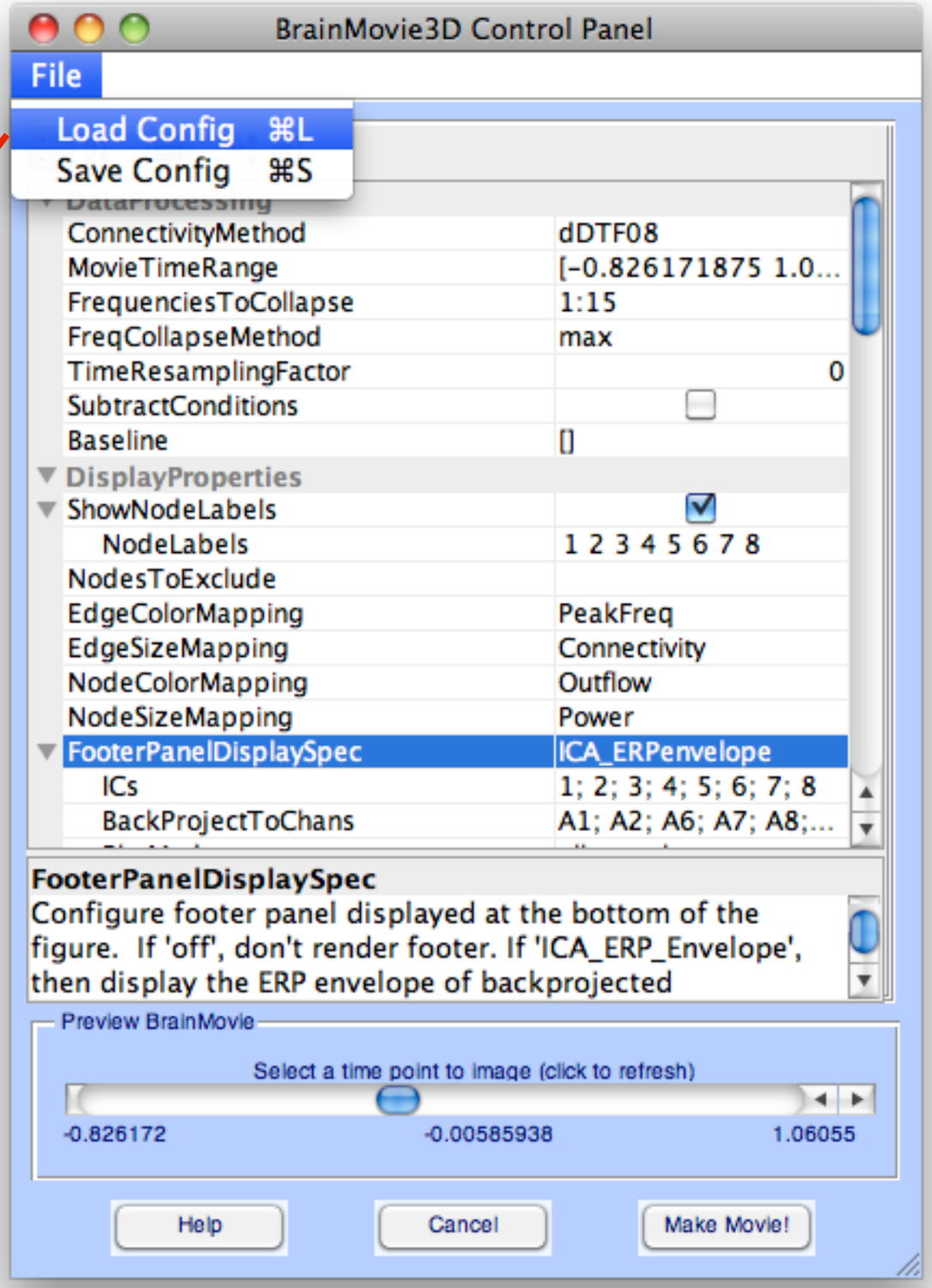
Event-related Spectral Perturbation

Frequency (Hz)

