Vision Science II – Monocular sensory aspects of vision _____ (name/PIN)

**Exam 3 – Motion perception to ROC curves**

12/8/08

(Maximum points = 68)

1. To visualize the magnitude of minimum detectable motion, imagine a bug crawling from the bottom to the top of a Snellen E in one second. The minimum movement that a person should be able to see is equal to the distance moved across a _____-sized letter in one second.

a. 20/80
b. 20/40
c. 20/20
d. 20/10

2. According to George Mather's theory of motion, which was demonstrated on the four-stroke motion animation, movement of an image, accompanied by a contrast reversal (black/white negative effect), would cause the image to …

a. continue moving in the same direction.
b. appear to become stationary.
c. appear to move in the opposite direction.
d. appear to move farther away.

3. If a person stares at a waterfall monocularly for a minute, then looks with the other eye only at a stationary object, it will appear to …

a. move downward in the same direction as the water.
b. move upward in the opposite direction as the water.
c. remain stationary.
d. move horizontally, perpendicular to the water.

4. Which of the following is most consistent with the trichromatic theory of color vision?

a. There are 3 cones types, one each that is sensitive to primary colors, X, Y or Z.
b. There are 3 cones types, one each that is sensitive to red, green or blue.
c. The 3 cones types have different, broad and overlapping absorption spectra.
d. The visual system has 3 pathways, two are color opponent and one is non-opponent.

5. Which of the following best describes a dichromat?

a. He could achieve a metameric match by adjusting the relative intensities of two wavelengths.
b. He would require 3 wavelengths to achieve a metameric match.
c. He would not be able to achieve a metameric match with 2 or 3 wavelengths.
d. All wavelength would appear to be the same hue.

6. A subject views two patches of light. One patch consists of an additive mixture of 475 and 510 nm, and the other patch consists of an additive mixture of 490 and 420 nm. By adjusting the intensities of the four wavelengths the subject is able to perfectly match the two patches. The subject … (1)

a. must be a monchromat.
b. must be a dichromat.
c. must be a trichromat.
d. could be any of the above.

7. Refer to the Figure 1 (next page), which shows the relative absorption of two hypothetical cone photopigments. In a color-matching experiment, the subject adjusts the intensities of 500- and 650-nm monochromatic lights, which are mixed, to match 550 nm light. Which of the following statements best describes this mix? (1)

a. 10 watts of 500 nm + 10 watts of 650 nm will look identical to 10 watts of 550 nm light.
b. 10 watts of 500 nm + 30 watts of 650 nm will look identical to 10 watts of 550 nm light.
c. 60 watts of 500 nm + 20 watts of 650 nm will look identical to 20 watts of 550 nm light.
d. 40 watts of 500 nm + 10 watts of 650 nm will look identical to 5 watts of 550 nm light.

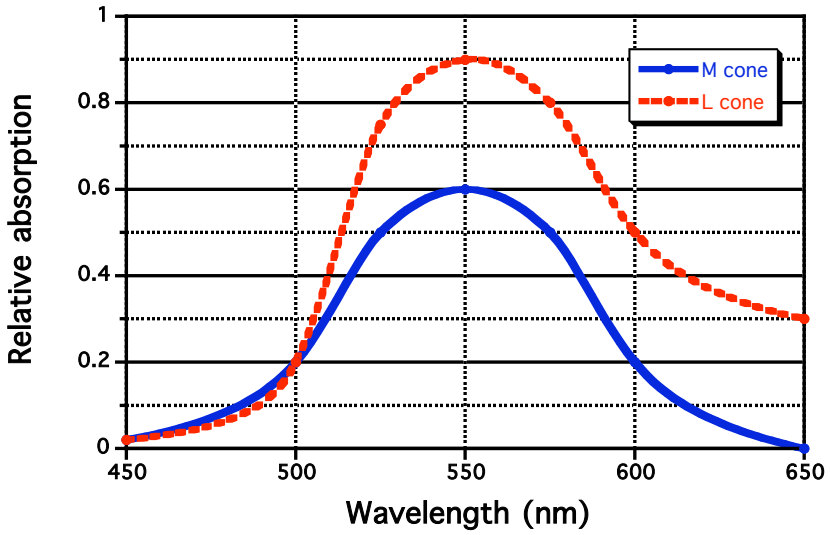



**Figure 1.** Hypothetical absorption spectra.

8. Scientists have used high-resolution adaptive optics fundus photography (Figure 2) in combination with retinal densitometry to study the S, M and L cones. If the cones had the relative absorption spectra shown in Figure 3, and you illuminated the fundus with 500-nm monochromatic light and reflect it off the RPE, you should observe that the (1)

