

Mining Event-Related Brain Dynamics

1. Consider, in so far as possible, the multi-dimensional dynamics of the brain as expressed in the whole recorded signal.
2. Un-mix source (and artifact) contributions of individual source areas using independent component analysis (ICA).
3. Visualize trial-by-trial *relationships* of source component activities to experimental variables (using 2-D 'ERP' image plots).
4. Model the event-related dynamics of the source components (using time/frequency analysis).
5. Localize the separated source areas using biophysical inverse modeling.
6. Compare similarities in source dynamics and locations across subjects using cluster analysis.
7. Model transient source network dynamics and the contexts in which they appear.

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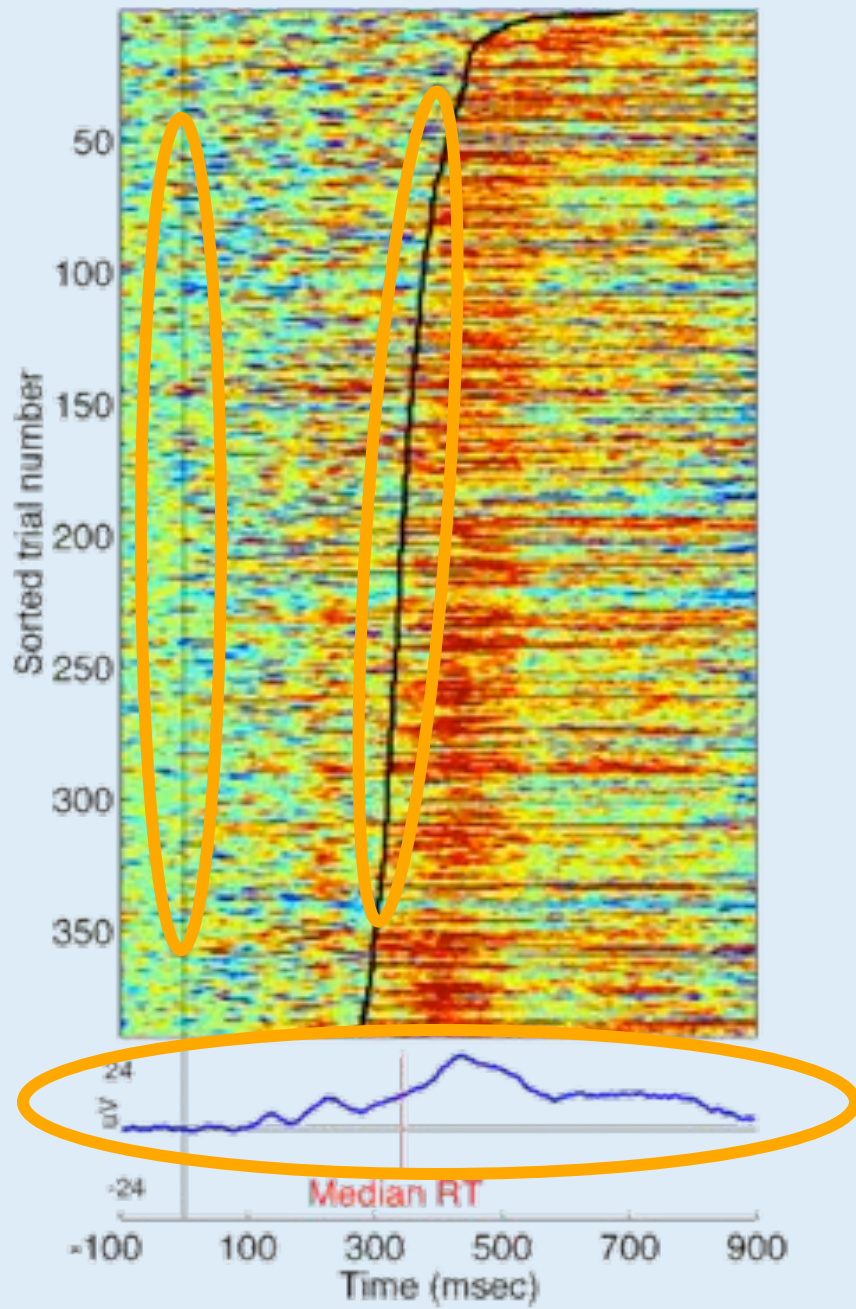
EEGLAB Concepts / Measures

- ERSP – event-related spectral power
- ITC – inter-trial coherence (phase locking)
- ERC – event-related coherence

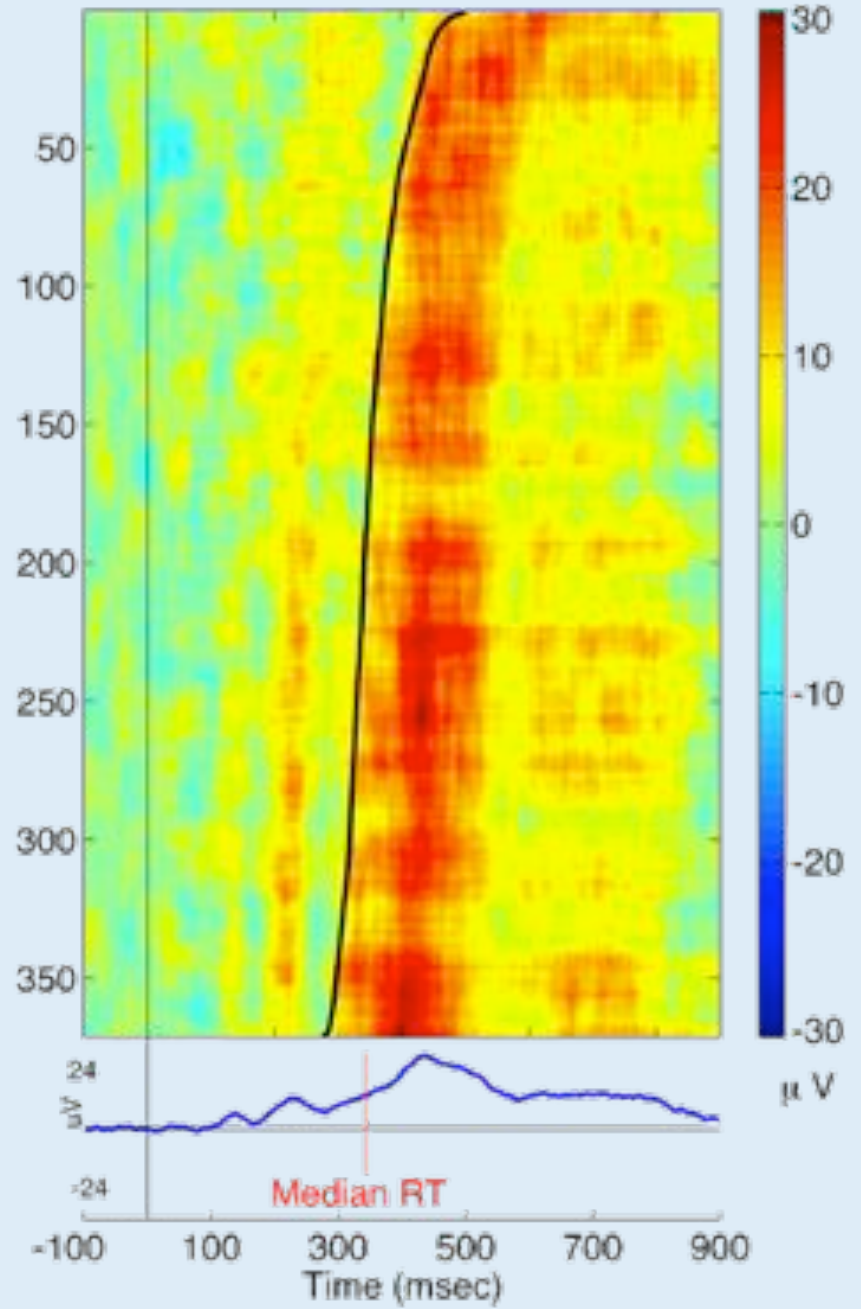
EEGLAB Measures / Visualizations

- `erpimage()` – sorted trial-by-trial dynamics
- `envtopo()` – ERPs and components
- `tftopo()` – event-related spectral power changes

