

# Biology 70, Lecture 4, Part II

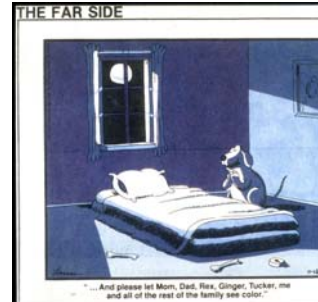
## Fall 2007

color



1

another bad joke



2

from lecture outline: COLOR

7. What property of light is responsible for color information? Under white light why does an opaque or translucent blue object appear blue? What would be the appearance of the blue object when illuminated with red light?
8. Know the following terms related to color vision:
  - a. trichromacy
  - b. metameric match
  - c. hue
  - d. saturation
  - e. simultaneous color contrast
9. What is the origin of the different spectral sensitivities of the three cone pigments?
10. What are color opponent cells?
11. Which of the major "parallel pathways" transmits color information?
12. How do the Young-Helmholz and Herring theories of vision differ? Are they incompatible?

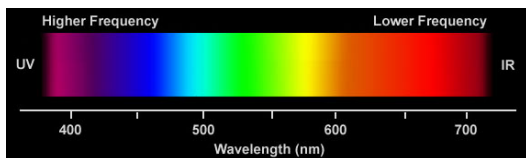
3

What's wrong here ??????



