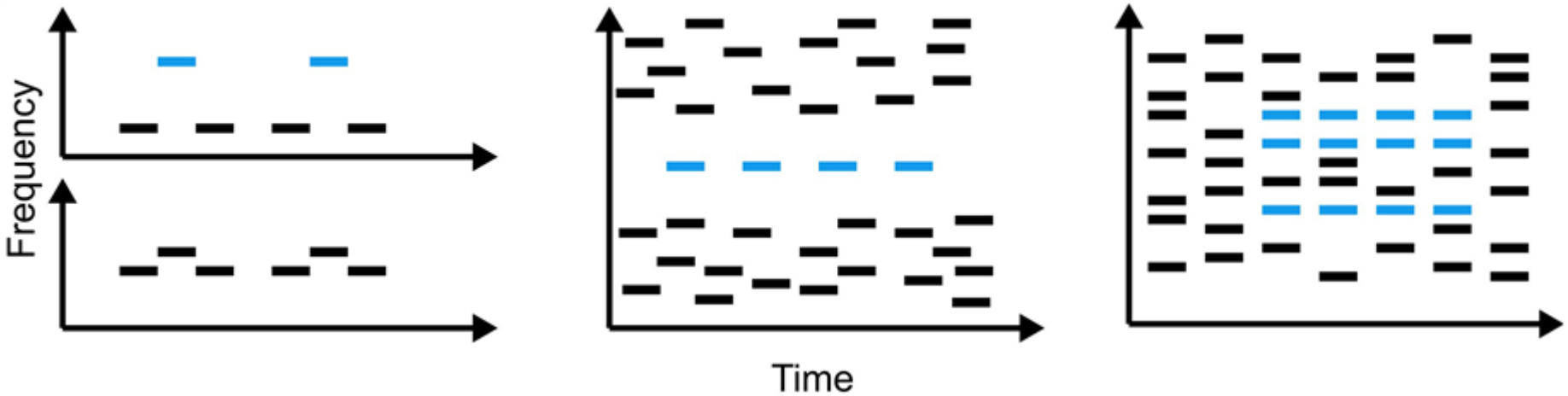
Sundeep Teki

UCL

Figure-ground segregation in complex acoustic scenes: an MEG study

Auditory Cognition Group
Wellcome Trust Centre for Neuroimaging

Auditory scene analysis



Dykstra and Gutschalk, 2013. *eLife*

Stochastic figure-ground stimulus

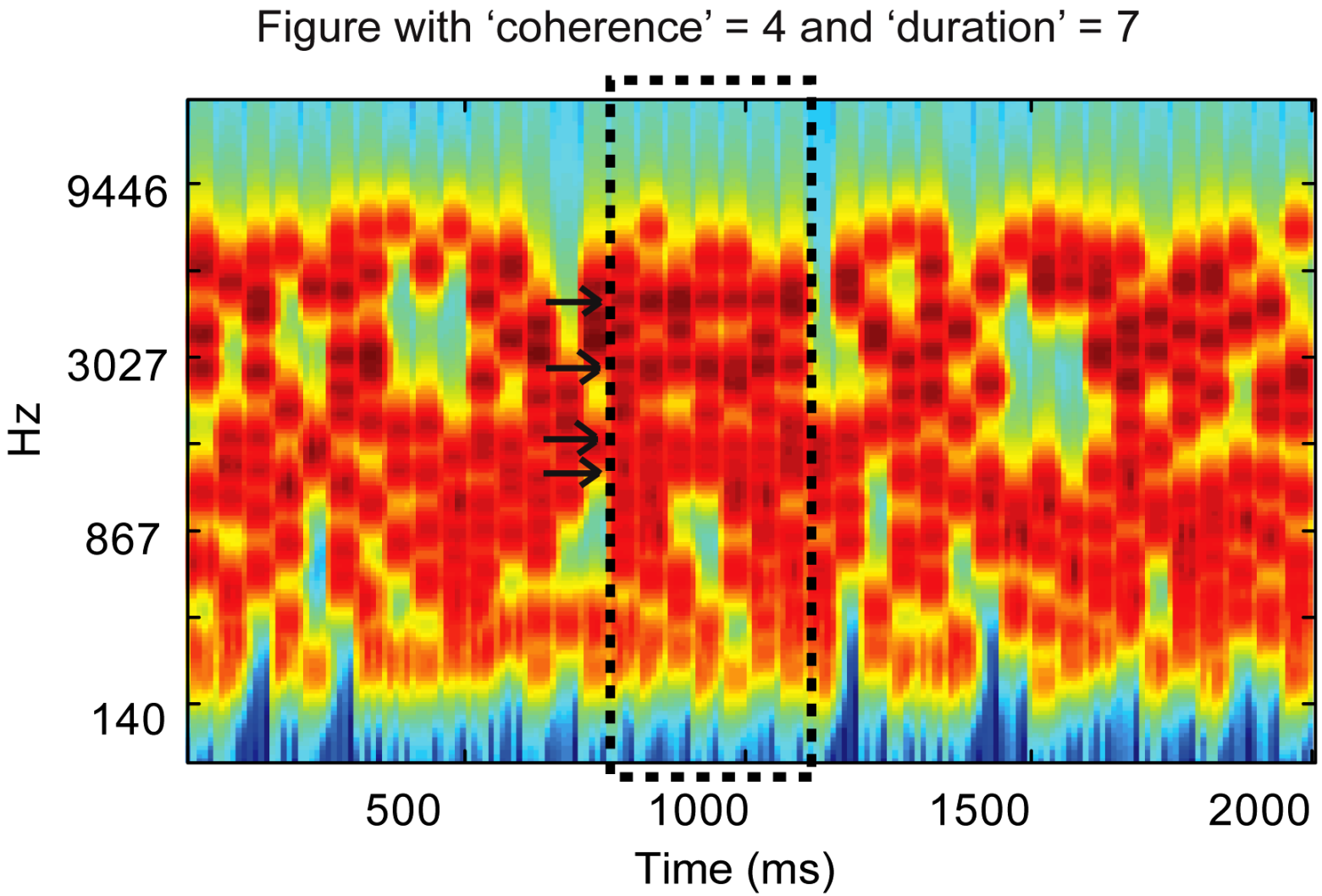
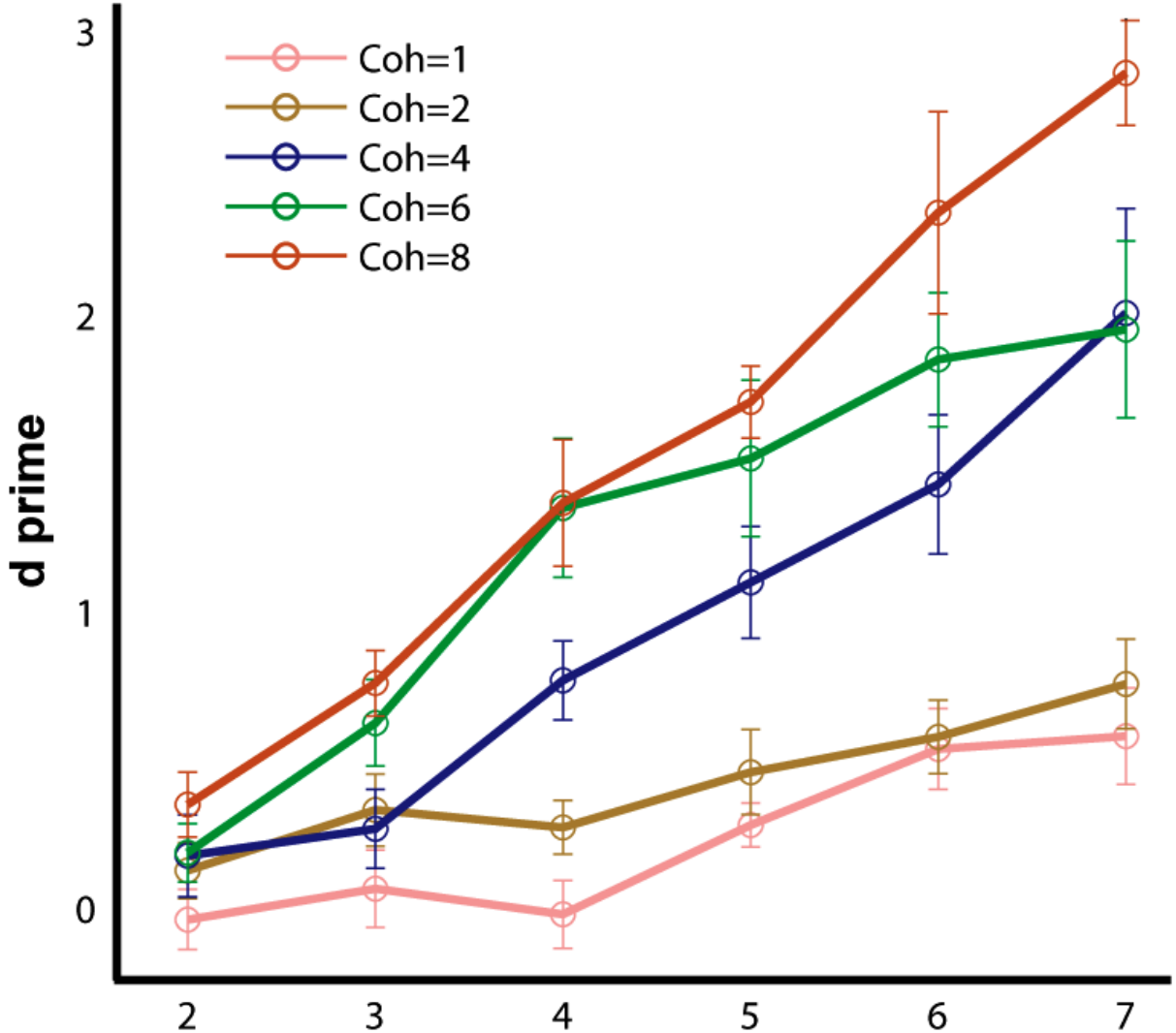


