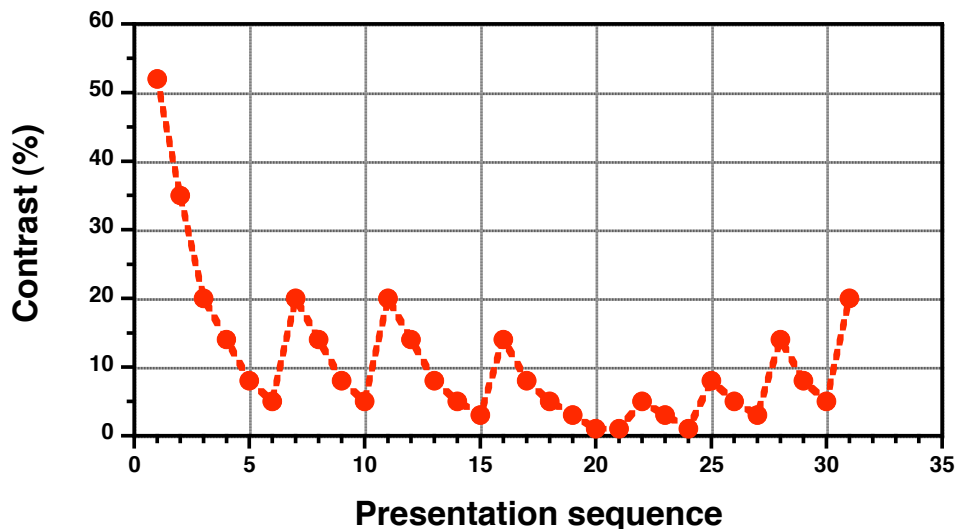


Vision Science II – Monocular Sensory Aspects of Vision

Final Exam

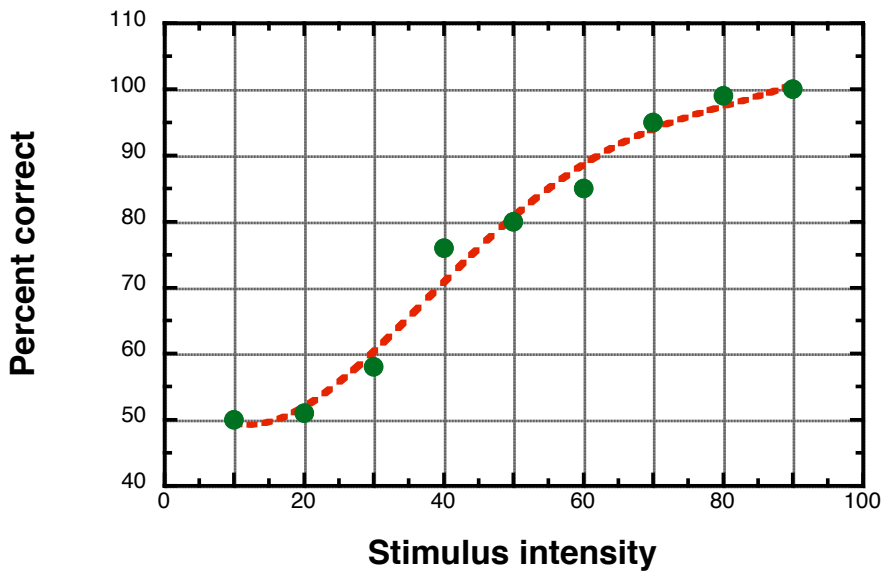
12/6/05

- Which of the following best describes characteristics of retinal ganglion cells?
 - Spatial antagonism, spatial summation, maintained discharge in the dark**
 - Excitation throughout the receptive field, spatial summation, graded potentials
 - Inhibition throughout the receptive field, lateral inhibition, action potentials
 - Hyperpolarization, color opponency, spontaneous discharge
- Which of the following best summarizes one of the biochemical events in the process of phototransduction?
 - Cyclic GMP clusters break up, sodium pores open, sodium influx, depolarization
 - Cyclic GMP clusters break up, sodium pores close, sodium influx stops, hyperpolarization**
 - Cyclic GMP clusters reconstitute, sodium pores open, sodium diffuses out, hyperpolarization
 - Cyclic GMP clusters break up, sodium pores open, sodium influx, depolarization
- Which of the following best describes the two main retino-cortical parallel pathways?
 - Cones send input to the parvo pathway; rods send input to the magno pathway.
 - Rods send input to the parvo pathway; cones send input to the magno pathway.
 - Central retinal cones send input to the parvo pathway; peripheral cones send input to the magno pathway.**
 - Central cones send input to the magno pathway; peripheral cones send input to the parvo pathway.



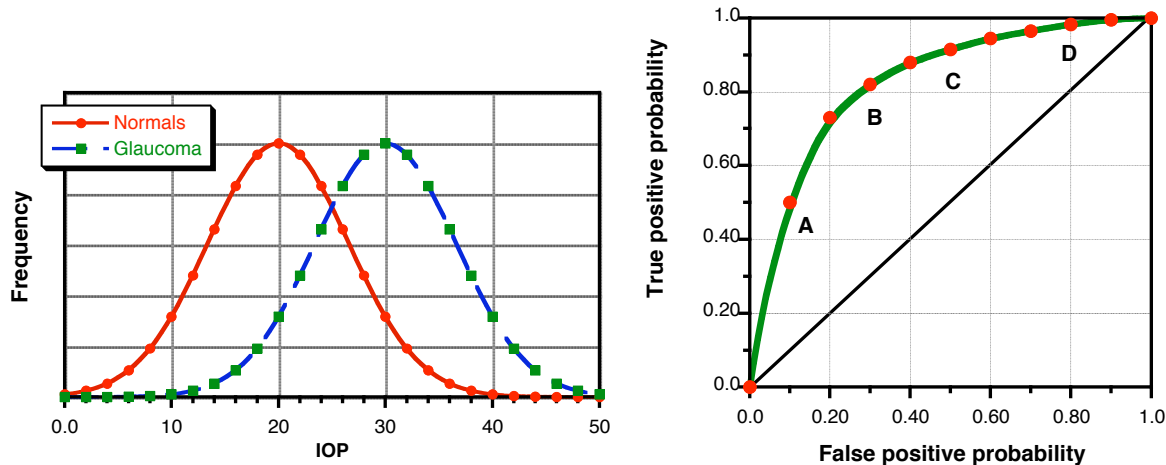
- The graph above plots the results of a contrast threshold experiment. What psychophysical technique was used and what is the threshold?
