Dynamics of Distributed Cortical Processing in the Macaque

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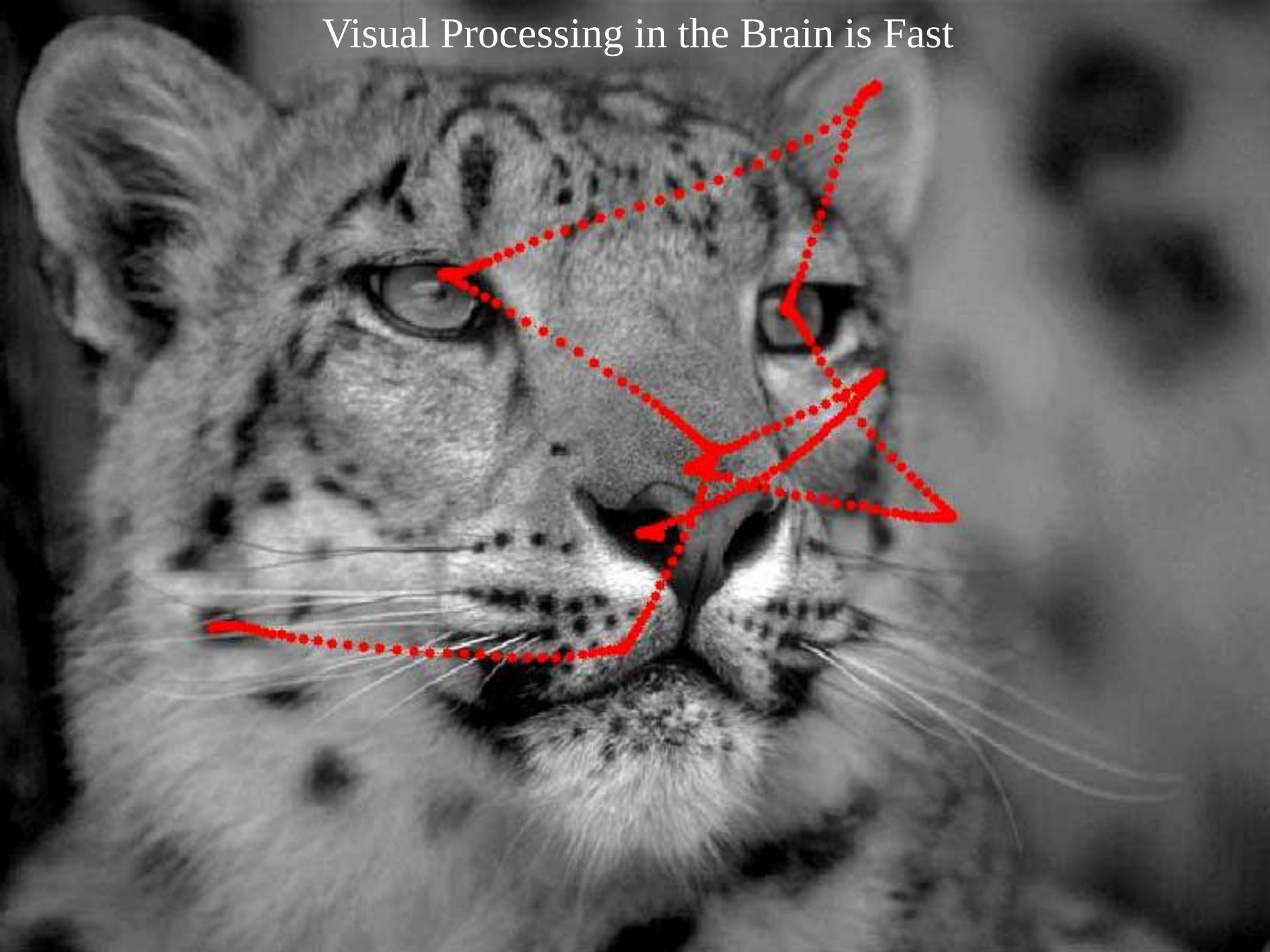
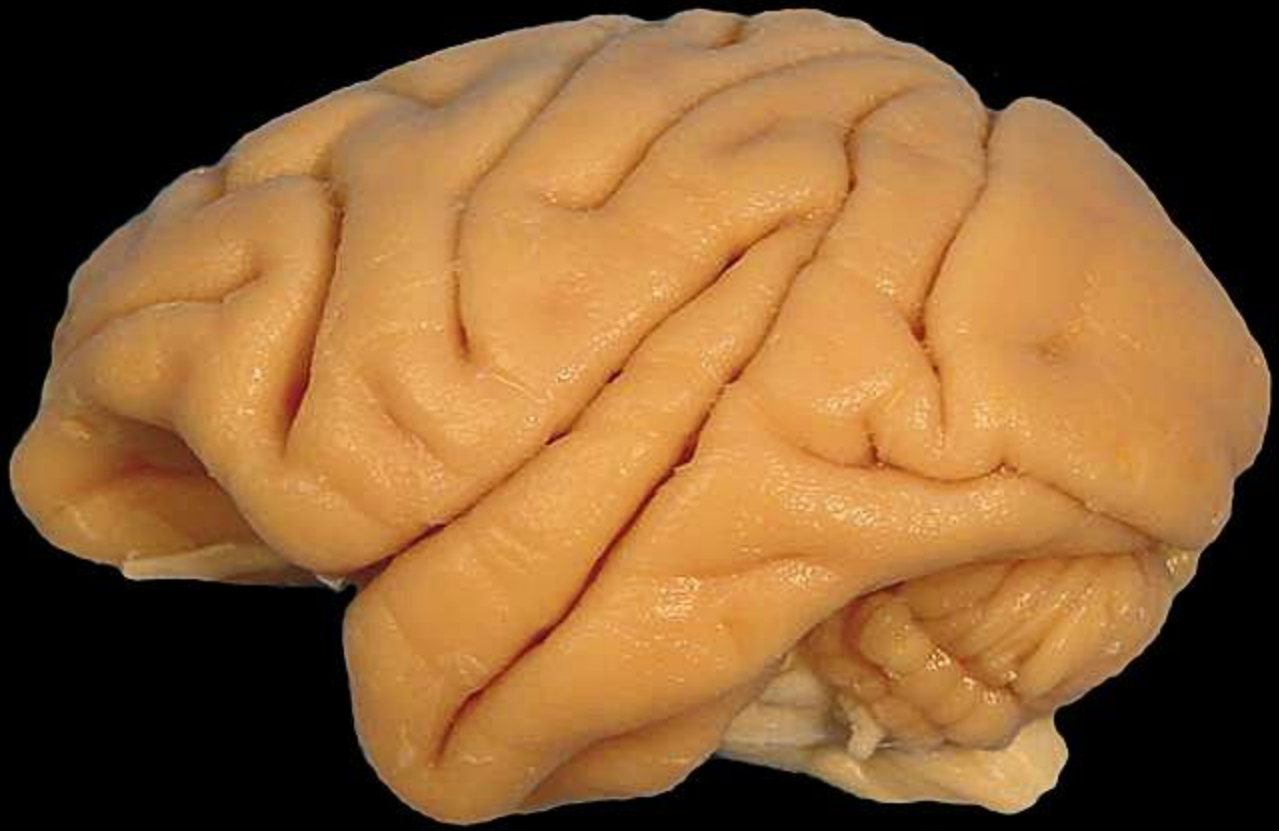
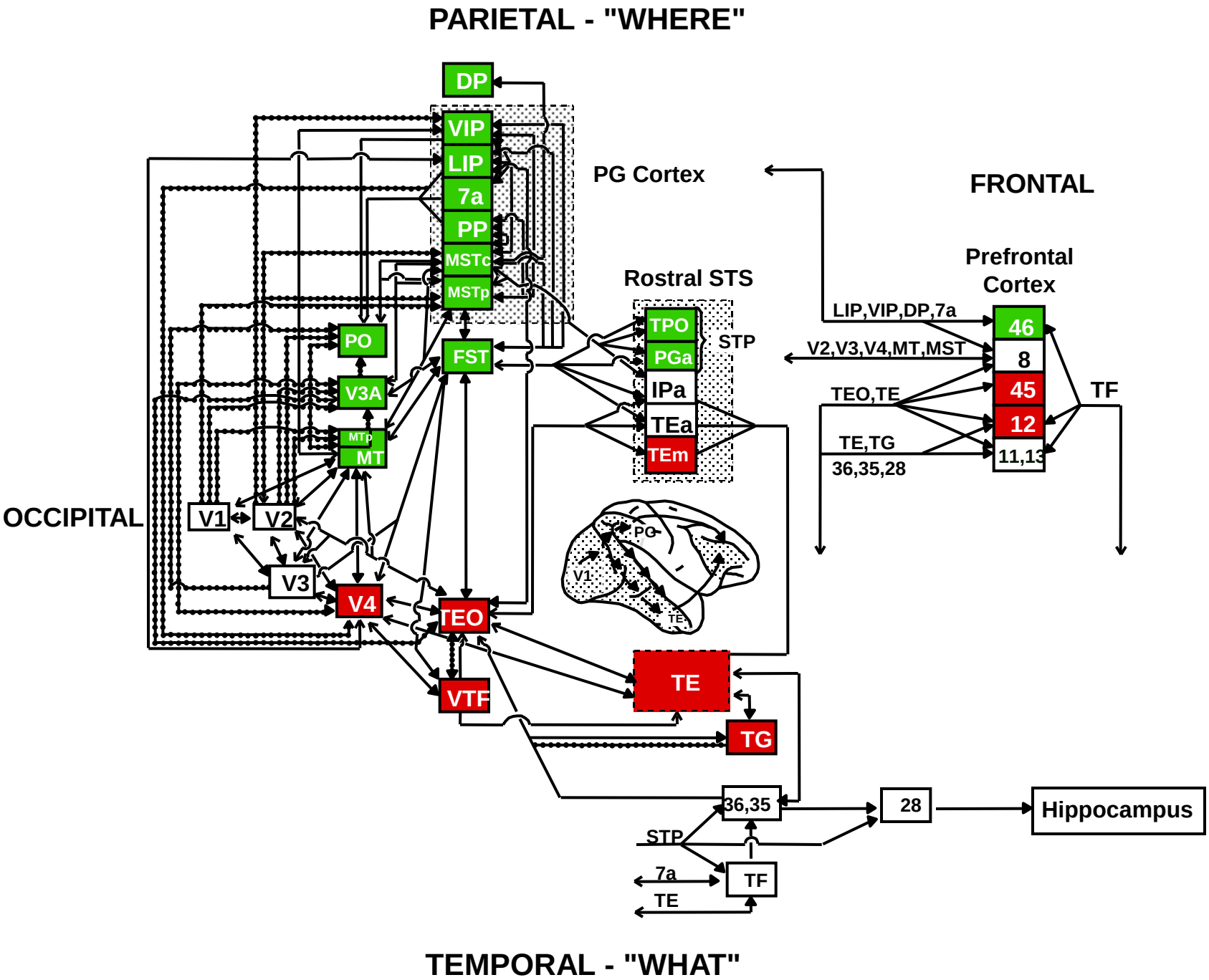
Visual Processing in the Brain is Fast



