Intermediate Visual Processing

MEDS 470 / NRSC 500B

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Admin

Assessment - make decisions early if possible, run ideas by me.

Today

1. How internal models of geometry help determine shape (pgs 604-607).
2. The role of depth perception in visual processing (pg 608).
3. The role of movement cues in object perception (pgs 608-611).
4. How context impacts perception (pgs 611-615).
5. The regions involves in intermediate processing, their inputs, and projections (Figure 27-2).

Overview

- Visual Primitives
  - Internal models of geometry
  - Depth in visual processing
    - The eye and ocular dominance
  - Role of movement cues
  - Context in vision
- Vision is learned

Introduction

- What constitutes intermediate visual processing?
  - Intermediate visual processing is the junction where bottom-up input, and top-down expectations meet in order for us to properly organize and interpret our visual surroundings
  - Known as Visual primitives

Visual primitives:
Building on V1

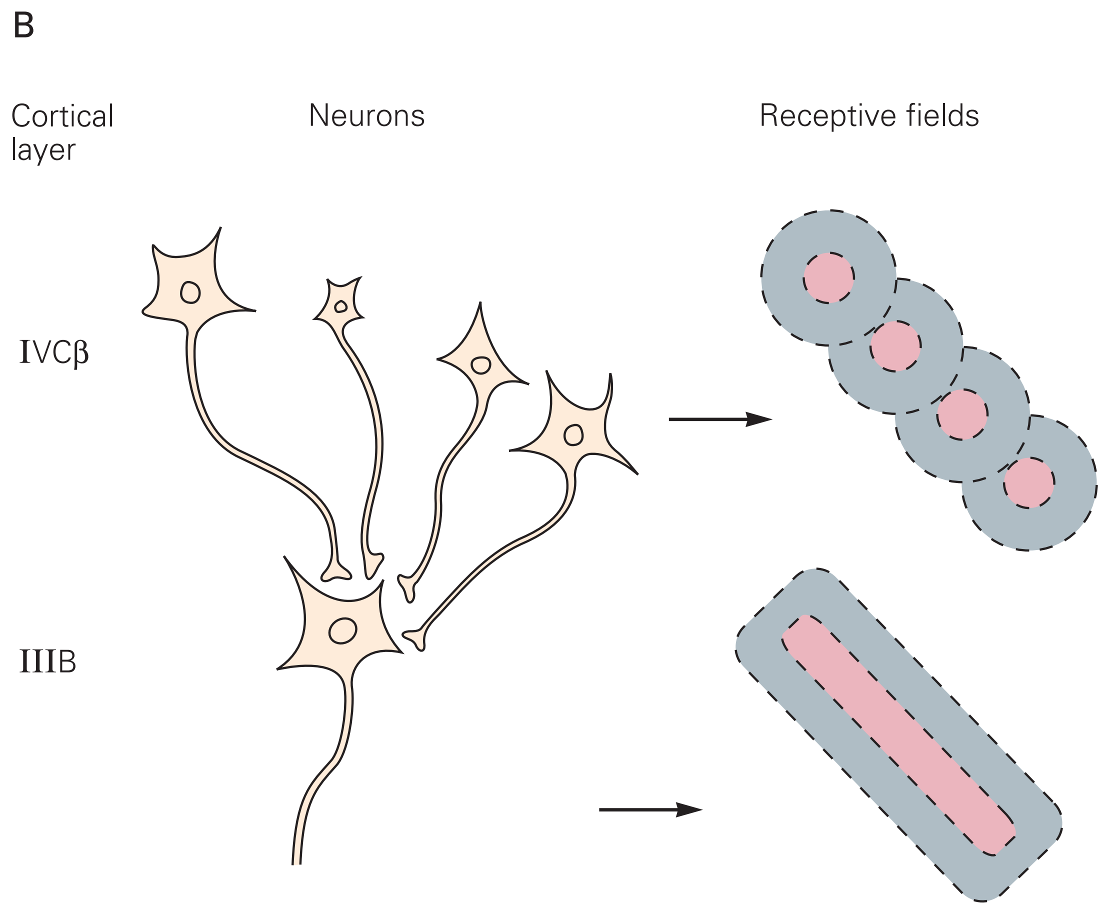
- Line orientation = object contours
- Local contrast = surface lightness
- Wavelength selectivity = colour constancy and surface segmentation
- Directional selectivity = object motion

