The Art and Science of Depiction

Introduction to Visual Perception

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Vision is not straightforward

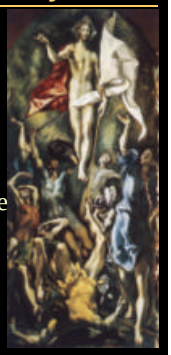
- The complexity of the problem was completely overlooked because
  - The problem is so difficult
  - The human visual system is so efficient

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

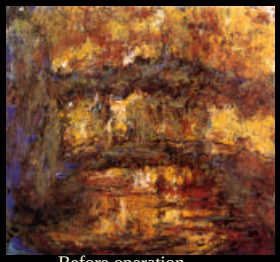
Beware of the El-Greco Fallacy

- 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

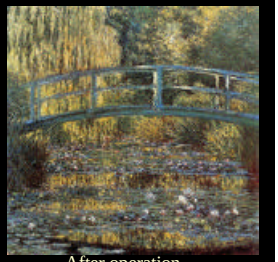


However…

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

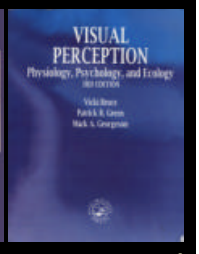


Before operation



After operation

Textbooks



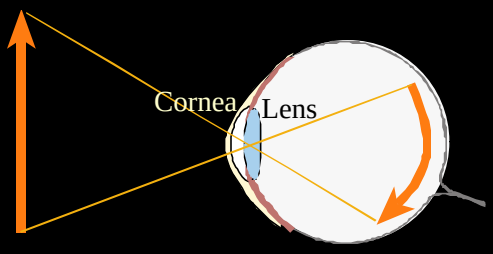
Plan

- Eye
- Low-level processing
- Different pathways

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

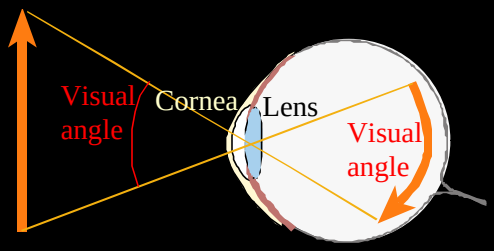
Eye: optics

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



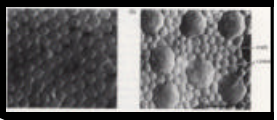
Eye: visual angle

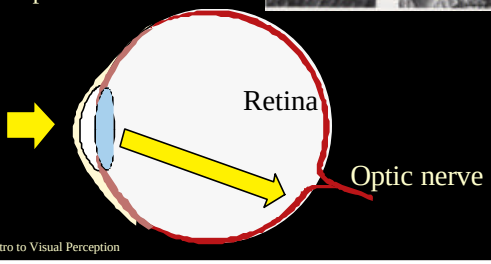
- Corresponds to size of the projection on retina
- Depends on real size and distance



Retina

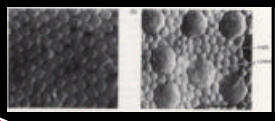
- Layer of photoreceptors
- Light->neural signal
- Optic nerve

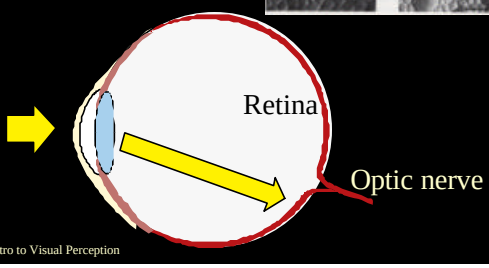




Photoreceptors

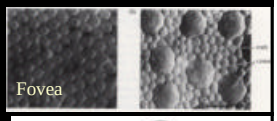
- Rod: night vision
- Cone: bright, color vision