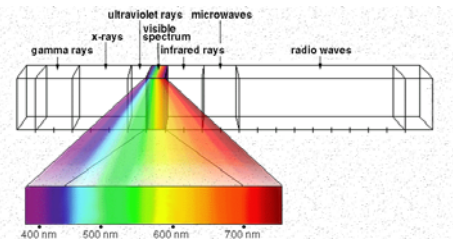
4

spectrum of visible light



5

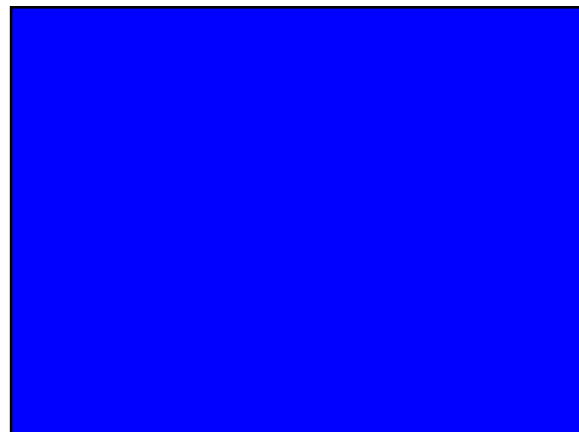
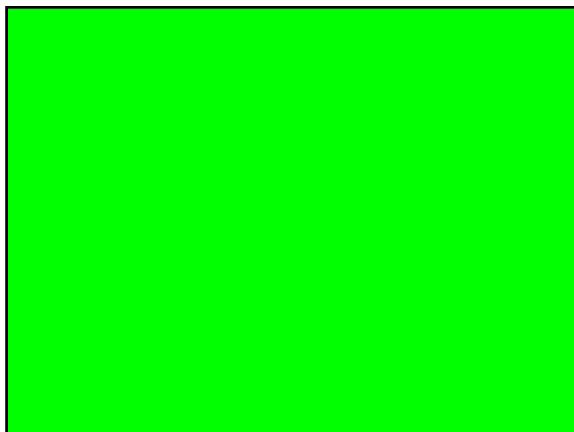
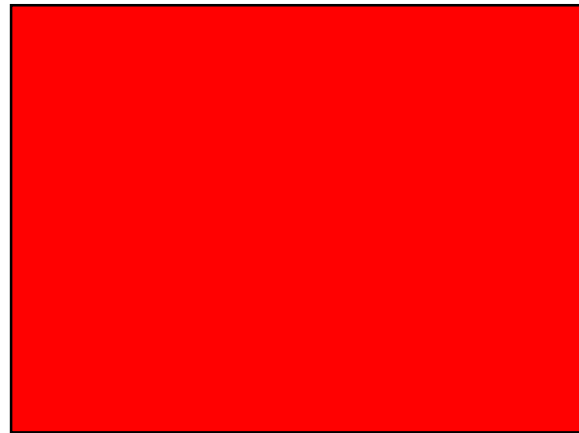
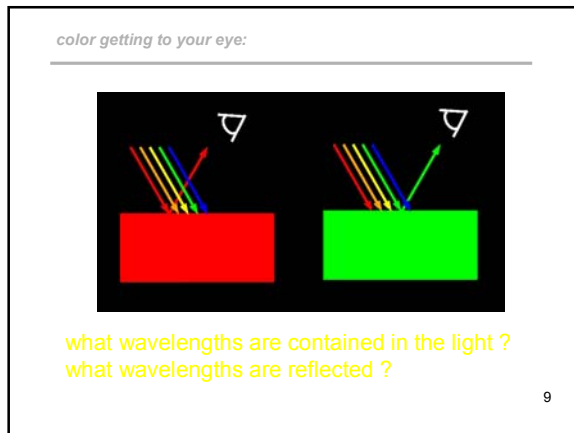
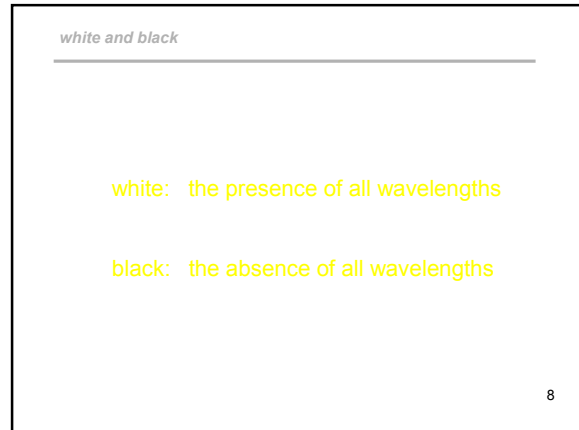
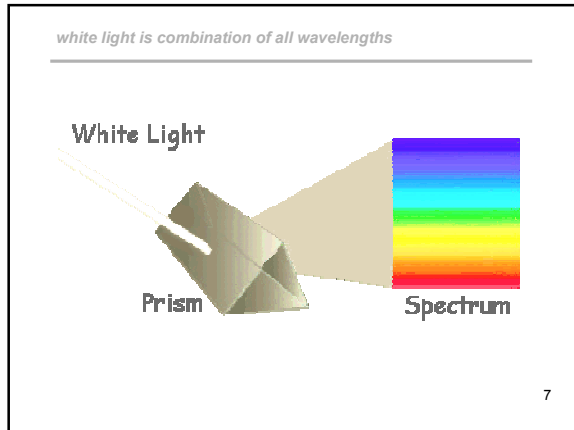
visible light is only region of electromagnetic spectrum



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## Fall 2007



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*hue and saturation (lightness)*

**hue**




PLATE 3. HUE indicates the character or kind of a colour (blue, red, green, blue, yellow, orange, etc.)

**saturation**




PLATE 4. LIGHTNESS indicates the brightness or, under the same conditions of visual conditions, the luminosity of a colour as determined from differences in saturation. The general name 'white' and its common name 'grey' imply a colour of low lightness, when used for the addition of grey to black.


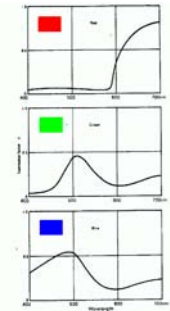


PLATE 5. SATURATION indicates the strength or purity of a colour. The general name 'red' and its usual name 'red' imply a colour of high saturation, when used for the addition of grey to black.

