COGS 101A: Sensation and Perception

Virginia R. de Sa

Department of Cognitive Science

UCSD

Lecture 6:

Beyond V1 - Extrastriate cortex – Chapter 4

Course Information

- Class web page: http://cogsci.ucsd.edu/ desa/101a/index.html
- Professor: Virginia de Sa
  - ⋆ I'm usually in Chemistry Research Building (CRB) 214 (also office in CSB 164)
  - ⋆ Office Hours: Monday 5-6pm
  - ⋆ email: desa at ucsd
  - ⋆ Research: Perception and Learning in Humans and Machines

For your Assistance

TAS:

- Jelena Jovanovic OH: Wed 2-3pm CSB 225
- Katherine DeLong OH: Thurs noon-1pm CSB 131

IAS:

- Jennifer Becker OH: Fri 10-11am CSB 114
- Lydia Wood OH: Mon 12-1pm CSB 114

Course Goals

- To appreciate the difficulty of sensory perception
- To learn about sensory perception at several levels of analysis
- To see similarities across the sensory modalities
- To become more attuned to multi-sensory interactions

Grading Information

- 25% each for 2 midterms
- 32% comprehensive final
- 3% each for 6 lab reports - due at the end of the lab
- Bonus for participating in a psych or cogsci experiment AND writing a paragraph description of the study

You are responsible for knowing the lecture material and the assigned readings. Read the readings before class and ask questions in class.

Academic Dishonesty

The University policy is linked off the course web page.

You will all have to sign a form in section

For this class:

- Labs are done in small groups but writeups must be in your own words
- There is no collaboration on midterms and final exam

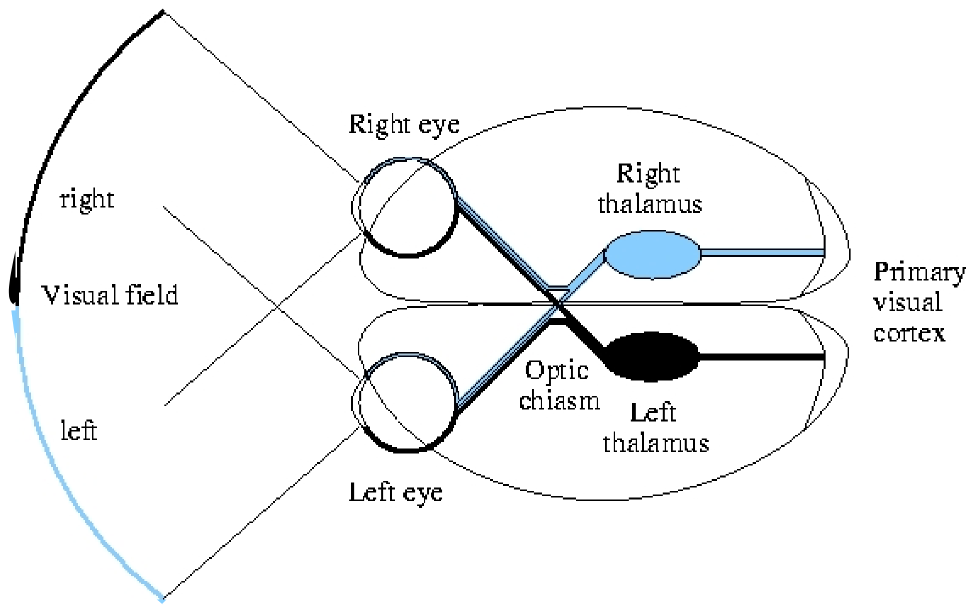
Last Class

What happened after the retina: LGN and V1 processing

This Class

Beyond V1 (extrastriate processing)

Pathway to Cortex



I redid the lines on this figure to be clearer (http://www.cs.utexas.edu/users/jbednar/papers/bednar.thesis/node6.html)

A great set of flash lecture notes

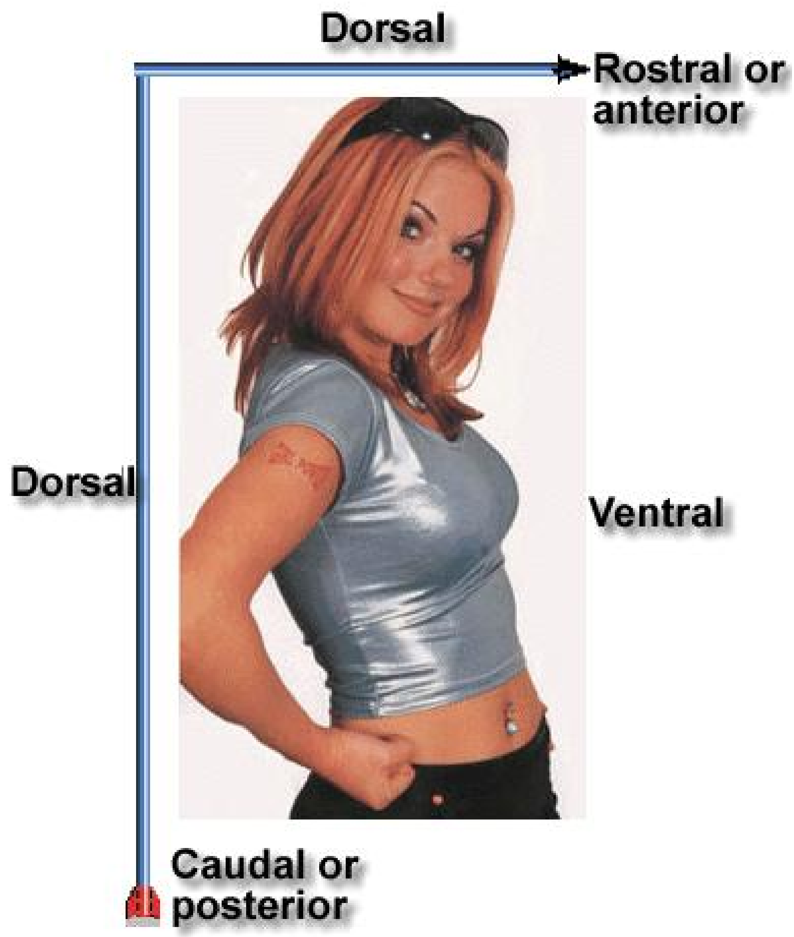
link to notes

http://www.med.uwo.ca/physiology/courses/sensesweb by Tutis Vilis, University of Western Ontario, Canada