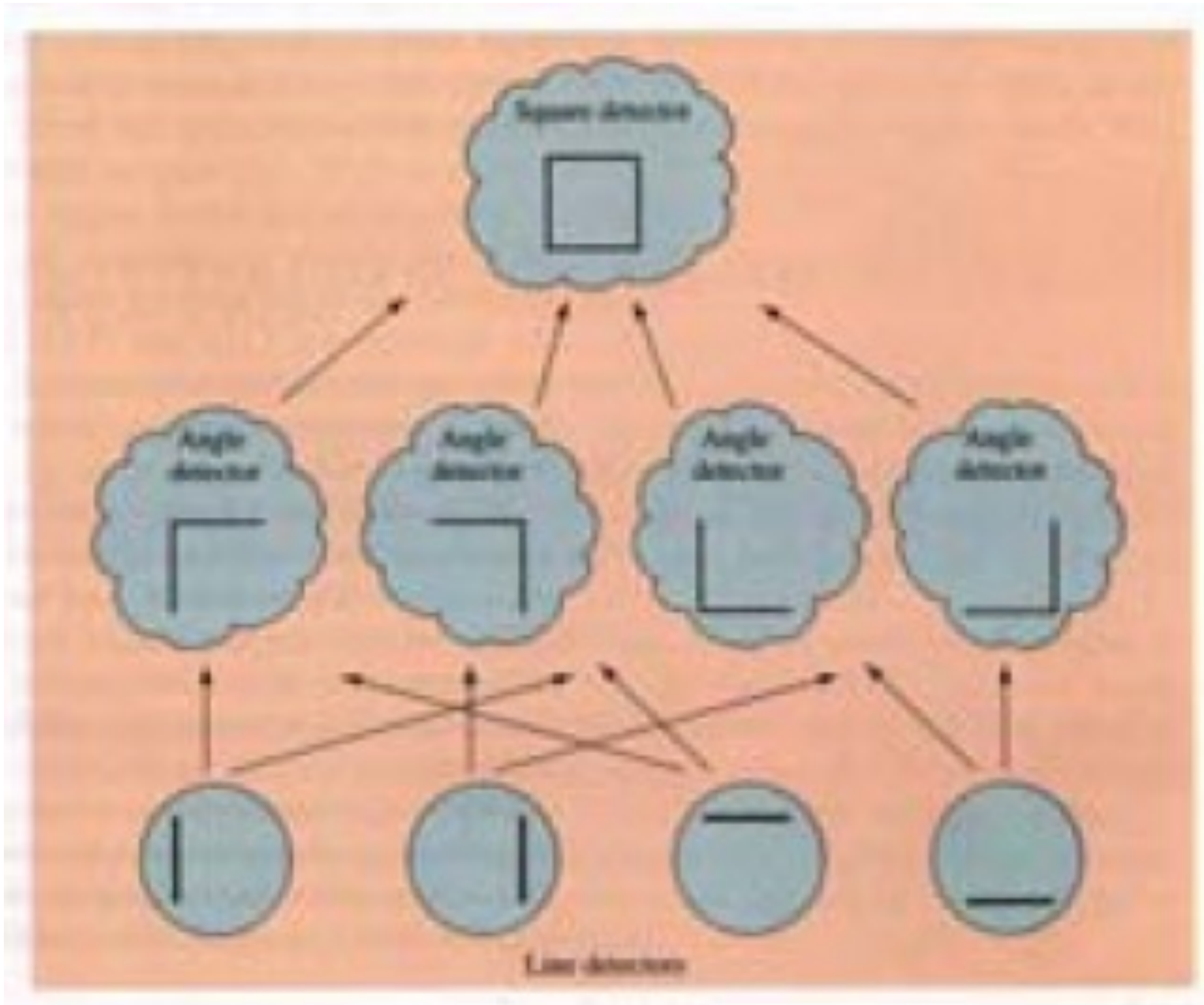
1. How internal models of geometry help determine shape (pgs 604-607).

