The Art and Science of Depiction

Introduction to Visual Perception

Fredo Durand and Julie Dorsey

MIT- Lab for Computer Science

Vision is not straightforward

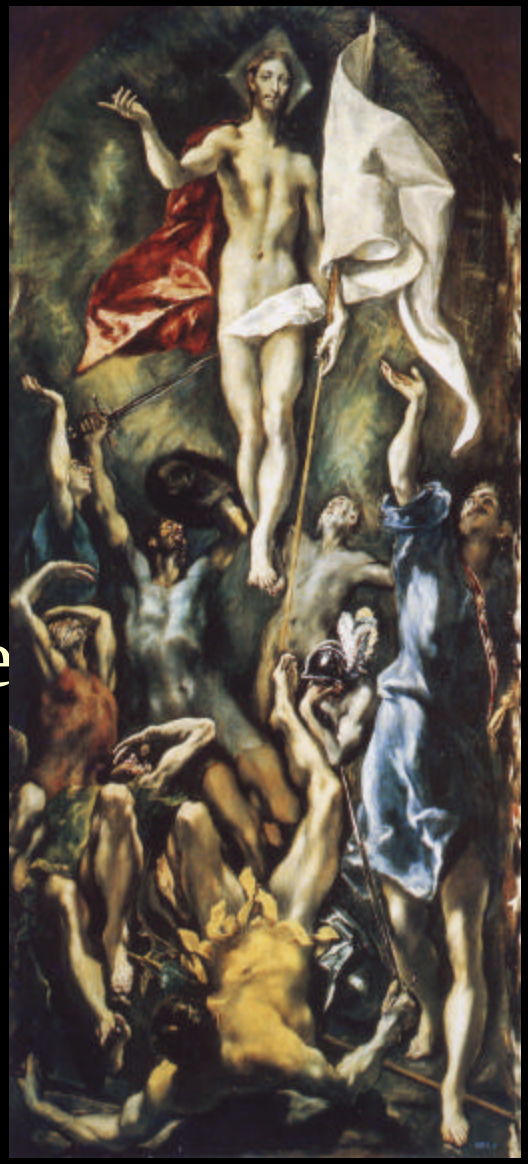
- The complexity of the problem was completely overlooked because
  - The problem is so difficult
  - The human visual system is so efficient

Vision and pictures

- Explain
- Inspire
- Malfunction & art
- Technical simplification
  - Cinema, Color, JPG
- Pictures can challenge or simplify perception
- Emphasize or eliminate cues or channels
  - Time, color

Beware of the El-Greco Fallacy

- El-Greco, elongated characters
- Were supposed due to astigmatism
- However, pictures and real people would have been stretched equally
- Almost as fallacious as assuming painting should be inverted because our eyes invert what we see



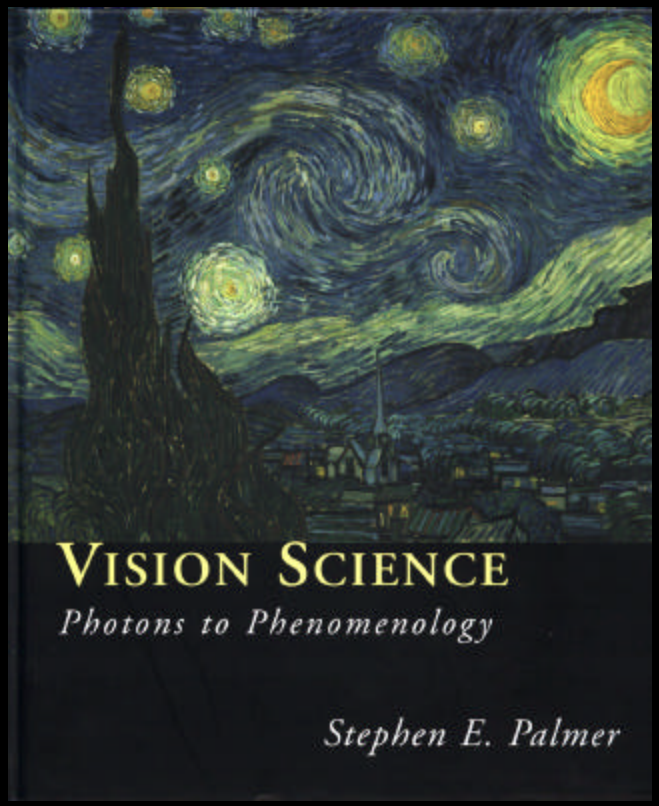
However…

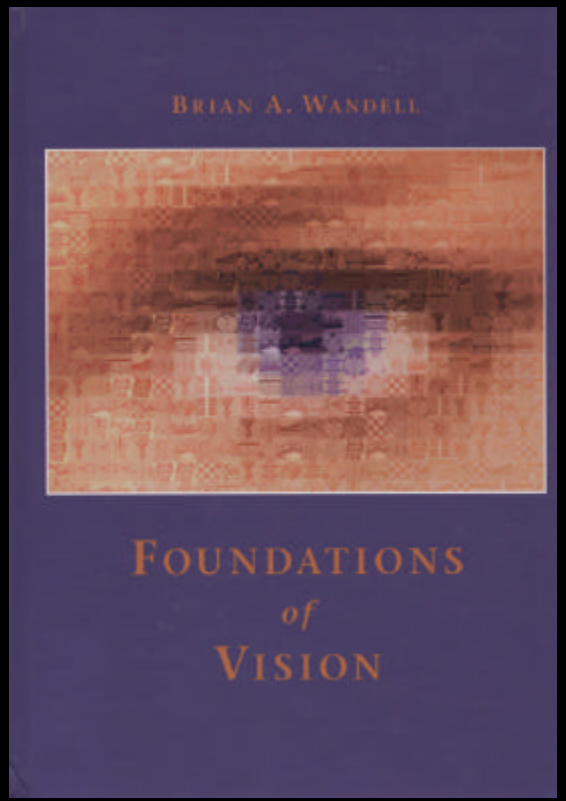
- Monet had a cataract operation
- Cataract makes vision blurry and yellowish

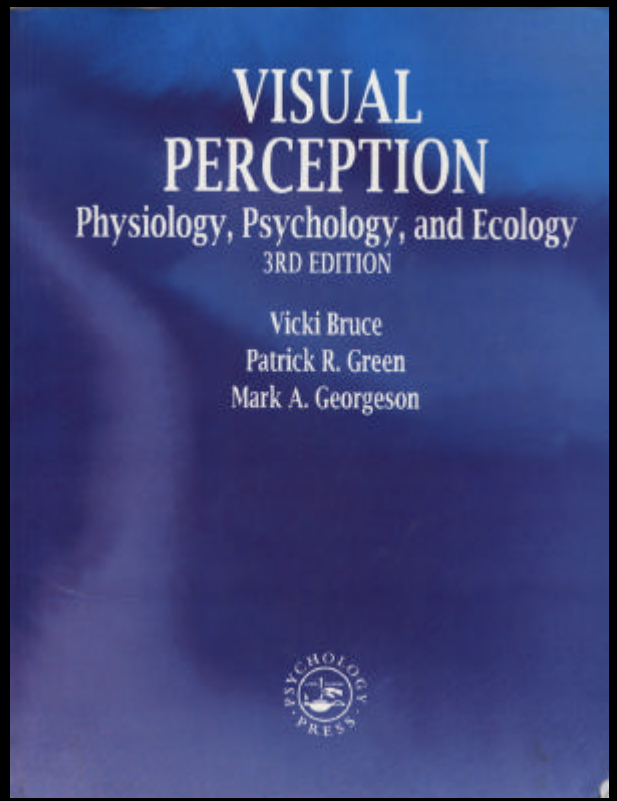
Before operation

After operation

Textbooks


VISION SCIENCE
Photons to Phenomenology
Stephen E. Palmer


BRIAN A. WANDELL
FOUNDATIONS
of
VISION


VISUAL
PERCEPTION
Physiology, Psychology, and Ecology
3RD EDITION
Vicki Bruce
Patrick R. Green
Mark A. Georgeson
PSYCHOLOGY PRESS

