Your name:_____

Based on 2004 exams

Perception Midterm
Prof. David J. Heeger
Oct 23, 2012

This exam is closed book, no notes, no index cards. For multiple choice questions, mark your answers on the scantron card with a #2 pencil. For the short answer questions, write your answers clearly in the space provided. Please make an effort to write legibly. MAKE SURE YOU PUT YOUR NAME ON BOTH ANSWER SHEET PAGES AND ON YOUR SCANTRON!! Answer all questions.

Part I. Short Answer (7 questions, 4 points each). Write your name and your answers on the accompanying answer sheet. Be concise (one or two sentences will suffice). If your answer includes lots of extraneous facts then you will not receive full credit, even if the extraneous comments are true and even if the correct answer is buried in there somewhere.

Different criterion for different jurors/juries.

1) Jimmy Farrell was born prematurely in October of 1969. Shortly after his birth he developed a rare disease, called retrolental fibroplasia (RLF) that left him blind. His parents sued the hospital for negligence in the case. As a premature infant, Jimmy was kept in an incubator, and the hospital used too much oxygen in the incubator, which led to Jimmy's blindness. After the trial, the two sides were seated together in the courtroom and were both informed, at the same time, that the jury had reached a decision. Both sides were worried that the decision would be unfavorable, and so at the last second they negotiated a final settlement for $500,000. The verdict, that was now irrelevant, had been in favor of the hospital. At just about the same time, a parallel trial was being held on behalf Gail Kalmowitz. She was also born prematurely, and was suing the doctors at the hospital where she was born because her near complete blindness was again caused by excessive oxygen in the incubator, thus leading again to RLF. At the end of the trial, both sides were again fearful of losing, and at the last minute they reached a settlement for $165,000. Moments later it was revealed that the jury would have awarded Gail Kalmowitz $900,000. And it was reported in the New York Times of that day that the jurors wept in the corridor of the Brooklyn courthouse when they learned that she had forfeited $735,000 by agreeing to her settlement. One of the jurors was quoted as saying, “You should have gone all the way. Our hearts were with you.” Let's assume that the juries were presented with the same facts. According to what you've learned in this class about signal detection theory, how is it that two such similar cases could be decided in completely opposite fashion? Be specific (a few words will suffice).

Acceptable answers:
- plasticity
- allows inhibitory and excitatory potentials
- one-way communication
- long- and short- lasting transmissions
- amplification of presynaptic signal
- selective
- more control
- greater specificity

2) What are *three* advantages of chemical synapses?

Your name:_____

3) You take part in a forced-choice detection experiment. What are the 4 possible outcomes of a single trial of the experiment? Create a table illustrating how these 4 possible outcomes relate to: a) what really happened on that trial of the experiment, and b) your choice on that trial of the experiment.

Bad idea, stabilized images fade.

4) Luke Skywalker and friends are hard at work on the next generation of Star-fighters. An engineer wants to install a device to help track the enemy during battle. He wishes to create a very complex system to keep enemy fighters centered in the pilots gaze. Once the pilot sees the enemy fighter and presses a “sight-lock” switch, the flight computer will take over the pilot's brain, moving her eyes to keep the enemy's image fixed, perfectly stabilized, on the fovea. Briefly evaluate the engineer's proposal based upon what you know about human visual perception.

- physiologically distinct: rods low light levels, cones high light levels.
- anatomically distinct: rod shape versus cone shape, no rods in fovea
- complete coverage: other than the fact that there are no rods in the fovea, both types of photoreceptors throughout retina/visual field.
- recombine: cone & rod signals merge by the time you get to ganglion cells.

5) Briefly describe the 4 properties that are typical of parallel pathways, using the rods and cones as an example.