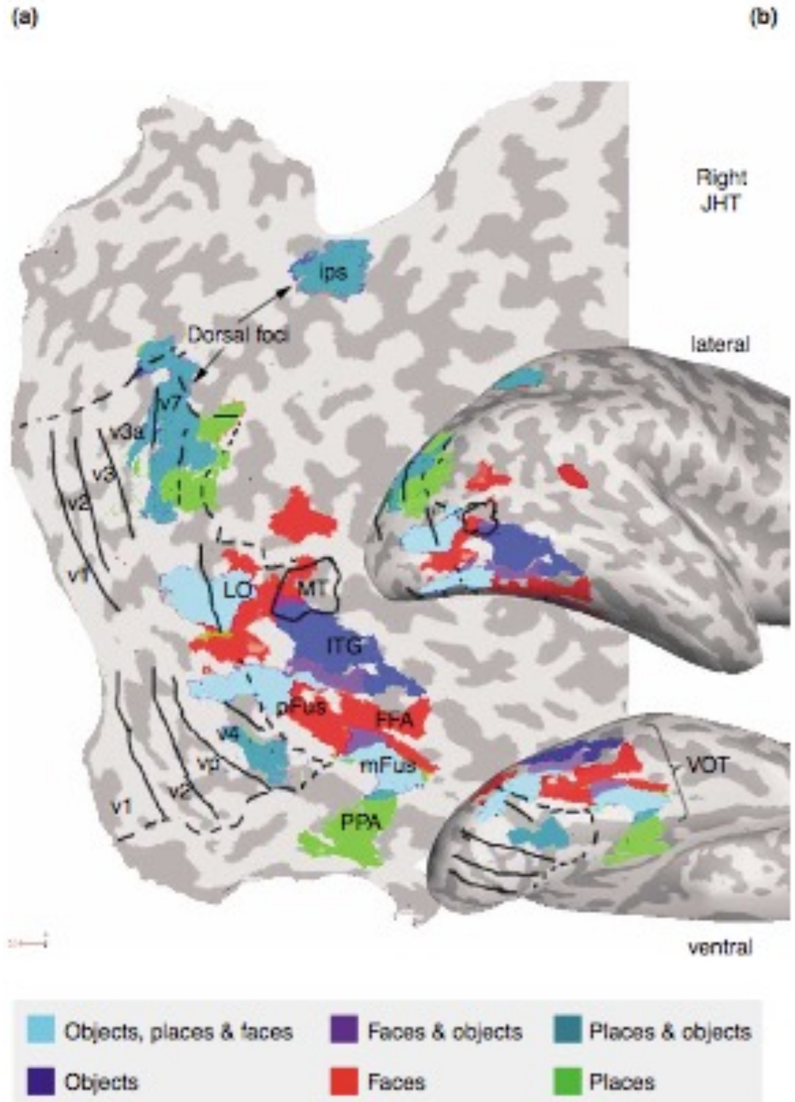
Internal models of geometry

Begins in V1 with line orientation

- Interplay of on/off center surround organization
- Neuronal selectivity for
  - Orientation (see orientation tuning)
  - Binocular disparity and depth
  - Direction