13

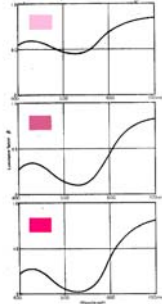
*reflectance of various hues*



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*reflectance and saturation*

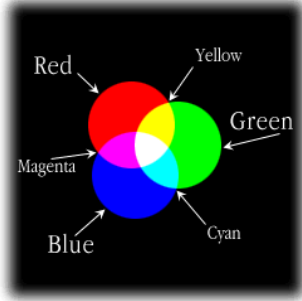
**less saturated**



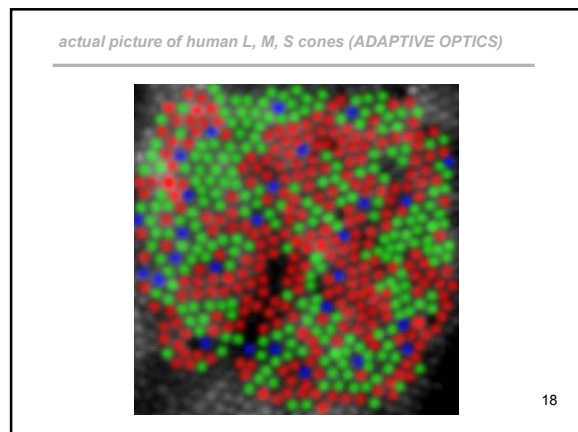
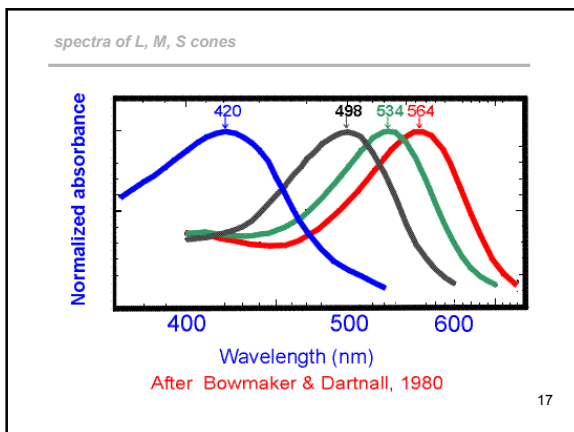
**more saturated**

