Quadrant and Laterality Effects in the Lateral Occipital Complex

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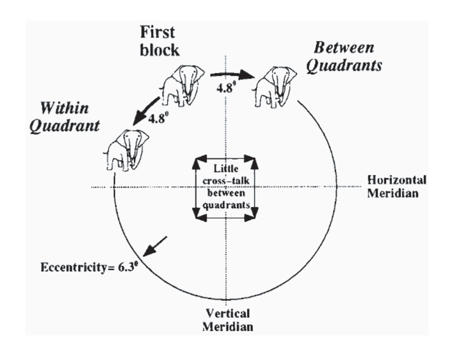
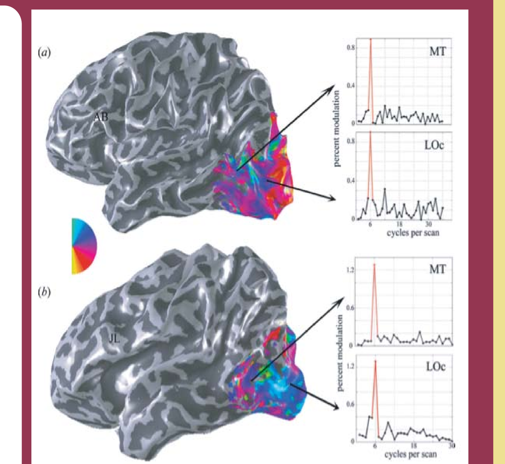
Problem: How far along the visual stream are



Bar and Biederman[1] observed quadrant-specific subliminal priming effects. They reasoned that these effects must be mediated by a population of neurons whose receptive fields were confined to a single quadrant but were sufficiently large to encompass a 4.X° translation. They speculated that a human V4 or TEO might be that locus, based on the work of Desimone & Ungerleider[2].

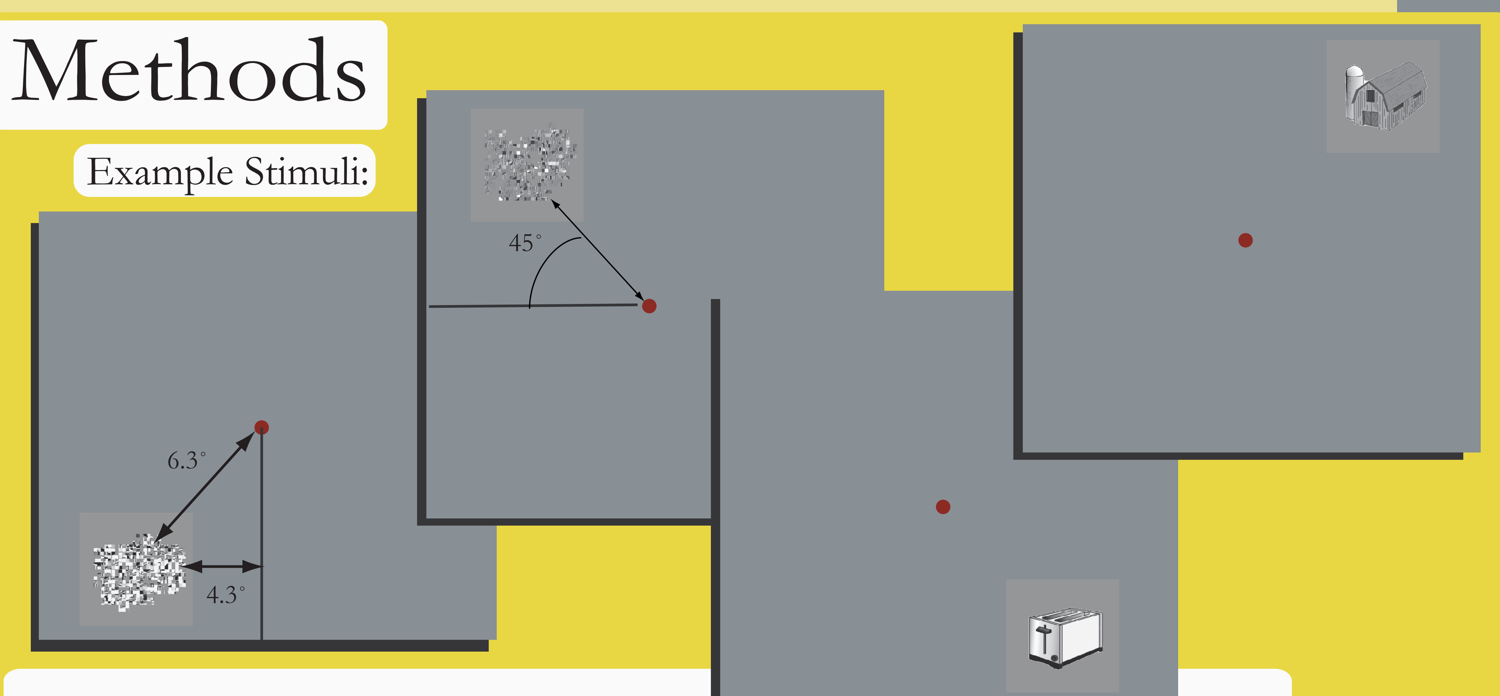
- Retinotopic maps of polar angle in the human Lateral Occipital cortex (LO) have recently been reported by Heeger et al.[3] and Wandell et al.[4]
- This suggests that neurons in LO might have receptive fields on the order of visual quadrant size, but probably not bigger.
- However, because they used simple patterned stimuli (wedges and rings) it could still be the case that a small subset of the neurons in LO respond to local features and are retinotopically organized, while a larger mass of LO neurons have larger receptive fields, represent more complex visual features and are not necessarily retinotopically organized.
- This could explain why it has been difficult to resolve polar angle transitions in LO.