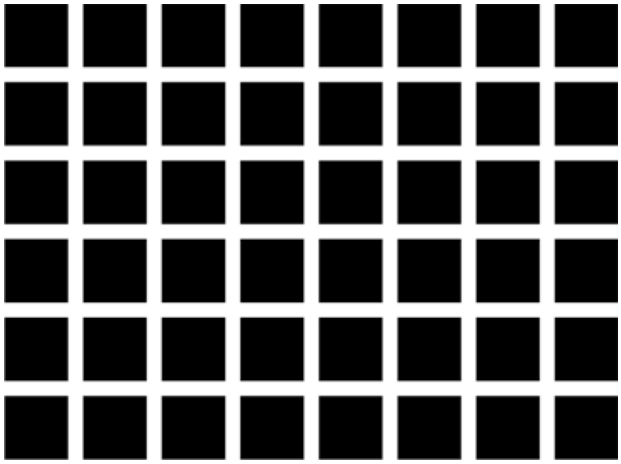
No rods in the fovea. Look off a bit to the side and the light from the dim star will fall outside the fovea where there are rods.

6) On a clear romantic night in Utah with minimal moonlight, Miles takes his girlfriend Carmine out to look for a star that he has officially registered under her name. He quickly locates the star and then points in that direction. Carmine looks in the direction of his gaze and tries in vain to find the star, but does not see it. Explain, in terms of what you know about the anatomy and physiology of the eye, why Carmine cannot see the star. Given that, what would you recommend that Carmine do if she wants to see this star?

Your name:_____

At an intersection, there's more white in the receptive field surround, more inhibition, diminished brightness percept.

7) Below is a pattern called the Hermann grid, in which you see illusory gray spots at the intersections. Briefly describe how the spatial filtering/lateral inhibition of retinal ganglion cells might be used to explain the illusion. Feel free to draw on the grid as part of your explanation.



Part II. Multiple Choice (36 questions, 2 points each). Write your name and fill in the circles using a #2 pencil on the accompanying scantron card.

1) The size of a neuron's action potential varies according to:
   a) the number of excitatory neurons that synapse with it.
   b) the number of inhibitory neurons that synapse with it.
   c) the length of its axon.
   d) the length of its refractory period.
   e) none of above because the size of an action potential never varies.

David Heeger Oct 15, 6:36 PM

2) Synaptic transmission is a chemical process that triggers a change in voltage in the postsynaptic neuron that always generates a new action potential in that neuron.
   a) True
   b) False

David Heeger Oct 15, 6:24 PM

3) Which site is a relay station for most of the sensory input to the cerebral cortex of the brain?
   a) thalamus
   b) 8th cranial nerve
   c) calcarine sulcus
   d) fusiform gyrus
   e) helicotrema

David Heeger Oct 15, 6:24 PM

4) If you were to apply a small electrical current directly to the visual cortex of a patient's brain, while they were undergoing brain surgery but fully awake, they would probably:
   a) feel intense pain
   b) feel a small shock
   c) see something
   d) have no sensation of the applied current
   e) don't know because it's inhumane to perform brain surgery while the patient is awake.

David Heeger Oct 15, 6:36 PM

5) fMRI measurements directly reflect:
   a) the number of action potentials
   b) dendritic electrical currents
   c) the relative amounts of oxygenated and deoxygenated hemoglobin
   d) brain pulsations caused by changes in blood flow
   e) the number of photons emitted

David Heeger Oct 15, 6:36 PM

6) Which of the following is an advantage of ERP over fMRI:
   a) ERP has better spatial resolution
   b) ERP has better temporal resolution
   c) ERP is non-invasive
   d) All of the above
   e) None of the above

David Heeger Oct 15, 6:36 PM

7) Compared to PET neuroimaging, fMRI neuroimaging:
   a) is less invasive.
   b) has better temporal resolution.
   c) has better spatial resolution.
   d) both a and c.
   e) all of the above.

David Heeger Oct 15, 6:36 PM

8) Moving the criterion to the right produces which of the following outcomes:
   a) an increase in d'.
   b) a decrease in d'.
   c) an increase in the hit rate.
   d) a decrease in the hit rate.
   e) an increase in the false alarm rate.

