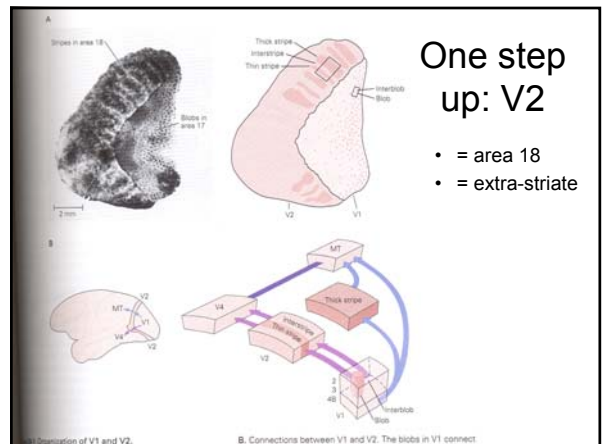
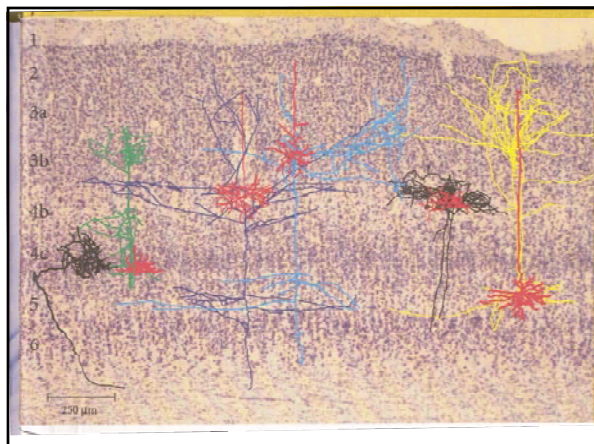
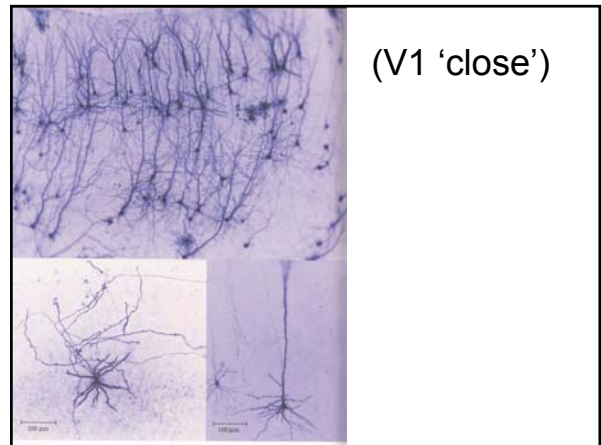


## Correction

- **LGN sits within the Thalamus**  
(not the Hypothalamus)



## V2 cell responses

- responses similar to V1 but V2 cells also respond to illusory contours

**Figure 28-16** Illusions of edges used to study the higher level information processing in V2 cells of the monkey. A: Examples of illusory contours. 1. A white triangle is clearly seen, although it is not defined by a continuous

## Inferior Temporal (IT) Cortex

**Figure 28-18** Response of a neuron in the inferior temporal cortex to complex stimuli. The cell responds strongly to the face of a toy monkey (A). The critical features producing the response are revealed in a configuration of two black spots and one horizontal black bar arranged on a gray disk (B). The bar, spots, and circular outline together were essential, as can be seen by the cell's responses to images missing one of these features (C, D, E, F). The contrast between the inside and outside of the circular contour was not critical (G). However, the spots and bar had to be darker than the background within the outline (H). (i = spikes.) (Modified from Tootell and Tanaka 1994.)

