A digital technique for art authentication

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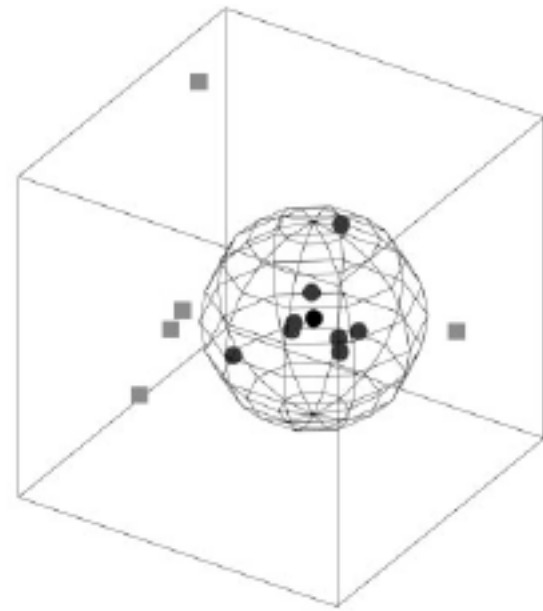
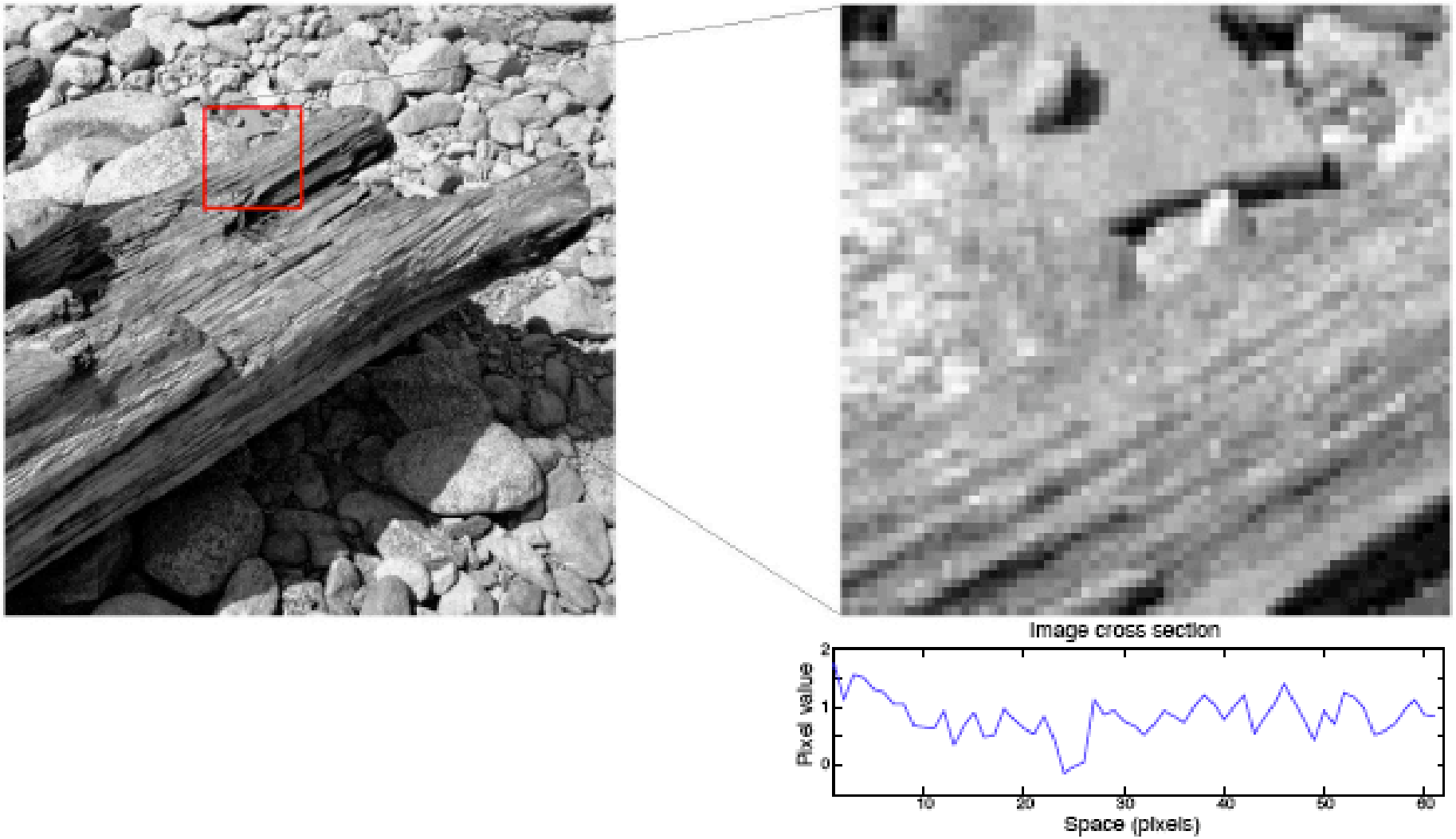


Towards intermediate-level representations

- The problem of scene analysis
- Insights from psychophysics
  - Occlusion and figure-ground representation (Nakayama & Shimojo)
  - Adaptation (Webster/Leopold)

The problem of scene analysis

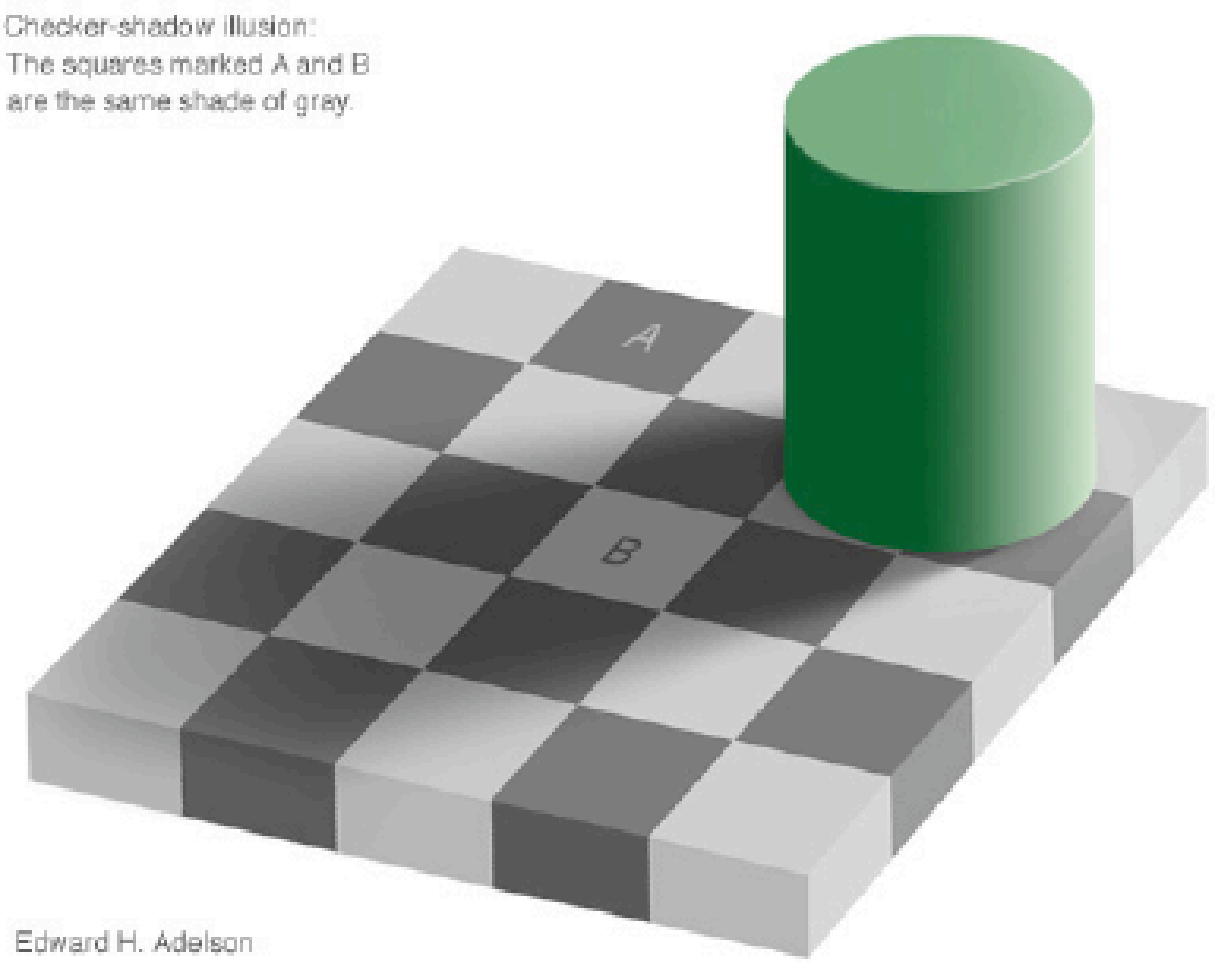


How do you interpret an edge?

