Dynamics of Distributed Cortical Processing in the Macaque

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Visual Processing in the Brain is Fast
... and Distributed
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

Diagram showing the sequence of events:
- Fix: 500 ms
- Sample: 500 ms
- Delay: 800-1200 ms
- Match: 500 ms

The diagram illustrates the stages of the task with visual markers for each step.
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

V
H

P_1
P_2
P_3
P_4
F_1
F_2
F_3
F_4

Fix
Sample
Delay
Match

Pre-Sample
Sample
Delay-1
Delay-2

200 ms
Task-Dependent Fronto-Parietal Coherence

Fix

Sample

Delay-1

Delay-2

Frequency (Hz)
Task-Dependent Fronto-Parietal Coherence

- **identity**
- **location**

- **n=243**

- **Sample**

- **Delay-1**

- **Delay-2**

- **Frequency (Hz)**
  - 10, 20, 30, 40, 50

- **coherence**
  - 0, 0.1, 0.2, 0.3

- **50th%**
- **80th%**
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)

[Graph A: Parieto-Frontal Beta Causality]

Fronto-Parietal Gamma Causality
(sample locked)

[Graph C: Fronto-Parietal Gamma Causality]

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
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.