 - Constant stimuli; 50%
 - Adjustment; 20%
 - Descending limits; 10%
 - Staircase; 10%**

5. Which of the following statements does *not* explain part of the theoretical basis for frequency doubling perimetry?
- a. The target's flicker frequency exceeds the parvocellular CFF, and is not temporally resolvable by that neural pathway.
 - b. The counter-phase flickering grating is linearly summed over time by the parvocellular system, and it perceives a uniform gray field (no gratings).
 - c. The flicker frequency is sub-CFF for the magnocellular system and is therefore resolvable by that neural pathway.
 - d. The magnocellular's non-linear response causes an apparent doubling of the sine-wave grating's temporal frequency, so it appears to flicker twice as fast.
 - e. This is essentially a contrast sensitivity task, and glaucoma will cause a decrease in contrast sensitivity.



6. The results of a vision experiment are graphed above. What is the best estimate of the threshold?
- a. 75
 - b. 62.5
 - c. 50
 - d. 45
7. In a signal detection-type task, a lax criterion causes _____, while a strict criteria causes _____.
- a. more hits; more false positives
 - b. more hits; fewer false positives
 - c. more misses; more false positives
 - d. more correct rejections; fewer misses

8. If a diagnostic test has high specificity, it will usually ...
- correctly diagnose a normal condition as normal (not diseased).
 - misdiagnose a normal condition as the diseased condition.
 - correctly diagnose the diseased condition as diseased.
 - misdiagnose the diseased condition as normal.