… and Distributed

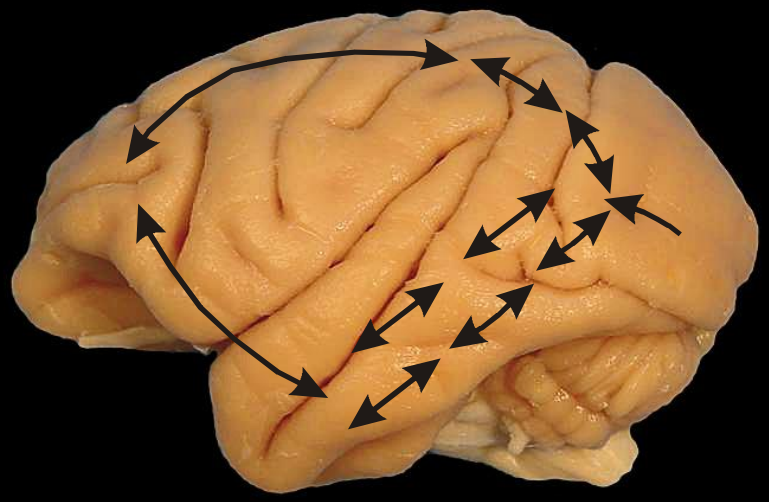



PARIETAL - "WHERE"
DP
VIP
LIP
7a
PP
MSTc
MSTp
PG Cortex
FRONTAL
Prefrontal Cortex
Rostral STS
TPO
PGa
IPa
TEa
TEm
STP
LIP,VIP,DP,7a
V2,V3,V4,MT,MST
TEO,TE
TE,TG
36,35,28
46
8
45
12
11,13
TF
PO
FST
V3A
MTp
MT
OCCIPITAL
V1
V2
V3
V4
TEO
VTF
TE
TG
36,35
28
Hippocampus
STP
7a
TE
TF
TEMPORAL - "WHAT"

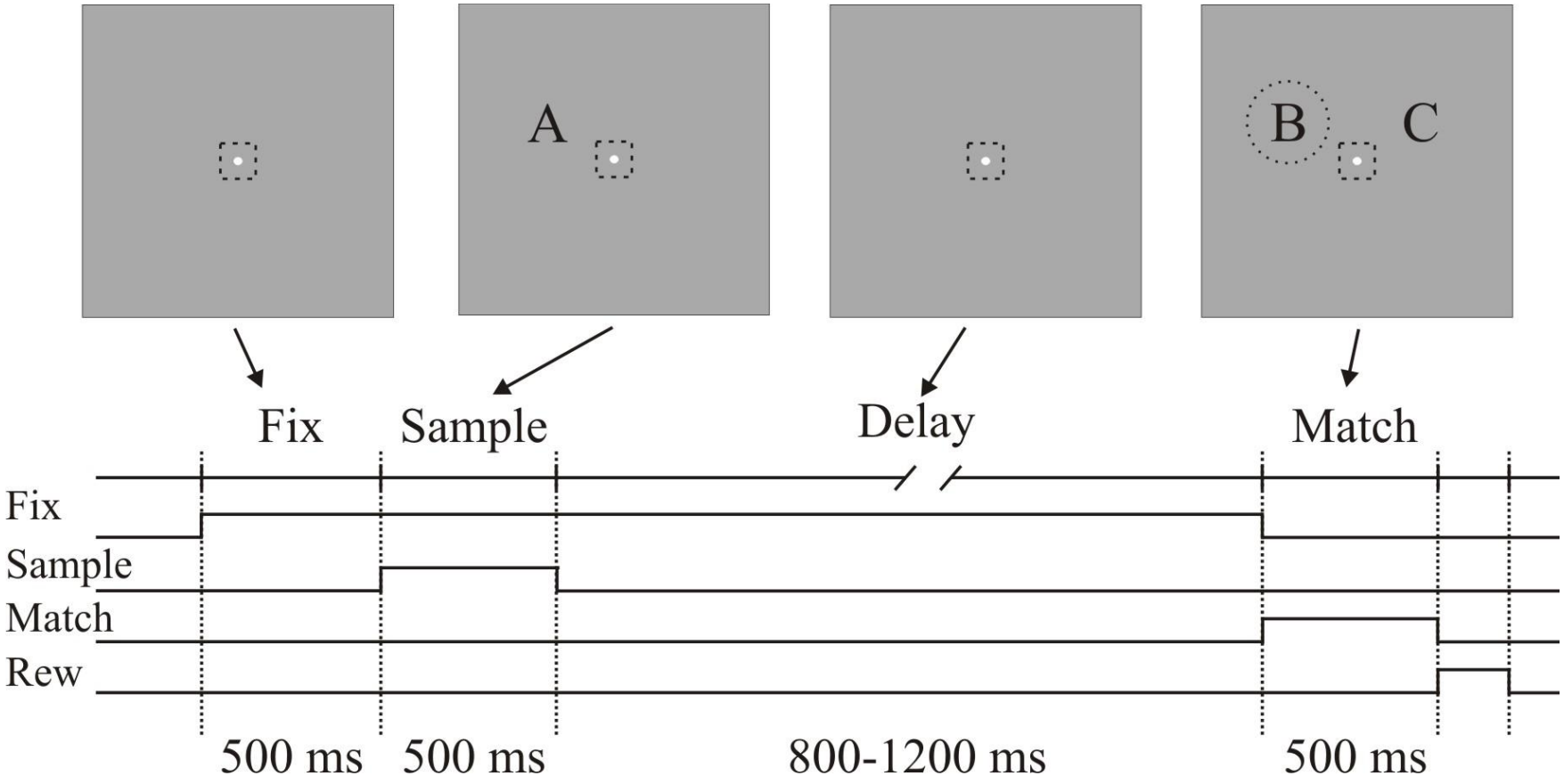
What form do cortico-cortical interactions take?

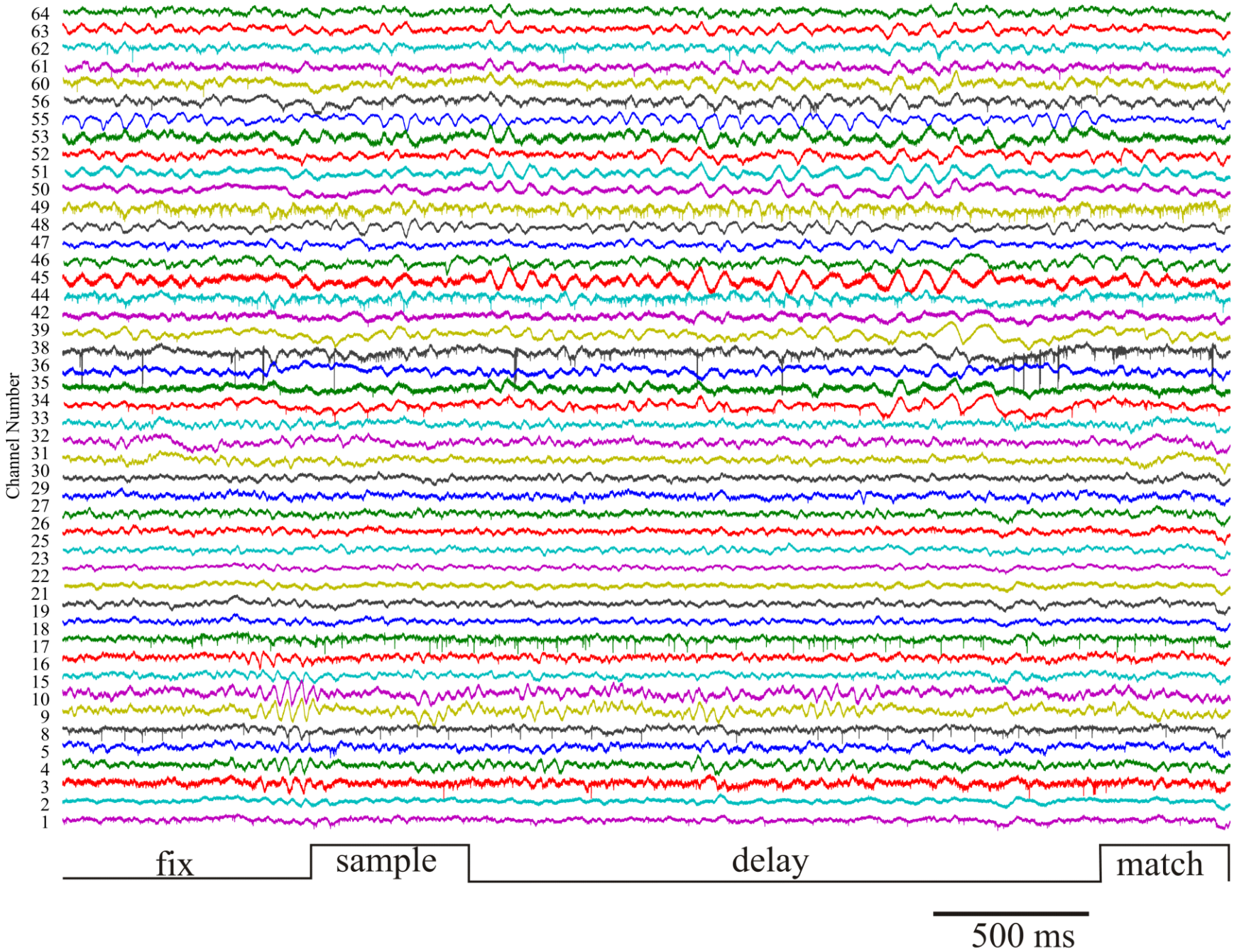
How do the interactions vary as a function of time, space and spectral composition?