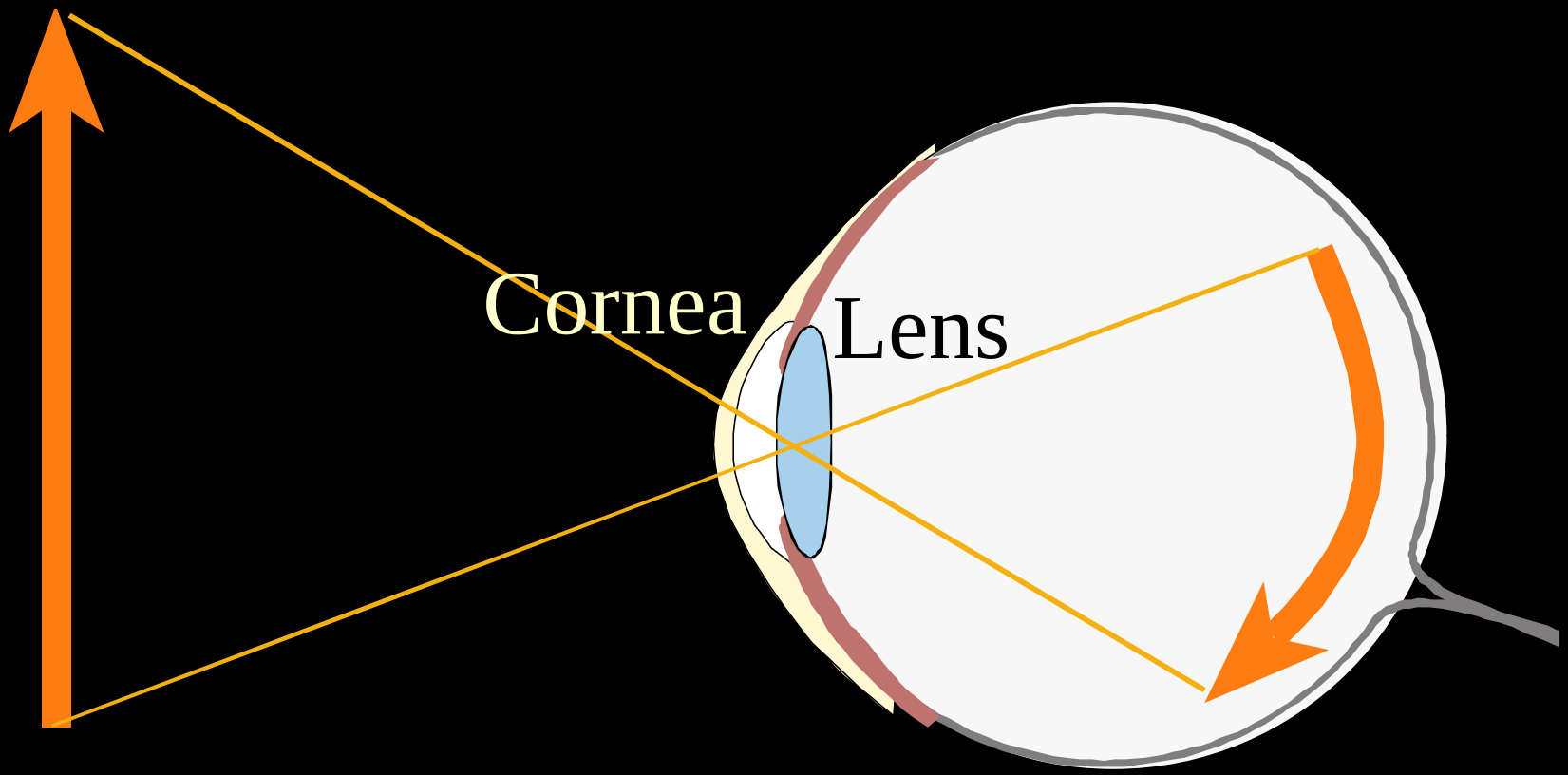
Plan

- Eye
- Low-level processing
- Different pathways

- Organization
- High-level
- Focus, attention
- Color

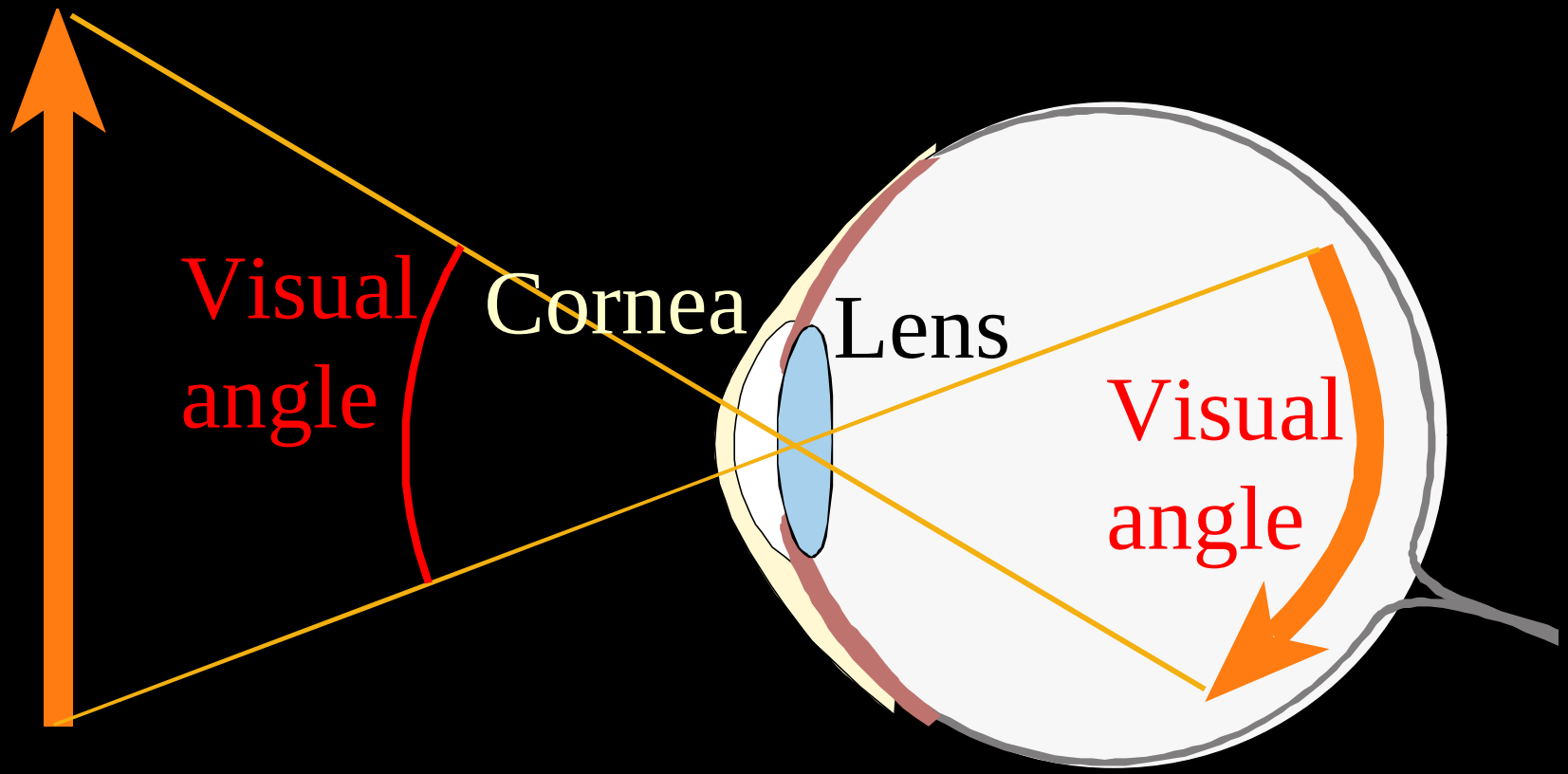
Eye: optics

- Image is inverted (mainly by cornea)
- Lens makes the focus



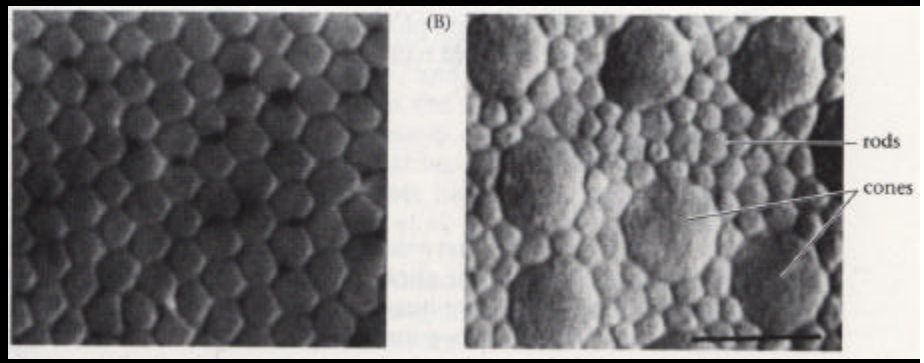
Eye: visual angle

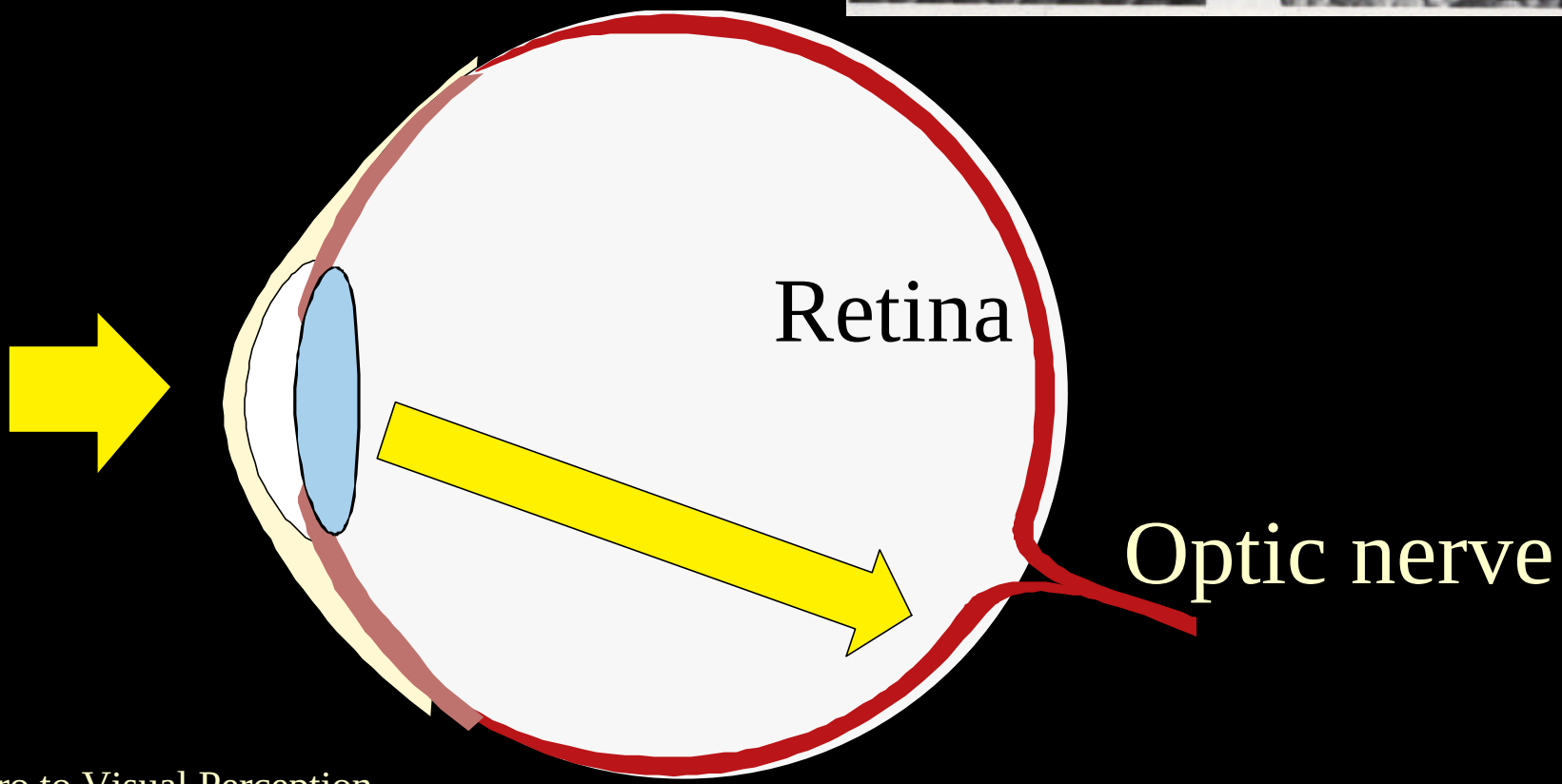
- Corresponds to size of the projection on retina
- Depends on real size and distance



Retina

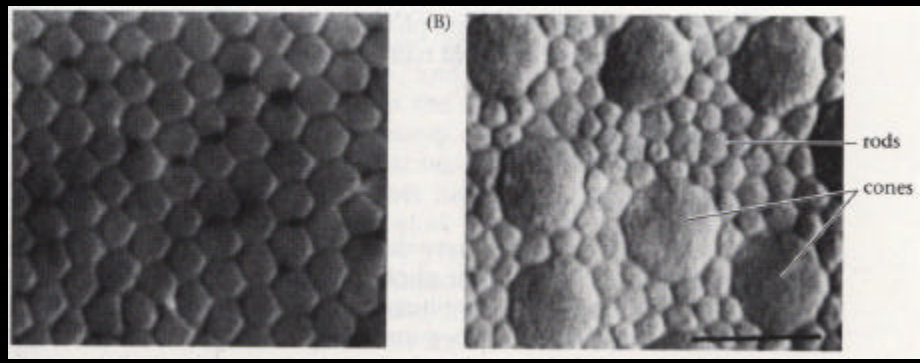
- Layer of photoreceptors
- Light->neural signal
- Optic nerve

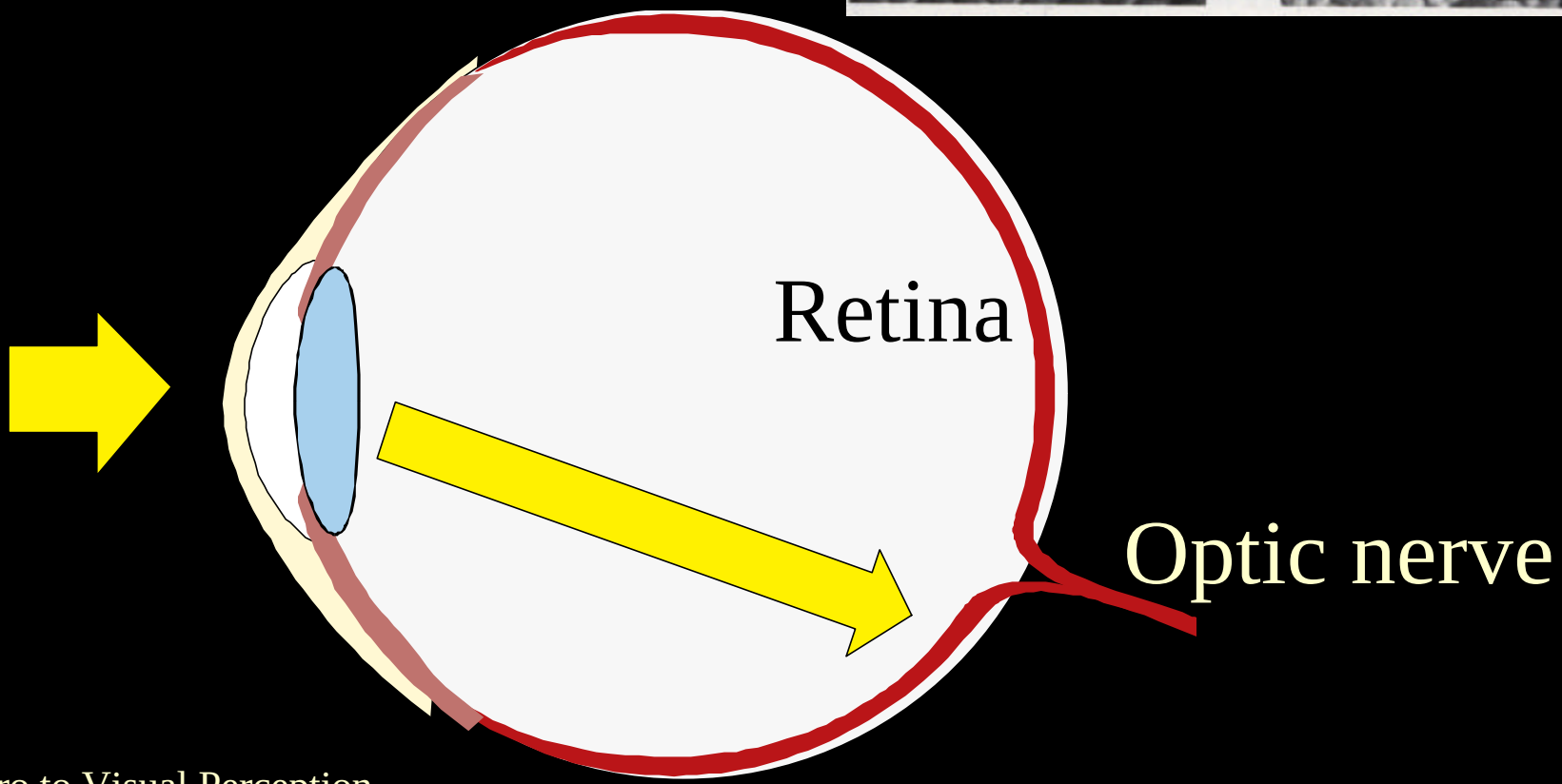




Photoreceptors

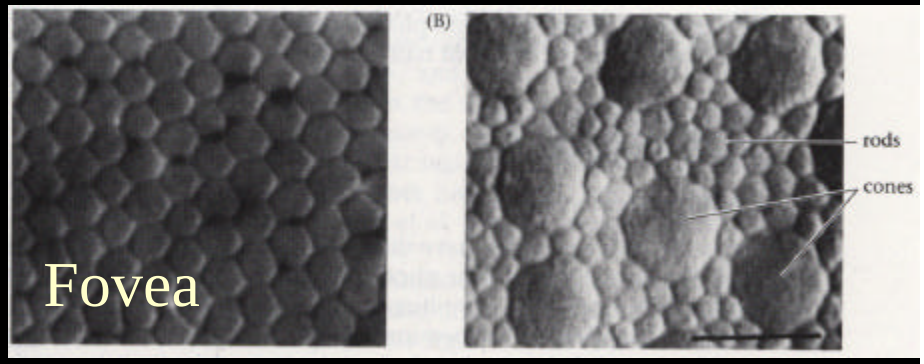
- Rod: night vision
- Cone: bright, color vision