15

*trichromacy*

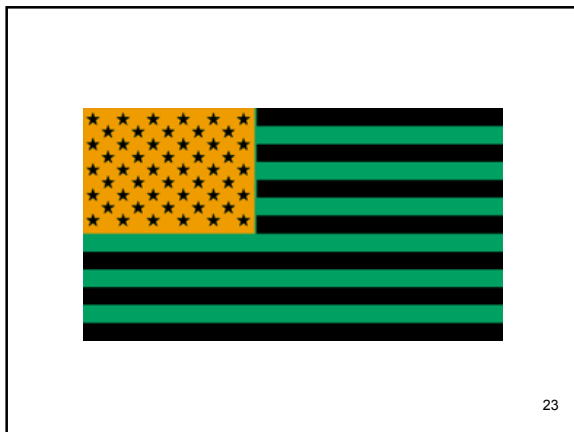
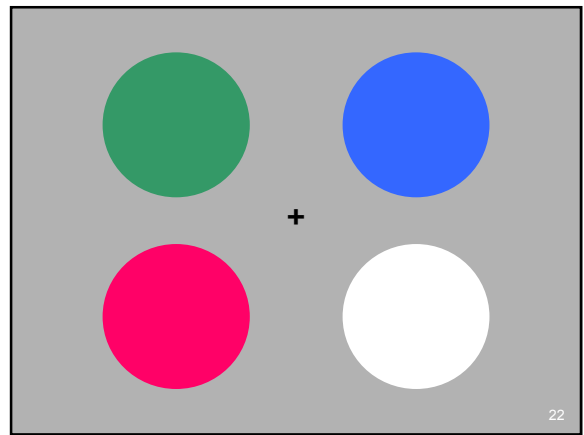
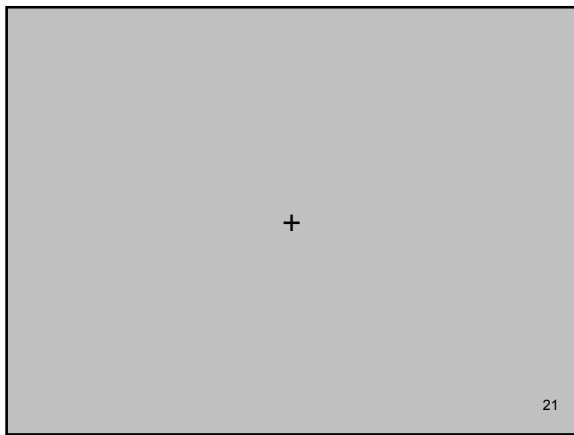
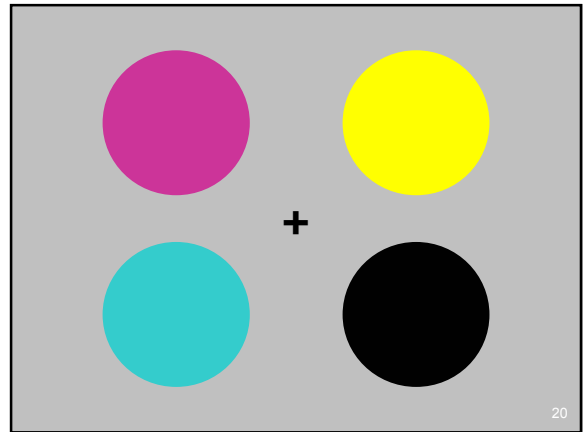
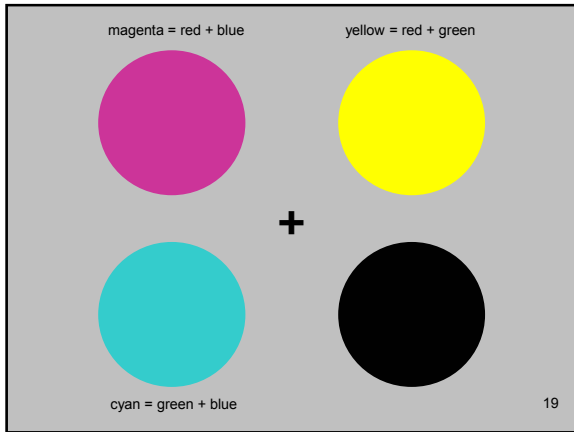


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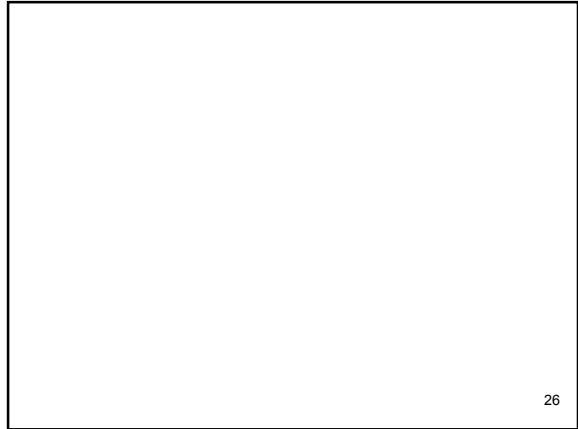


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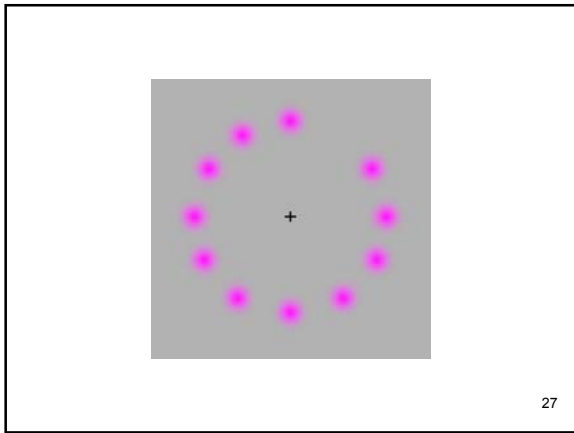
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### metamers