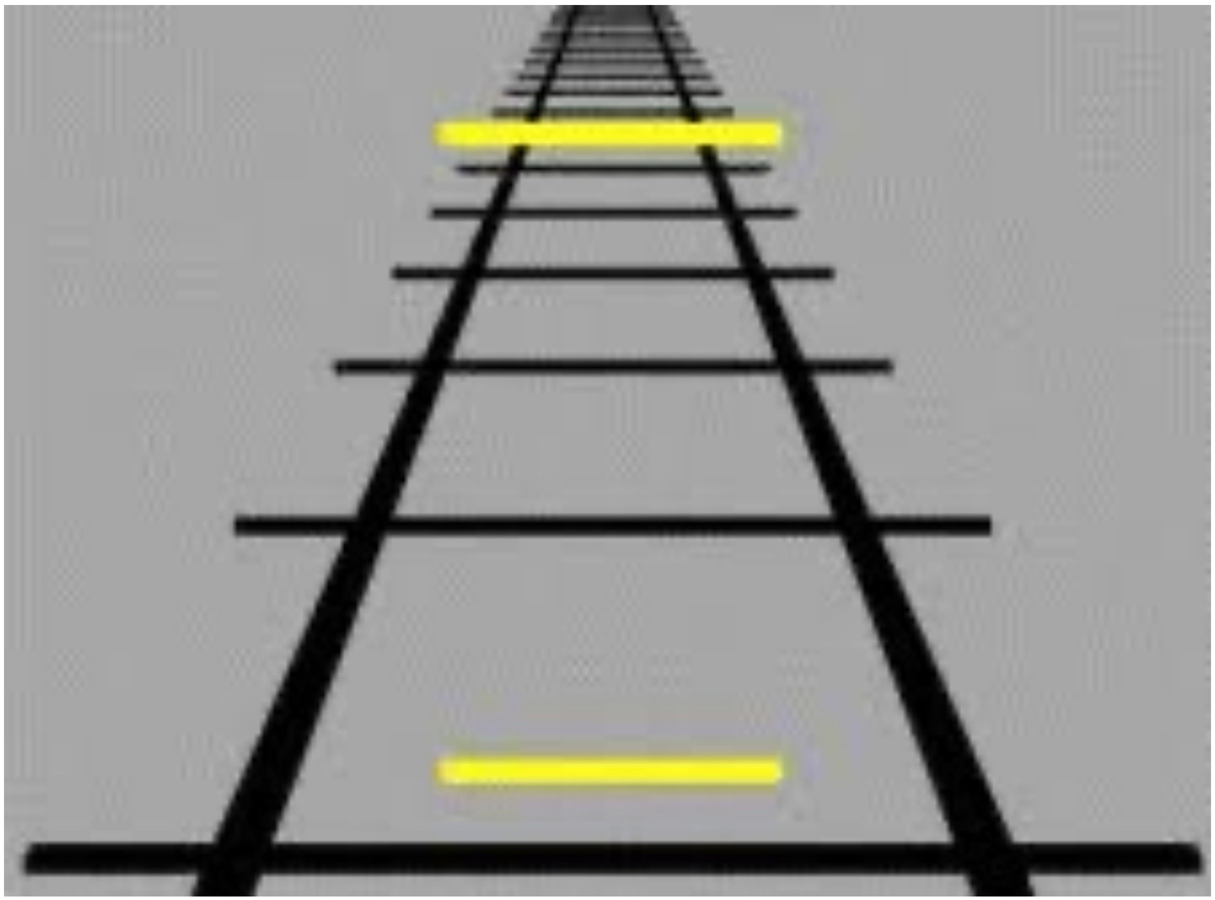

B
Cortical layer
Neurons
Receptive fields
IVCβ
IIIB





(a)
(b)
Right
JHT
lateral
ventral
ips
Dorsal foci
v7
v3a
v3
v2
v1
LO
MT
ITG
pFus
FFA
v4
vp
mFus
v2
v1
PPA
VOT
Objects, places & faces
Faces & objects
Places & objects
Objects
Faces
Places

2. The role of depth perception in visual processing (pg 608).



Parallax Displacement:

3. The role of movement cues in object perception (pgs 608-611).

Role of movement cues in object perception

Movement cue: the process in which movement direction is determined

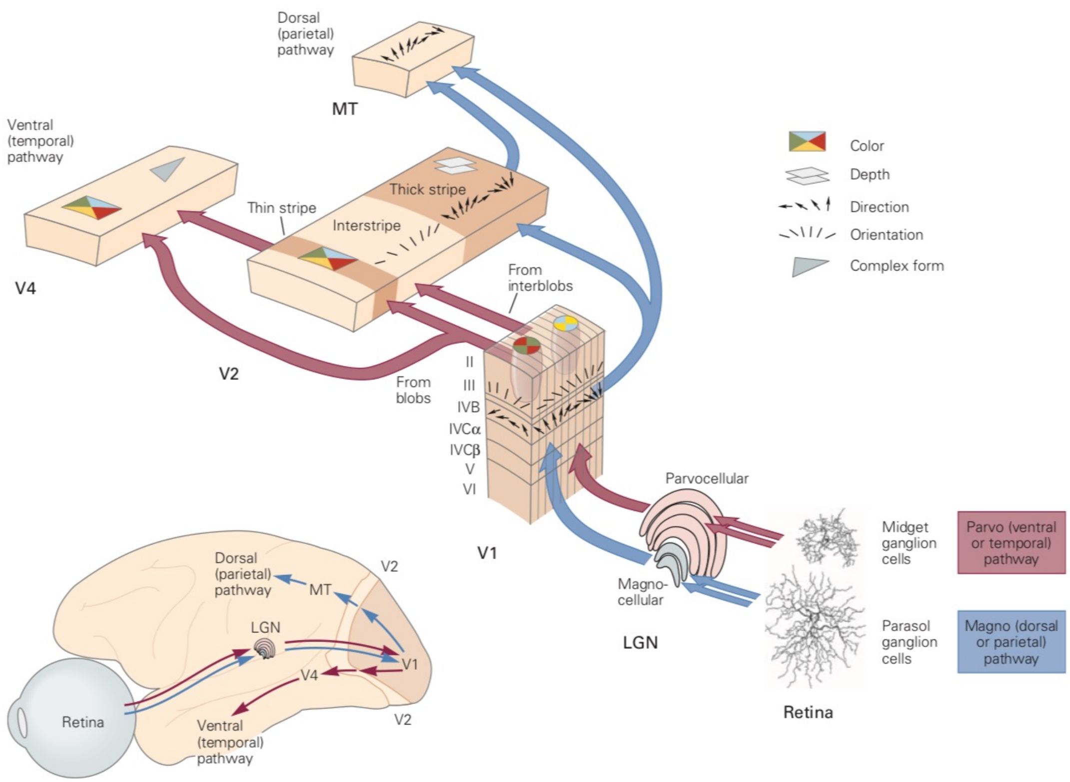
Problem in early visual coding:
In V1 and V2 receptive fields are still relatively small, so how does this information summate to accurately depict motion? We cannot detect true motion if the ends of an object are not visible

