Exam 2 Questions by Prof. Shadmehr

Question 1 (4 pts total)

The cashier at the local supermarket turns to you and, unexpectedly, gives you a beautiful smile. You are surprised, and delighted. When you saw the smile, what neurotransmitter was released in your brain? Which part of your brain is the major recipient of this neurotransmitter?

Question 2 (8 pts total)

You are at a wedding and a waiter approaches with a tray of drinks. He is holding the tray with one hand, and asks whether you'd like one. Consider two possibilities:
a) You reach out and pick up a drink. What is likely to happen to the tray? Why?

b) The waiter reaches and pick up a drink and hands it to you. What is likely to happen to the tray? Why?

Question 3 (10 pts total)

For each condition listed below, indicate which area of the brain may be damaged. If possible, indicate whether it is the left or right side of that structure.

a) A mouse is dropped into a pool of water. There is a platform hidden, and its location is constant. Even after days of training, the animal does not learn the spatial location of the platform.

b) The patient writes in exceedingly small letters.

c) The patient holds a basket in one hand holds a ball in the other hand. When she drops the ball into the basket, the basket slips out of her hand.

d) When asked to copy a drawing of a clock, the patient copies only the right side.

e) When given a tooth brush, the patient uses it to comb their hair.

Question 4 (4 pts total)

Describe two events that take place in the spinal cord in the hours following spinal cord injury.

Question 5 (8 pts total)

True or False:
a) In Polio, the number of muscle fibers in a given motor unit tend to be smaller than normal.
b) For a given neuronal input to a muscle, force produced by that muscle tends to be larger at longer muscle length.
c) When vibration artificially excites the spindle receptors on the biceps muscle, we have a sensation that our elbow is flexing.
d) If in a split brain patient an image is flashed to the left of fixation, the patient will not be able to name that image, but will be able to draw that image with the left arm.

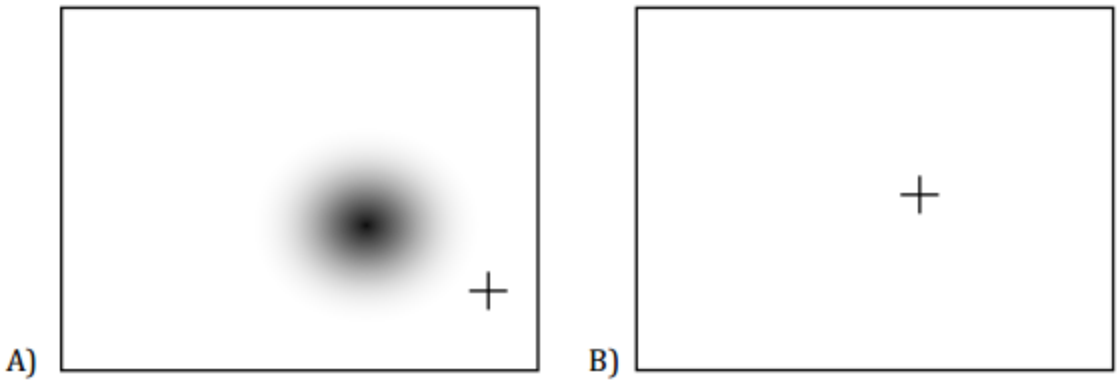
Question 6 (6 pts total)

You are working on a project to help restore some function to the hand of patients who have suffered spinal cord injury in the cervical regions, as is typical in automobile accidents where whiplash takes place. You will try to electrically stimulate the hand muscles so that they can form a grip. However, you need to give the

patient a way to turn the stimulation on and off. You are considering two candidate approaches: in the first approach, you will implant a sensor in the shoulder so that raising it will turn the sensor on or off. In the second approach, you will implant a sensor on the bottom of the foot, so that tapping the foot will turn the stimulation on or off. Which is a better idea? Explain.

