Visual perception

PSY 200

Greg Francis

Lecture 09

Why you see color afterimages.

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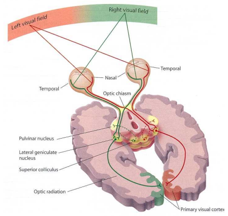
Visual perception

- Light enters eye
- Signals sent to area V1 in cortex
- Neural networks tuned to
  - brightness
  - color
  - form
  - motion
  - texture
  - depth...



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Neurophysiology

- How we see things is largely determined by the properties of receptive fields
  - on-center, off-surround
  - simple cells
  - complex cells
- And by network interactions among cells

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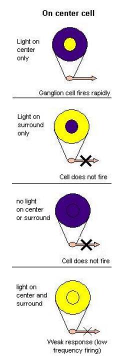
On-center, off-surround

- Characteristics of cell receptive fields force additional properties of the visual system
  - center-surround cells tend to not respond well to homogeneous light that covers both excitatory and inhibitory parts
  - => percepts of the middle of an object is derived from the edges



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On-center, off-surround

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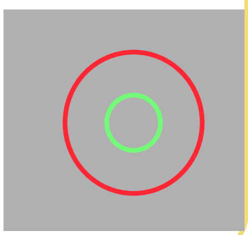

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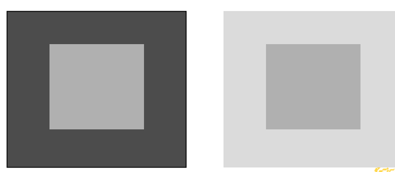
Brightness contrast

- Edge responses are influenced by the surrounding light
  - both center squares have the same light intensity



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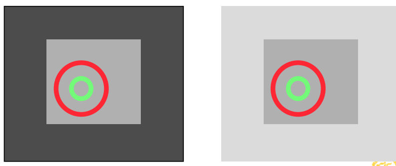
Brightness contrast

- Two receptive fields inside the middle square receive the same excitatory and inhibitory signals
  - Little response



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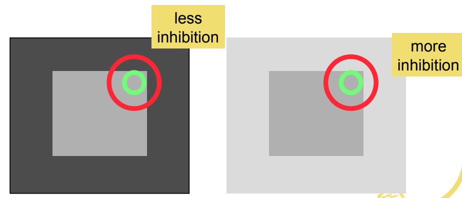
Brightness contrast

- Receptive fields on the corner
  - Receive the same excitation at the center
  - differ in the amount of inhibition in the surround



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Brightness contrast

- Thus, the visual system computes brightness as something like *local* contrast
  - It's a property of the center-surround cells
  - Our percept of brightness is determined by the responses of cells at contrast edges
  - As a result, things that have equal physical intensities can look dramatically different (next slide)

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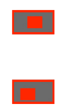
Brightness contrast

Checker-shadow illusion:
The squares marked A and B
are the same shade of gray.



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Brightness contrast

Checker-shadow illusion:
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Brightness contrast

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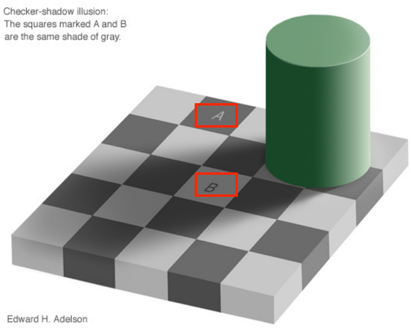

Edward H. Adelson

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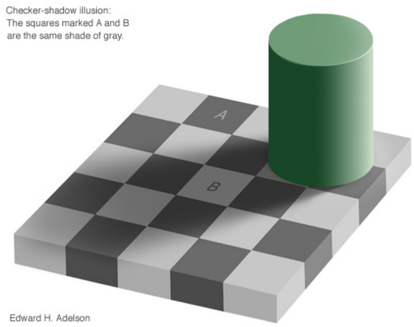
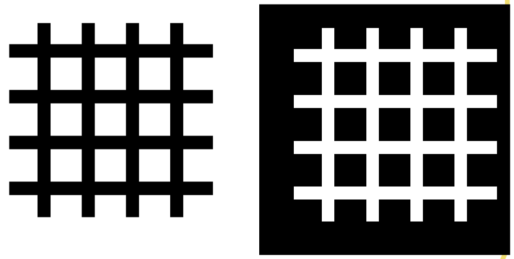
Brightness contrast

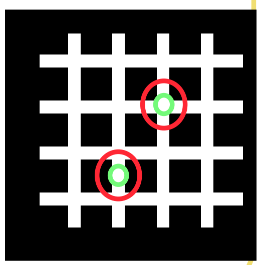


Hermann grid



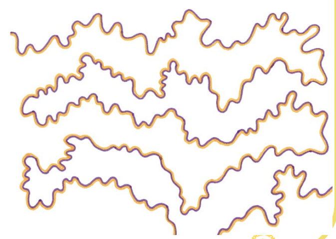
Hermann grid

- Seems related to on-center, off-surround cells
- Cells at intersections receive more inhibition than cells at single roads
- How do we explain the other version?