Polar angle retinotopy in LO from Wandell 2005

Methods

Example Stimuli:



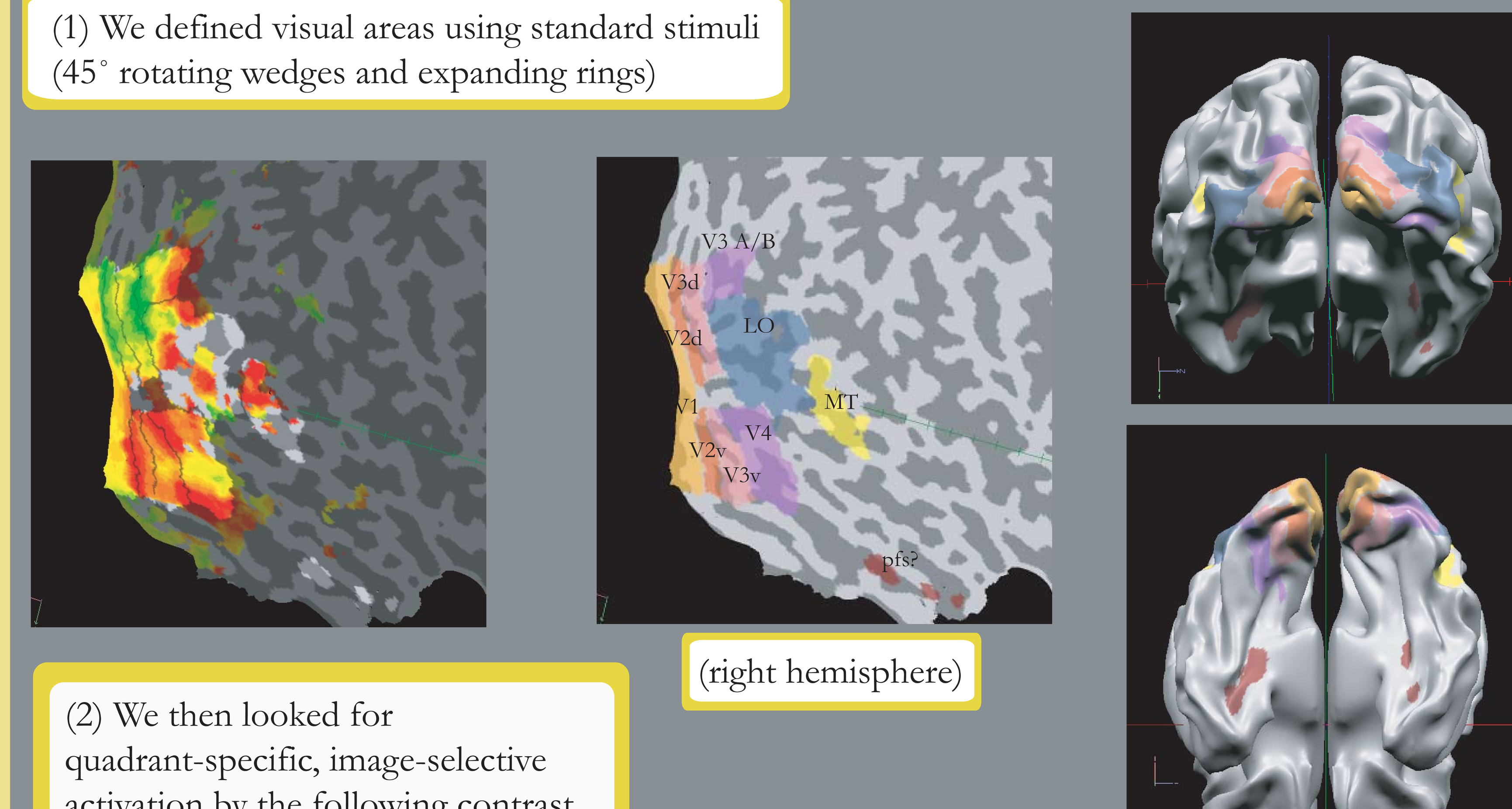
Block Design:
- 32 images* presented in 16s, with 16s fixation between
- Broken up by 16 seconds of fixation between blocks
- Images appeared in one of the four positions shown or at the fovea
- Each subject saw both coherent and scrambled objects at each position in every trial.

