

# Biology 70, Lecture 4, Part II

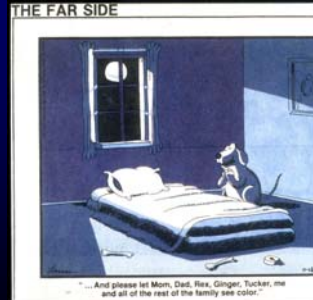
## Fall 2007

### 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. metamerism
  - 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?

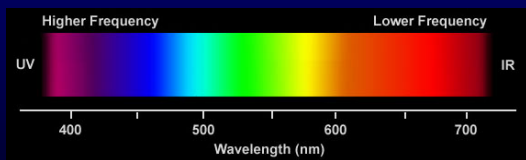
3

### What's wrong here ??????



4

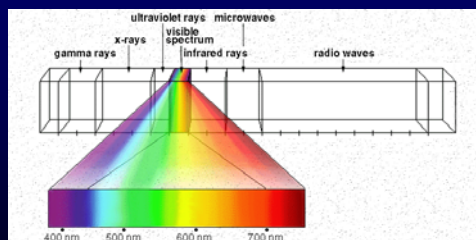
### spectrum of visible light



V I B G Y O R

5

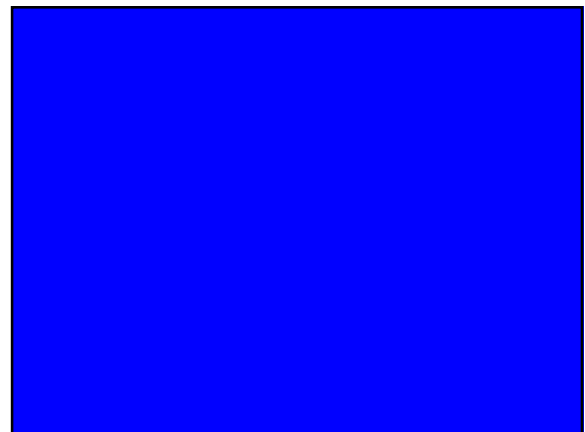
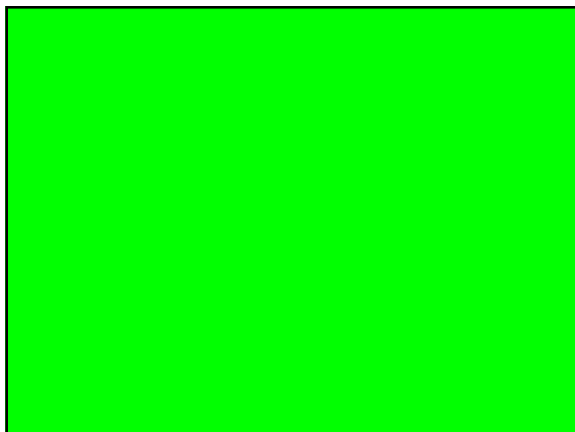
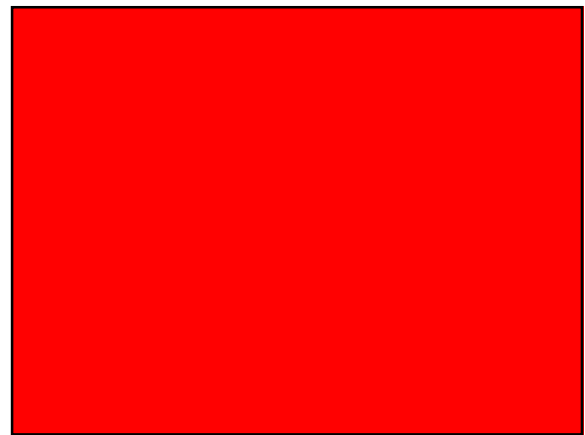
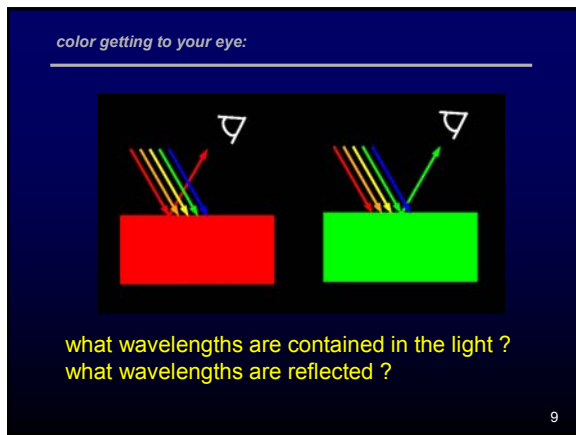
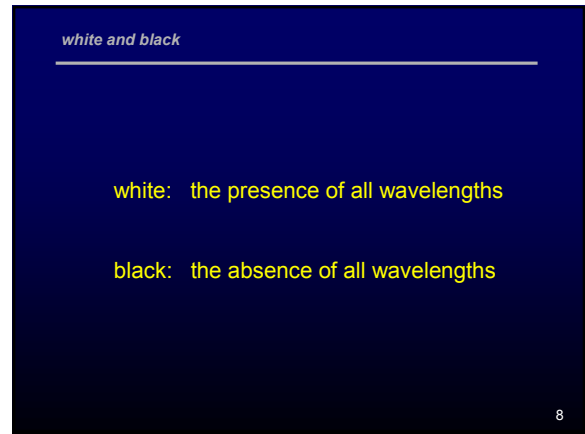
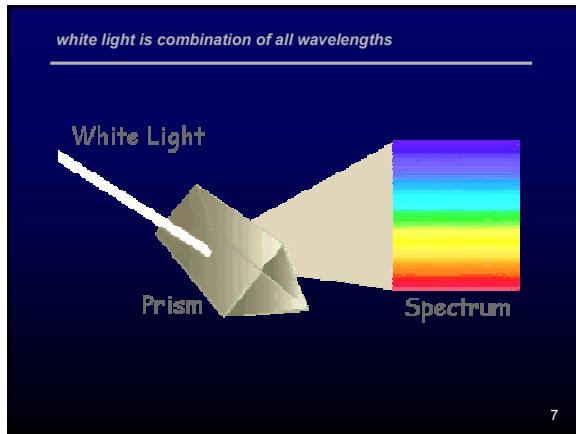
### visible light is only region of electromagnetic spectrum



