

*Vision Science II – Monocular Sensory Aspects of Vision*

**Final Exam**

12/15/06

0. Two-part question: Would you like to receive a copy of the new edition of Borish's Clinical Refraction, and do you think you will use it? (Non-credit question)

- a. yes, yes
- b. yes, no
- c. no, no
- d. no, yes

1. Which of the following best describes the magnocellular ganglion cells?

- a. Susceptible to damage in glaucoma; large axon diameters; slow signal transmission; supports peripheral scotopic vision
- b. Resistant to damage in glaucoma; large axon diameters; fast signal transmission; supports peripheral photopic vision
- c. Susceptible to damage in glaucoma; small axon diameters; slow signal transmission; poor spatial resolution
- d. Susceptible to damage in glaucoma; large axon diameters; fast signal transmission; poor spatial resolution

2. How is it possible for frequency doubling technology (FDT) to stimulate the magnocellular ganglion cells but not the parvocellular cells?

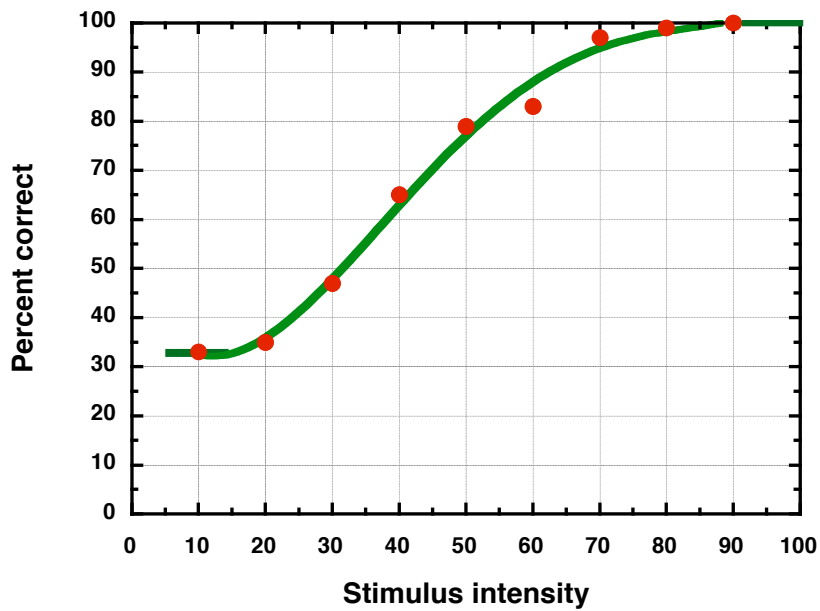
- a. The vertical flickering grating is only visible to the vertically oriented magnocellular neurons.
- b. The counter-phase flickering grating flickers so quickly that it is visible only to the parvocellular neurons.
- c. The counter-phase flickering grating is fused into a uniform gray field by the parvo system, but is resolvable both temporally and spatially by the magno system.
- d. The non-linear response of the parvocellular system masks peripheral vision but stimulates central vision, which is dominated by the magnocellular neurons.

3. Which of the following scientist has been recognized as the father of psychophysics?

- a. Gustav Fechner
- b. James Clerk Maxwell
- c. Steven Schwartz
- d. George Foster

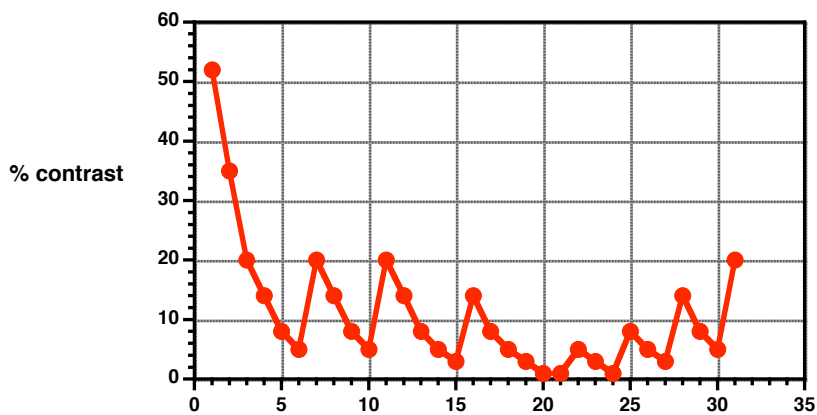
4. Which of the following uses the most meticulous methodology for measuring psychophysical thresholds?