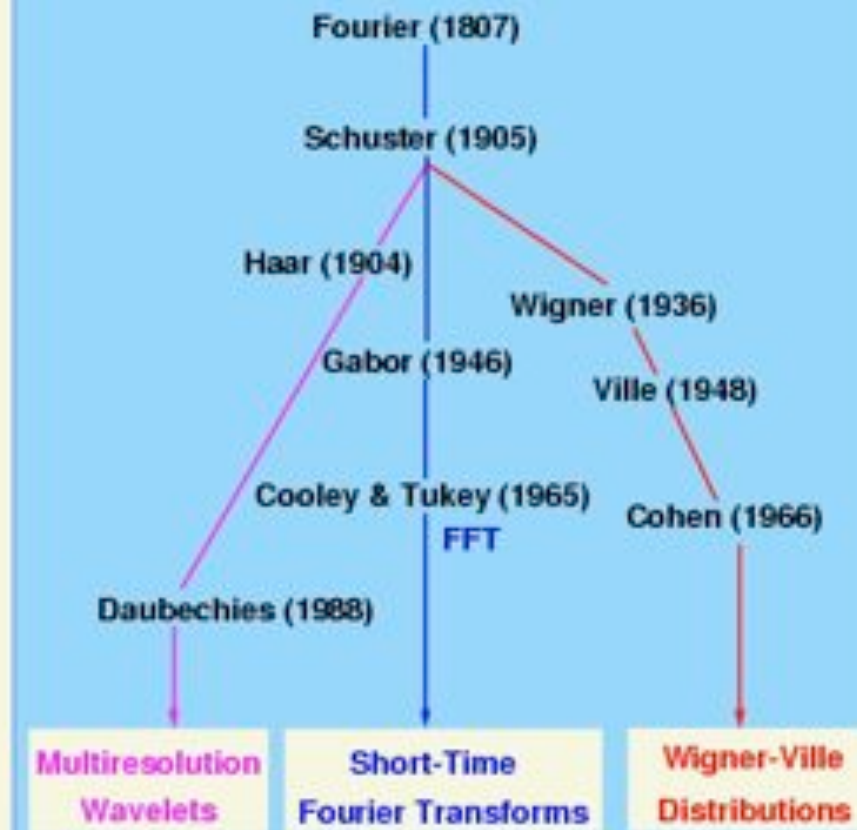
Single-trial ERPs at Cz

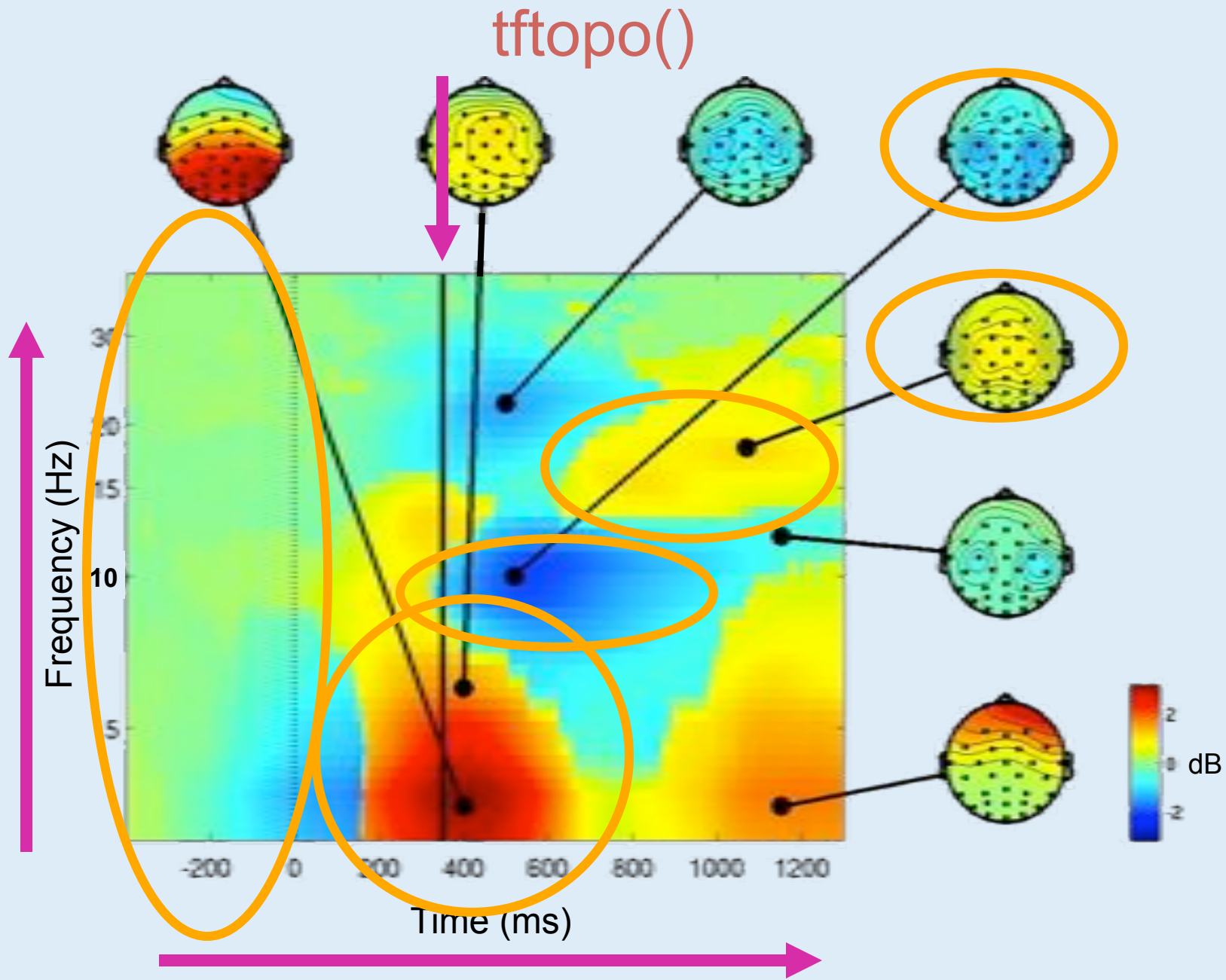


Single-trial ERPs at Cz



Time-Frequency Analysis

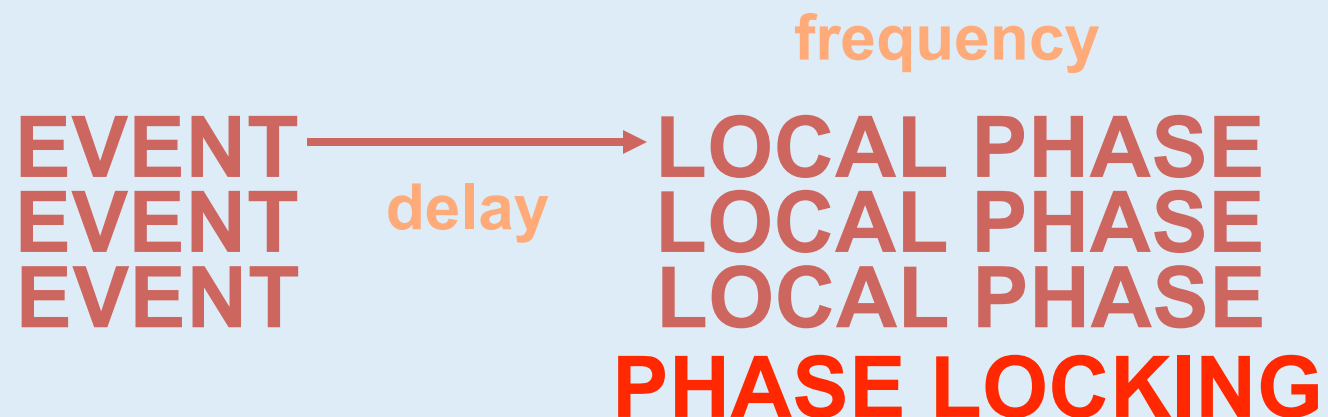




Inter-trial Coherence (ITC)