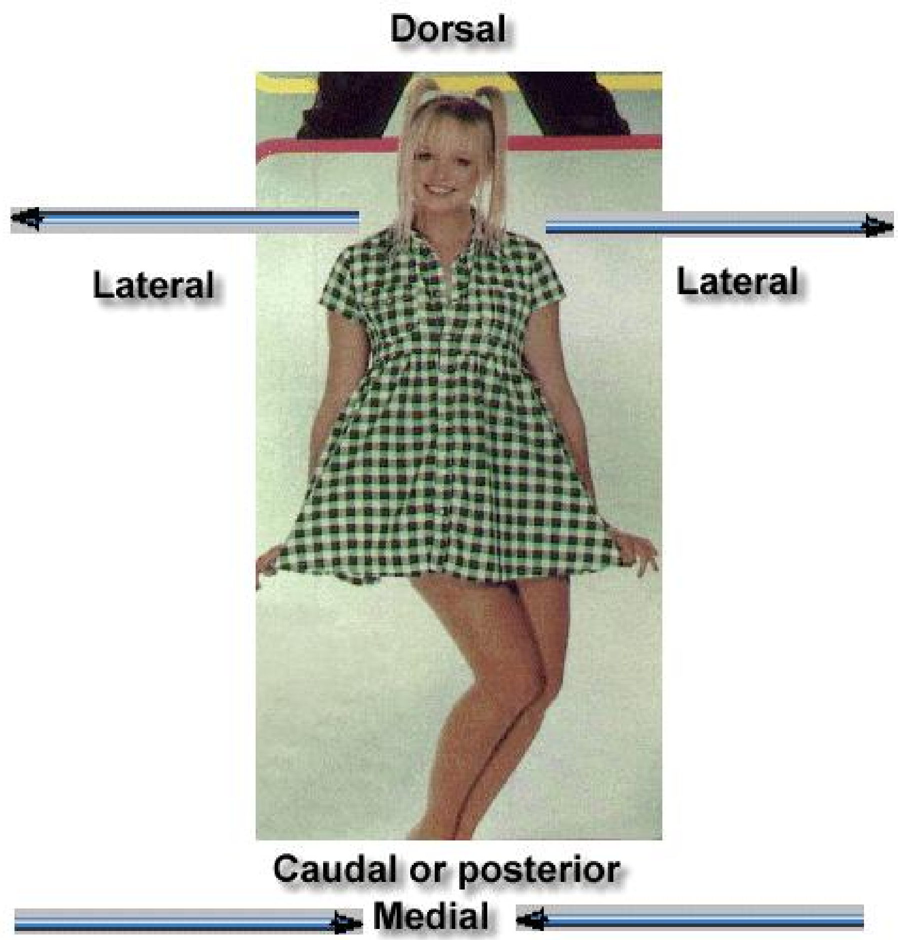
Directional terms

Direction	Description
Ventral	Toward the front (belly) of the body
or towards the bottom of the head Dorsal	Toward the back of the body, or towards
Rostral	Toward the nose
Caudal	Toward the feet (humans) or tail
Lateral	Away from the midline
Medial	Toward the midline
Bilateral	On both sides of the body or head
Ipsilateral	On the same side of the body or head
Contralateral	On the opposite side of the body or head

http://salmon.psy.plym.ac.uk/year1/neurotr.htm



http://salmon.psy.plym.ac.uk/year1/neurotr.htm



http://salmon.psy.plym.ac.uk/year1/neurotr.htm

Magno/parvo review

Magno pathway transmits information about motion and low spatial frequency

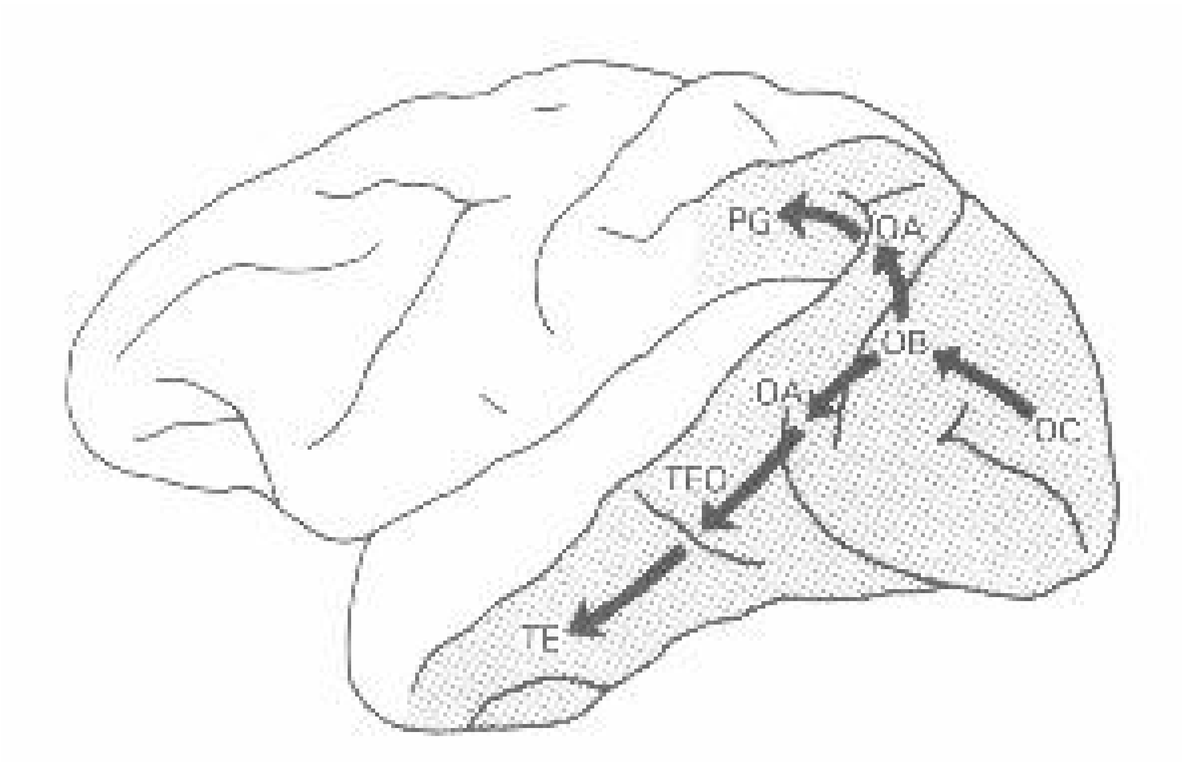
Parvo pathway transmits information about Red-green distinctions in high spatial frequency