fMRI Specifications:
- TR = 2 seconds TE = 71 ms 28 slices
- Siemens 3T Scanner

*images from Rossion & Portois[5]

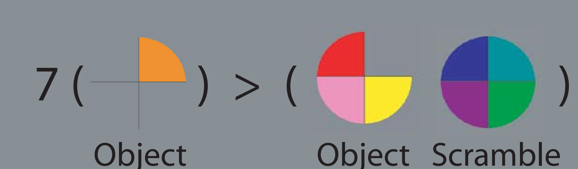
Citations:
1. Bar, M. & Biederman, I. "Localizing the cortical region mediating visual awareness of object identity." PNAS. 2/1999. Vol. 96, 1790-1793
2. Boussaoud, D., Desimone, R., Ungerleider L.G. "Visual topography of area TEO in the macaque." J. Comp. Neurol. 4/1991. 306(4):554-575
3. Wandell, B., Brewer, A., Dougherty, R. "Visual field map clusters in human cortex." Phil. Trans. of the Royal Society. 2005
4. Larsson, J., Landy, M., Heeger, D. "Orientation-selective adaptation to first- and second- order patternsn in human visual cortex. 2006 J. Neurophysiology. 95:862-881
5. Rossion, B. Pourtois, G. "Revisiting Snodgrass and Vanderwart's object set: The role of surface detail in basic-level object recognition." 2004. Perception, 33, 217-236. 2004.