Are the interactions content specific?



Rule-Based, Oculomotor, Delayed Match-to-Sample Task

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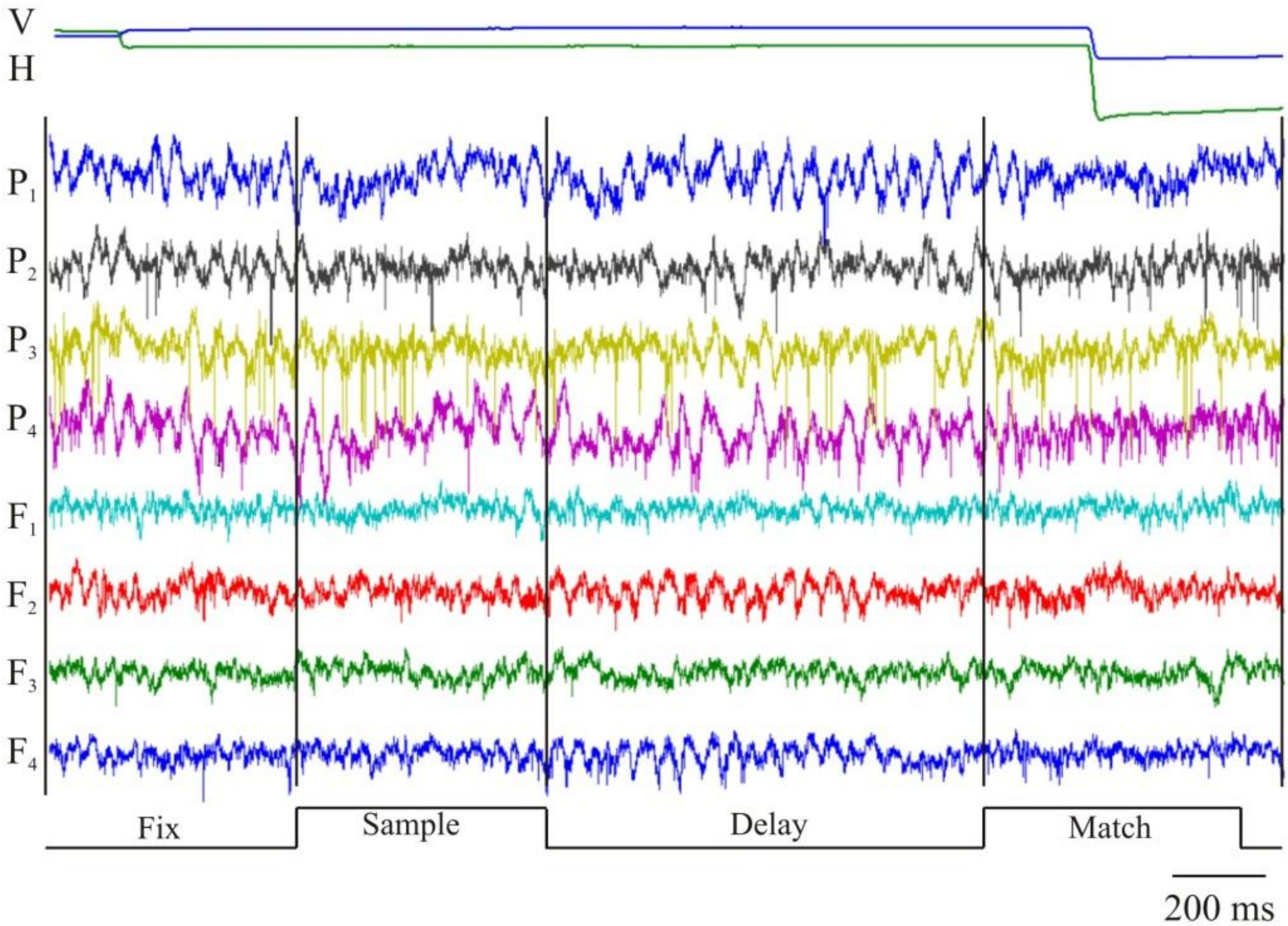
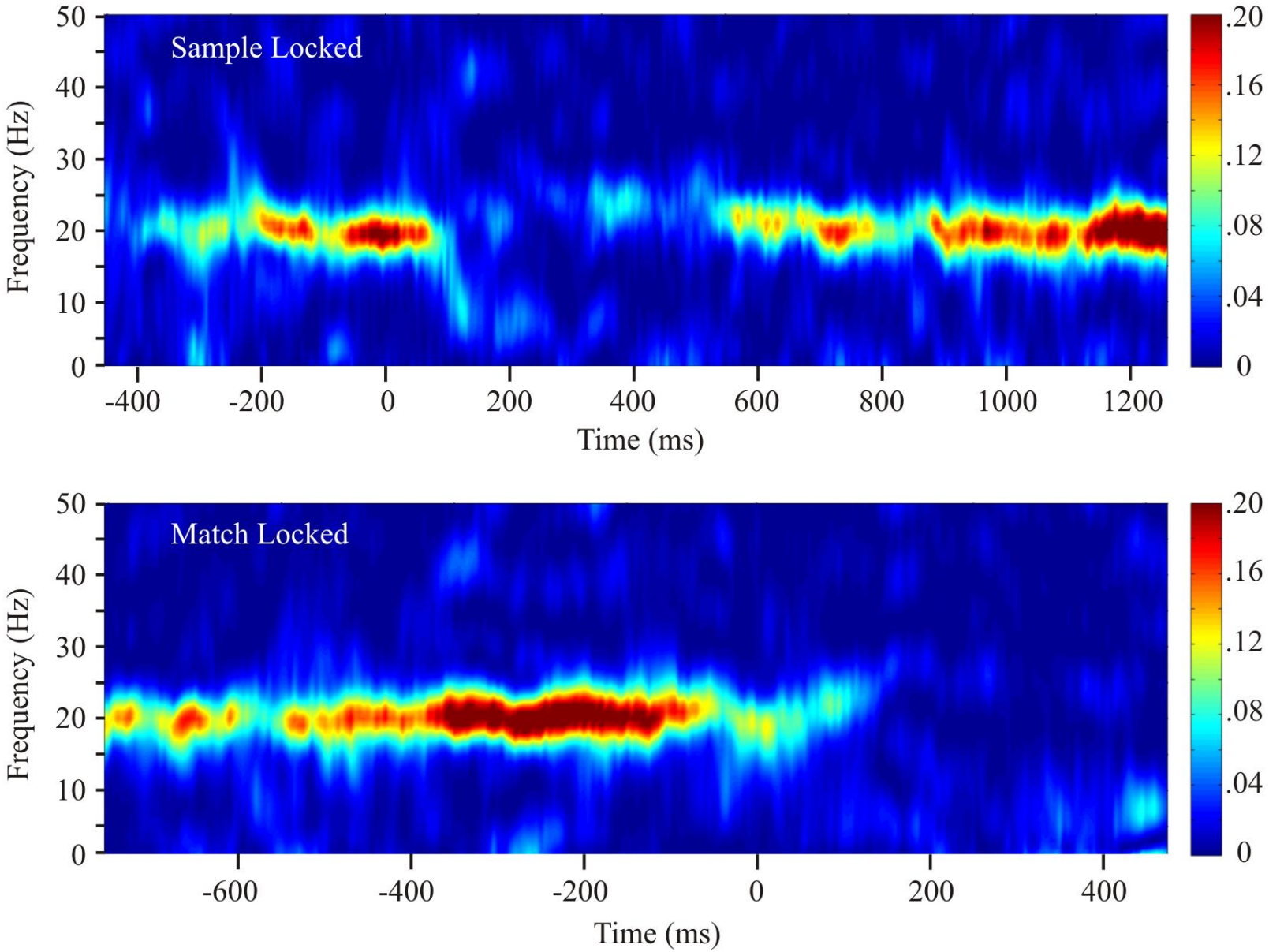
5
4
3
2
1
fix
sample
delay
match
500 ms

