QUIZ 07 - KEY

Instructions: Do NOT submit this quiz. It is for your study purposes only.

For each question, select the one **best answer** from among those given (multiple choice). .

1. A monkey sits at a table eating – one plate of raisins is on its left and one plate of bananas is on its right. Which statement(s) accurately describe(s) what a neuron might be encoding as the monkey eats (as it reaches to and from its mouth)?

   a) Neuron #1 discharges differently as monkey reaches from the right to its mouth, as it does when it reaches from the left to its mouth. This neuron encodes the kinetics of the monkey's movement.
   b) Neuron #2 is activated when the monkey reaches from its mouth to the right and also from its mouth to the left. This neuron encodes the kinetics of the movement.
   c) Neuron #3 is activated when the monkey grasps the raisin, but not when it grasps the banana piece. This neuron encodes affordances of the movement.
   d) a and c are correct
   e) all of the above

Answer Key: B is incorrect because these actions would be using different muscle groups.

2. You are recording from a neuron in the cortex of a subject reaching for a variety of objects centered on a table. It increases its firing rate just before she reaches towards a pen (regardless of where it is placed on the table), but its activity doesn't change at all when she reaches towards the same locations for an apple. What is this neuron coding for, and where is the recording electrode MOST likely to be?

   a) Coding for kinematics, electrode in parietal cortex
   b) Coding for affordance, electrode in primary motor cortex
   c) Coding for kinetics, electrode in primary motor cortex
   d) Coding for affordance, electrode in parietal cortex
   e) Coding for kinematics, electrode in premotor cortex

Answer Key: This can't be kinetics, because it is the same response regardless of the location of the object. It is most likely coding for affordances, since it happens before the reach, and for a particular object.

3. What is a kinematic to kinetic coordinate transformation, and how is it implemented?

   a) It translates spinal motor neuron activation into muscle force, which requires calcium.
   b) It functions to maintain posture, and it works by connecting a muscle stretch to the contraction of that same muscle.
   c) It translates a goal, or target in space, into the exact muscles that must be activated to reach that goal. The transformation requires knowledge of the current posture.
   d) It translates a leftward movement into a delayed rightward one, and vice versa, during left-right alternation. It uses a half-center oscillator.

Answer Key: This is the definition of kinetic and kinematic.

4. A patient walks into the doctors' office for a follow-up appointment 4 months after a stroke. You notice that the right half of his face is cleanly shaved, but on the left half there is an emerging beard. You ask the patient if he is trying to make a new fashion statement, but he reports no knowledge of his funny appearance, saying casually, "What? I shaved this morning," and thinking that everything is normal. Where is his stroke likely to have occurred?

   a) Right parietal cortex
   b) Left parietal Cortex
   c) Right premotor cortex
   d) Left premotor cortex
   e) Right supplementary motor area

Answer Key: This is a case of hemineglect.

5. Suppose you are recording from basal ganglia output neurons in the GPi and you observe a brisk increase in firing rate immediately preceding the termination of a movement. What might cause this rate increase?

   a) Activation of a D1 expressing medium spiny neuron, which projects via the direct pathway directly to the GPi.
   b) Activation of a D2 expressing medium spiny neuron, which would suppress activity in the GPe, resulting in activation of the GPi neuron via disinhibition.
   c) Activation of GPe neuron that projects to the GPi.
   d) GPi can't exhibit rate increases because they are already firing at such high rates.
   e) None of the above.

Answer Key: Answer A would affect the initiation of, not termination of movements (direct pathway). C is wrong because activating GPe would inhibit GPi and decrease its firing rate. D just isn't true- review the lecture.

6. You have a patient with Parkinson's who is no longer responsive to L-Dopa therapy. You refer her to a neurosurgeon to implant deep brain stimulating electrodes into her basal ganglia. Her son asks you how DBS works, what might you tell her?

   a) We think it might work by restoring dopamine levels in the basal ganglia.
   b) We think it might work by increasing the amplitude of low frequency oscillations in the basal ganglia, which are pathologically reduced in Parkinson's.
   c) We think it might work by disrupting abnormal pathological synchronous oscillations that are observed in the basal ganglia of Parkinson's patients.
   d) We think it might work by inducing low frequency oscillations that are pathologically absent in Parkinson's but present in normal individuals.
   e) None of the above

Answer Key: A can't be true because you aren't stimulating the DA creating nucleus. In normal individuals, you don't have oscillations in the basal ganglia, so B and D are not true. In PD, you get abberant synchrony, and thus C is the right answer.

7. Which statement regarding dopamine is NOT true?

   a) Phasic dopamine output computes the difference between expected reward and actual reward.
   b) Dopamine neurons can fire to a reward-predicting cue rather than the reward itself.
   c) Dopamine neurons can fire in response to satisfying events.
   d) Dopamine suppresses the direct pathway through D1 receptors, and activates the indirect pathway through D2 receptors.
   e) Dopamine projections to the striatum are global – they are specific to local neuronal types/areas (e. g. topographically organized).

Answer key: D is wrong because D1 receptors on MSNs in the direct are excitatory, not inhibitory, and D2 receptors on MSNs in the indirect pathway are inhibitory, not excitatory.