(“phase-locking factor”)

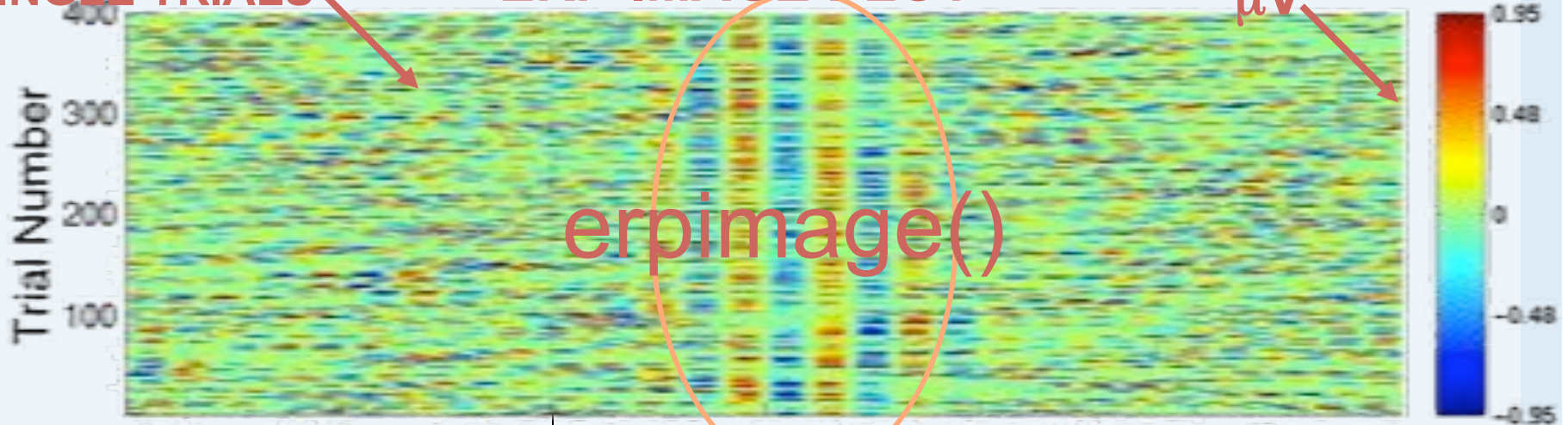
- Significant consistency of **local phase** of a physiological waveform across successive trials.



SINGLE TRIALS

ERP-IMAGE PLOT

μV



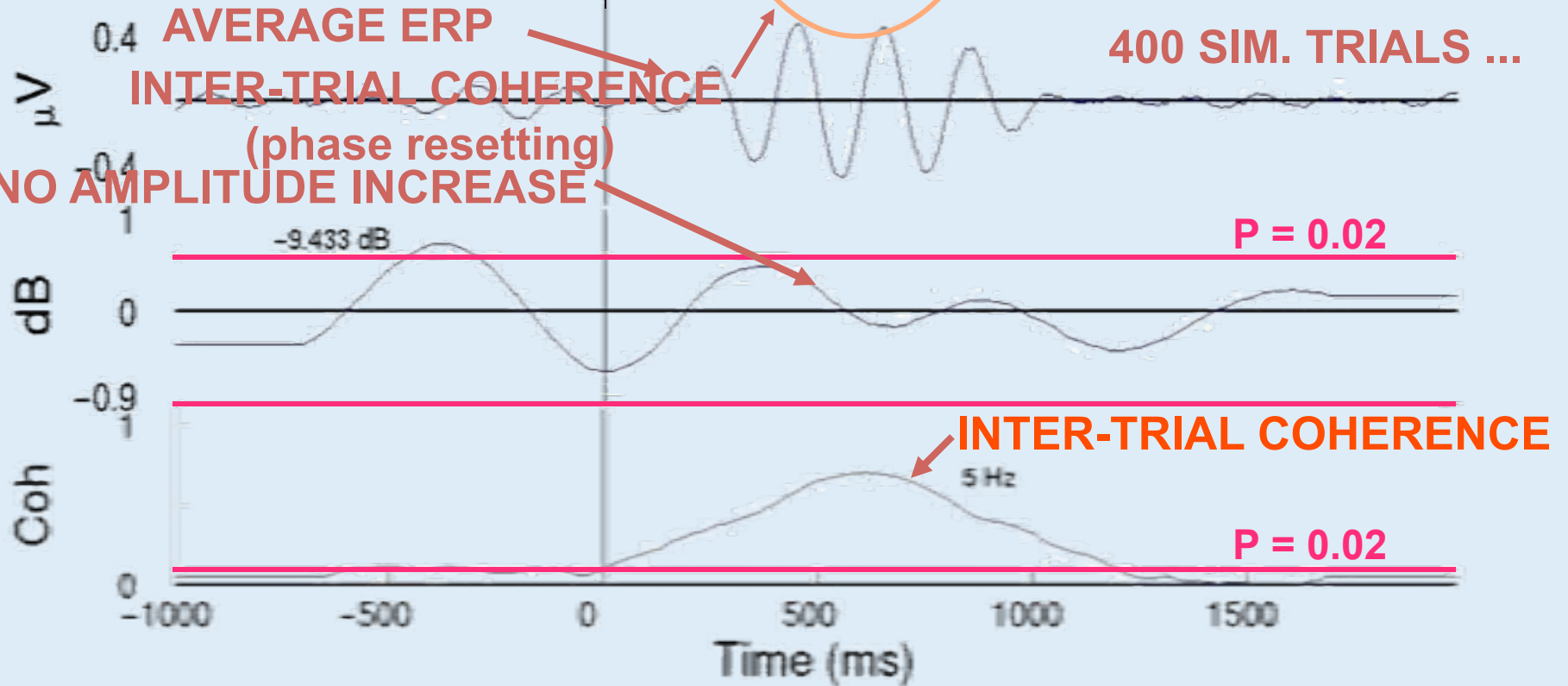
AVERAGE ERP

INTER-TRIAL COHERENCE

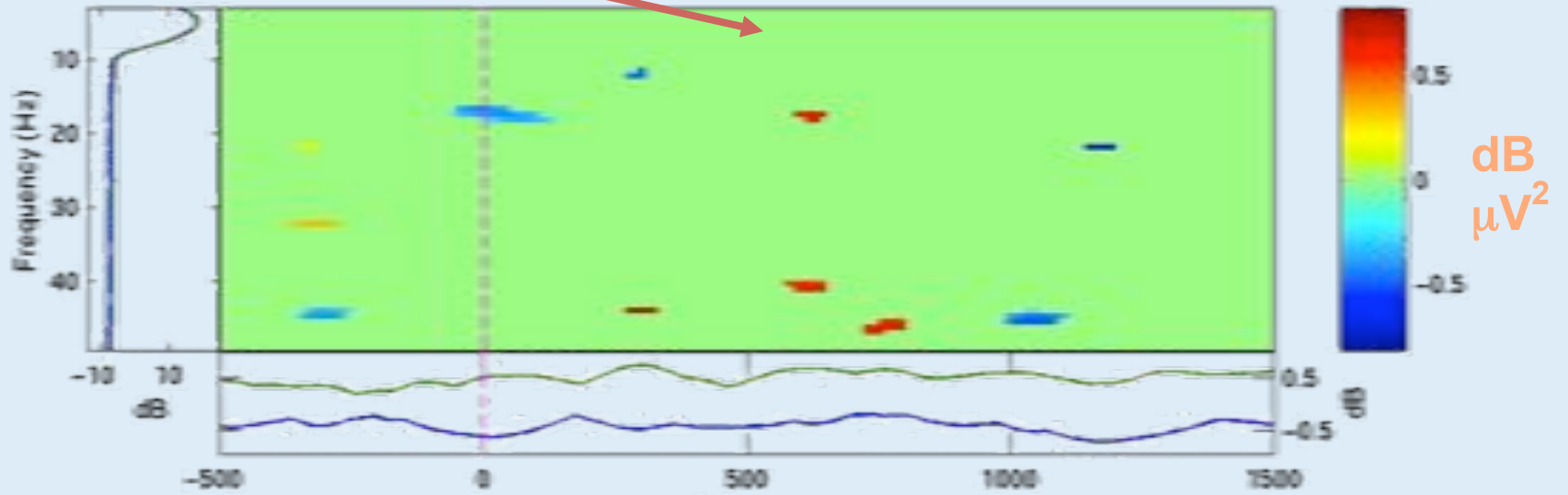
(phase resetting)