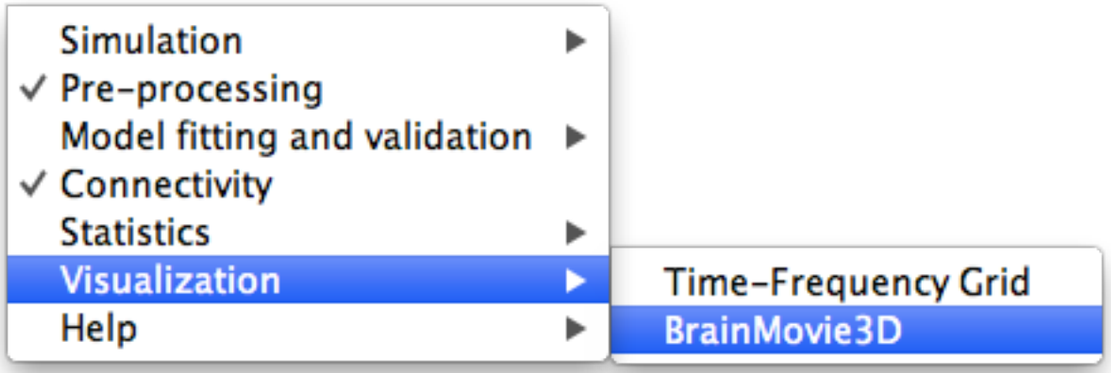
9 Visualization: Causal BrainMovie3D

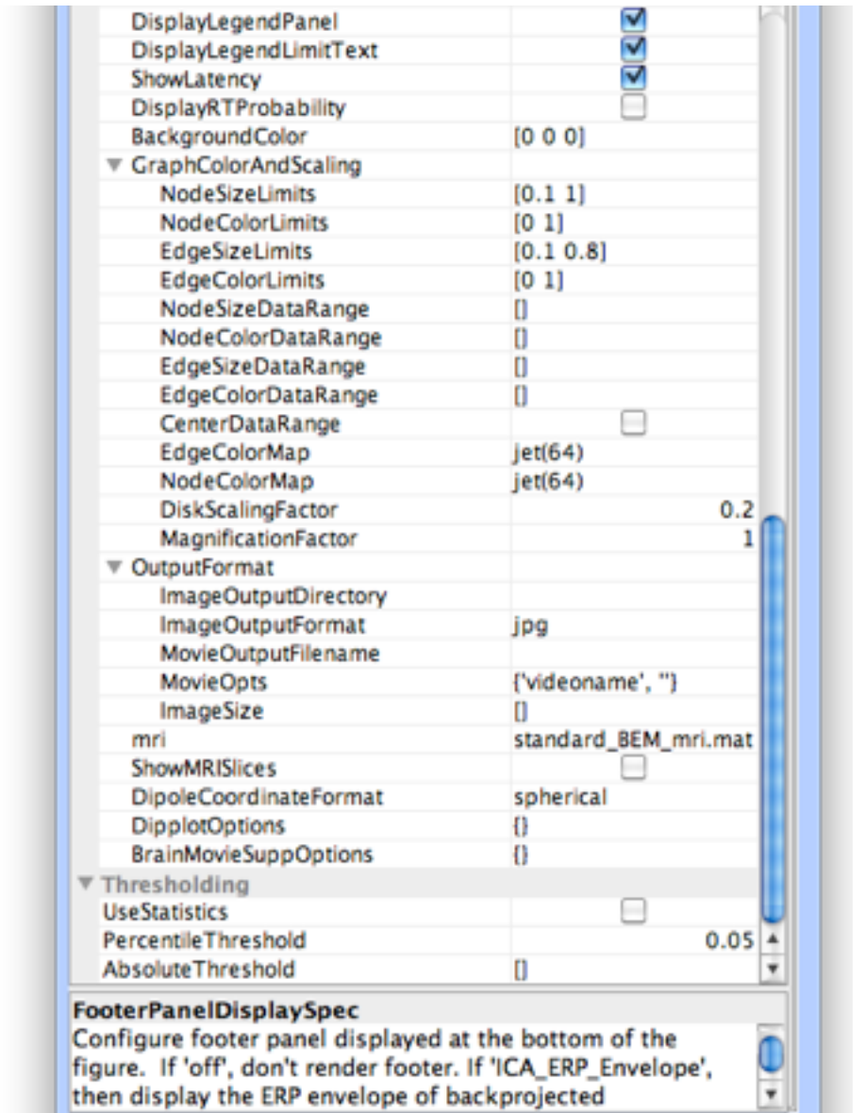






9 Visualization: Causal BrainMovie3D





