Name/PIN _____

Vision Science II – Monocular sensory aspects of vision

# Exam 2 – Light adaptation to motion perception

October 19, 2005

1. An extended or asymmetric photostress recovery time would most likely indicate a problem with …
a. intraocular pressure.
b. photoreceptor physiology.
c. higher-order aberrations.
d. neural conductivity in the optic nerve.

2. Because of Weber's law, how do changes in pupil diameter affect the ability to detect a spot of light projected onto a uniform background (increment threshold)? The spot's contrast, relative to the background, …
a. must increase with larger pupil sizes.
b. must decreases with larger pupil sizes.
c. remains constant.
d. must decrease only in eyes with glaucoma.

3. According to Ricco's Law, for spot diameters smaller than the critical diameter, the intensity (quanta/area) of the spot necessary for detection
a. must increase for smaller spot diameters.
b. must decrease for smaller spot diameters.
c. must remain constant for all spot diameters (within the critical diameter).
d. is unrelated to spot diameter.

4. According to Bloch's Law, for durations within the critical duration, the product of intensity (quanta/time) and time
a. must increase with increasing duration.
b. must decrease with increasing duration.
c. must remain constant (within the critical duration).
d. is unrelated to duration.

5. Assuming a critical duration of 10 milliseconds (photopic system), which of the following is correct?
a. If a light (with 75% of threshold luminance) is flashed, then 90 milliseconds later re-flashed, the person will see two flashes.
b. If a light (with 75% of threshold luminance) is flashed, then 5 milliseconds later re-flashed, the person will not see any flash.
c. If a light (with 75% of threshold luminance) is flashed, then 2 milliseconds later re-flashed, the person will see two flashes.
d. If a light (with 125% of threshold luminance) is flashed, then 25 milliseconds later re-flashed, the person will see two flashes.

6. The Stiles-Crawford effect of the first kind …
a. is the name of the phenomenon wherein the human eye is more sensitive to light coming from the center of the pupil than from the periphery.
b. is of greater magnitude in cones than rods.
c. is due to the waveguiding of light in the photoreceptors.
d. all of the above

7. Name three features of the scotopic system that improve visual sensitivity, but sacrifice visual resolution. (3)

greater spatial summation
greater temporal summation
absence of a Stles-Crawford effect

8. According to the definition of spatial vision we discussed in class, which of the following tests spatial visual performance?
a. visual acuity
b. photostress test
c. pupil reflexes
d. temporal modulation transfer function

9. If a 4-cycle-per-degree sine wave grating is used as the test target, how will optical aberrations affect the quality of its retinal image?
a. Spatial frequency and contrast will both be reduced.
b. Spatial frequency will be reduced, but contrast will remain the same.
c. Spatial frequency will remain the same, but contrast will be reduced.
d. Spatial frequency and contrast will both remain constant.

10. Which of the following tests optical performance of the eye?
a. visual acuity
b. modulation transfer function
c. contrast sensitivity
d. temporal modulation transfer function

11. Which of the following spatial frequencies, expressed in cycles per degree, most closely corresponds to a 20/20 Snellen letter?
a. 20
b. 30
c. 40
d. 50

12. A contrast sensitivity test designed for a 10-foot viewing distance has sine-wave gratings with spatial frequencies of 3, 6, 12 and 18 cycles per degree. If you incorrectly test at a distance of 5 feet, what will happen to visibility of the gratings?
a. Visibility should remain the same for all of the gratings.
b. All of the gratings should be easier to see.
c. All of the grating should be more difficult to see.
d. None of the above.

13. A contrast sensitivity test designed for a 10-foot viewing distance has sine-wave gratings with spatial frequencies of 3, 6, 12 and 18 cycles per degree. How should the Boxer-Wachler normalized scores be affected by a moderate cataract?
a. They should be less than 1.0 for all spatial frequencies.
b. They should be greater than 1.0 for all spatial frequencies.
c. They should be less than 1.0 for 3 and 6 cycles per degree, but greater than 1.0 for 12 and 18 cycles per degree.
d. They should be greater than 1.0 for 3 and 6 cycles per degree, but less than 1.0 for 12 and 18 cycles per degree.

14. Briefly explain what Yellot's ring is, what causes it, and what information it gives us about the eye. (3)

It's a ring that appears in the Fourier spectrum of a retinal photograph
The spatial frequency associated with the ring's location corresponds to the cone array.
It allows us to calculate the size of the cones.