NO AMPLITUDE INCREASE

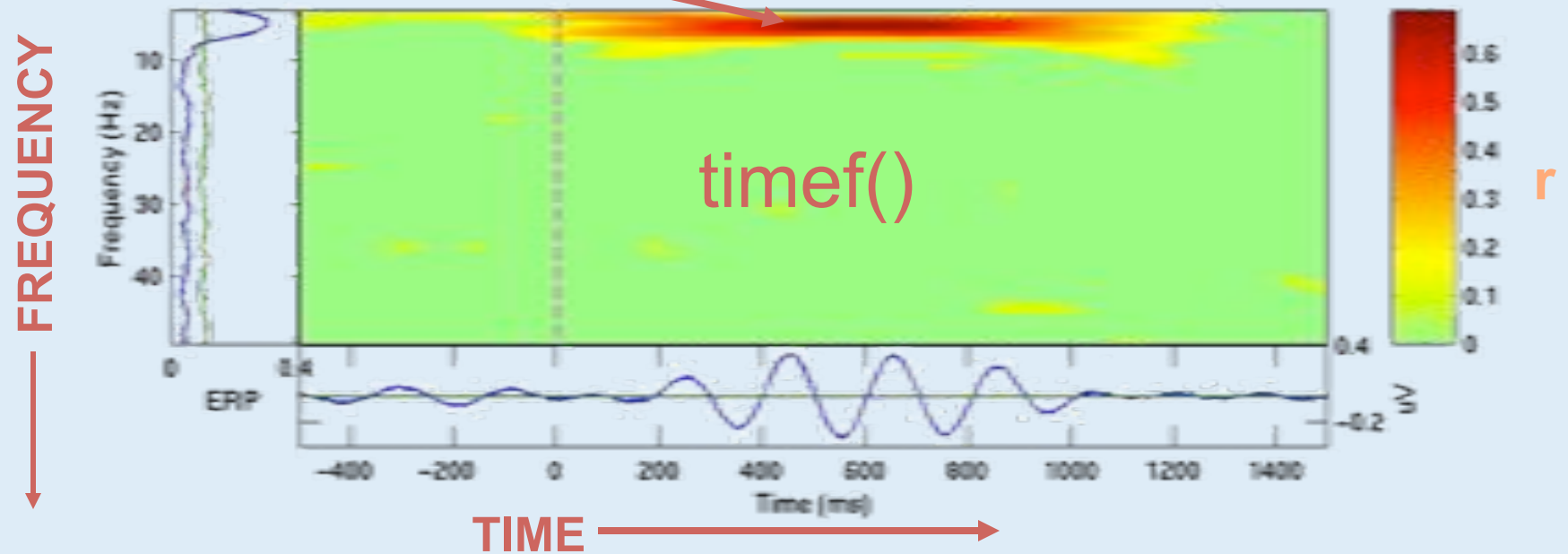
400 SIM. TRIALS ...



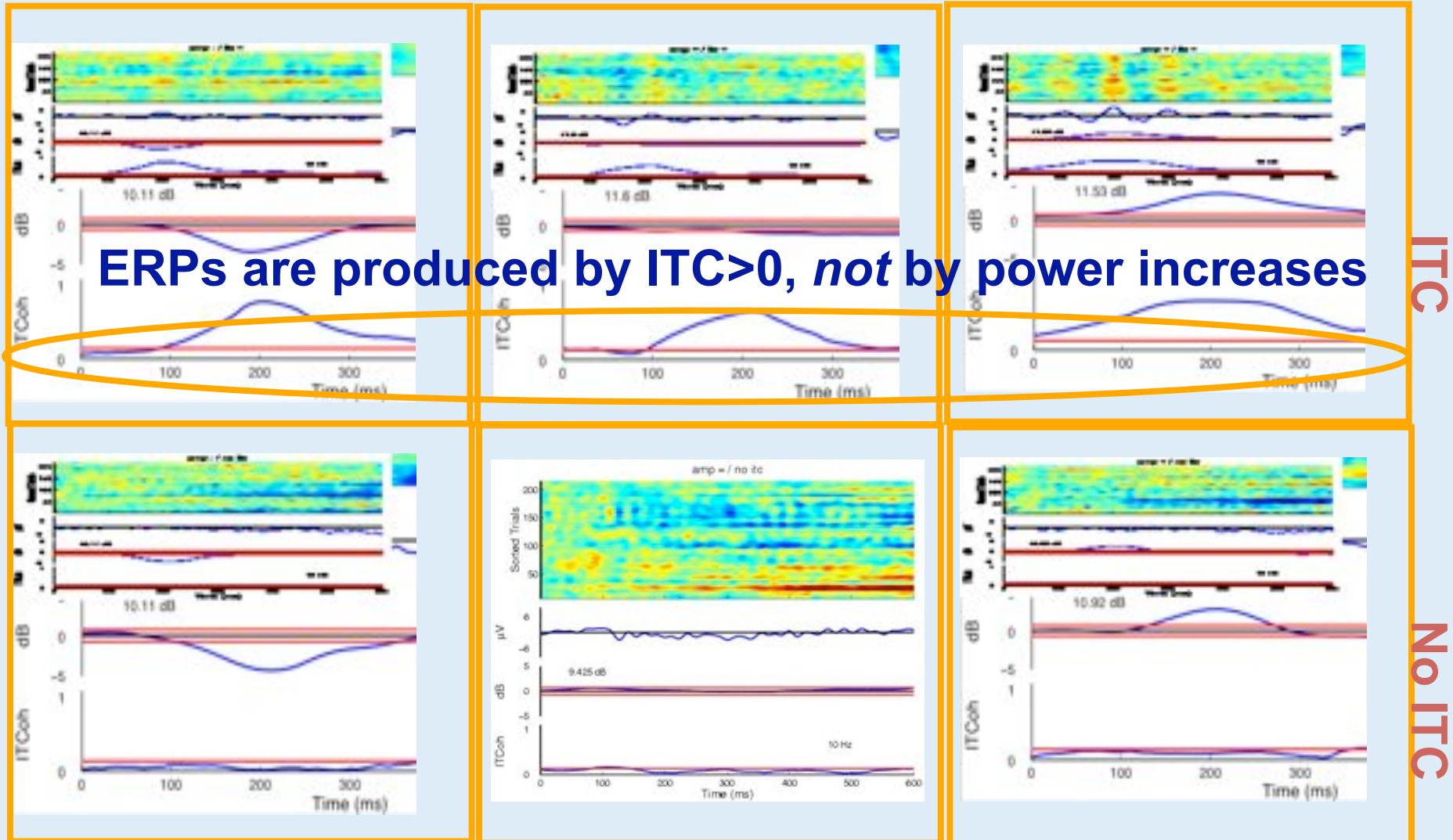
NO AMPLITUDE INCREASE



ITC / PHASE LOCKING



Space of time / frequency changes ...