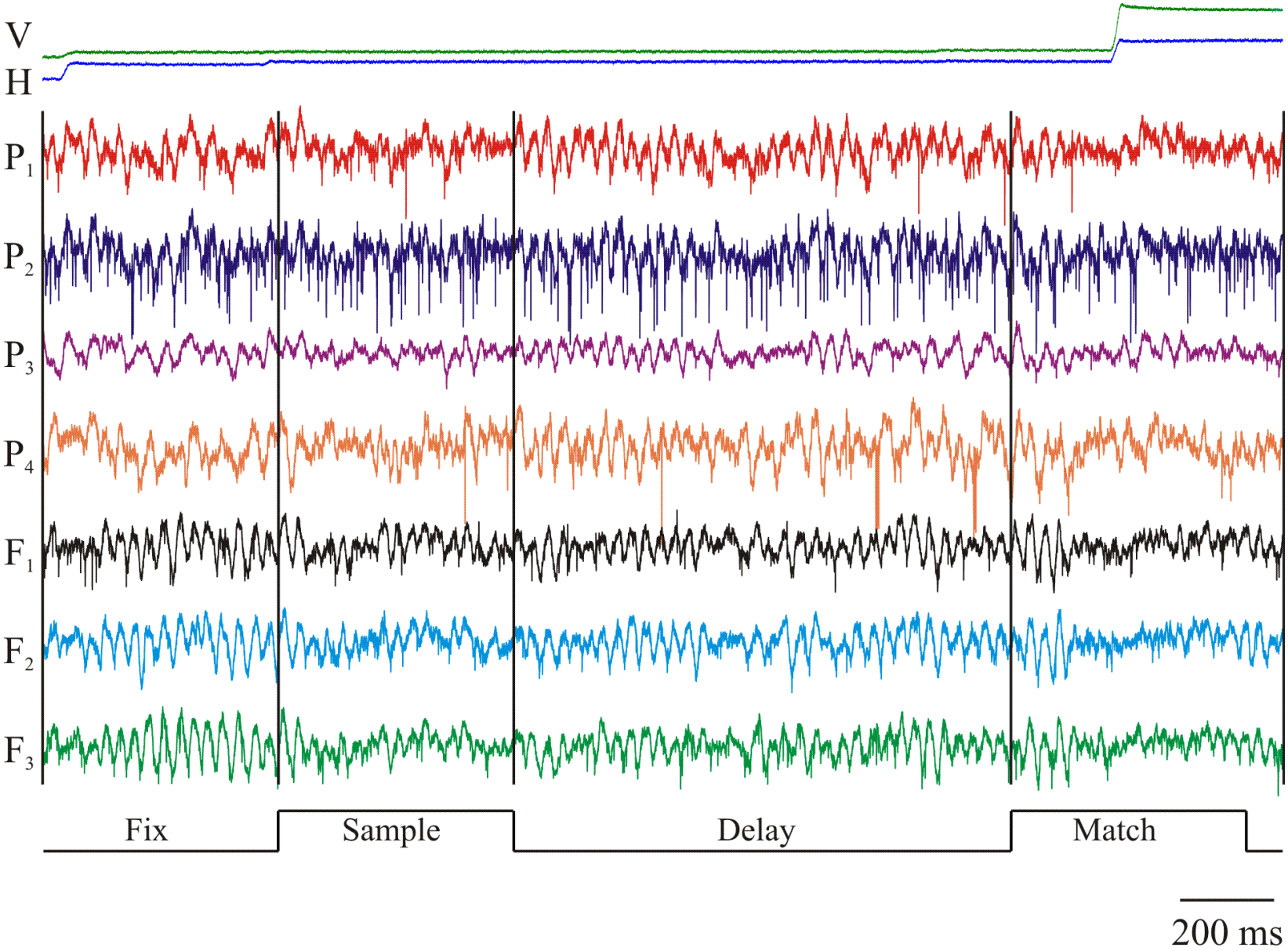
Single Trial Fronto-Parietal Recording (Beta)



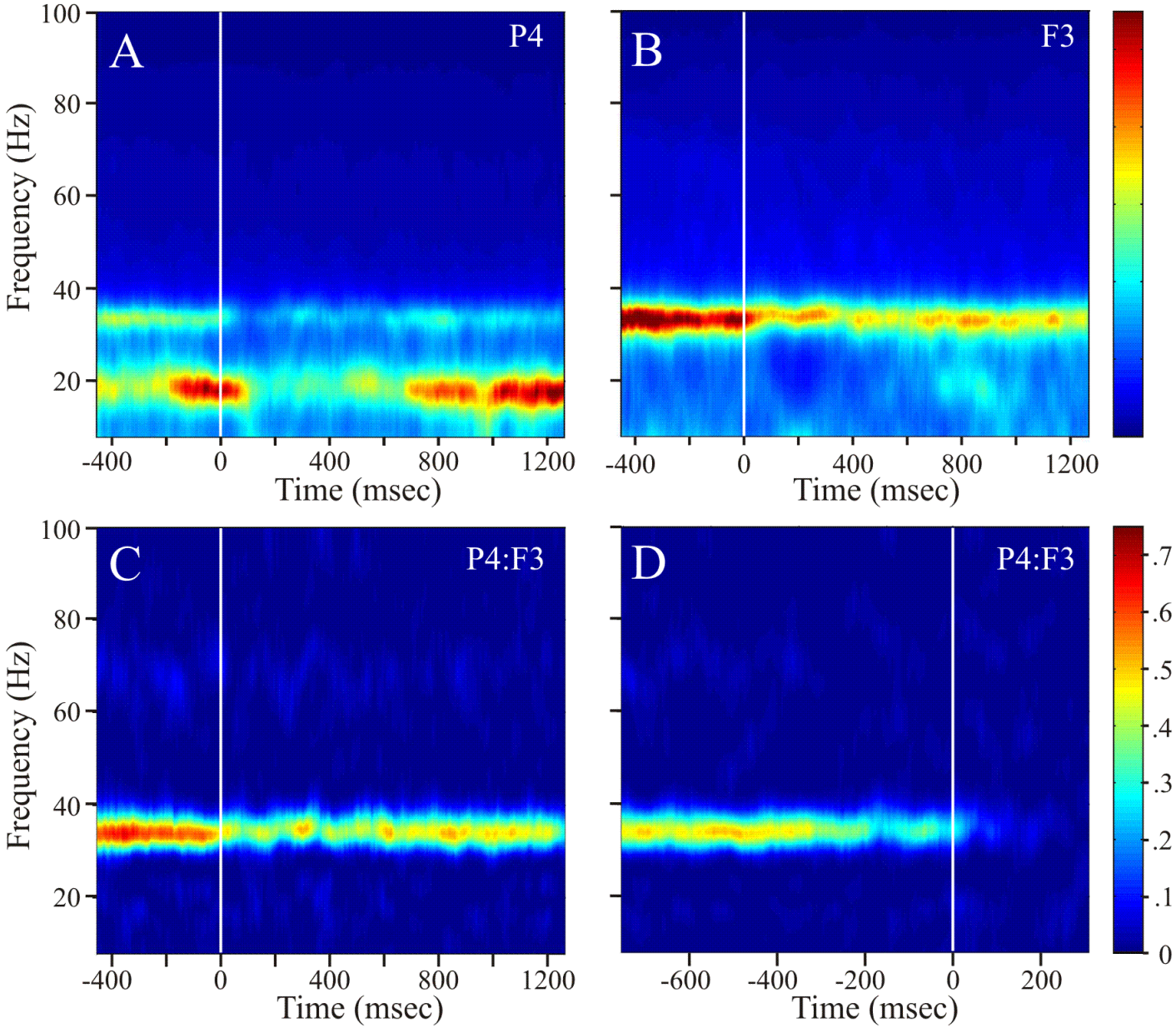
Task-Dependent Fronto-Parietal Beta Coherence (AMVAR)



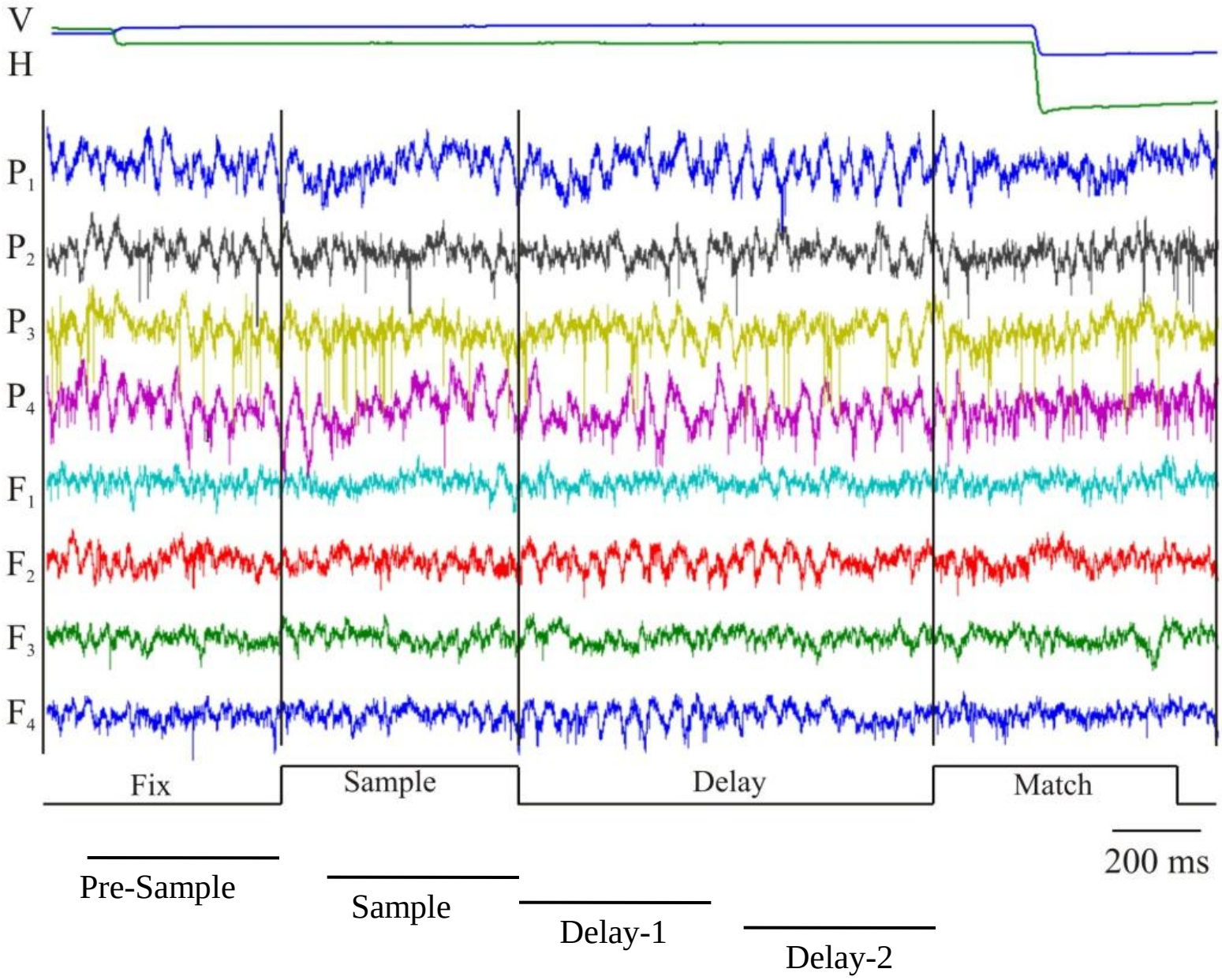
Single Trial Fronto-Parietal Recording (Gamma)