spectra of light from objects

activation of L-, M-, and S-cones and resultant color

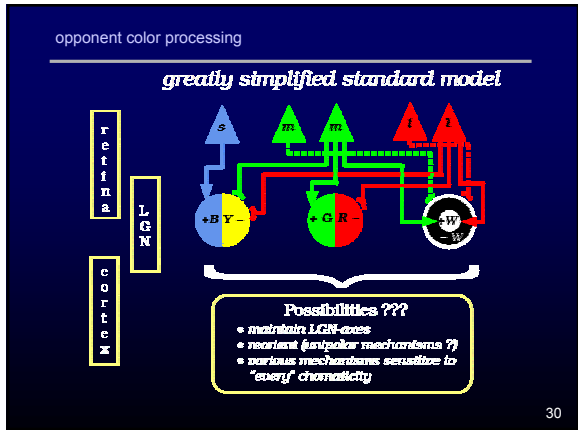
[http://tux.cs.brown.edu/exploratory/ColorWeb/color\\_TOC.html](http://tux.cs.brown.edu/exploratory/ColorWeb/color_TOC.html)

### more metamers

spectra of light from objects

activation of L-, M-, and S-cones and resultant color

[http://tux.cs.brown.edu/exploratory/ColorWeb/color\\_TOC.html](http://tux.cs.brown.edu/exploratory/ColorWeb/color_TOC.html)



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Kalat 6.13 (B+Y-)

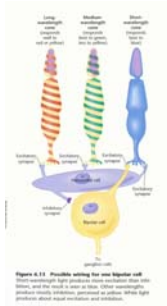


Figure 6.13 Double cones for cone bipolar cell. When monochromatic light stimulates these structures that cells, produce signals that are processed by the brain. When light produces signals that are processed by the brain.

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from lecture outline: COLOR

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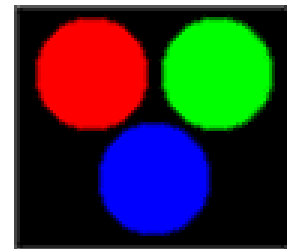
32

from lecture outline

13. What is a possible explanation for Benham's color wheel?
14. Describe the differences between additive and subtractive color mixing. Which types of color mixing applies to (1) paint pigments, (2) stage lighting (multi spotlight), and (3) Pointalist art?

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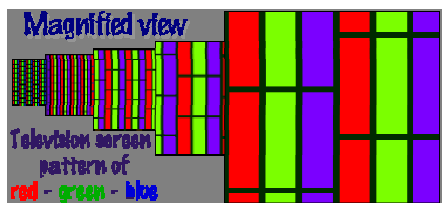
additive color mixing (red, green, blue)



<http://home.att.net/~RTRUSCIO/>

34

additive color mixing TV's and color monitors



35

additive color mixing: stage lighting

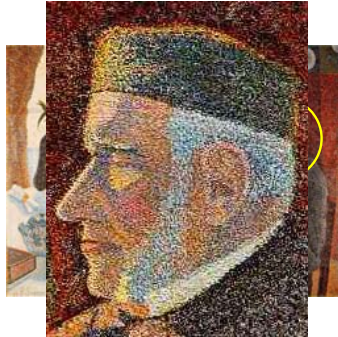


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additive color mixing: Pointalist art (la salle a manger (Paul Signac)