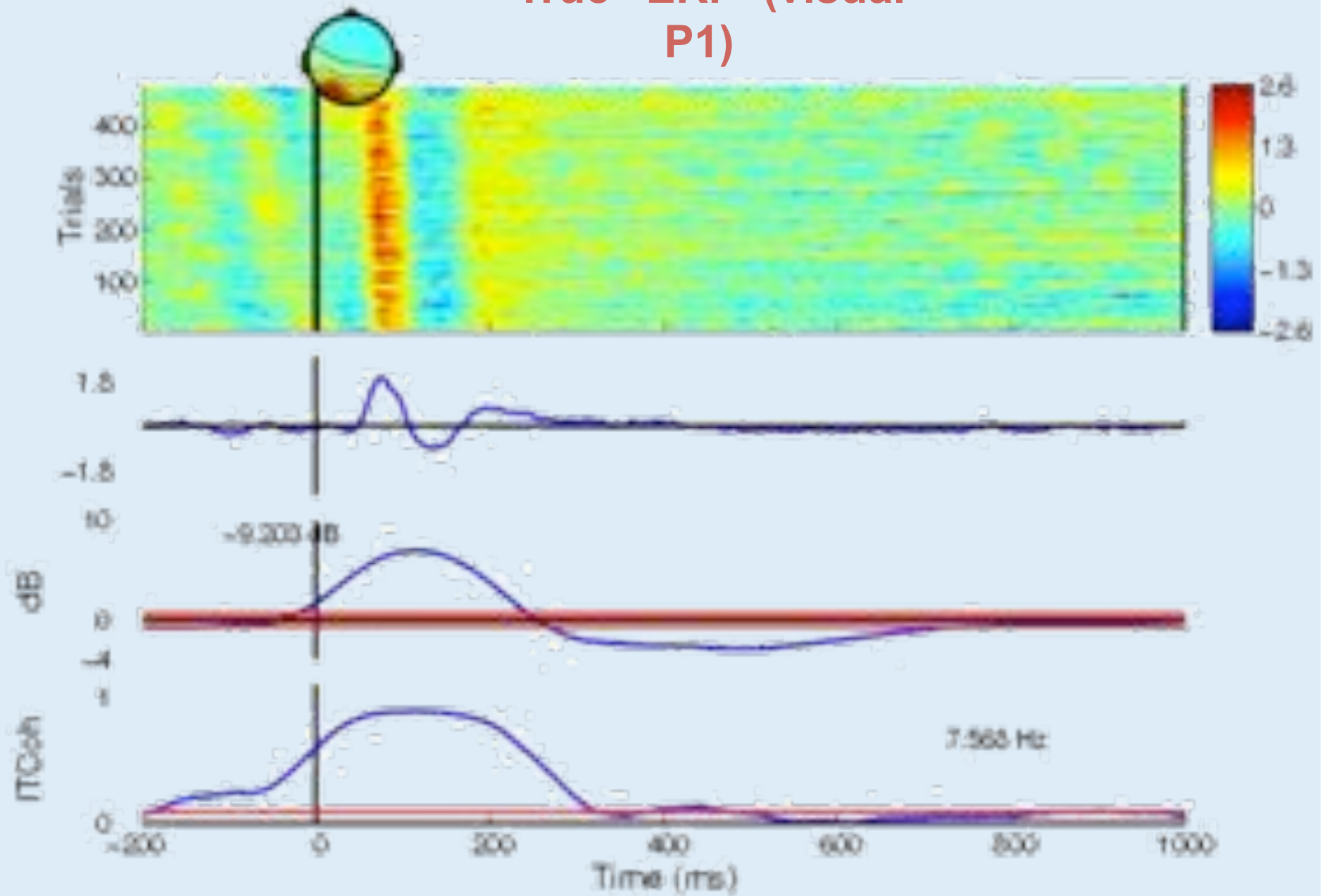
ERPs are produced by $ITC > 0$, not by power increases

ERD

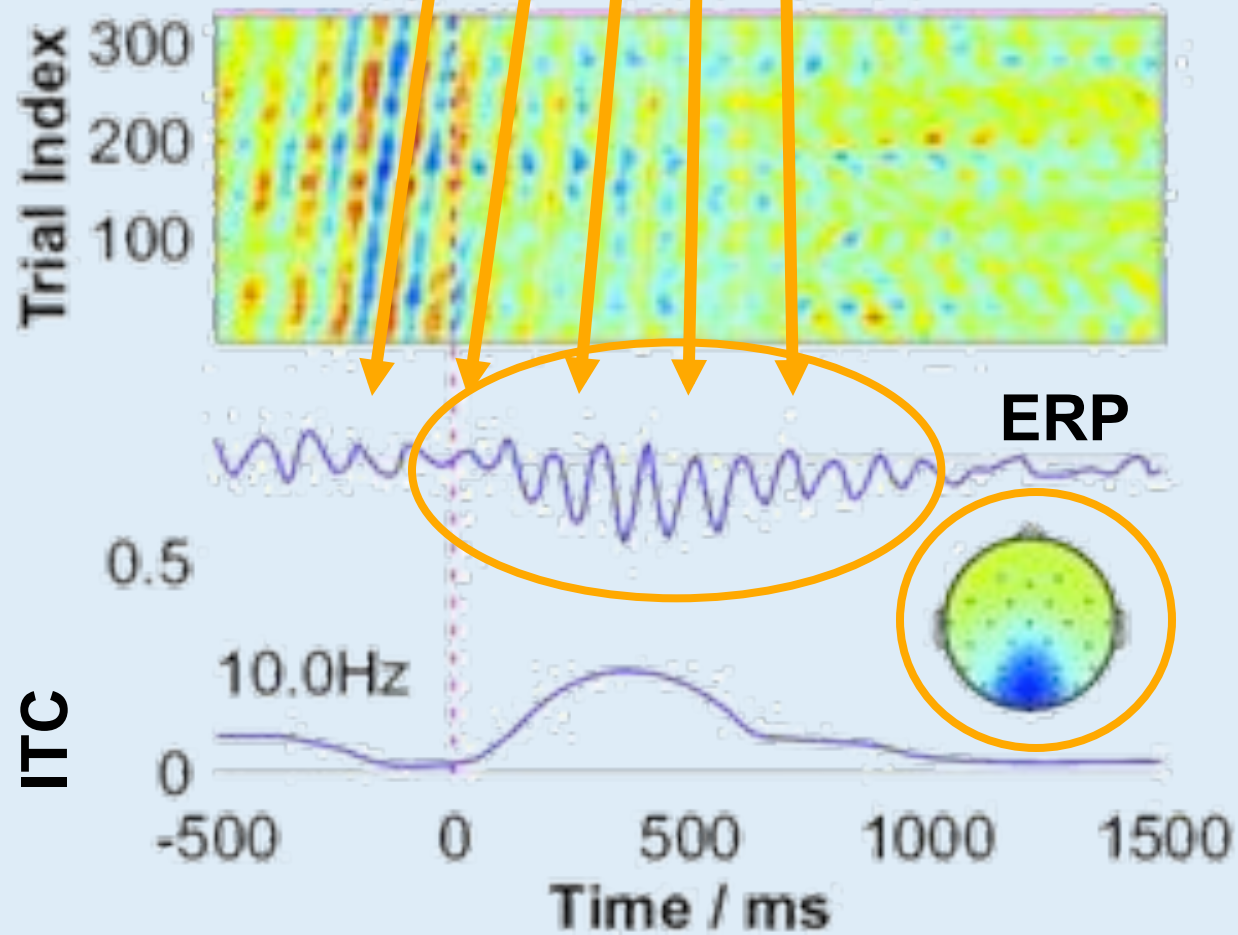
Baseline

ERS

“True” ERP (visual P1)

