Separate Extrastriate Visual Regions Process Form and Texture in the Absence of Explicit Deployments of Attention

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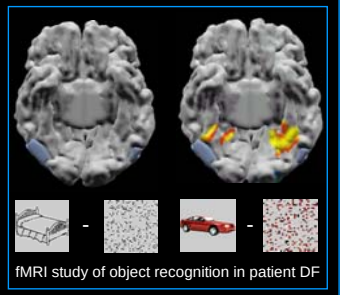
Introduction

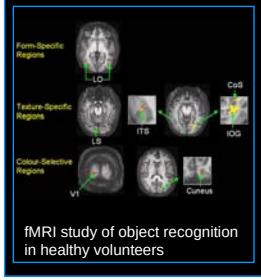
Fruit depicted in line drawings, grayscale, and full colour

- Object recognition is generally studied with a focus on form cues.
- But surface properties such as colour and texture also contribute to object recognition (particularly when these cues are diagnostic).



fMRI study of object recognition in patient DF

- Patient DF: compromised form perception, spared surface-property perception.
- Cerebral achromatopsics: spared form perception, compromised colour perception.
- Suggests separate form and surface-property pathways in the human visual system.



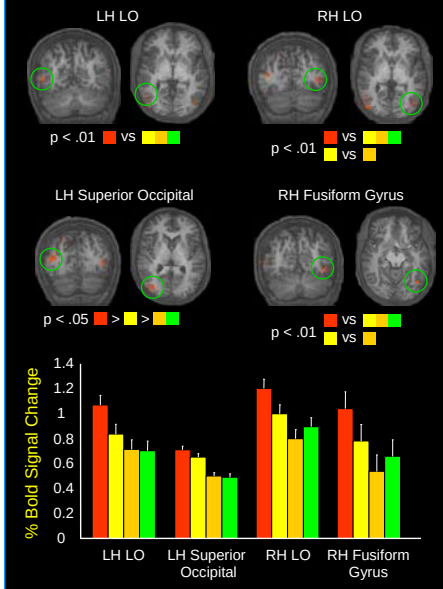
fMRI study of object recognition in healthy volunteers

- Cant & Goodale (2007) showed evidence of separate form and surface-property pathways using fMRI in healthy volunteers.
- But how specialized are these separate pathways?
- We used an fMR-adaptation paradigm to examine the specialization of form, texture, and colour regions in occipito-temporal cortex.

Hypotheses: area LO will be most sensitive to form and the Cos will be most sensitive to texture; not sure what to expect with colour.

Results

Form-Specific Regions



Analysis

- Applied LTR, high-pass filter
- Eliminated runs which had substantial head movement
- Conducted a voxelwise analysis, comparing 4 conditions using a random effects GLM on every voxel
- Used cluster-size thresholding to correct for multiple comparisons
- Carried out a conjunction analysis looking for areas sensitive to form, texture, and colour

Legends

- Form Change
- Texture Change
- Colour Change
- No Change

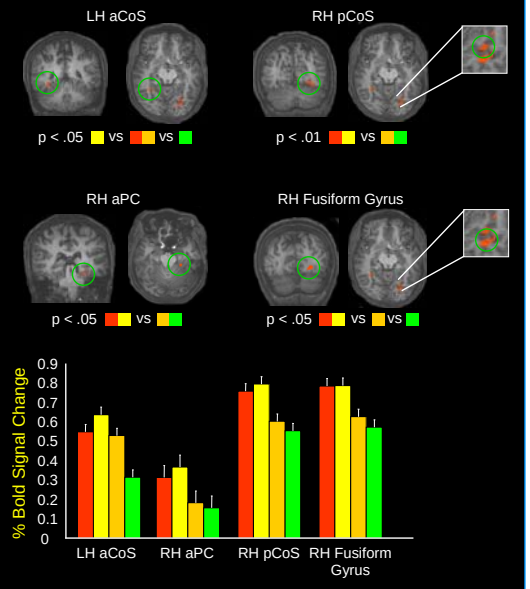
LO – Lateral Occipital Area

aCoS – Anterior Collateral Sulcus

aPC – Anterior Parahippocampal Cortex

pCos – Posterior Collateral Sulcus

Texture-Specific Regions

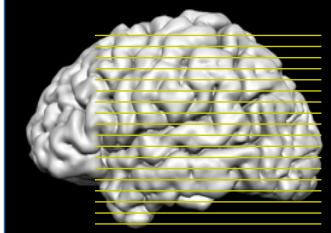


Note: No colour-specific regions were found

Method

Imaging Parameters

- 4T whole body fMRI scanner (Varian/Siemens) with an RF head coil
- 17 axial slices, covering a large section of occipital, temporal, and parietal cortex
- Scanned 17 healthy volunteers

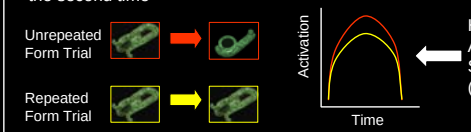


Stimuli

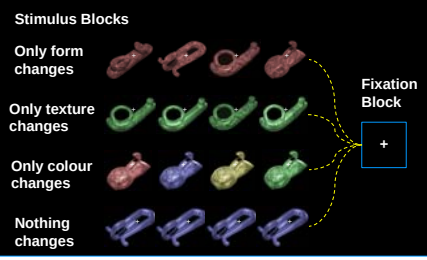
- Computer rendered images of unfamiliar nonsense objects
- 4 different forms, colours, and textures

fMR-Adaptation

- If you show the "same" stimulus twice in a row, you get a reduced response the second time



Experimental Design



- Stimulus blocks interleaved with fixation blocks (all blocks 16-s long)
- Task: fixate cross in both stimulus and fixation blocks
- Stimulus blocks: 16 images presented in 16-s

Summary and Discussion

- Processing of form is mediated by area LO, and processing of texture is mediated by the CoS; no colour-specific cortical regions found.
- Evidence from passive adaptation paradigm suggests that these regions can respond in a very stimulus-driven manner.
- Along with other functional subdivisions of the ventral stream, is a gradient of processing for form and surface properties.

Studying the functional organization of the ventral stream will:

1) Help in the diagnosis and rehabilitation of patients with vision problems following cerebral damage.

2) Shed new light on the multidimensional functional organization of the object recognition pathways in the brain.

3) Help engineers in machine vision design better human-machine interfaces by utilizing ***both*** form and surface-property information.

References

Cant JS & Goodale, MA. (2007). Attention to form or surface properties modulates different regions of occipitotemporal cortex. *Cerebral Cortex, 17*, 713 – 731.

James TW, Culham J, Humphrey GK, Milner AD, & Goodale MA. (2003). Ventral occipital lesions impair object recognition but not object-directed grasping: an fMRI study. *Brain*, *126*: 2463-2475.