Mooney faces

Mooney faces

Lightness perception depends on 3D scene layout



Object recognition depends on scene context

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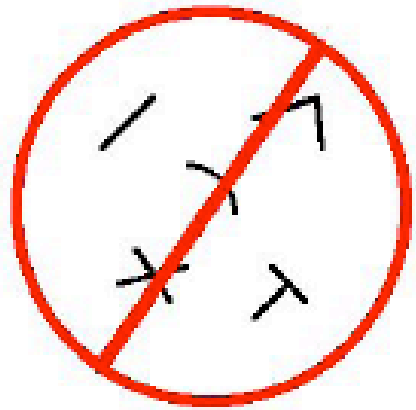
Visual representations are 3D, not 2D

Nakayama K, He ZJ, and Shimojo S. (1995) **Visual surface representation: a critical link between lower-level and higher level vision.** In: S.M. Kosslyn and D.N. Osherson, Eds, *An Invitation to Cognitive Science*. MIT Press, pp. 1-70.



Images vs. surfaces

"One of the most striking things about our visual experience is how dramatically it differs from our retinal image.

....

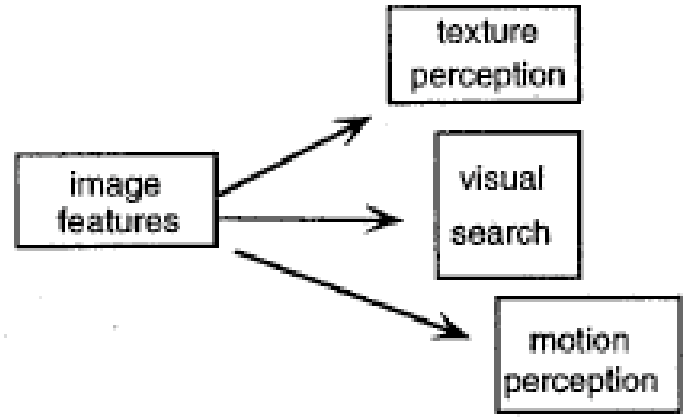
Our perception is closely tied to surfaces and objects in the real world; it does not seem tightly tied to our retinal images.

...

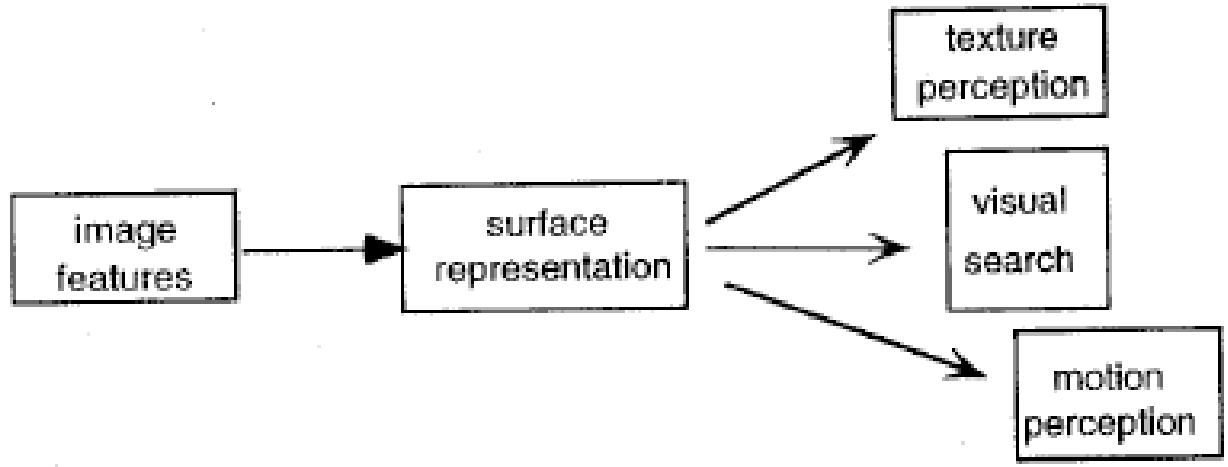
Our view is that higher functions require, as an input, a data format that explicitly represents the world as a set of surfaces."

A new view of visual processing

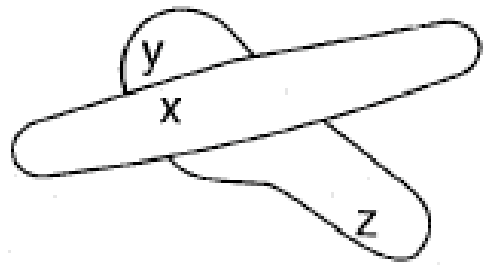
Old:



New:



Rules of occlusion

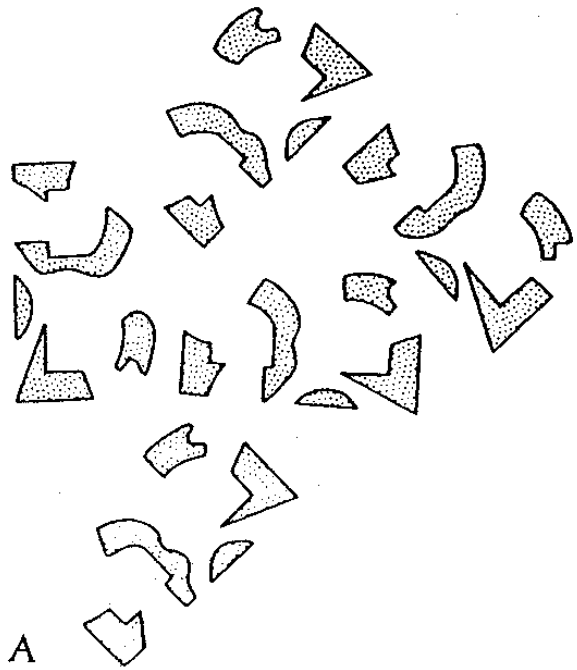


1. When image regions corresponding to different surfaces meet, only one region can "own" the border between them.

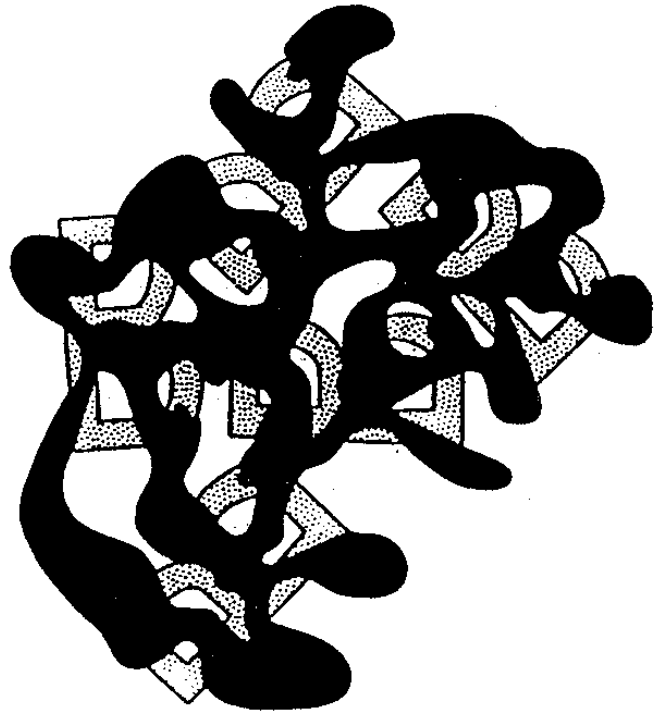
2. Under conditions of surface opacity, a border is owned by the region that is coded as being in front.

3. A region that does not own a border is effectively unbounded. Unbounded regions can connect to other unbounded regions to form larger surfaces completing behind.