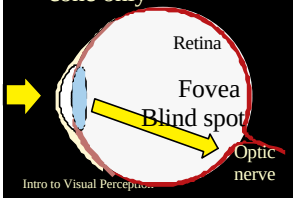


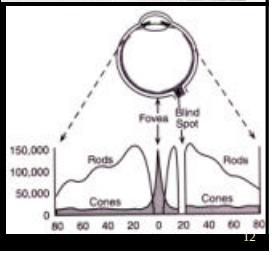


Photoreceptors

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

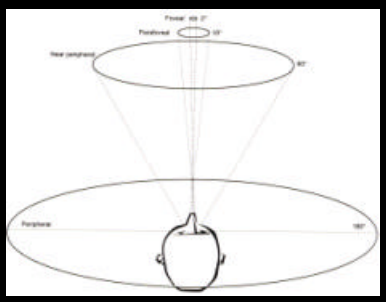






Field of view

- Fovea=2-5 degrees



Field of view

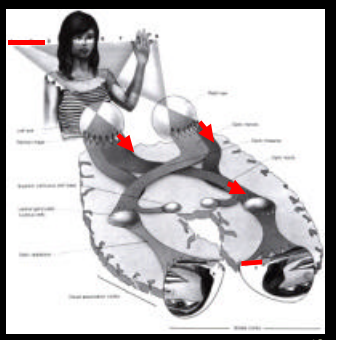
- Fovea=2 degrees

Summary

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

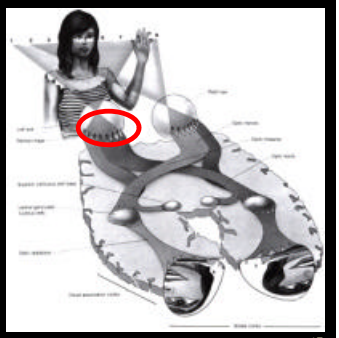
Overview of pathway

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



Visual processing

- First step in the retina itself

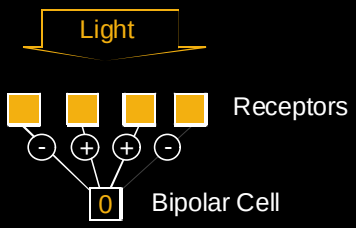


Contrast processing

- 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



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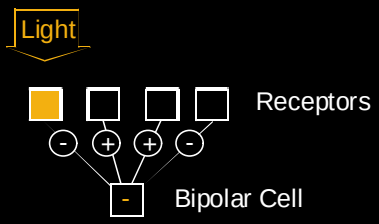

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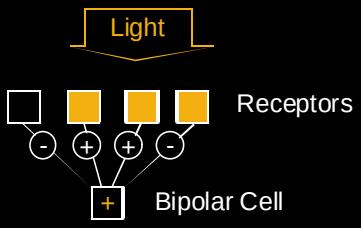

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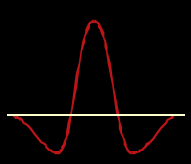
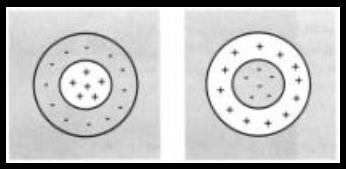
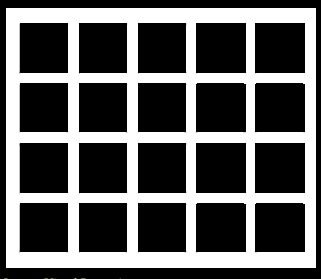
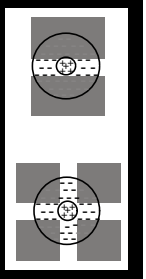