Figure-detection behavior

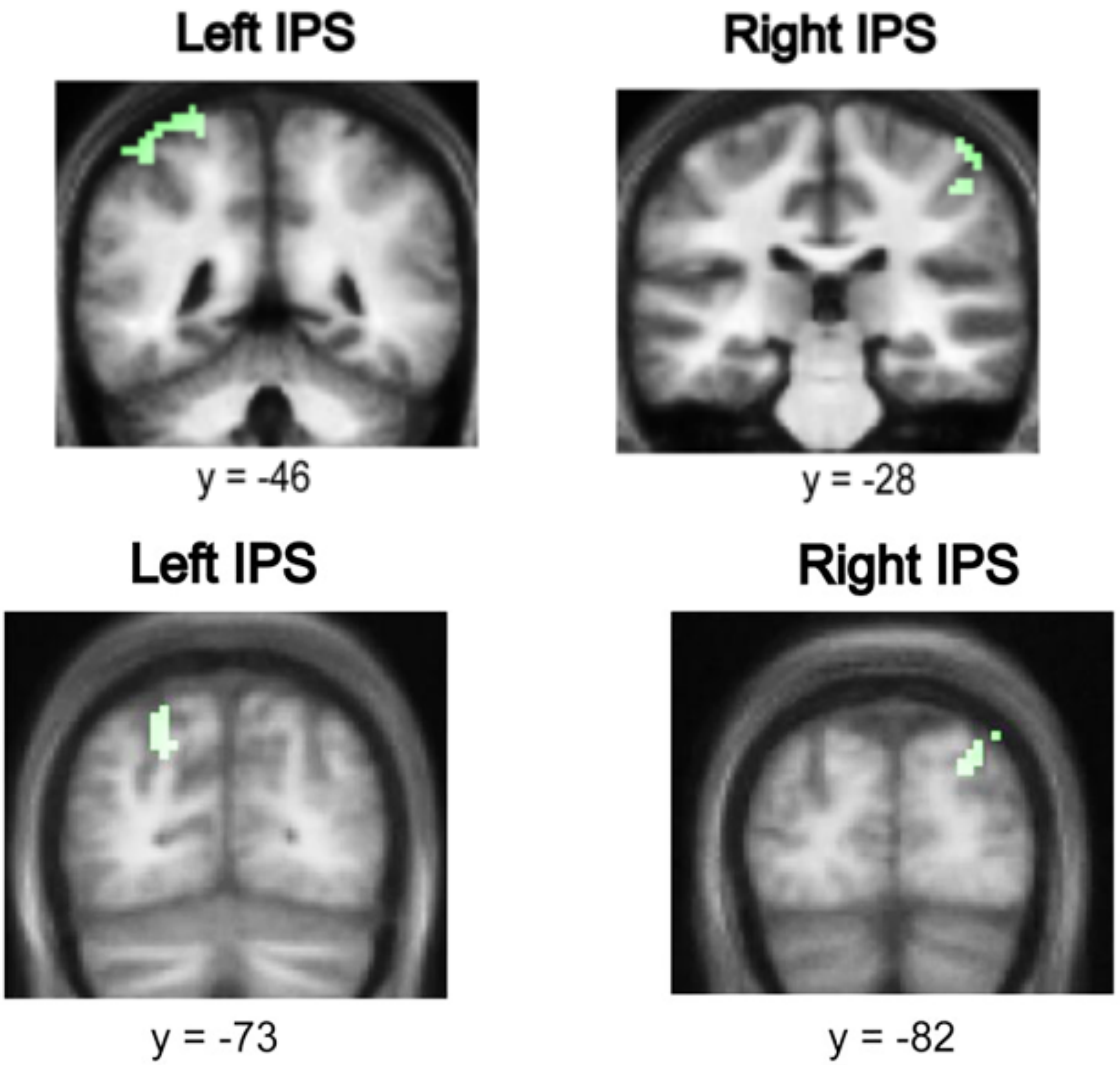


Teki, Chait et al., 2013. *eLife*

fMRI

DURATION:

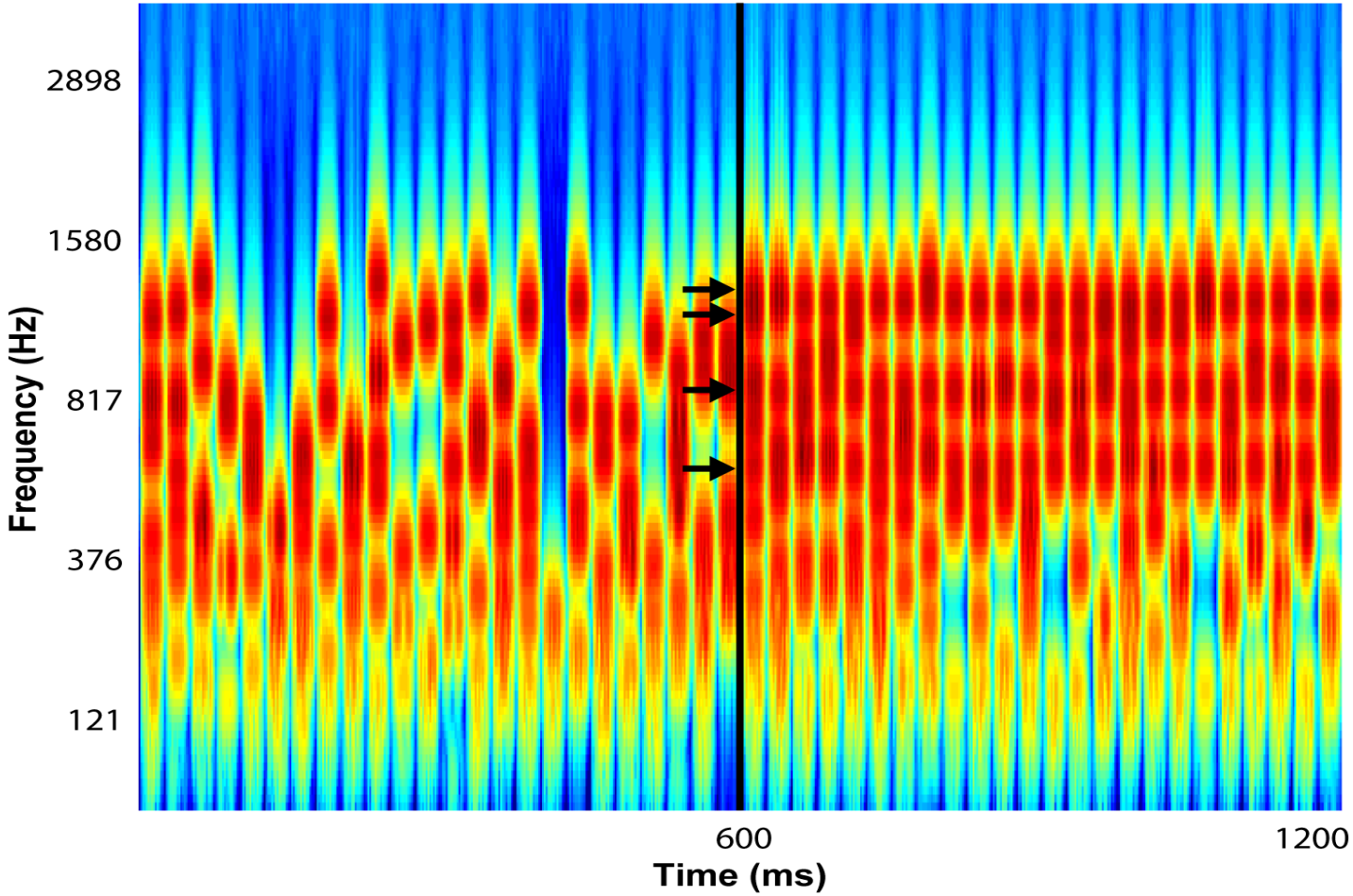
COHERENCE:



IPS: Intraparietal Sulcus

Teki, Chait et al., 2011. *J Neurosci*

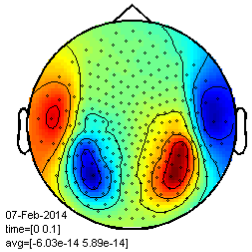
MEG paradigm



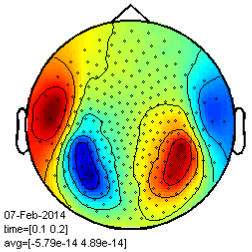
- Figure with 'coherence' = 0, 2, 4 or 8.
- 25 ms chords; bandwidth: 2.5kHz; duration of ground & figure: 600ms
- N=20; listeners engaged in concurrent visual task

MEG sensor topography (coh = 8)

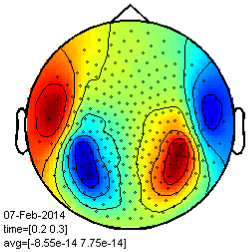
0-100ms



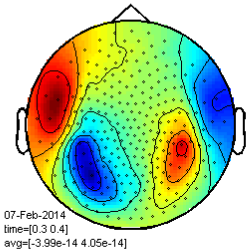
100-200ms



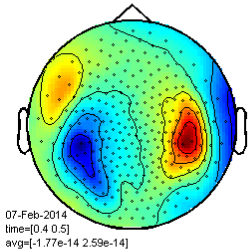
200-300ms



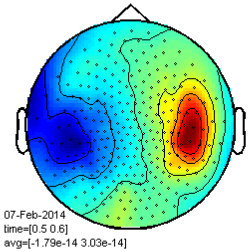
300-400ms



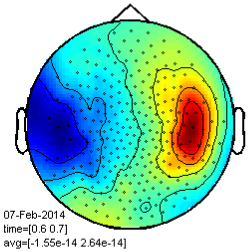
400-500ms



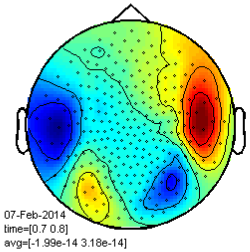
500-600ms



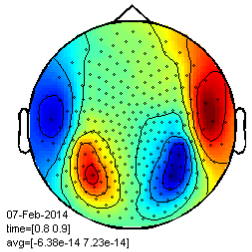
600-700ms



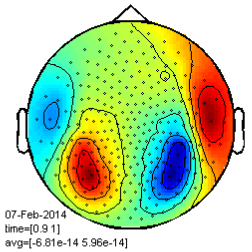
700-800ms



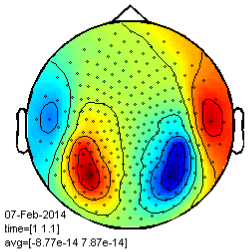
800-900ms



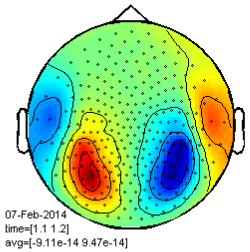
900-1000ms



1000-1100ms



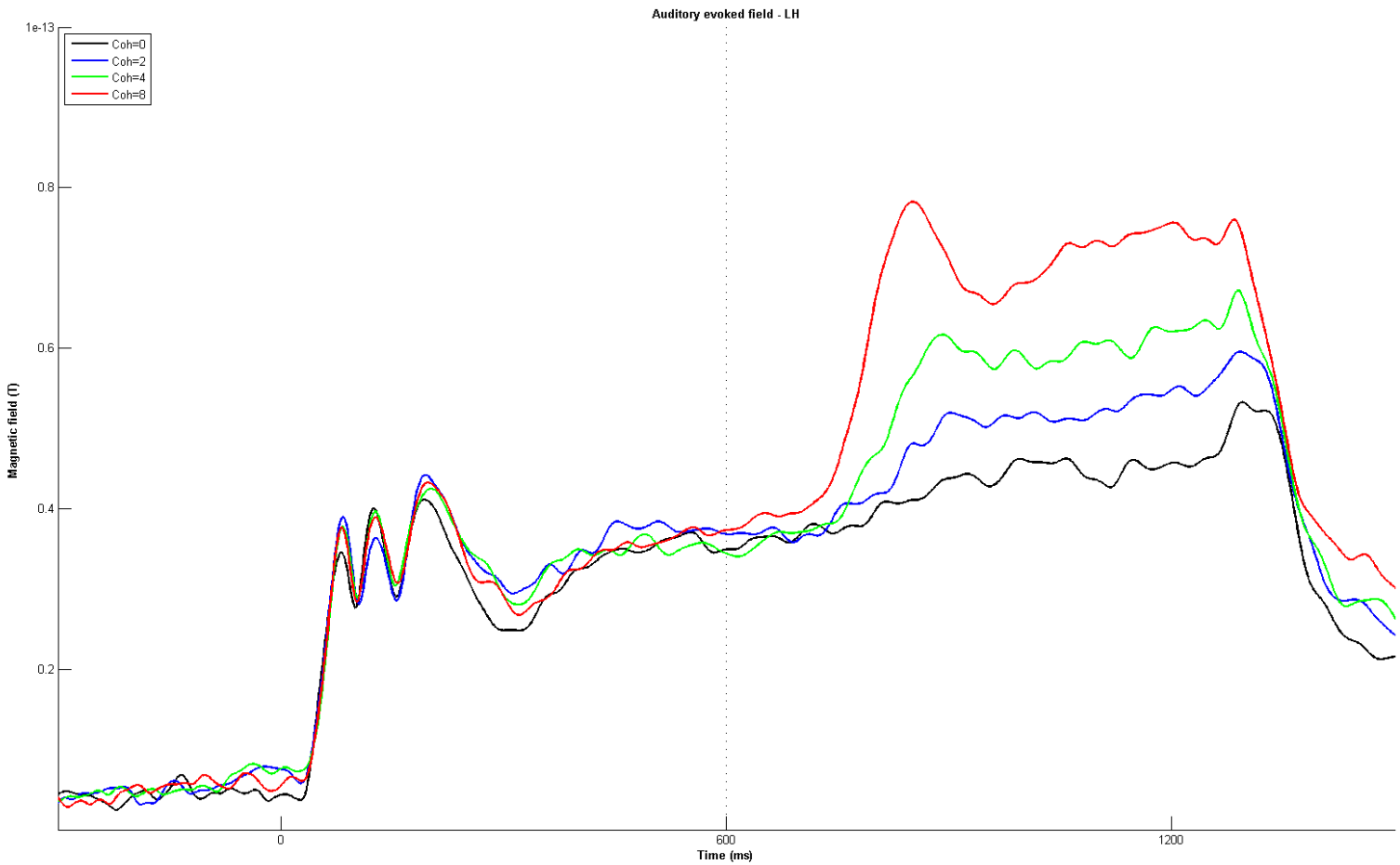
1100-1200ms



Ground: 0-600ms

Figure: 600-1200ms

Evoked fields: left hemisphere

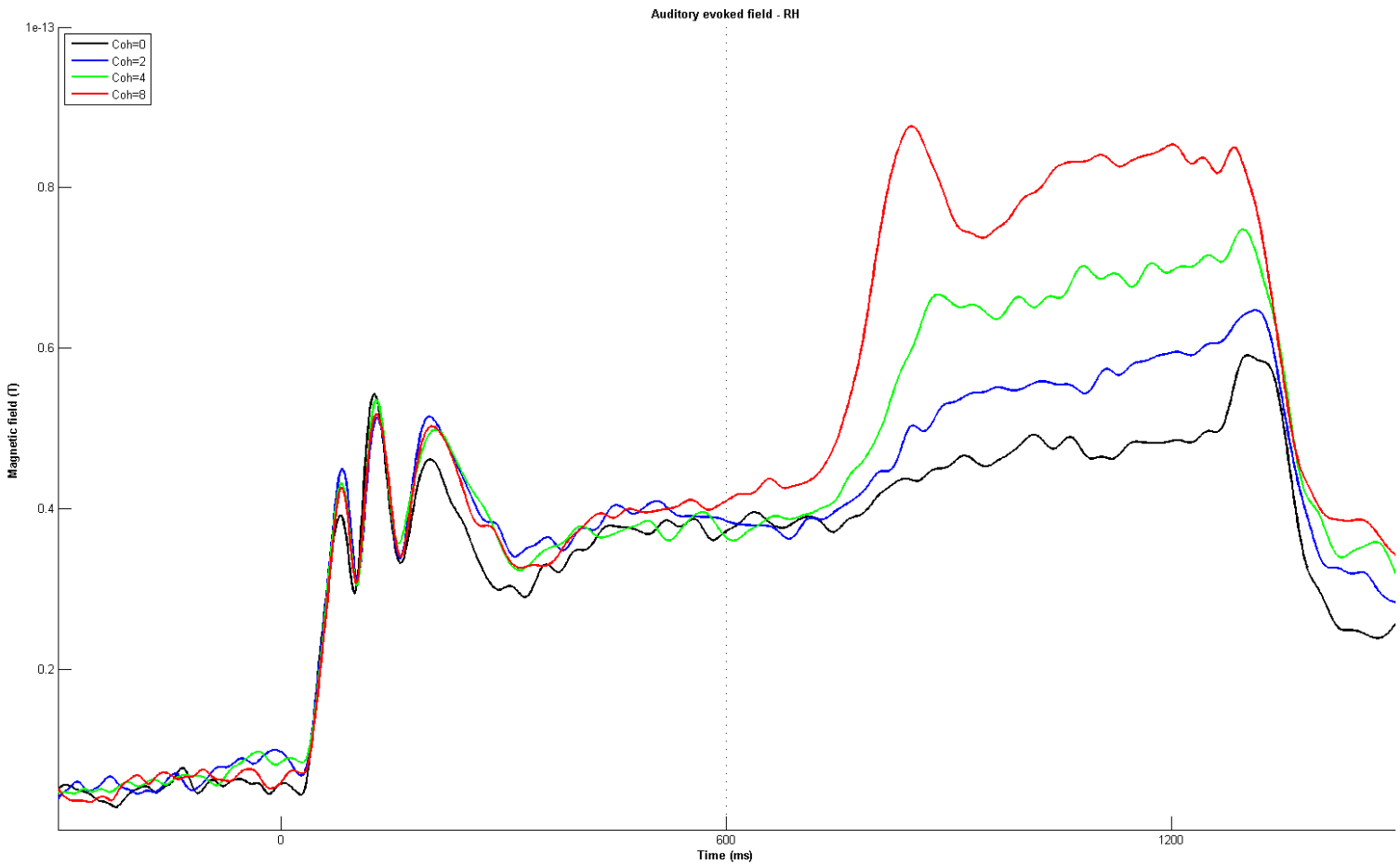


Significant effect of coherence on <u>peak amplitude</u>: F = 4.2, p = 0.0087

No significant effect of coherence on <u>area under figure</u>: F = 2.0, p = 0.15

N=20; RMS data from 20 channels in left hemisphere most responsive to sound onset