- a. constant stimuli
- b. limits
- c. adjustment
- d. signal detection



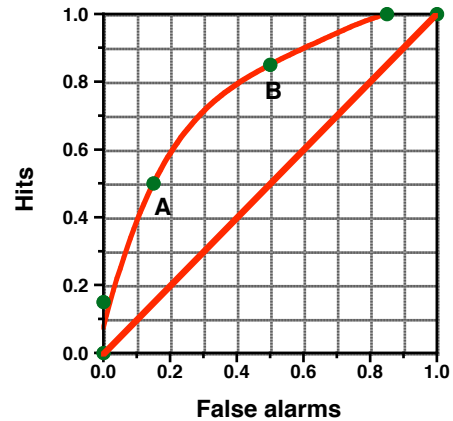
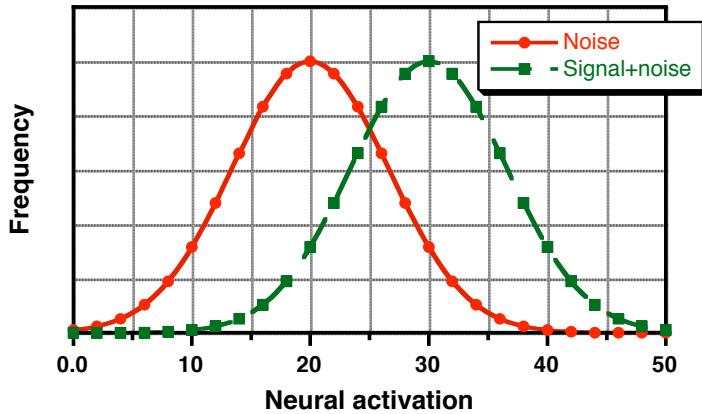
5. Refer to the psychometric function plotted above. What is the best estimate of the threshold?

- a. 33
- b. 42
- c. 50
- d. 66



6. The figure above plots the results of an experiment that used the staircase method. What should the label for the x axis be?

- a. Neural activation
- b. Percent correct
- c. Stimulus intensity
- d. Presentation sequence number



6. Refer to the figure above showing the noise (left curve) and signal plus noise (right curve) distributions. If the criteria for detection were set to 25, what would the false alarm and hit rates be?
- 0.35 and 0.35
  - 0.65 and 0.65
  - 0.35 and 0.65
  - 0.65 and 0.35
7. If the detection criterion were set to 25, what would the specificity be?
- 0.35
  - 0.50
  - 0.65
  - 1.0
8. Refer to the ROC curve above. What level of neural activation would be associated with Point A?
- 10
  - 20
  - 30
  - 40
9. A gray spot in the middle of a red field is seen tinged with green. This is an example of ...
- color constancy.
  - simultaneous color contrast.
  - successive color contrast.
  - the Purkinje shift.
10. Which of the following best supports the principle that letter size from line to line in visual acuity charts change in proportion to the log of the visual angle?
- Weber's law
  - Stephen's law
  - Fechner's law
  - Penisten's law

**Reference formulas for Questions 11-13.**

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

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

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

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

$$S = M - C/2$$

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

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

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

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

11. One autorefractor estimates a patient's refraction to be -3.21 -0.86 x 010. Another machine estimates the same patient's refraction to be -3.77 -0.58 x 023. If you don't which machine is most accurate, the best estimate of the true refraction is the mean of the two measurements. Compute the mean refraction. If expressed in minus cylinder form, the spherical power of the mean is closest to which of the following?

- a. -3.10
- b. -3.30
- c. -3.50
- d. -3.70

12. The minus cylinder power of the mean refraction is closest to which of the following?

- a. -0.50
- b. -0.70
- c. -0.90
- d. -1.10

13. The minus cylinder axis of the mean refraction is closest to which of the following?

- a. 10
- b. 15
- c. 20
- d. 25

14. Assume that an aberrometer reports the following Zernike coefficients, in micrometers ( $\mu\text{m}$ ),  $Z_2^{-2} = -0.70$ ;  $Z_2^0 = +3.25$ ;  $Z_2^2 = -0.60$ , for a 6.0-mm diameter pupil. From these second order coefficients, compute the equivalent spectacle Rx. Which of the following is closest to the minus cylinder sphere power?