a. S cones would be brightest and the L cones would be the darkest.
b. S cones would be the darkest and the L cones would be the brightest.
c. S cones would be the brightest and the M cones would be the darkest.
d. S cones would be the darkest and the M cones would be the brightest.

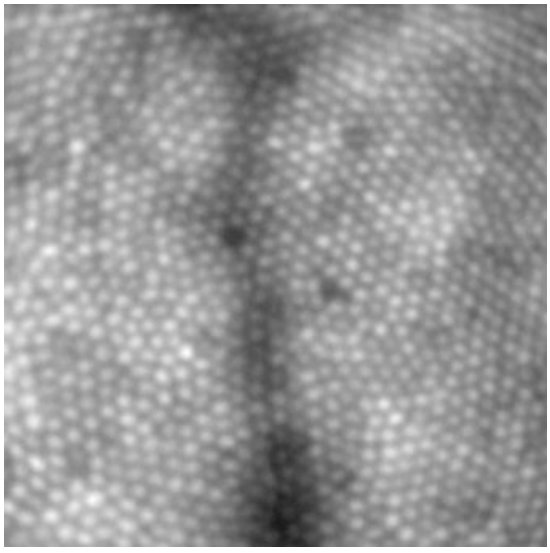


**Figure 2.** High resolution retinal photo by a adaptive optics fundus camera, showing individual cones.

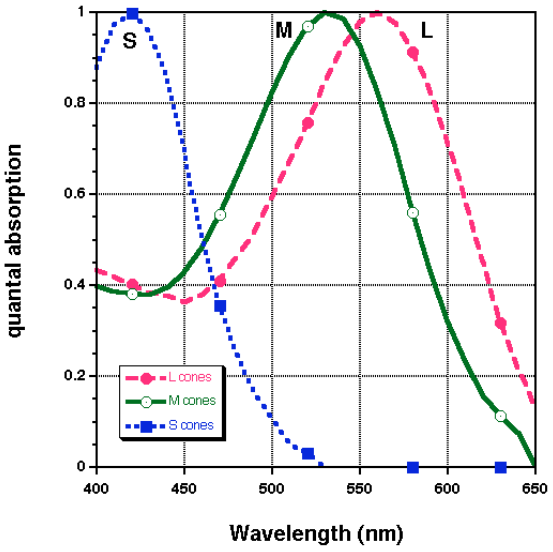
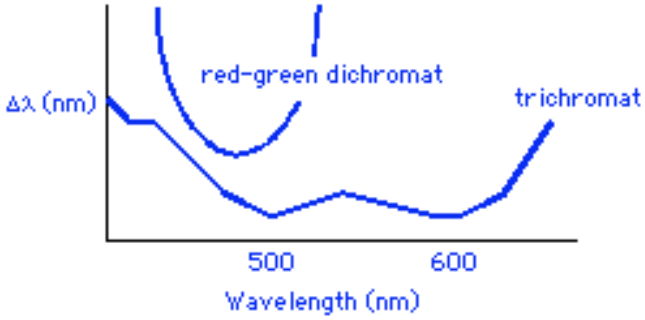



**Figure 3.** Absorption by S, M and L cone pigments.

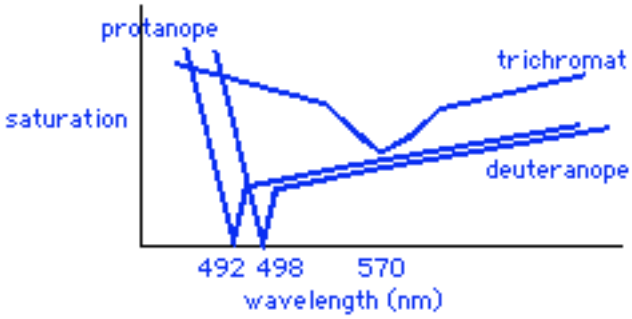
9. Draw a simple x-y plot that shows how wavelength discrimination ( $\Delta\lambda$ ) varies as a function of wavelength for a normal trichromat and for a deuteranope. Label axes and the curves, and indicate approximate values for important wavelengths. (5)