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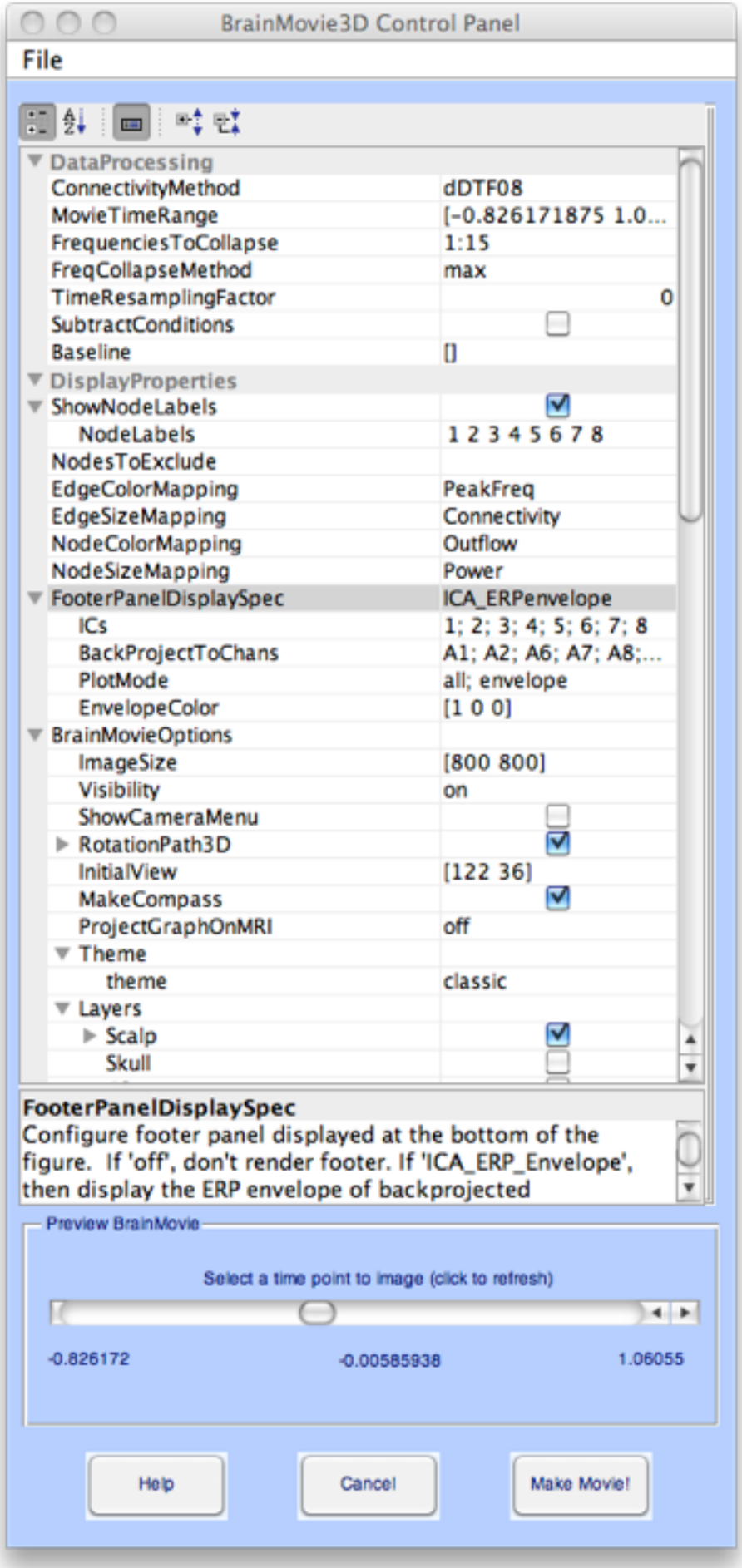
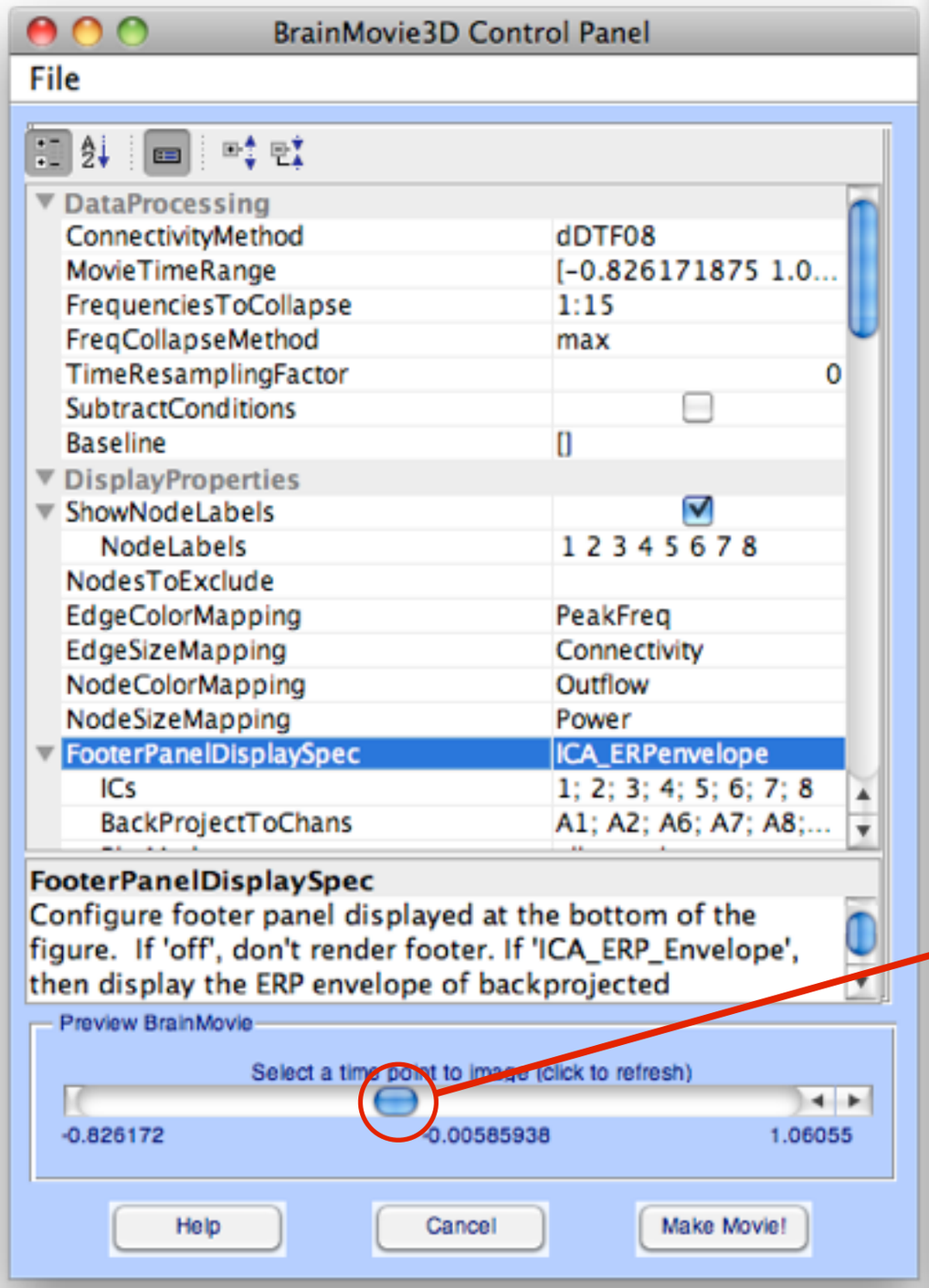
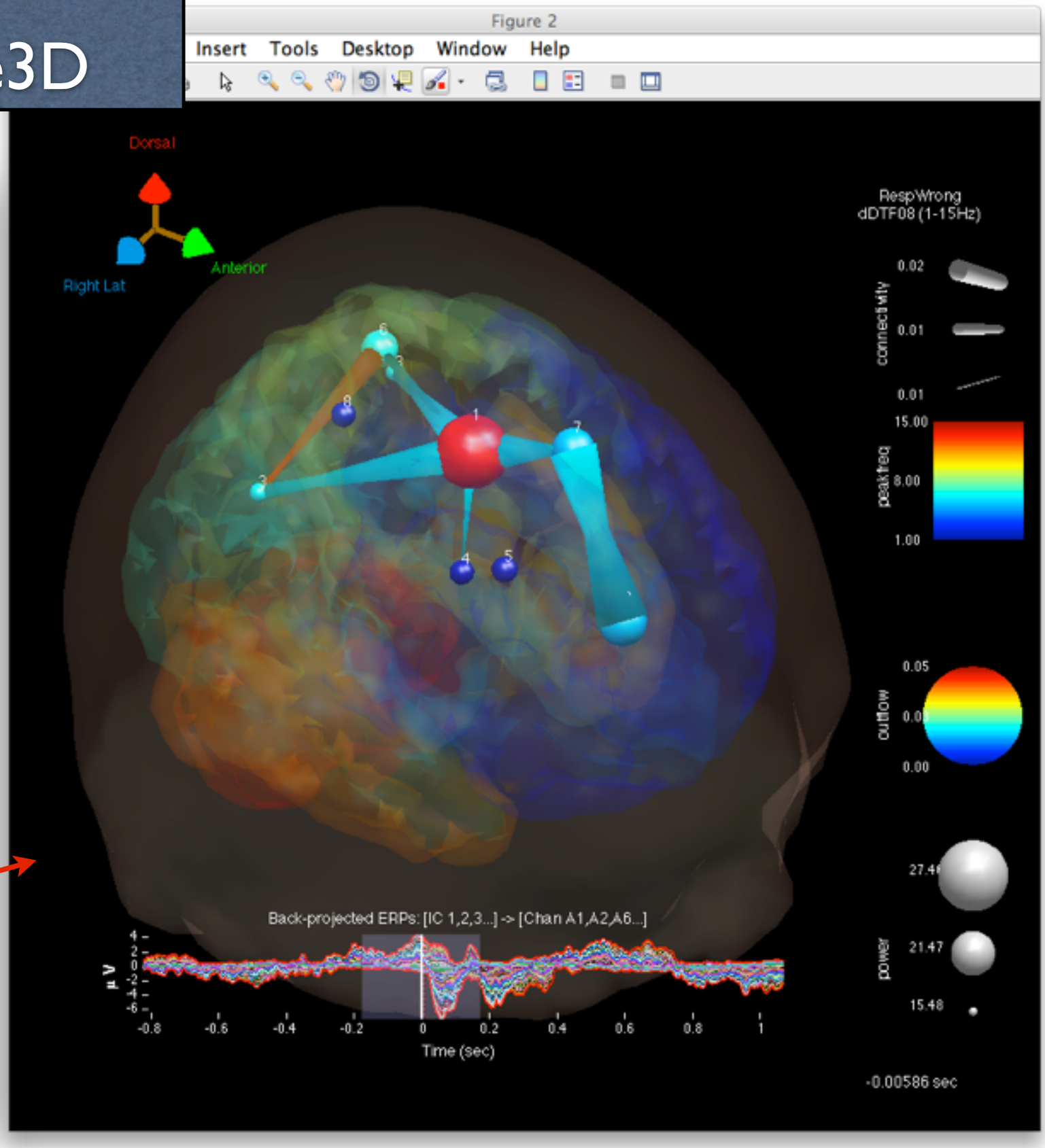