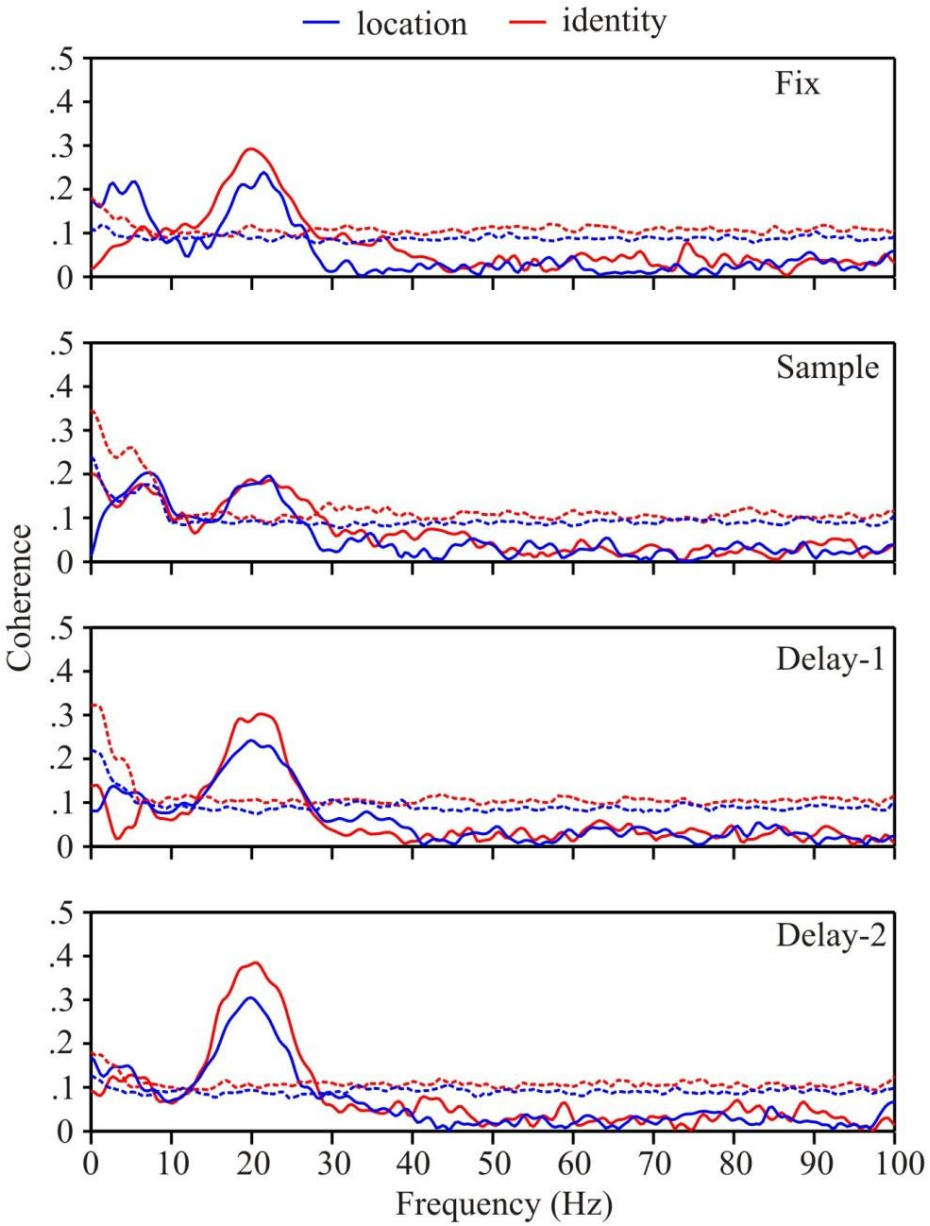
Task-Dependent Fronto-Parietal Gamma Coherence (AMVAR)



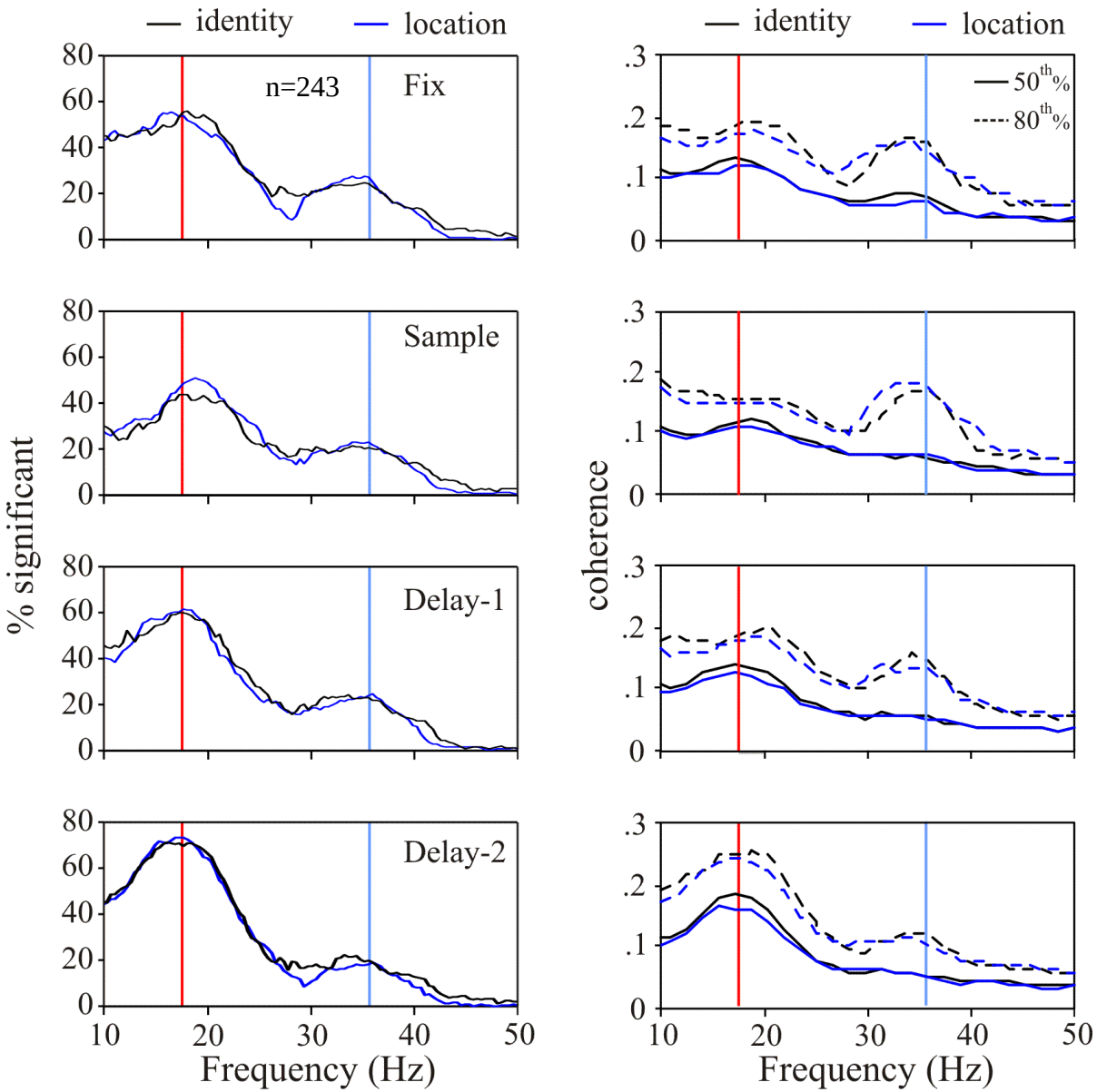
Windowed Analysis



Task-Dependent Fronto-Parietal Coherence



Task-Dependent Fronto-Parietal Coherence

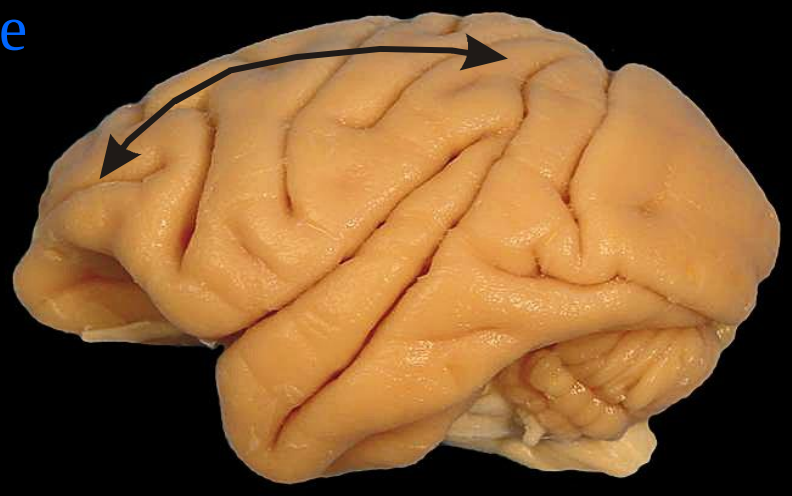


Fronto-Parietal coherence during visual working memory is robust, task-dependent and occurs in the beta (15-25 Hz) and gamma (30-40 Hz) bands.