9. Based on the frequency distributions and ROC curves shown above, which of the following IOP criteria most closely corresponds with Point D on the ROC curve?

- 12
- 20
- 25
- 30

10. At suprathreshold levels, what is the relationship between stimulus intensity and magnitude of sensation?

- Weber's law
- Law of univariance
- Fechner's law
- Ricco's law

11. What do aberrometers directly measure?

- Corneal higher-order aberrations
- Refractive errors
- MTF of the eye
- Contrast sensitivity

12. What is the difference between the total RMS and the HO RMS of the same eye?

- Total includes the sphere and astigmatism only; HO includes all aberrations.
- Total includes all aberrations; HO includes sphere and astigmatism only.
- Total includes all aberrations; HO includes all aberrations from the third order and above.
- Total includes all aberrations; HO includes all aberrations from the second order and above.

13. Which of the following *cannot* be computed directly from the wavefront aberrations function?

- Point spread function
- Strehl ratio
- MTF
- Contrast sensitivity

Reference formulas for Questions 14-16.

$$J_{45} = -\frac{C}{2} \sin(2A)$$

$$M = S + \frac{C}{2}$$

$$J_{180} = -\frac{C}{2} \cos(2A)$$

$$C = -2\sqrt{J_{45}^2 + J_{180}^2}$$

$$S = M - C/2$$

$$A = \frac{1}{2} \tan^{-1} \left(\frac{J_{45}}{J_{180}} \right)$$

$$J_{45} = (-2\sqrt{6}/y^2)C_2^{-2}$$

$$M = (-4\sqrt{3}/y^2)C_2^0$$

$$J_{180} = (-2\sqrt{6}/y^2)C_2^2$$

14. Suppose you have a patient who is very difficult to refract. Autorefraction and subjective refraction yield the following data for the right eye.

Autorefraction: -3.25 -1.50 x 013

Subjective refraction: -4.00 -0.50 x 067

Calculate the J45, M and J180 power vector components that represent the mean of these two refractions. List them and circle your answers. (3)

$$J_{45} = 0.254$$

$$M = -4.125$$

$$J_{180} = 0.250$$

15. Correctly compute the mean from above and express it as sphere, cylinder and axis to the nearest quarter diopter. List the axis as the simple result of the equation above. (3)

$$-3.75 -0.75 \times 023$$

16. Convert the following Zernike coefficients to the equivalent spectacle Rx (sphere, cylinder, axis) assuming that the pupil diameter is 4.0 mm. (3)

$$C_2^{-2} = -0.70$$

$$C_2^0 = +1.15$$

$$C_2^2 = -0.41$$

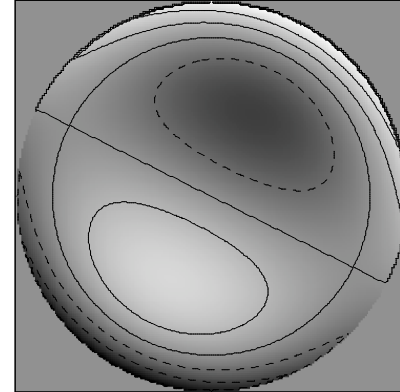
$$-1.00 -2.00 \times 030$$

17. Which of the following is closest to the expected mean HO RMS wavefront error (in micrometers) for a normal adult eye with a 6.0-mm diameter pupil?

- a. 0.05
- b. 0.15
- c. 0.25
- d. 0.55

18. Which higher-order aberration is represented by the wavefront map to the right?

- a. defocus
- b. trefoil
- c. coma
- d. spherical aberration



19. Which of the following is correct?

- a. Total RMS wavefront error is a useful predictor of visual acuity for eyes with large and small aberrations.
- b. If they have the same coefficient, all Zernike modes will have the same affect on visual acuity.
- c. Most normal eyes have just one visually significant Zernike coefficient among the higher-order modes, though the particular significant mode can vary from person to person.
- d. Even with the same RMS, different combinations of Zernike modes can affect visual acuity differently.