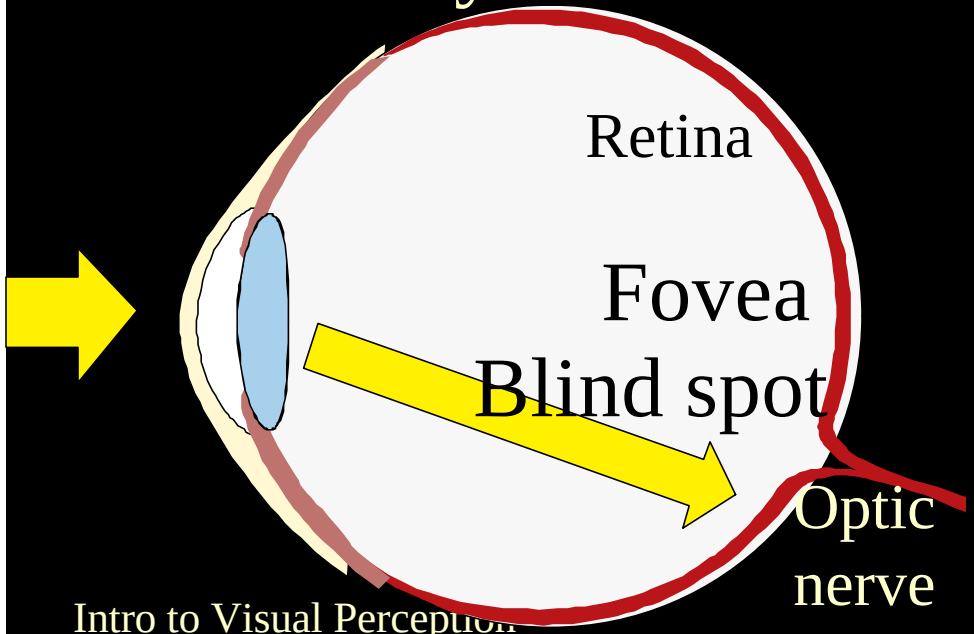


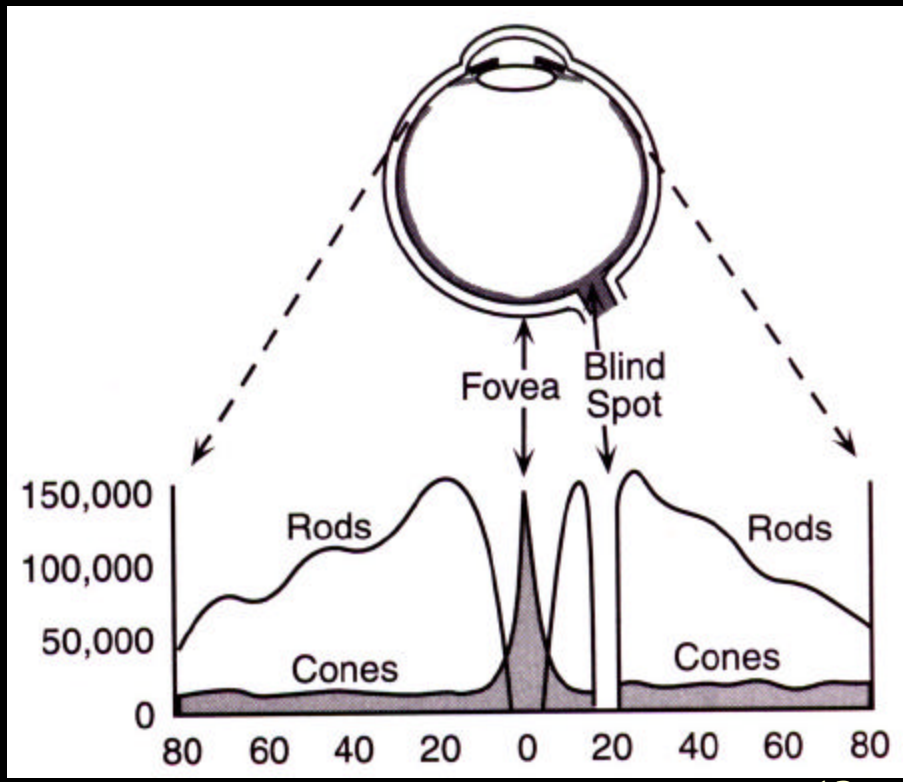


Photoreceptors

- 100M rods
- 5M cones
- Variable density
- Fovea: most acuity, cone only

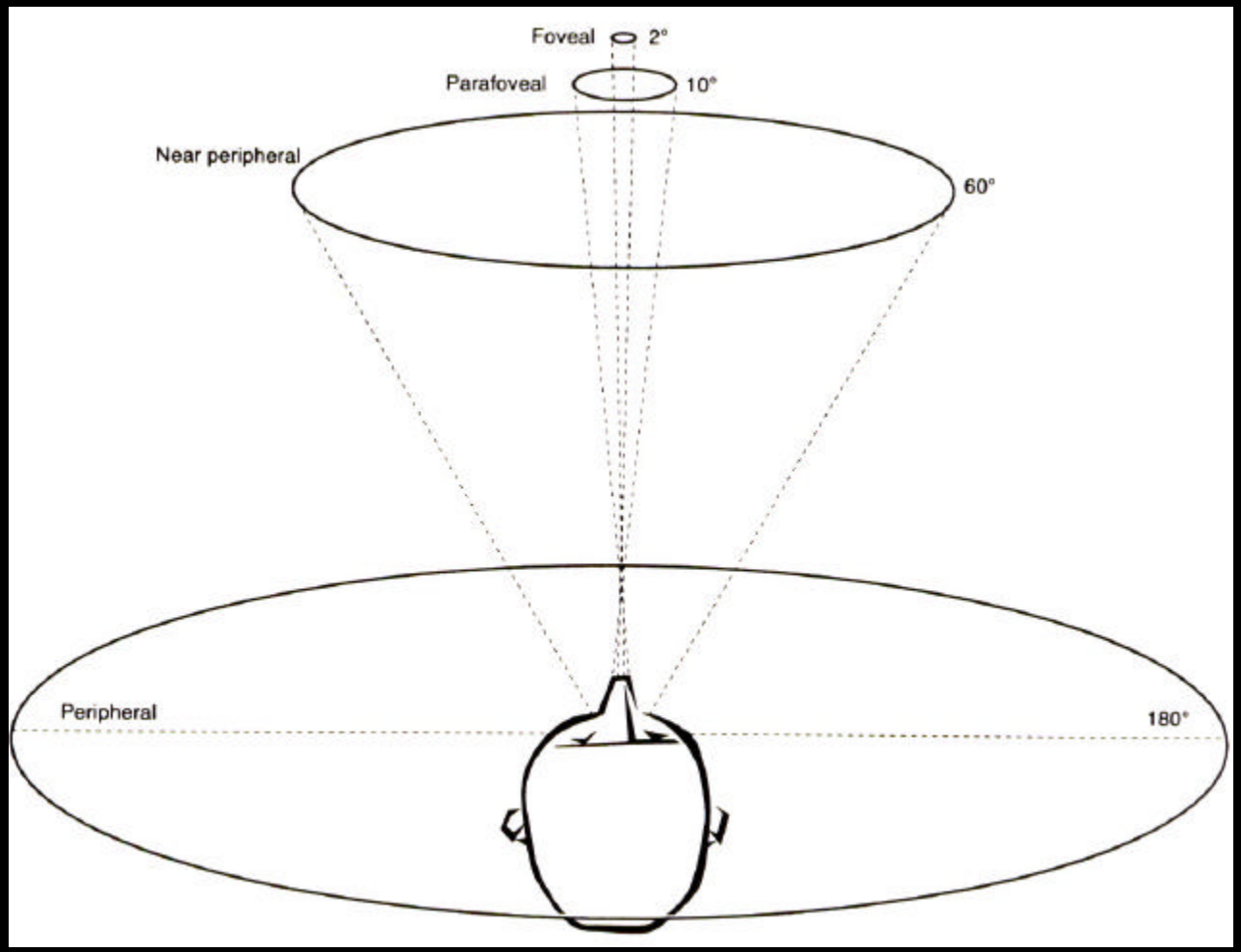






Field of view

- Fovea=2-5 degrees



Field of view

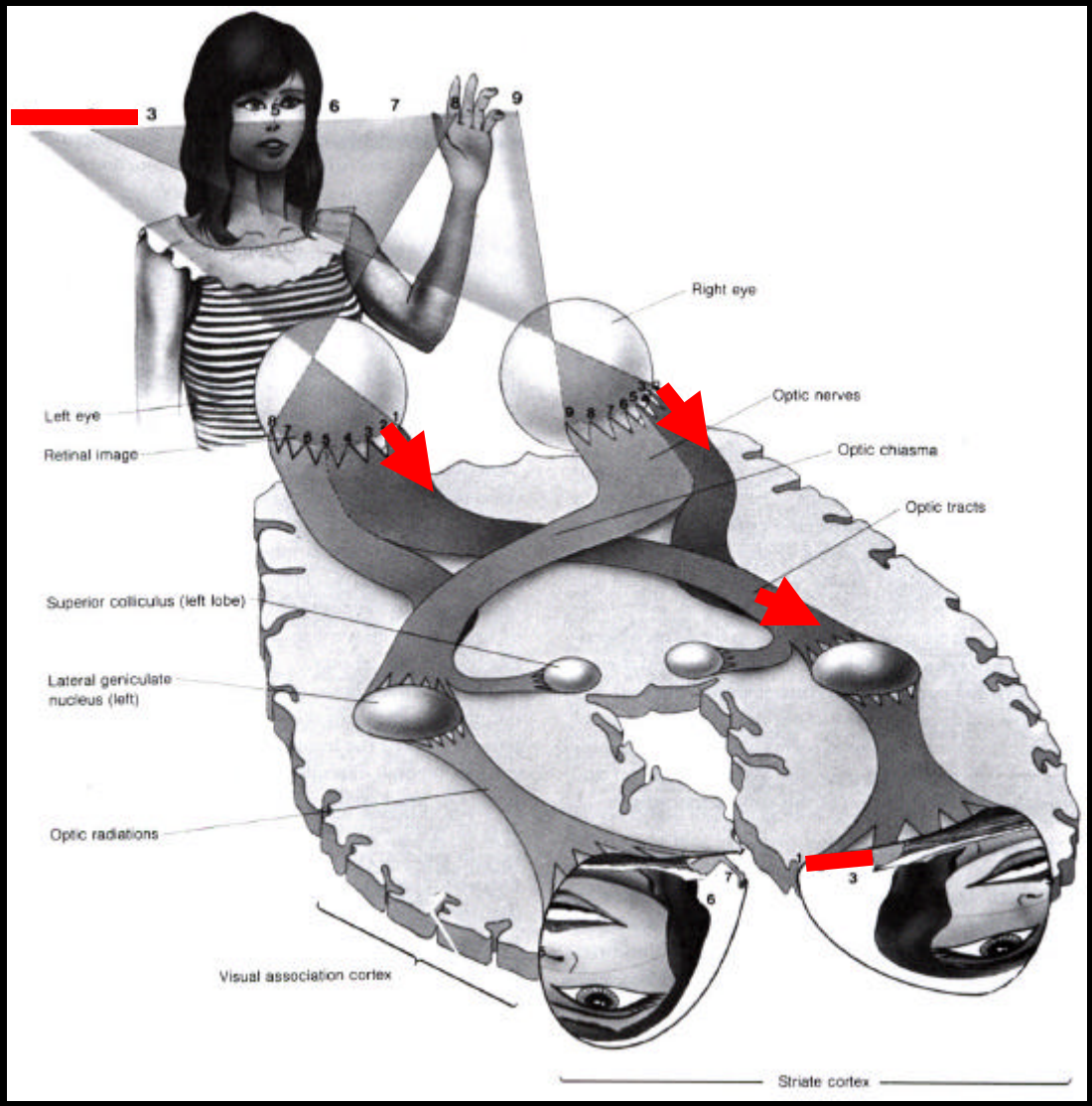
- Fovea=2 degrees

Summary

- Light is transformed into 100M neural signals
- But… optic nerve has only 1M nerve fibers

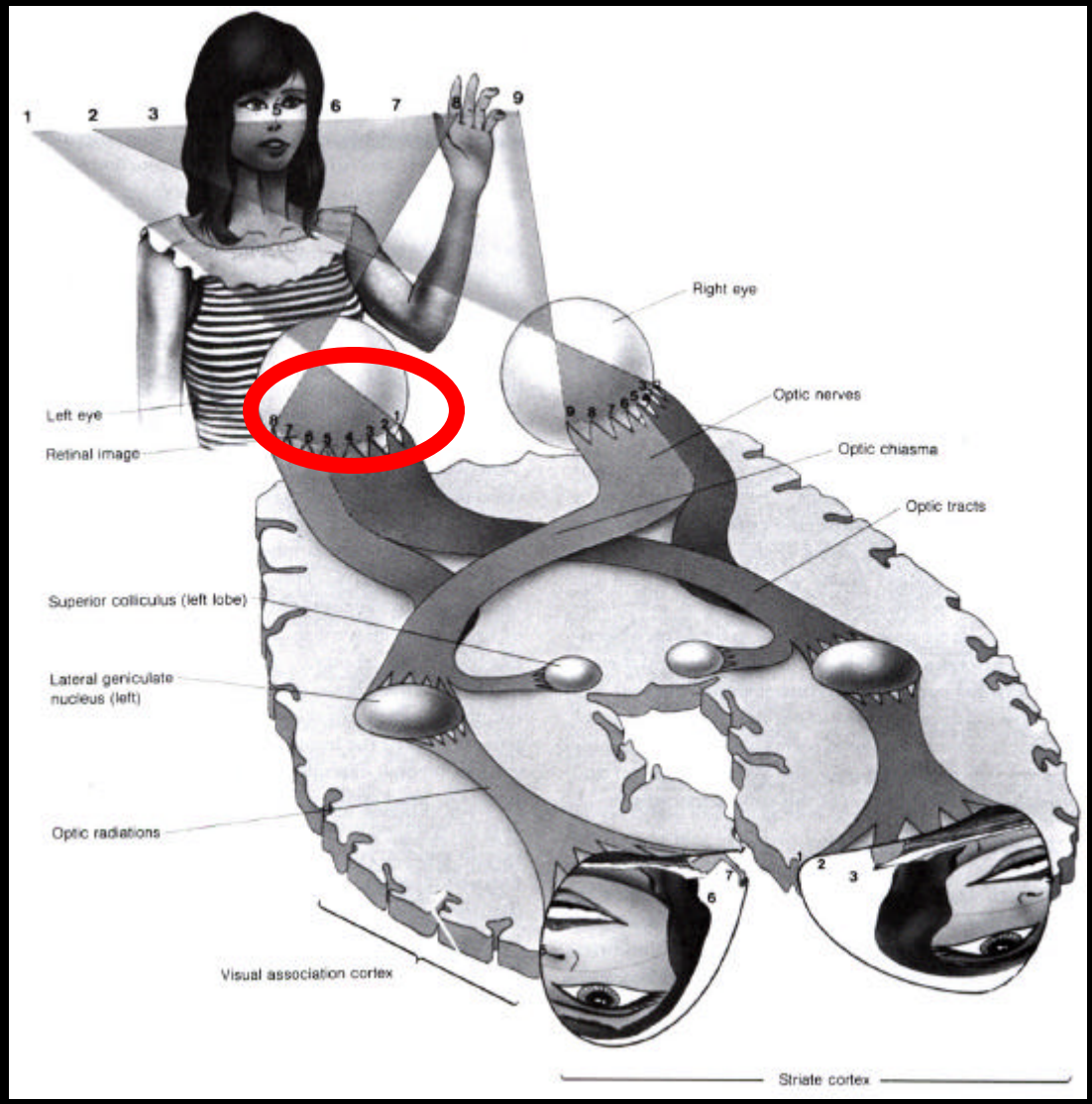
Overview of pathway

- Input from both eyes is dispatched
- Left brain : right part of visual field



Visual processing

- First step in the retina itself

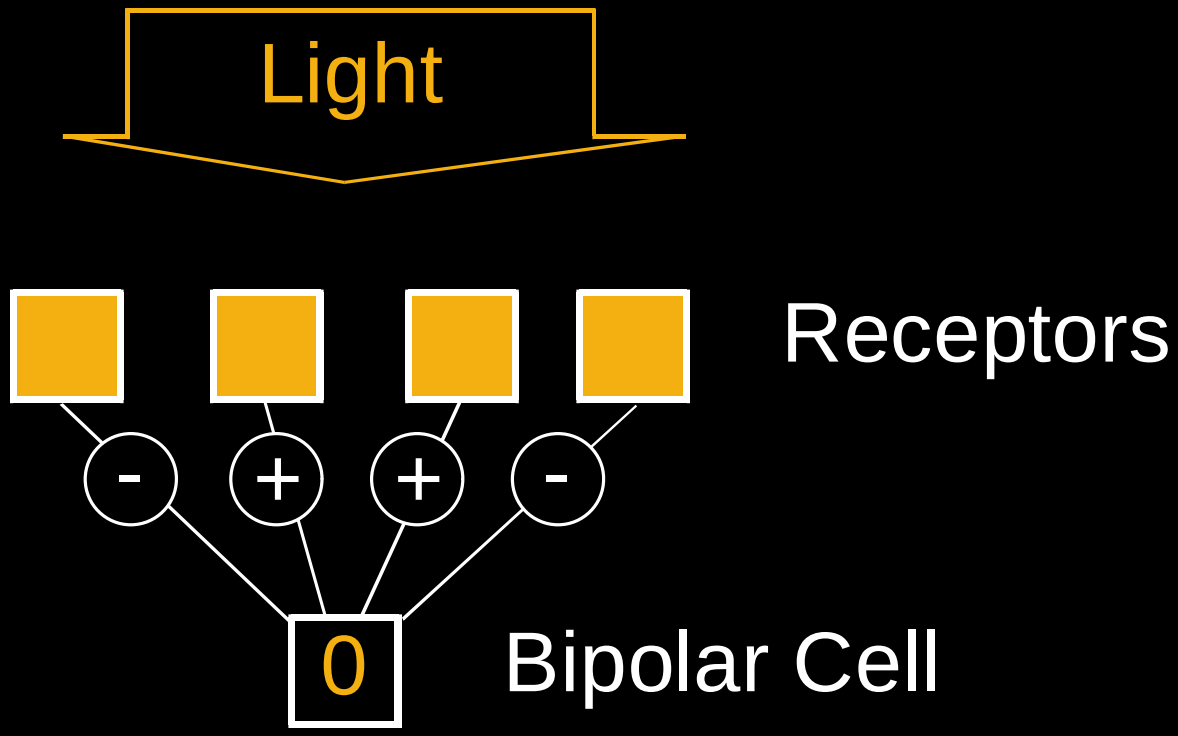


Contrast processing

- We are sensitive to contrast, not to absolute luminance
- Useful because contrast is more invariant (it depends less on illumination)

