

*The Art and Science of Depiction*  
**Introduction to  
 Visual Perception**

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 MIT- Lab for Computer Science

*Vision is not straightforward*

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

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*Vision and pictures*

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

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*Beware of the El-Greco Fallacy*

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- 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





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*However...*

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


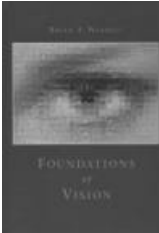
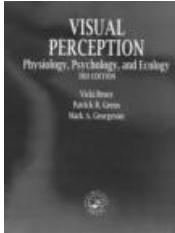



Before operation After operation

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*Textbooks*

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### Plan

- Eye
- Low-level processing
- Different pathways

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

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### Eye: optics

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

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### Eye: visual angle

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

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### Retina

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

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### Photoreceptors

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

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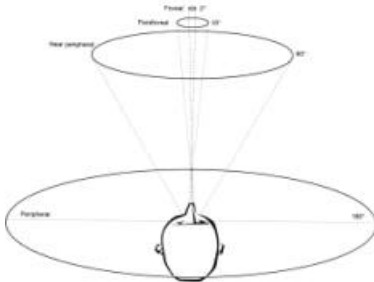
### Photoreceptors

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

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## Field of view

- Fovea=2-5 degrees



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## Field of view

- Fovea=2 degrees



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## Summary

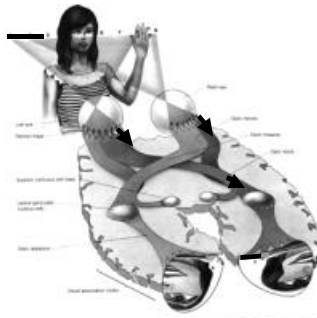
- Light is transformed into 100M neural signals
- But... optic nerve has only 1M nerve fibers

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## Overview of pathway

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

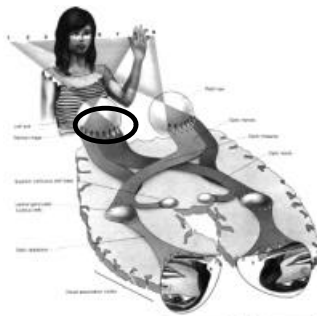


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## Visual processing

- First step in the retina itself



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## Contrast processing

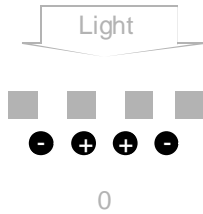
- We are sensitive to contrast, not to absolute luminance
- Useful because contrast is more invariant (it depends less on illumination)

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### Contrast processing

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

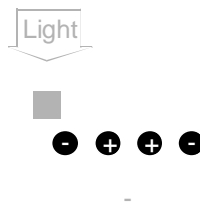


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### Contrast processing

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

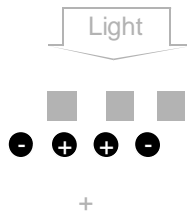


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### Contrast processing

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

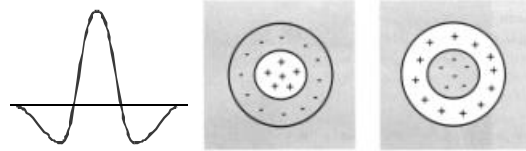


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### Contrast processing

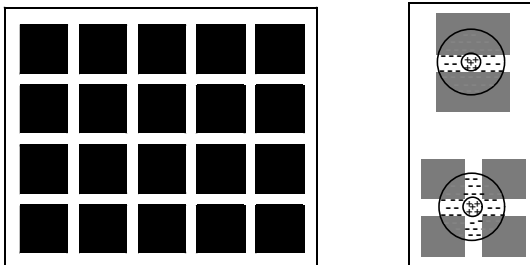
- Receptors are wired to other neurons
- Center-surround organization



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### Hermann Grid

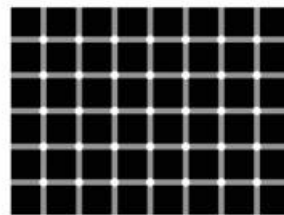


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### Hermann Grid

#### Florida Election Recount

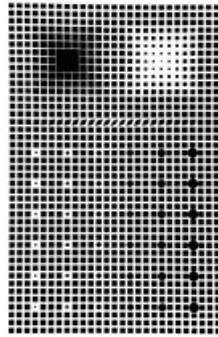


Count and total black dots for Al Gore and white dots for George Bush. Recount to confirm

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## Vasarely, *Supernovae*

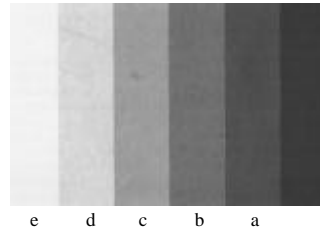


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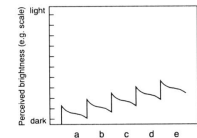
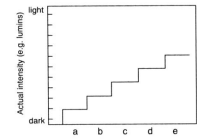
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## Mach Bands

- Contrast is enhanced at region boundaries



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## Relation with photo and painting

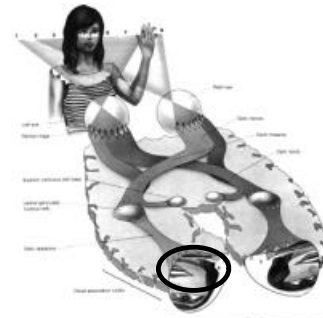
- Low contrast is not that much a problem
- A photo can be brighter/lighter than the original