9 Visualization: Causal BrainMovie3D





10 Additional Exercises

1. Explore changing some of the Time-Frequency Grid parameters. Try plotting the TF-Grid with logarithmic frequency spacing (option: FrequencyScale). Change the SourceMarginPlot to “topoplot” to see your ICA topographic plots.

2. Explore different parameters for the BrainMovie3D. What is different between delta (1-3 Hz) and theta (3-7 Hz) band connectivity?

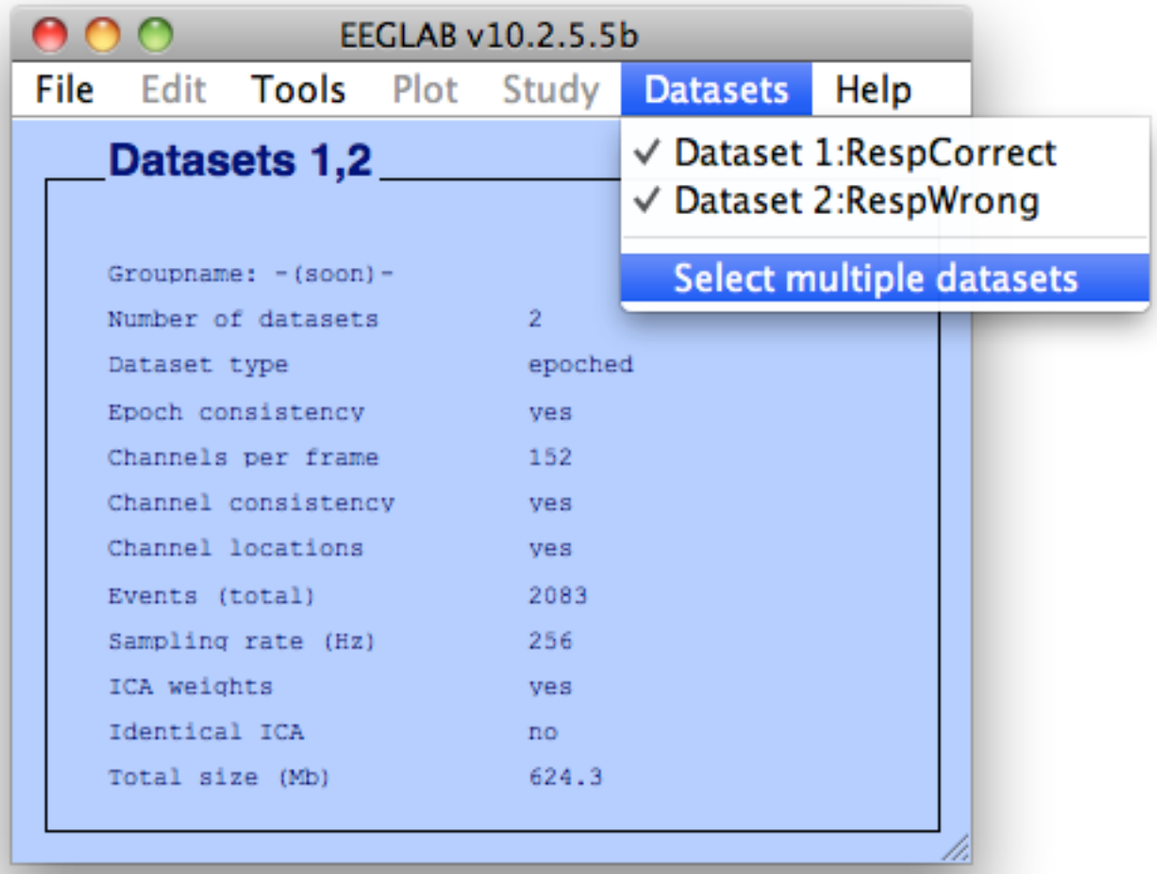
3. Recompute connectivity for the RespWrong condition, selecting the Coherence (Coh) and Partial Coherence (pCoh) methods in addition to the original nPDC, nDTF, dDTF08, and S methods. Create a Time-Frequency Grid laying out Coherence (Coh) on the UpperTriangle, Partial Coherence (pCoh), on the LowerTriangle and the ERSP (S) on the diagonal. Use a baseline of [-1 -0.25]. What is different between coherence and partial coherence? Create another Time-Frequency Grid with dDTF08 on the Upper and Lower Triangles. What is different between coherence and dDTF (Granger-Causality)?

