

Project 2.1.3: Map-A-Brain – Brain Dissection Alternate (Optional)

Introduction

The brain is a truly amazing organ. But while there is a good deal we know about the way it functions, there is still much that is unknown. Neuroscientists have the daunting task of trying to decipher how this one structure can control every aspect of our lives. Over the years, scientists have worked tirelessly to uncover the mystery of the human brain. They have studied the external features of the head, the internal structures of the brain and the effect of injuries on this organ to understand how this one organ is able to control the functioning of every human system.

In this activity, you will explore the case of Phineas Gage, a young man who, in the 1800’s, suffered a horrific brain injury and simply walked away. He recovered and went on to live many more years, but his friends and co-workers said he was never the same. Physical wounds healed, but internal damage changed the personality of the man they all knew. His case will introduce you to the way our brain works and to the way in which specific areas of the brain control different parts of our personality and our ability to function. You will also explore the history of mapping the function of the human brain, from early methods based purely on observation to current methods using high-tech scans and measurements.

In Activity 2.1.2, you built a brain on your Maniken® and explored the primary functions of key brain regions. In this project, you will investigate the parts of the brain that control specific abilities, such as musical talent and sense of taste, and create a map of your findings on a dissected sheep brain. You will review the main structures of the brain and create a “map” on your dissection that highlights key brain landmarks, Use a system of icons and words to allow a person to navigate around the brain’s complex functioning.

Equipment

* Computer with Internet access and Microsoft Excel or other spreadsheet software (optional)
* Sheep brain
* Dissection pan
* Dissection tool kit
* Toothpicks and labels to make tape flags
* Colored markers
* Anatomy in Clay® Maniken®
* Laboratory journal
* Camera (optional)

Procedure

Part I- Unlocking the Mysteries of the Brain

1. As you begin your exploration of brain function, meet an amazing man named Phineas Gage. With your partner (or as a class), view the following videos and read the article referenced below. Your teacher may show you an additional video.
	* + Read the article “The Incredible Case of Phineas Gage” at <http://neurophilosophy.wordpress.com/2006/12/04/the-incredible-case-of-phineas-gage/>
* View video clips #1 and #2 of Phineas’ injuries at the New England Journal of Medicine: <http://www.nejm.org/doi/full/10.1056/NEJMicm031024>
1. Answer conclusion question 1.

Part II: Creating a Brain Map

1. Work with a partner to create a map of brain function. The case of Phineas Gage gave us insight into the specific role of the frontal lobe. You are responsible for filling in the rest of the map.
2. Working with a team of four, research the areas of the brain responsible for the following actions, emotions, personality traits, or functions. Each team member is responsible for researching four or five items from the list and reporting his/her findings to the group. Work together to divide the work. Use the websites that are listed in Step 5 to begin your research.
* Vision (1)
* Muscle coordination (2)
* Breathing (3)
* Happiness (4)
* Language understanding (5)
* Thirst and Hunger (6)
* Speech Production (7)
* Movement (8)
* Smell (9)
* Reasoning (10)
* Long-term memory (11)
* Hearing (12)
* Bodily sensations, such as touch, temperature and pain (13)
* Taste (14)
* Blood pressure regulation (15)
* Sleeping and waking (16)
* Balance (17)
* Problem-solving (18)
1. Use information presented at the following websites to explore the brain’s structure and function:
* Cold Spring Harbor Laboratory – 3D Brain <http://www.g2conline.org/2022>
* National Geographic: Brain Anatomy <http://science.nationalgeographic.com/science/health-and-human-body/human-body/brain-article.html>
* PBS- The Secret Life of the Brain: 3-D Brain Anatomy: <http://www.pbs.org/wnet/brain/3d/>
* BBC – Science and Nature: Human Body and Mind - Human Brain Map <http://www.bbc.co.uk/science/humanbody/body/interactives/organs/brainmap/>
* Time Magazine: Images of Brain Structure: <http://cognitrn.psych.indiana.edu/busey/Q301/BrainStructure.html>
1. Share your findings with your team.
2. Open your laboratory journal or your computer spreadsheet file to the table you started in Activity 2.1.2: Build-A-Brain. Add additional headings to the right side of the table as shown.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Region of the Brain** | **Location** | **Primary Function** | **Specific Activities/Processes** | **Icons/Keys for Map** |
| Cerebrum |  |  |  |  |