- Normally a W-shaped function
- x-axis for λ, y-axis for Δλ or wavelength discrimination
- Min at ~500 nm and ~600 nm
- Dichromat has a U-shaped function
- No wavelength discrimination above about 550 nm

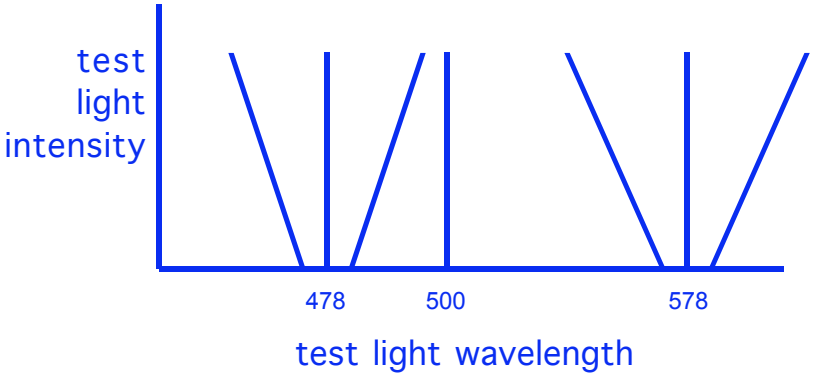



10. Draw an x-y plot that shows how the relative saturation of different hues varies as a function of wavelength for a normal trichromat and deuteranope. Label axes and the curves, and indicate approximate values for important wavelengths. (3)

- normal dip at about 570 nm
- x-axis for λ, y-axis shows relative saturation
- Dichromats neutral points at 498 for deuteranopia.




11. Draw a simple graph that illustrates the Bezold-Brücke phenomenon. Label axes and lines, and indicate approximate values for important wavelengths. (3)




* x, y axes labels
* 3 wavelengths
* 7 lines with correct tilts

12. Assume that you have one eye dilated for the clinical methods lab, and measure an eyeglass prescription using a lensometer that has a greenish-yellow field. You usually look into the lensometer with the right eye, but this time you look with each eye, and notice that the color of the field looks slightly different for each eye. How would you expect the color seen by the dilated eye to compare to the color seen by the non-dilated eye, and why? (2)

The color seen by the dilated eye should look more yellow because of the Bezold-Brücke phenomenon.

13. An apple illuminated by an incandescent light with relatively strong yellow content looks the same color even if is illuminated by a fluorescent lamp (which has more blue content), despite the fact that the mix of wavelengths reflected by the apple are different. This is an example of …

a. color constancy
b. the Bezold-Brücke phenomenon
c. the Stiles-Crawford effect
d. time-intensity reciprocity

14. List five different characteristics that can help you differentially diagnose an acquired from a hereditary color anomaly. (5)

An acquired anomaly would have the following characteristics:

- Could be blue/yellow as well as red/green
- Monocular or asymmetric
- Recent onset and progressive
- Color naming errors more common
- Other ocular symptoms or indications of disease
- The patient could be a woman
- Diagnosis as a protan/deutans/tritan defect might not be clear-cut

15. Briefly explain why color after-images are strong evidence for the presence of color opponent processes in the visual system. (3)

- Adaptation to one perception causes decreased sensitivity to that stimulus and
- increased sensitivity to the opposite perception.
- In after images, red and green behave this way, as sensory opposites of a single system.