Beta-band coherence is more prevalent than gamma.

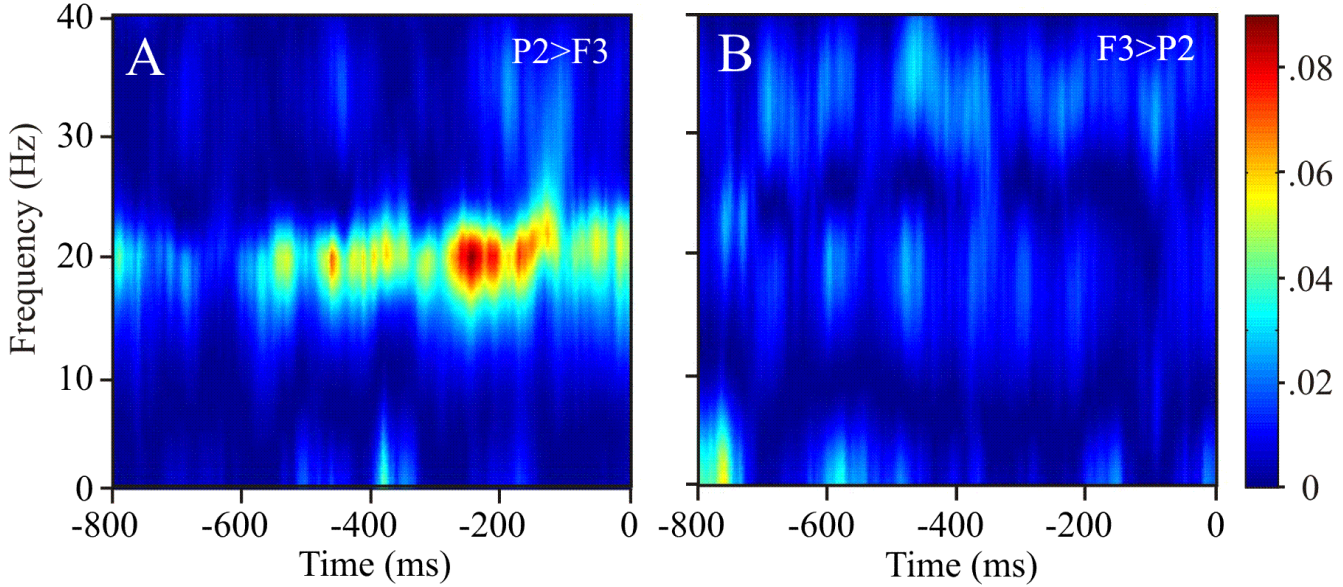
Are the interactions causal and content specific?

Use Granger causality analysis
Evaluate stimulus dependence

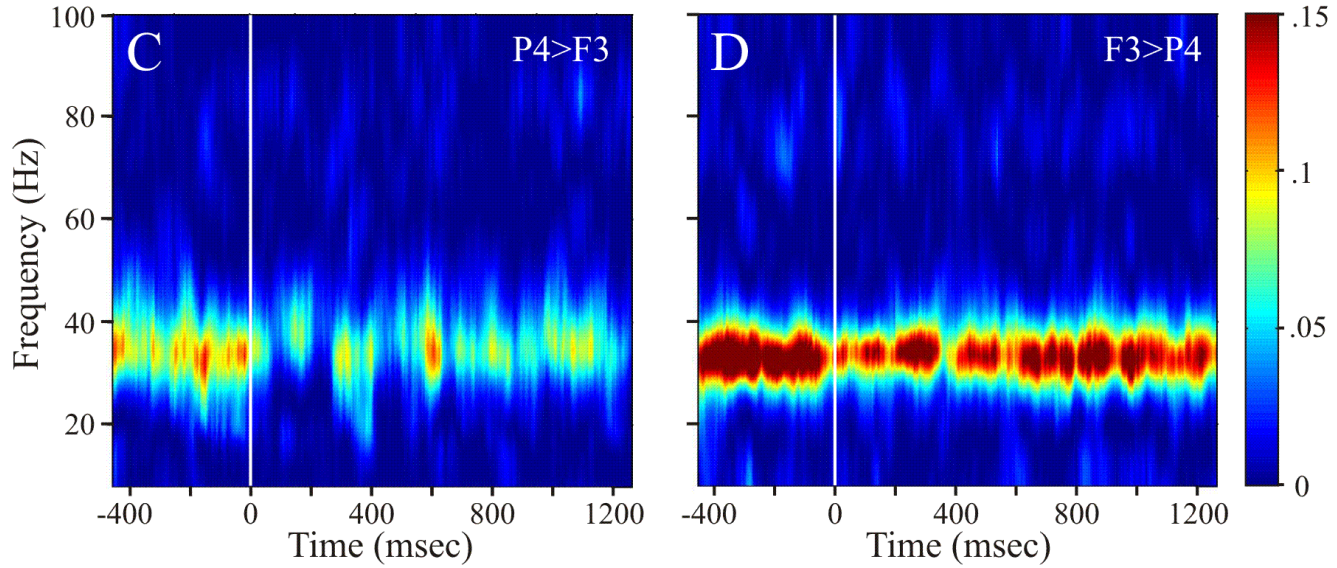


Task-Dependent Causal Interactions in the Beta and Gamma Frequency Ranges

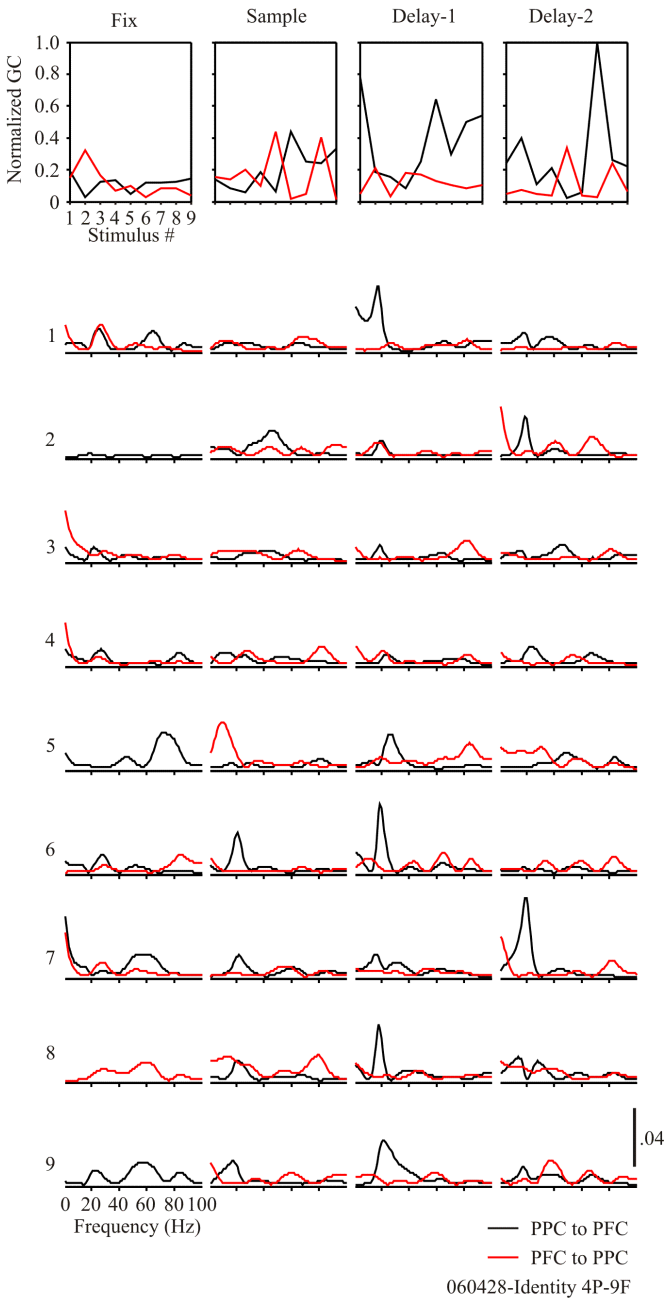
Parieto-Frontal Beta Causality
(match locked)

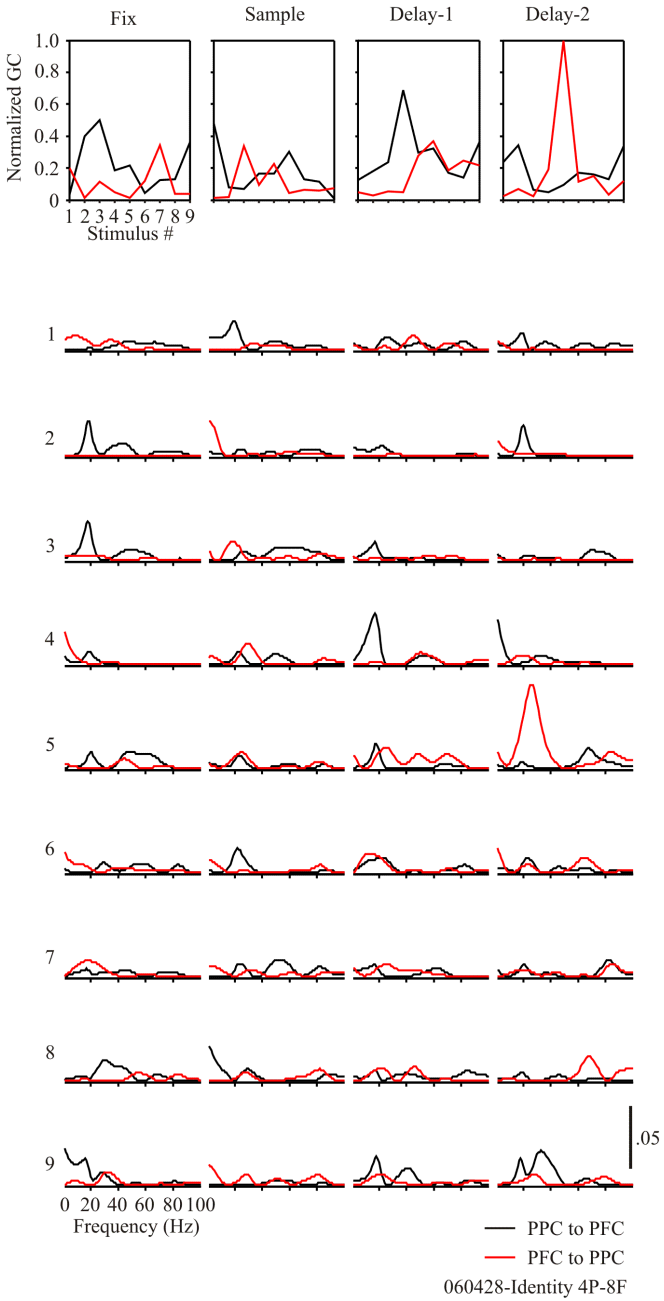


Fronto-Parietal Gamma Causality
(sample locked)