Bregman B's

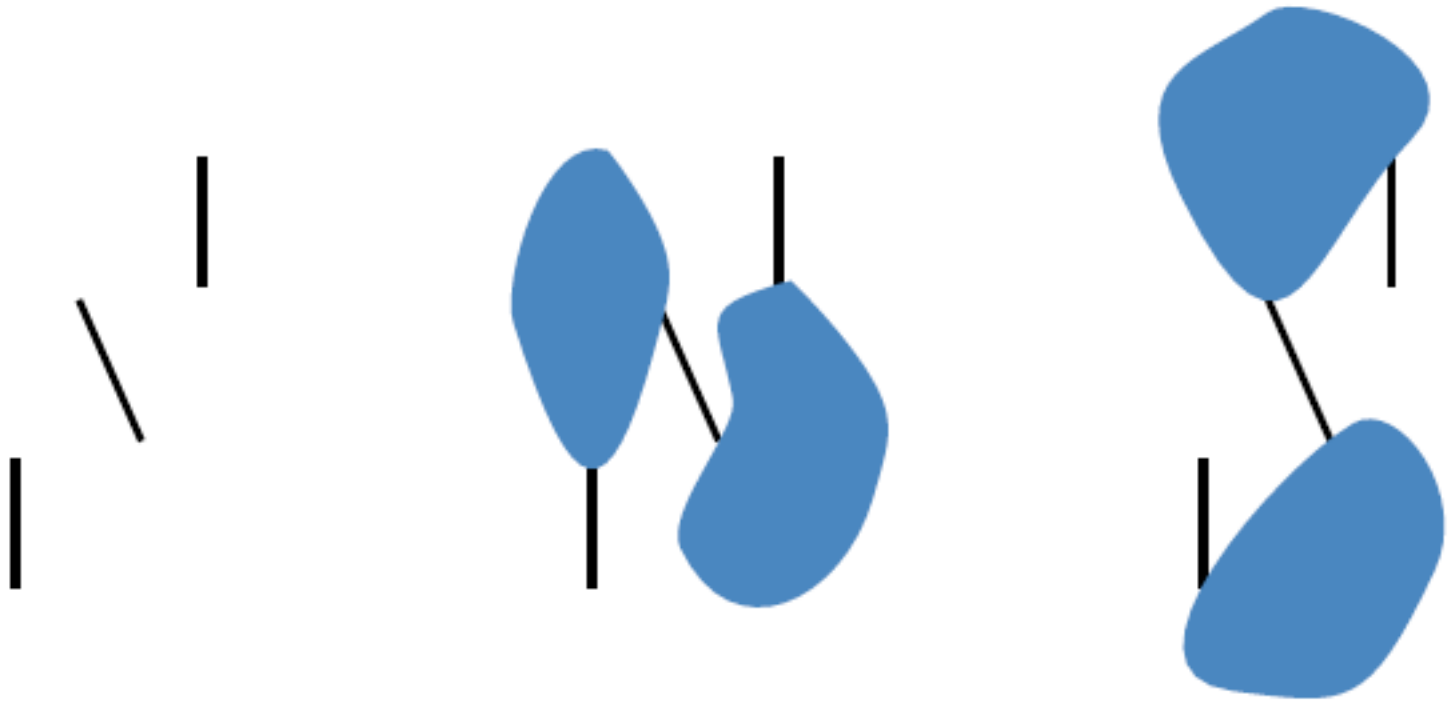


A

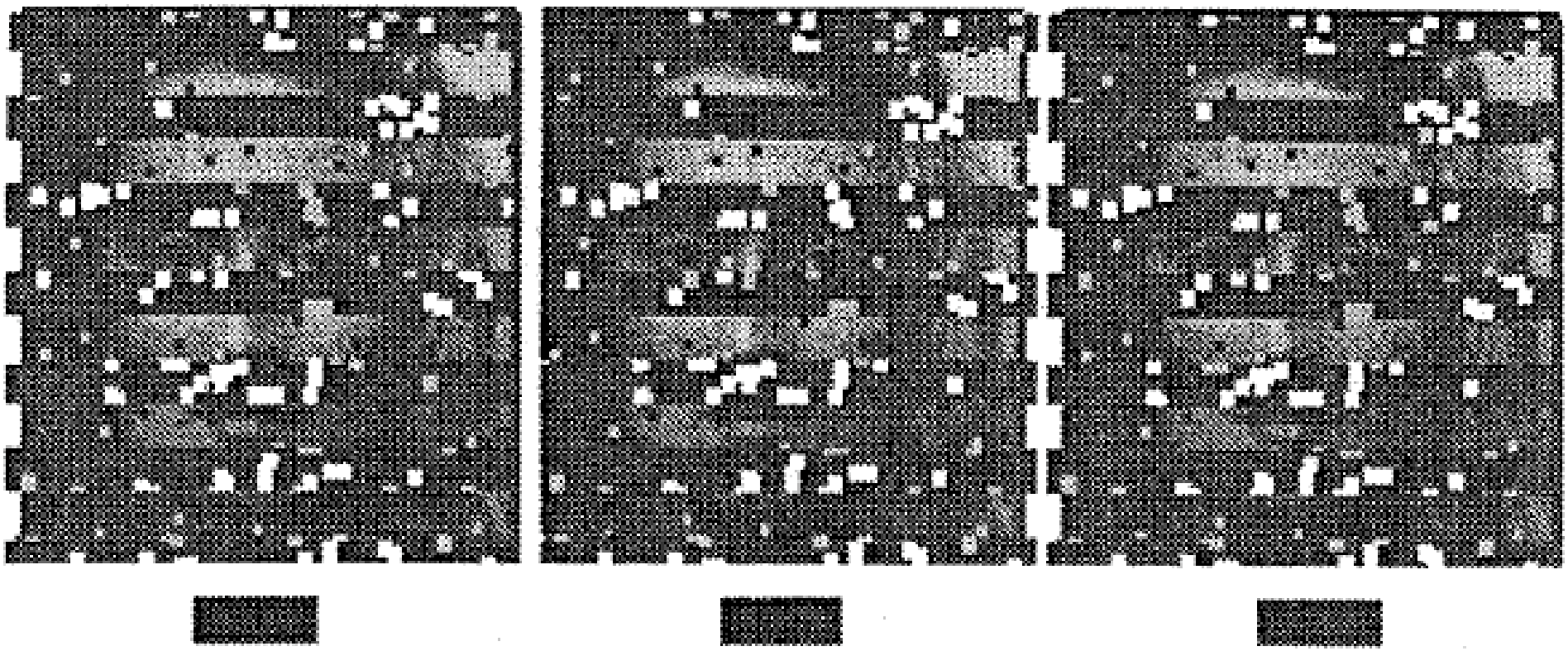


B

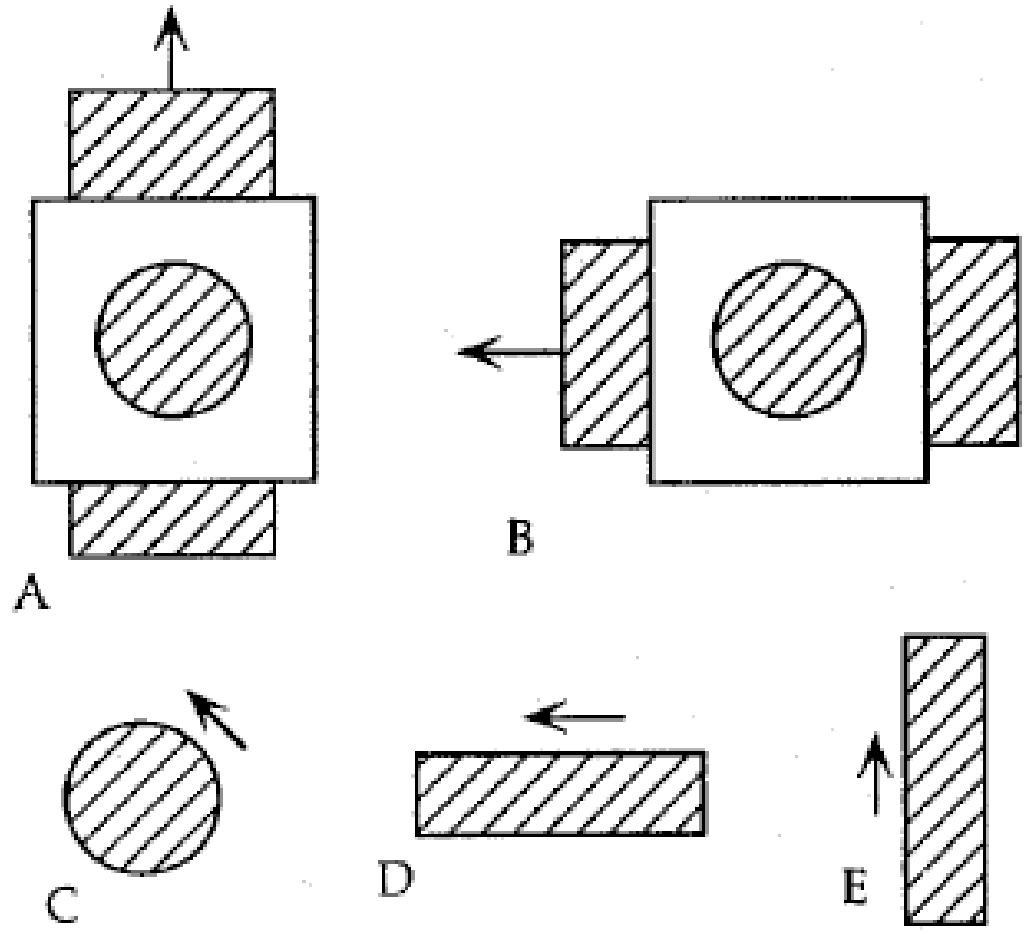
Occluders determine object completion



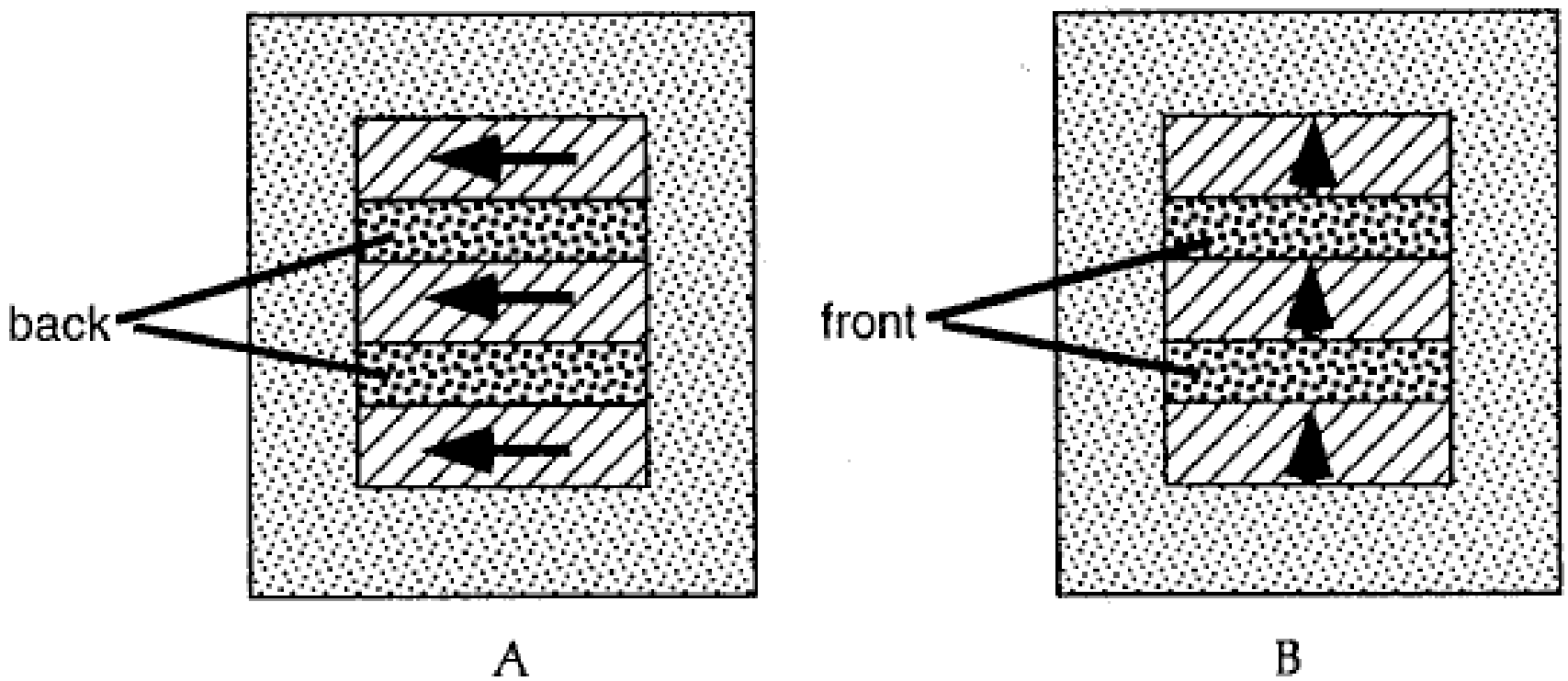