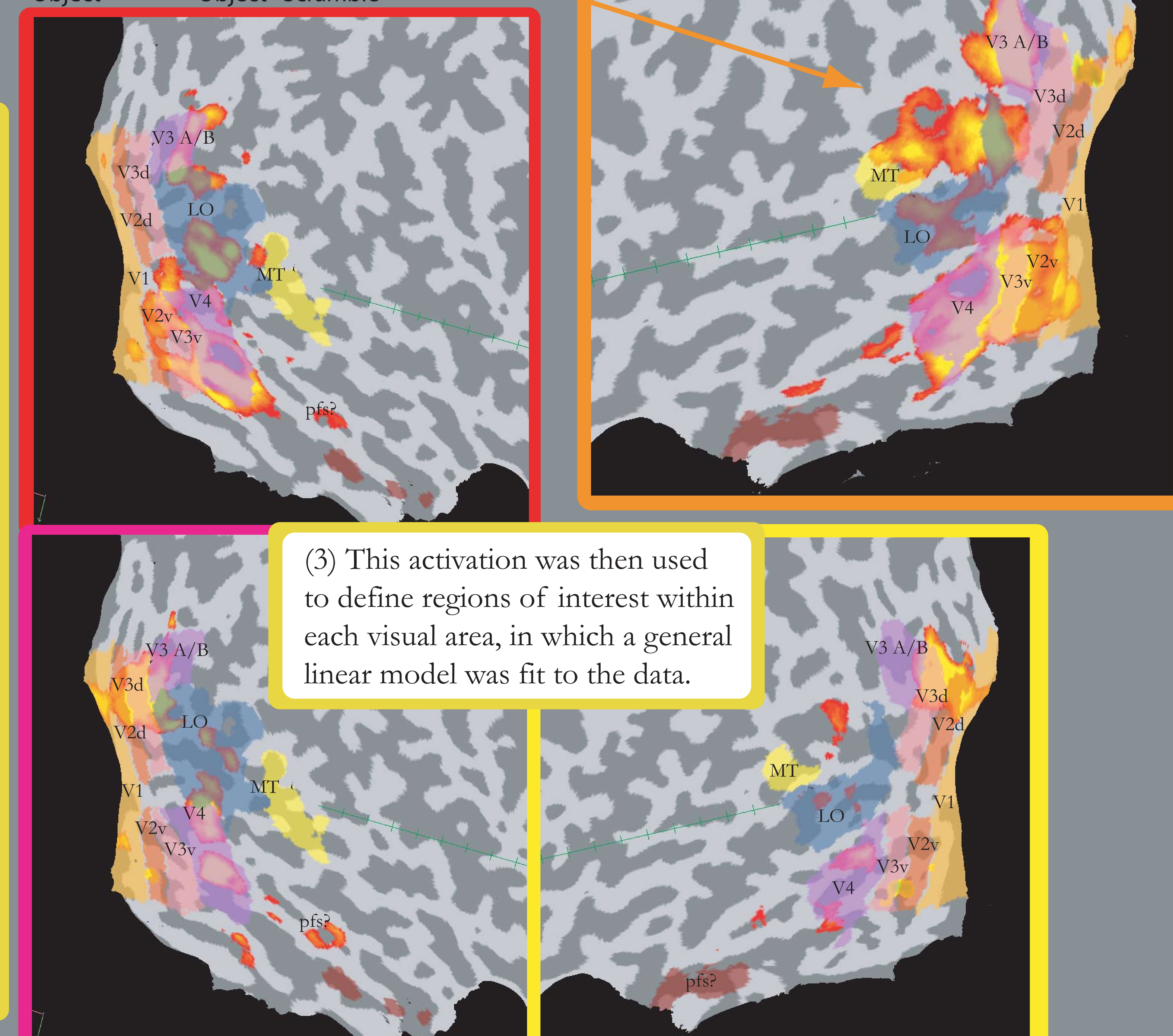
(1) We defined visual areas using standard stimuli (45° rotating wedges and expanding rings)



(right hemisphere)

(2) We then looked for quadrant-specific, image-selective activation by the following contrast (repeated for each visual quadrant):





(3) This activation was then used to define regions of interest within each visual area, in which a general linear model was fit to the data.