20. According to research by Hecht, Schlaer and Pirenne a minimum of ___ photon(s) is/are sufficient to activate a rod, but the person won't actually see a light unless a minimum of ___ photon(s) is/are absorbed within a 10 arc minute area.

- a. ten, one
- b. one, ten
- c. one, one
- d. ten, ten

21. In a photopic heterochromic flicker photometry experiment, the standard light is set to 555 nm, and the test light, with a different wavelength, is adjusted until the flicker stops. When this happens the ...

- a. radiance of the test light will be greater than that of the standard light.
- b. luminance of the test light will be greater than that of the standard light.
- c. radiance of the test light will be less than that of the standard light.
- d. luminance of the test light will be less than that of the standard light.

22. Assuming a standard human observer, how will the perceived brightness of the following two monochromatic lights compare if they both have a luminous power equal to 500 lumens? One light has a wavelength of 550 nm ($V_\lambda=0.995$) and the other has a wavelength of 650 nm ($V_\lambda=0.107$)?

- a. The 550-nm light will appear brighter.
- b. The 650-nm light will appear brighter.
- c. They will appear equally bright.
- d. There is not enough information to compute relative brightness.

23. Which of the following is a photometric unit for luminance?

- a. lumens
- b. lux
- c. candelas
- d. candelas/m²

24. Which of the following gives about the correct extent of the normal visual field in the superior (S), nasal (N), inferior (I) and temporal (T) directions?

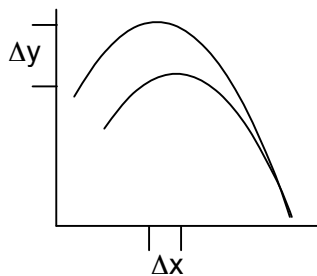
	S	N	I	T
a.	50	60	70	90
b.	70	50	70	90
c.	90	60	90	90
d.	90	80	70	60

25. How can you use a luminance meter and a white sheet of paper to determine the illumination on a desktop?

- a. Place the paper on the desk and measure the luminance in lux. Divide this by π to get the illumination in apostilbs.
- b. Place the paper on the desk and measure the luminance in nits. Multiply this by π to get apostilbs. This will equal the illumination in lux.
- c. Place the luminance meter under the paper facing upward and directly measure the illumination falling on the paper.
- d. It can't be done. You will need to use an illuminance meter rather than a luminance meter.

26. After a DFE the patient's pupils are dilated to 8.0 mm. When the exam is finished, you offer the patient mydriatic spectacles, but he prefers to use his own sunglasses, which have a transmittance of about 50%. This will reduce his retinal illumination, but not as much as his pupils would if they could respond normally to light. His sunglasses would reduce retinal illumination to the equivalent of which of the following pupil diameters?

- a. 6.5 mm
- b. 5.5 mm
- c. 4.5 mm
- d. 3.5 mm



27. On the figure above, which of the following would be most closely associated with the photochromic interval for a wavelength of about 515 nm?

- a. Δy
- b. Δx
- c. Δx divided by Δy
- d. The area between the two curves

28. If the period of preadaptation is extended, what is the expected change in the dark-adaptation threshold function?

- a. The rod plateau will be lower.
- b. The cone plateau will be lower.
- c. The rod-cone break will come sooner.
- d. **The rod-cone break will come later.**

29. Which of the following is true for complete temporal summation (flash duration less than the critical duration)?

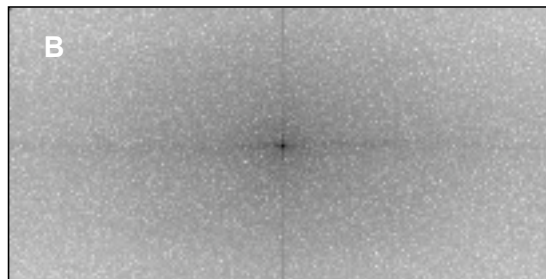
- a. The longer the flash, more total quanta will be needed for threshold.
- b. The effects of quanta delivered early in the critical period are less than those delivered later.
- c. **The effects of all quanta delivered during the critical period sum.**
- d. Within the critical period, the shorter the flash, the more total quanta needed for threshold.