Hermann Grid





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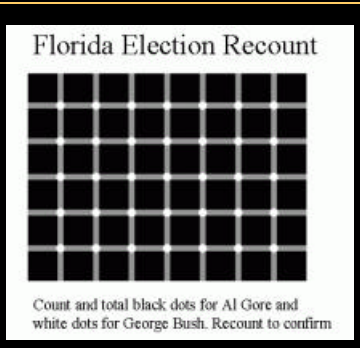
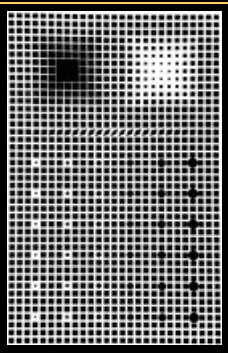
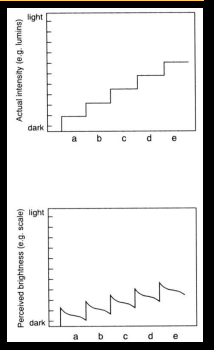


Vasarely, Supernovae



Mach Bands

- Contrast is enhanced at region boundaries

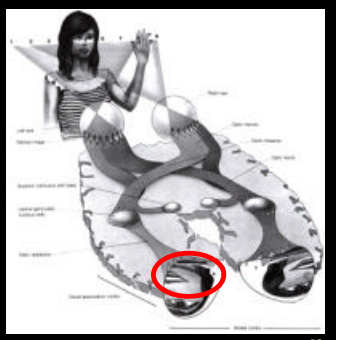


Relation with photo and painting

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

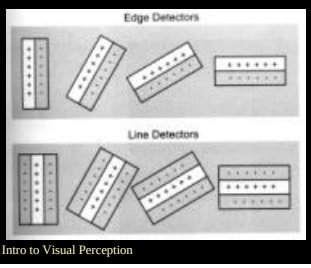
Visual processing

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



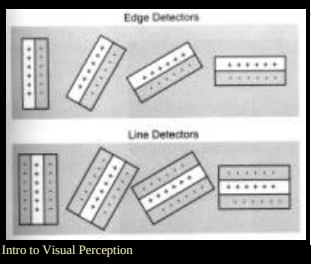
Edge detection

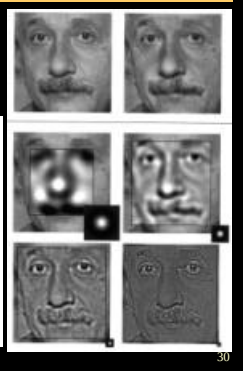
- Similar to center-surround
- Measured using micro-electrodes



Edge detection: Multi-resolution

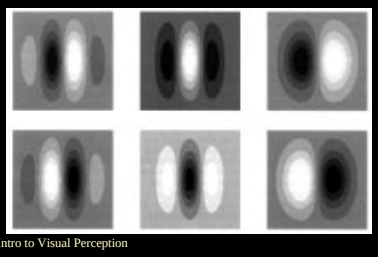
- Edge of different sizes





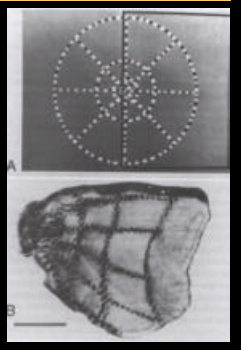
Edge detection: not so simple

- Edges are only a special case
- Patterns



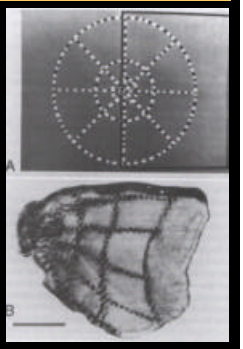
Retinotopic

- 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

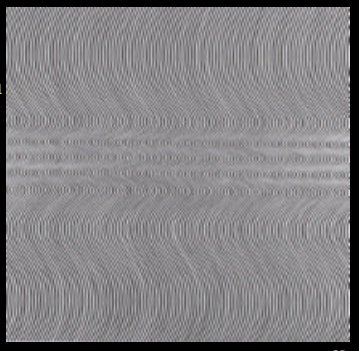


Relation with line drawing

- The information is ~ the same
- Drawing simplifies edge detection
- Some neurologist believe that line drawing nicely excites areas of the brain