Koniocelullar pathway more recently discovered transmits information about blue-yellow

The magno cells form the major input to the dorsal stream (parietal pathway)(where or how pathway). The parvo cells form the major input to the ventral stream (temporal pathway)(what pathway)

But there is significant crosstalk (especially to ventral stream)

Parallel Pathways in Visual Cortex



[Mishkin & Ungerleider 1982]

The what and where pathways

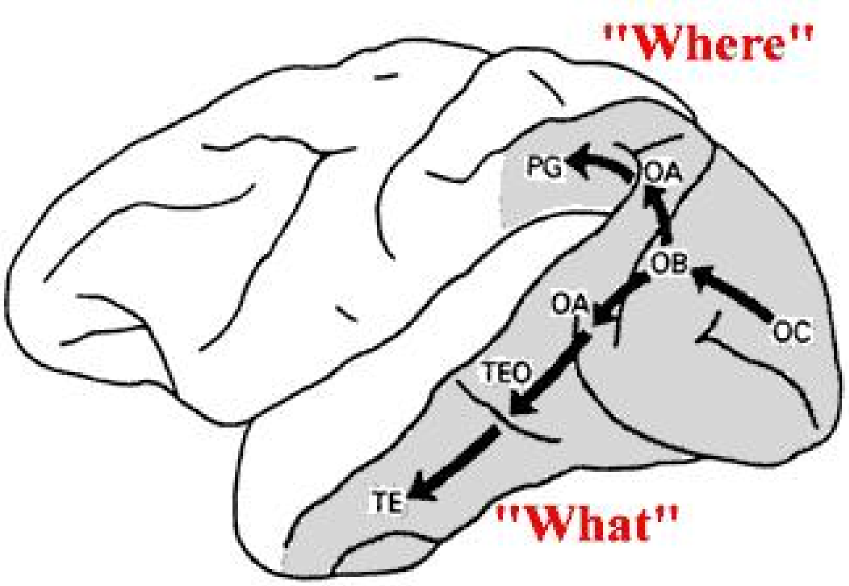
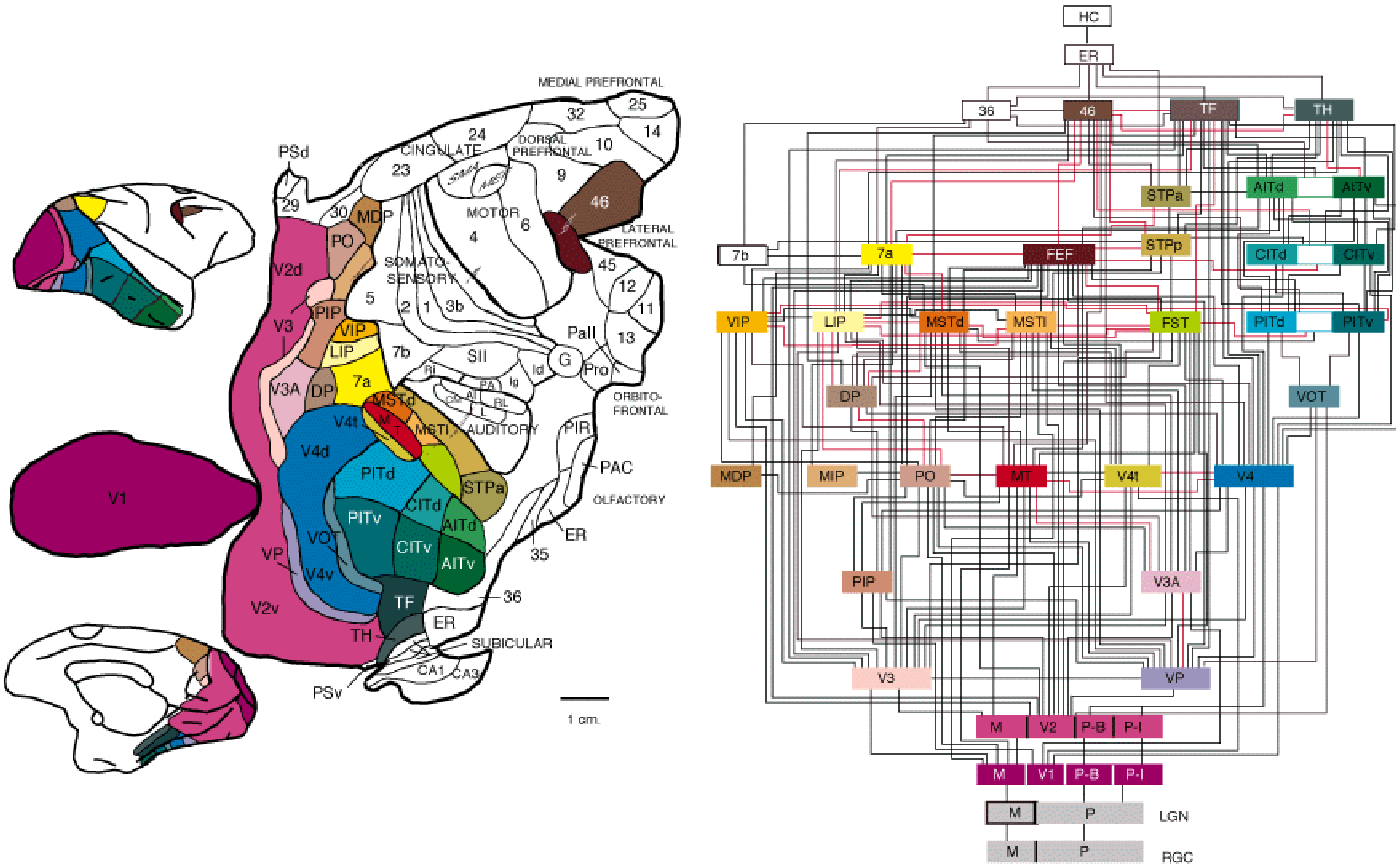