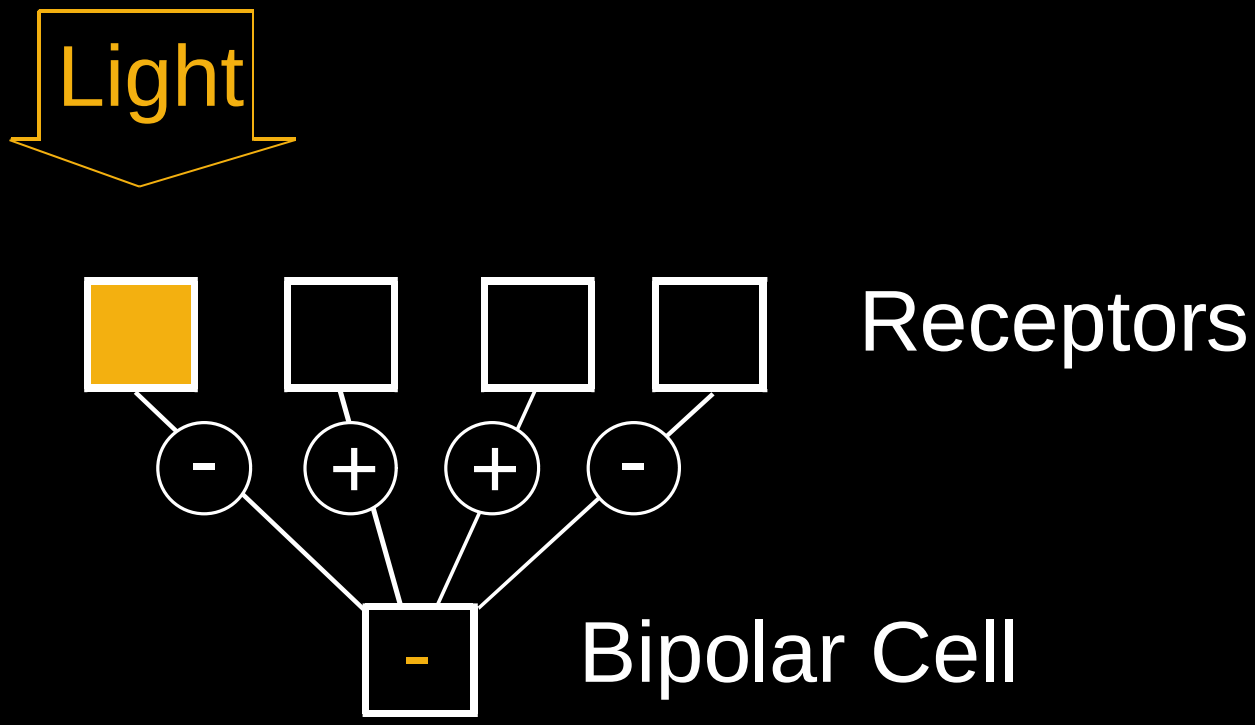
Contrast processing

- Receptors are wired to other neurons
- Center-surround organization



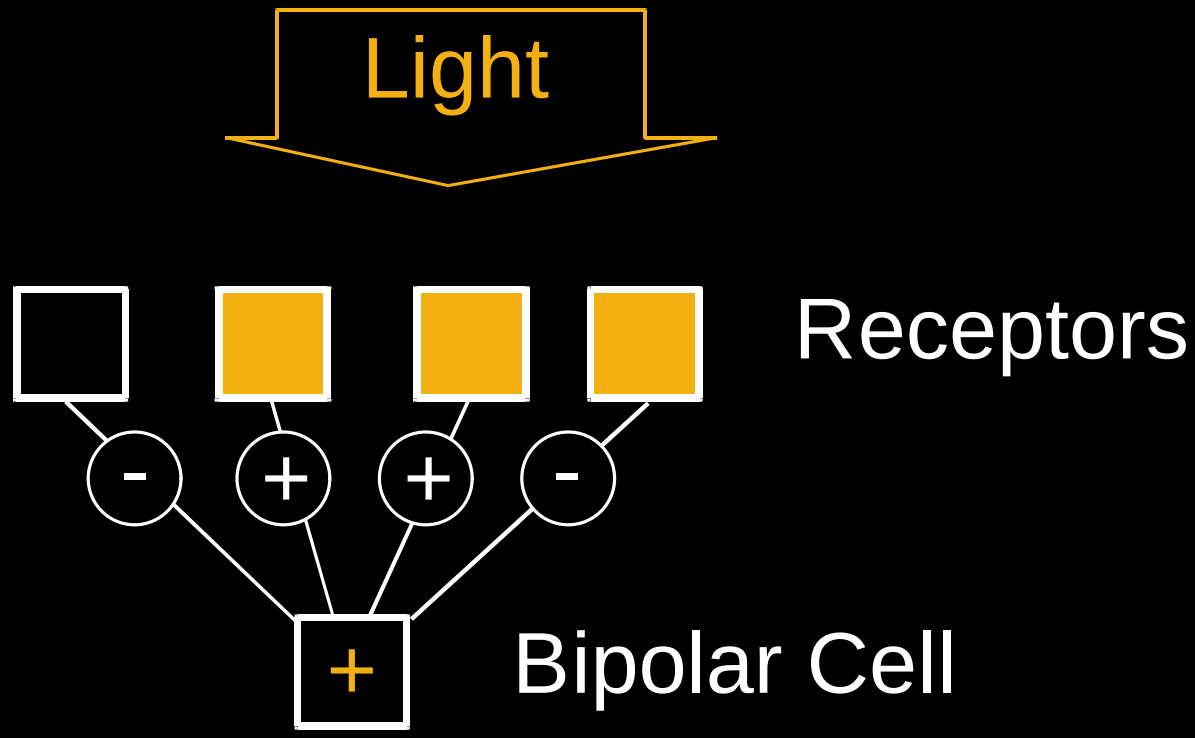
Contrast processing

- Receptors are wired to other neurons
- Center-surround organization



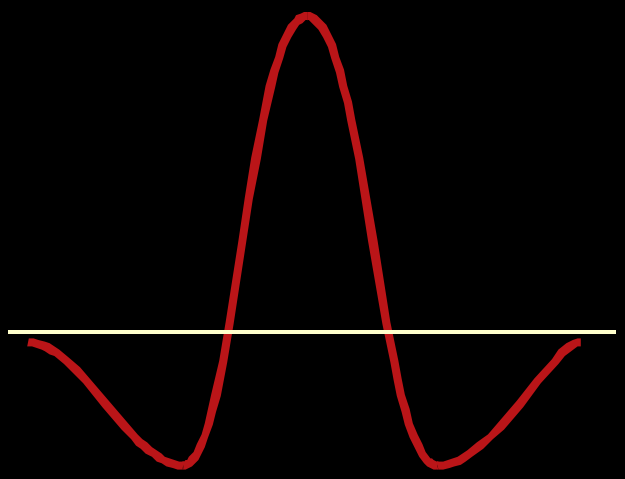
Contrast processing

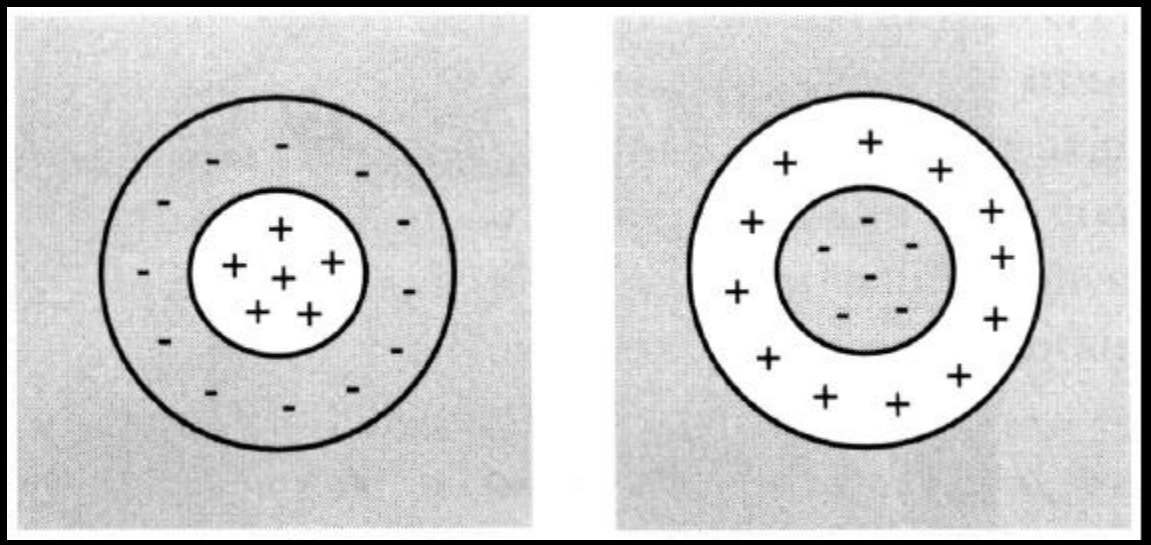
- Receptors are wired to other neurons
- Center-surround organization



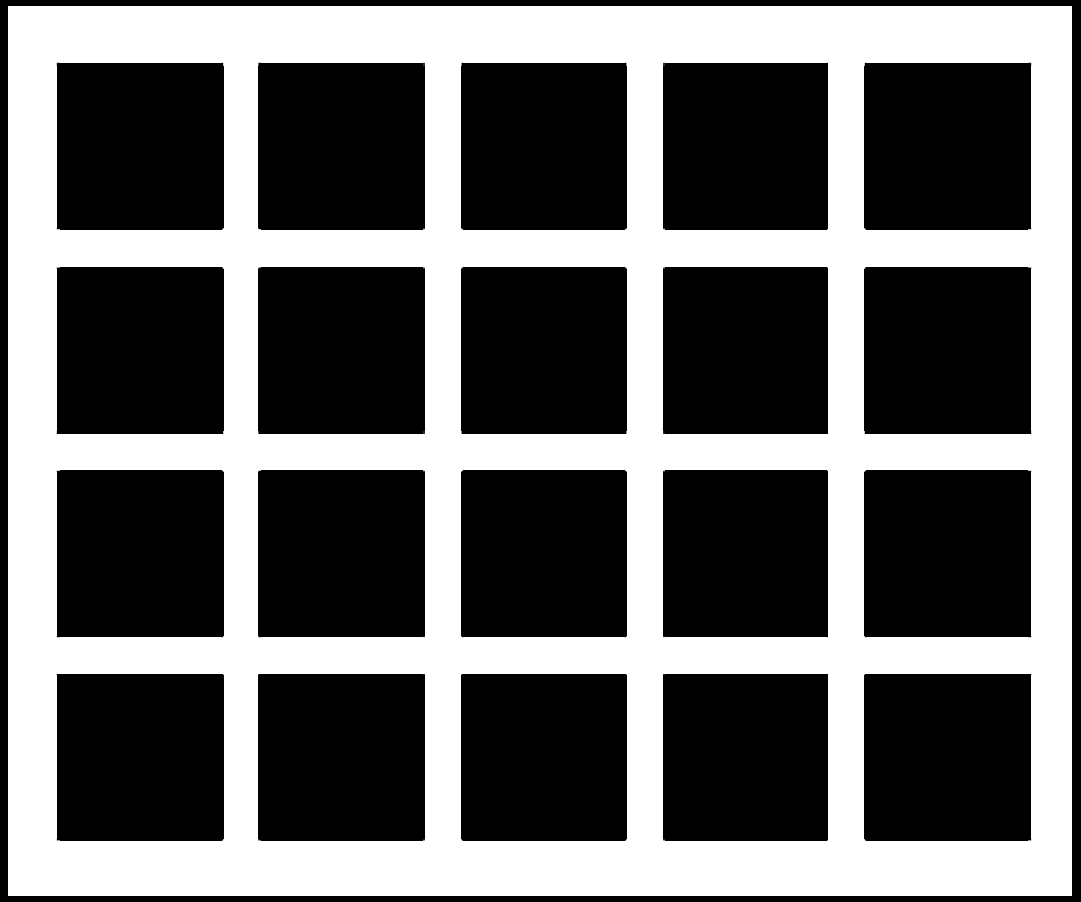
Contrast processing

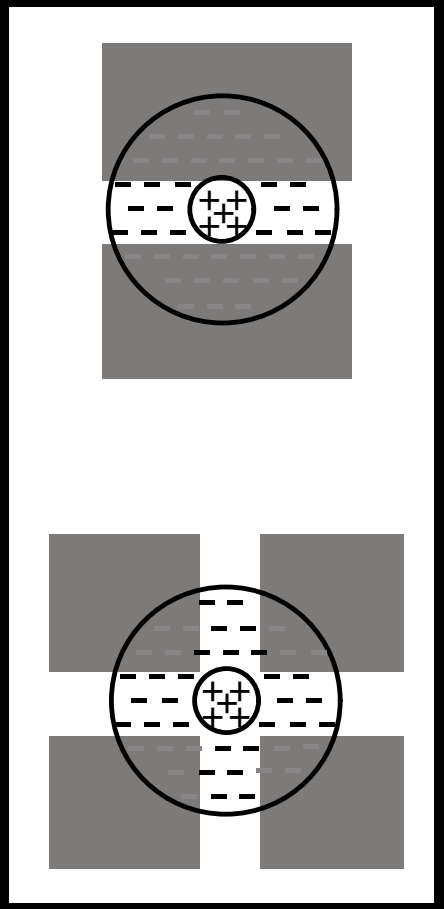
- Receptors are wired to other neurons
- Center-surround organization