David Heeger Oct 15, 6:36 PM

9) Two observers, A and B, both participate in a psychophysical experiment. Observer A's data: 100 hits, 100 misses, 50 false alarms, and 100 correct rejections. Observer B's data: 80 hits, 20 misses, 30 false alarms, and 60 correct rejections. We can conclude which of the following?
   a) Subject A is more sensitive than B.
   b) Subject B is more sensitive than A.
   c) The sensitivities of these two observers cannot be compared without further information.

David Heeger Oct 15, 6:36 PM

10) According to Weber's Law, if the difference threshold for discrimination of a 100g weight from a slightly heavier one is 5g, the difference threshold for discrimination of a 600g weight from a slightly heavier one will be
   a) log(600).
   b) 5g.
   c) 30g.
   d) unpredictable from only the data on the 100g weight.

David Heeger Oct 15, 6:29 PM

11) The physical intensity of sound A is 100 times greater than sound B. How many units does this correspond to?
   a) 100 Hz
   b) 2 sones
   c) 100 dB
   d) 40 dB

David Heeger Oct 15, 6:36 PM

12) There are more _____ than _____. Auditory nerve fibers receive the vast majority of their inputs from _____.
   a) inner hair cells, outer hair cells; outer hair cells
   b) inner hair cells, outer hair cells; inner hair cells
   c) outer hair cells, inner hair cells; outer hair cells
   d) outer hair cells, inner hair cells; inner hair cells
   e) outer hair cells, inner hair cells; both inner and outer hair cells

David Heeger Oct 15, 6:35 PM

13) For a shift-invariant linear system (like the motion of the basilar membrane in response to sound), the response to a sinusoidal stimulus will:
   a) also be sinusoidal.
   b) have the same amplitude as the stimulus.
   c) have the same frequency as the stimulus.
   d) both a and c.
   e) all of the above.

David Heeger Oct 15, 6:37 PM

14) We are studying a system in which stimulus A produces a response of 3 units and stimulus B produces a response of 5 units. Which of the following requirements must be true for the system to be linear?
   a) Doubling stimulus A produces a response of 6 units, and doubling stimulus B produces a response of 10 units.
   b) Presenting stimulus A and B at the same time produces a response of 8 units.
   c) Both a and b.

David Heeger Oct 15, 7:19 PM

15) The Fourier spectrum of a sound
   a) is a plot of sound pressure level versus time.
   b) is a plot of sound pressure level versus frequency.
   c) is a plot of hertz versus frequency.
   d) is a plot of frequency versus time.
   e) can only be plotted for pure tones.

David Heeger Oct 15, 6:37 PM

16) Traveling along the basilar membrane, away from the stapes,
   a) characteristic frequency goes from high to low
   b) best frequency goes from low to high
   c) tonotopy becomes less regular
   d) hair cells stop vibrating

David Heeger Oct 15, 6:38 PM

17) A visual image is brought into focus on the retina primarily because
   a) the curved transparent surface of the cornea bends light.
   b) the vitreous humor causes the lens to change its shape.
   c) the pupil is really small so that they eye behaves like a pinhole camera.
   d) the lens in the eye moves back and forth adjusting its distance from the retina, like the lens of a camera.

David Heeger Oct 15, 6:42 PM

18) Glaucoma
   a) results in a decrease in the pressure in the eye.
   b) results in an increase in the pressure in the eye.
   c) leads to an imbalance in the ocular dominance columns.
   d) is due to a hereditary degeneration of the receptor cells.
   e) refers to visual disorders in which there is no problem with the eye (the optics and retina are fine), but one eye has better vision than the other.

David Heeger Oct 15, 6:43 PM

19) Amblyopia
   a) results in a decrease in the pressure in the eye.
   b) results in an increase in the pressure in the eye.
   c) results in a clouding of the lens.
   d) is due to a hereditary degeneration of the receptor cells.
   e) refers to visual disorders in which there is no problem with the eye (the optics and retina are fine), but one eye has better vision than the other.