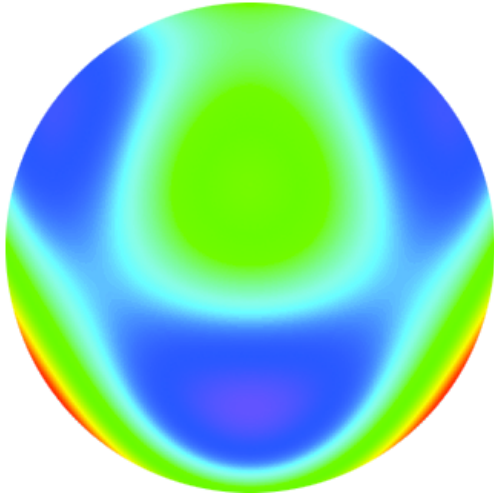
- a. -1.25
- b. -1.50
- c. -1.75
- d. -2.00

15. Which of the following is closest to the minus cylinder cyl power?

- a. -1.00
- b. -1.50
- c. -2.00
- d. -2.50

16. Which of the following is closest to the minus cylinder axis?

- a. 15
- b. 20
- c. 25
- d. 30



17. The figure above show a higher-order wavefront aberration map. Which of the following aberrations appears to be the most prominent in this eye?
- piston
  - astigmatism
  - spherical aberration
  - trefoil
18. Which of the following is correct?
- Even with the same RMS, different combinations of Zernike modes can affect visual acuity differently.
  - Each Zernike modes will have the same affect on visual acuity if they have the same magnitude.
  - Most normal eyes have just one visually significant Zernike coefficient among the higher-order modes.
  - Total RMS wavefront error correlates closely with high contrast Snellen visual acuity for eyes with small aberrations.
19. Which of the following is closest to the mean higher-order RMS wavefront error expected for a normal adult eye with a 6.0-mm pupil?
- 0.1  $\mu\text{m}$
  - 0.3  $\mu\text{m}$
  - 0.5  $\mu\text{m}$
  - 0.7  $\mu\text{m}$
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.
- one, ten
  - ten, one
  - one, one
  - 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 determine how the brightnesses will compare.

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

- a. nits
- b. lux
- c. watts
- d. apostilbs

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

- a. lumens
- b. lux
- c. apostilbs
- d. candelas

25. In a photopic heterochromic flicker photometry experiment, the standard light is set to 555 nm and the test light (another wavelength) is adjusted until the flicker stops. When this happens,

- a. both lights will have the same radiance and luminance.
- b. the luminance of the test light will be greater than that of the standard light.
- c. the radiance of the test light will be greater than that of the standard light.
- d. the radiance of the test light will be less than that of the standard light.

26. Which of the following gives the visual field limits in the superior (S), nasal (N), inferior (I) and temporal (T) directions for a normal healthy eye?

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

27. 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 retinal illumination, but not as much as if his pupils could respond normally. His sunglasses would reduce retinal illumination to the equivalent of which of the following pupil diameters?

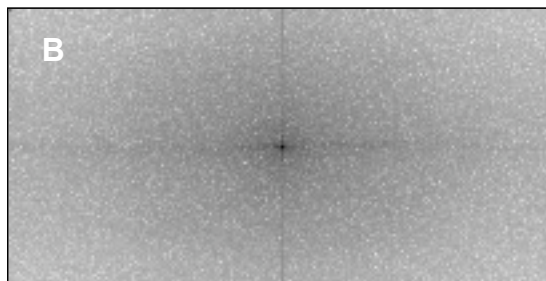
- a. 6.5 mm
- b. 5.5 mm
- c. 4.5 mm
- d. 3.5 mm

28. 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.

29. 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.



30. The images above show a scene (A) and its spatial frequency spectrum (B). Which of the following 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.

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. Which of the following descriptions of spatial vision is *not* correct?

- a. Objects with high contrast are always easier to see than with low contrast.
- b. Less contrast is needed to see middle spatial frequency gratings than high spatial frequency gratings.
- c. Lower spatial frequencies are always easier to see than higher spatial frequencies.
- d. The highest spatial frequencies always require high contrast to be seen.

33. Under best conditions, vernier acuity thresholds are ...

- a. 2-10 arc seconds
- b. 2-10 arc minutes
- c. 10-20 arc seconds
- d. 10-20 arc minutes

34. 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.