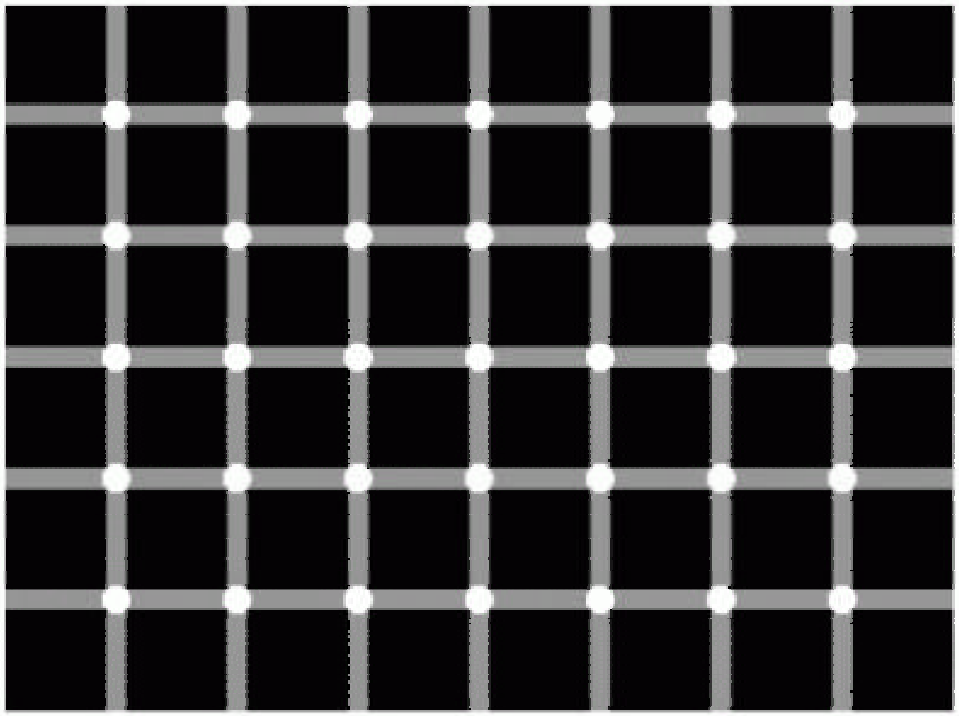
Hermann Grid





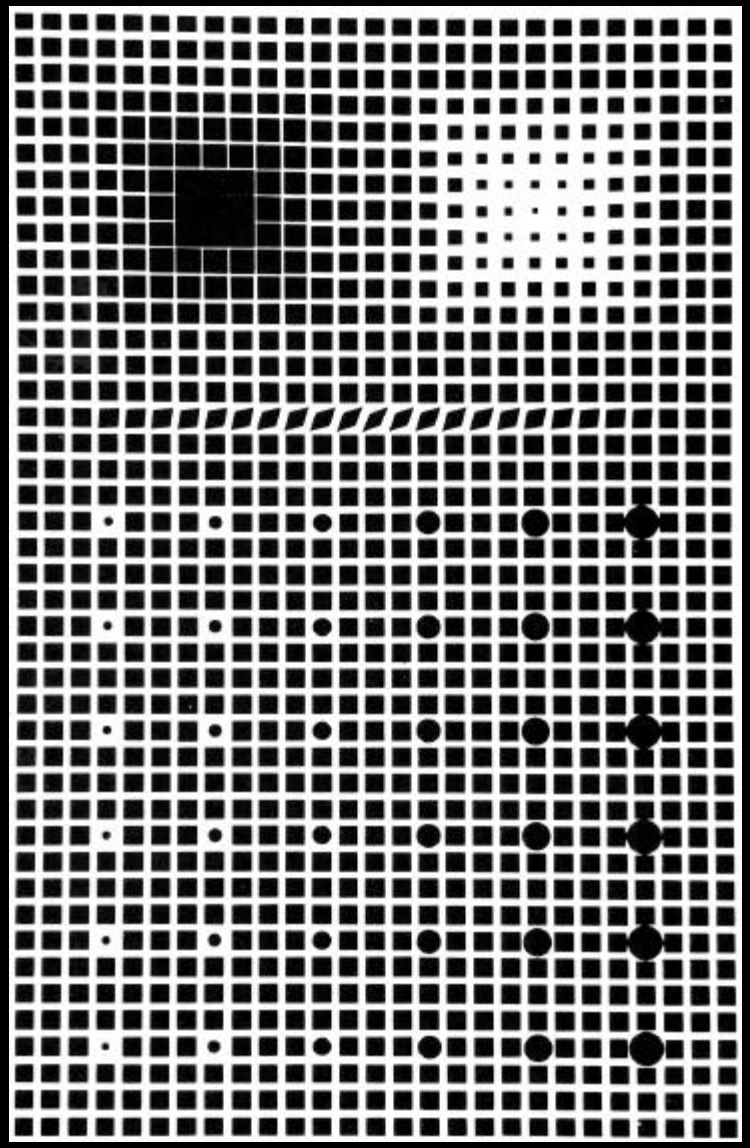
Hermann Grid

Florida Election Recount



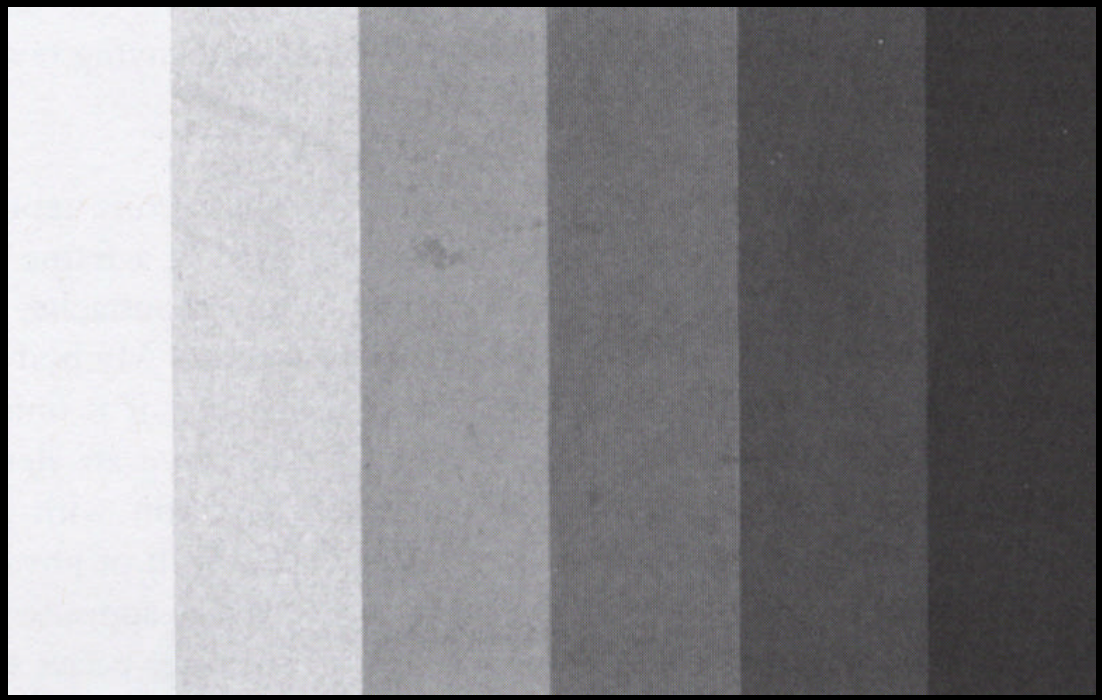
Count and total black dots for Al Gore and white dots for George Bush. Recount to confirm

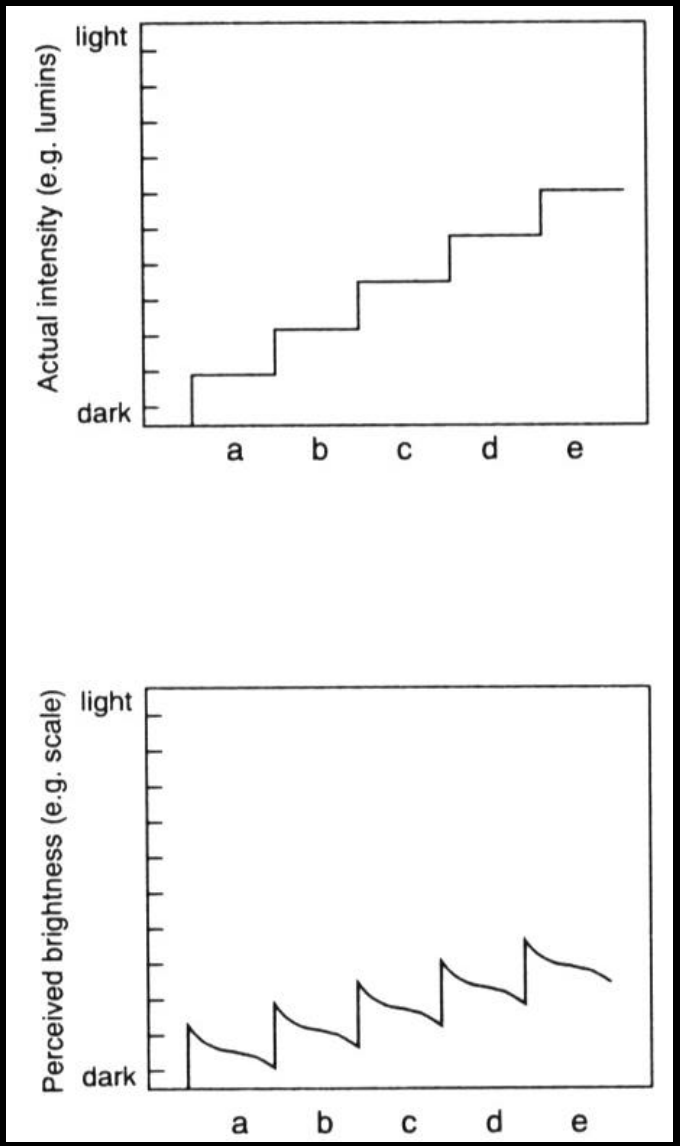
Vasarely, Supernovae



Mach Bands

- Contrast is enhanced at region boundaries



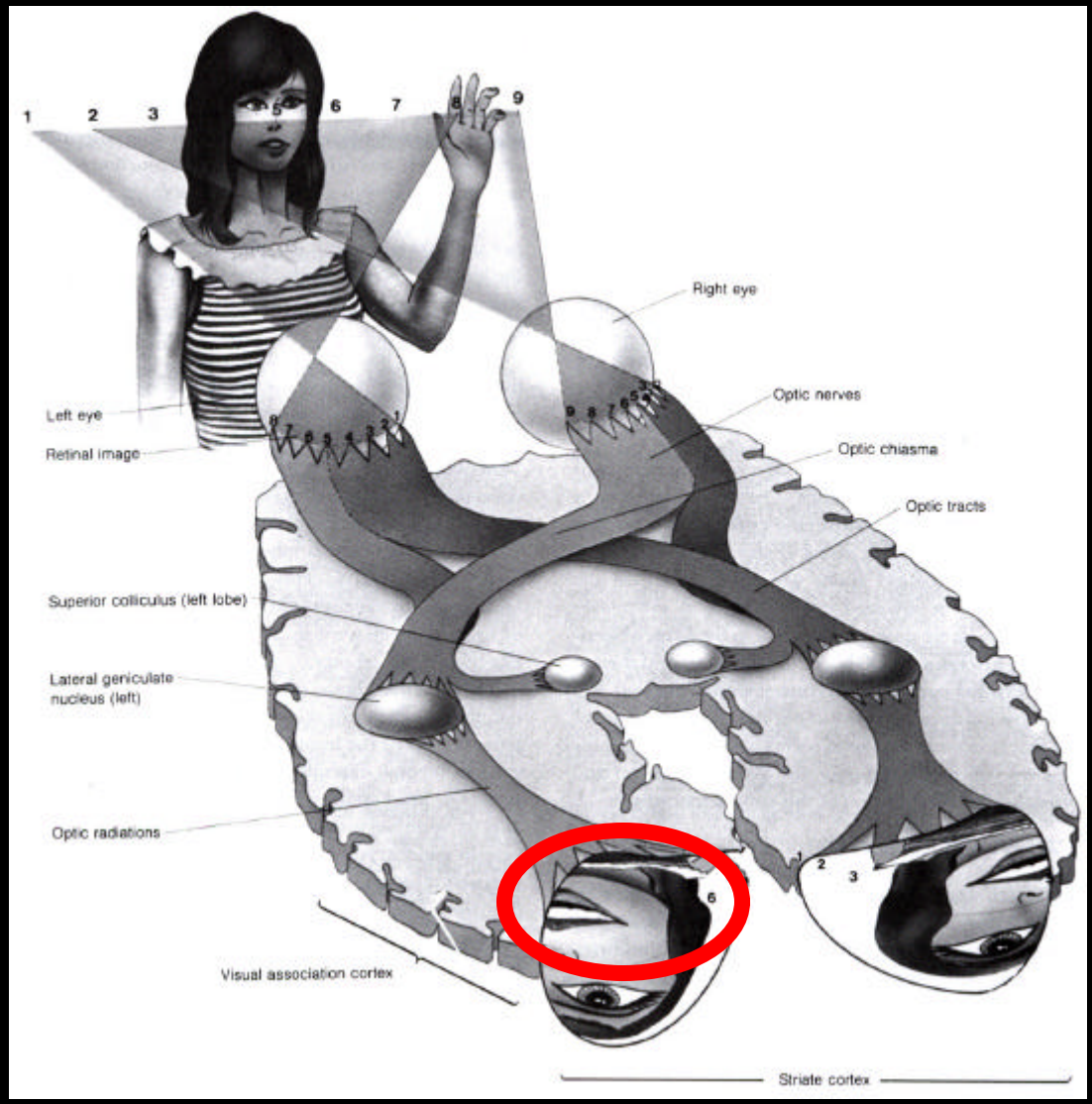


Relation with photo and painting

- Low contrast is not that much a problem
- A photo can be brighter/lighter than the original

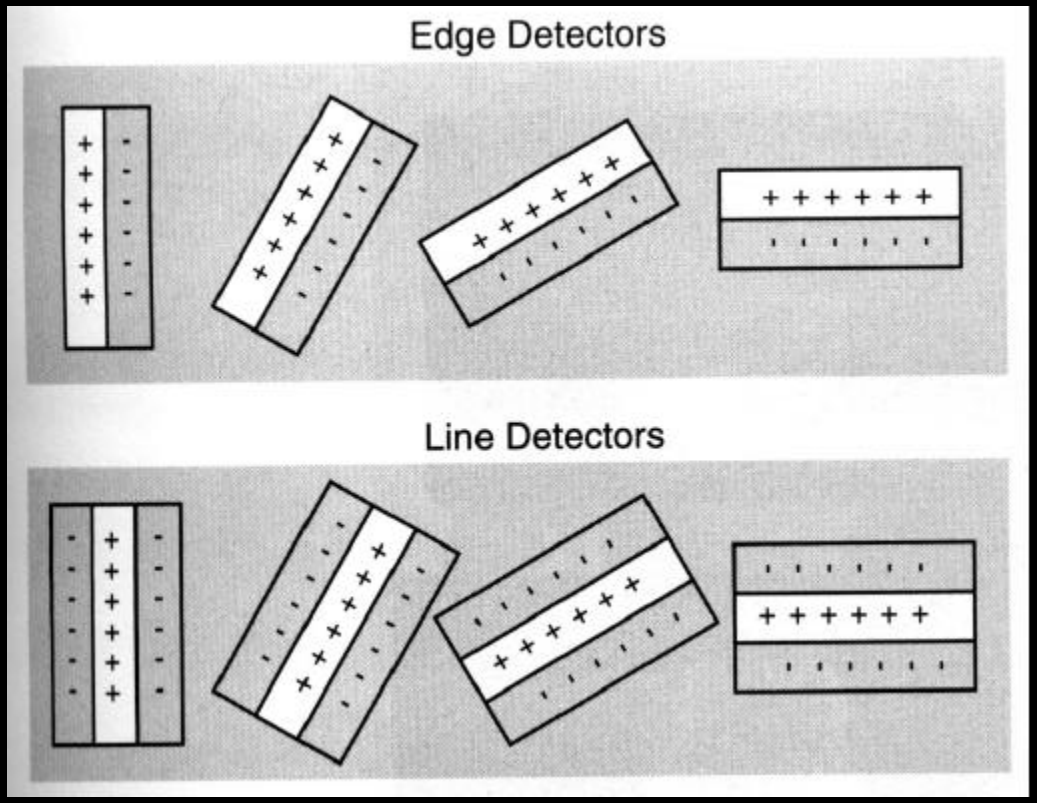
Visual processing

- First step in the retina itself
- …
- Next step: visual cortex area V1



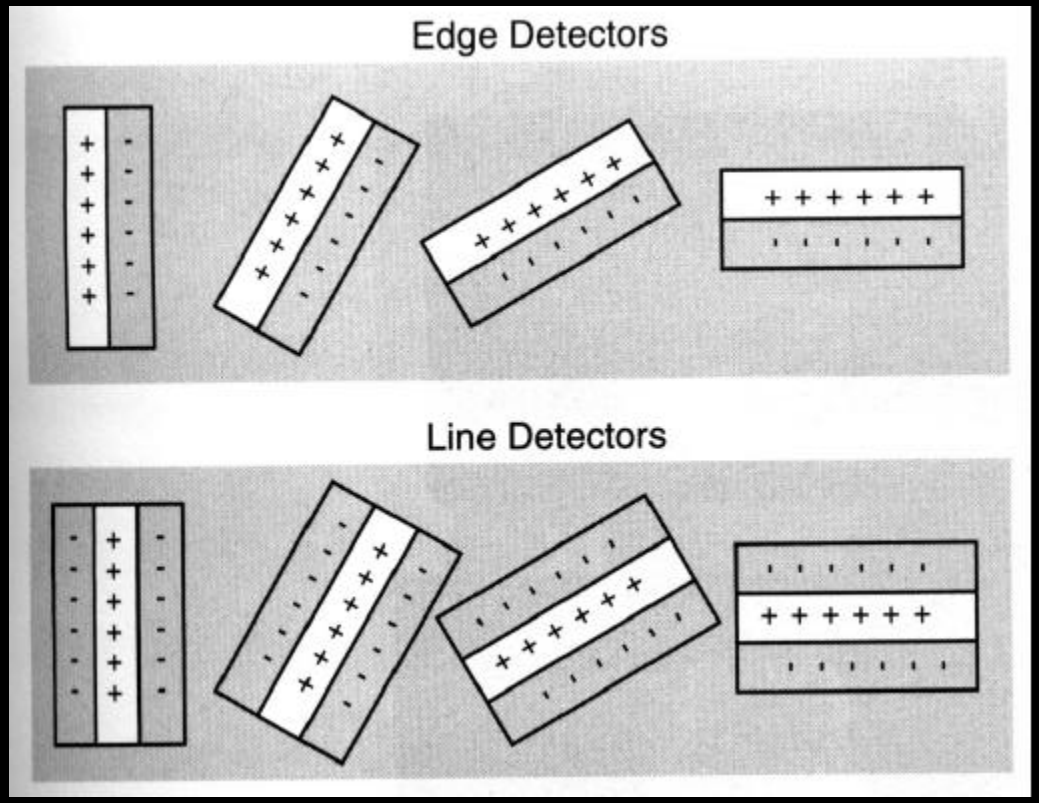
Edge detection

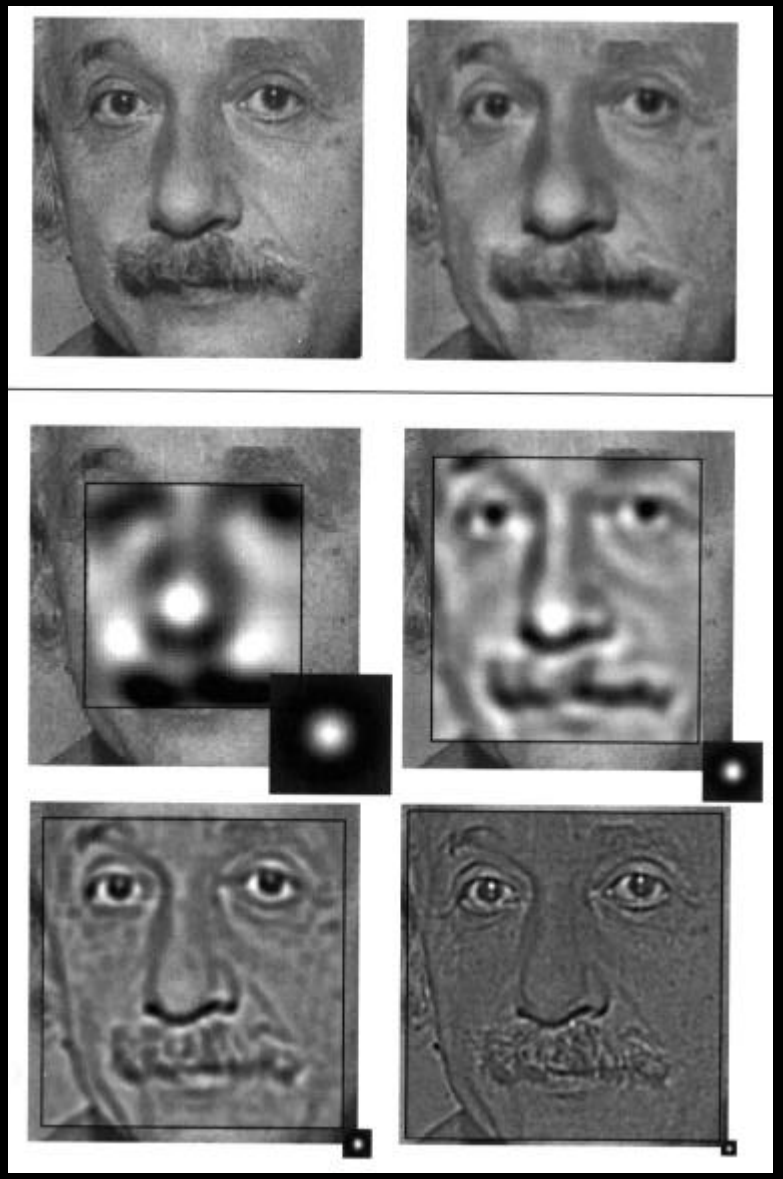
- Similar to center-surround
- Measured using micro-electrodes