Amodal completion depends on depth assignment



The motion aperture problem

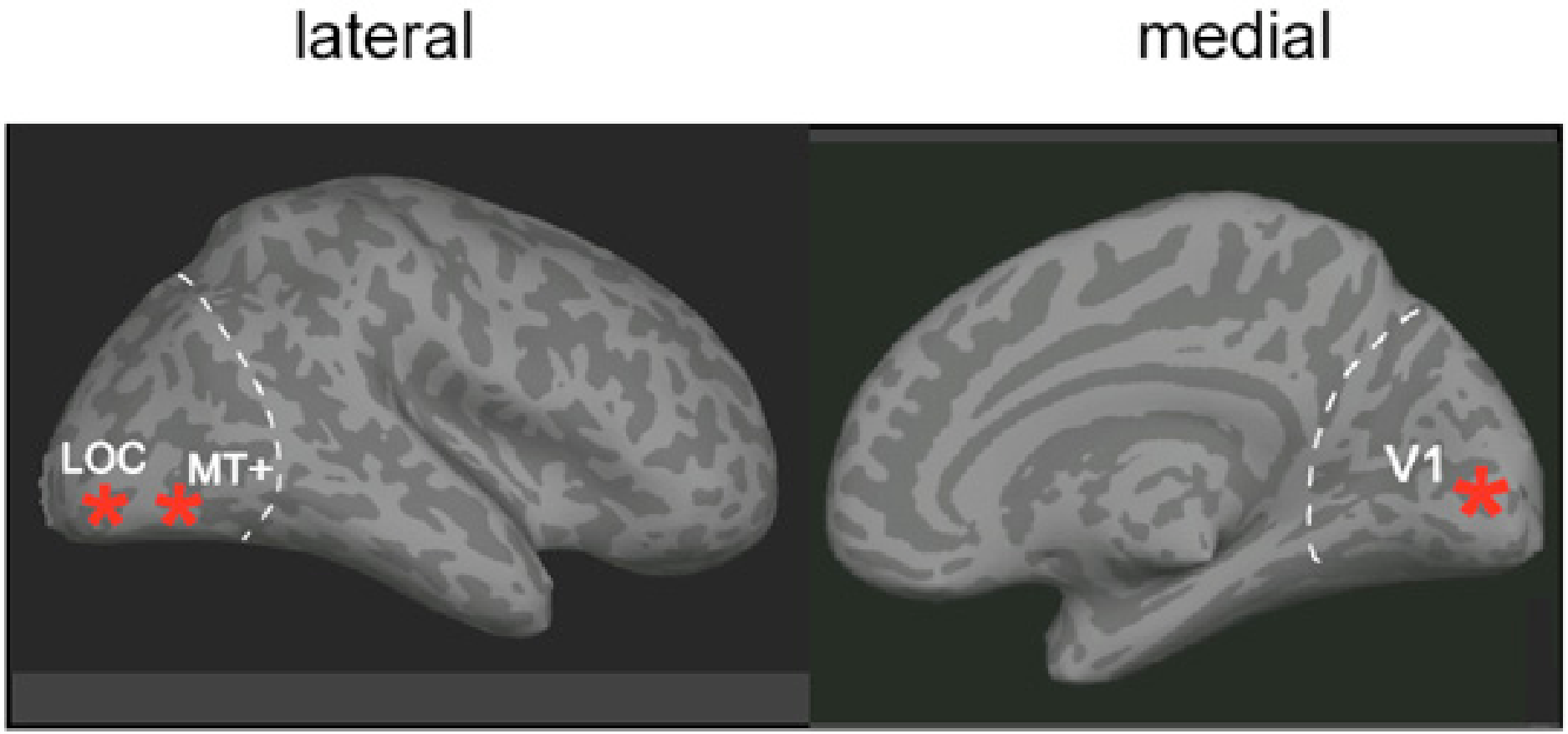


Motion perception depends on figure-ground assignment

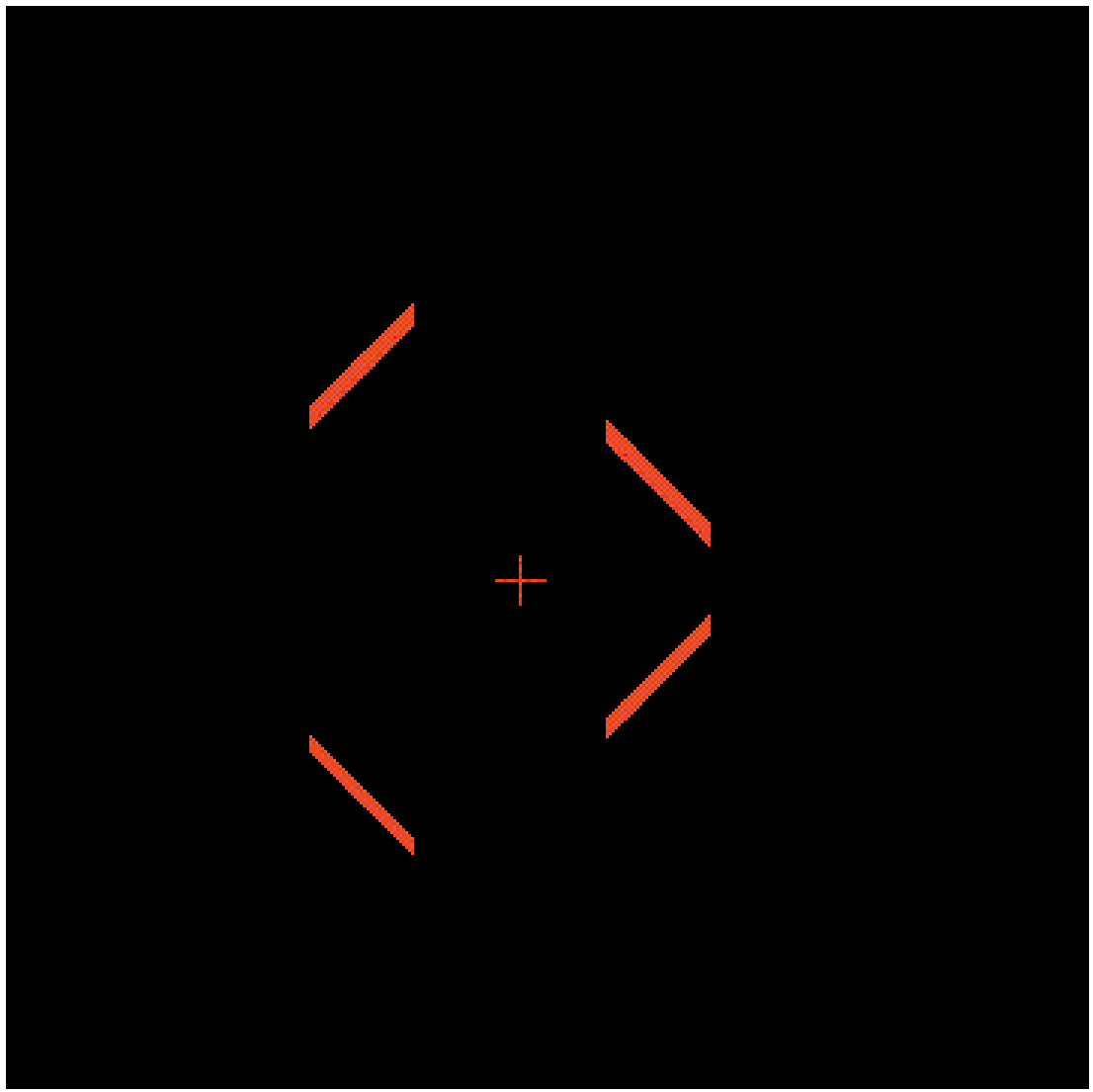


Shape representation in human visual cortex (fMRI)