- IT cells respond to orientations, faces, objects but also to color

## (On the side: Measurements on Epileptic Patients)

### Category-specific visual responses of single neurons in the human medial temporal lobe

Gabriel Kreiman<sup>1</sup>, Christof Koch<sup>1</sup> and Itzhak Fried<sup>2</sup>

<sup>1</sup> Computation and Neural Systems Program, California Institute of Technology, 129-74, Pasadena, California 91125, USA  
<sup>2</sup> Division of Neurosurgery and Department of Psychiatry and Behavioral Sciences, Box 95308, UCLA School of Medicine, 740 Westwood Plaza, Los Angeles, California 90095-7028, USA  
 Correspondence should be addressed to I.F. (ifried@mednet.ucla.edu)

The hippocampus, amygdala and entorhinal cortex receive convergent input from temporal neocortical regions specialized for processing complex visual stimuli and are important in the representation and recognition of visual images. Recording from 427 single neurons in the human hippocampus, entorhinal cortex and amygdala, we found a remarkable degree of category-specific firing of individual neurons on a trial-by-trial basis. Of the recorded neurons, 14% responded selectively to visual stimuli from different categories, including faces, natural scenes and houses, famous people and animals. Based on the firing rate of individual neurons, stimulus category could be predicted with a mean probability of  $0.74 \pm 0.04$ . In the hippocampus, the probability of correct classification was

**Fig. 2.** Sample of stimuli presented in each category. Figures (mostly color) were drawn from a group of nine categories that included faces denoting emotional expressions by unknown actors<sup>17</sup>, household objects, spatial layouts (including house exteriors, interiors and natural scenes), animals, cars, drawings of famous people or cartoon characters, photographs of famous people, food items and abstract patterns. Stimuli were presented for 1000 ms. Subjects had to indicate by pressing a button whether the image was a human face or not.

**Fig. 3.** Visually selective neuron in the entorhinal cortex. (a) Raster plots and histograms (PSTH) of the responses of a neuron in the right entorhinal cortex. The raster and histograms are aligned to the onset of the stimulus. The stimulus was presented between  $t = 0$  and  $t = 1000$  ms (indicated by dashed vertical lines in each histogram). Responses were averaged for all stimuli within a given category using a bin size of 200 ms. The dashed horizontal line indicates the mean firing rate over the whole experiment (15.3 spikes/s). The category and the number of stimuli presented in each category are indicated at the top of each histogram. The firing rate in the 1000–1500 ms interval upon presentation of a picture of an animal was significantly different from that in the 1000 to 0 ms baseline preceding the stimulus onset ( $p < 10^{-7}$ ). The probability of error ( $\alpha$ ) from the ROC analysis (Fig. 4b) was 0.21. There were only five presentations of food items in this experiment, and they were not included in the graph. The neuron did not respond to food items based on these five repetitions. (b) Distribution of firing rates during presentation of pictures of animals. Histogram distribution of mean firing rate of responses in each trial, bin size of 1.5 spikes/s. There is no clear sign of bimodality in the distribution. (c) PSTHs showing the responses of this neuron to each individual stimulus within the category of animals. Although the responses vary from one stimulus to another, the neuron responds to all stimuli within the category (comparison with baseline,  $p < 0.05$ ). An analysis of variance comparing the responses to different individual animals did not yield significance ( $p = 0.4$ ). The scale is the same as in (a).

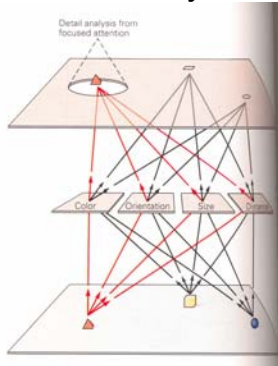
10.1 | Mechanistic Accounts of Attention 175