4.Redo the entire pipeline (Steps 1-9) for the RespCorrect condition (located in same /Data folder as RespWrong). Select both conditions in EEGLAB (Datasets-->Select Multiple Datasets). Create a Time-Frequency Grid. Choose to the plot the difference RespWrong-RespCorrect (option: PlotConditionDifference->ConditionOrder) with the dDTF08 on the Upper and Lower Triangle and ERSP on the diagonal.

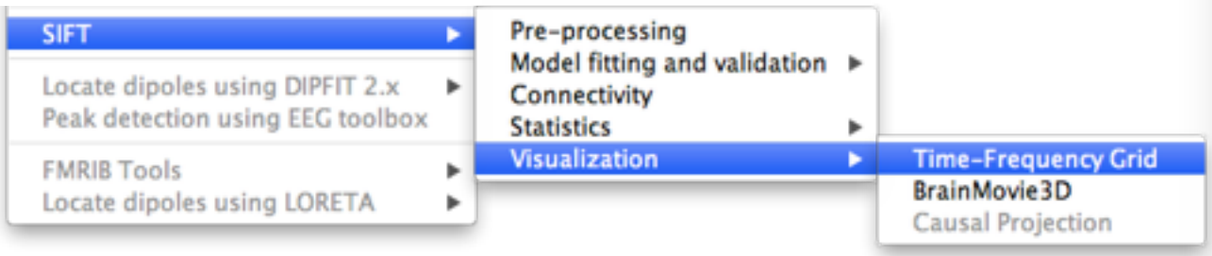
5. Advanced Users: Try executing the previous pipeline entirely from the command line. Consult `<sift_root>/scripts/ScriptingExample_1_0b.m` for guidance.

Visualization of condition differences

Select RespWrong and RespCorrect datasets



Visualization of condition differences



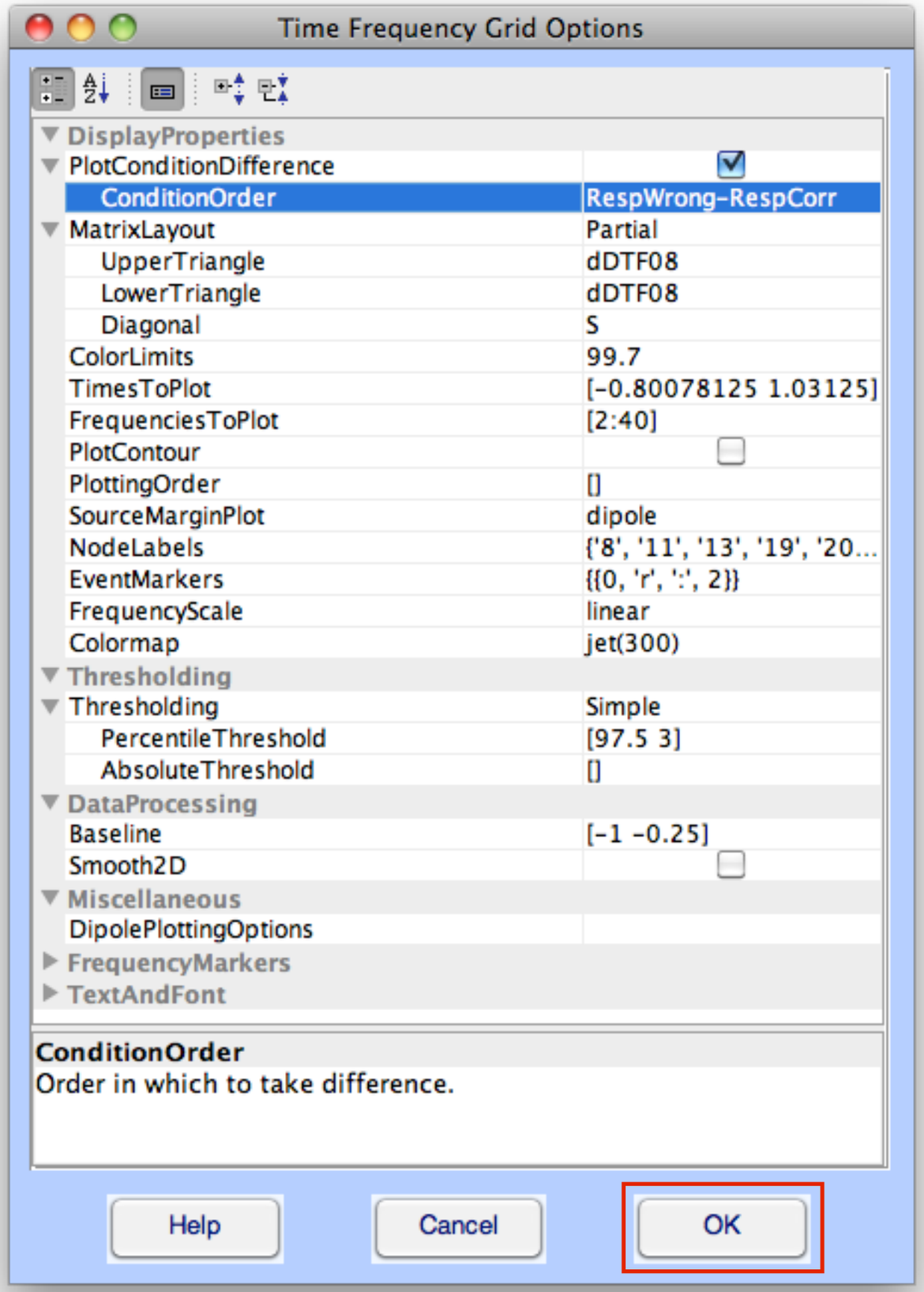


Figure 10: Subj eb79. Cond (RespWrong) – (RespCorr).