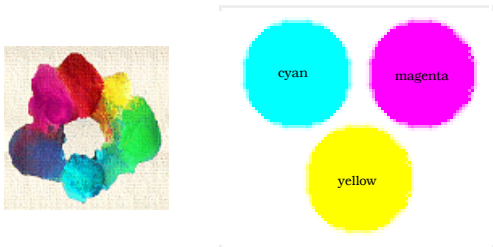
37

more Pointalist additive color mixing  
Seurat, jeune femme se poudrant



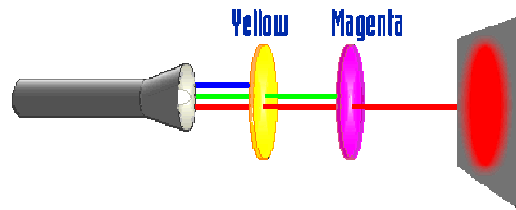
38

subtractive color mixing (magenta ('red'), yellow, cyan ('blue'))



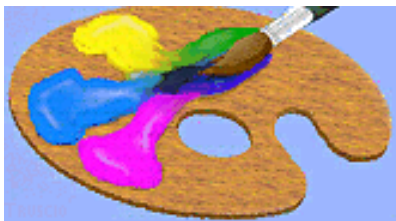
39

subtractive: Yellow (-B) + Magenta (-G) == RED



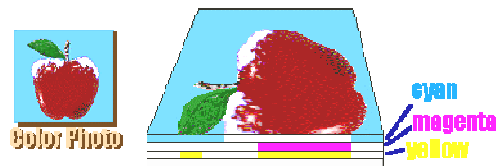
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pigment paint colors via subtractive color mixing



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subtractive color mixing: color photography

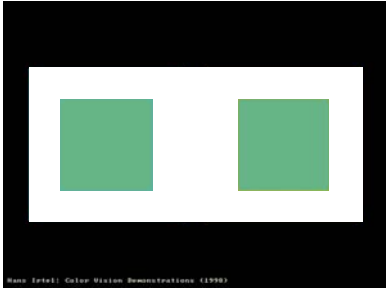


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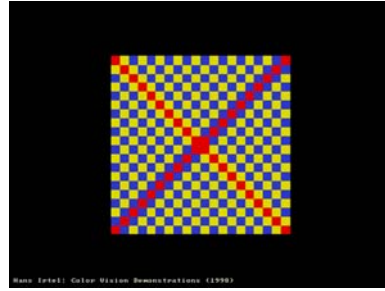
### simultaneous color contrast



Watts [Total] Color Vision Demonstrations (1998)

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### color assimilation



Watts [Total] Color Vision Demonstrations (1998)

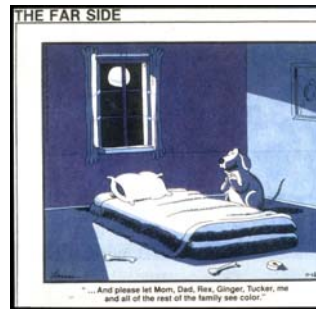
44

### from lecture outline

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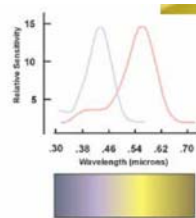
45

### another bad joke



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### animal psychophysics of wavelength discrimination



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### YES, FiFi le chien can discriminate colors !!



Final Neuroscience (1995), 3, 119-123. Printed in the USA.  
Copyright © 1999 Cambridge University Press 0953-2238/99 \$15.00 + .00

### Color vision in the dog

JAY NEITZ, TIMOTHY GEST, AND GERALD H. JACOBS  
Department of Psychology, University of California, Santa Barbara  
(Received February 24, 1999; Accepted April 15, 1999)

**Abstract**  
The color vision of three domestic dogs was examined in a series of behavioral discrimination experiments. Measurements of increment-threshold spectral sensitivity functions and direct tests of color matching indicate that the dog retina contains two classes of cone photoreceptors. These two classes are estimated to have spectral peaks of about 429 nm and 555 nm. The results of the color vision tests are all consistent with the conclusion that dogs have dichromatic color vision.

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### Visual Illusions

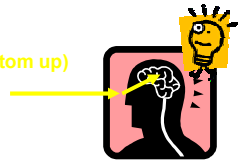
49

*from lecture outline*

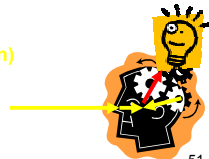
15. How are the following factors involved in various visual illusions?
  - a. illusions with explicitly known physiological origins
  - b. context or association including size constancy
16. Give examples of the visual system "making bets" or "filling in" and understand how these can lead to illusions.
17. Distinguish between bottom-up and top-down processing.