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## Visual processing

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

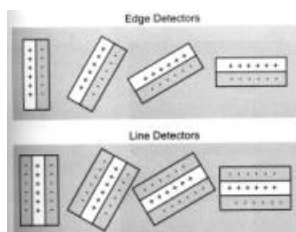


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## Edge detection

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

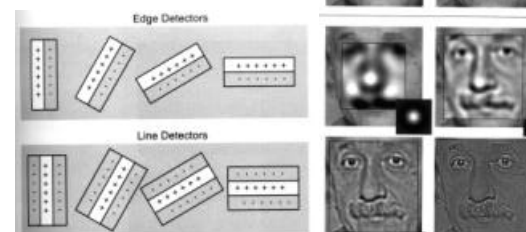


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## Edge detection: Multi-resolution

- Edge of different sizes

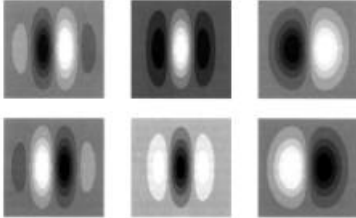


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### Edge detection: not so simple

- Edges are only a special case
- Patterns

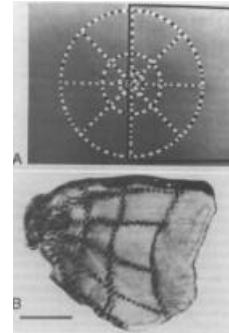


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### Retinotopic

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

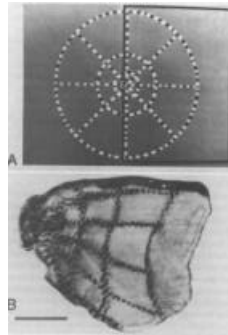


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### Retinotopic

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



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### 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

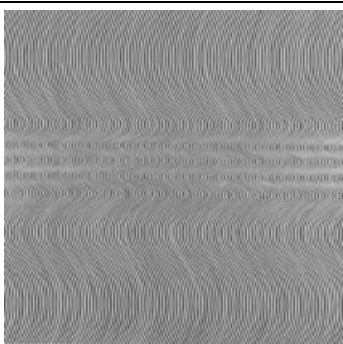


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### Optical art

- Op' Art directly exploits low-level vision



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### Higher-level visual processing

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

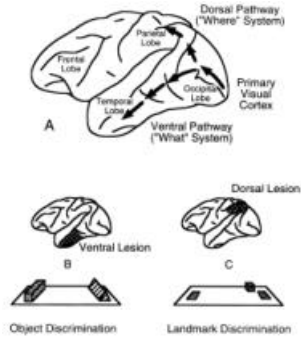


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## Dorsal vs. Ventral pathways

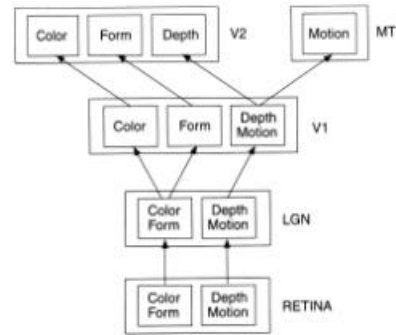
- Ventral pathway: What?
  - Object recognition
- Dorsal Pathway: Where?
  - Location
- Study on monkeys with damaged brain



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## Different visual channels

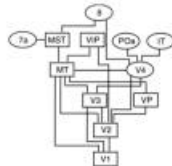


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## Different visual channels

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



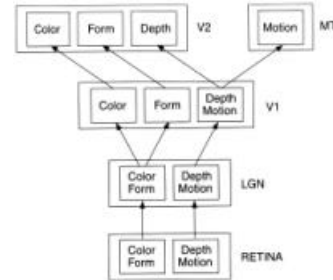
Some interconnections in the Monkey brain

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## Relation to visual arts

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

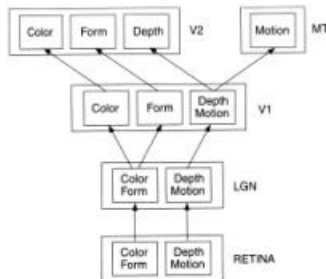


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## Relation to visual arts

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

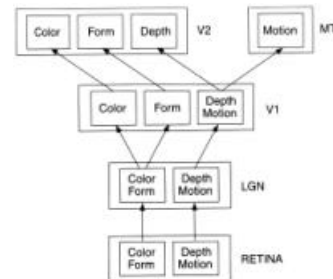


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## Relation to visual arts

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



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*Form and color*



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*Lines*



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*Absence of color, contrast*



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*Shape*



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*Duet: shape and texture*



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*Symphony*



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## *Plan of the few next sessions*

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

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## *Assignments*

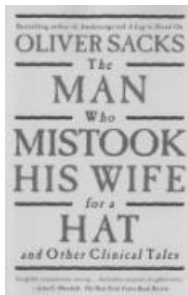
- Feedback
- Image
- Reading
- Piranesi

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## *Reading*

- Do not forget Gombrich...



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## *Assignment*

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



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## *Talk*

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

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