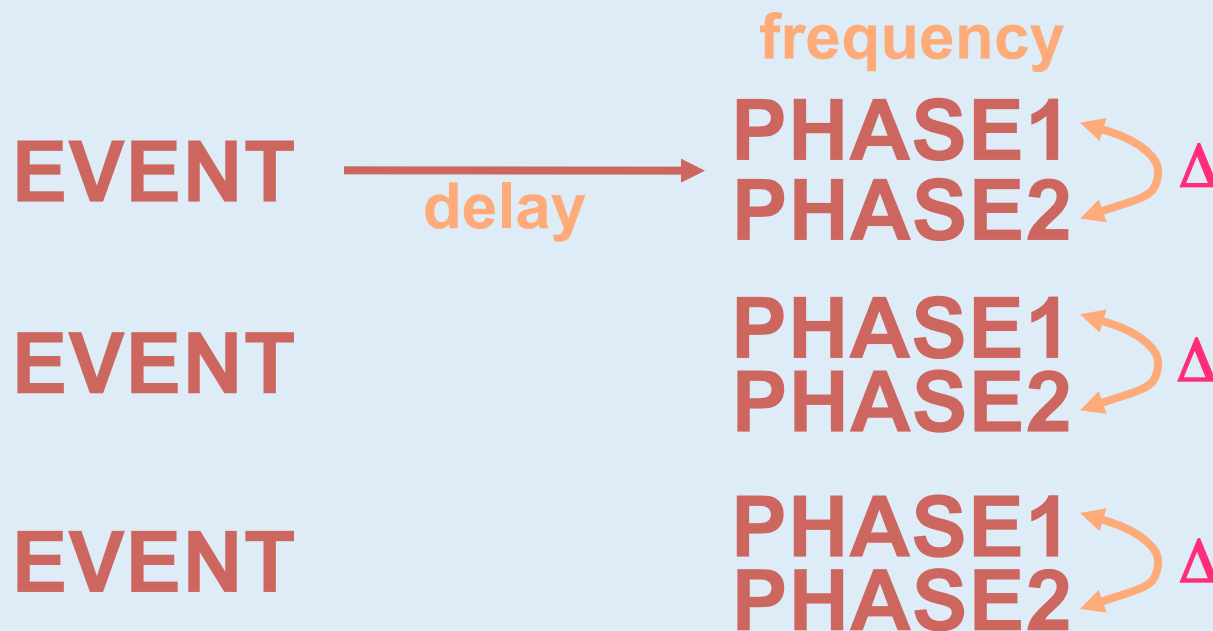


“True” PPR (visual ‘alpha ringing’)

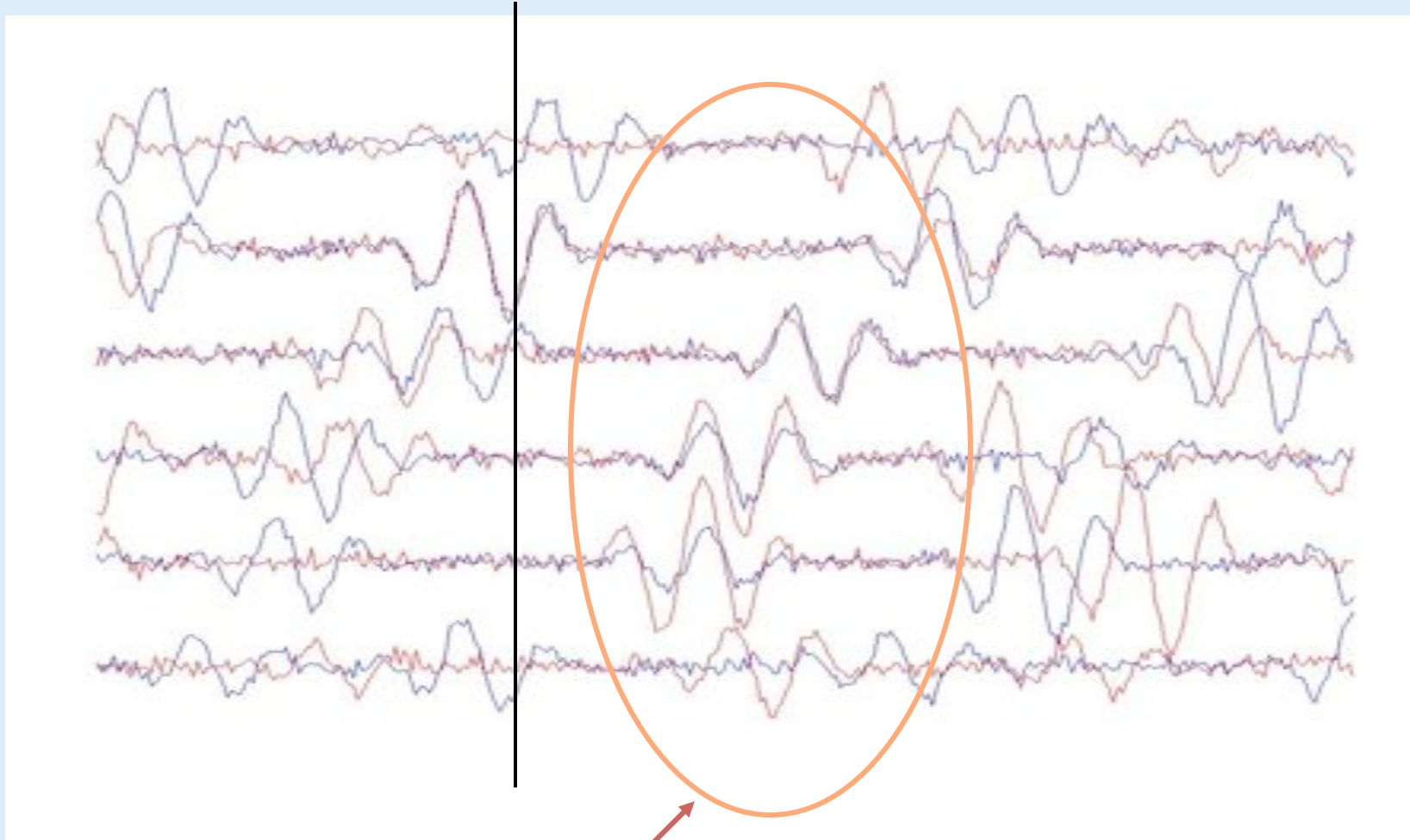


Event-Related Coherence (ERC)

- Significant consistency of **local phase difference** between **two** concurrent physiological waveforms.