Evoked fields: right hemisphere

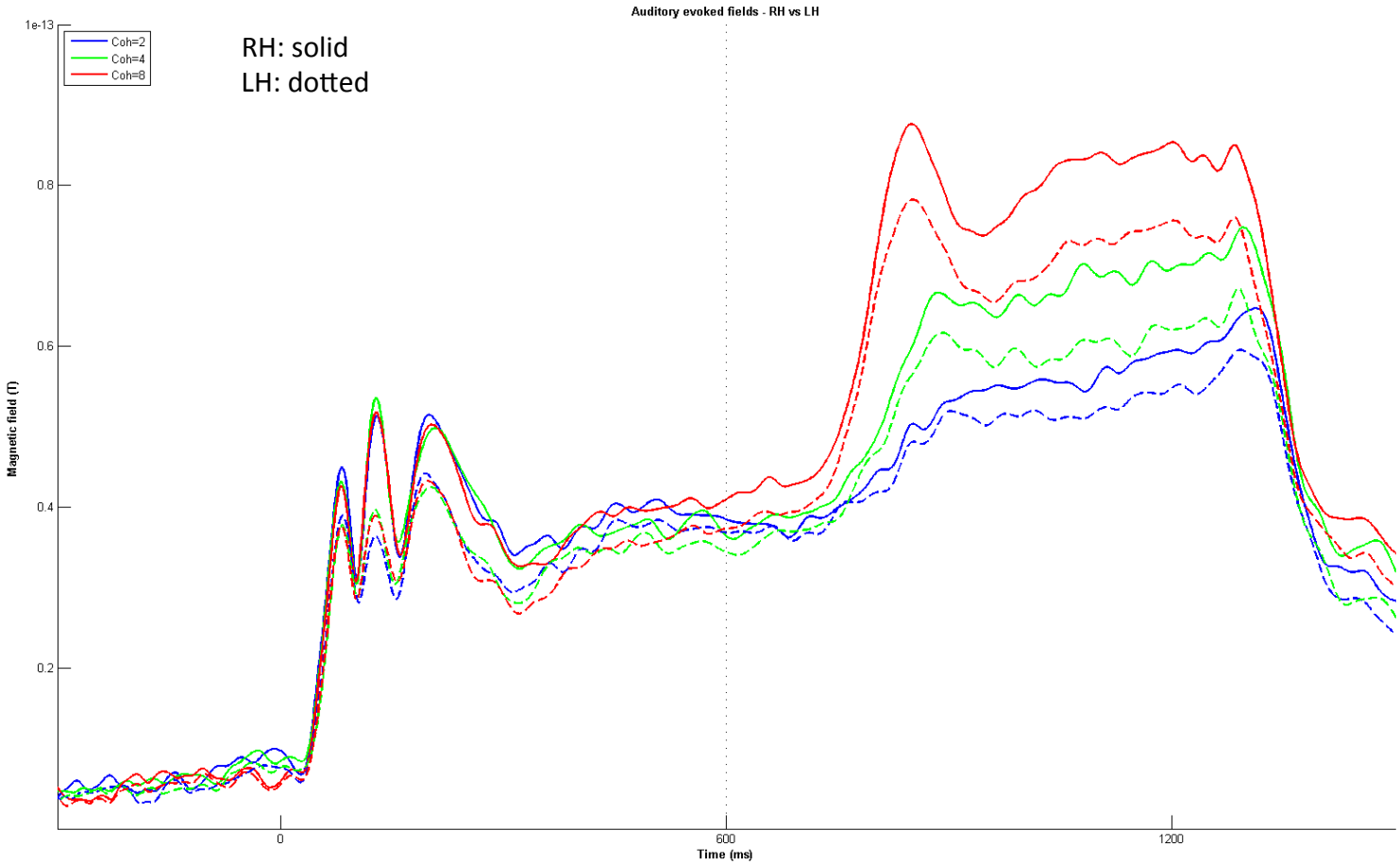


Significant effect of coherence on <u>peak amplitude</u>: F = 6.8, p = 0.0004

Significant effect of coherence on <u>area under figure</u>: F = 3.6, p = 0.03

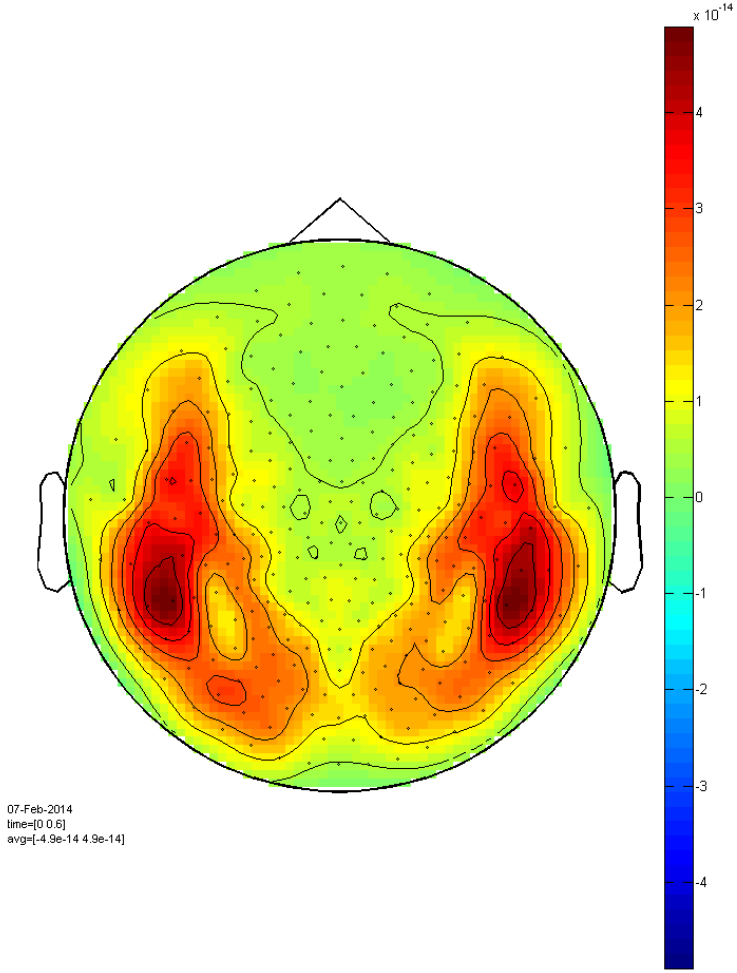
N=20; RMS data from 20 channels in right hemisphere most responsive to sound onset

Right vs. Left hemisphere