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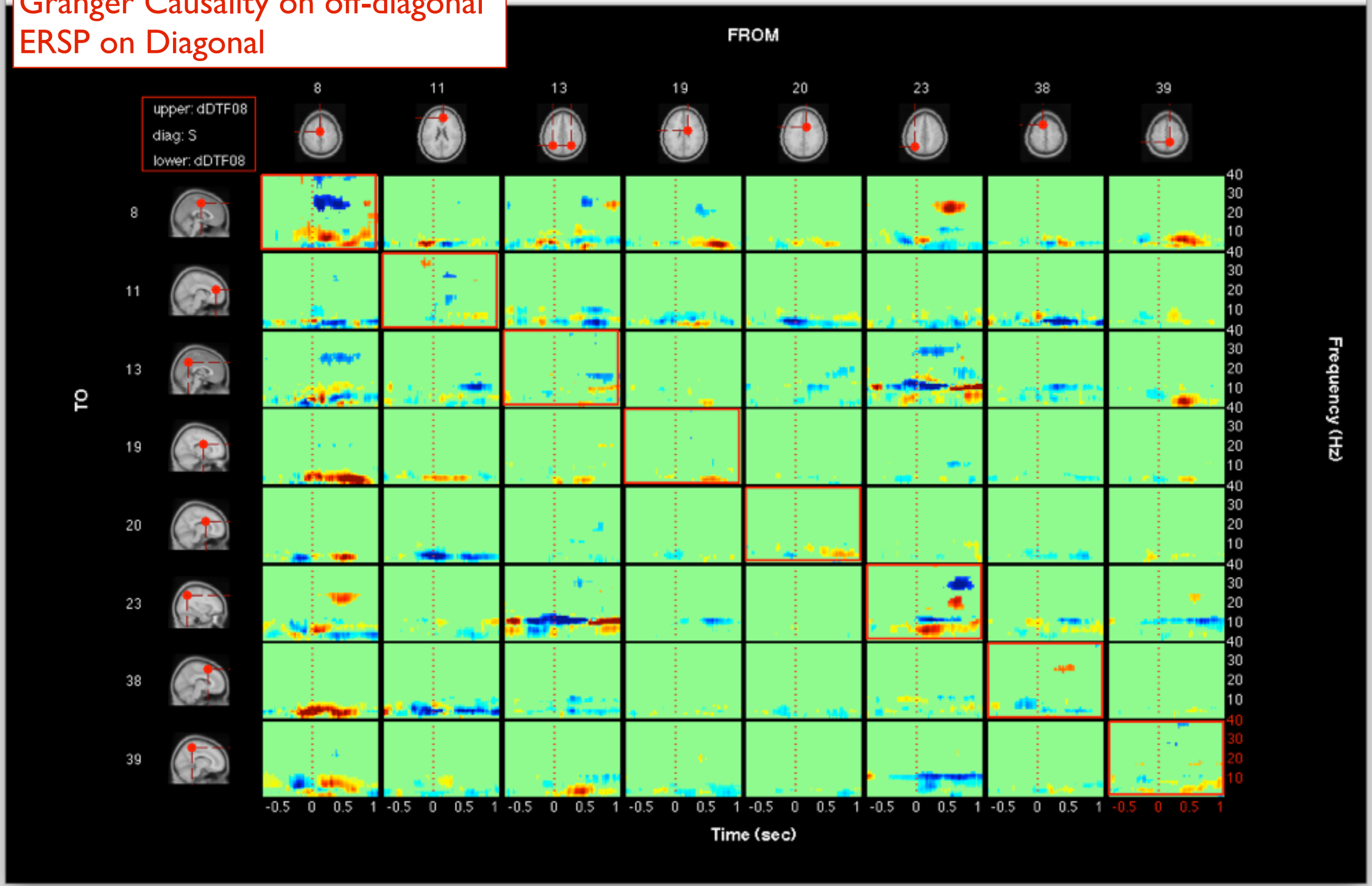
Granger Causality on off-diagonal
ERSP on Diagonal



