

Exam 2 – Spatial vision, temporal vision, motion perception, illusions

October 14, 2009

Maximum points = 37

1. Which of the following best describes what we mean by “spatial vision” in this course? It is the study of how we perceive ...
 - a. wavelength as a function of space and time.
 - b. luminance as a function of location.
 - c. luminance as a function of time.
 - d. distances and space relationships between objects.

2. Which of the following best describes what we mean by “temporal vision” in this course? It is the study of how we perceive ...
 - a. wavelength as a function of space and time.
 - b. luminance as a function of location.
 - c. luminance as a function of time.
 - d. distances and space relationships between objects.

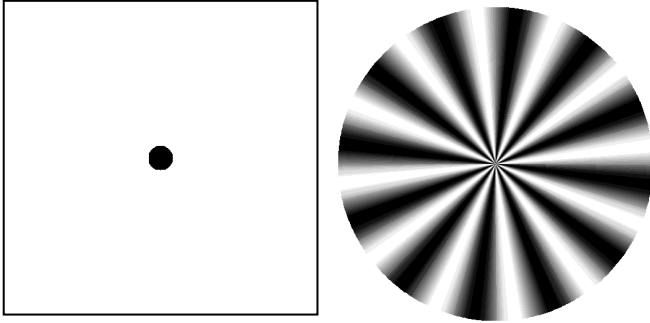
3. Name three different clinical spatial vision tests. (3)
 - High contrast visual acuity
 - Low contrast visual acuity
 - Contrast sensitivity

4. What is the main reason and logic for using sine wave gratings to evaluate vision?
 - a. Sine wave gratings can be designed with a greater range of contrasts than letters.
 - b. A typical sine wave grating contains more spatial frequencies than a typical letter.
 - c. By testing visual performance with sine wave gratings we can know how an eye sees anything.
 - d. Sine wave gratings are not affected by optical blur so they are more sensitive to subtle changes in vision.

5. If you focus two coherent points of light into the pupil plane, on either side center in the horizontal meridian, what will the patient see?
 - a. Two small bright spots of light
 - b. Three small bright spots of light
 - c. A beam of light containing the visible spectrum
 - d. A pattern of light and dark stripes

6. Referring to Question 5, if you spread the two lights out from the center, how will the appearance change?
 - a. The spots will get brighter.
 - b. The spots will get dimmer.
 - c. The spectrum will rotate.
 - d. The stripes will get thinner.

7. Which of the following functions have the most similar shapes for a well-corrected eye?
 - a. The spatial CSF and the temporal MTF
 - b. The spatial MTF and the temporal MTF
 - c. The spatial MTF and the spatial CSF
 - d. The points spread function and the spatial CSF

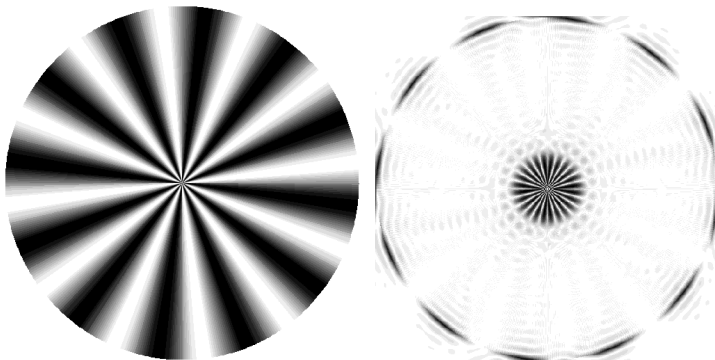


8. The left image above represents a large data array with values equal to 1.0 in the center (black) and zero everywhere else (white). If you multiply this array times the right image, and then compute its Fourier spectrum, what should the image of the frequency spectrum look like?

- a. High values in the center and low values in the periphery
- b. High values in the periphery and low values in the center
- c. High values uniformly distributed throughout the spectrum
- d. High values randomly distributed throughout the spectrum

9. Referring to the same images above, what would happen if the black represented zero and the white represented values of 1.0. What should the image of the frequency spectrum look like?

- a. High values in the center and low values in the periphery
- b. High values in the periphery and low values in the center
- c. High values uniformly distributed throughout the spectrum
- d. High values randomly distributed throughout the spectrum



10. Starting with the photo on the left, list the three main image processing steps needed to produce the image on the right. (3)

- 1. Fourier transform the original image
- 2. Remove the low spatial frequencies (center of the Fourier spectrum)
- 3. Inverse Fourier transform to get the high-pass filtered image

11. A test is designed to test vision using 10% contrast sine wave gratings with spatial frequencies of 1, 3, 6 and 12 cycles per degree. Which of the following best describes what this tests?