Lateralization index = 0.084 ± 0.04;
t= 2.03; p = 0.057

Evoked fields: figure vs. ground



Ground: 0-600ms

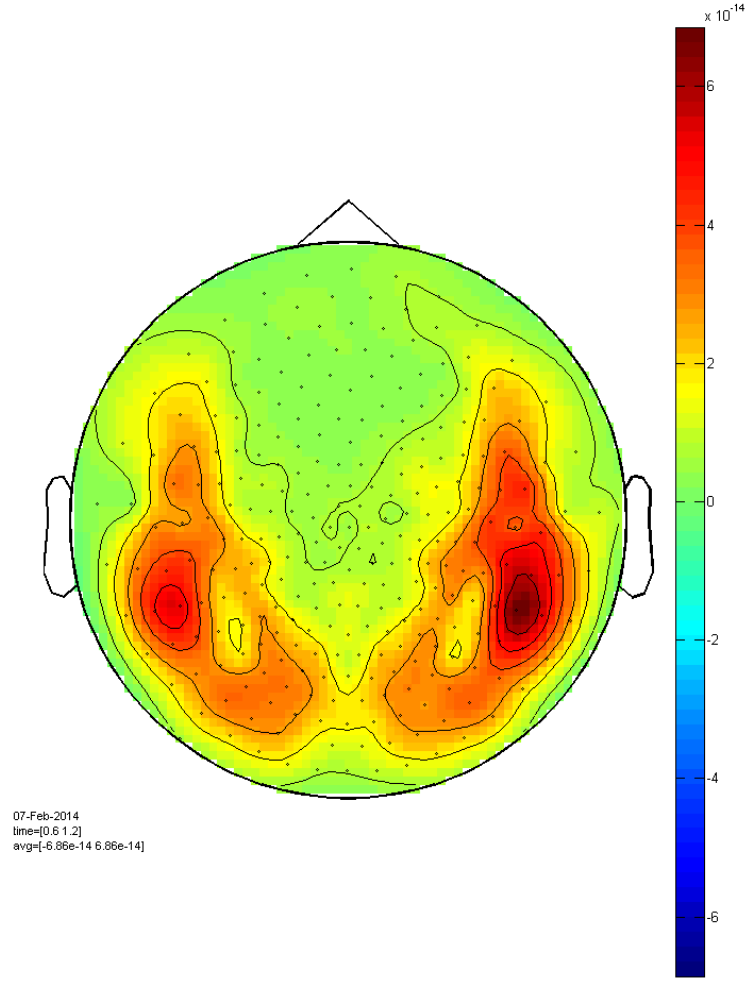
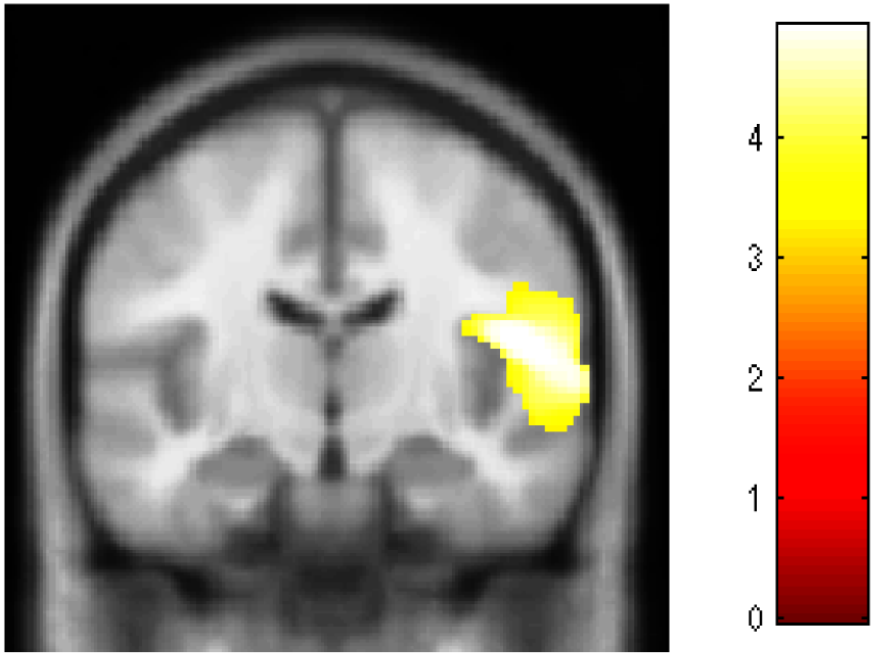


Figure: 600-1200ms

Sources of evoked power (early phase) that vary as a function of coherence

EARLY PHASE:
0-300ms post transition

Auditory cortex, PT, STS

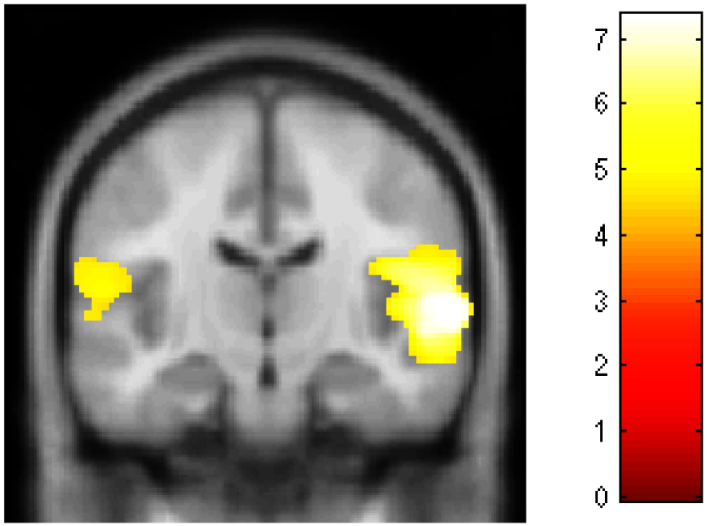


t = 4.91; p < 0.001 (unc.)