30. In an eye that had had conventional LASIK, the higher-order aberrations would most likely be worse if the eye had ...

- a. small pupils and no Stiles-Crawford effect.
- b. large pupils with double the normal Stiles-Crawford effect.
- c. small pupils with double the normal Stiles-Crawford effect.
- d. **large pupils with no Stiles-Crawford effect.**

31. You can evaluate an optical system by seeing how well it makes images of test targets that consist of high-contrast sine-wave gratings. How do optical systems change the image of a sine-wave grating, compared to the original test pattern, especially for mid to high spatial frequencies?

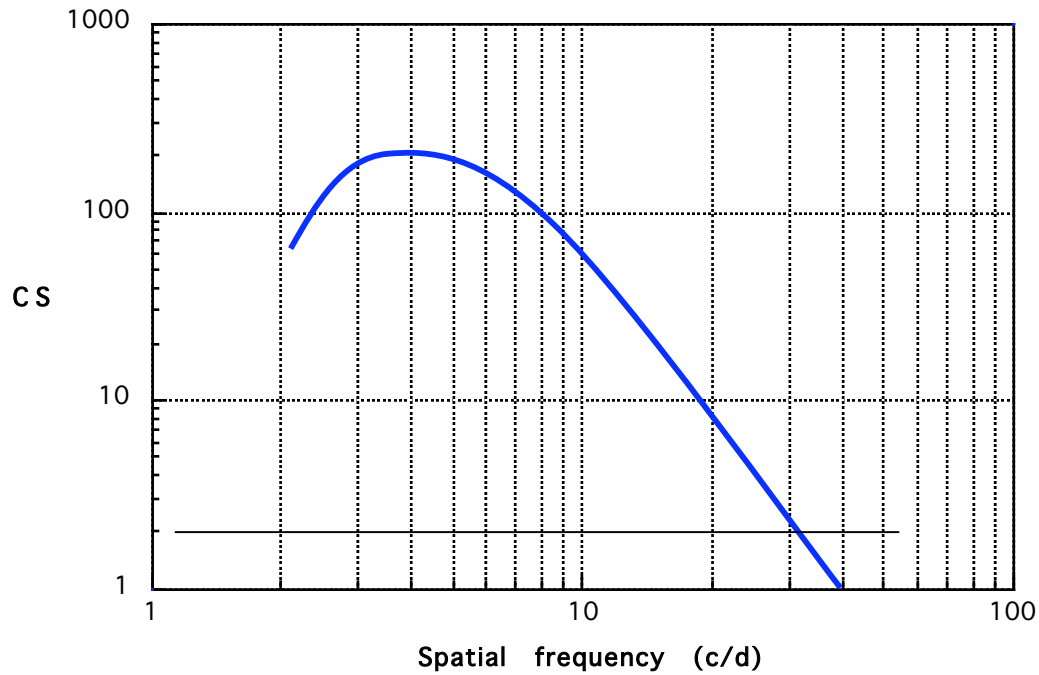
- a. **They reduce contrast but spatial frequency remains the same.**
- b. They reduce spatial frequency but contrast remains the same.
- c. They reduce both contrast and spatial frequency.
- d. They increase both contrast and spatial frequency.



32. The images above show a scene (A) and its spatial frequency spectrum (B). Which of the follow best describes how image C was made?