- a. 20/36
- b. 20/40
- c. 20/44
- d. 20/50

35. What is the spatial frequency equivalent (size in cycles/degree) of a -0.3 logMAR letter?

- a. 0.5
- b. 10
- c. 40
- d. 60

36. According to the Ferry-Porter law, the CFF ...

- a. is directly proportional to the log of the stimulus luminance.
- b. is directly proportional to stimulus luminance.
- c. is inversely proportional to the log of the stimulus luminance.
- d. increases as the log of stimulus area.

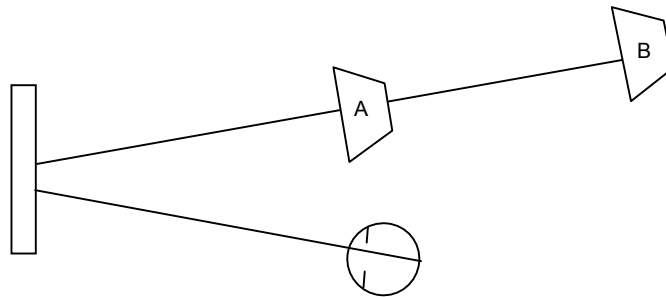
37. Which of the following correctly describes the relationship between the size of a flashing light and the maximum rate of flicker than a person can normally see.

- a. As a flashing light gets smaller, the flicker will be easier to see.
- b. As a flashing light gets larger, the flicker will be easier to see.
- c. The fastest flicker that a person can see remains constant for flashing lights of any size.
- d. As a light becomes dimmer at the same time it becomes smaller, the flicker becomes easier to see.

38. 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 brighter than a steady light of the same radiance.
  - a light that is flashed on for about 75 msec will look slightly dimmer than a steady light of the same radiance.

39. The law that applies to the apparent luminance of an intermittent light stimulus with an alternating frequency above the CFF when fused is ...

- Bloch's law.
- brightness enhancement.
- Stephen's power law.
- the Talbot-Plateau law.



40. Refer to the figure, above. A lamp located at position A illuminates a paper, which is observed by a subject. What happens when the lamp is moved to position B?

- The illumination onto the paper and the retinal illumination will both remain constant.
- The illumination onto the paper will decrease, but the retinal illumination will remain constant.
- The illumination onto the paper will decrease and the retinal illumination will also decrease.
- The illumination onto the paper will remain constant, but the retinal illumination will decrease.

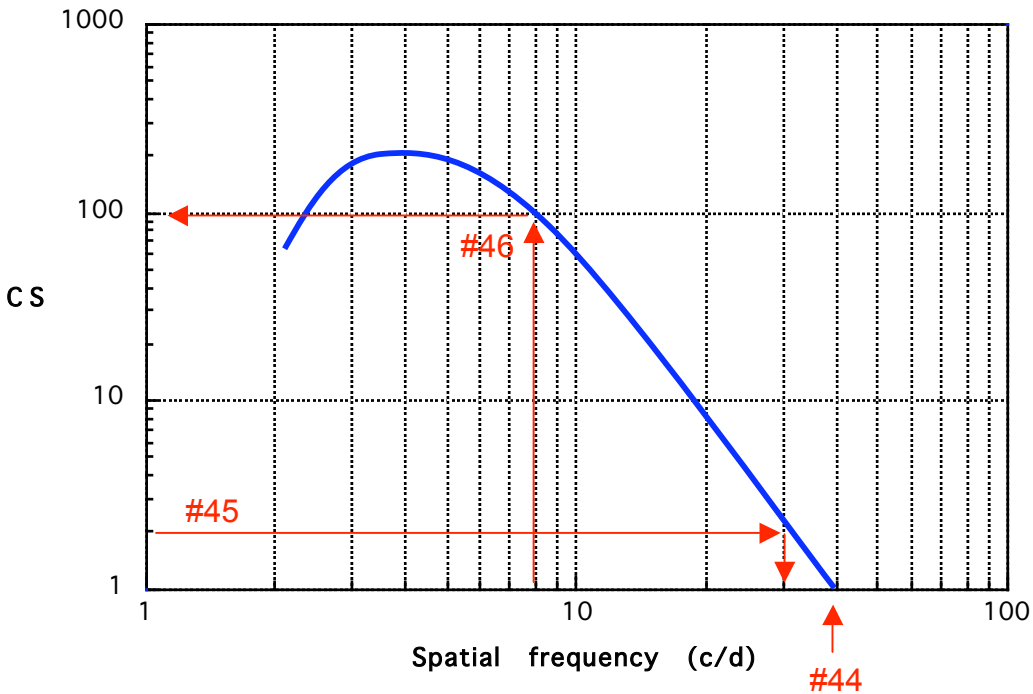
41. Most color vision tests, such as the D-15 test, recommend that the test objects be illuminated by ...