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*hue and saturation (lightness)*

**hue**




PLATE 3. HUE indicates the character or kind of a colour (that is, 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, 'lighter', and its common name, 'paler', imply a colour of low lightness, when used as the adjective of grey or black.


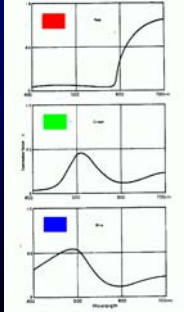


PLATE 5. SATURATION indicates the strength, or force, of a colour. The general name, and such other suitable terms of conventional colour theory, refer to the absence of white.

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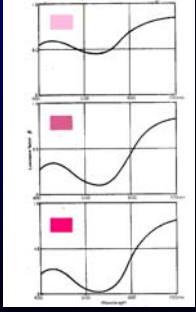
*reflectance of various hues*



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*reflectance and saturation*

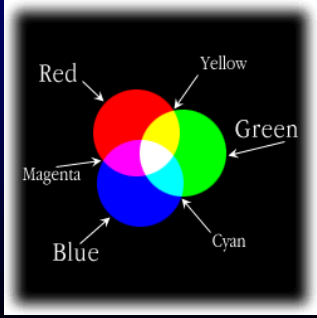
**less saturated**



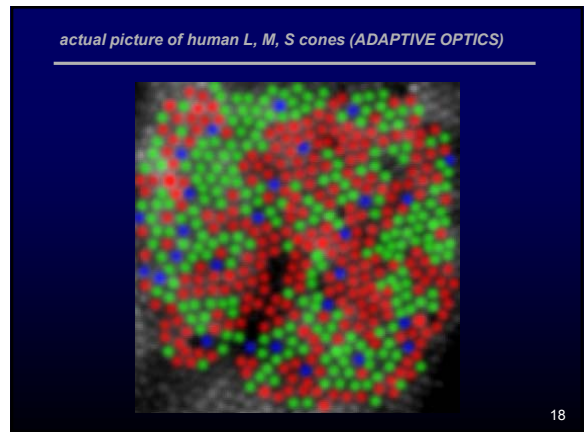
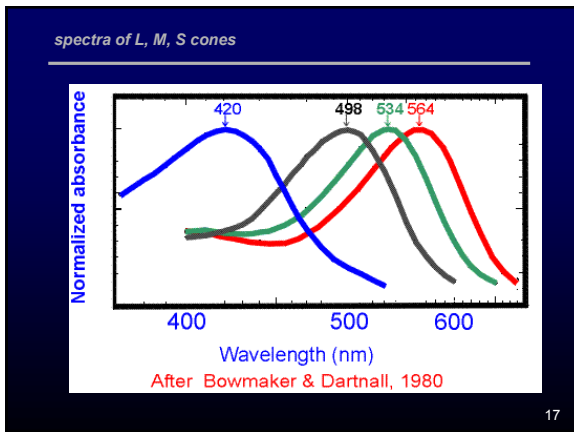
**more saturated**

15

*trichromacy*

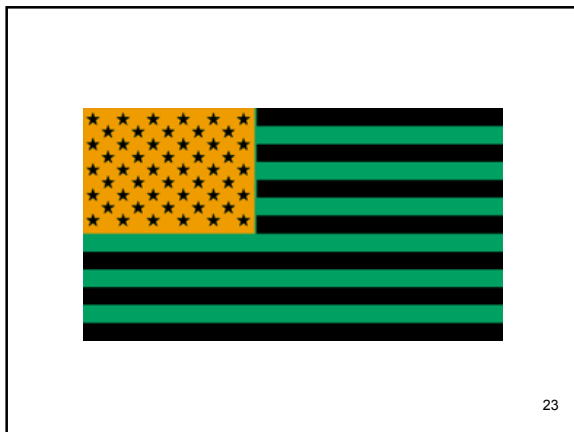
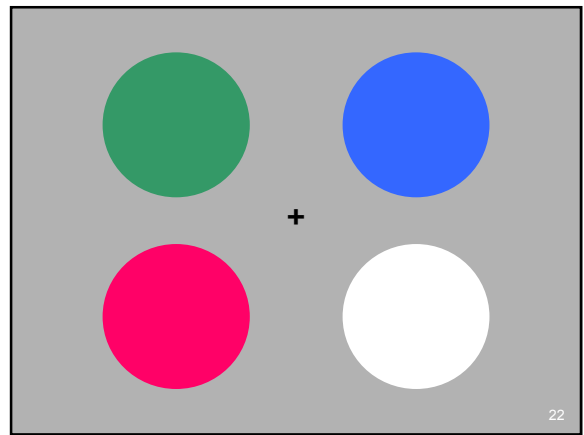
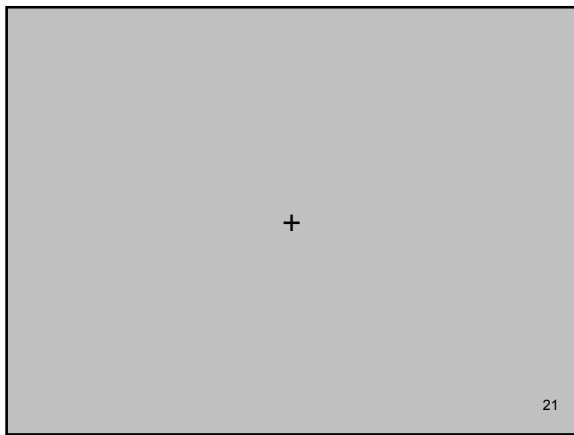
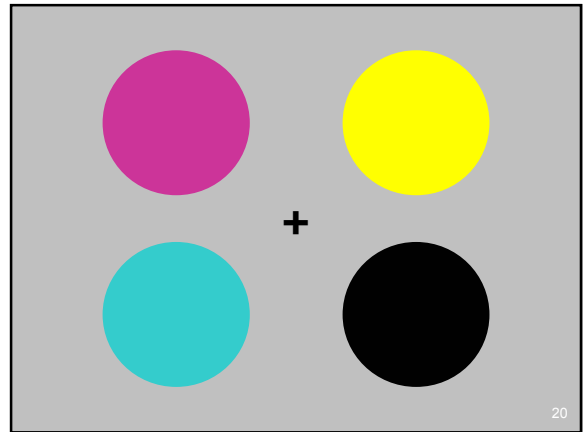
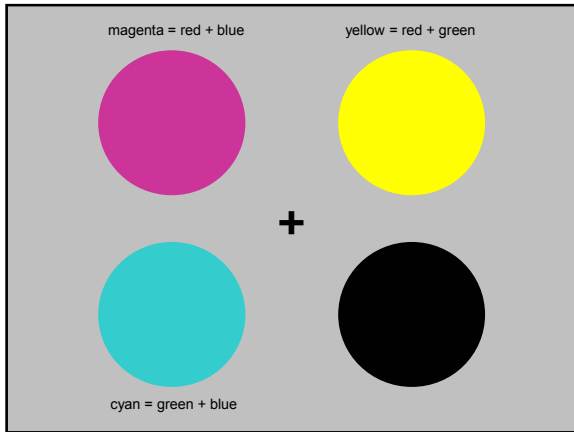