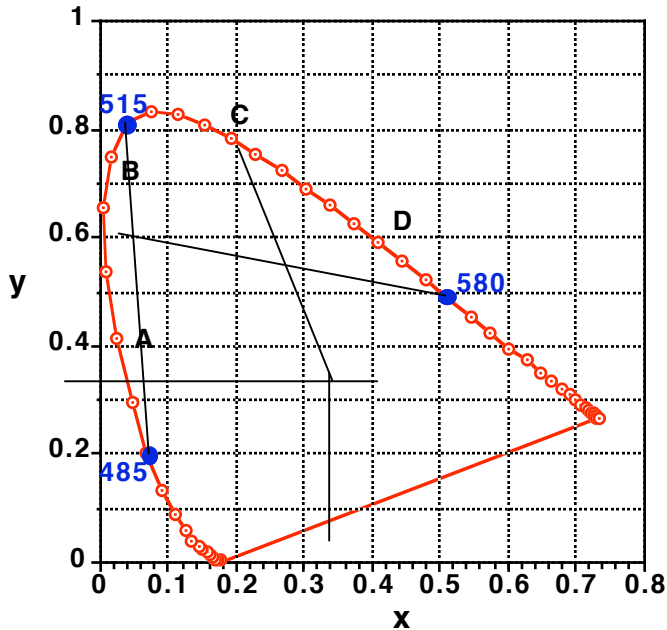
- a. A high-pass filter removed spatial frequencies from the periphery of the spectrum.
- b. **A high-pass filter removed spatial frequencies from the center of the spectrum.**
- c. A low-pass filter removed spatial frequencies from the periphery of the spectrum.
- d. A low-pass filter removed spatial frequencies from the center of the spectrum.

33. Which of the following descriptions of spatial vision is *not* correct?
- Objects with high contrast are always easier to see than with low contrast.
 - Less contrast is needed to see middle spatial frequency gratings than high spatial frequency gratings.
 - Lower spatial frequencies are always easier to see than higher spatial frequencies.**
 - The highest spatial frequencies always require high contrast to be seen.
34. Under best conditions, vernier acuity thresholds are ...
- 2-10 arc seconds**
 - 2-10 arc minutes
 - 10-20 arc seconds
 - 10-20 arc minutes
35. Using a logMAR ETDRS visual acuity chart, a patient reads as far as the 0.3 line but missed two letters on that line. What is his equivalent Snellen visual acuity? Choose the closest answer.
- 20/36
 - 20/40
 - 20/44**
 - 20/50
36. What is the spatial frequency equivalent (size in cycles/degree) of a -0.3 logMAR letter?
- 0.5
 - 10
 - 40
 - 60**
37. According to the Ferry-Porter law, the CFF ...
- is directly proportional to the log of the stimulus luminance.**
 - is directly proportional to stimulus luminance.
 - is inversely proportional to the log of the stimulus luminance.
 - increases as the log of stimulus area.
38. Which of the following correctly describes the relationship between the size of a flashing light and the maximum rate of flicker than a person can normally see.
- As a flashing light gets smaller, the flicker will be easier to see.
 - As a flashing light gets larger, the flicker will be easier to see.**
 - The fastest flicker that a person can see remains constant for flashing lights of any size.
 - As a light becomes dimmer at the same time it becomes smaller, the flicker becomes easier to see.
39. According to the Broca-Sulzer effect,
- the longer a light (with fixed radiance) is left on, the brighter it appears to become.
 - a flickering light appears dimmest if it is flashed at a rate of about 10 Hz.
 - a light that is flashed on for about 75 msec will look slightly dimmer than a steady light of the same radiance.
 - a light that is flashed on for about 75 msec will look slightly brighter than a steady light of the same radiance.**
40. The law that applies to the apparent luminance of an intermittent light stimulus with an alternating frequency above the CFF when fused is ...
- the Talbot-Plateau law.**
 - the Brücke-Bartley law.
 - Stephen's power law.
 - Bloch's law.