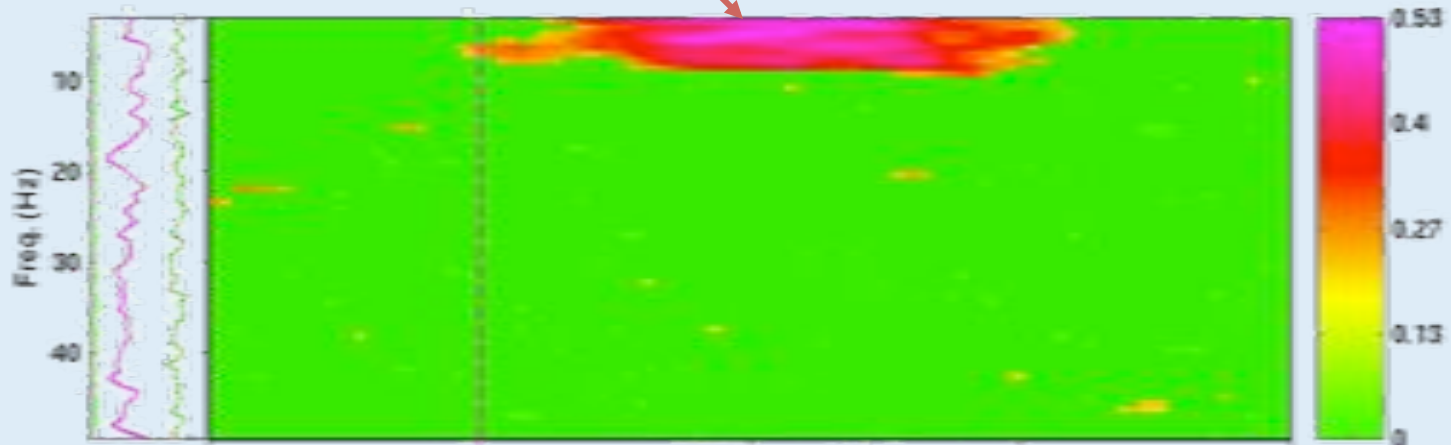
TWO SIMULATED THETA PROCESSES



Event-related Coherence

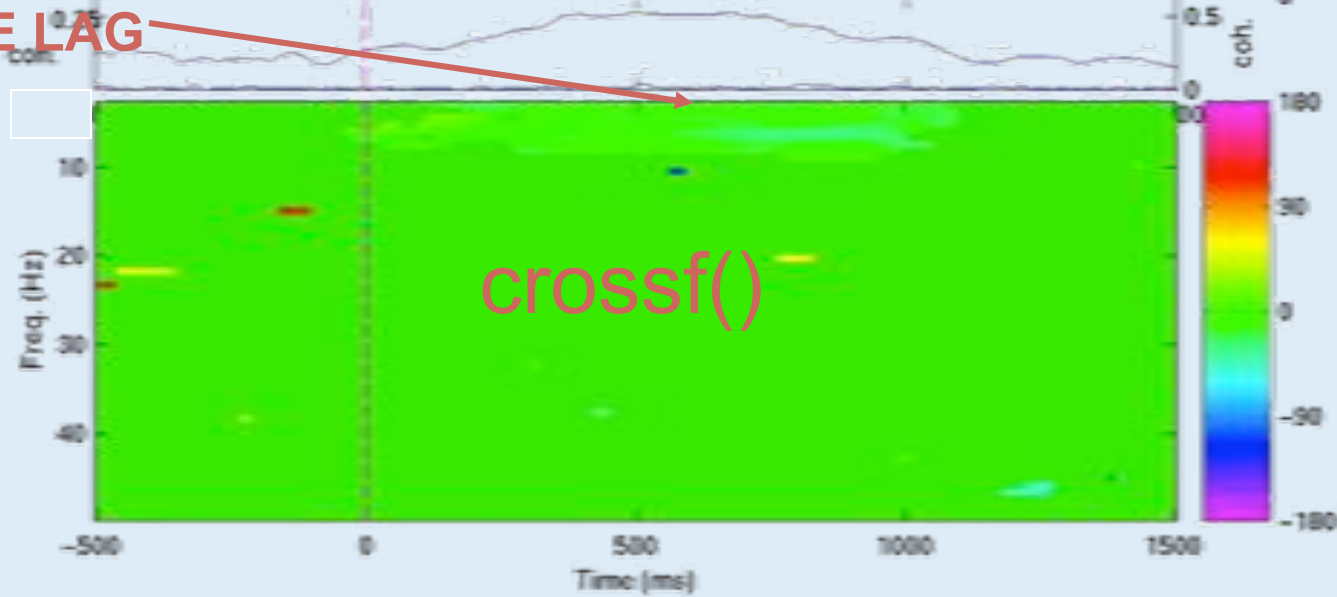
EVENT-RELATED COHERENCE

ERC



COHERENCE LAG

FREQUENCY



TIME



Fusiform

10-Hz Coh.