Sources of evoked power (late phase) that vary as a function of coherence

LATE PHASE:
300-600ms post transition

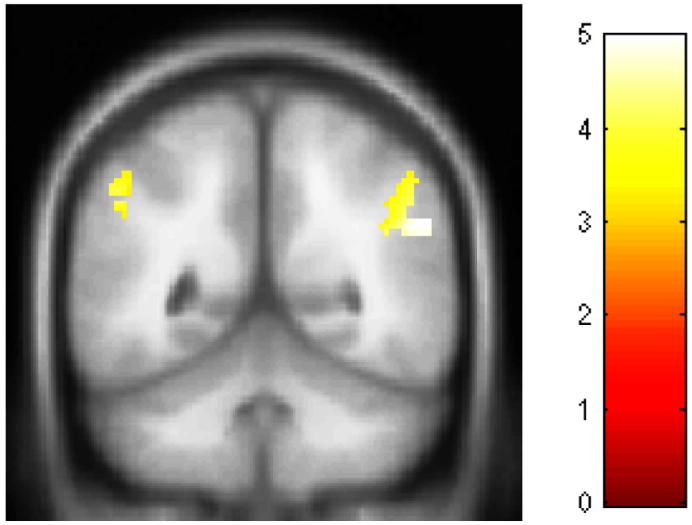
Auditory cortex, PT, STS



t = 5.84; p < 0.05 (FWE)

t = 7.35; p < 0.05 (FWE)

IPS, Parietal cortex

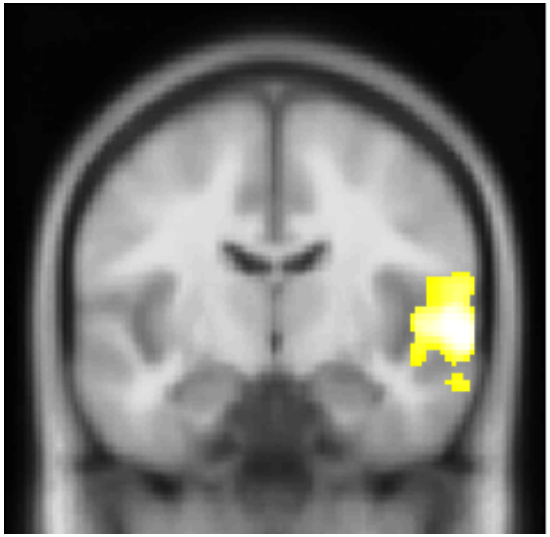


t = 3.98; p < 0.001 (unc.)

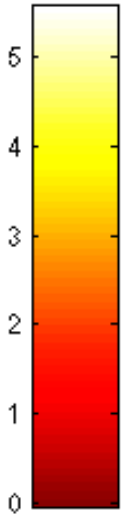
t = 4.98; p < 0.001 (unc.)

Sources of evoked power: Late vs. Early phase

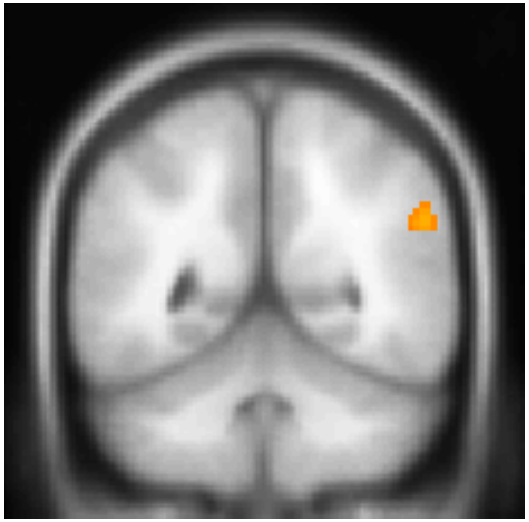
Auditory cortex, PT



t = 5.55; p < 0.001 (unc.)