8. A monkey has been trained on a behavioral task so that each time it presses a green button on a touch screen it receives a reward one second later. After the monkey learns the task, you randomly introduce trials in which there is no reward given for green button presses. How would you expect the monkey's dopaminergic neurons to respond on trials when it does not receive the expected reward?

   a) The dopaminergic neurons will decrease firing rate shortly after the expected reward failed to appear.
   b) Dopaminergic neurons will decrease firing rate when the button is pressed.
   c) Dopaminergic neurons will not fire the next time the monkey is rewarded.
   d) Dopaminergic neurons will increase firing rate shortly after the expected reward failed to appear.
   e) There will be no change in dopamine neuron firing rate.

Answer key: If the reward had appeared, there would be no change in DA neuron firing, but if the expected reward is absent, the outcome is surprisingly bad, so DA neuron firing rate decreases.

9. You had a head-on collision playing basketball and your index finger is weak and clumsy. You sit down to type an email and see that your ability to type accurately is messed up. For example, when you try to hit the $ key with your injured finger you hit the @ key, which is two keys to the left of the $. But you quickly recover - after a couple of minutes of typing practice everything is OK and you hit the $ sign whenever you want. Which statement(s) regarding the neural correlates of this adaptive learning is/are true?

   a) A climbing fiber spike discharged immediately before you pressed the @ key signaling that you were about to make a mistake.
   b) Part of the learning involved long term depression of some parallel fiber inputs to Purkinje cells.
   c) After you adapted and were hitting the $ key on demand, the climbing fiber spike occurred every time you hit the $ to reinforce the correct action.
   d) Some parallel fiber inputs encode the sensorimotor context that you are currently advancing your index finger to strike the $ key.
   e) b and d

   Answer key: This is an example of cerebellar learning, like the dart task after you are given prism glasses. Therefore, you would get LTD at some parallel to purkinje cells for this adaptation to occur. 'A' is wrong because the climbing fiber gives you feedback to how you missed in the previous trial, not what you are about to do. This signal is critical for FUTURE performance, not within a given trial. C is wrong because as your performance improves, you have no error and no feedback error signal from the climbing fiber. The learning has occurred already and you have no need for further plasticity in the cerebellum. (Note: It is unclear what the damage was- it could be in your visual perception or somatosensory feedback perhaps).

10. You are told you need to figure out which way to move a joystick in response to a triangle that appears on the screen. The triangle appears, and you guess down. Nothing happens. Different shapes appear, but after a while the triangle appears again. This time you guess Left and immediately afterwards bells ring and you are told that you guessed right and won a hundred dollars! What process occurred inside your brain at some point during this process?

    a) Climbing fibers discharged after the first guess down, making you not guess down again.
    b) Dopamine neurons discharged after you guessed down, making you not guess down again.
    c) Dopamine neurons were activated when the bells rang because it was an unexpected surprise.

d) After the $100 there was an increase in the synaptic weight connecting a corticostriatal neuron representing the triangle and a medium spiny neuron whose output pushes the joystick left.
e) c and d

Answer key: This is an example of the 3 factor learning rule and corticostriatal plasticity (need cortical neuron to be firing, MSN to be firing, and DA present).

11. **Thought question (ungraded):** The Libet experiments suggest that the sense that you are 'about to move' can actually begin AFTER specific parts of your brain have begun to initiate the movement. Below, explain how these experiments lead to this conclusion. Do you agree with their conclusions? Why or why not?

Answer Key: Libet affixed EEG electrodes to participants. He told them to note the time on a timer when they were first aware that they wanted to move, and then also measured when on the timer they actually moved (pressed a button). They then compared a 'readiness potential' on the EEG. They found that there was a change in the readiness potential a bit before they noted they were consciously aware that they were going to move. The next part of the question is your opinion, but one thing to think about is timing issues related to self-reporting. How long does it take you to notice you'll move to the time it takes you to note the time?

12. **Thought question (Ungraded)**: A friend of yours has implanted cannulas into the basal ganglia of a mouse. This means you can inject a chemical directly into the brain! You inject the selective dopamine D2 receptor agonist Sumanirole. (This drug mimics dopamine action at D2 receptors only). Circle the correct effect of this drug on the firing of GPe and GPi, and on the animal's overall movement.

Affect on GPe:	Firing increase	Firing decrease	No change
Affect on GPi:	Firing increase	Firing decrease	No change
Affect on movement:	Increase	Decrease	No change

Answer Key: The key here concept here is that dopamine promotes movement through its action on both pathways. D2 receptors agonists will activate D2 receptors, which have an inhibitory effect on D2 expressing MSNs of the indirect pathway. This will increase GPe firing, decrease GPi firing, and promote movement (hyperkinesis).

13. **Thought question (ungraded):** Your friend gives you a new pair of glasses when you are out to dinner and you notice that when you reach for your fork you see your hand miss the fork by about 3 inches to the right. On the next reach, you get a little closer – and after a few tries you can pick up your fork just fine and you return to eating – and everything seems normal. Then she asks for her glasses back. On the first reach after you give the glasses back,

what's likely to happen?

Answer key: You again you miss the fork, but this time by a few inches to the left.

Now she passes the glasses to your neurobiology professor who is joining you for dinner. He is a nice guy but he has severe cerebellar ataxia. What will happen when he puts on the glasses?

Answer key: He does not correct the error but continues to miss the fork. This is because this type motor error correction takes place in the cerebellum, which is damaged in cases of cerebellar ataxia.