Assumption: the movement of a contour is perpendicular to its orientation. How does the mind decide if this is true or not?

Role of movement cues in object perception: Bottom-up and top-down processing

Bottom-up:
Information from the retina arrives as a jumbled mess!
Relevant info is at it's most basic
- Countless small pieces
  - Different orientation boundaries
  - Moving at different velocities

Top-Down:
Scene segmentation: the separating of movement in the background from the foreground (POF mechanism)
- We see predominantly in global terms, rather than simple attributes



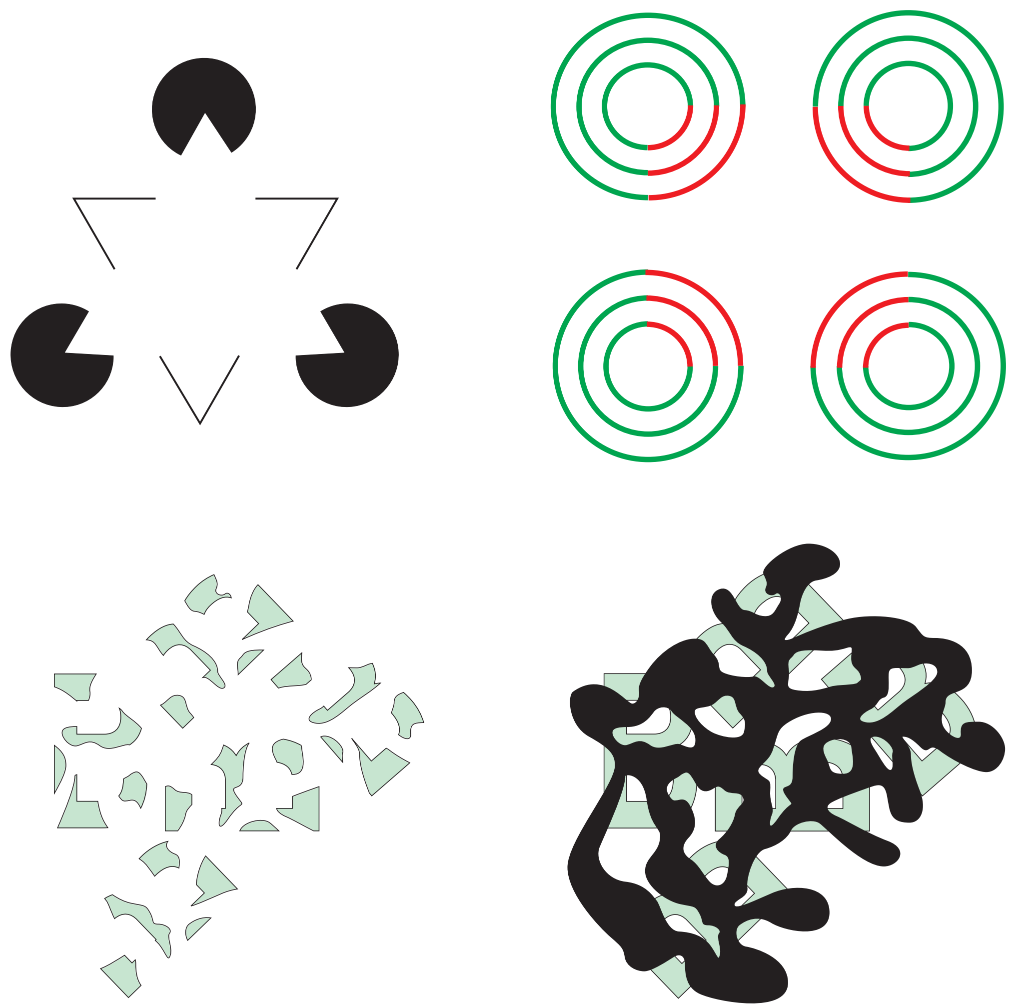
The Middle temporal Cortex (MT area)