15. Years ago a spacecraft sent moon photographs back to the earth, but because of transmission artifacts, the picture contained several thin vertical black lines (example below). Using Fourier transformation astronomers were able to remove the black lines and perfectly restore the image with nothing missing except the black lines. Briefly explain how they probably did this. (3)

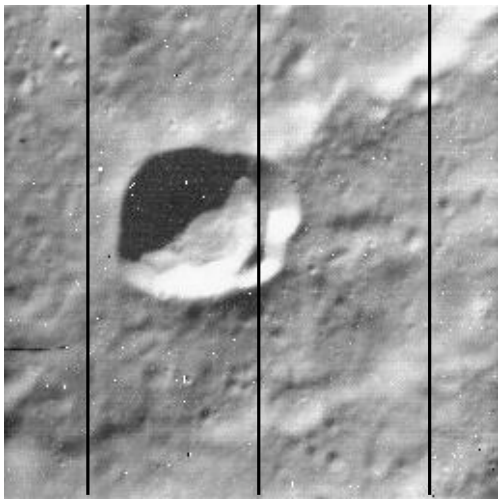

**Figure 1.** Moon photograph with transmission artifacts.

1. Computed spatial frequency spectrum of the image
2. Zeroed out the part of the spectrum corresponding to the vertical lines
3. Inverse Fourier transformed the picture back.

16. The width of a typical computer monitor's pixel is 0.28 mm. The finest pattern of stripes that this monitor could produce is illustrated in Figure 2, below. If the computer were viewed at a distance of 48 cm, what spatial frequencies from the pattern would be visible to a normal human eye? (3)

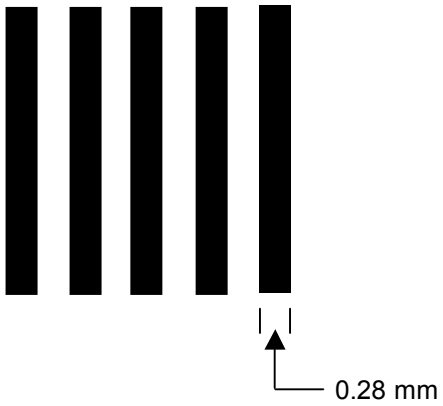


**Figure 2.** Example stripe pattern produced by the monitor described in Question 16.

1 MAR = atan(0.28/480) = 0.0334 deg = 2 arc min
This equates to 20/40
This is equal to 600/40 = 15 cycles/degree
Square wave contains 15, 45, 75 ... cycles/deg
Only 15 and 45 cycles/deg would be visible.

17. Under ideal conditions, Vernier acuity thresholds can be as good as …
a. 2 to 10 arc seconds
b. 2 to 10 arc minutes
c. 2 to 10 degrees
d. 2 to 10 radians

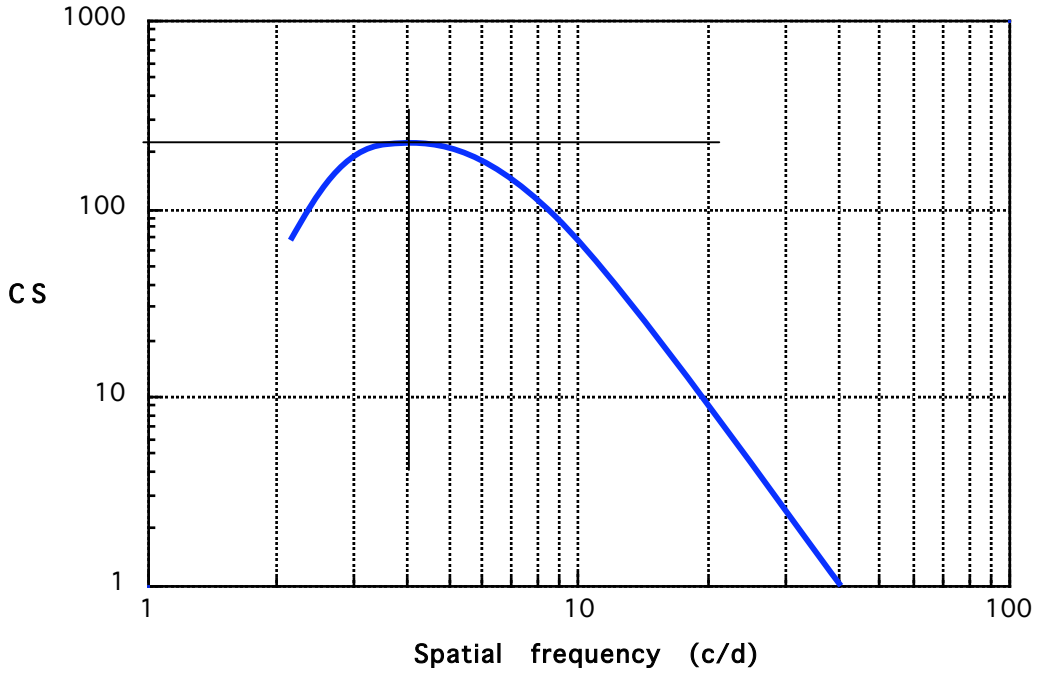


**Figure 3.** Example contrast sensitivity function

18. Based on the information in Figure 3, what is the high-contrast visual acuity of this eye? (1)

20/15

19. What would the visual acuity be if a 5%-contrast chart were used? (1)

About 20/40 (between 20/30 and 20/60)

20. What is the contrast threshold for a target, which has a size equivalent to 20/15? (1)

100%

21. What is the contrast threshold for a 20/150-sized target? (1)

About 0.5% or 0.005

22. Which of the following types of targets can be used to test contrast sensitivity?
a. Sine-wave gratings
b. Letters
c. Pictographs (simple images of familiar shapes, like a hand, bird, birthday cake, etc.)
d. All of the above

23. If the center-to-center distance between foveal cones is 1.8 μm, and 1.0 degree on the retina is 312.0 μm wide, what is the maximum visual acuity this retina is capable of?