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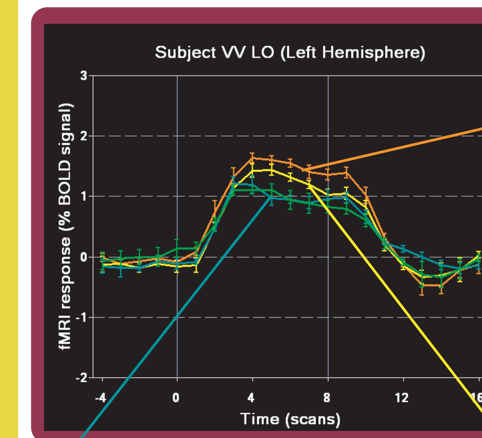
Defining Quadrant-Specificity:

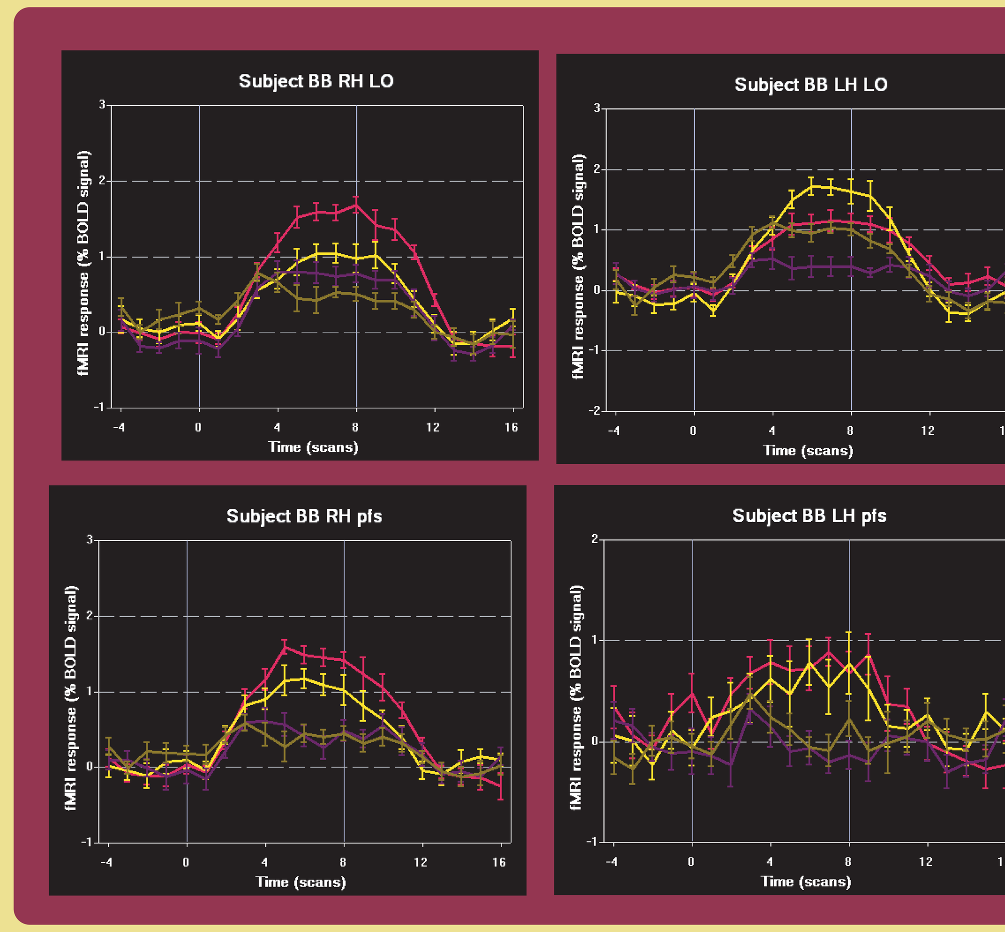


For each ROI:
- The coherent image condition in the visual field quadrant used to define that ROI was labeled "On-Quadrant" here:
- The scrambled image condition in the same visual quadrant as the "On-Quadrant" condition was labeled "Scrambled" here:
- The coherent image condition in the other visual field quadrant in the same hemifield was labeled "Off-Quadrant" here:

The Trend:

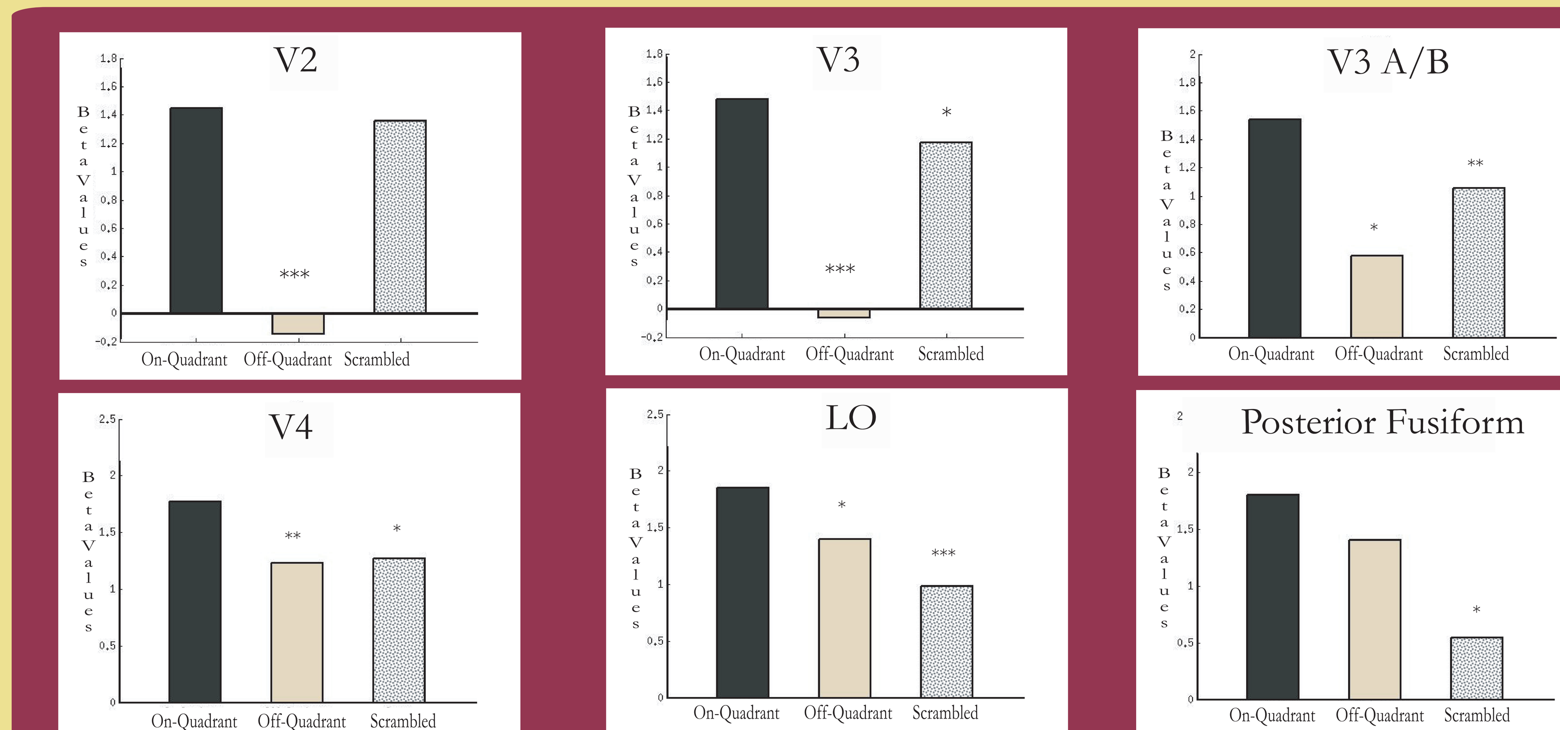
Laterality Effects

Object Scramble



Key:
(two-tailed paired t-test probability that the conditions are different from On-Quadrant Condition)
*** P<.001
** P< .01
* P< .05

Quadrant Effects



Conclusions:

- The object-selective population of neurons in LO did show some degree of the retinotopy that has been observed in response to simpler stimuli.

- However, large regions of LO in all subjects did not demonstrate quadrant specificity, whereas almost all of V3 A/B and V4 did. This could mean that large portions of LO represent foveal regions to the exclusion of the periphery.

- The most anterior region of object-selective cortex, i.e. that in the posterior fusiform gyrus, showed less quadrant and hemispheric specificity than did LO.