Edge detection: Multi-resolution

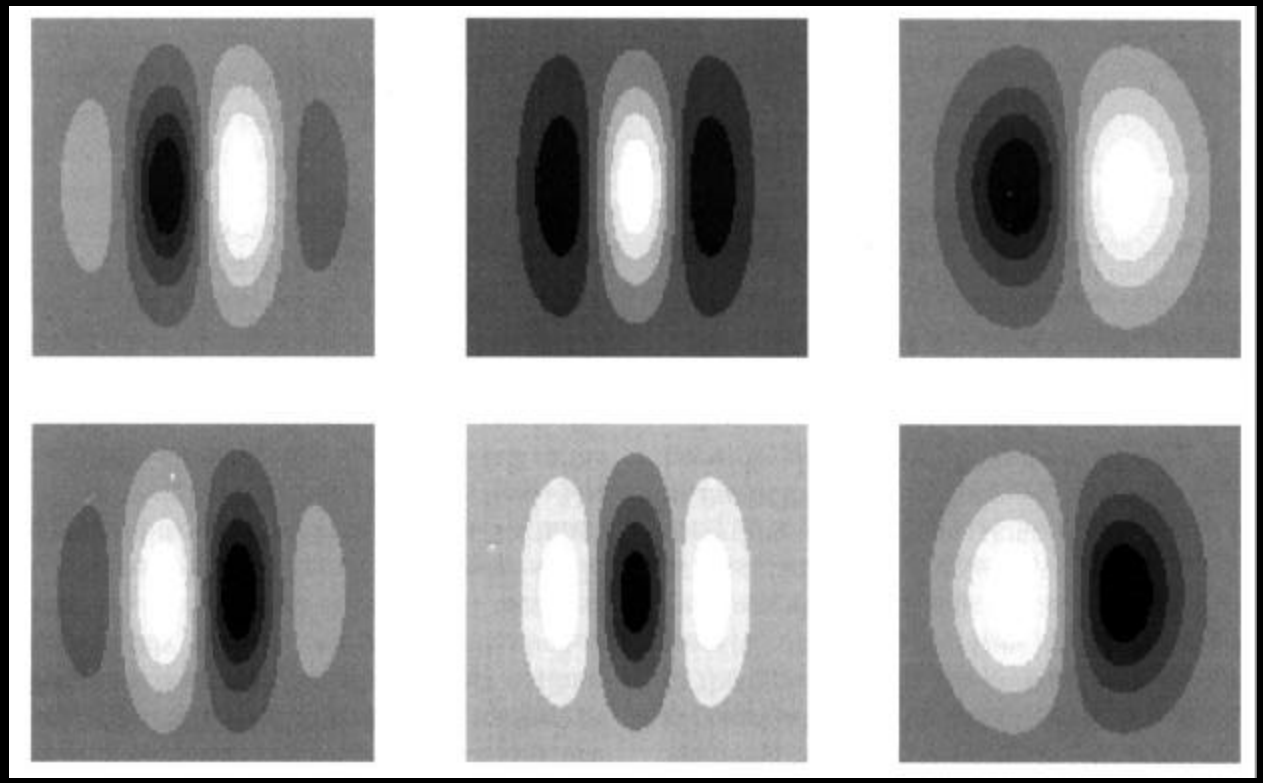
- Edge of different sizes





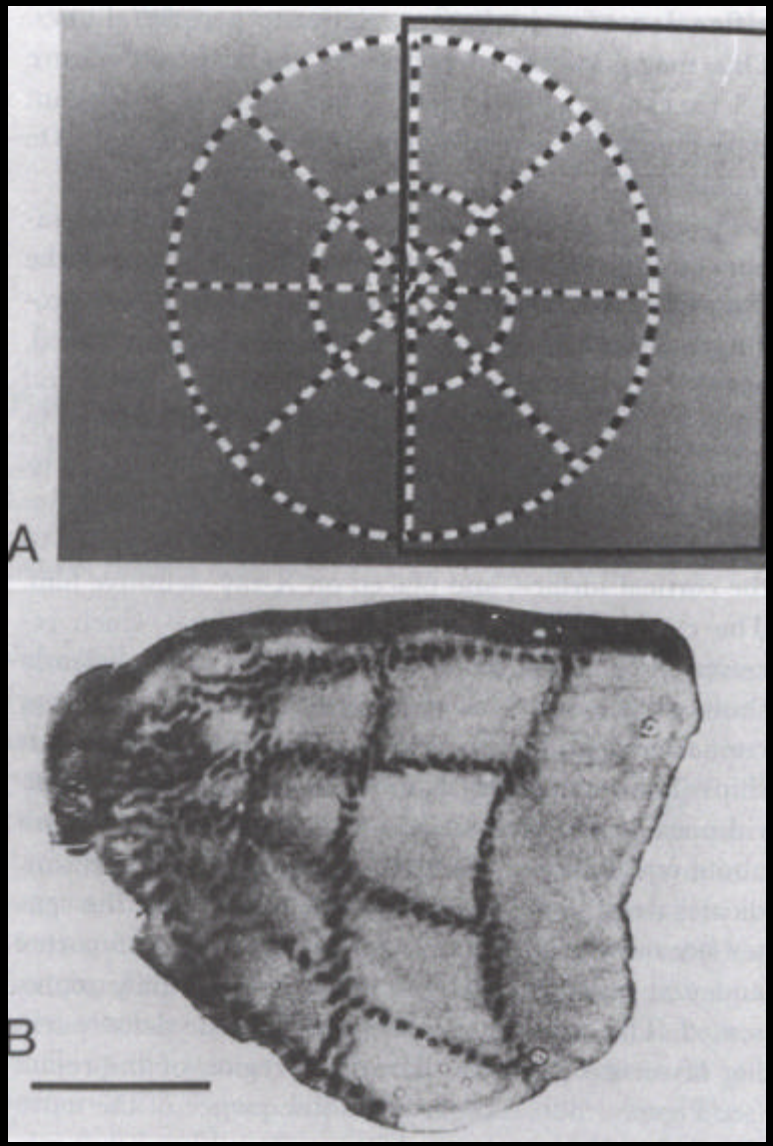
Edge detection: not so simple

- Edges are only a special case
- Patterns



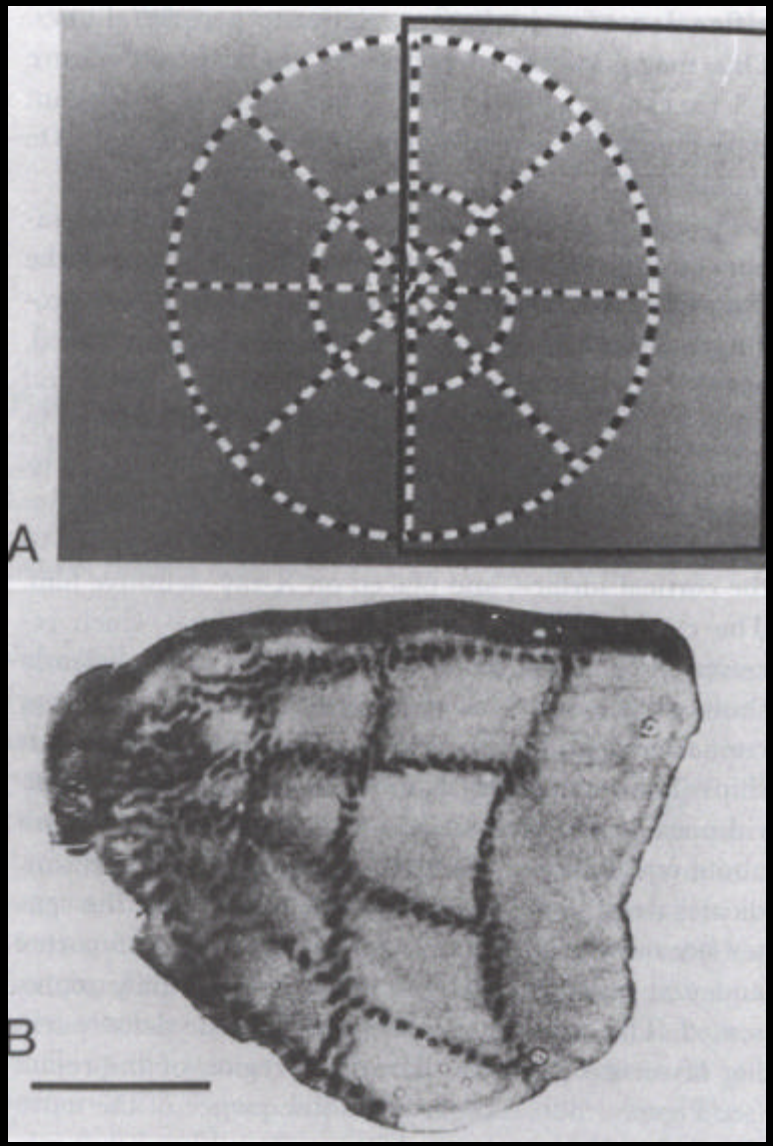
Retinotopic

- Close optical stimulus map to close parts of V1
- A monkey is shown A
- Radioactive tracer
- His V1 area is shown in B



Retinotopic

- Close optical stimulus map to close parts of V1
- But not complete correspondence