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## Fall 2007



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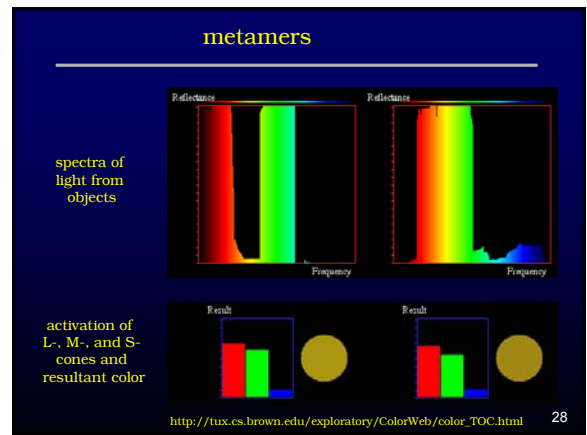
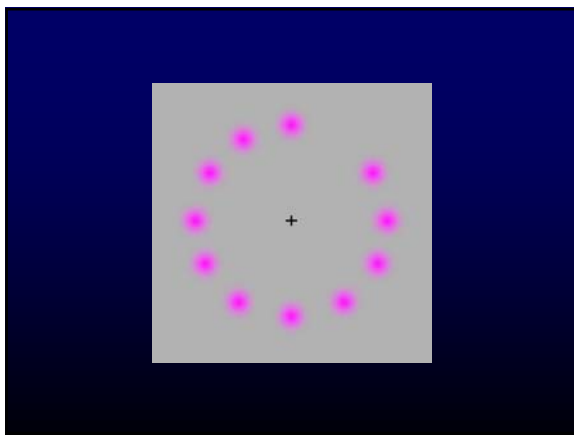
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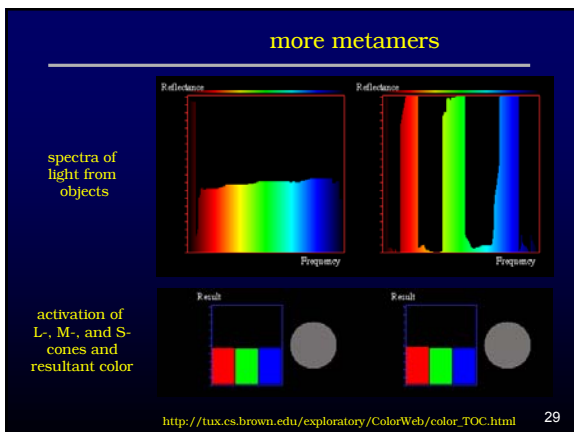
25



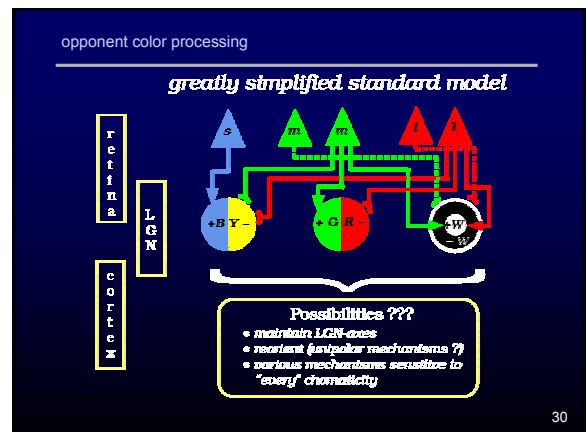
26



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Kalat 6.13 (B+Y-)