Question 7 (6 pts total)

A monkey is fixating a cross on the screen. A cell in the posterior parietal cortex that has a retinocentric receptive field discharges when a spot of light appears in the area shown below in A. The discharge is strongest in the area that is darkest in color. Now the monkey shifts his eyes to the new fixation point in B. Draw the region where the cell will have its receptive field. [2 pts]



Now suppose that we keep the monkey fixating the center point in B. While he is fixating, a light is flashed in the left edge of the cell's receptive field. Now slowly we move the light along the x-axis (horizontal line) so that it crosses the center of the receptive field and then moves to the right of it. Plot the cell's firing frequency as a function of stimulus position with respect to center of receptive field. If this cell has gain-field properties, what would its response look like if you did the same experiment in part A (assume that the gain field has a slope that is decreasing as the eyes move to the right). (4 pts)

Question 8 (4 pts total)

A stroke has affected the hand region on the right motor cortex of a patient. She now relies solely on the unaffected arm. You suggest that she enrolls in a constrained motion rehabilitation program. When she enrolls, which arm will be constrained (left or right)? Why?

Exam 2 Questions by Prof. Wang

Question 1 (11 pts total)

a) Explain physiological mechanisms that give rise to the frequency selectivity of the auditory system. [3 pts]
b) An auditory nerve has a characteristic frequency of 1000 Hz. Sketch its receptive field (or tuning curve). Please mark all axes. [2 pts]
c) If you record action potentials (spikes) from the auditory nerve with a characteristic frequency of 500 Hz using a pure tone stimulus with frequency of 500 Hz and duration of 10 ms, sketch the post-stimulus histogram (PSTH) of this nerve's responses. Assume multiple trials are recorded. Mark axes and explain all features of the PSTH in your sketch (i.e., why you sketch the PSTH in particular ways). [3 pts]
d) Repeat (c) above for an auditory nerve with a characteristic frequency of 5000 Hz and a pure tone stimulus with frequency of 5000 Hz and duration of 10 ms. [3 pts]

Question 2 (9 pts total) [suggested time: 9 minutes]

Neurons in the medial superior olive (MSO) compute inter-aural time difference (ITD) based on spikes trains from auditory nerves of both ears. Answer the following questions:

a) What are anatomical and physiological bases for the ITD computation by MSO neurons? [3 pts]

b) If a tone of 6000 Hz is played from a loudspeaker located 45 degrees to the left of the midline, can MSO neurons compute the ITD between the two ears? Why? [3 pts]

c) If a broadband noise (i.e., its spectrum is flat for all frequencies) is played from a loudspeaker located 45 degrees to the left of the midline, can MSO neurons compute the ITD between the two ears? Why? [3 pts]

Exam 2 Questions by Prof. Connor

Question 1 (6 pts)

List the steps in phototransduction, from absorption of photons to change in transmitter release by photoreceptors (rods/cones).

Question 2 (4 pts)

Explain why spatial acuity is different between the parvocellular and magnocellular visual pathways

Question 3 (4 pts)

Explain why the center/surround receptive field structure of retinal ganglion cells is functionally advantageous.

Question 4 (8 pts)

Visual information originates in eye-centered spatial coordinates but is transformed into other coordinate systems by higher-level visual cortex.

a) What is the spatial coordinate system in the ventral pathway, and why is it functionally advantageous? [4 pts]

b) What is the spatial coordinate system in posterior cingulate cortex (part of the dorsal pathway), and why is it functionally advantageous? [4 pts]

Exam 2 Questions by Prof. Young

Question 1 (8 pts)

Which of the following are true about cochlear implants (answer true or false for each)?

a) They are effective in restoring hearing in cases of complete degeneration of the auditory nerve.

b) They work best when the patterns of activity in the auditory nerve are restored to approximately normal.

c) A single-electrode implant restores a good sense of the frequency content of a stimulus and provides little information about temporal patterns.

d) Typically the implant has up to 8 or so independent channels of electrical stimulation.