Fig. 1. *Lateral view of the left hemisphere of a rhesus monkey. The shaded area defines the cortical visual tissue in the occipital, temporal and parietal lobes. Arrows schematize two cortical visual pathways, each beginning in primary visual cortex (area OC), diverging within prestriate cortex (areas OB and OA), and then coursing either ventrally into the inferior temporal cortex (areas TEO and TE) or dorsally into the inferior parietal cortex (area PG). Both cortical visual pathways are crucial for higher visual function, the ventral pathway for object vision and the dorsal pathway for spatial vision.*

After V1

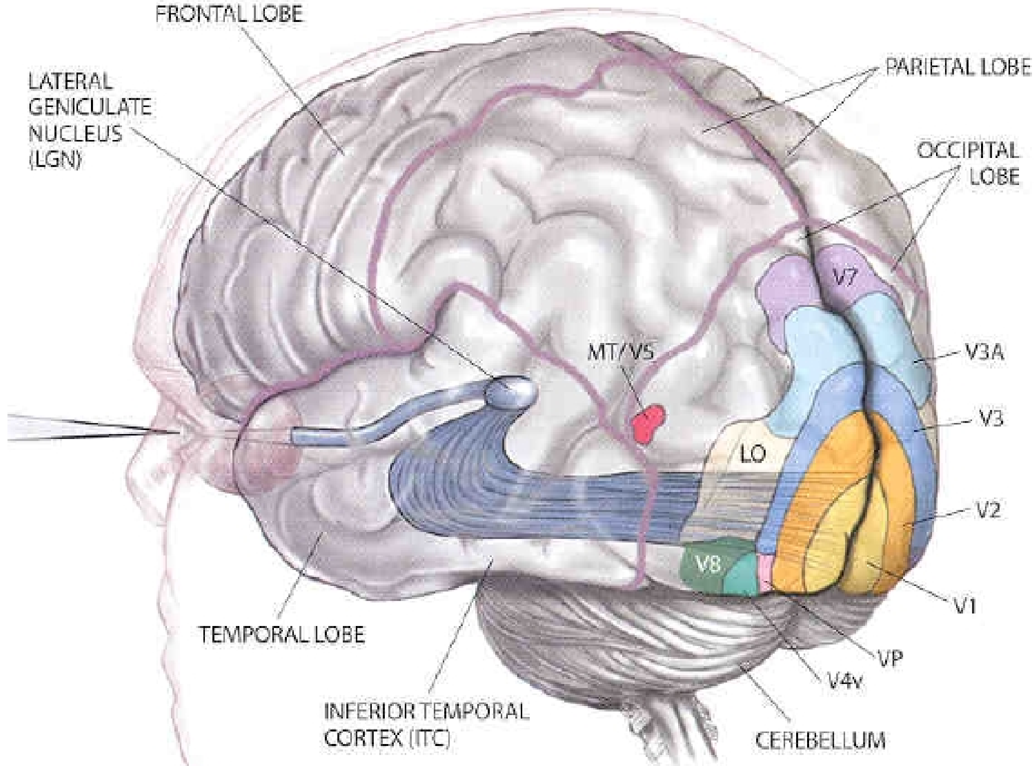
neurons prefered stimuli gets more complex but they have less sensitivity to location

Visual Cortical Areas



from Felleman, D.J. and Van Essen, D.C. (1991) *Cerebral Cortex* 1:1-47.

Visual Cortical Areas – Human



KEY TO FUNCTION

V1: Primary visual cortex; receives all visual input. Begins processing of color, motion and shape. Cells in this area have the smallest receptive fields.

V2, V3 and **VP:** Continue processing; cells of each area have progressively larger receptive fields.

V3A: Biased for perceiving motion.

V4v: Function unknown.

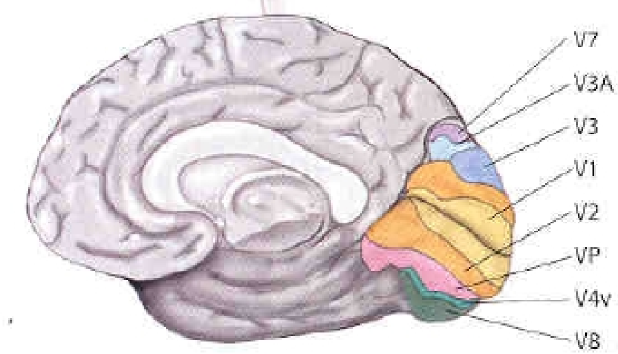
MT/V5: Detects motion.

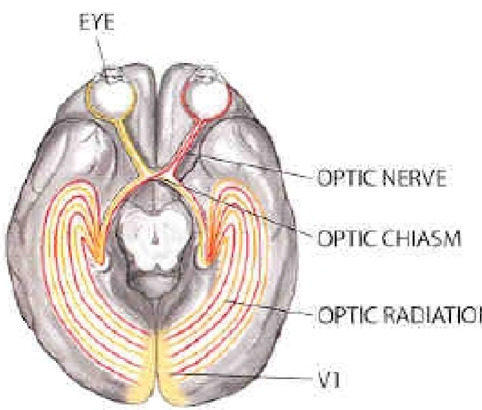
V7: Function unknown.

V8: Processes color vision.