**RF sizes**

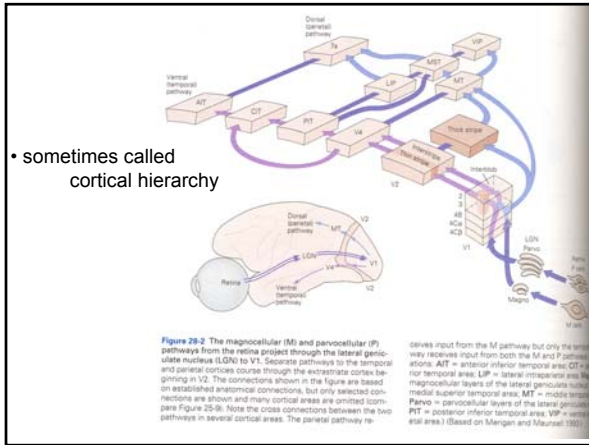
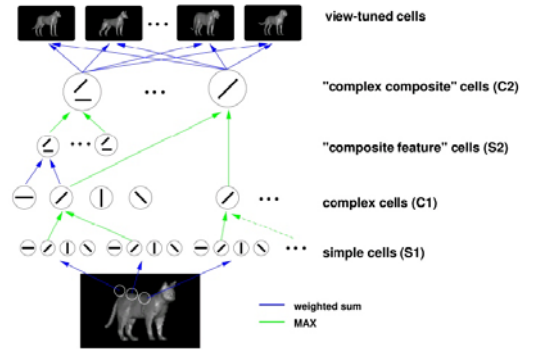
**FIGURE 10.1** The Need for Attention Suppose you are looking at my family in this high

# Feature-Integration Theory

**Figure 25-15** A hypothetical model of how different types of visual information processed separately are combined into a coherent image. The elementary properties of objects in the visual field (such as color, orientation, size, and distance) are encoded in separate parallel pathways, each of which generates a feature map. Selected features from these maps are then integrated into a master map, which is a representation of those features that distinguish objects from the background. Focused attention can occur only after features have been associated in a small region of the master map. (After Treisman 1986.)



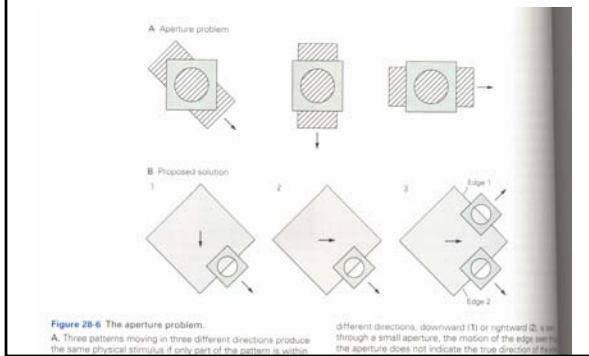
# (On the side: Prototypical Network)



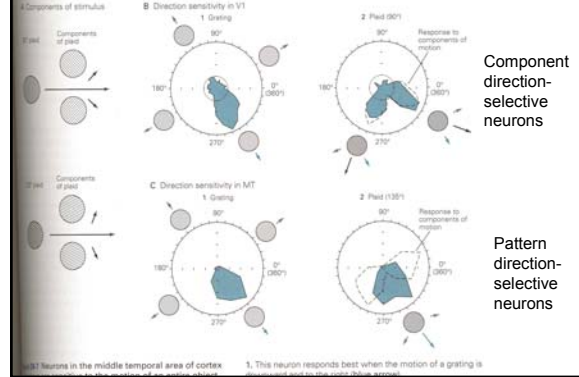
# Motion Pathway

- V1 cells project to MT, some of them over V2
- V1 cells motion sensitive, but only for small (local) RFs
- aperture problem

# The Aperture Problem



# MT cells solve the aperture problem



## One effect of MT/MST Lesions

- Difficulties perceiving smooth movement

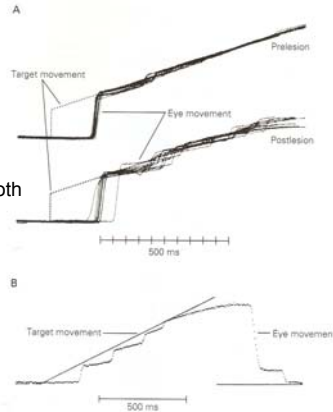
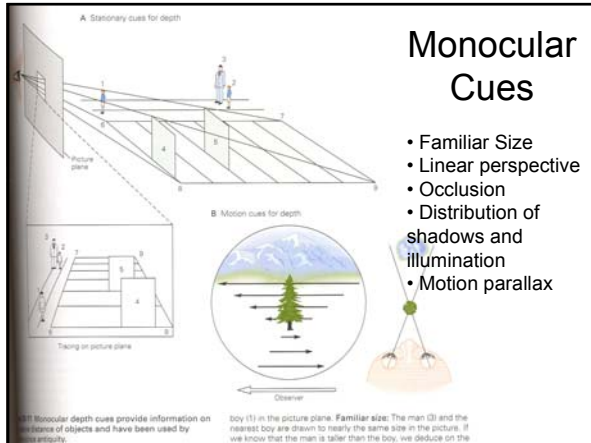