Where the magic of motion occurs

- The summation of direction movement from the smaller subunits of information in V1 are passed along here
- Certain neurons detect a larger overall pattern of movement

4. How context impacts perception (pgs 611-615).

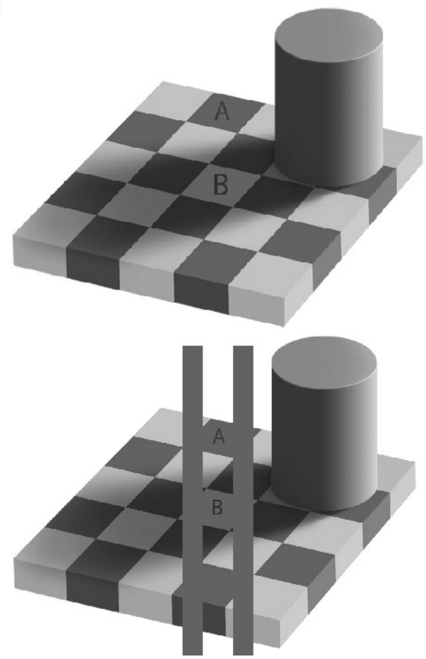
Context modulation: allowing the perception of an object in a complex scene



Context matters

Our environment and our past experiences influence our vision as much as the real-world light signals that hit our retina.

What we expect to see, is what we perceive.



Visual Primitives expanded:

Context matters: colour and brightness

- Neurological mechanism: at early visual levels, most neurons respond to surface boundaries, with the minority focusing on the interior of a surface.
  - Perceptual fill in: a calculation that determines the brightness of a surface occurs based off the information about the contrast at the edge of the view
    - Example: a red shirt appears as the same red in bright or dim light
- Why? It is better to determine an objects surface features rather than the reflected light, which is always changing based on level of light, location, saccades, etc….
- Some neurons in V4 have shown to respond to different illumination wavelengths as long as the perceived colour remains constant

Visual Primitives expanded:

Context matters: receptive fields

- A response even to low-level features of an object are dependent on the global contect within which the feature is embedded.

  Example: You can think of it like a sentence containing the word Bark.

  “Look at the *bark* on that tree!”

  “Why does the dog have to *bark* so loud?”

  In each of these cases the word is the same, but its meaning and interpretation is different. The brain applies similar mechanisms to objects in relation to their visual field.