LO: Plays a role in recognizing large-scale objects.

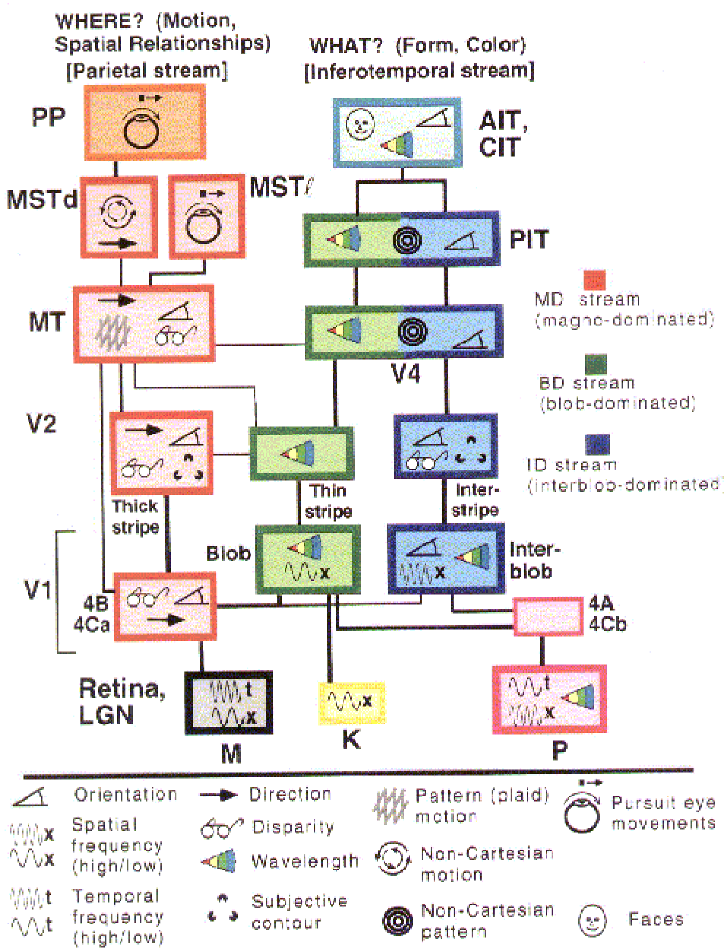
Note: A V6 region has been identified only in monkeys.





Scientific American, November 1999 (Vision: A Window on Consciousness)

Parallel Pathways in Visual Cortex



[Van Essen & Gallant 1994]

The what and where pathways

Called because of results with monkeys that had lesions to the dorsal or ventral pathway.

Lesions to the dorsal pathway in monkeys resulted in failure in the **landmark discrimination task**.

Lesions to the ventral pathway in monkeys resulted in failure in the **object discrimination task**.

The object and landmark discrimination tasks

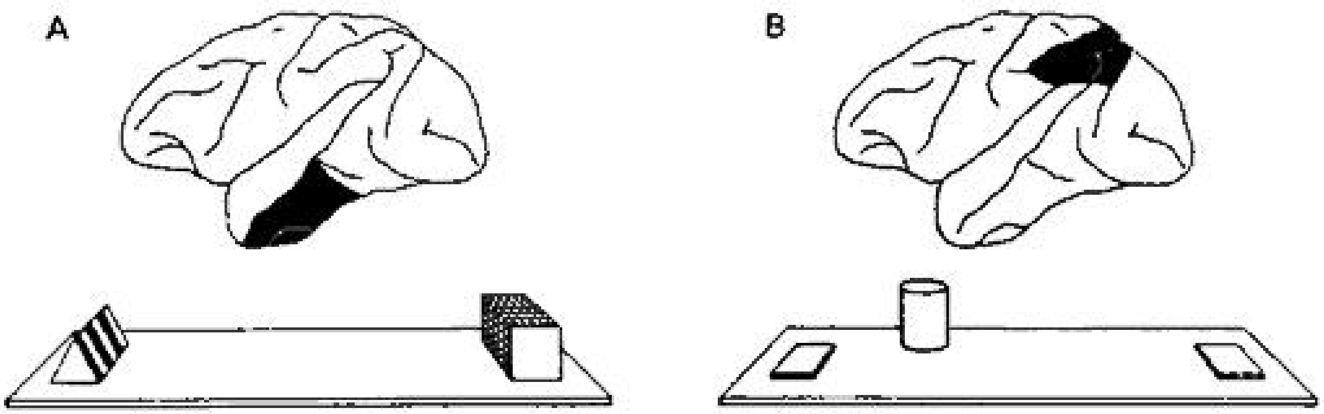


Fig. 2 *Behavioral tasks sensitive to cortical visual lesions in monkeys.* **(A)** *Object discrimination. Bilateral removal of area TE in inferior temporal cortex produces severe impairment on object discrimination. A simple version of such a discrimination is a one-trial object-recognition task based on the principle of non-matching to sample, in which monkeys are first familiarized with one object of a pair in a central location (familiarization trial not shown) and are then rewarded in the choice test for selecting the unfamiliar object.* **(B)** *Landmark discrimination. Bilateral removal of posterior parietal cortex produces severe impairment on landmark discrimination. On this task, monkeys are rewarded for choosing the covered foodwell closer to a tall cylinder, the 'landmark', which is positioned randomly from trial to trial closer to the left cover or closer to the right cover, the two covers being otherwise identical.*