16. Assume that you will provide a comprehensive eye exam for 12 male patients next semester. Based on the statistics of hereditary color anomalies, how many patients with a red-green color anomaly should expect to see? one

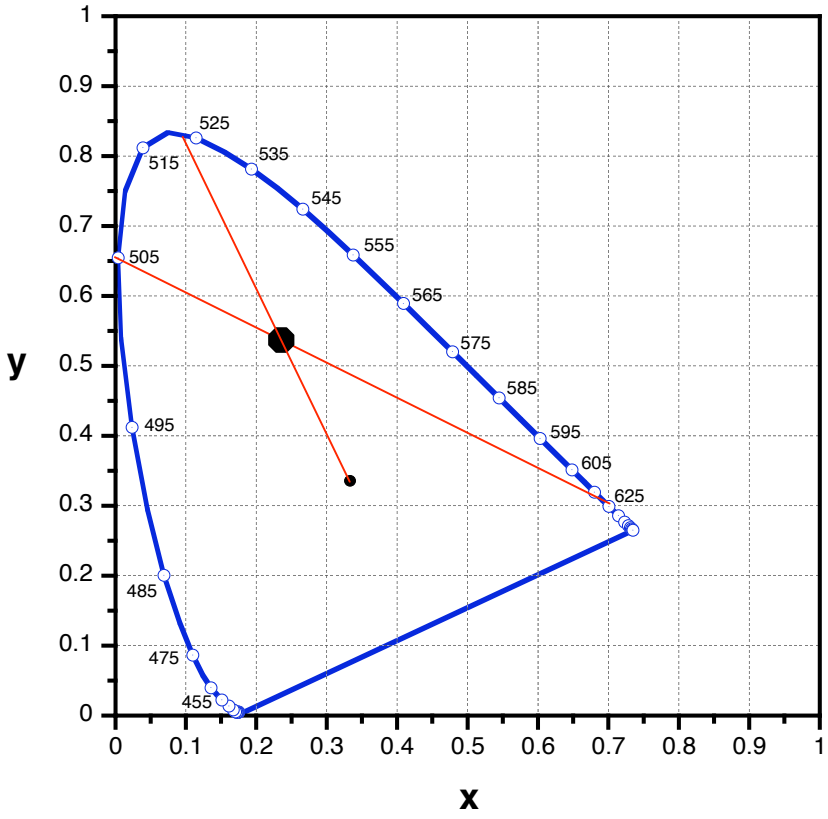



**Figure 4.** CIE chromaticity diagram for Questions 17-21.

17. What are the chromaticity coordinates for the larger dot in the CIE diagram above? (1) (0.24, 0.54)

18. What other wavelength should you mix with 625-nm light in order to create this color? (1) 505-nm

19. What should the ratio of the mix be? (1) 505 to 625 ratio = 2:1

20. What is the dominant wavelength? (1) About 524 nm

21. What is the excitation purity of the color resulting from the mix? (1) 0.4

22. A patient mixes monochromatic green and red lights to obtain a metameric match with monochromatic yellow. If the he thinks any red-green mixture looks the same hue, but not necessarily the same brightness, as the yellow light, which condition(s) could he have?
a. protanomaly
b. protanopia
c. deuteranomaly
d. deuteranopia
e. tritanopia

23. What if, in order to get a perfect match, the patient must reduce the radiance of the yellow light below normal when the mixture setting is pure red, and increase it when the mixture is set to pure green. Which condition(s) could he have?
a. protanomaly
b. protanopia
c. deuteranomaly
d. deuteranopia
e. tritanopia

24. For which of the following anomalies would the patient not accept normal mixture and luminance settings?
a. protanomaly
b. protanopia
c. deuteranomaly
d. deuteranopia
e. tritanopia

25. Suppose the mixture setting contains a slightly greater-than-normal green but the luminance setting is normal. He probably has …
a. protanomaly
b. protanopia
c. deuteranomaly
d. deuteranopia
e. tritanopia

26. Suppose the mixture setting contains a slightly greater-than-normal amount of red but the luminance setting is significantly greater than normal. He probably has …
a. deuteranomaly
b. deuteranopia
c. protanomaly
d. protanopia
e. none of the above

27. The EOG test would be most useful in diagnosing which of the following?
a. optic neuritis
b. retinitis pigmentosa
c. Stargardt's disease
d. corneal abrasion

28. The standard ERG test would be most useful in diagnosing which of the following?
a. optic neuritis
b. retinitis pigmentosa
c. Stargardt's disease
d. corneal abrasion

