Using phase-encoded fMRI to evaluate the neural bases of spatial attention vs. spatial working memory

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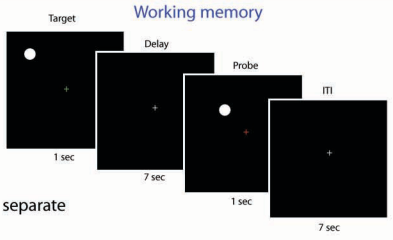
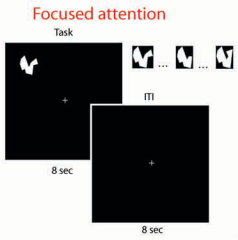
Introduction

- What are the functions supported by delay-period activity?
- Although "storage" has historically been emphasized, a growing body of evidence suggests that some delay-period activity may represent regulation of attention.
- We used retinotopic mapping to assess whether brain areas showing WM-related activity are also involved in attentional processing.

Tasks

- Targets presented along or near a radius of 5° of visual angle from fixation at one of 8 angles, each separated by 45°.
- 20 trials presented at each angle over 5 task blocks.
- Working memory and focused attention tasks performed during separate scanning sessions.

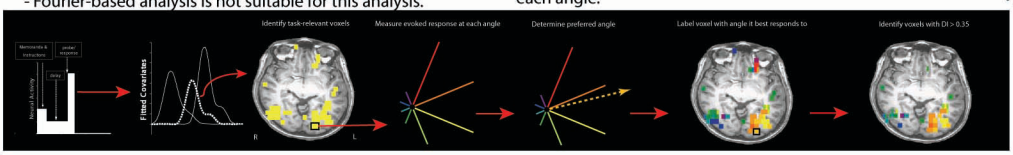




fMRI Analysis

- 4 Subjects (1 female; mean age = 27.8) participated.
- Slow event-related design allowed for isolation of delay period-evoked activity.
  - Fourier-based analysis is not suitable for this analysis.
- Task-related voxels identified for each task by analyzing all trials together.
- The magnitude of each voxel's activity was assessed for each angle.
- The preferred angle for each voxel was calculated by vector averaging.
- Directionality index (DI) calculated for each angle:

$$DI = 1 - \frac{activity\ at\ antipreferred\ angle}{activity\ at\ preferred\ angle}$$



Results

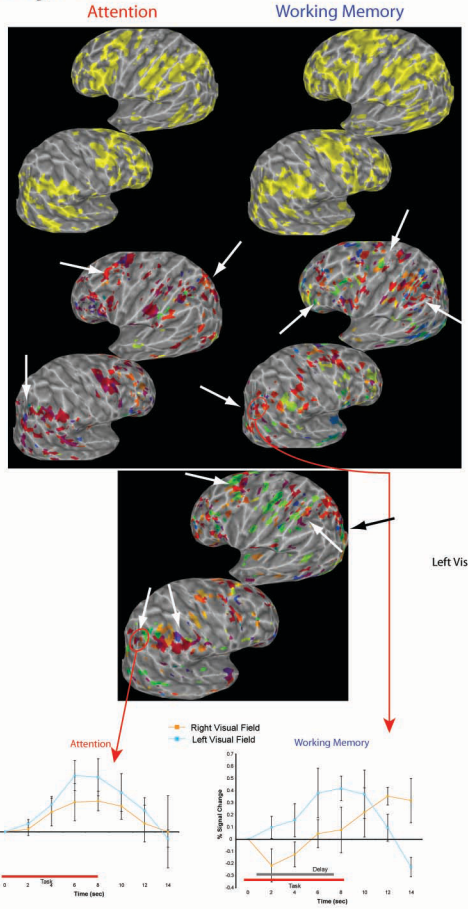
Task-specific voxels identified

Preferred angles

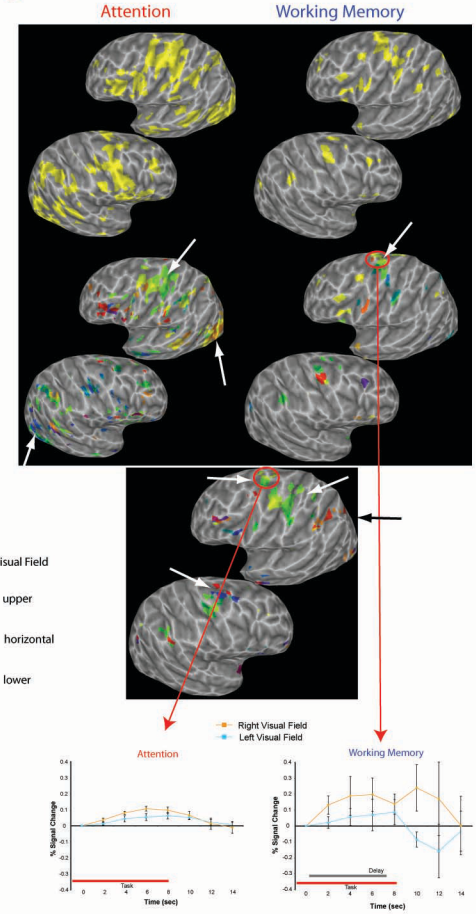
Are there attention-related maps in "working memory regions"?

arrows indicate the presence of retinotopic maps

Subject 2



Subject 3





Locations of Retinotopic Maps

		Attention voxels: Attention Maps	Working Memory voxels: Attention Maps	Working Memory voxels: Working Memory Maps
Subject 1	LH	IFG	SFG, SPL	FEF
	RH	MFG, IPS	MFG	
Subject 2	LH	MFG, SPL	MFG, Angular, IPS	IFG, Precentral G., Angular
	RH	IPS	Angular, IPS	IPS
Subject 3	LH	Precentral G., IT	FEF, Precentral G., IPS	FEF
	RH	IT	FEF	
Subject 4	LH	IFG, IT, SPL	Angular, SPL, IFG	MFG, SPL
	RH	IFG, IT, SPL		SPL

Conclusions

- In many regions, similar patterns across tasks are consistent with an attentional function for delay-period activity.
- More similarity may emerge when we examine encoding and response phases of the working memory task, as well as if the attention task requires a spatial discrimination.

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