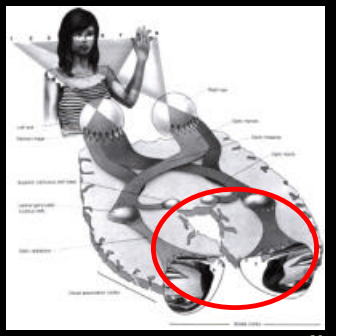
Optical art

- Op' Art directly exploits low-level vision



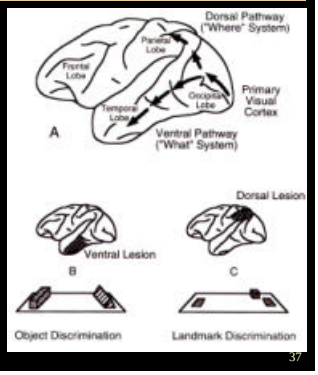
Higher-level visual processing

- More complex
- Less understood or "measured"
- Different pathways

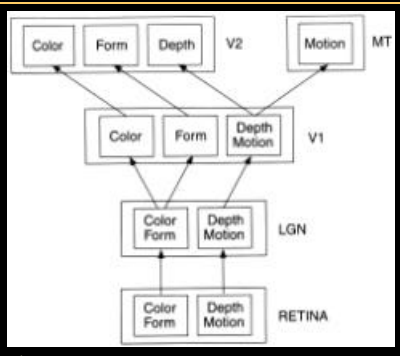


Dorsal vs. Ventral pathways

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

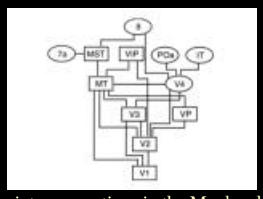


Different visual channels



Different visual channels

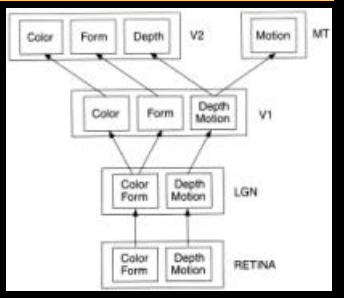
- Quite complex interactions
- Not sequential
- Not one-way
- Not strictly separate



Some interconnections in the Monkey brain

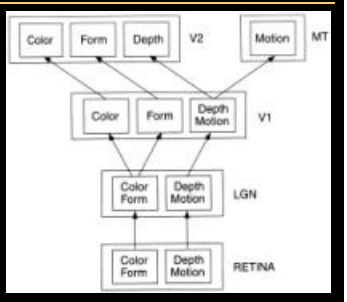
Relation to visual arts

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



Relation to visual arts

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



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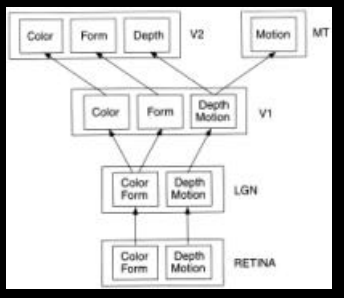


Form and color

Lines

Absence of color, contrast

Shape

Duet: shape and texture

Symphony

Plan of the few next sessions

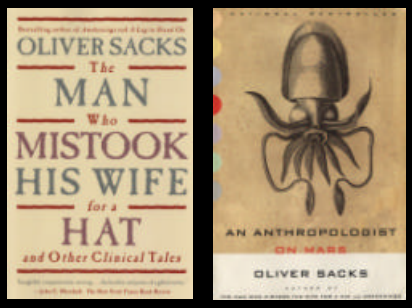
- Stepping back
- Organization, Gestalt
- Perceiving shape and objects
- Focus, attention
- Color vision

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