http://www.cis.rit.edu/people/faculty/montag/vandplite/pages/chap_11/ch11p4.html

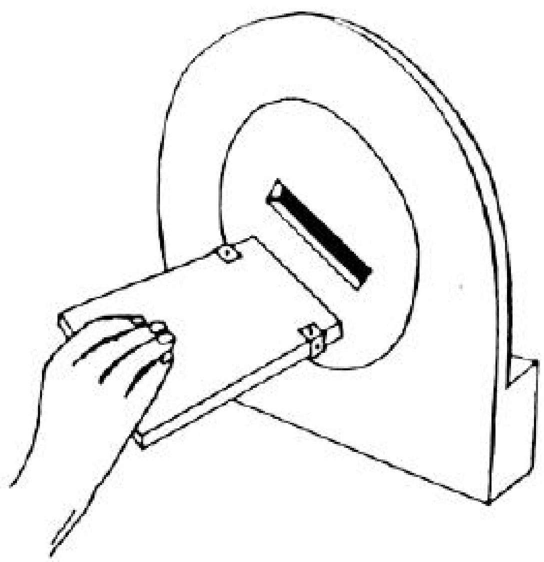
The how pathway

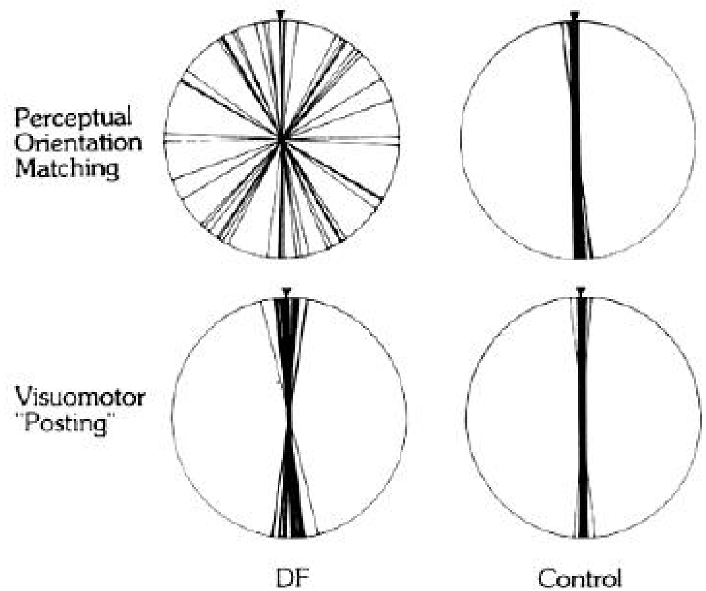
Neuropsychology - study of patients with brain damage

double dissociation - when function A is present but not B in one animal and function B but not A in another

double dissociations are useful for discerning independent mechanisms

Patient D.F - The "how" pathway





Patient D.F is unable to "match orientation" but when posting a letter orients the letter appropriately (even before touching the slot). Her "what" pathway is damaged but her "how" pathway is intact.

Let’s look at some extra striate areas : MT

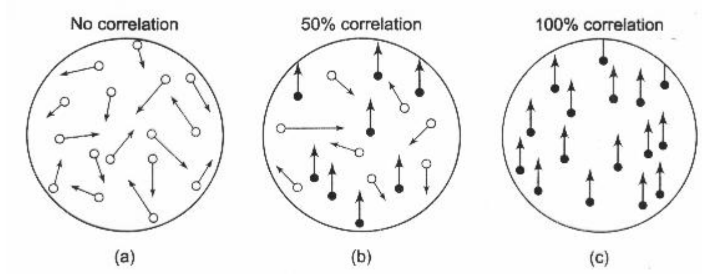
MT (middle temporal) is the “motion” area (more than 90% of the recorded neurons in MT are selective for motion) (for comparison only 5% of neurons in V4 are selective for motion)

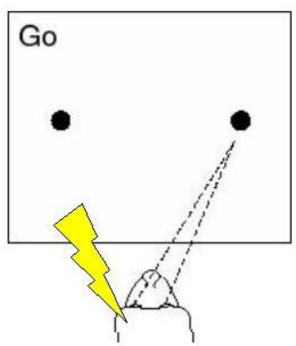
lesioning MT results in worse performance in visual movement direction tasks

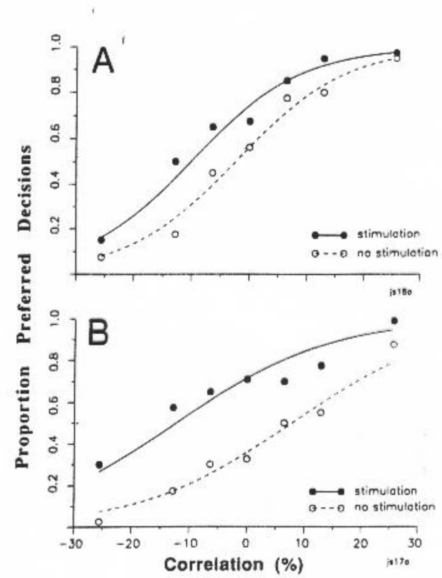
Motion stimuli

Common motion stimuli are the correlated moving dots stimuli see movies

Microstimulation in MT influences monkey's decision in a motion direction task







from Mike Shadlen and http://zeus.rutgers.edu/~ikovacs/SandP/prepI_3_1.html

Neurons near the end of the Temporal pathway respond to very complex stimuli

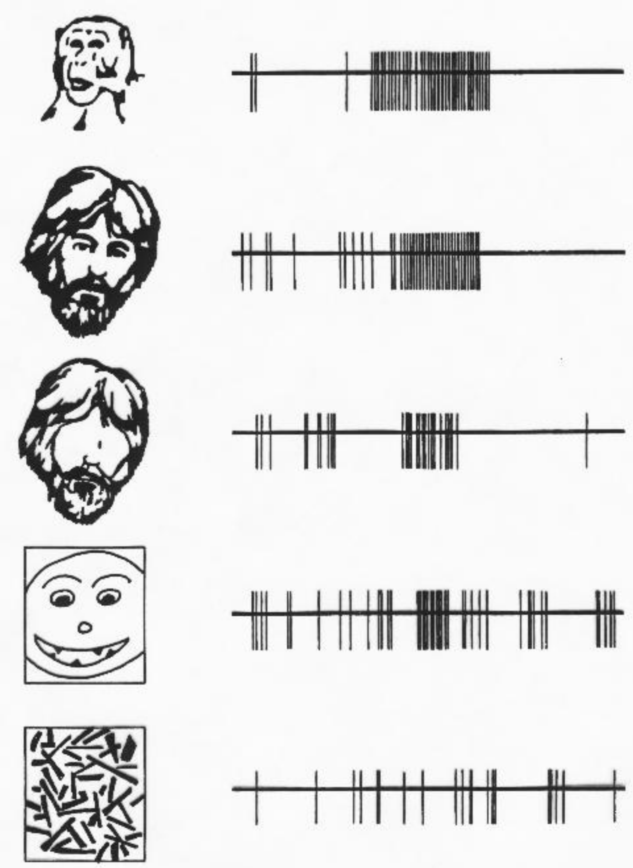


Figure 3.24
Responses of a neuron in a monkey's area IT to various

http://zeus.rutgers.edu/˜ikovacs/SandP/prepI_3_1.html

Inferotemporal (IT) cortex is important for form recognition

"optimal patterns" for IT neurons (from Keiji Tanaka) are quite complex but require little spatial precision (compare with V1 neurons)