1. Note that some actions, emotions, or functions are controlled by regions you have built on your Maniken®. Some are controlled by structures you have not yet researched (such as parts of the limbic system). You should add these additional brain regions and structures to the table you started in the previous activity, making sure to describe location and primary function.
2. Add each of the specific activities, processes, or emotions you researched in Step 4 to the appropriate box in the table. Make sure you find the row for the brain region associated with this activity.
3. Note that you will work with a partner and use information from your table to create a map of brain functioning. Design a map of the brain that identifies key structures as well as the specific abilities or traits linked to each region. Design your map in a way that is going to make sense to you and that will allow a person reading this map to easily find a specific destination.
4. Note that you will first review the main structures of the brain by observing and dissecting a sheep brain. At the completion of your dissection, use tape flags placed on the outside and cross-section of the brain to identify the region responsible for the actions, emotions, personality traits, or functions you investigated in Step 4.
5. Obtain a dissection pan, a set of dissecting tools, some toothpicks and labels for tape flags, as well as a sheep brain.
6. Assemble approximately 15 tape flags using the toothpicks and adhesive labels. Assemble more as needed as you complete the initial dissection as well as your map.
7. Follow the steps listed below to complete the dissection of the sheep brain. In the instructions you will find terms in italics. These are the structures you should identify and mark using a flag in the tissue at the correct location. Use your research from Activity 2.1.2, the websites listed in Step 5, as well as the completed brain on your maniken as a resource.
8. Locate the ***brain stem***. In the sheep brain, the brain stem will exit the brain horizontally. Sheep are four legged animals, so their brain and spinal cord line up horizontally. Humans, on the other hand, are bipedal (two legged) animals. Therefore, the human spinal cord must exit the brain vertically to travel down the spinal column. Use a tape flag to label the *brain stem*.
9. The structure connected to the brain stem is the ***cerebellum*** and will appear as a densely folded structure located at the base of the brain. Use a tape flag to label the *cerebellum*.
10. The largest portion of the brain is the ***cerebrum.*** This portion of the brain consists of four lobes. Use a tape flag to label the *cerebrum*.
11. Place the brain in your dissecting tray with the frontal lobes facing away from you. This positioning will ensure that the right side of the brain is the same as the right side of your body as you continue the dissection.
12. Locate and use your tape flags to label the following lobes of the cerebrum**: *right and left frontal lobes, right and left parietal lobes, right and left occipital lobes, and right and left temporal lobes****.*
13. Have your teacher check your flag placement before moving to the next step.
14. Turn the brain over so that you are viewing the bottom, or ventral side, of the brain with the frontal lobes still facing away from you.
15. Two nerves involved in sensing input from the environment are visible on the surface of the brain. Locate and use your tape flags to label the following structures:
* A pair of ***olfactory bulbs*** may be seen, one under each lobe of the frontal cortex.
* A pair of ***optic nerves*** may be seen as they meet in the ***optic chiasm***, which is the X-shaped structure on the bottom surface of the cerebrum. It is named after the Greek letter chi, c, which it resembles.
1. If desired, take a picture of your labeled brain or make a sketch of your brain in your laboratory journal.
2. Have your teacher check your flag placement before beginning the internal dissection.
3. Temporarily remove tape flags from the bottom of the brain and set them aside.
4. Place the brain with the brain stem closest to you and carefully cut along the longitudinal fissure, the natural division between the left and right hemispheres of the cerebrum.
5. Gently cut and separate the two hemispheres of the brain. Continue cutting the cerebellum and brain stem so you have two similar halves.