- Standard illuminant A
- Standard illuminant B
- Standard illuminant C
- Standard illuminant D

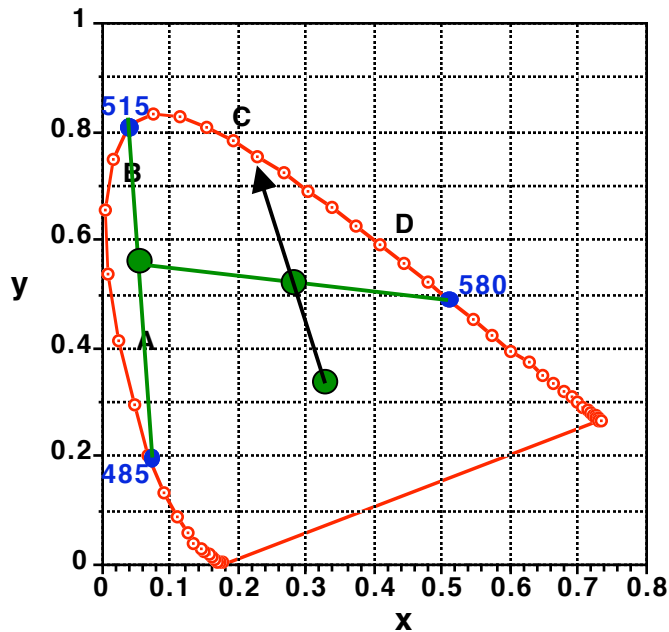
42. After a DFE we give patients disposable sunglasses, since their pupils will not be able to constrict in response to light. What sunglass transmission would provide the equivalent protection to that offered by pupil constriction, if it would normally change from a maximum of 7 mm to 2 mm when the patient steps outside? Choose the closest answer.

- 12%
- 10%
- 8%
- 5%

43. In Step 1 of the standard ERG protocol we tests 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  $25$  nits, what is the luminance used in Step 1, in apostilbs?
- 2500
  - 100
  - 0.8
  - 0.25



44. 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
45. 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
46. 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%



47. 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

48. 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

49. A patient mixes monochromatic green and red lights to obtain a metameric match with monochromatic yellow. If 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

50. For which of the following anomalies would the patient accept normal mixture and luminance settings?

- a. protanomaly
- b. protanopia
- c. deuteranomaly (d is the better answer, but b is also acceptable)
- d. deuteranopia

51. Suppose the mixture setting contains a slightly greater-than-normal amount of green but the luminance setting is normal. He probably has ...

- a. protanomaly
- b. protanopia
- c. deuteranomaly
- d. deuteranopia

52. Which of the following tests would be most useful in helping you diagnose a case of suspected malingering?

- a. EOG
- b. VER
- c. ERG
- d. visual acuity

53. 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?

- a. visual acuity
- b. EOG
- c. ERG
- d. VER

54. One speaker at the American Academy of Optometry presented results from a clinical trial comparing the new Biofinity contact lens with other silicon-hydrogel lenses. He described visual performance for the lenses in terms of the mean logMAR visual acuity. Subjects using the Biofinity had a mean LogMar VA = 0.014 and subjects using another lens had a score of 0.011. Which of the following best describes the results of this comparison?

- a. The Biofinity provided at least one line of better acuity.
- b. The other lens provided at least one line of better acuity.
- c. The Biofinity provided less than one letter of better acuity.
- d. They both provided essentially the same mean VA (less than one letter different).

55. An eye chart displays several rows of gray letters on a white background. All of the letters have the same contrast, but they vary in size from top to bottom. This chart tests ...

- a. High contrast visual acuity
- b. Low contrast visual acuity
- c. Contrast sensitivity
- d. Contrast threshold

*Thank you for being great students. It's been a wonderful blessing to work with you. I hope you all enjoy a well-deserved break. Merry Christmas, and see you next year!*  
-- Dr. Salmon