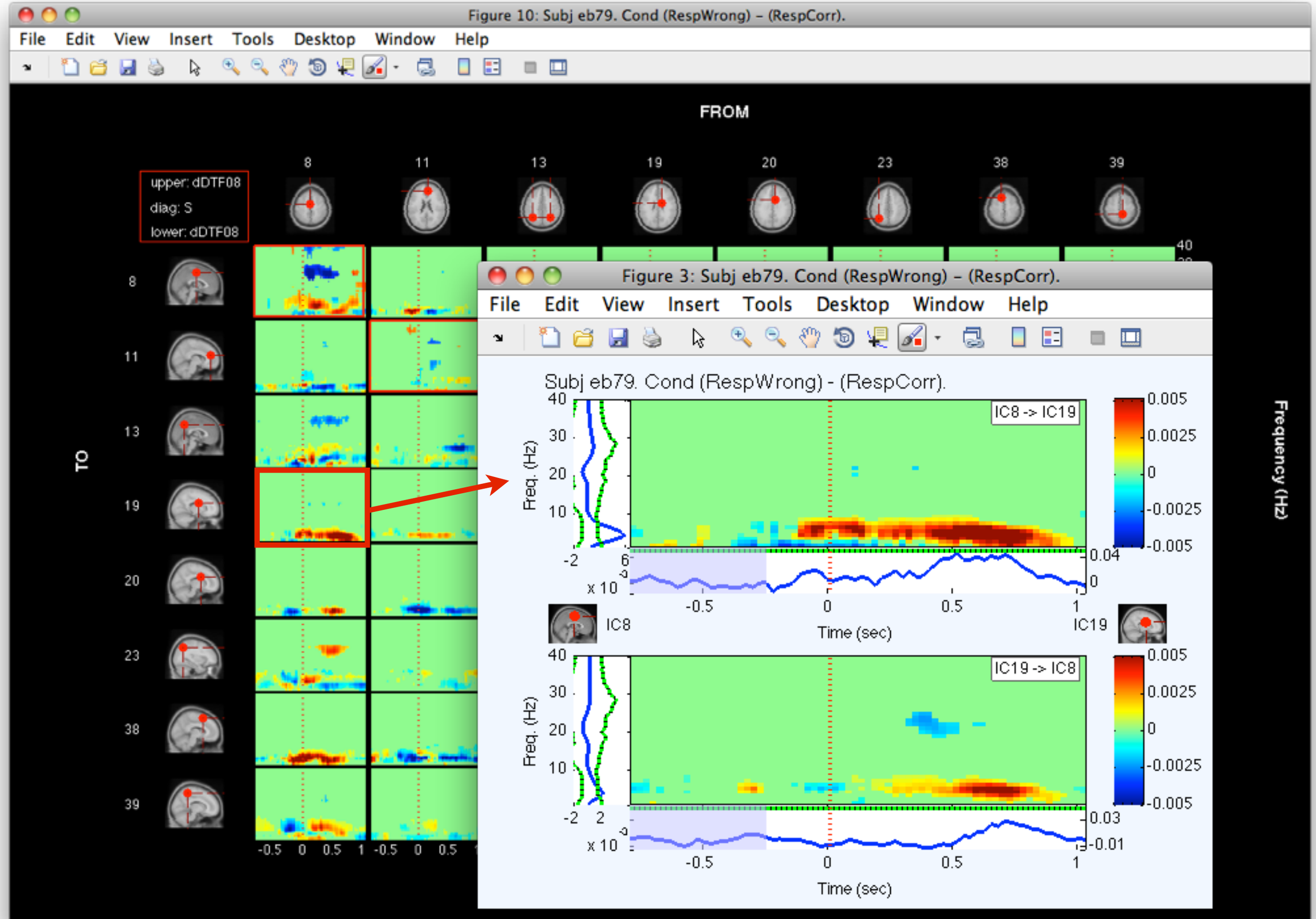
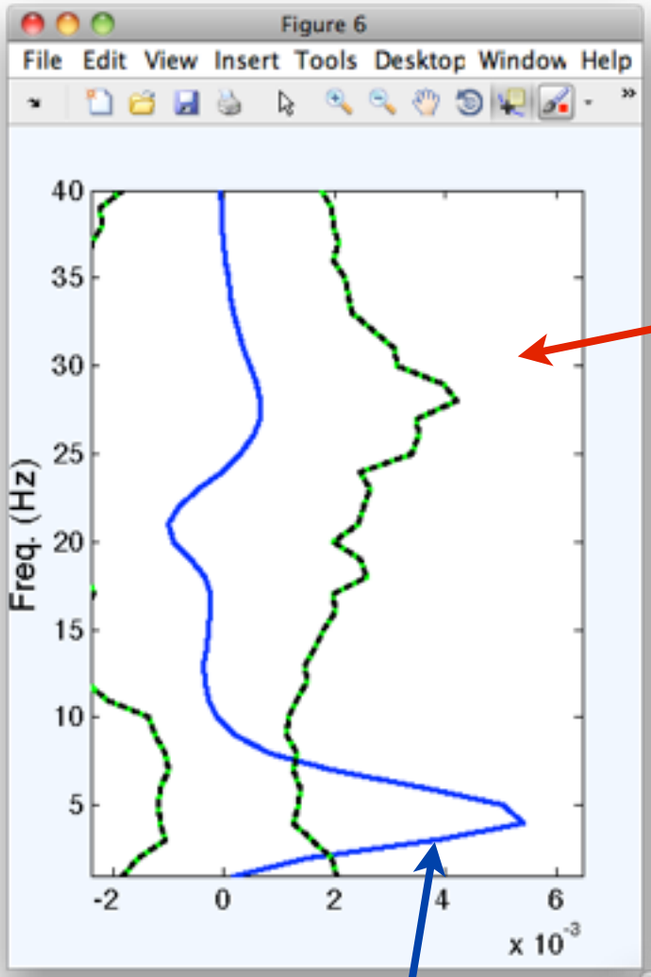
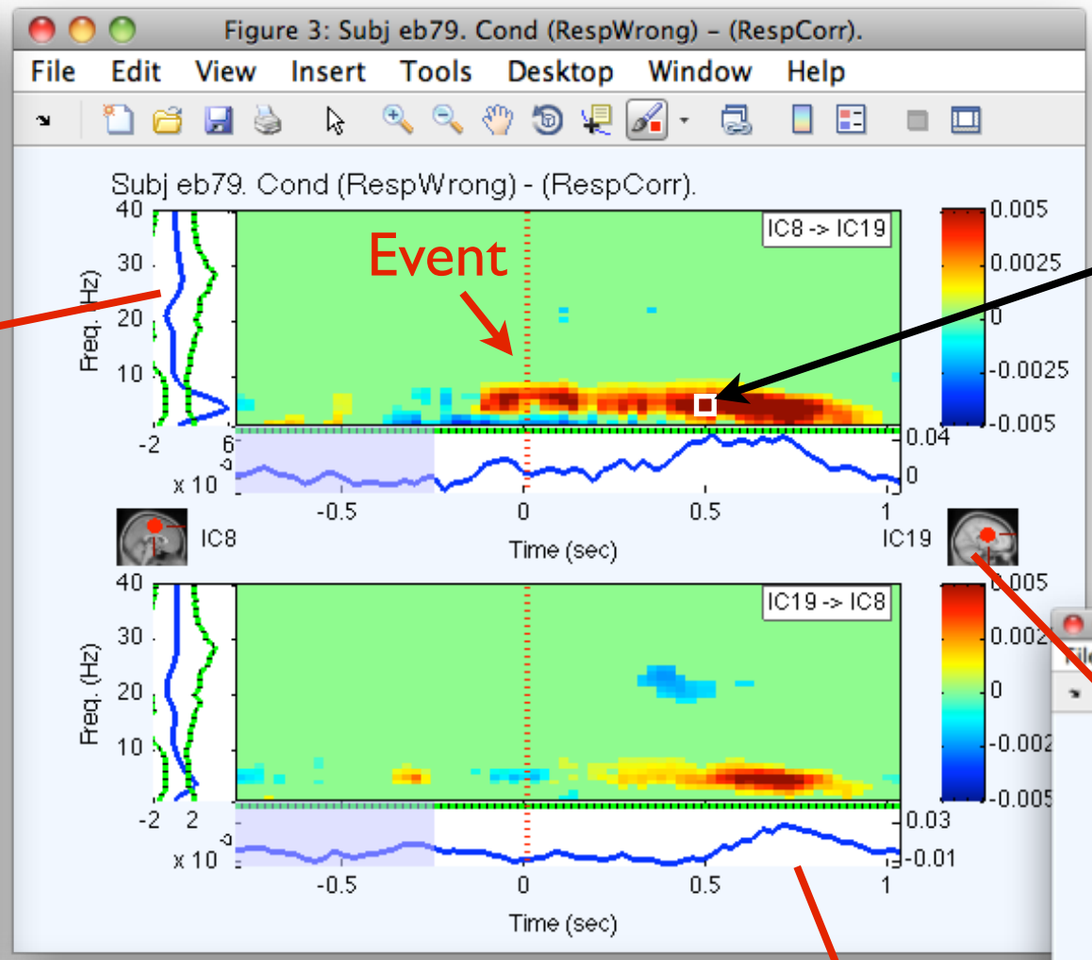
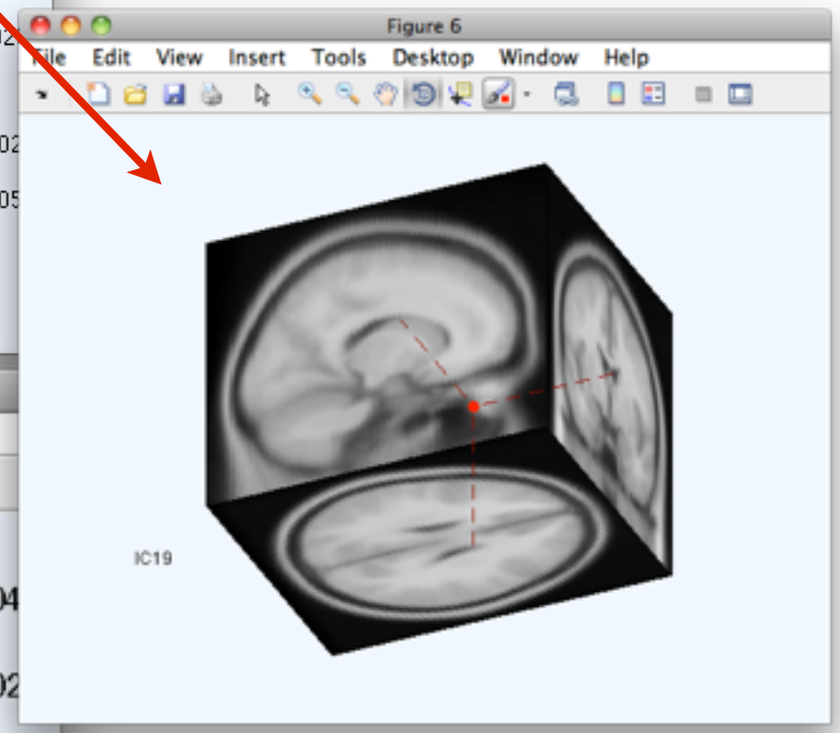