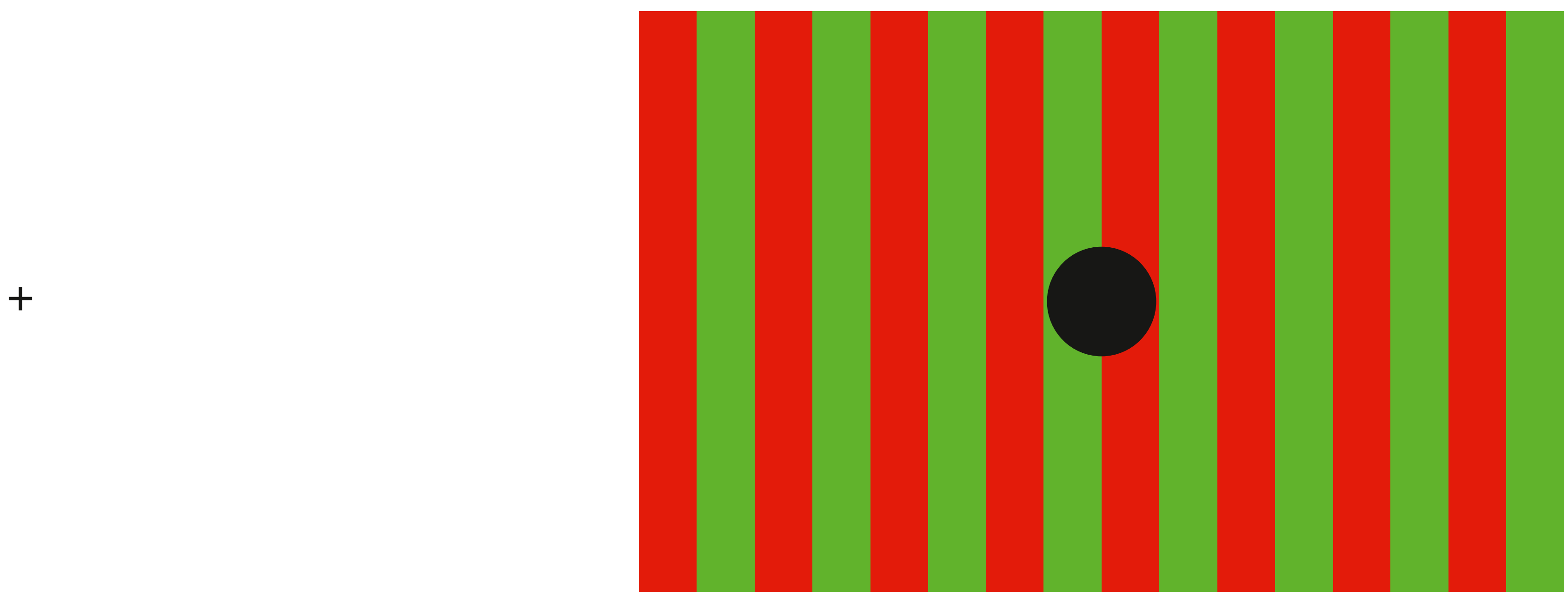
  A visual example can be seen in the first image of my slides: where you can make out the shape of two triangles in a negative space based on the information presented in the environment.

Vision is learned

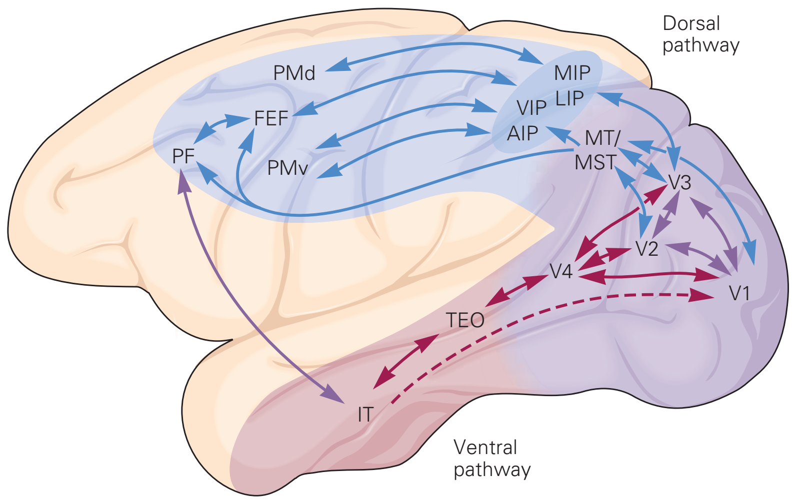
Intermediate level processing requires a pre-existing representation of the laws that govern our world.