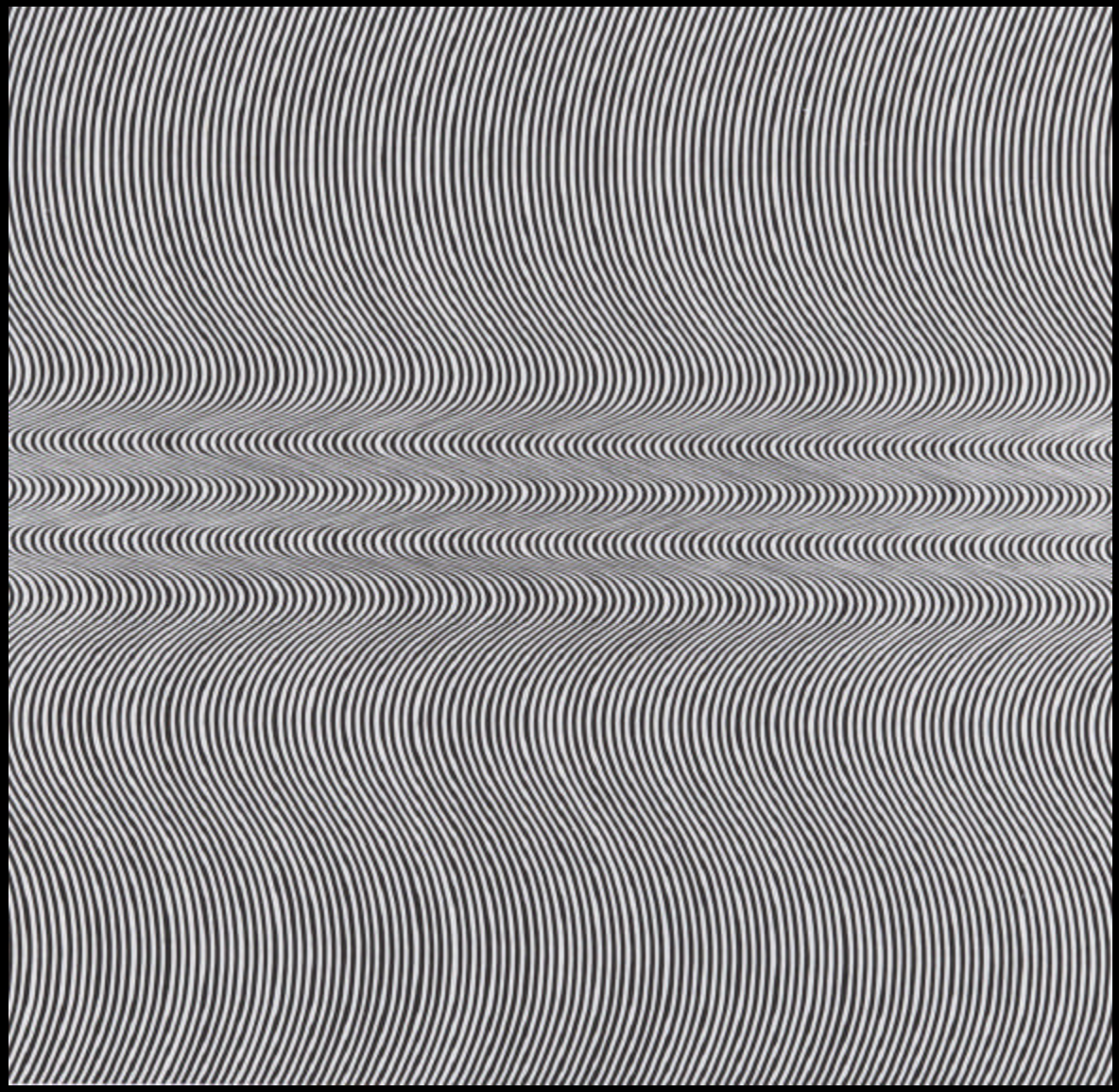
Relation with line drawing

- The information is ~ the same
- Drawing simplifies edge detection

- Some neurologist believe that line drawing nicely excites areas of the brain

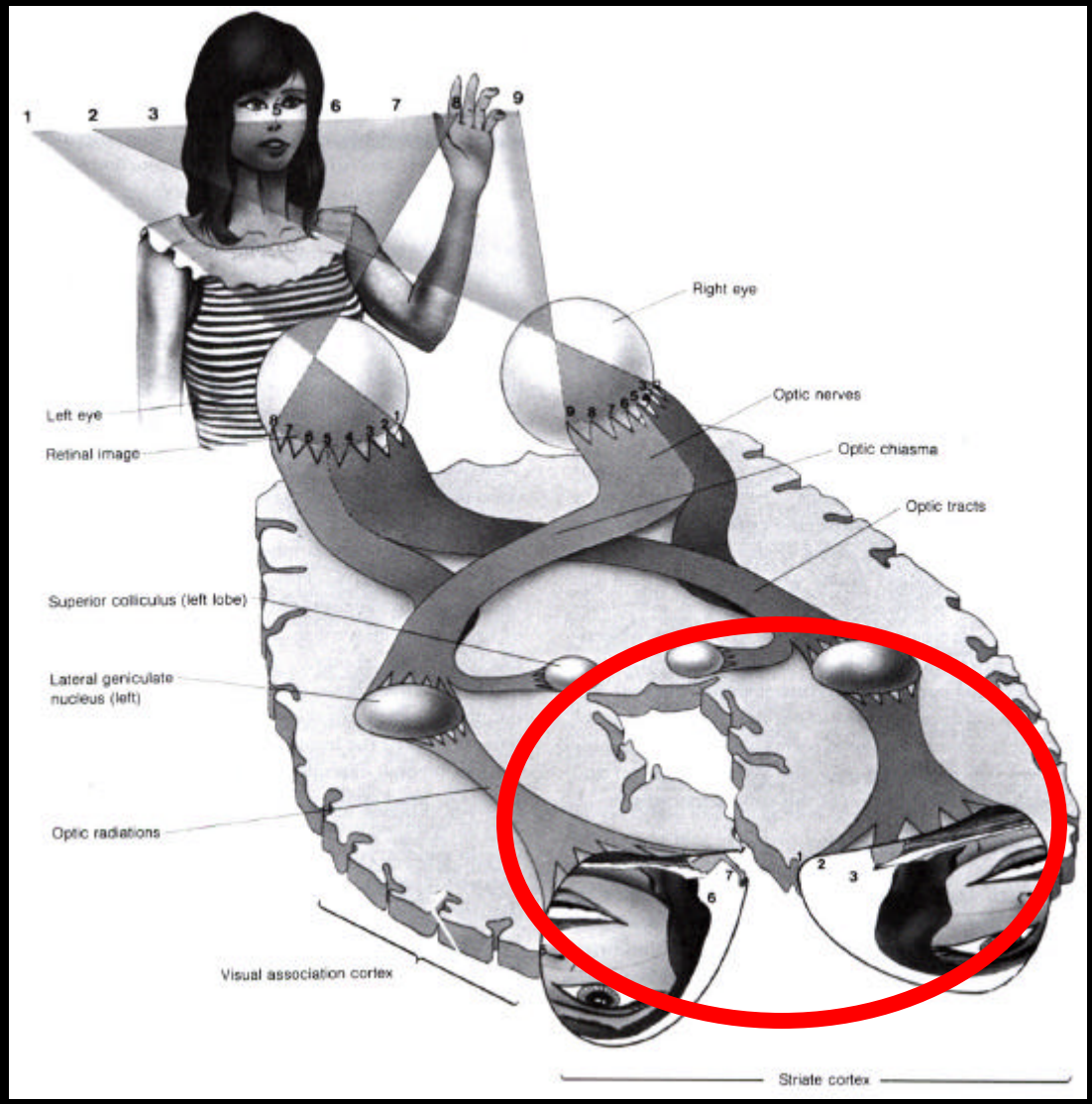
Optical art

- Op’ Art directly exploits low-level vision



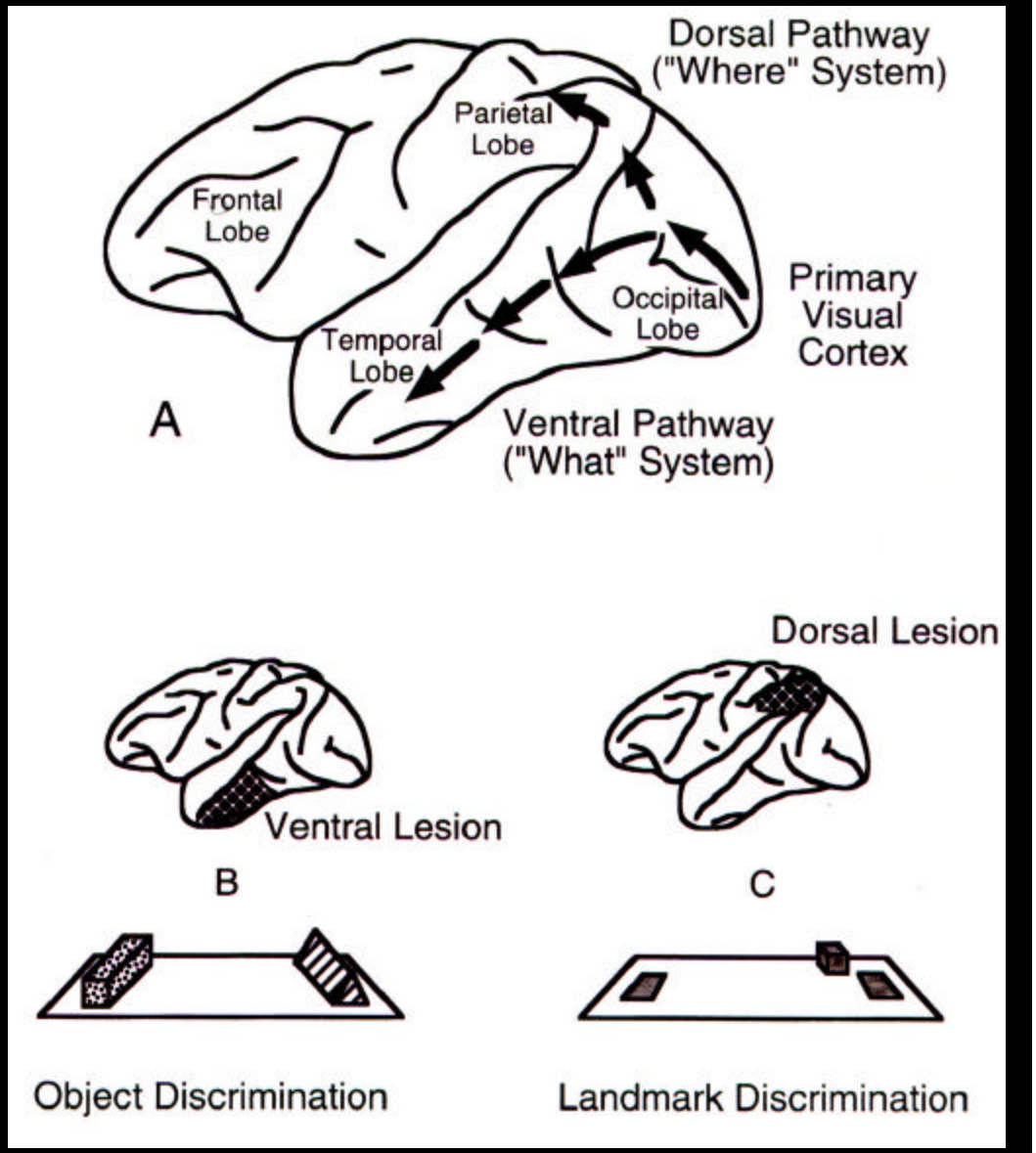
Higher-level visual processing

- More complex
- Less understood or “measured”
- Different pathways

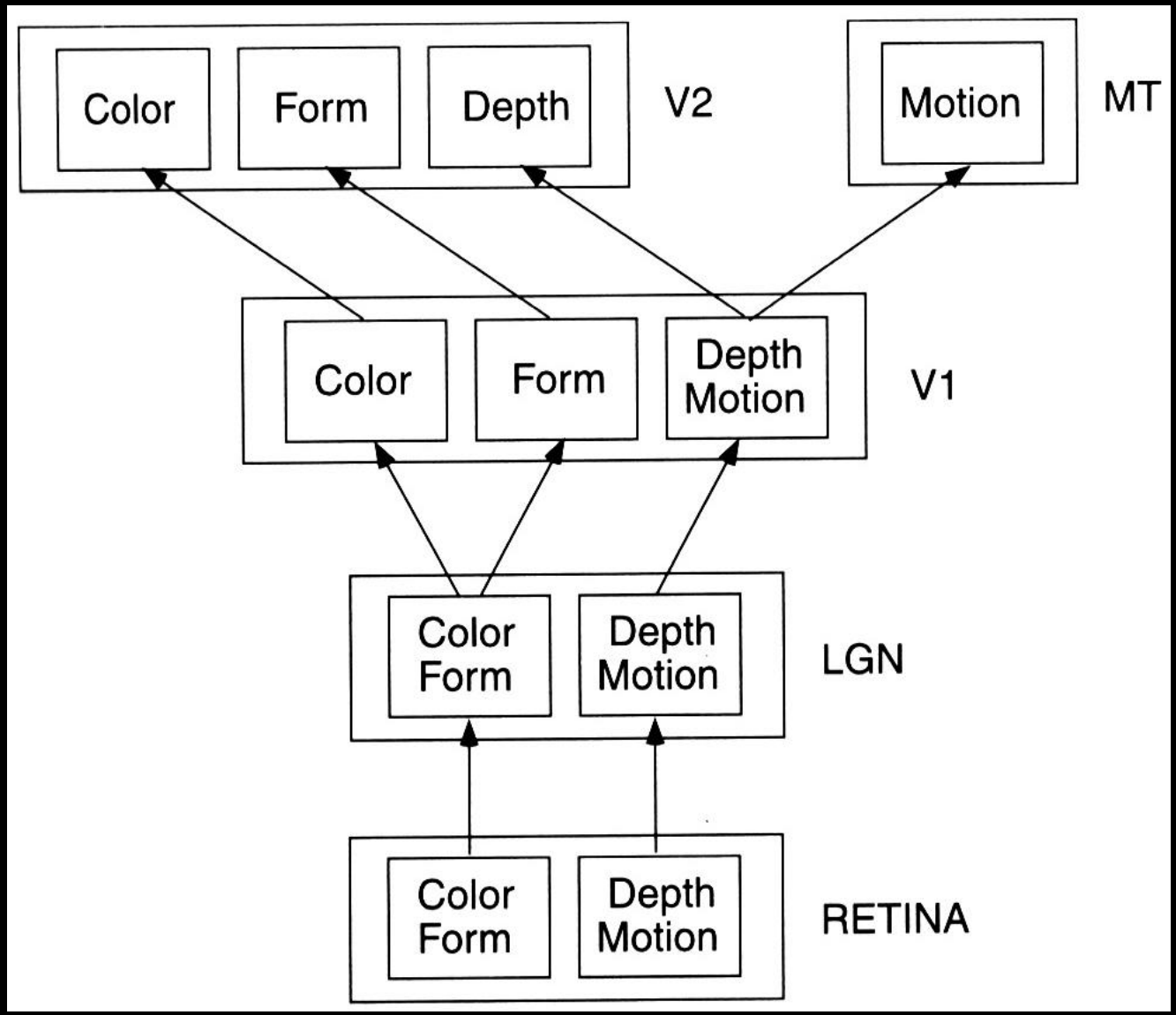


Dorsal vs. Ventral pathways

- Ventral pathway: What?
  - Object recognition
- Dorsal Pathway: Where?
  - Location
- Study on monkeys with damaged brain

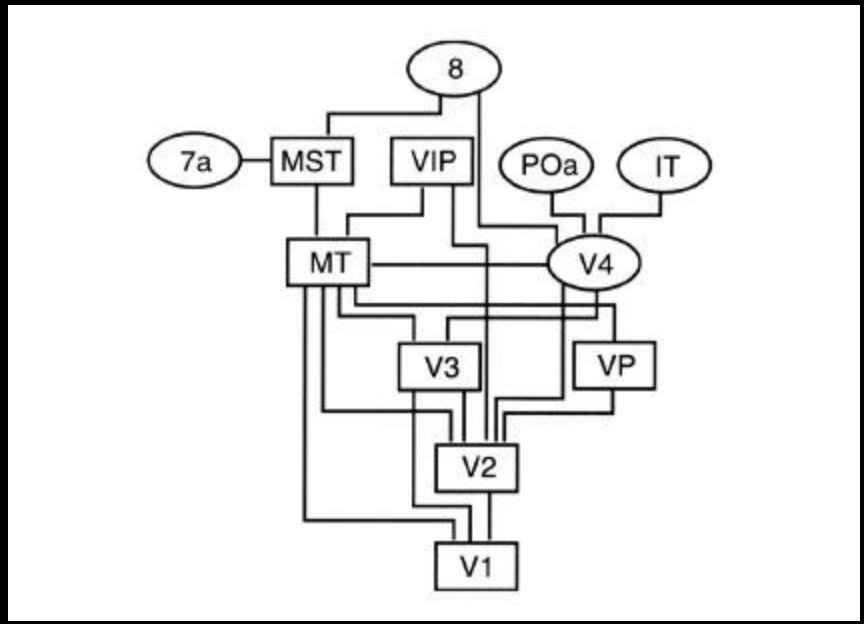


Different visual channels



Different visual channels

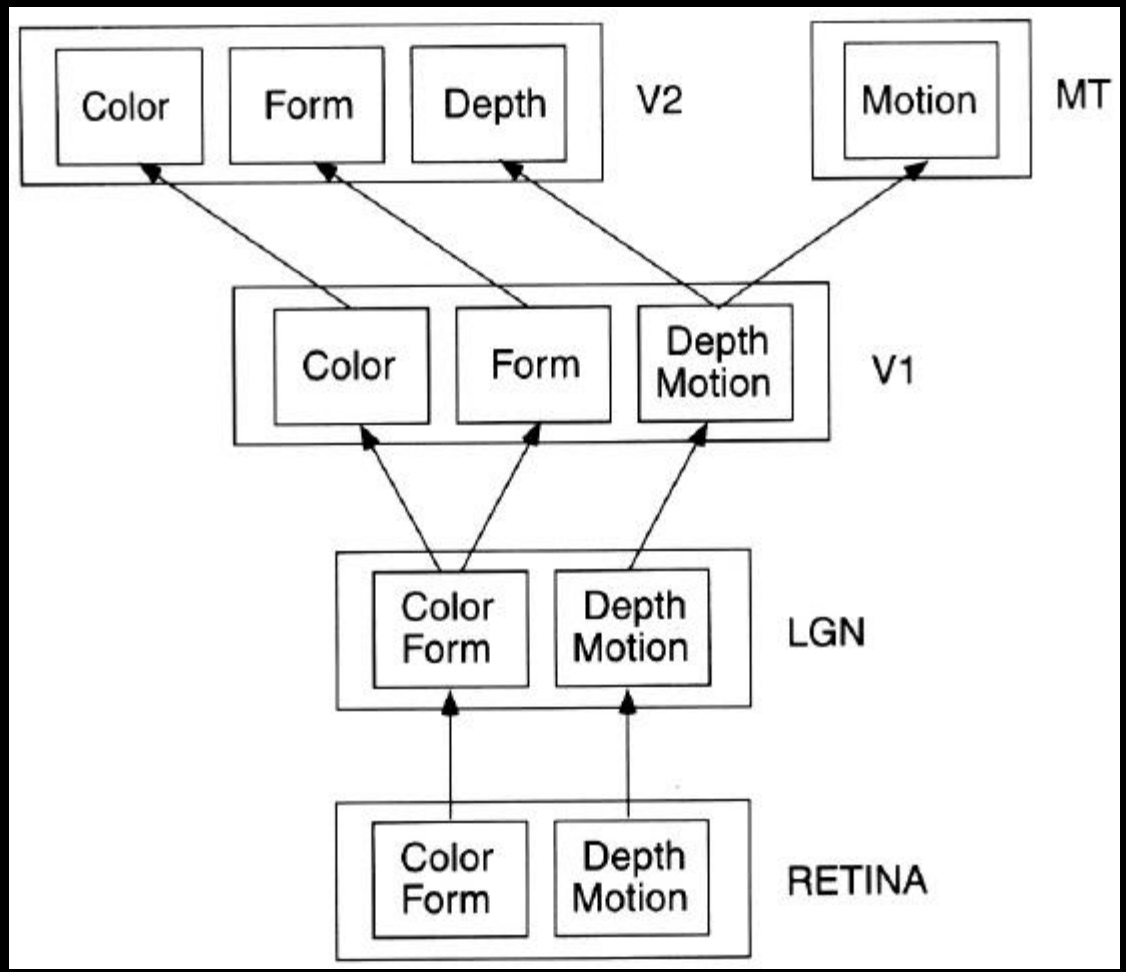
- Quite complex interactions
- Not sequential
- Not one-way
- Not strictly separate