- a. Contrast sensitivity
- b. Visual acuity
- c. Hyperacuity
- d. None of the above

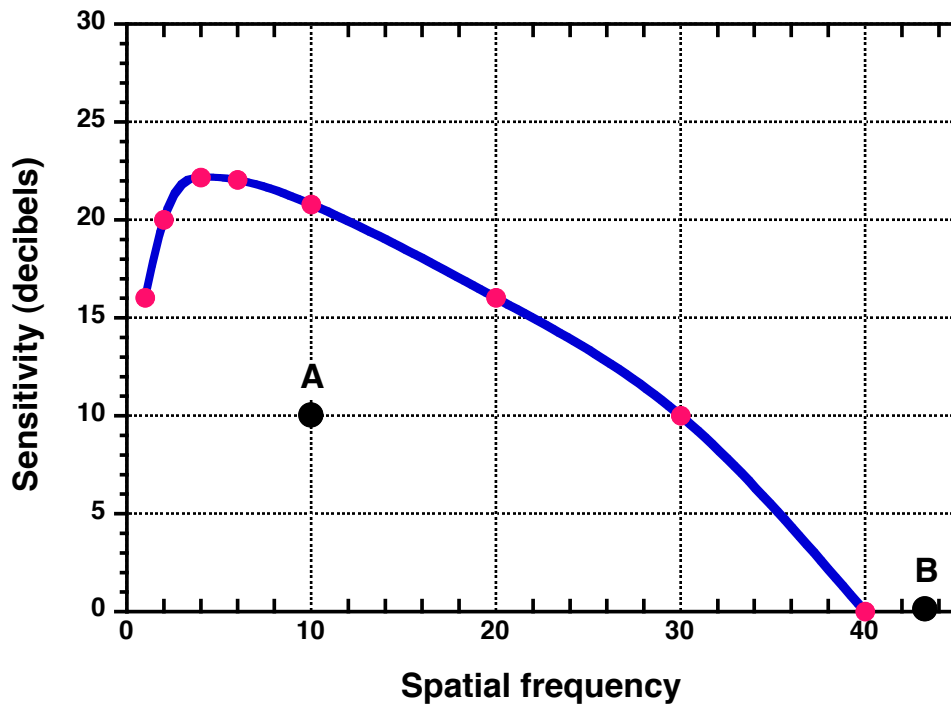
12. Compute the logMAR, decimal acuity and spatial frequency equivalents of Snellen 20/20. (1)

logMAR = 0

Decimal acuity = 1.0

Spatial frequency = 30 c/d

Figure for Questions 13 – 16.



13. What is the minimum contrast that this eye can see for a sine wave grating with a logMAR of 1.176? (2)

logMAR 1.176

MAR = $10^{(1.176)} = 15$

Snellen denom = 300

spat freq = 2

(1 point for this answer)

Contrast sens = 20 decibels

Sens = $10^{(2)} = 100$

contrast = $1/100 = 1\%$

(1 point for this answer)

14. Since the patient can barely see this grating, what could he do to make it more visible?
- Move closer to the chart
 - Optically magnify the chart
 - Move farther away from the chart
 - None of the above would help

15. Which of the following condition would this patient most likely have?
- Emmetropia
 - 1.00 D of uncorrected myopia
 - 3.00 D of uncorrected myopia
 - A dense nuclear cataract

16. Calculate his spatial resolution limit for a 10% contrast grating. (2)

10% contrast sensitivity = $1/.10 = 10$ log sens = 1 decibels = 10

At this level, the VA (spatial resolution limit) has a value of 30 cycles/degree

17. Which of the following best describes Point A on the graph?
- It has both a contrast and a spatial frequency that cannot be seen.
 - It has a contrast that cannot be seen, but a spatial frequency that can be seen.
 - It has a contrast that can be seen, but a spatial frequency that cannot be seen.
 - Both the contrast and spatial frequency are within the visible range.

18. Which of the following best describes Point B on the graph?
- It is the ultimate resolution limit for this eye.
 - It is too small to be seen.
 - If its contrast could be increased, it would become more visible.
 - None of the above.



AH-64 Longbow Apache front view

19. The US Army AH-64 Longbow Apache attack helicopter has a wingspan of 5.2 meters and height of 3.9 meters. If it were hovering and observing an enemy target from distance of 10 kilometers, would it be visible to the enemy, assuming ideal visual conditions and a minimum detectable visual acuity (for the enemy) of 1 arc second? (1)

Angular size = $\text{atan}(5.2/10,000) = 107$ arc seconds. Yes it would be visible.

20. A soldier who is well camouflaged might become visible if he moves. If he is 200 meters from an enemy, what is the maximum lateral movement he can make per second, and remain invisible, assuming the enemy is looking with his bare eyes, but has excellent vision? (1)

Minimum detectable movement is 1-3 arc minutes per second. Compute using 1 arc minute.