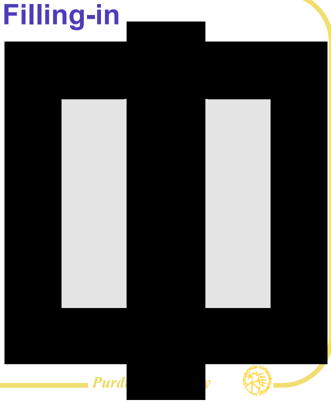
Filling-in

- We *see* color and brightness inside objects
  - so edge information must fill-in to the interior
- It sometimes gets things messed up
- Water color effect



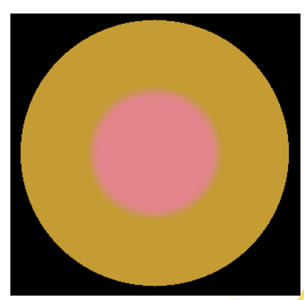
Filling-in

- Brightness information spreads across surfaces
  - Craik-O'Brien-Cornsweet effect



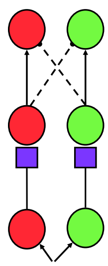
Filling-in

- Carefully fixate the pink center
- If you keep your eyes *very* still, it will disappear
- The yellow fills-in!



Color system

- competition between opposite colors
  - red-green
  - blue-yellow
  - black-white
- habituating gate
- offset of one color leads to rebound in other
- Gated dipole circuit



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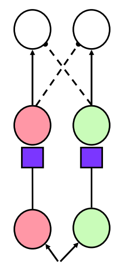
Color system

- competition between opposite colors
  - red-green
  - blue-yellow
  - black-white
- Initial balance
  - Neither color wins competition



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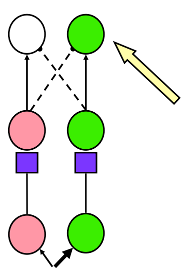
Color system

- competition between opposite colors
  - red-green
  - blue-yellow
  - black-white
- Extra input to green
  - Green wins competition



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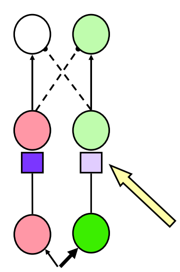
Color system

- competition between opposite colors
  - red-green
  - blue-yellow
  - black-white
- Extra input to green
  - Fading of green signal



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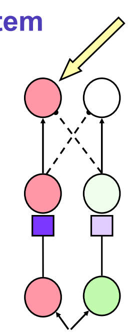
Color system

- competition between opposite colors
  - red-green
  - blue-yellow
  - black-white
- Offset of green
  - Rebound of red signal



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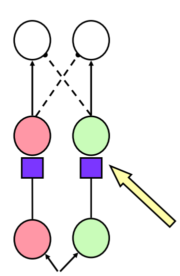
Color system

- competition between opposite colors
  - red-green
  - blue-yellow
  - black-white
- Recovery of green pathway
  - Disappearance of rebound
  - Return to initial state



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Color afterimage

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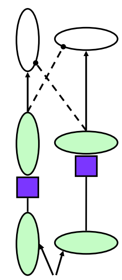
Orientation competition

- competition between orthogonally tuned cells
- habituating gate
- offset of horizontal leads to rebound in vertical
- Same kind of gated dipole circuit
  - Principles of neural computation!
- Baseline response
  - Due to tonic input



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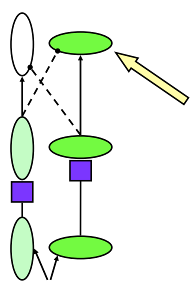
Orientation competition

- With additional input to horizontal pathway, horizontal channel wins competition



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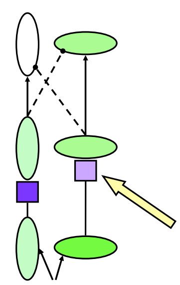
Orientation competition

- With additional input to horizontal pathway, horizontal channel wins competition
- But as horizontal gate habituates, horizontal signal weakens
- It still wins the competition, though



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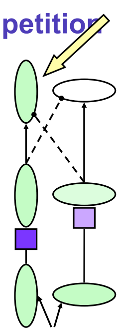
Orientation competition

- At offset of horizontal input, the gated horizontal signal is weaker than the vertical signal
- A vertical rebound appears



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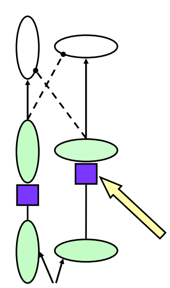
Orientation competition

- As the horizontal gate recovers, the system returns to baseline and the vertical after response disappears



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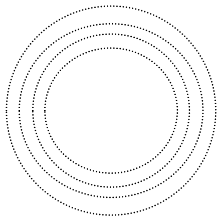
Oriented afterimages

- Oriented reset signals are also implicated in an unusual type of afterimage



Conclusions

- Visual perception
  - brightness
  - color
  - form
- Largely determined by the receptive fields and network structure of visual circuits
- Neurophysiology strongly determines what we see!

Next time

- Visual dynamics
  - Flicker
  - Persistence
  - Motion perception
- CogLabs on Apparent motion and Metacontrast Masking due!
- *Why computer monitors work.*