Case study: anophthalmia

Names: **Puzzle number:**

Your role during this case study: Alex has just come back from his fMRI, and he seems to be in high spirits. It'll take some time before the imaging specialists compile the data, afterwhich, Alex will go over the information with his doctor. In the meantime, he's in the clinic, and he's got some questions about his brain. Luckily, you've got materials to help him understand how his brain is organized, so you guide his fingers along the models of the brain. You describe the hindbrain, midbrain, and forebrain and how these parts all communicate with each other.

Part A. Deep structures of the brain: You're given the picture of a skull onto which you will place the structures that make up the hindbrain, midbrain, and forebrain. First, identify the following structures: pons (with attached midbrain) ☐, cerebellum ☐, medulla oblongata ☐, diencephalon ☐, corpus callosum ☐, infundibulum with pituitary gland ☐, and olfactory nerve ☐. ***these pieces have the same colored sticker on their opposite side*** ***tick the boxes as you find the pieces*** Place these structures onto the skull matching them to their appropriate velcro spots.

Discussion questions: associate the following functions with the parts of the diencephalon, mesencephalon, and rhombencephalon. Use a dry-erase marker to label the appropriate structures according to their function (the number in the brackets describes the number of structures that perform this function):

Label	Functions	Label	Function
1	Portions of the hindbrain that coordinates our breathing rate (2)	7	Portion of the hindbrain that contains nuclei that coordinate chewing and swallowing reflexes (2)
2	Portion of the hindbrain that coordinates our heart rate (1)	8	Site where ascending sensory and descending motor signals cross to the opposite side of the body (1)
3	Contains parts of the reticular activating system (5)	9	Site where the majority of our dopamine is produced (1)
4	Helps maintain equilibrium (2)	10	Damage to this site can cause ataxia (1)
5	Portion of the hindbrain that coordinates dilation and contraction of blood vessels (1)	11	Site that filters unimportant sensory signals (causing them to not be perceived) (1)
6	Secretes melatonin to help regulate our circadian rhythms (1)	12	A structure that monitors several set points to maintain homeostasis and communicates with the pituitary gland (1)

Part B. Superficial structures of the brain: Identify the following structures of the forebrain: frontal lobe ☐, parietal lobe ☐, temporal lobe ☐, precentral gyrus ☐, postcentral gyrus ☐, and occipital lobe ☐. ***tick the boxes as you find the pieces*** Place these inside the skull over the structures you placed previously, making sure to anchor them to the velcro spots.

Discussion questions:

1. What is a multimodal association area?
2. Some sensory information doesn't make it to the cerebral cortex. How does this sensory information differ from the information that's received by the cerebral cortex? Give an example of the former. Which structure in the brain is responsible for filtering out these sensory signals?
3. Some motor signals don't begin at the cerebral cortex. How do these motor signals differ from the motor signals that do originate from the cerebral cortex? Give an example of the former.

Part C. Cortical areas of the cerebral cortex and their connections: Next, we'll familiarize ourselves with the cortical areas and consider how they communicate with each other. Below, you will find four different pathways that describe behaviors based on a single sensory signal received and a single motor signal projected. Information about the multimodal association areas are described (rather than identified). You need to fill in the blanks, filling each with the appropriate sensory, motor, and association area according to the information given in the "Scenario" and middle columns.

Scenario	Sensory area stimulated	Sensory association area stimulated	Motor signal initiated by a multimodal association area	Motor association area stimulated	Motor area stimulated
1. At a picnic, an ant finds its way onto your forearm. The nerve receptors at the base of your arm hair get stimulated.	1a	1b	Signals are interpreted, and you feel anxious and weird about an ant on your arm. **A signal to dislodge the ant is sent to your bicep.**	1c	1d
2. It's 2am. You're hungry and in your kitchen looking for food. You've made it there without turning on the lights. You hear an odd scurrying sound, like small claws tapping along a hard-wood floor.	2a	2b	Signals are interpreted, and you've appropriately decided the sound belongs to a hideously mutated rat-monster. **You've decided the best course of action is to yell, "Be gone, foul beast!".**	2c	2d
3. You're at a restaurant on a date. Both of you are anxious but very happy to be in each other's company. Suddenly, you sense a chemical signature in your left nostril. You're quite familiar with these chemical signatures...	3a	3b There is no olfactory association area. Signals are typically sent to parts of the limbic system for processing.	Signals are interpreted, and it is, in fact, a fart. You think it might be your waiter or even your date, but you find it funny. **You send signals to the muscles around your mouth to smile.**	3c	3d
4. You're crouching at your locker placing your A&P textbook in your bag. You're about to leave to catch the bus when your crush walks up behind you and says, "Hello."	4a	4b (two areas apply here)	Signals are interpreted, and your stomach twists, your heart races, and your pupils dilate. **You reach up with your arm to pull yourself up.**	4c	4d

Part D. Discussion (27 pts):

Questions:	Answers:	
1. Nerves can be underdeveloped if the sensory structures or effectors they innervate do not develop properly. Which of Alex's cranial nerves is likely underdeveloped as a result of his anophthalmia? List three and explain why you chose these. (4 pts)	1. 2. 3. Explain:	
2. Describe the series of structures that would carry perceived visual information to the brain and the structures that would carry motor signals to a voluntary eye muscle in a sighted person. (1 pt for each structure)	**<u>Afferent</u>** Sensory receptor: _____ Identity of cranial nerve: _____ Origin of cranial nerve: _____ Internal relay structure: _____ Sensory cortical area: _____	**<u>Efferent</u>** Motor cortical area: _____ Origin of cranial nerve: _____ Identity of cranial nerve: _____ Eye muscle: _____
3. For this question, refer to scenario 1 in part D: describe where you'd expect to see a signal being sent along: a) a longitudinal association fiber? (1 pt) b) a projection fiber? (1 pt)	a) b)	
4. Examine the fMRI images and corresponding models of Alex's brain. Each image displays a highly active cortical area. Match the images with the appropriate task and identify the active cortical area. (1 pt each)	Task / Image / Name of cortical area Manipulating fork ☐ Speaking words ☐ Listening to music ☐ Being pricked by a needle on both hands ☐	
5. Examine image A in figures 1 and 2. This cortical area is active when Alex is using echolocation to map his surroundings. a) Which cortical area does this region correspond to? (1 pt) b) Why is it peculiar that this region is active in someone like Alex? (1 pt) c) Are there any similarities in how Alex and non-visually impaired people use this cortical area? Explain. (2 pts)	a) b) c)	