NOTE: This image represents the cross section of a human brain. Free images courtesy of Wikimedia Commons <http://commons.wikimedia.org/wiki/Main_Page>

1. Choose one side of the brain.
2. Locate and label with a tape flag the following structures: *corpus callosum, thalamus, hypothalamus, brain stem, cerebellum, frontal lobe, parietal lobe, temporal lobe, and occipital lobe.*
3. Now that you are familiar with the external and internal anatomy of the brain, use a system of words and pictures to link the actions listed in Step #4 to specific areas of the brain. Create a flag for each action and place it in the appropriate part of the brain.
* For example: Once you locate the part of the brain that is responsible for the sense of smell, you can either identify this landmark on your map by simply writing “smell” or by drawing a icon symbol as a nose in the appropriate brain region.
1. Make sure your placement of symbols is accurate and clearly shows the part of the brain that controls this action.
2. Keep track of your map key (if needed) on the chart in your laboratory journal. You may have more than one icon per brain region as that region may control more than one activity or process.
3. If possible, take a picture of your completed brain map and include the picture(s) in your laboratory journal.
4. If your table was created using computer software, affix the completed spreadsheet in your laboratory journal.
5. Answer Conclusion questions 2 – 5.

Part III: Determining Function (Optional)

You may be asking yourself, “How do we know all of this about the human brain?” How were scientists able to pinpoint the specific area of the brain responsible for movement or language? As you noticed, our current knowledge of the brain is not a product of studying the bumps on your head. In the past two centuries, scientists have worked to move past the pseudoscience of phrenology and analyze the internal structure of the brain to determine function of key regions. Read the information and complete the activities presented below to learn how scientists explore the mystery of the brain.

1. When you built a brain in Activity 2.1.2, you added the motor cortex to the back of the frontal lobe. Visit the following website to learn about mapping of the motor cortex. Read “Mapping the Motor Cortex”, Parts 1 and 2, and “A Map of the Motor Cortex”
* PBS: A Science Odyssey <http://www.pbs.org/wgbh/aso/tryit/brain/cortexhistory.html>
1. Complete the “Probe a Brain” activity found at the PBS site [http://www.pbs.org/wgbh/aso/tryit/brain/#](http://www.pbs.org/wgbh/aso/tryit/brain/). Use the probe to touch various parts of the motor cortex and watch how your patient reacts. Keep an eye on the body parts that move when you touch each region. Continuing probing until you have mapped all 17 motor regions.
2. Complete Conclusion questions 2 and 3.
3. Visit the following website to learn about mapping of the language centers of the brain. Read the first section entitled, “Broca’s Area, Wernicke’s Area and Other Language Processing Areas of the Brain” at The Brain from Top to Bottom- Canadian Institutes of Health Research: <http://thebrain.mcgill.ca/flash/d/d_10/d_10_cr/d_10_cr_lan/d_10_cr_lan.html>
4. Answer the remaining conclusion questions.

Conclusion

1. Why is the story of Phineas Gage considered so extraordinary? What does his story teach us about the brain?
2. New research is using functional MRI (magnetic resonance imaging), a scan of the brain that shows specific areas that are activated during certain tasks, as a lie detector test. Explain which area(s) of the brain you think might light up to show that you are telling a lie or telling the truth. Explain your reasoning.
3. Explain the function of the brain’s limbic system.
4. Return to the first paragraph of Activity 2.1.2: Build-A-Brain and re-read the description of your morning activities. Use your map to determine the part of the brain responsible for each of the actions, thoughts or emotions that occur in this paragraph. Either re-write the paragraph and add brain regions in () after each activity or simply list the actions and write the brain region next to it.
5. Ten-year-old Alex Fuentes damaged his occipital lobe and his cerebellum in a car accident. Explain to his parents some of the possible effects of this injury.
6. (Optional) How did Gall and Penfield differ in their approach to studying brain function?
7. (Optional) Scientists have used a drawing called a motor homunculus to show the connection between different body parts and areas of the brain. This drawing is a cartoon of the human body, where the bigger the body parts, the more area of the motor cortex that is dedicated to controlling them. If you were to draw this figure, what body parts do you think would be most exaggerated? Explain.
8. (Optional) How did Broca and Wernicke determine the location of key language areas in the brain?