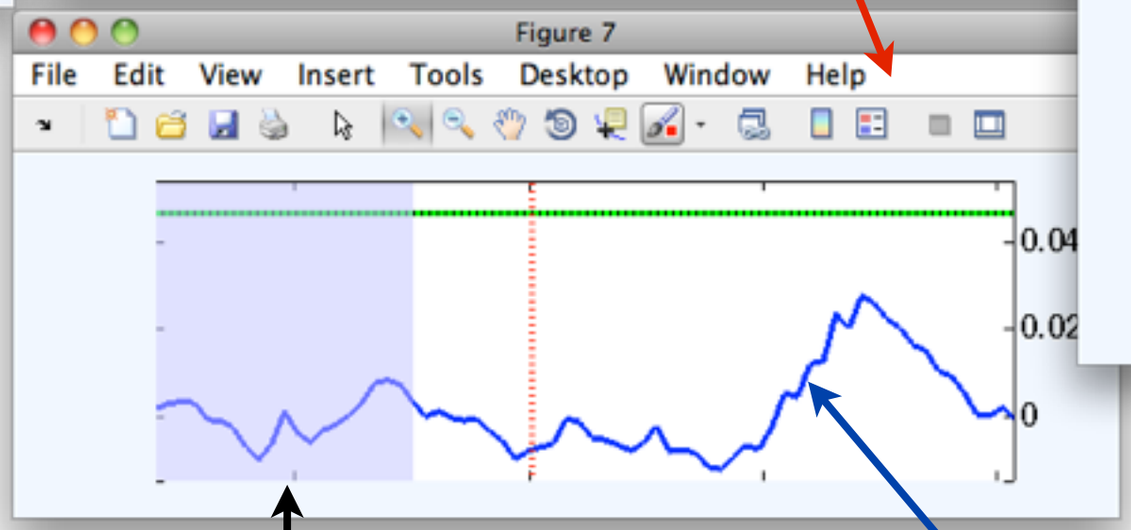
Figure 10: Subj eb79. Cond (RespWrong) – (RespCorr).
File Edit View Insert Tools Desktop Window Help
FROM
8 11 13 19 20 23 38 39
upper: dDTF08
diag: S
lower: dDTF08
TO
8 11 13 19 20 23 38 39
-0.5 0 0.5 1
Figure 3: Subj eb79. Cond (RespWrong) – (RespCorr).
File Edit View Insert Tools Desktop Window Help
Subj eb79. Cond (RespWrong) - (RespCorr).
IC8 -> IC19
Freq. (Hz)
Time (sec)
IC8
IC19
IC19 -> IC8
Frequency (Hz)
0.005
0.0025
0
-0.0025
-0.005

Increase in event-related information flow from IC8 -> IC19 in Error condition relative to Correct condition. This pixel indicates GC at 5 Hz and 0.5 sec post-event









Frequency-varying net GC (integrated over time)

Baseline

Time-varying net Granger causality (integrated over frequency)

Figure 10: Subj eb79. Cond (RespWrong) – (RespCorr).

File Edit View Insert Tools Desktop Window Help

FROM

8 11 13 19 20 23 38 39

upper: dDTF08
diag: S
lower: dDTF08

TO

8 11 13 19 20 23 38 39

-0.5 0 0.5 1 -0.5 0.5 1

40 30 20 10

Frequency (Hz)

Figure 8: Subj eb79. Cond (RespWrong) – (RespCorr).

File Edit View Insert Tools Desktop Window Help

Subj eb79. Cond (RespWrong) - (RespCorr).

IC8

Freq. (Hz)

40 35 30 25 20 15 10 5

4.3 2.1 0 -2.1 -4.3

dB

50 -50

-4 3

IC8

-0.5 0 0.5 1

Time (sec)

Event-related Spectral Perturbation