There are many "face cells"

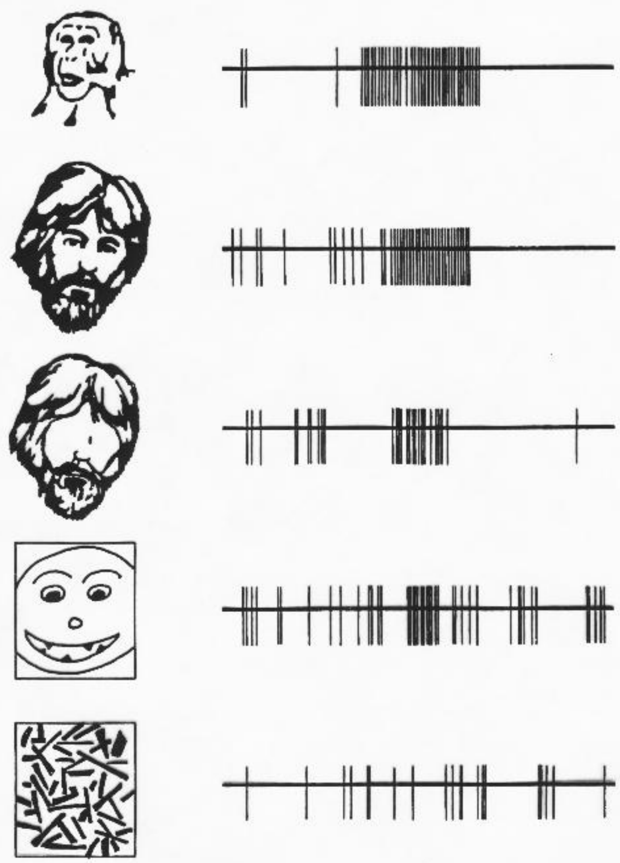


Figure 3.24
Responses of a neuron in a monkey's area IT to various

Thesse neurons respond selectively to faces

`http://zeus.rutgers.edu/~ikovacs/SandP/prepI_3_1.html`

There is also a columnar structure in Inferotemporal (IT) cortex

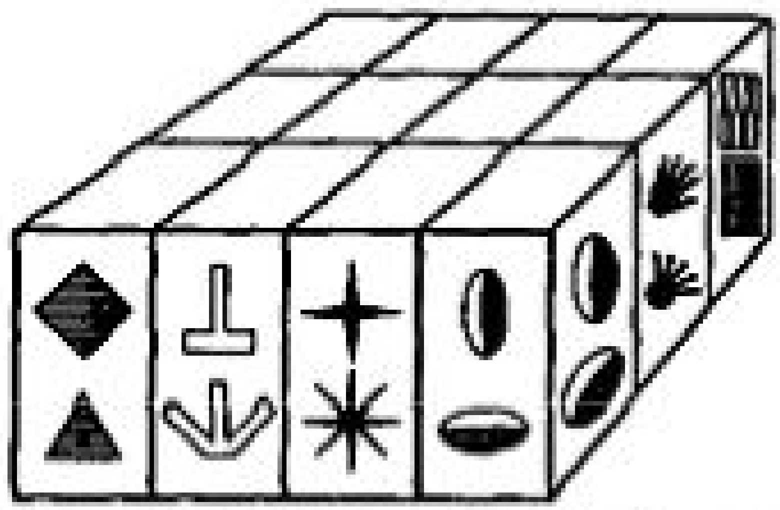
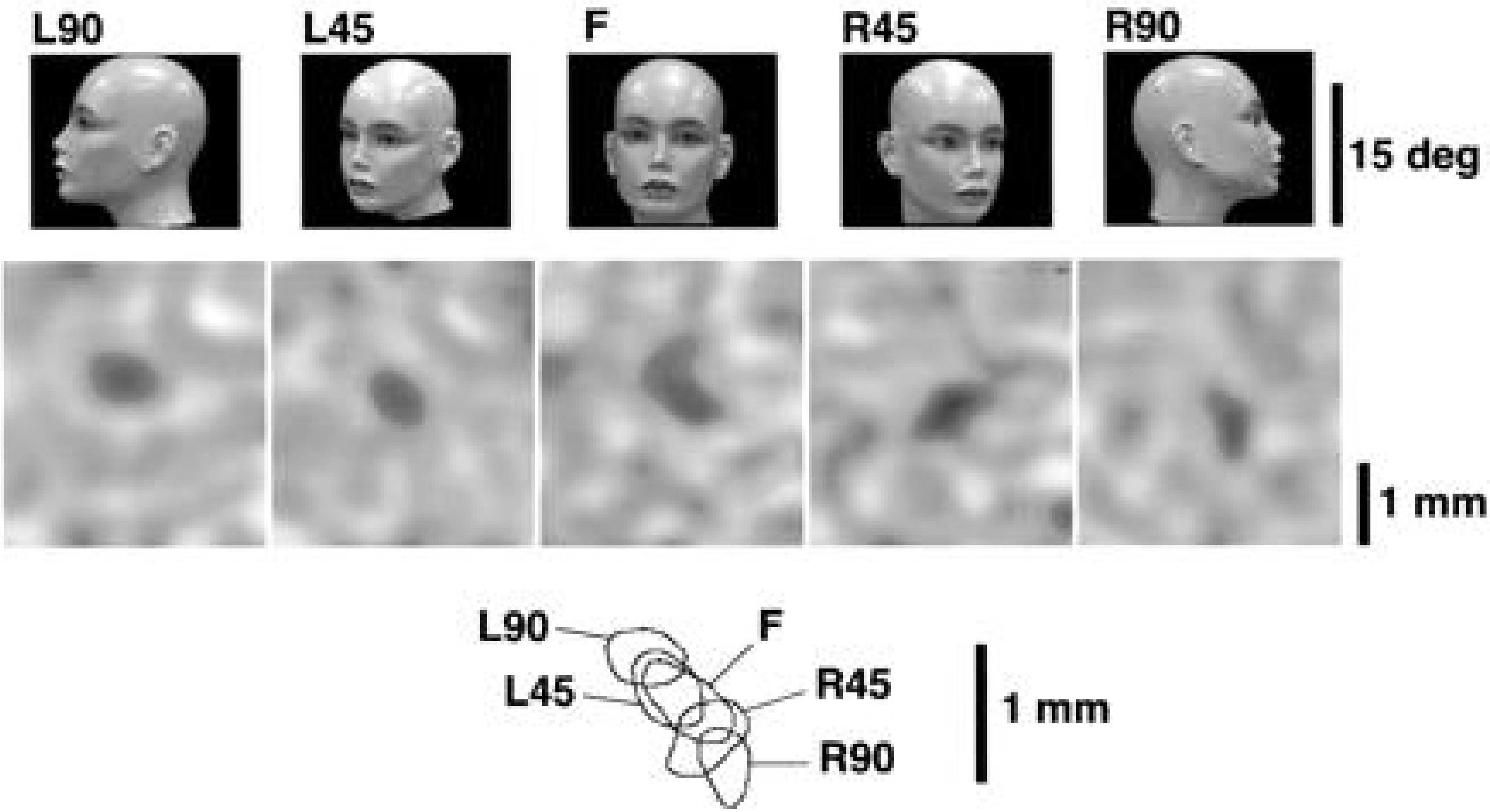