About 20/7

24. How would heavy deposits on a contact lens affect the contast sensitivity function? (2)

Reduce CS at high as well as mid spatial frequencies.

25. Assume you are using an ETDRS high contrast chart to test visual acuity. If a patient can read all of the 0.3 line, and two letters on the 0.2 line, what is his logMAR visual acuity. (1)

0.26

26. If study reports that the mean logMAR visual acuity of a sample population is 0.26, what is the equivalent Snellen visual acuity? (1)

20/36

27. What is the equivalent Snellen visual acuity for a decimal acuity of 2.0? (1)

20/10

28. What is the logMAR equivalent of a visual acuity of 20/15? (1)

-0.125

29. The temporal modulation transfer function provides information about the visual system, including all of the following, except one. Which one?
a. The frequency (in Hz) at which the eye can best see flicker.
b. The duration (in seconds) at which a single flash of fixed radiant power appears brightest.
c. For a low temporal contrast (percent depth modulation) the fastest flicker that a person can see.
d. For a low temporal contrast (percent depth modulation) the slowest flicker that a person can see.

30. According to the Ferry-Porter law, the CFF …
a. is directly proportional to stimulus luminance.
b. is directly proportional to the log of the stimulus luminance.
c. is inversely proportional to the log of the stimulus luminance.
d. increases as the log of stimulus area.

31. Which of the following correctly describes the relationship between the size of a flashing light (of fixed radiant power) 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. The fastest flicker that a person can see remains constant for flashing lights of any size.
c. As a flashing light gets larger, the flicker will be easier to see.
d. As a light becomes dimmer at the same time it becomes smaller, the flicker becomes easier to see.

32. According to the Broca-Sulzer effect,
a. the longer a light (with fixed radiant power) is left on, the brighter it appears to become.
b. a flickering light appears dimmest if it is flashed at a rate of about 10 Hz.
c. a light that is flashed on for about 75 msec will look slightly less bright than a steady light of the same radiant power.
d. a light that is flashed on for about 75 msec will look slightly brighter than a steady light of the same radiant power.

33. How doe the frequency of flicker affect the perceived brightness of a light with fixed radiant power?
a. It will be constant for all rates of flicker below the CFF.
b. It will be constant for all rates of flicker above and below the CFF
c. It appears brightest if flickered at a frequency of about 10 Hz.
d. It appears to get brighter the faster it is flickered.

34. Vision scientists sometimes employ a mask, presented immediately before, and spatially adjacent to the location of a test stimulus. This technique is referred to as …
a. simultaneous masking
b. paracontrast
c. backward masking
d. metacontrast

| | | | |
|---|---|---|---|
|  |  |  |  |
| **Frame 1** | **Frame 2** | **Frame 3** | **Frame 4** |

**Figure 4.** Four sequential frames from an animation.

35. George Mather's web site described the importance of both spatial and temporal cues to motion perception. Assume that the four frames shown above are sequentially flashed at a rate of about 17 frames per second. Based on the relative location of the soccer ball within each frame and the black/white contour, how should the ball appear to move? (1)

It should appear to move from the middle to the left, continuously.

36. A clock has a diameter of 1 foot and the minute hand moves with a smooth continuous motion. (It doesn't jump from minute to minute.) Assuming ideal viewing conditions, what is the greatest distance from the clock that a normal person should be able to barely see movement of the minute hand? (2)

You need to know that the optimal threshold for motion detection is 1-3 arc minutes.
Then compute the answer to be between about 90 and 30 cm.

37. Briefly explain why the moon appears to be larger when it is low on the distant horizon. (The moon illusion) (3)

The moon on the horizon appears farther than when it's high in the sky.
Normally retinal image size decreases as objects get farther away.
The brain compensates with size constancy, so it doesn't appear to shrink.
If the image size remains the same (doesn't decrease), but distance appears to increase, the brain's compensation makes the object appear larger.

**Bonus question:**
Do you plan to support the Oklahoma College of Optometry's soccer team during the upcoming intramural season? (1)
a. Yes
b. Si
c. Ja
d. Oui
e. はい

*I hope everyone has a safe, enjoyable fall break.*

*-- Dr. Salmon*