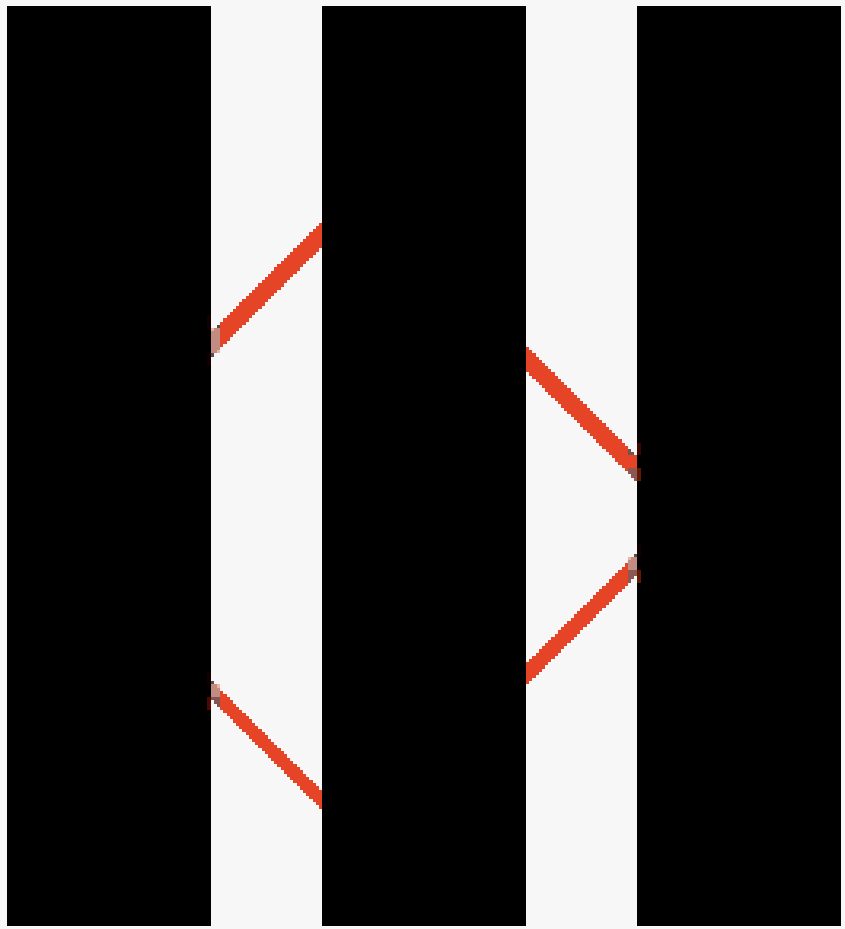
(Scott Murray - Ph.D. thesis)