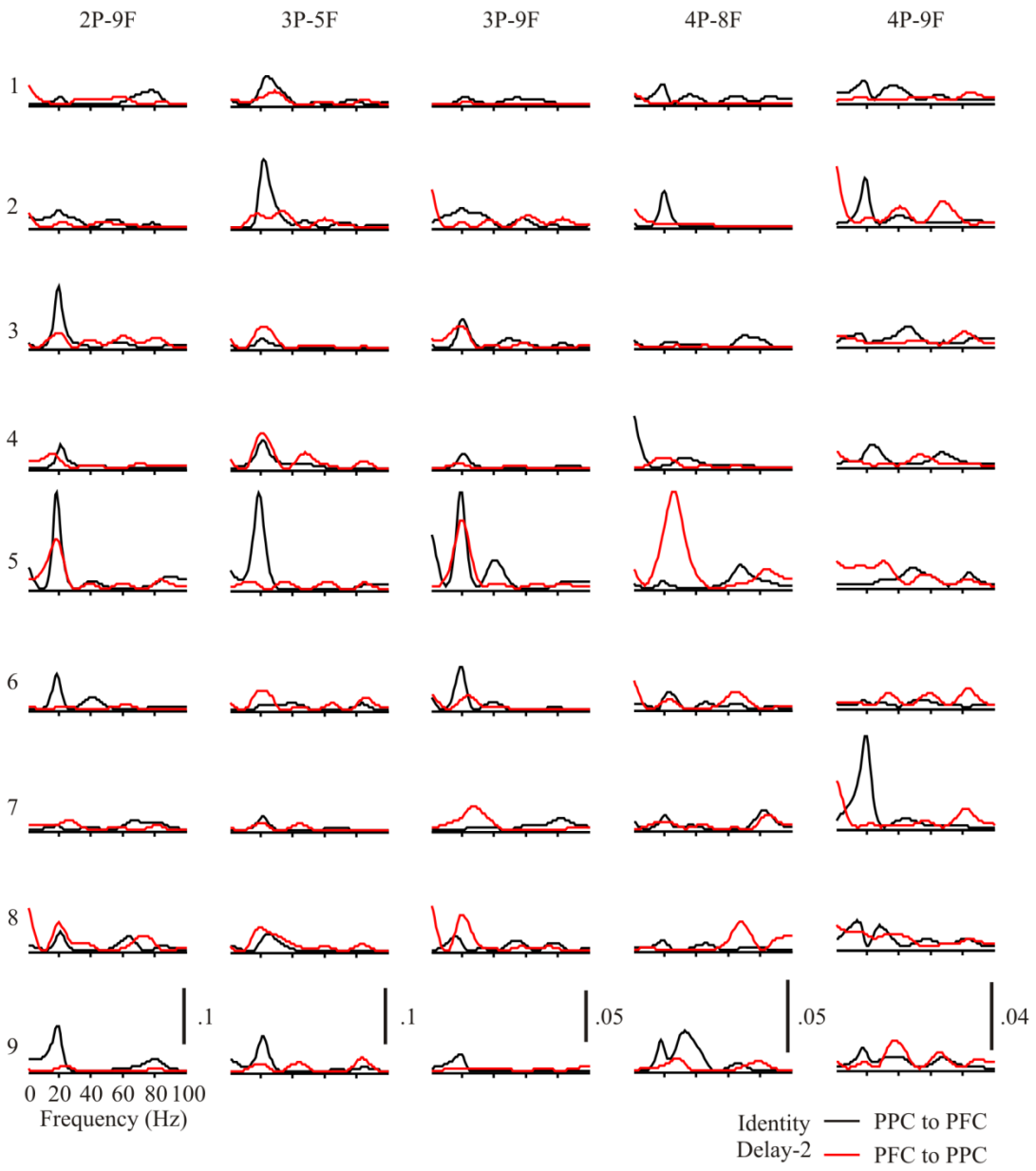


Fronto-Parietal Causal Influence is Content-Specific

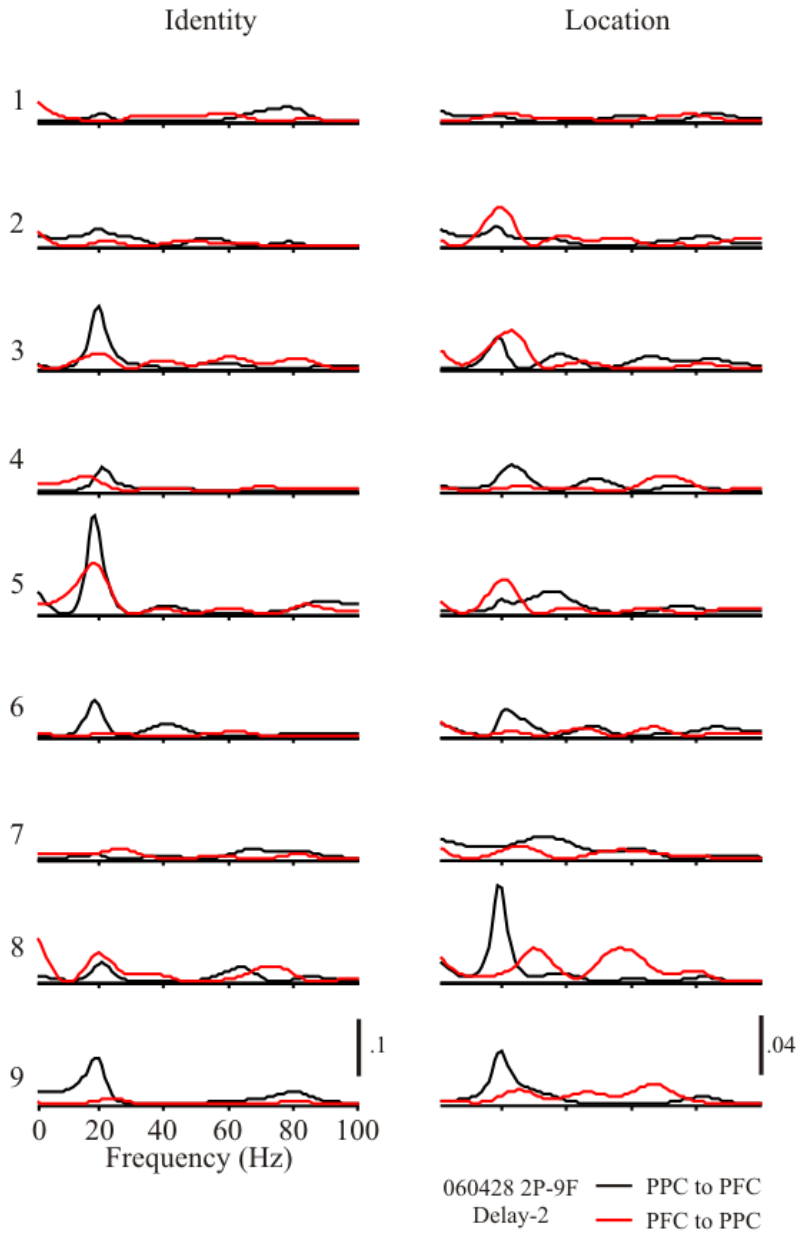




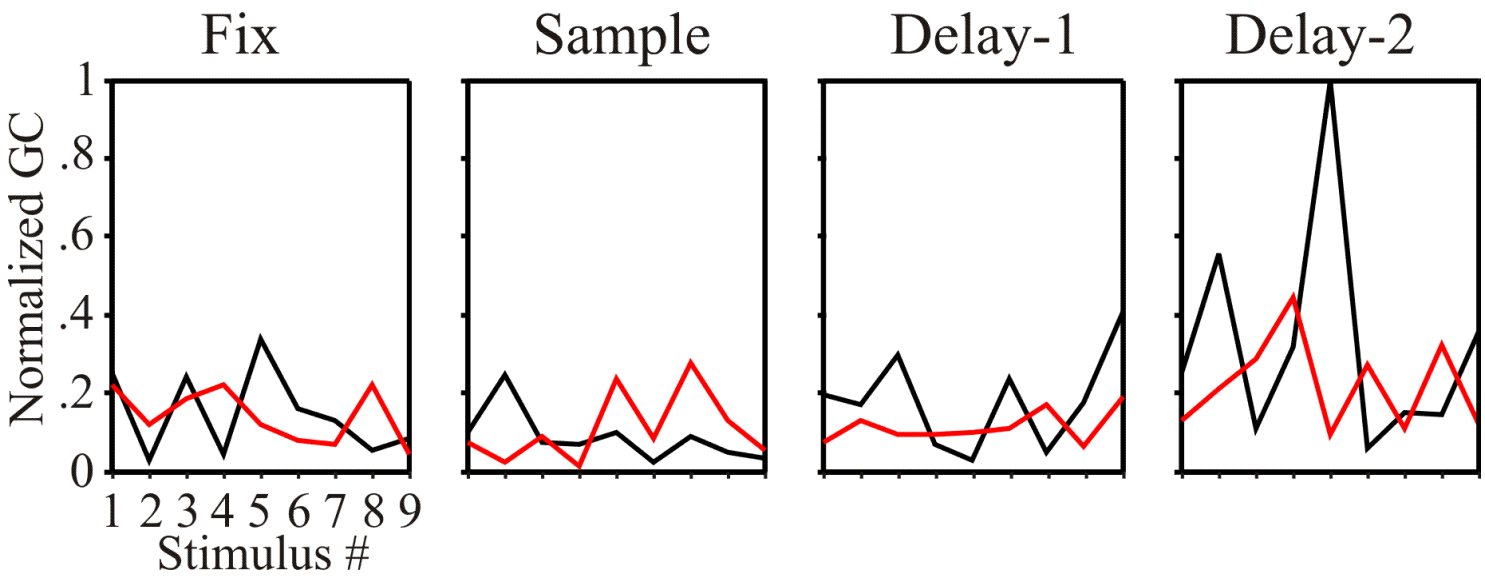
Fronto-Parietal Causal Interactions Exhibit Content-Specific Spatial Patterns



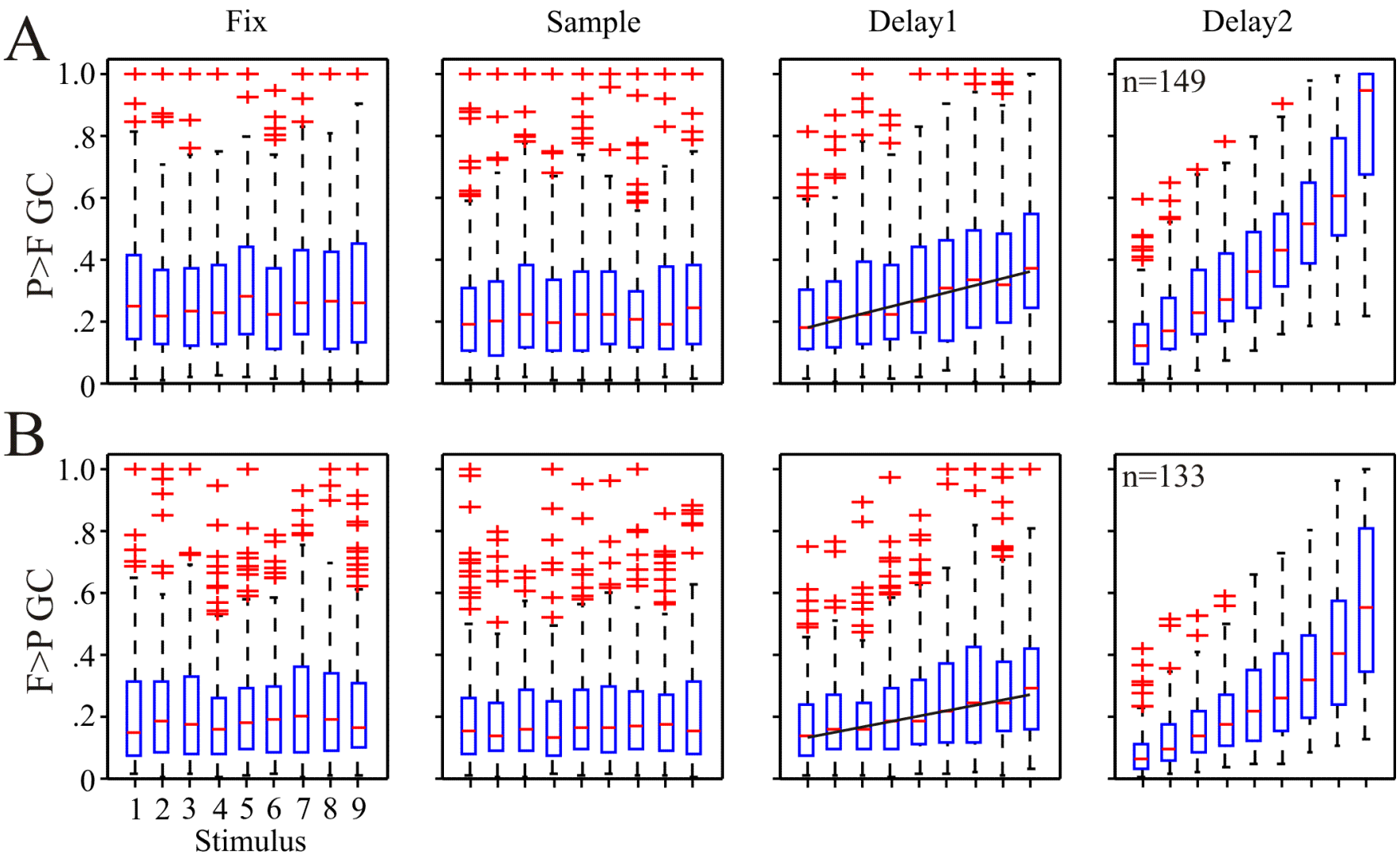
Fronto-Parietal Causal Influence is Content and Rule Specific



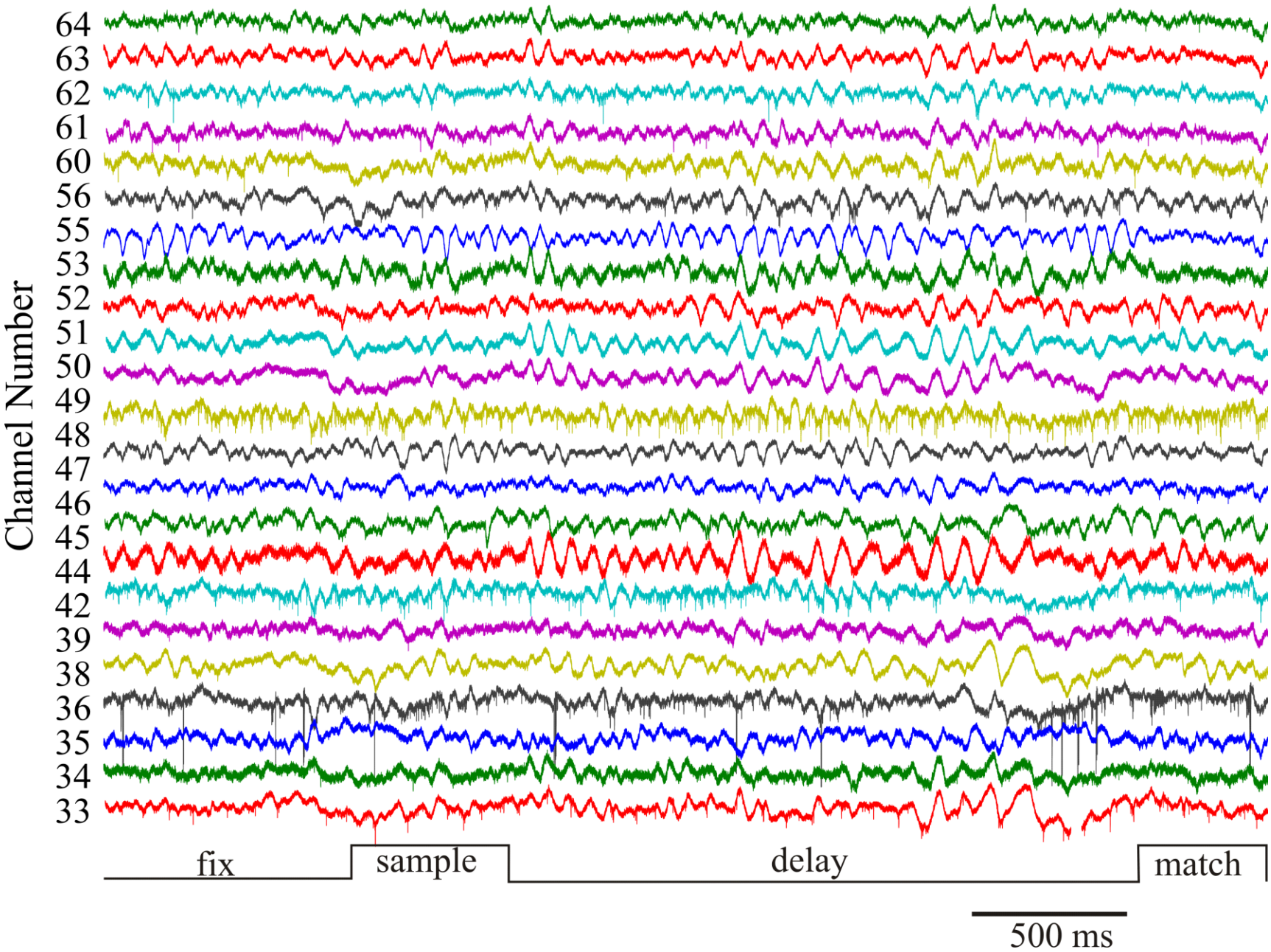
Rank Order Analysis of Stimulus Dependent Granger Causality



Content Specificity of Fronto-Parietal Causal Influence During Working Memory



Win4-PF-Location-Paired-Pos-Slope-win3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delay
match
500 ms

Conclusions

1) Fronto-Parietal coherence during visual working memory is robust, task-dependent and occurs in the beta (15-25 Hz) and gamma (30-40 Hz) bands.

2) Beta-band coherence is more prevalent than gamma.

3) Causal influences during working memory are content specific.

Postulate: Working memory is characterized by content-specific, spatio-temporal patterns of synchronous causal interactions across the fronto-parietal network.