David Heeger Oct 15, 6:43 PM

20) Macular degeneration results in
   a) a building of pressure inside the eye.
   b) a loss of central vision.
   c) retinal detachment.
   d) blurry vision.

David Heeger Oct 15, 7:21 PM

21) What causes us to have a blind spot in our visual fields?
   a) Light that comes into the eye from just the right angle reflects off the back of the eye.
   b) The Purkinje tree blocks the light from reaching the photoreceptors.
   c) There is no room for photoreceptors where ganglion cell axons leave the eye.
   d) The most responsive photoreceptors are easily bleached by intense lights.

David Heeger Oct 15, 7:24 PM

22) Which of the following retinal neurons generate action potentials?
   a) photoreceptors
   b) bipolar cells
   c) horizontal cells
   d) retinal ganglion cells

David Heeger Oct 15, 6:43 PM

23) There is a _____ density of ganglion cells in the periphery than at the fovea. Peripheral ganglion cells have _____ dendritic trees, and _____ receptive fields.
   a) lower; smaller; smaller
   b) lower; smaller; bigger
   c) lower; bigger; bigger
   d) higher; bigger; bigger
   e) higher; bigger; smaller

David Heeger Oct 15, 6:43 PM

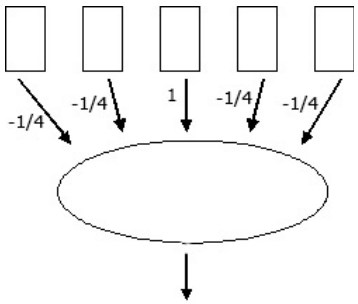
24) Rod vision is more sensitive at low light levels compared to cone vision because:
   i) each molecule of rhodopsin (the photopigment found in rods) is more likely to absorb a photon of light, compared to the photopigment molecules in cones.
   ii) rod photopigment regenerates in few seconds which is much faster than the cone photopigments.
   iii) there is more convergence from rods to retinal ganglion cells compared to cones.
   iv) rod spectral sensitivity peaks at longer wavelengths compared to cones.
   a) i and ii
   b) i and iii
   c) only iii
   d) i, iii, iv

David Heeger Oct 15, 6:44 PM

25) Which of the following is the correct sequence of processing a photon of light after it has landed on the retina?
   a) photoreceptor → bipolar cell → ganglion cell → optic nerve fiber
   b) photoreceptor → ganglion cell → bipolar cell → optic nerve fiber
   c) pigment epithelium → photoreceptor → bipolar cell → optic nerve fiber
   d) pigment epithelium → ganglion cell → photoreceptor → bipolar cell → optic nerve fiber

David Heeger Oct 15, 6:45 PM

26) On the right is a wiring diagram for a particular retinal neuron. This neuron receives inputs from 5 photoreceptors, excitation from the receptor in the center and inhibition from the other 4 receptors. The amount of inhibition from each of the surrounding receptors is one-fourth as big as the excitation from the central receptor. The retina is properly adapted to a mean light level of 1/2. Then a stimulus is flashed on briefly. Below are listed the light intensities for each of several possible stimuli. For each stimulus, the five numbers correspond to the light intensities presented to each of the five photoreceptors. Pick the stimulus that evokes the largest response.



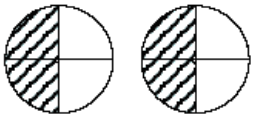
   a) –1/4 –1/4 1 –1/4 –1/4
   b) 0 0 1 0 0
   c) 1 1 0 1 1
   d) 1 1 1 1 1

David Heeger Oct 15, 6:45 PM

27) Which object will appear the lightest (most white)?
   a) a square reflecting 9,000 candelas on a background reflecting 18,000 candelas
   b) a square reflecting 7,500 candelas on a background reflecting 12,500 candelas
   c) a square reflecting 3,000 candelas on a background reflecting 5,000 candelas.
   d) a square reflecting 1,000 candelas on a background reflecting 500 candelas.

David Heeger Oct 15, 6:47 PM

28) Which of the following would be the most likely cause of the visual field deficit diagram?