29. The VER test would be most useful in diagnosing which of the following?
a. optic neuritis
b. retinitis pigmentosa
c. peripheral retinal hole
d. corneal abrasion

30. A patient complains that vision in her right eye has recently decreased. Best-corrected visual acuities are 20/40 OD, 20/15 OS; the media is clear and all ocular structures appear normal. A red cap appears grayish-red to OD, but normal red to OS. Among the following, this is most likely due to …
a. macular degeneration
b. hereditary deuteranomaly
c. retinitis pigmentosa
d. optic neuritis

31. A patient complains of reduced vision, but there are no refractive errors by retinoscopy, no signs of disease, normal color vision and normal dark adaptation. The smallest letter the patient can read, at both 20 feet and 10 feet is 20/200. Which of the following tests would be most helpful in the diagnosis?
a. EOG
b. ERG
c. EKG
d. VER

32. A patient with mild congenital deuteranopia, is prescribed Plaquenil for arthritis. His physician requests that you examine his fundus for signs of Plaquenil toxicity (Bulls-eye maculopathy). Since he already has a hereditary color anomaly, how could you differentially diagnose an acquired anomaly? (3)

In contrast with a hereditary anomaly, the acquired anomaly might show:
- A change or progression, especially since taking the medication
- New color naming errors
- Tritan defect, or ambiguous results on color vision test
- Right/left asymmetry

33. Describe the testing conditions, procedure and expected response for the HRR color vision test. Assume that the patient has medium deuteranomaly. (6)

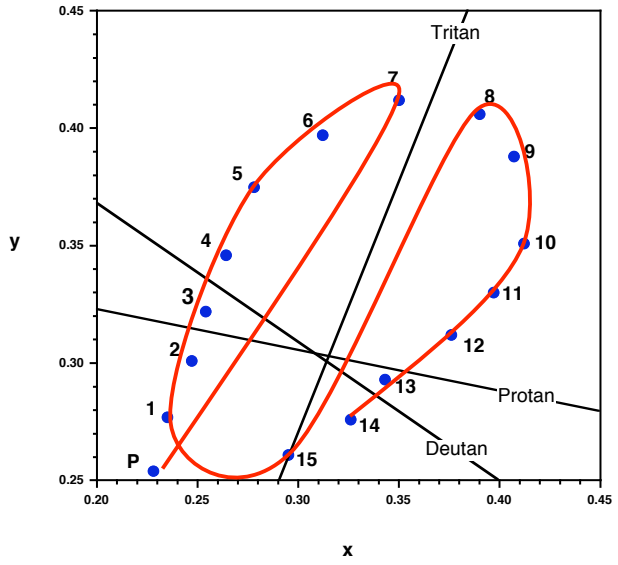
- Use Standard illuminant C
- Test eye separately (monocularly)
- Start with the 6 screening plates. He should get error in the R-G section.
- Test with the R-G diagnostic series. Record correct responses in the protan or deutan column.
- The column labeled, "deutan" will have more checks.
- The last errors will be in the middle section.

34. Which of the following hereditary color anomalies is most common?
a. protanopia
b. protanomalous trichromacy
c. deuteranopia
d. deuteranomalous trichromacy
e. tritanopia

35. Refer to the list of answers in Question 33, above. From among them, select the color anomaly that best matches the descriptions listed in the table below, and enter the your choice (a, b, c, d or e) in the space after each description. (5)

| | |
|---|---|
| Missing the S cone pigment | e |
| Missing the M cone pigment | c |
| Missing the L cone pigment | a |
| Anomalous M cone pigment | d |
| Anomalous L cone pigment | b |