Figure 28-8 Cortical lesions in monkeys and humans pro-

## Depth - Understanding of 3D

- Comes from monocular and stereoscopic cues
- Monocular cues: > 100 feet (ca. 30m)
- Stereoscopic cues: < 100 feet

## Monocular Cues



- Familiar Size
- Linear perspective
- Occlusion
- Distribution of shadows and illumination
- Motion parallax

Figure 28-11 Monocular depth cues provide information on the relative distance of objects and have been used by artists for centuries.

Figure 28-11 Motion cues for depth. The man (M) and the nearest boy are drawn to nearly the same size in the picture. If we know that the man is taller than the boy, we deduce on the basis of their relative positions that the man is farther away.

## Stereoscopic Cues

- spatial (3D) vision
- possible by the two separate eyes
- binocular disparity

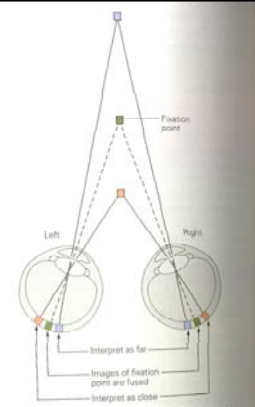


Figure 28-12 When we fix our eyes on a point in the center of the scene, the two eyes see different parts of the scene. The distance between the eyes causes that point (the fixation point) to be seen from two different angles.

## Cortical Cells code for Binocular Disparity

- taking place in V1 and other areas
- ...in addition to orientation/ocular dom./blobs...V1 is analyzing many different aspects of the visual image

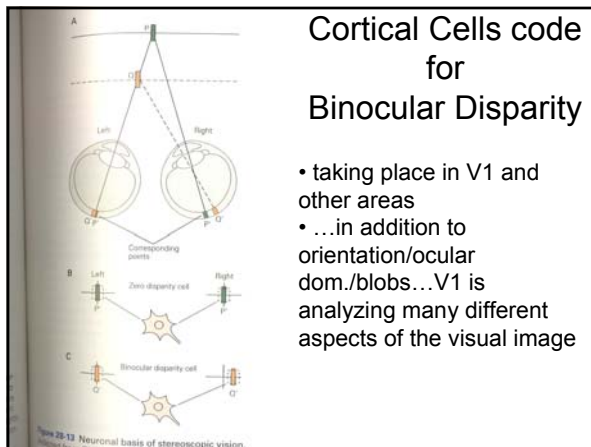


Figure 28-13 Neuronal basis of stereoscopic vision. The diagram shows how the two eyes see different parts of the scene. The distance between the eyes causes that point (the fixation point) to be seen from two different angles.

## Is 'motion' and 'color' processing taking place separately?

- fMRI study
- ...apparently it is.

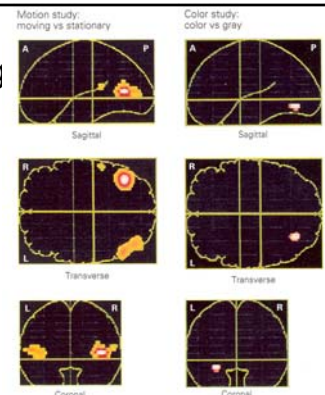


Figure 28-5 Separate human brain areas are activated by motion and color. Motion studies: Six subjects viewed a black and white video of a moving object. Color studies: Six subjects viewed a color and gray video of a moving object.