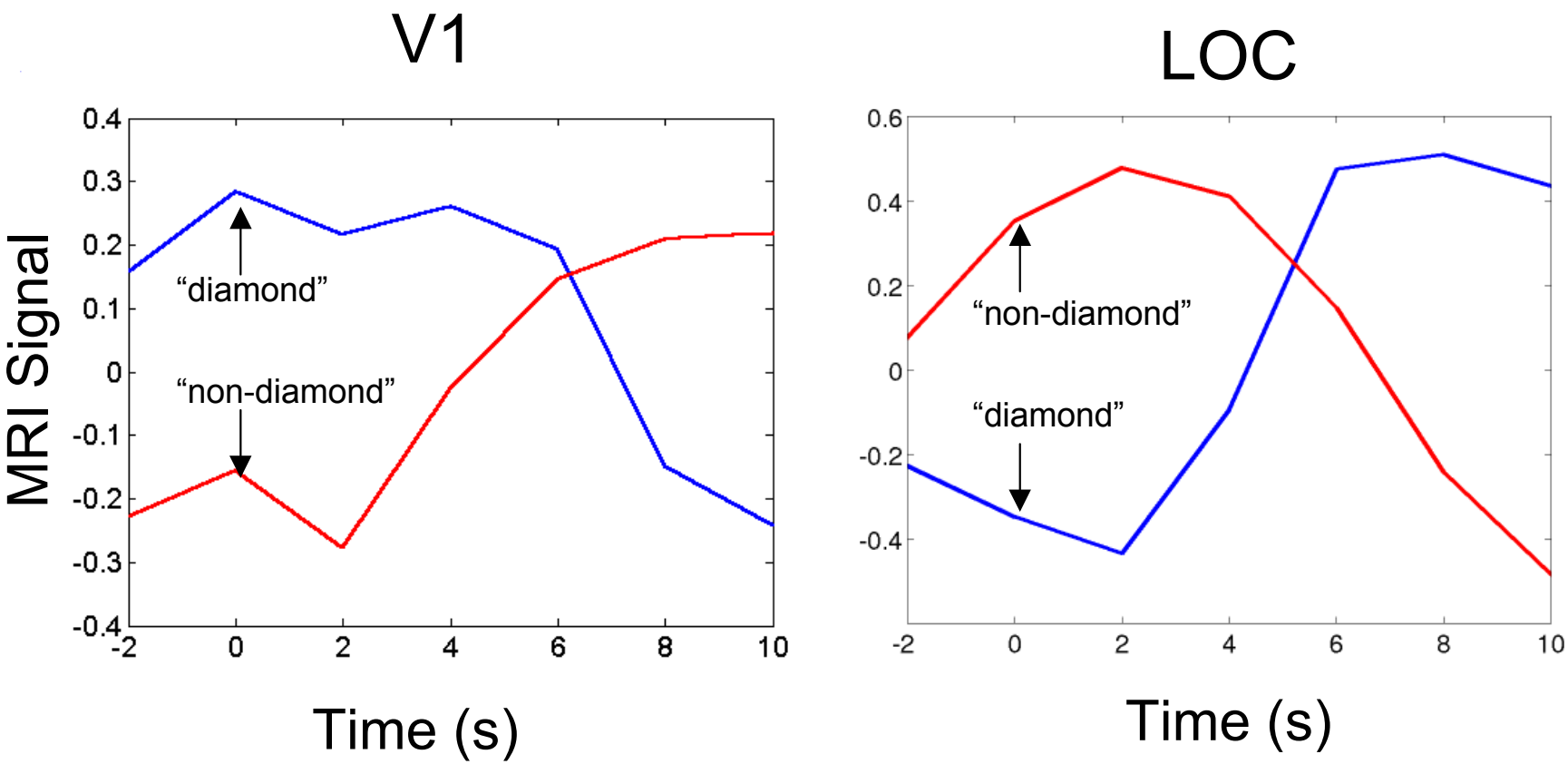
Moving diamond behind occluders



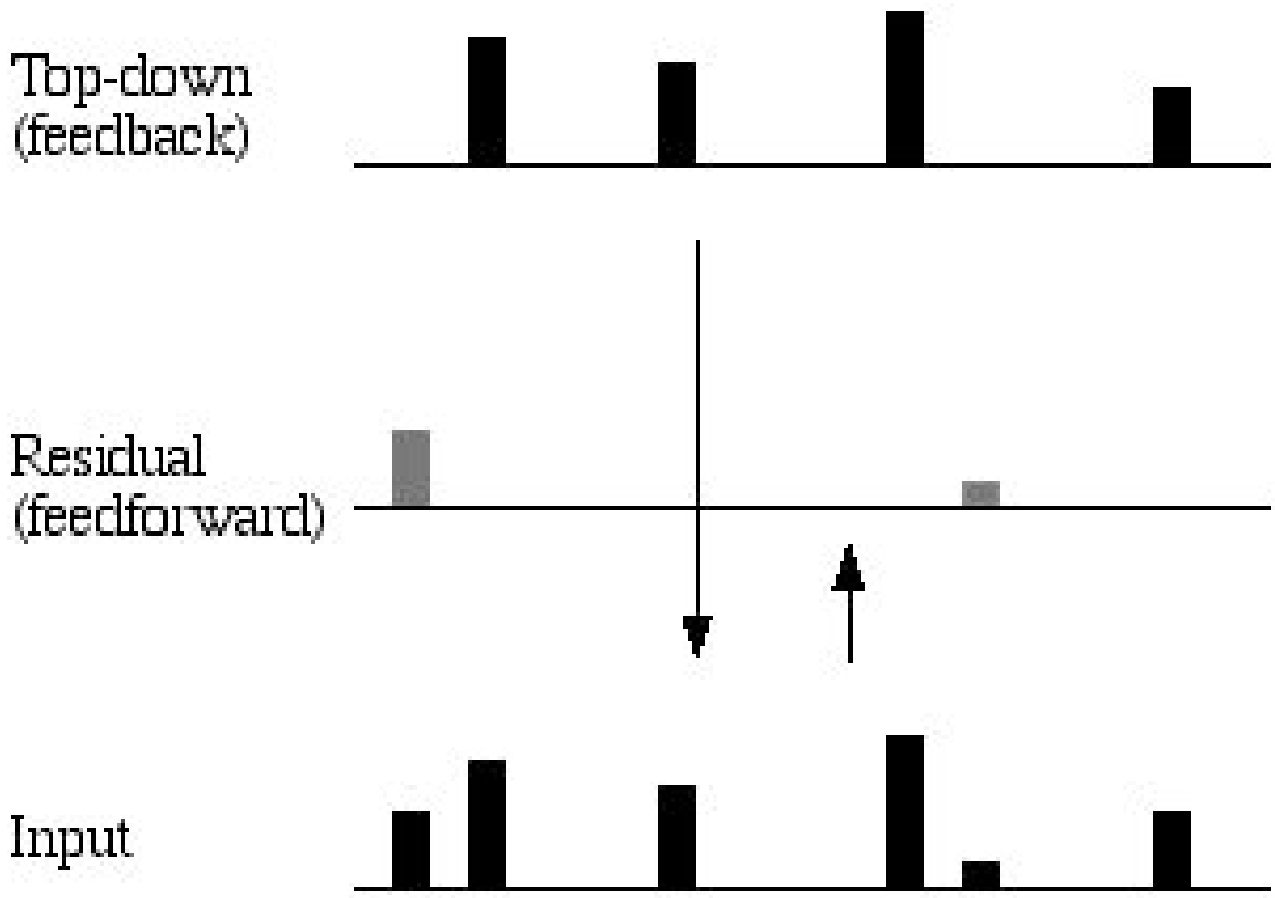
Moving diamond behind occluders (easy version)