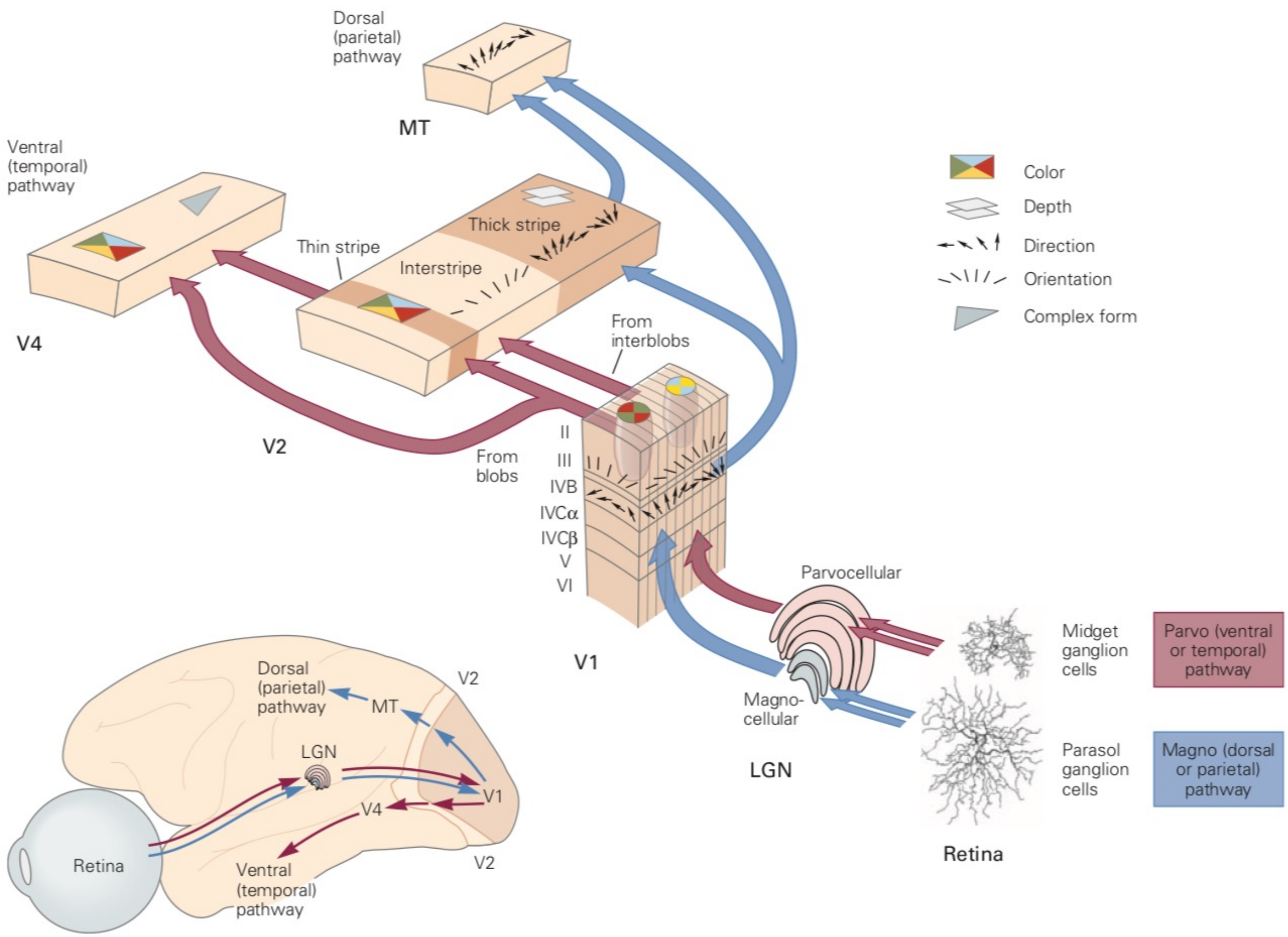
This is reflected by the interplay in the feed-back mechanisms from higher level visual processing and more anterior cortical regions.

Examples:
- Rule of good continuation
- Context modulation
- Global disparity cues
- Perceptual fill in



5. The regions involves in intermediate processing, their inputs, and projections (Figure 27-2).





Dorsal (parietal) pathway
MT
Ventral (temporal) pathway
V4
Thin stripe
Thick stripe
Interstripe
V2
From interblobs
From blobs
II
III
IVB
IVCα
IVCβ
V
VI
V1
Parvocellular
Magno-cellular
LGN
Midget ganglion cells
Parasol ganglion cells
Retina
Parvo (ventral or temporal) pathway
Magno (dorsal or parietal) pathway
Color
Depth
Direction
Orientation
Complex form
Dorsal (parietal) pathway
MT
V2
LGN
V1
V4
Retina
Ventral (temporal) pathway
V2

Selectivity for low-level features of objects in the human ventral stream

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A B S T R A C T

Category selective regions in the ventral visual stream are considered to support higher-level representations of objects. The aim of this study was to determine the extent to which category selectivity in face and place regions can be explained by selectivity for low-level features of these complex objects. First, we compared the relative responses to intact and Fourier-scrambled images of faces and places. Next, we compared the magnitude of fMR adaptation to both intact and scrambled faces and places. The results revealed that global differences in the amplitude spectrum of face and place images can explain a small proportion of the category selectivity that is found in regions such as the fusiform face area (FFA) and parahippocampal place area (PPA). However, a whole-brain analysis revealed selectivity to scrambled images in more posterior regions of the ventral stream. Consistent with the pattern evident for intact images, more lateral regions responded selectively to scrambled faces, whereas more medial regions responded more strongly to scrambled places. These findings suggest that selectivity for object categories emerges from the differential processing of low-level features that are typical of different object categories in early visual areas.