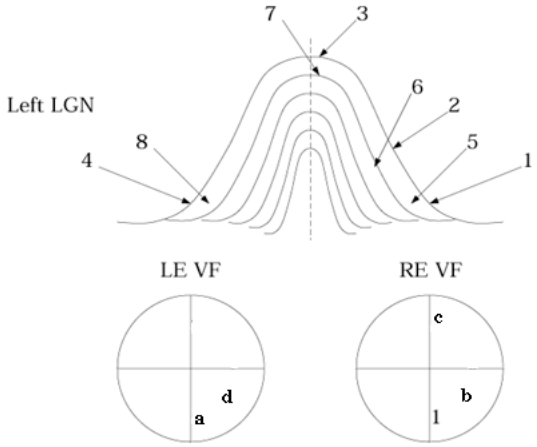


a) Left optic nerve damage.
b) Right optic nerve damage.
c) Cut left optic tract.
d) Cut right optic tract.
e) Puncture in lower-right retina of right eye.

David Heeger Oct 15, 6:52 PM

b

29) We place a microelectrode at position 1 in the LGN shown below, record from an LGN neuron, and find that its receptive field is located as marked by the "1" in the diagram of the visual fields. Then we move the electrode to position 2 in the LGN and record from another LGN neuron. Choose the most likely location for its receptive field.



30) A simple cell in V1 responds most when
a) a large field of light is turned on so that it covers the entire receptive field.
b) a small spot of light is flashed on so that it covers only the center of the receptive field.
c) a line or bar of the appropriate orientation is flashed at just the right position within the receptive field.

David Heeger Oct 15, 6:55 PM

31) Which of the following are found in V1, but not at earlier stages of the visual pathways?
i) orientation selectivity
ii) disparity selectivity
iii) direction selectivity
iv) receptive fields
a) i and ii
b) ii and iii
c) i, ii, and iii
d) i, ii, iii, and iv

David Heeger Oct 15, 6:57 PM

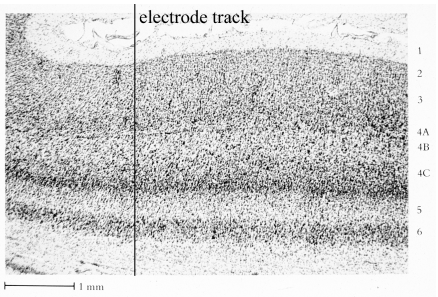
32) The key difference between simple and complex cell receptive fields is that
a) only complex cells are binocular.
b) only simple cells are orientation selective.
c) only complex cells show length summation.
d) only simple cells have separate ON and OFF subregions.

David Heeger Oct 15, 6:57 PM

33) What would you do to distinguish between a complex cell and a hypercomplex cell?
   a) Move the test stimulus across the visual field.
   b) Shorten and lengthen the test stimulus.
   c) Change the orientation of the test stimulus.
   d) Reverse the center-surround relationship of the stimulus.

David Heeger Oct 15, 7:30 PM

34) The figure on the right shows an electrode track that penetrates vertically (perpendicular to the surface) through **primary visual cortex** (V1). As the electrode moves along this path, we record from a bunch of neurons. All of the neurons along the way will have
   a) the same orientation preference.
   b) the same ocular dominance.
   c) largely overlapping receptive fields.
   d) a and b
   e) all of the above.



David Heeger Oct 15, 7:01 PM

35) The proportion of primary visual cortex devoted to the central 10° of the visual field is _____ that devoted to more peripheral locations (>10°).
   a) greater than
   b) less than
   c) roughly equal to

David Heeger Oct 15, 7:04 PM

36) Experiments on kittens have demonstrated that monocular deprivation (e.g., by closing one eye for an extended period of time)
   a) does not affect development of visual cortex.
   b) can cause abnormalities in visual cortex, but only if the eye is deprived throughout the first few months of age.
   c) can cause abnormalities in visual cortex at any age, as long as the eye is deprived for a long enough period of time.

David Heeger Oct 15, 7:32 PM