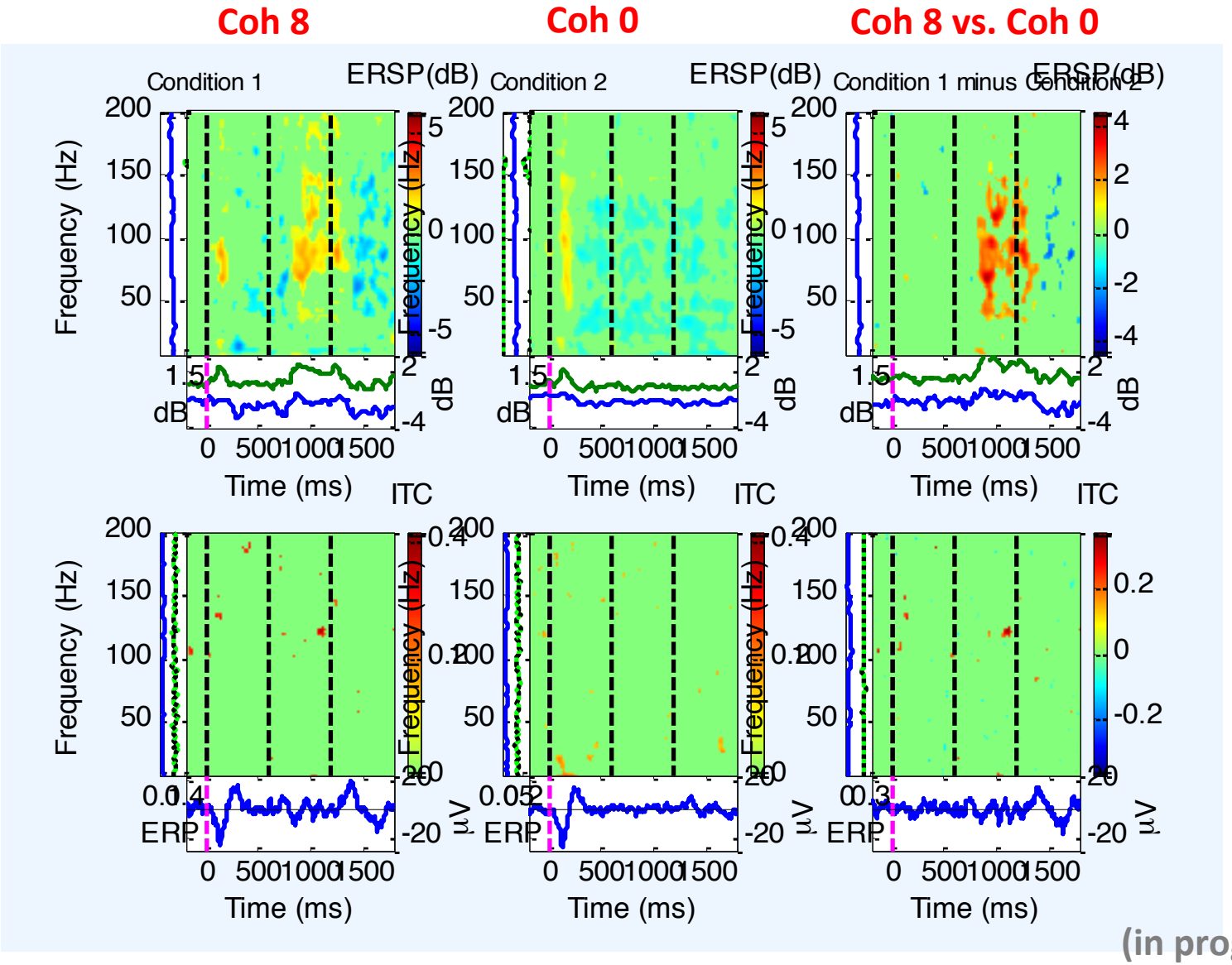


Posterior Parietal cortex

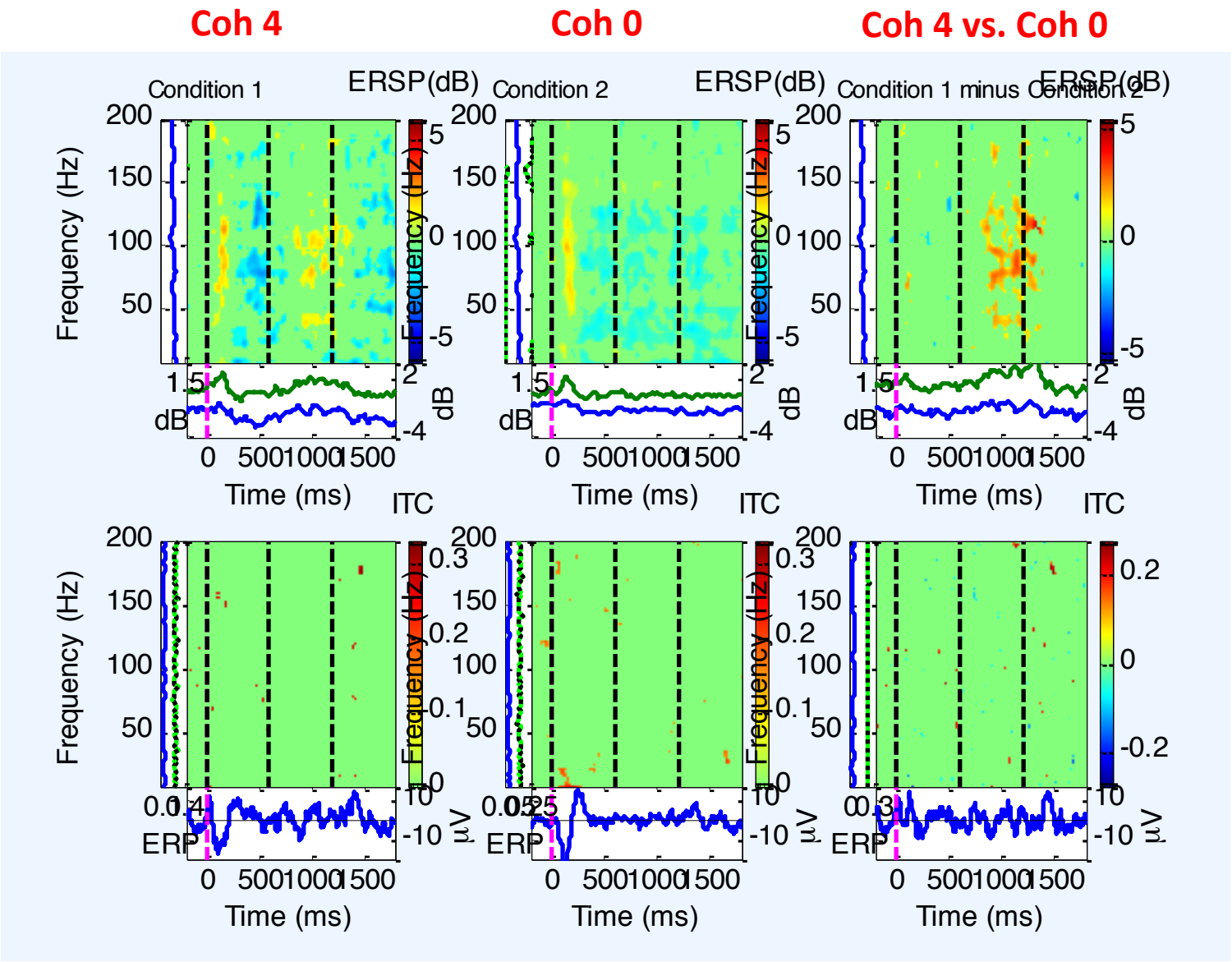


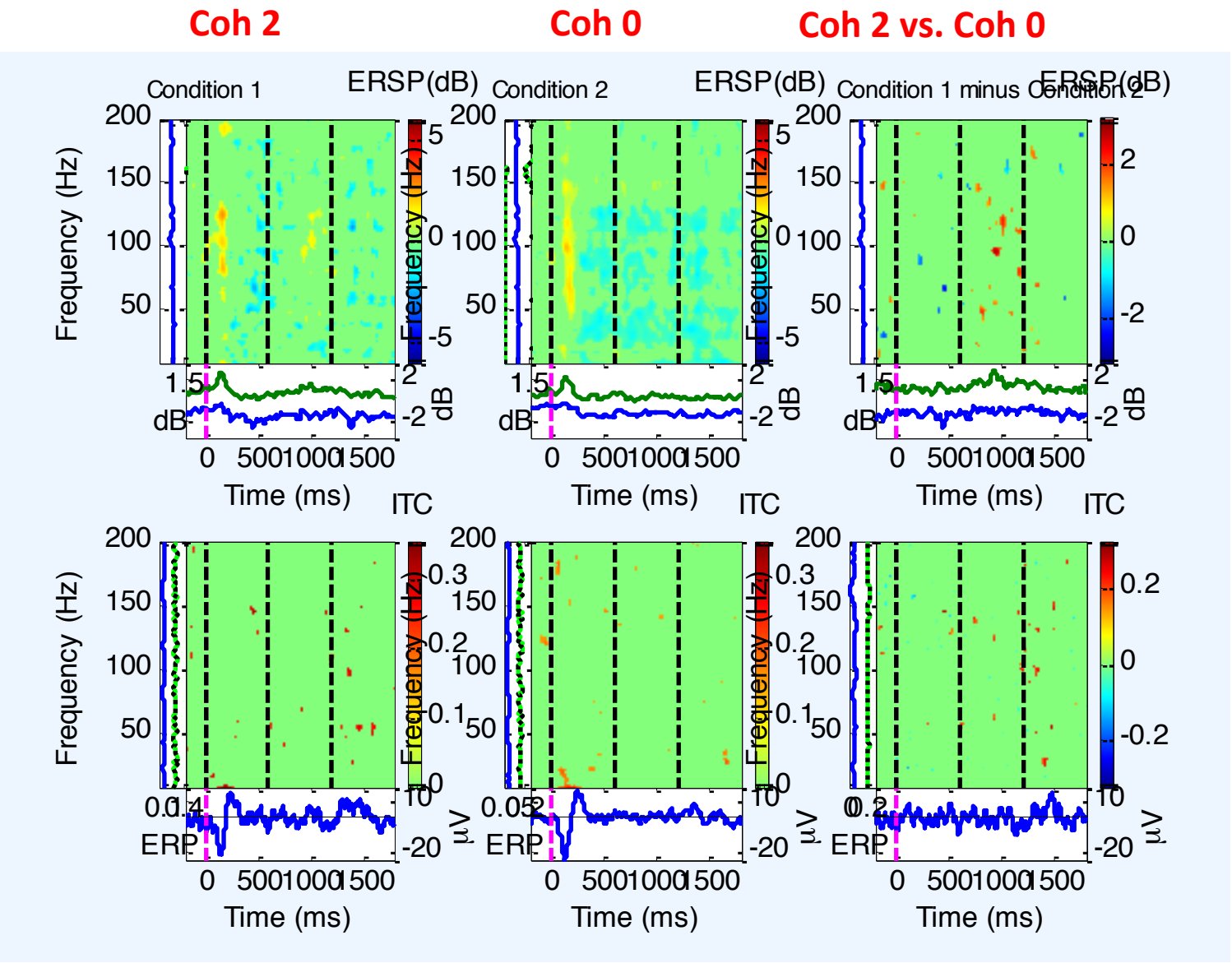
t = 2.97; p < 0.005 (unc.)