36. Using the figure below, plot an example showing test results for a tritanope. (1)

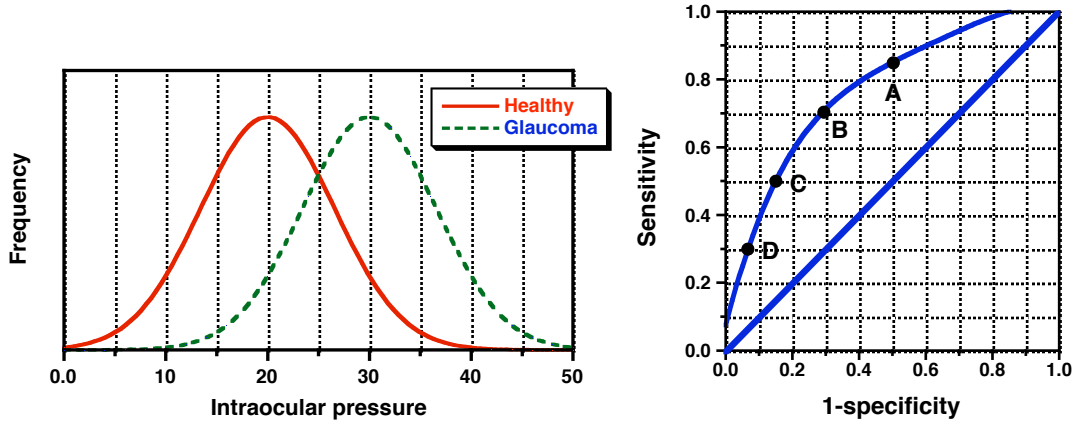



37. When using IOP to screen for glaucoma you must set a diagnostic criterion to decide whether the patient is normal or a glaucoma suspect. If you want high sensitivity your criterion should be a
a. low IOP.
b. a mid-range IOP.
c. a high IOP.
d. lax for normals but strict for glaucoma suspects.

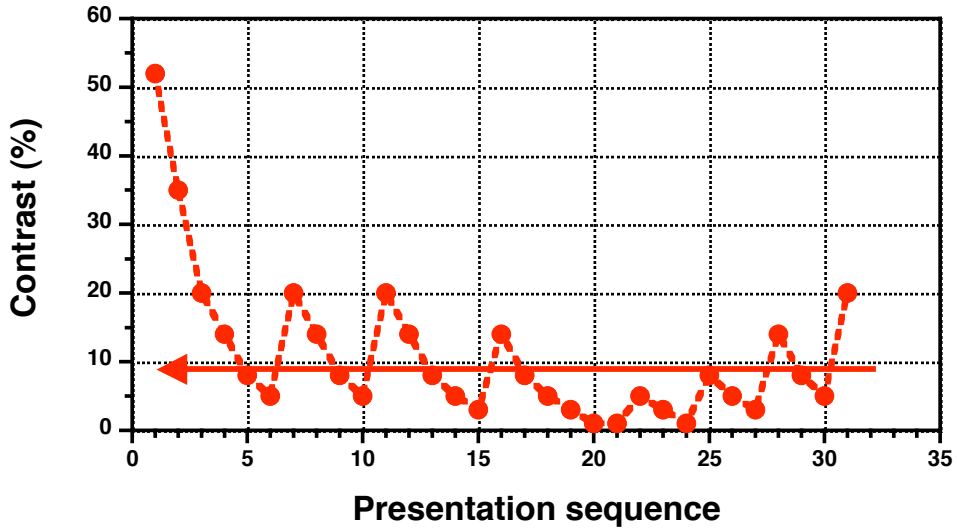
38. If you change your diagnostic criterion to increase sensitivity, how will specificity be affected? It will …
a. increase.
b. decrease.
c. not be affected
d. may increase or decrease depending on how much you change the criterion.

39. How does the Humphrey Matrix frequency doubling technology perimeter work to isolate the magnocellular ganglion cells from the parvocellular neurons?
a. The parvo non-linear response doubles the frequency seen by the magnocellular system.
b. The grating flickers so rapidly that it cannot be temporally resolved the parvo system.
c. The counter-phase flickering grating is fused into a uniform gray field by the parvo system.
d. Both b and c work together.

40. Refer the figures below. If you want to screen for glaucoma with a sensitivity and specificity of 70%, which IOP value should you use as your diagnostic criterion?
a. 15
b. 20
c. 25
d. 30




41. Assume that a scientist is comparing four different screening tests for glaucoma by computing the area under the ROC curve for each. Which value indicates the best test?
a. 1.5
b. 0.9
c. 0.5
d. 0.0




42. Which psychophysical technique was most likely used to collect the data graphs in the figures above?
a. Constant stimuli
b. Descending limits
c. Staircase
d. Adjustment