50

Physiological basis (mostly bottom up)

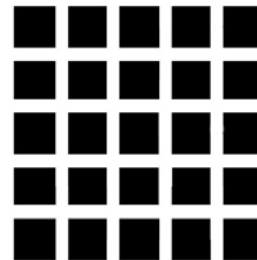


Context and expectations (top down)

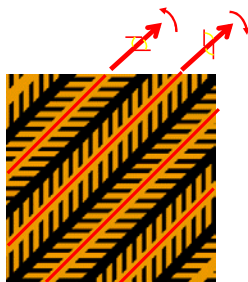


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*physiological explanations (concentric RF's, lateral inhibition)*

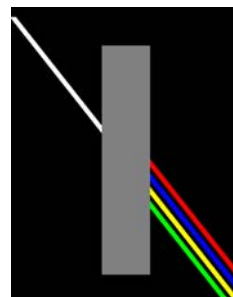


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*angle dilation illusion (Poggendorf)*



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Poggendorf illusion: acute angle dilation

[Poggendorf Interactive Illusion](#)

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Subjective Contours (expectation; top-down effect)

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more "top-down" vision

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Ponzo illusion: size constancy (expectation)

[Interactive Ponzo Illusion](#)

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Terra Subteranea©1997 Shepard

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Size Constancy

demo

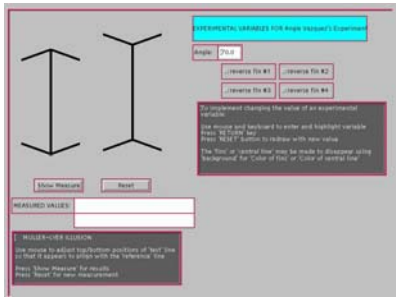
Terra Subteranea©1997 Shepard

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### Muller-Lyer illusion: size constancy??



Muller-Lyer Interactive Illusion

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### Gregory's 'corners' and size constancy (pp. 230-231)



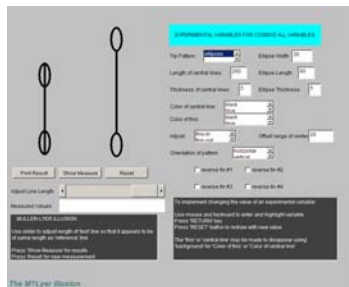
looks further away  
same size appears larger



looks closer  
same size appears smaller

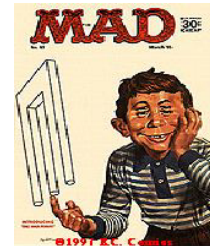
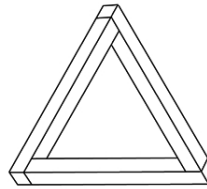
62

### Muller-Lyer Illusion [centroid (blur) at end of vertical line]



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### Impossible Figures



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### Escher



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### from lecture outline

How are the following factors involved in various visual illusions?

- physiological origins
- size constancy
- context or association

16. Give examples of the visual system "making bets" or "filling in" and understand how these can lead to illusions.

17. Distinguish between bottom-up and top-down processing.

66

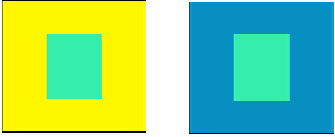
# Biology 70, Lecture 4, Part II

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*End Lecture 4*

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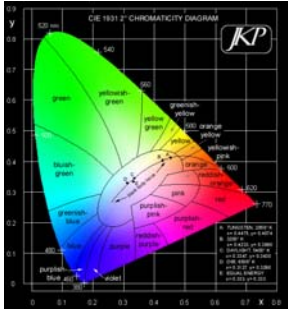
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CIE diagram

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