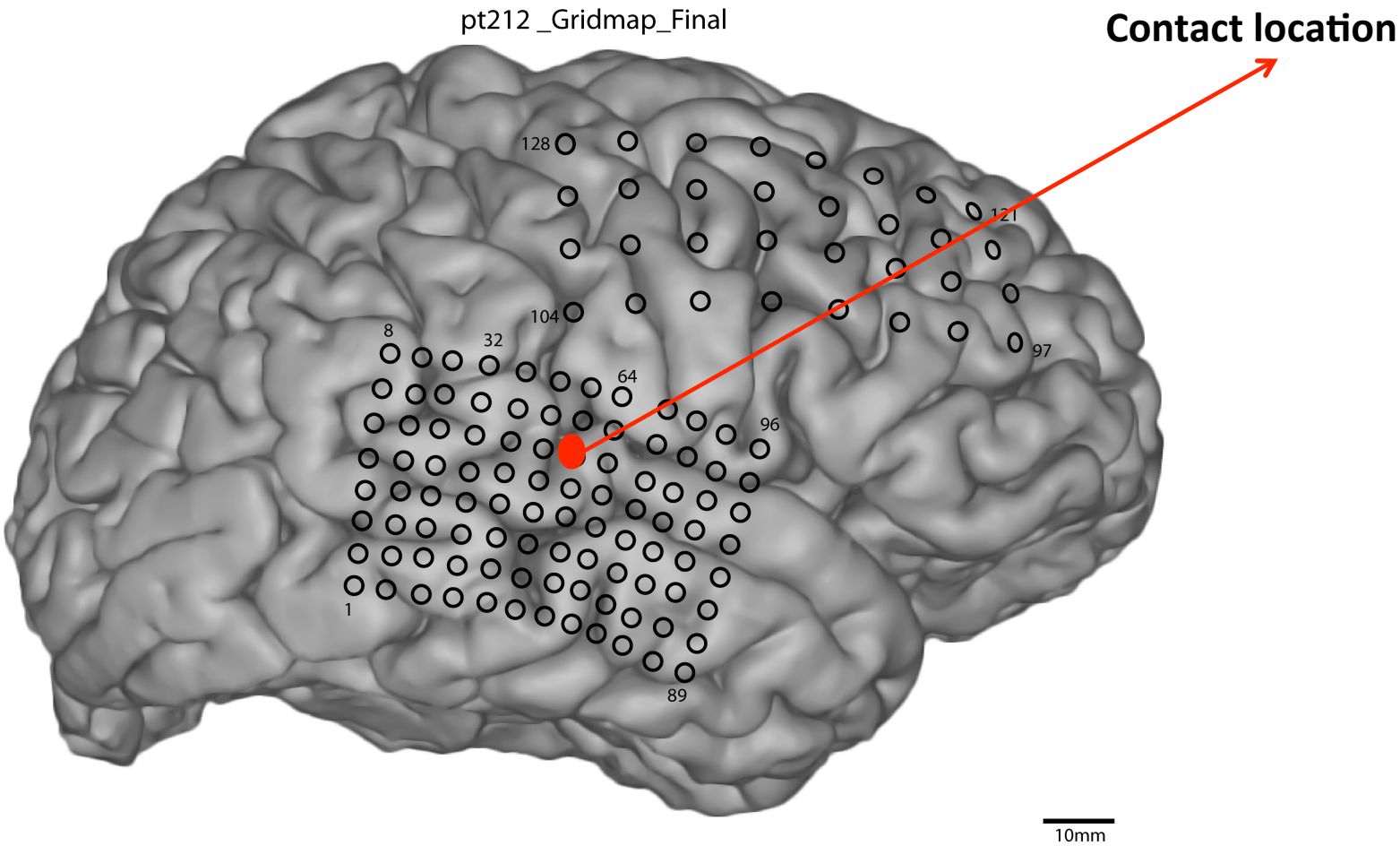
Direct recordings from human auditory cortex



Kumar et al.
(in progress in Iowa)

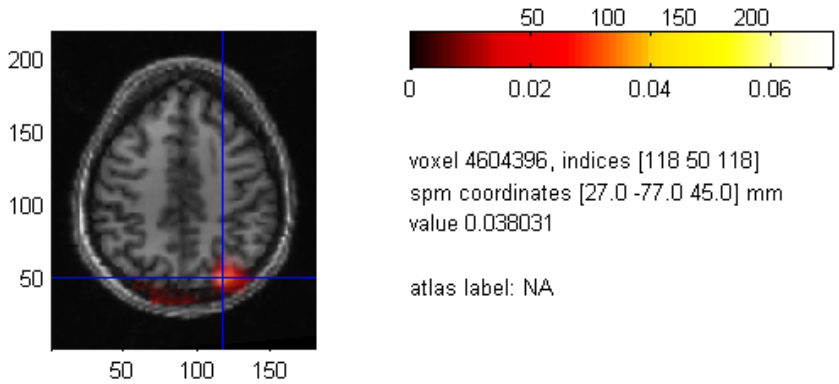

Coh 4
Coh 0
Coh 4 vs. Coh 0
Condition 1
Condition 2
Condition 1 minus Condition 2
ERSP(dB)
ITC
ERP
Frequency (Hz)
Time (ms)
dB
μV


Coh 2
Coh 0
Coh 2 vs. Coh 0
Condition 1
ERSP(dB)
Condition 2
ERSP(dB)
Condition 1 minus Condition 2
ERSP(dB)
Frequency (Hz)
Time (ms)
dB
ITC
ERP
μV

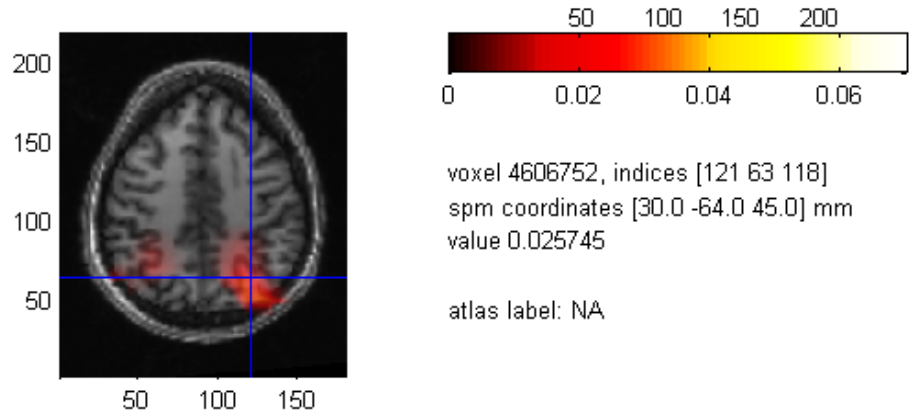

pt212 _Gridmap_Final
Contact location
128
121
104
8
32
64
97
96
1
89
10mm

MEG sources of induced power

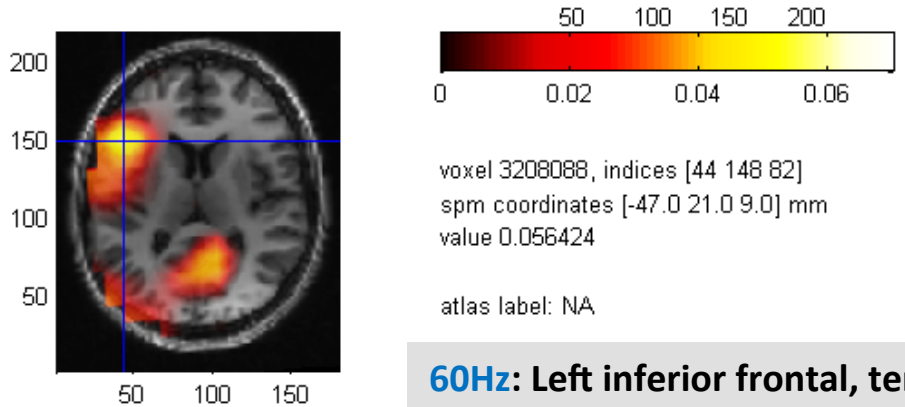
Using DICS beamformer; FOI: 60-100Hz
Coh 8 vs. Coh 0 (figure segment)



100Hz: Right posterior parietal



80Hz: Right posterior parietal



60Hz: Left inferior frontal, temporal

** Single subject data;*
Work in progress

Summary

Stimulus:
A complex stochastic signal that enables parametric variation of target salience.

Psychophysics:
Robust figure-detection behaviour for a variety of spectrotemporal manipulations.

Mechanism:
A mechanism based on temporal coherence can explain binding of correlated repeating frequency channels as the 'figure'. (cf Shamma et al., 2011; Teki, Chait et al., 2013)

Substrate:
Sources of evoked power in auditory and parietal cortex that vary as a function of coherence

Dynamics:
- Robust time-locked responses at transition to figure: vary with coherence.
- Induced sources in high gamma band: demonstrated with depth electrode data, and to be validated with MEG beamformer. (cf Sedley et al., 2011)

Acknowledgments

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wellcome trust

ACTION ON HEARING LOSS