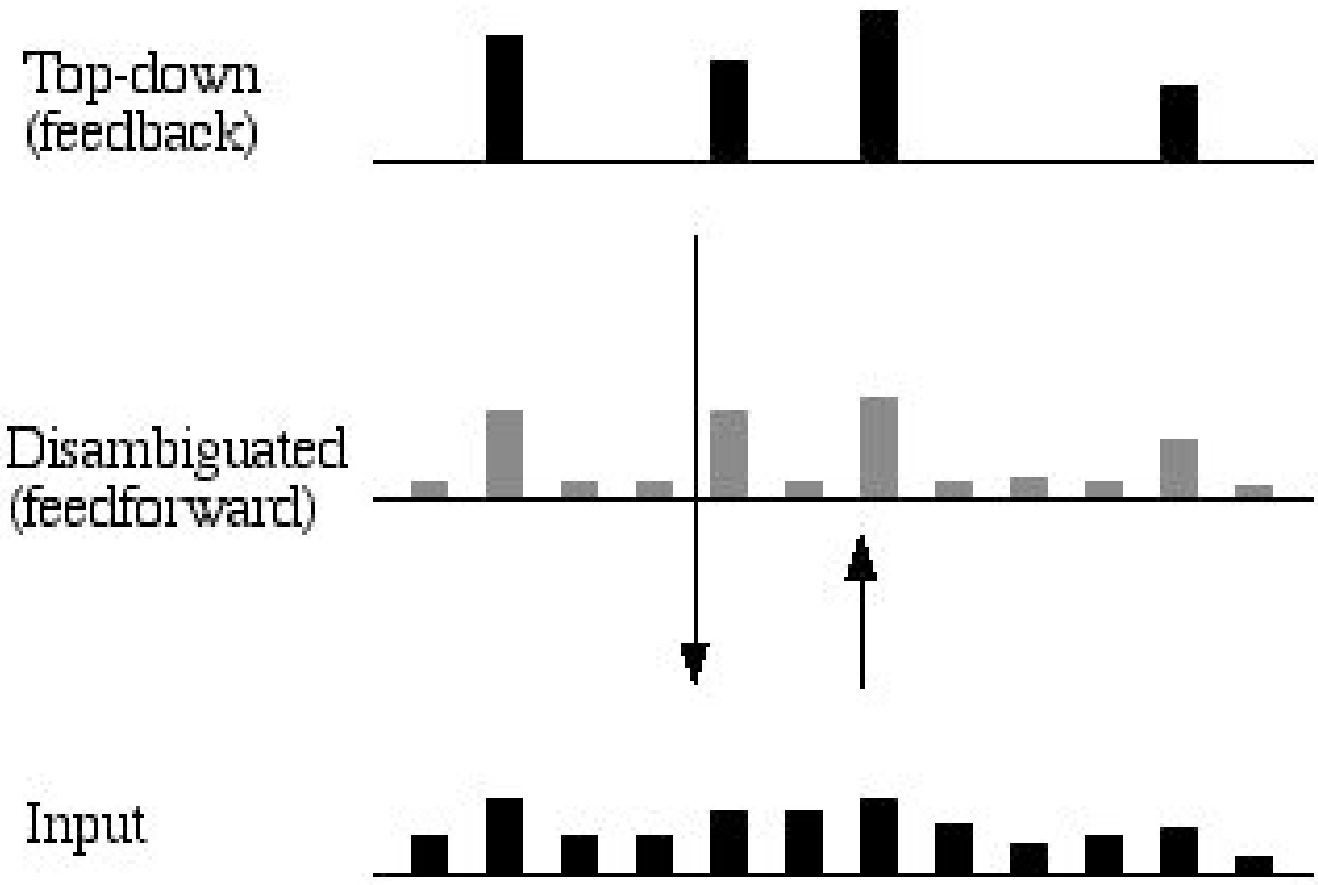
BOLD signal: LOC vs. V1



Predictive coding

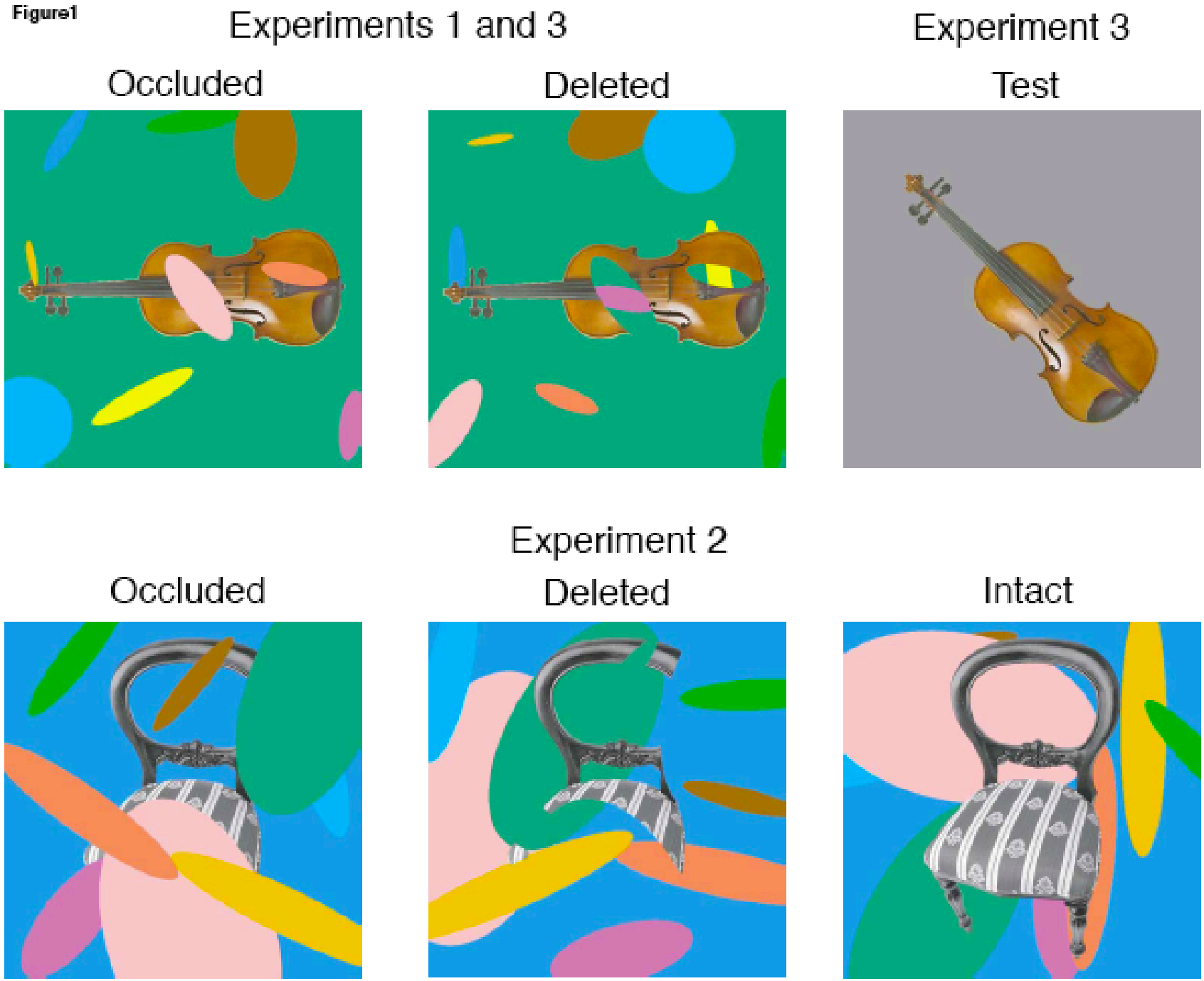


Disambiguation

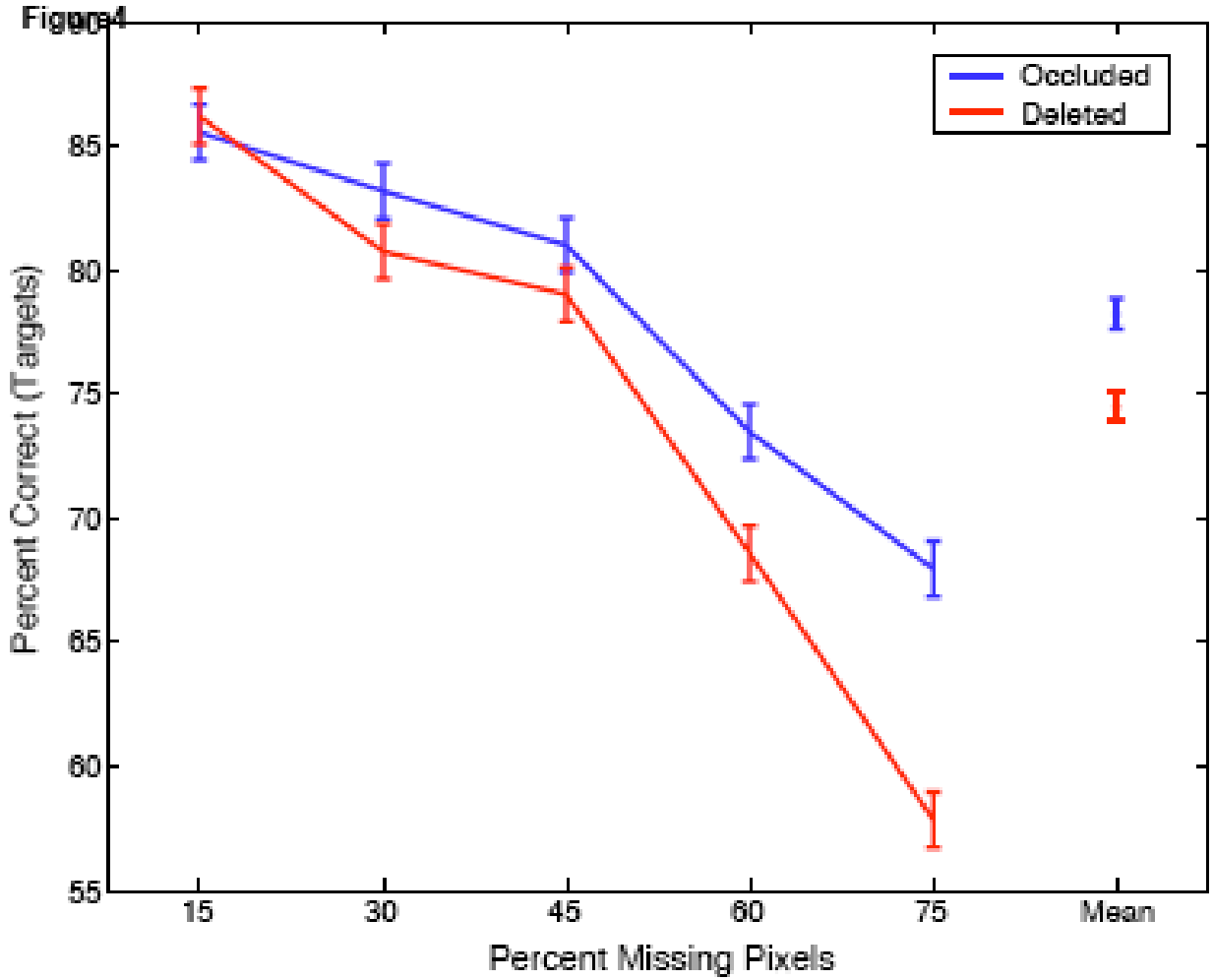


Effects of occlusion vs. deletion on recognition
Jeff Johnson, Ph.D. Thesis

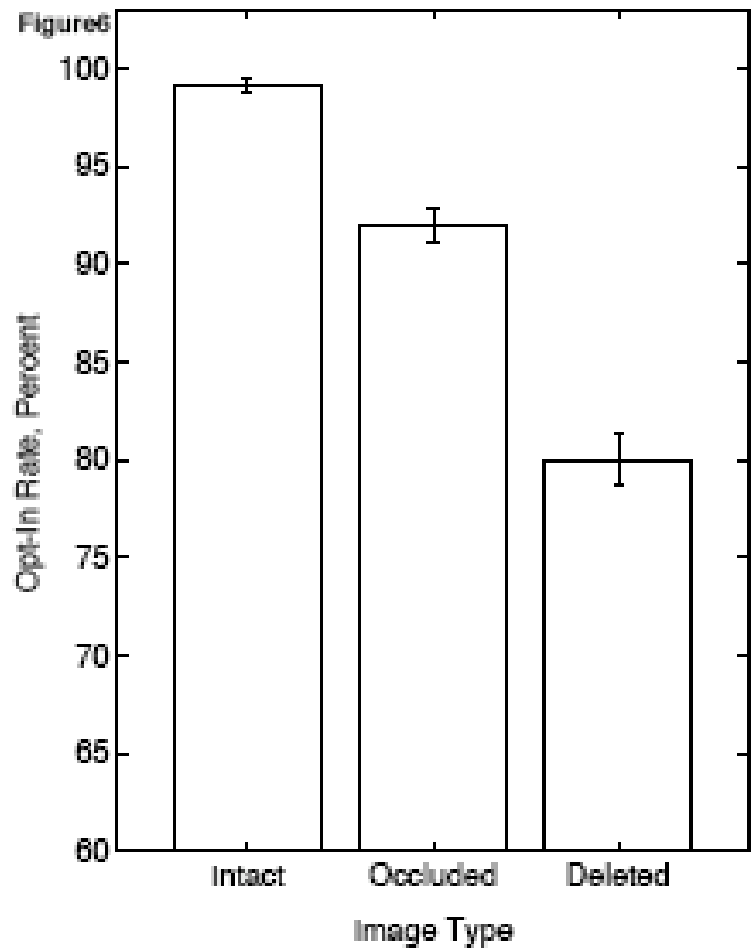
Figure1



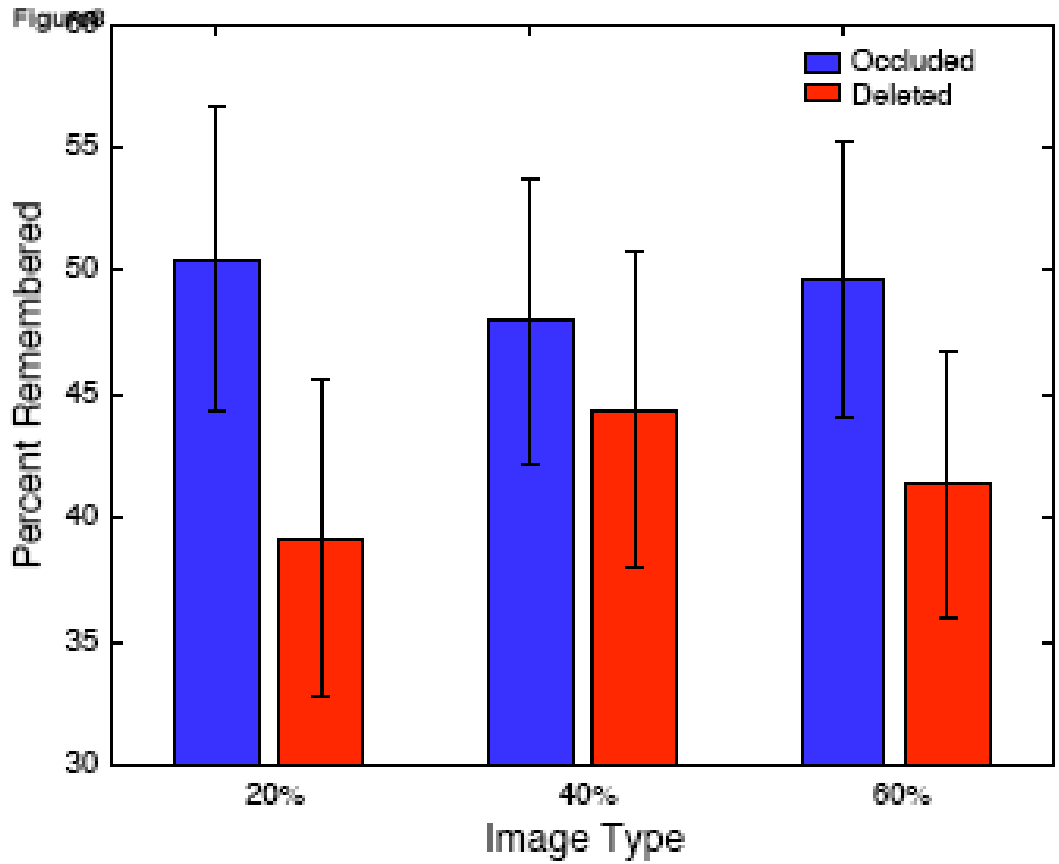
Recognition advantage for occlusion vs. deletion