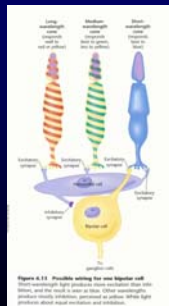


Figure 6.13. Structure of the eye. Light enters the eye through the cornea, passes through the aqueous humor, the lens, and the vitreous humor, and is focused on the retina. The retina contains rods and cones, which are sensitive to light. The optic nerve carries the visual information from the retina to the brain.

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from lecture outline: COLOR

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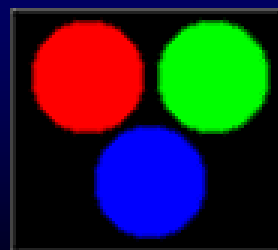
32

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) Pointillist art?

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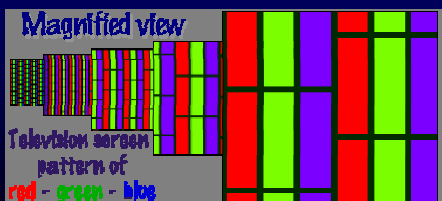
additive color mixing (red, green, blue)



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

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additive color mixing TV's and color monitors



35

additive color mixing: stage lighting

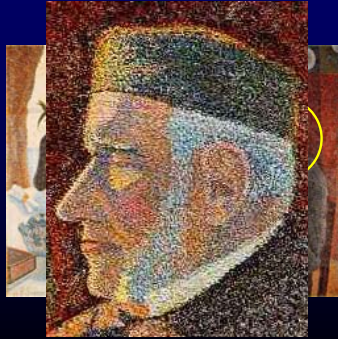


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additive color mixing: Pointalist art (*la salle a manger* (Paul Signac)



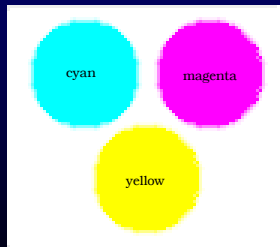
37

more Pointalist additive color mixing  
Seurat, *jeune femme se poudrant*



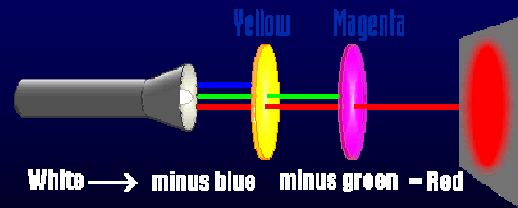
38

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



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



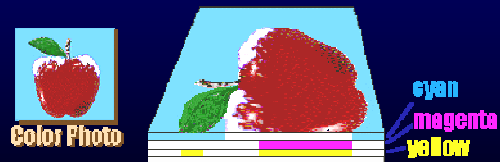
40

pigment paint colors via subtractive color mixing



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subtractive color mixing: color photography

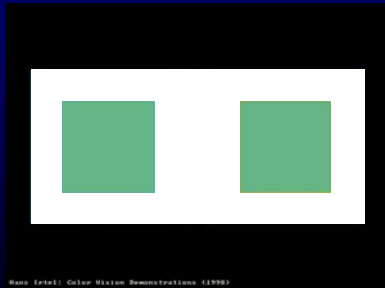


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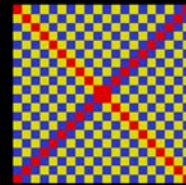
### simultaneous color contrast



Maxi Intel: Color Vision Demonstrations (1998)

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### color assimilation



Maxi Intel: Color Vision Demonstrations (1998)

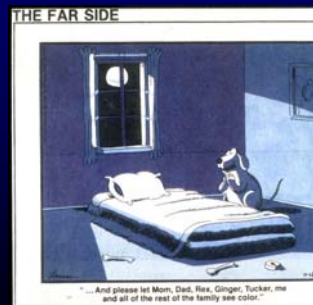
44

### from lecture outline

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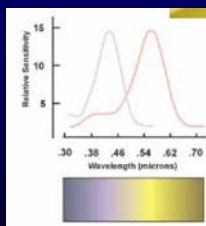
45

### another bad joke



46

### animal psychophysics of wavelength discrimination



Neitz, J., Carroll, J., & Neitz, M. (2001) Color Vision: Almost Reason Enough for Having Eyes. Optics and Photonics News 12, 28-33.