Some interconnections in the Monkey brain

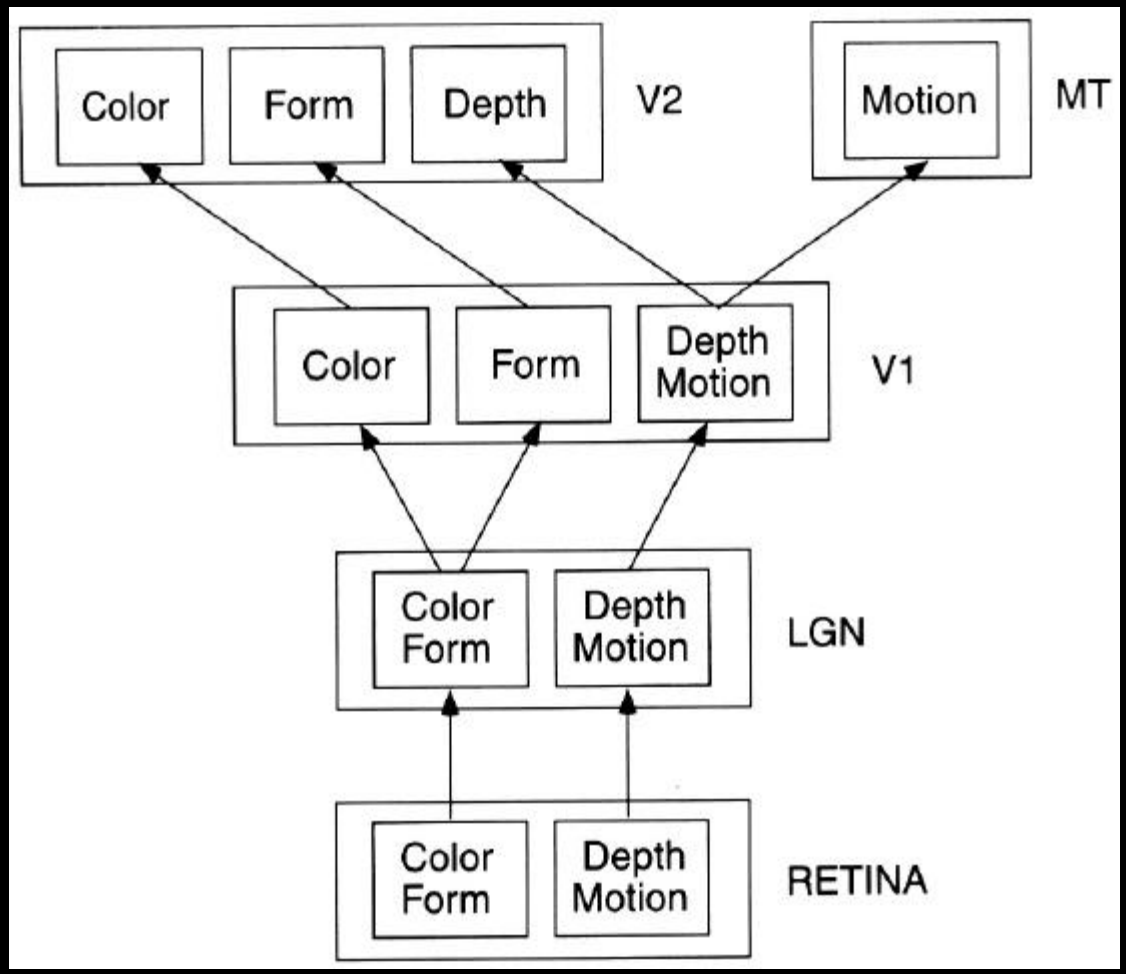
Relation to visual arts

- Same elements:
  - Color
  - Form
  - Layout
  - Texture



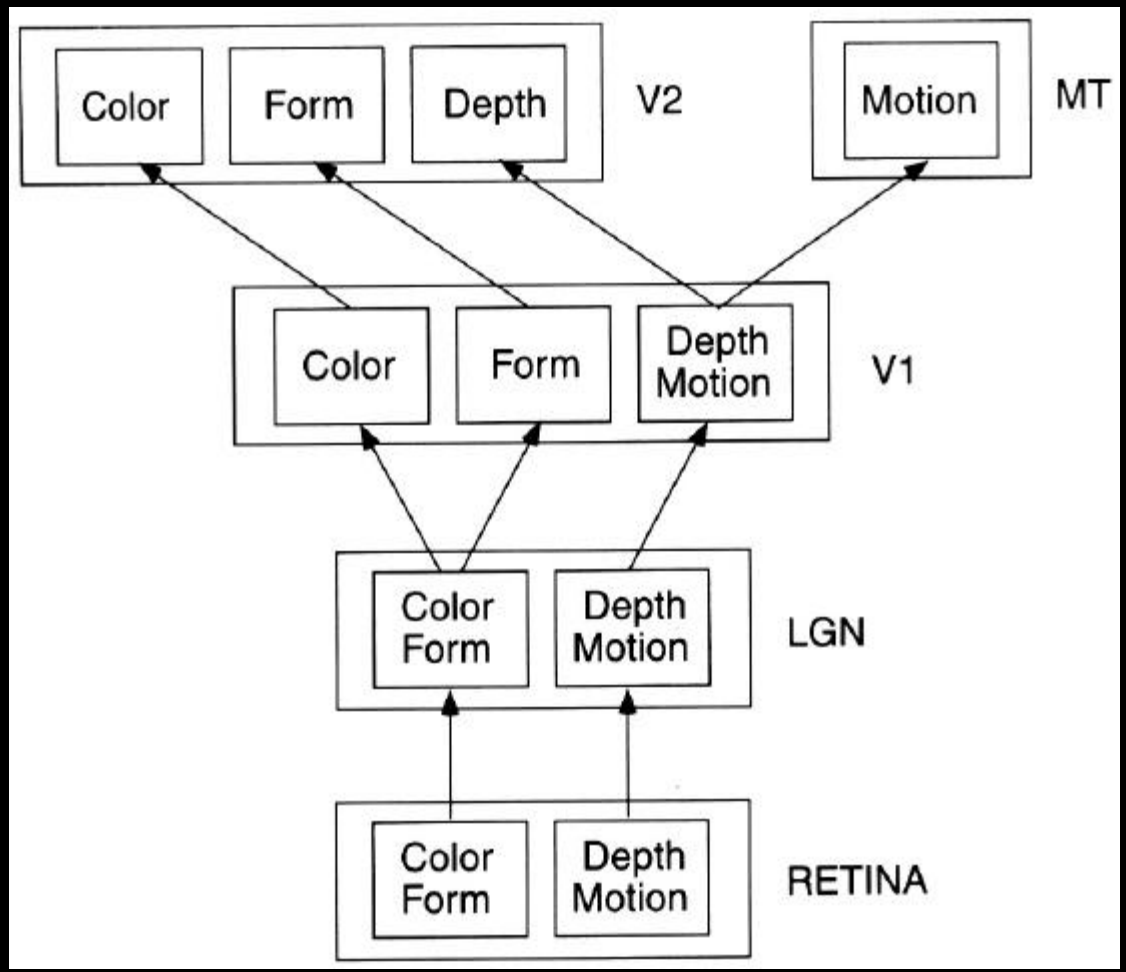
Relation to visual arts

- Same elements:
  - Color
  - Form
  - Layout
  - Texture
- Selective treatment
  - Focus in brain
- Orchestra metaphor



Relation to visual arts

- Same elements:
  - Color
  - Form
  - Layout
  - Texture
- Selective treatment
  - Focus in brain



Form and color

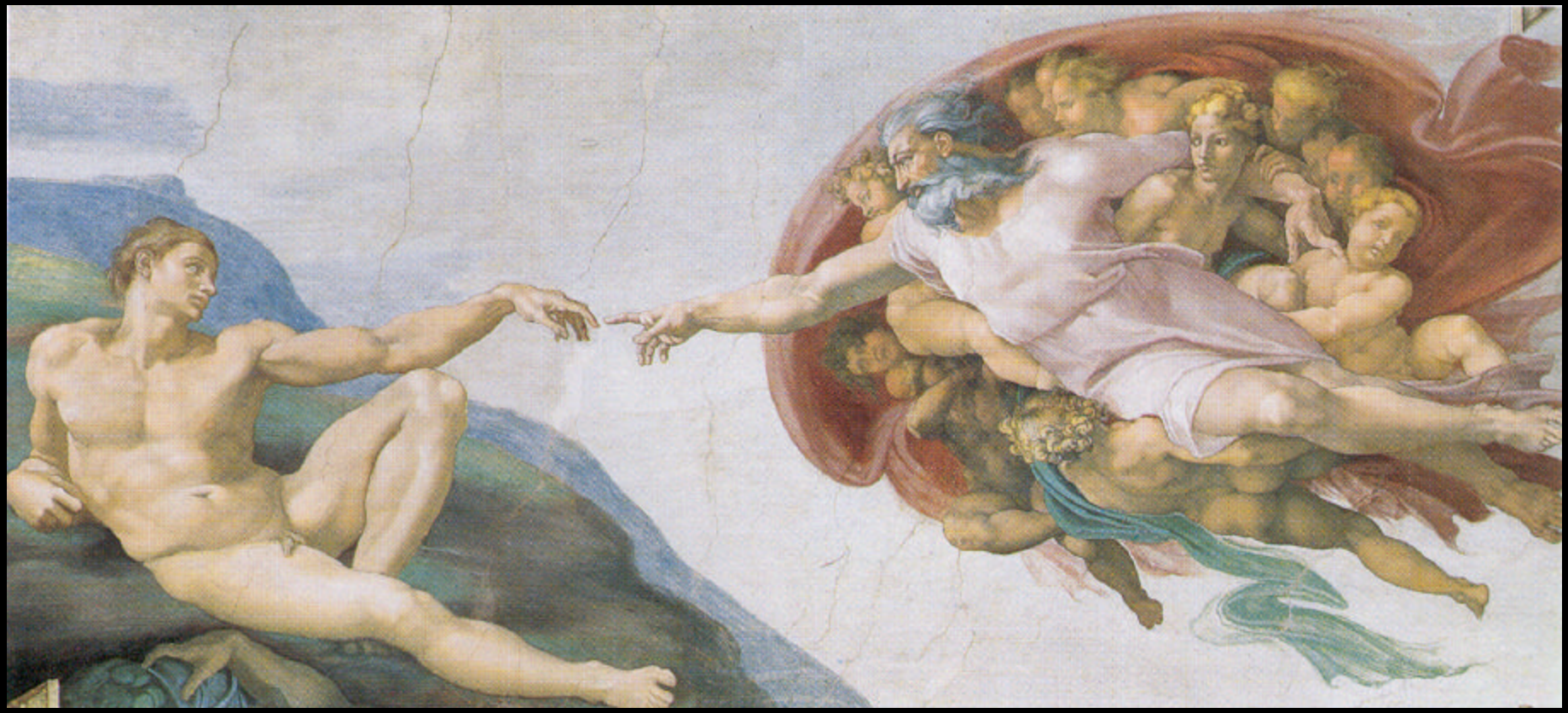
Lines

Absence of color, contrast

Shape

Duet: shape and texture

Symphony



Plan of the few next sessions

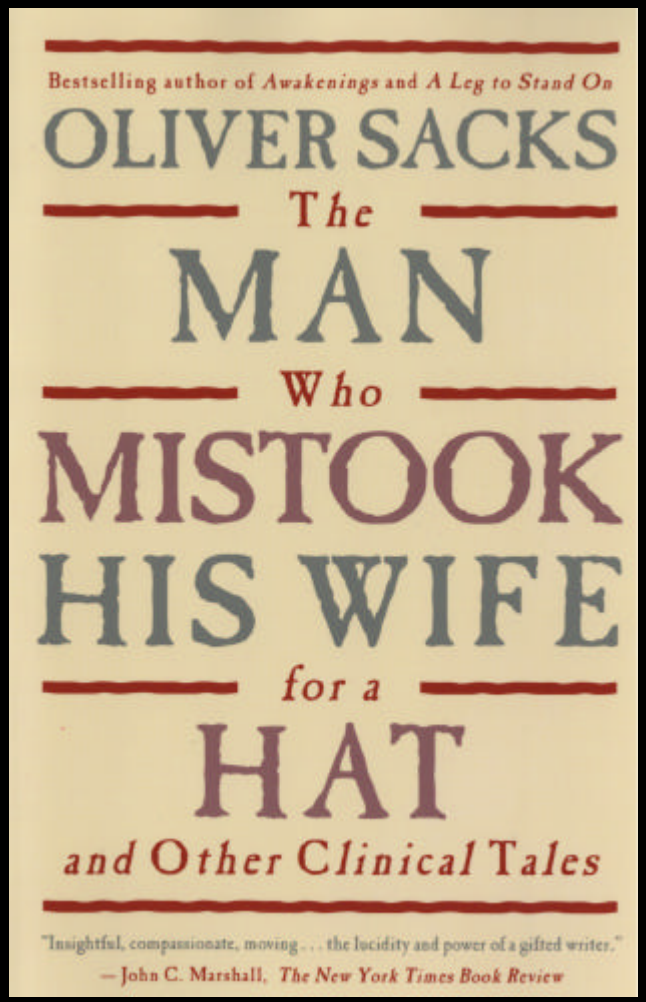
- Stepping back
- Organization, Gestalt
- Perceiving shape and objects
- Focus, attention
- Color vision

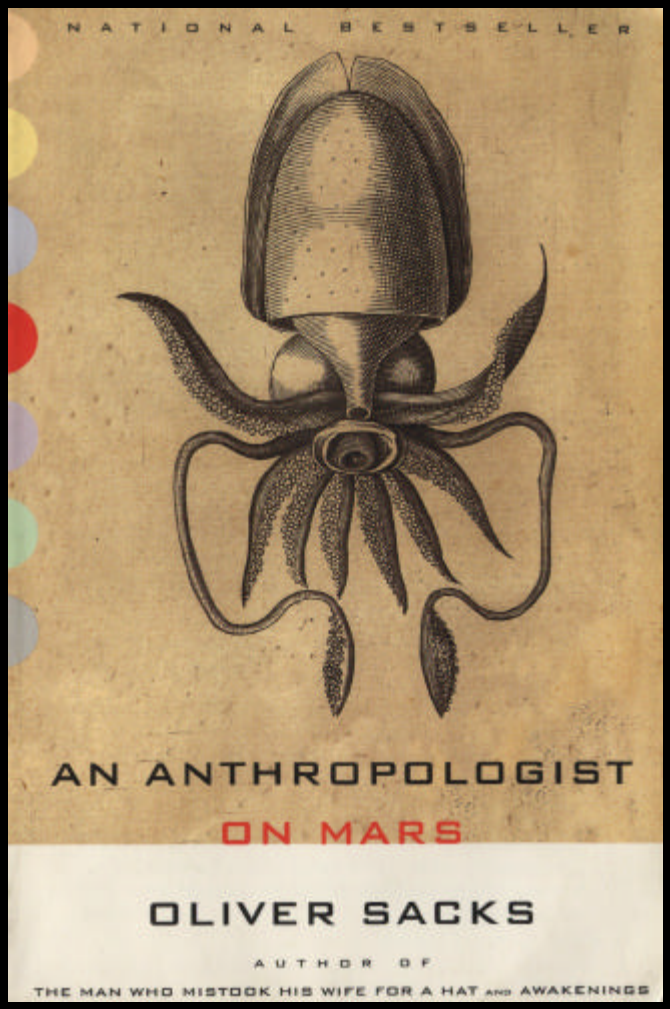
Assignments

- Feedback
- Image
- Reading
- Piranesi

Reading

- Do not forget Gombrich…





Assignment

- Piranesi tutorial
  - Demo version on the class web page
  - Non-photorealistic rendering
  - Tutorial 1 to 3
  - Skip 2.4


Talk

- Decision next week
- Either come with a subject
- Or look on the class web page for suggestions