Fig. 3. Schematic diagram of the columnar organization in TE. Cells with similar but slightly different selectivity cluster in elongated vertical columns, perpendicular to the cortical surface.

[Tanaka 1993]

There is also evidence that nearby columns have somewhat similar preference

Horizontal rotations are mapped to nearby columns



[Tanaka 2003]

The human face area

In humans the fusiform face area (FFA) has been shown to respond selectively to faces

People with damage in the temporal pathway have **prosopagnosia** - inability to recognize familiar faces

The FFA has also been shown to respond selectively to within category classifications by experts in an area (e.g. bird experts, car experts). It may be more of a "fine discrimination" or "expertise" area. This is hotly debated.

Distributed Coding

distributed coding - represent specific stimuli by a pattern of firing across many neurons

as opposed to **grandmother cell representation** (book uses specificity coding) - one neuron fires for your grandmother (and nothing else)

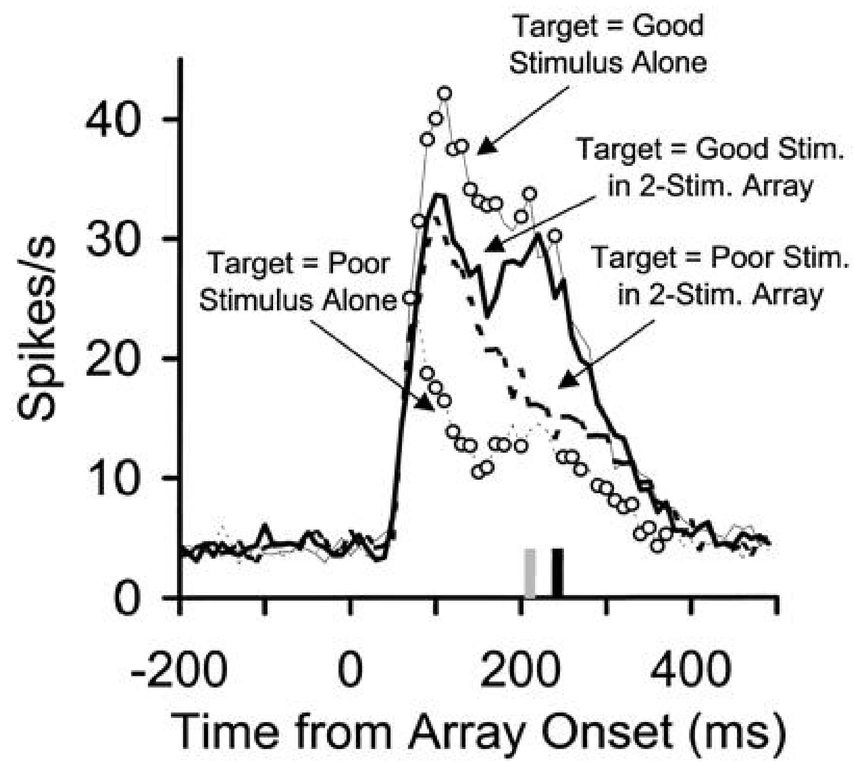
example on board

Attention

In higher areas (further removed from the retina), **attention** plays a large role in how the neurons respond (and perception).

We must pay attention to things in order to see them

Evidence for attention modulated responses in V4 (along the temporal pathway



Response varies depending on whether the "good" stimulus or the "bad" stimulus is attended

Inattentional Blindness

If you have subjects doing one task but throw in another signal irrelevant to the task and later ask them what they saw, they may not remember the task irrelevant signal.

Inattention blindness demos

Change Blindness

change blindness - inability to detect (unattended) changes in changing environments

Great change blindness demos

Interactive change blindness demos

Attentional Blink

Attentional blink demos

attentional blink: There is a time period (about half a second) after detecting one target when you are less likely to remember the 2nd

Next Class

MIDTERM 1 (worth 25%)

short answer, fill in the blanks, explain this, match this