# Visual Agnosias - Deficits

Table 25-1 The Visual Agnosias

Type	Deficit	Most probable site of the lesion
<b>Agnosia for form and pattern</b>		
Object agnosia	Naming, using, recognition of real objects	Areas 18, 20, 21 on left and corpus callosum
Agnosia for drawings	Recognition of drawn objects	Areas 18, 20, 21 on right
Prosopagnosia	Recognition of faces	Areas 20, 21 bilaterally
<b>Agnosia for color</b>		
Color agnosia	Association of colors with objects	Area 18 on right
Color anomia	Naming colors	Speech zones or connections from area 18
Achromatopsia	Distinguishing hues	Areas 18, 37
<b>Agnosia for depth and movement</b>		
Visuospatial agnosia	Stereoscopic vision	Areas 18, 37 on right
Movement agnosia	Discerning movement of object	Medial-temporal area bilaterally (posterior occipital and temporal cortex)

Modified from Kolb and Whishaw 1980.

# Agnosia for Drawings

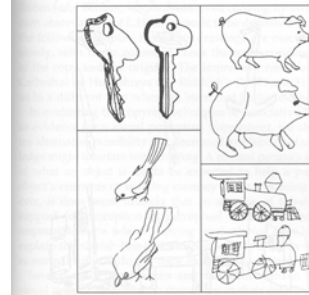
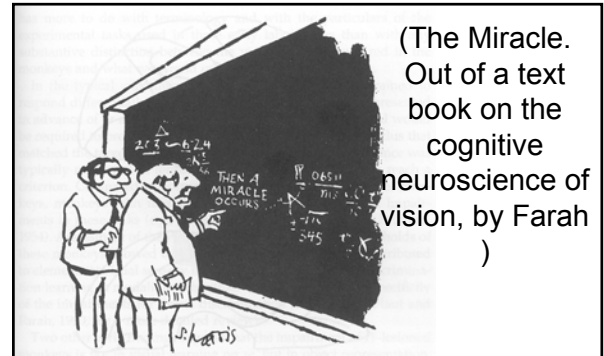


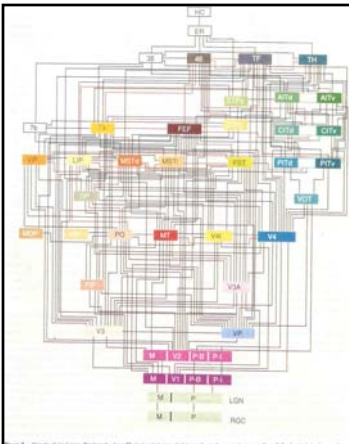
Figure 4.7 Copies of pictures made by an associative visual agnostic who could not recognize the pictures, either before or after copying them. From A. B. Rubens and D. F. Benson, "Associative visual agnosia," Archives of Neurology, 34, 1974, with permission of the American Medical Association.

# Prosopagnosia



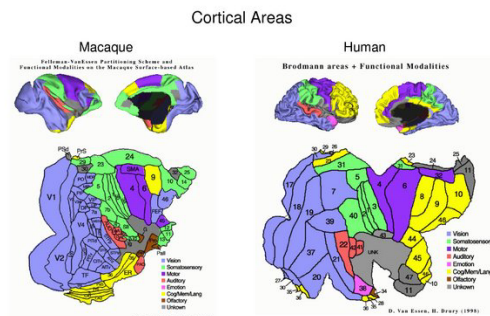
"I think you should be more explicit here in step two."  
 Figure 4.1 Sidney Harris's classic cartoon, which about sums up our understanding of the neural information processing performed between V4 and IT.  
 From Harris, "I think you should be more..." in Chalk Up Another One: The Best of Sidney Harris, New Brunswick, NJ, Rutgers University Press, 1992; copyright Sidney Harris.

(On the side: The more realistic picture of connections)



• sometimes called a hierarchy

(On the side: Monkey-Human comparison)



- Number of visual areas (macaque): 30 or more  
 - 30-50% of cortex involved in visual processing