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



Final Neuroscience (1996), 3, 115-121. Printed in the USA.  
Copyright © 1999 Cambridge University Press 0953-2220/99 \$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

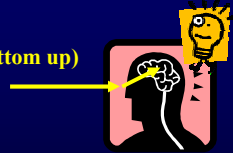
*from lecture outline*

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.

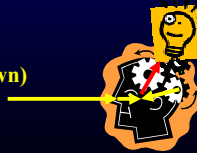
50

*major classes of illusions*

Physiological basis (mostly bottom up)

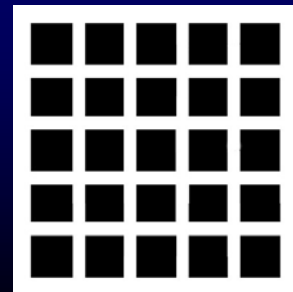


Context and expectations (top down)



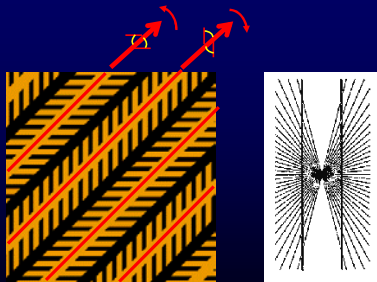
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*physiological explanations (concentric RF's, lateral inhibition)*



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*Acute Angle Dilation Illusions (physiological)*

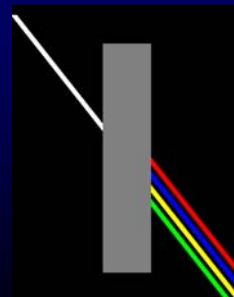


Zollner

Herring

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*angle dilation illusion (Poggendorf)*



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**Poggendorf illusion: acute angle dilation (physiological)**

**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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**Size Constancy**

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**Size Constancy**

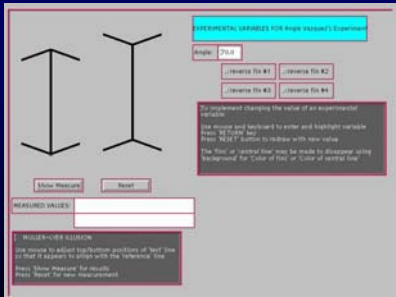
demo

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



Muller-Lyer Interactive Illusion

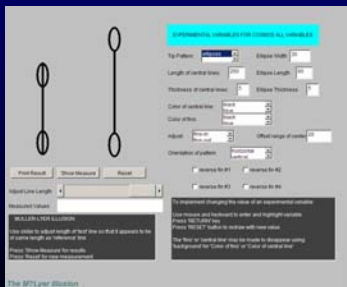
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### Gregory's 'corners' and size constancy (pp. 230-231)



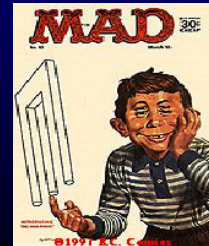
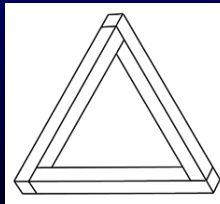
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### Muller-Lyer Illusion [centroid (blur) at end of vertical line]



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### Impossible Figures



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### Escher



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### from lecture outline

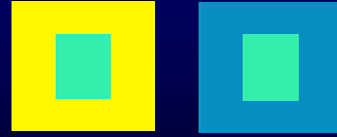
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66

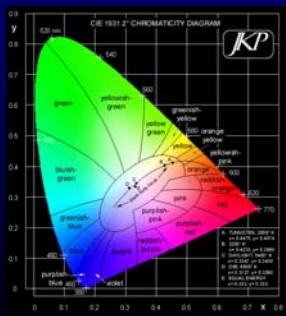
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End Lecture 4



CIE diagram



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