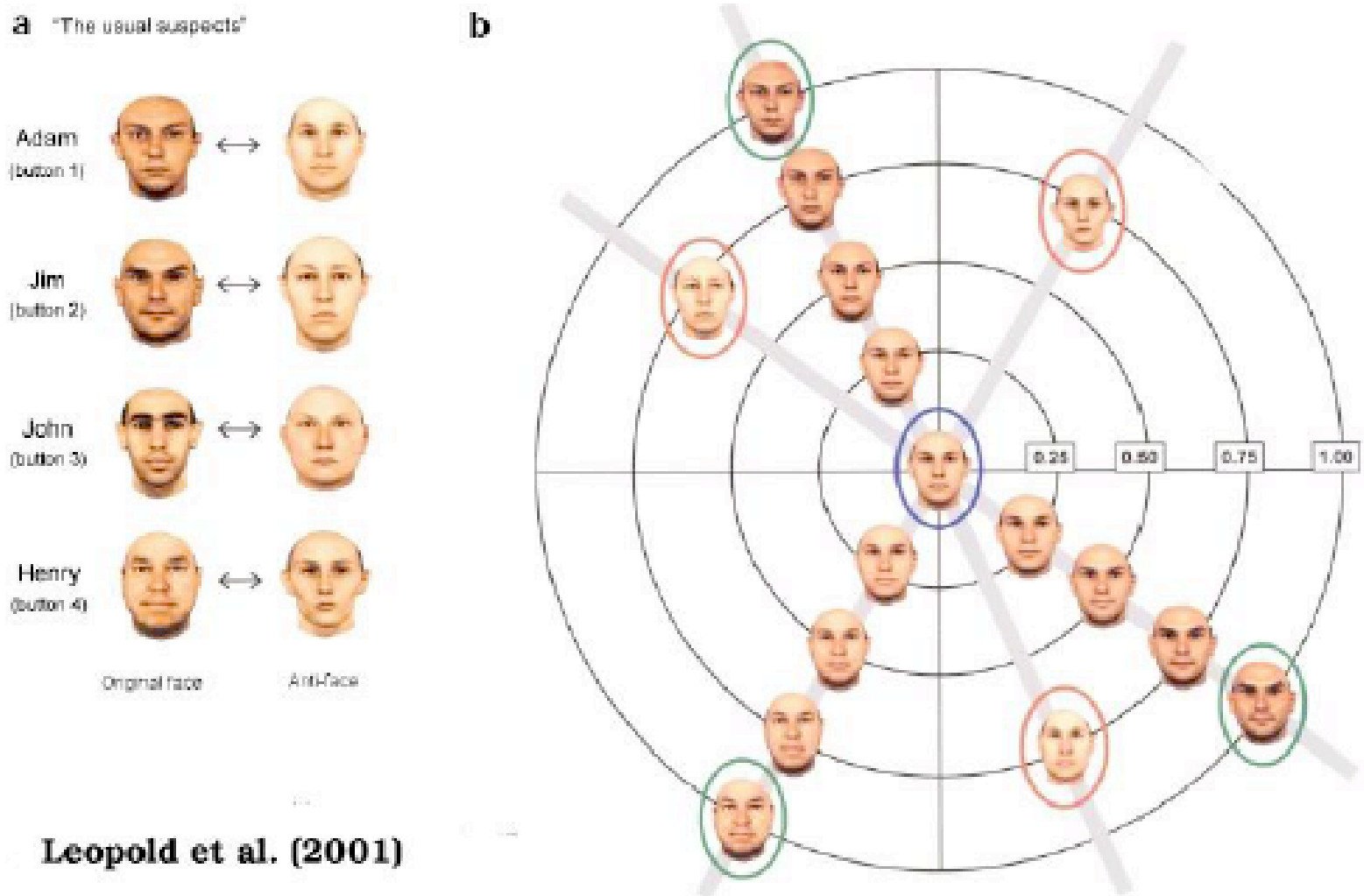
Higher opt-in rate



Occluded objects are more easily remembered

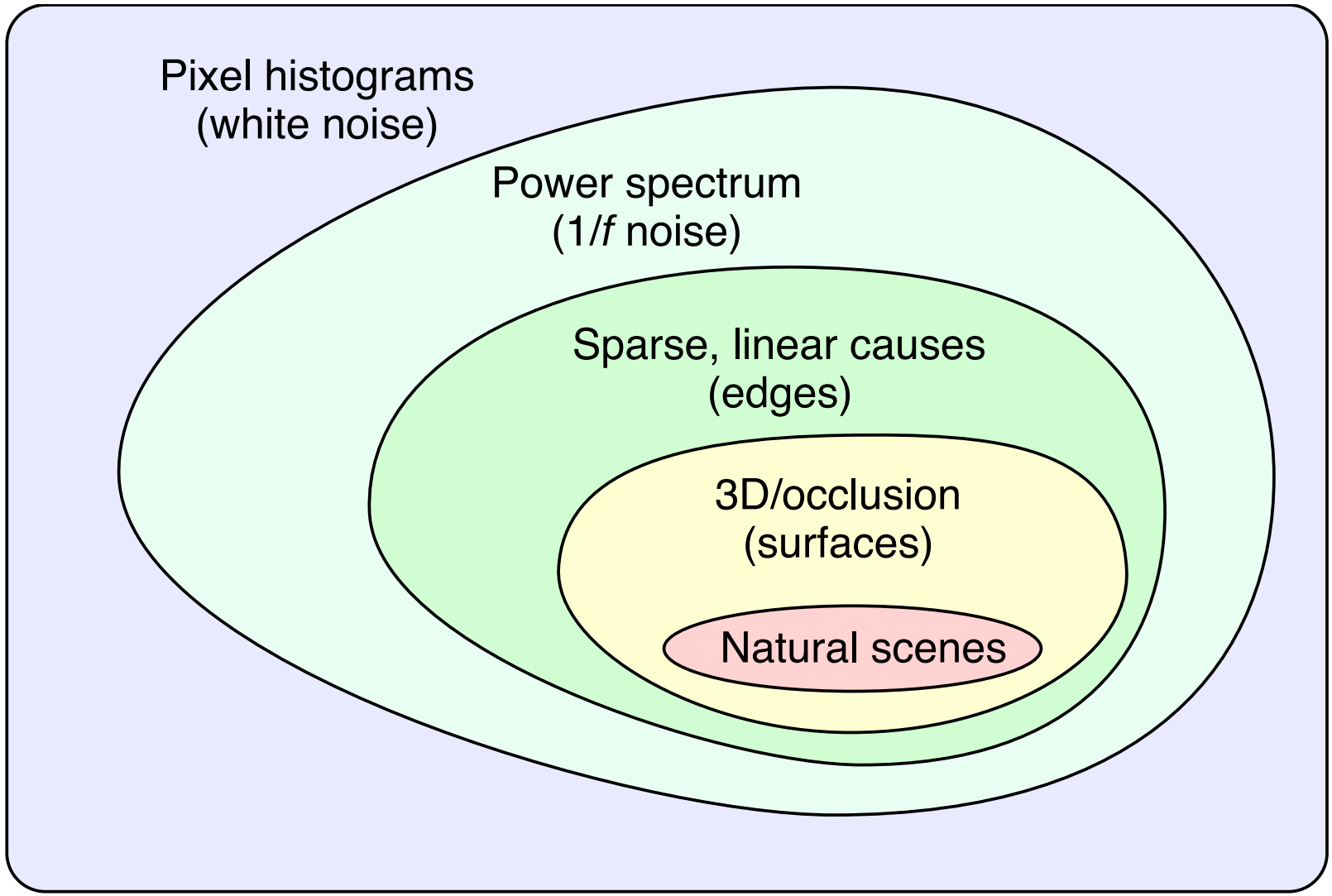


Adaptation reveals internal axes of representation



Leopold et al. (2001)

Image models



Lab 'products'

- Theories of cortical function
  - sparse representations
  - invariance
  - hierarchy and feedback
- Empirical studies
  - analysis of neural response properties
  - EEG/psychophysics of intermediate-level vision
- Applications
  - image analysis (denoising/super-resolution)
  - video compression
  - scene analysis and recognition

Other stuff

- Fixational eye movements
- Realistic model of retina
- Crowding/lateral masking
- Tiling of amplitude and feature space
- sound2image