

Project 2.1.3: Map-A-Brain

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 an elastic swim (bathing) cap. Just as a street map directs people around a city and provides a description of key sights, your brain map will display key structures as well as a visual representation of the actions they control - whether the action is smelling the roses, feeling pain, moving a leg, or distinguishing a cow from a horse. Like a map, your “thinking cap” should highlight key brain landmarks and should 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)
* White latex swim (bathing) cap
* Foam wig stand or inflated balloon (optional)
* Sharpie™ Colored markers
* Anatomy in Clay® Maniken®
* Laboratory journal

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. Use the tips in Steps 11 -13 to organize your design before you obtain a swim cap and markers.
4. Design a map of the brain that identifies key structures as well as the specific abilities or traits linked to each region. It is up to you to decide how you want to represent each structure of the brain and how you want to organize your map. 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.
5. Because it may be difficult to fit all of the information on one side of the cap, work on both sides. On one side of the cap, you should map the structures you have already located on the external view of the brain. You should use the other side of the cap to display an internal view of the brain and show structures not visible on your Maniken®. An example layout of the exterior and interior brain can be found at the National Geographic: Brain Anatomy site: <http://science.nationalgeographic.com/science/health-and-human-body/human-body/brain-article.html>
6. Sketch your drawings on paper before you draw on the swim cap.
7. Obtain a white bathing cap and a set of colored markers from your teacher.
8. Carefully draw the regions of the brain on your cap. Show accurate placement and label each region. Keep these labels relatively small as you will need to add additional icons or words to represent function. Use the drawing of the brain you completed in your laboratory journal or website diagrams to help you design the brain on the cap.
9. Use a system of words and pictures to link the actions listed in Step #4 to specific areas 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 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 your table was created using computer software, affix the completed spreadsheet in your laboratory journal.
4. 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. 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>
3. 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?