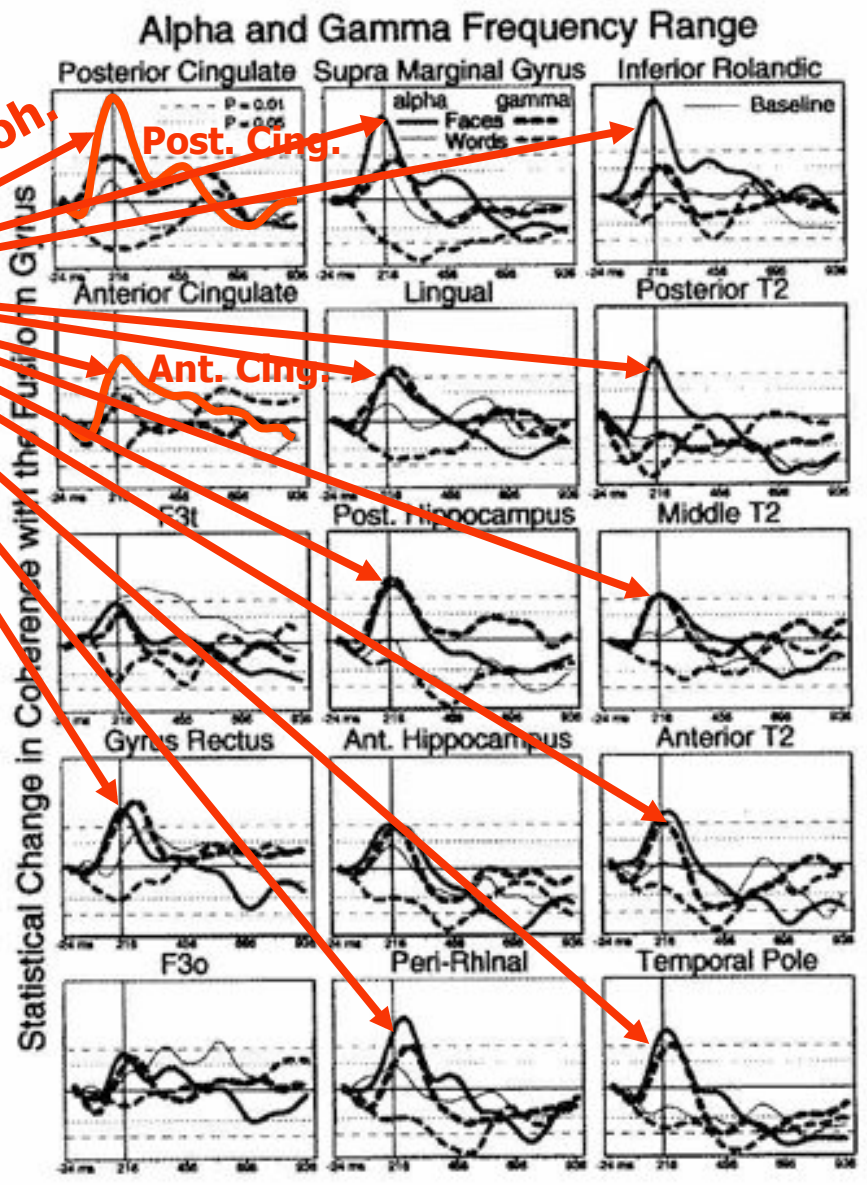
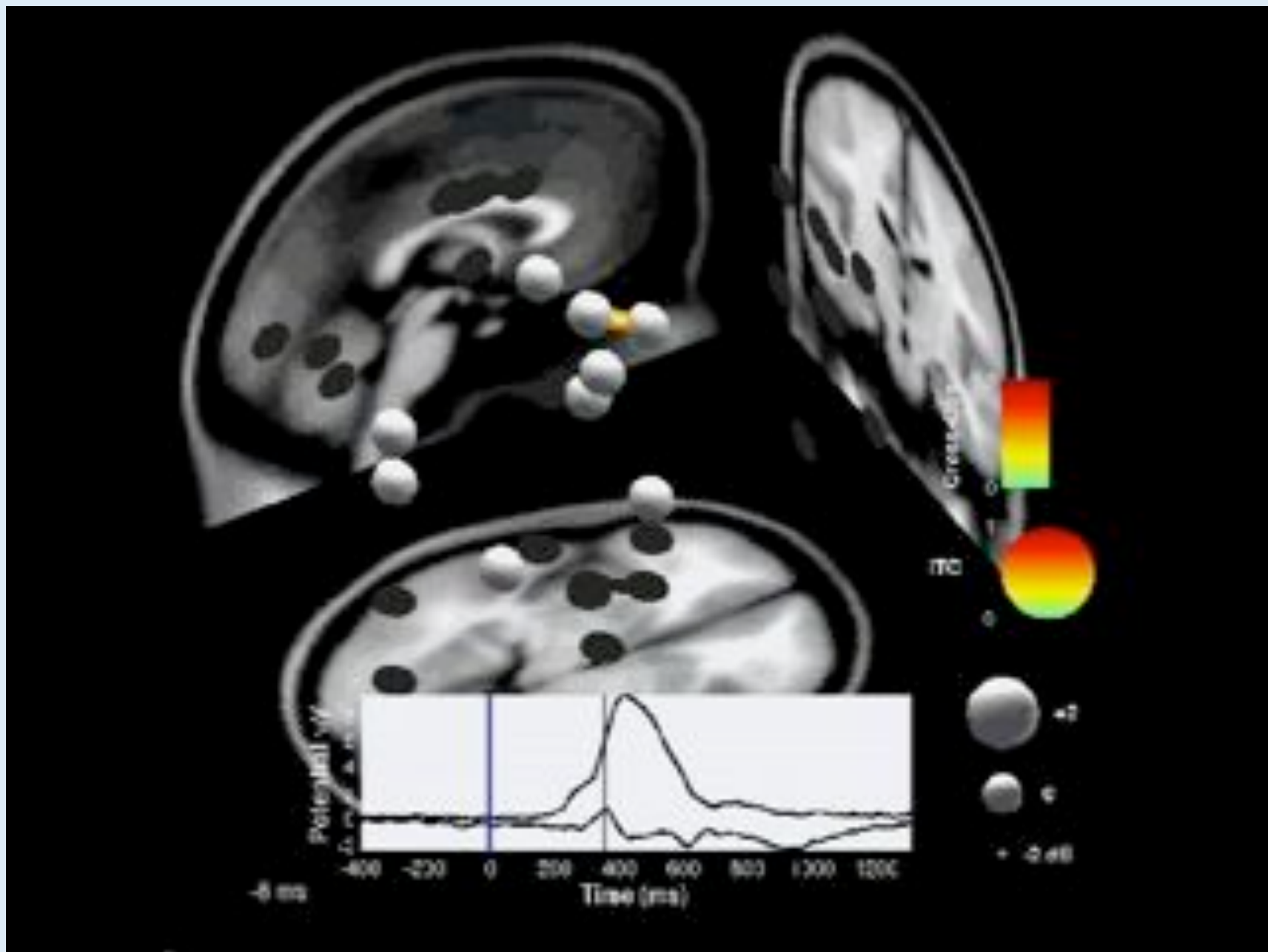
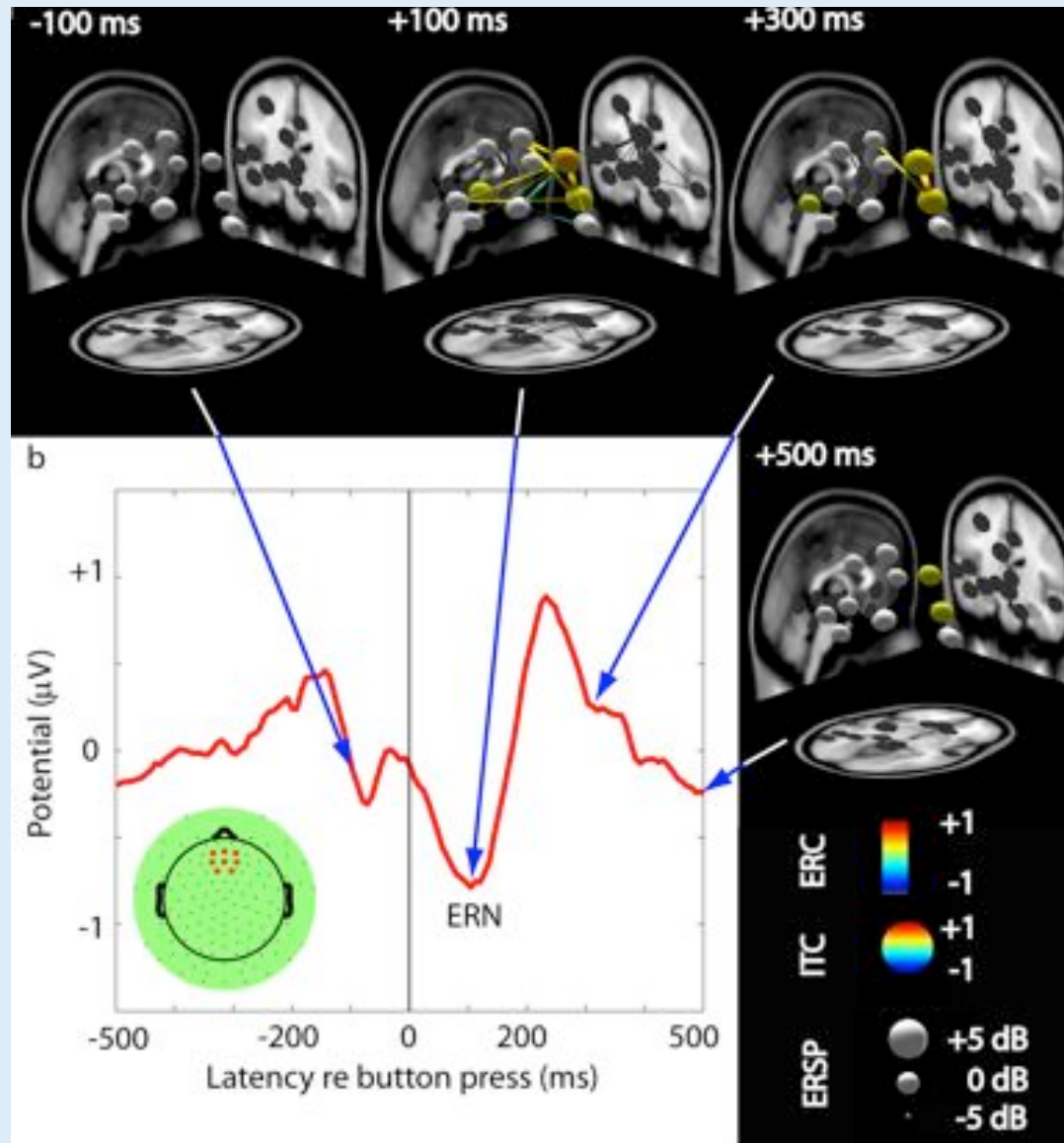


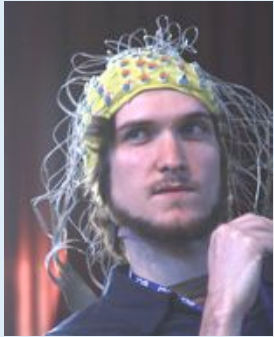
Figure 3.
 Across-subject averages of alpha and gamma-band coherence between the fusiform gyrus and 15 other areas. A sharp transient face-selective increase in coherence centered at 200 ms is seen in all sites for alpha activity and a majority of sites in the gamma band. Abbreviations as in Figure 1.

J Klopp, K Marinkovic, P Chauvel, V Nenov, E Halgren *Hum Br Map* 11:286-293 (2000)



fEEG: Functional EEG Source Imaging





Transient EEG Network Connectivity

SIFT: A toolbox for modeling EEG source information flow