What lateral distance at a range of 200 meters has an angular size of 1 arc minute?

$$x = \tan(1') \cdot 200 = 0.0582 \text{ meters} = 5.8 \text{ cm.}$$

Three times this for 3 arc minutes. Therefore, if he moves less than 5.8-17.4 cm he should be OK.

21. Using an interferometer, a patient is able to resolve gratings as small as 20/8. If one degree on the retina has a lateral distance of 330 μm , what is the diameter of this person's foveal cones? (1)

$$20/8 = 600/8 = 75 \text{ cycles per degree.}$$

$$\text{Width of one cycle} = 330/75 = 4.4 \mu\text{m}$$

One cone would be half this width, therefore 2.2 μm

22. Under ideal conditions, Vernier acuity thresholds are about ...

- a. 2-10 arc seconds
- b. 2-10 arc minutes
- c. 2-10 prism diopters
- d. 2-10 degrees

23. You will always improve visibility if you ...

- a. both increase contrast and increase size.
- b. both increase contrast and decrease size.
- c. increasing contrast without changing size.
- d. decreasing contrast without changing size.

24. 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. For a low temporal contrast the fastest flicker that a person can see.
- c. For a low temporal contrast the slowest flicker that a person can see.
- d. The duration (in seconds) for which a single flash of fixed radiant power appears brightest.

25. 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.

26. Which of the following correctly describes the relationship between the size of a flashing light (of fixed radiant power) and how well a person can see high frequency flicker?

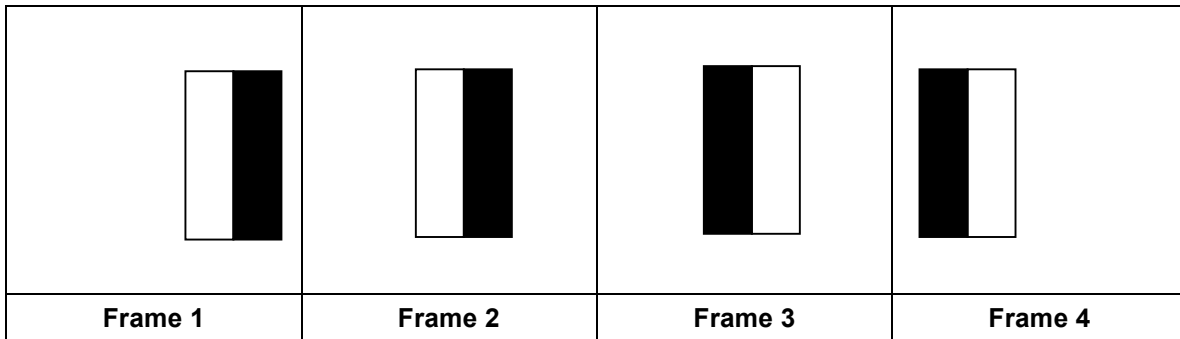
- a. If a flashing light gets smaller, the flicker will become more visible.
- b. The fastest flicker that a person can see remains constant for flashing lights of any size.
- c. If a light becomes dimmer and smaller, the flicker will become more visible.
- d. If a flashing light gets larger, the flicker will become more visible.

27. 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. lights that enters the peripheral pupil appears dimmer than light entering the center.
- c. a light that is flashed on for 50-100 msec will look slightly dimmer than a steady light of the same radiant power.
- d. a light that is flashed on for 50-100 msec will look slightly brighter than a steady light of the same radiant power.

28. According to the Talbot-Plateau law, how will the brightness of a light that is flickering above the CFF compare to a steady non-flickering light, which has the same radiance?

- a. The flickering light will appear dimmer.
- b. The flickering light will have the same brightness.
- c. The flickering light will appear brighter.
- d. None of the above.



29. Assume that an animation loops through the four frames shown above in sequence. Based on George Mather's theory about motion perception, the image should appear to be continuously moving to the left even though it actually stops from Frame 2-3. Briefly explain why. (2)

Motion perception can be indicated by the change in position of an image as well as by a change in light/dark contours.
Frames 1-2 and 3-4 indicate motion by the change in position.
Frames 2-3 indicate motion by a change in polarity of the image.

30. Which of the following best explains the moon illusion?

- a. Objects on the horizon make the moon appear closer. Since closer objects have a larger angular size the moon appears larger on the horizon.
- b. The moon on the horizon appears to be farther than when it is above. Normally object that are farther have a smaller angular size, but since the moon doesn't get smaller, the brain misperceives that it has gotten larger.
- c. Objects on the horizon make the moon appear closer. Since closer objects have a larger angular size, the moon appears smaller on the horizon.
- d. The moon on the horizon appears to be farther than when it is above. Normally object that are farther have a smaller angular size, so the moon appears smaller on the horizon.

Dear students,

Thank you for your efforts to learn vision science or, as they say in Japan, お疲れさまでした。 . I hope you enjoy a safe and relaxing fall break.

-- Dr. Salmon