41. Refer to contrast sensitivity function above. What would the Snellen visual acuity be for a target with 100% contrast?
- 20/12
 - 20/15
 - 20/30
 - 20/40
42. Assume that you are testing visual acuity with a 50% contrast acuity chart. What would the Snellen visual acuity be for the upper (solid) curve?
- 20/20
 - 20/25
 - 20/30
 - 20/40
43. Assume that you are testing contrast sensitivity with letters that have an MAR of 3.75 arc minutes. What would the contrast threshold be?
- 3.75%
 - 1.5%
 - 1.0%
 - 0.5%
44. A sine-wave grating modulates 25 apostilbs above and below an average luminance of 50 apostilbs. What is the modulation?
- 1.00
 - 0.67
 - 0.50
 - 0.33

45. Acquired color deficiencies differ from congenital ones in that they ...
- are more likely than congenital anomalies to be blue-yellow.
 - may be associated with a change in visual acuity.
 - may affect one eye more than the other.
 - all of the above



46. The CIE diagram above shows the location of points for the pure spectral hues 485, 515 and 580 nm. Which of the following is closest to the dominant wavelength of a 1:2:3 mixture (respectively) of these three wavelengths.

- Point A
- Point B
- Point C
- Point D

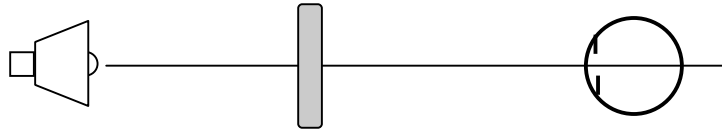
47. What would the excitation purity be for a point that is midway between the point with (x,y) coordinates (0.333, 0.333) and the pure spectral hue indicated by Point D?

- 1.00
- 0.50
- 0.33
- 0.00

48. 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 as the yellow light, but its relative brightness varies depending on the mixture setting, he most likely has ...

- protanomaly
- protanopia
- deuteranomaly
- deuteranopia

49. For which of the following anomalies would the patient accept normal mixture and luminance settings?
- protanomaly
 - protanopia
 - deuteranomaly
 - deuteranopia
50. Suppose the mixture setting contains a slightly greater-than-normal amount of green but the luminance setting is normal. He probably has ...
- protanomaly
 - protanopia
 - deuteranomaly
 - deuteranopia
51. Which of the following tests would be most useful in helping you diagnose a case of suspected malingering?
- EOG
 - VER
 - ERG
 - visual acuity
52. Suppose that a patient, who has multiple sclerosis, visits you complaining of decreased vision. Since there is no significant refractive error and no sign of ocular disease (by slit lamp biomicroscopy or ophthalmoscopy), so you suspect optic neuritis. Which of the following tests would be most helpful in diagnosing this patient's condition?
- visual acuity
 - EOG
 - ERG
 - VER
53. A gray spot in the middle of a green field is seen tinged with red. This is an example of ...
- simultaneous color contrast.
 - color constancy.
 - successive color contrast.
 - the Bezold-Brücke phenomenon.
54. In Step 1 of the standard ERG protocol we test scotopic vision using a flash with a luminance of -25 decibels. Step 2 uses a flash with a luminance of 0 decibels. If 0 decibels corresponds to a luminance of 30 candela/m^2 , what is the luminance used in Step 1, in apostilbs?
- 9500
 - 0.09
 - 0.30
 - 0.25
55. Which of the following tests visual performance?
- photostress test
 - aberrometry
 - videokeratography
 - GDx



56. The figure above shows a translucent glass plate (gray rectangle) back-illuminated by a lamp. How can you increase the retinal luminance of the plate?

- a. Move the eye closer to the plate, while leaving the distance between the lamp and plate unchanged.
- b. Move the plate closer to the lamp, while leaving the distance between the lamp and eye unchanged.
- c. Move the plate closer to the eye, while leaving the distance between the lamp and eye unchanged.
- d. Move both the lamp and eye away from the plate at the same time.

57. (Bonus)

Which of the following vision science activities are you most likely to do during the Christmas break?

- a. Observe red-green color opponency on Christmas decorations.
- b. Test if color constancy holds when viewing Christmas presents under different colored lights.
- c. Use high-contrast lettering to improve visibility of Christmas cards addresses.
- d. Regenerate retinal photopigments by dark adapting for at least 8 hours.



Dear students,

I has been a privilege and blessing to have worked with you and gotten to know you during this semester. I hope you have a successful finals week and a restful Christmas break. Merry Christmas!

Sincerely,

Dr. Salmon