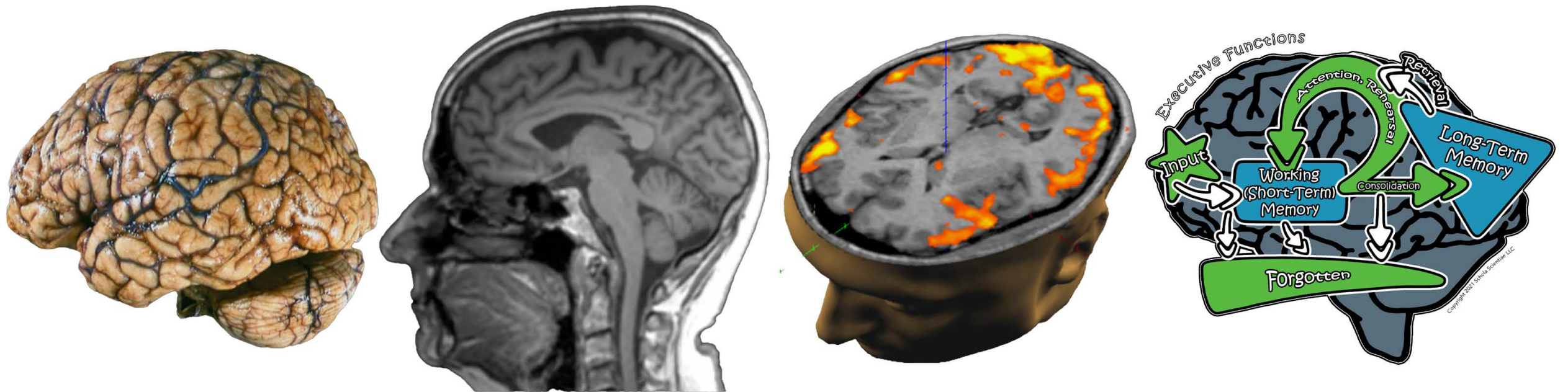




Student Guide

Tips for Success

- ▶ Login to your account on the Human Prenatal Development Student Portal, then leave the page open so you can access the Introduction & Fun Facts, Concept Slides, and other pages.

1.1 Identify your work:

You will work with a collaborative team of scientists for Phases 1 and 2. Doing so will increase the reliability of your results.

You will complete Phase 3 independently. Doing so will enable you to reflect on your personal development and process as a whole.

Your Name:

Group or lab Partners: :

1.3 Baseline Observation:

Briefly explain what you currently understand about the anatomy and functions of the human brain. Doing so will allow you to evaluate your work over time.

2.1 Background Research:

Open the *Introduction* and *Concept Slides* via the *Student Portal*. As you read through the information, think critically, asking questions and evaluating the claims - not simply accepting what you read. Take note of any information that will help you answer the *Phase 2.2* questions. After reading the research, complete the *Student Guide* through and including *Phase 2.2*, and prepare to share your thoughts during the class presentation of the information.

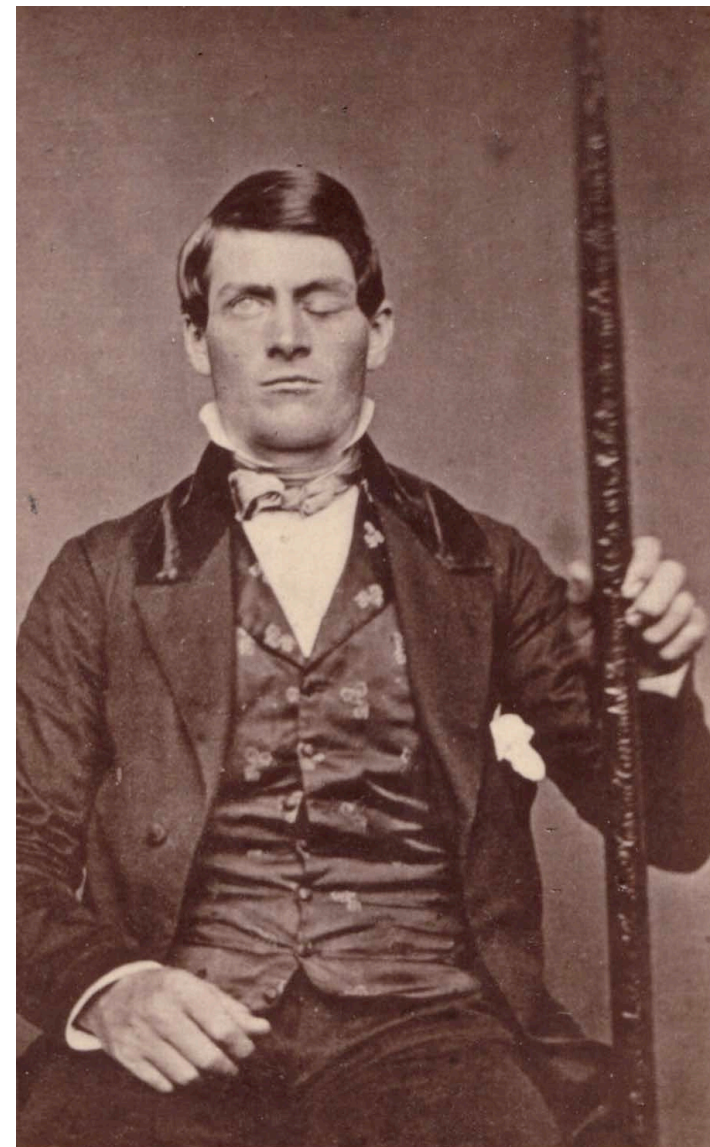
Phineas Gage

On September 13, 1848, 25-year old Phineas Gage survived a horrific injury that would lead to a very important discovery about the human brain. Phineas Gage was a construction foreman for the Rutland and Burlington Railroad.

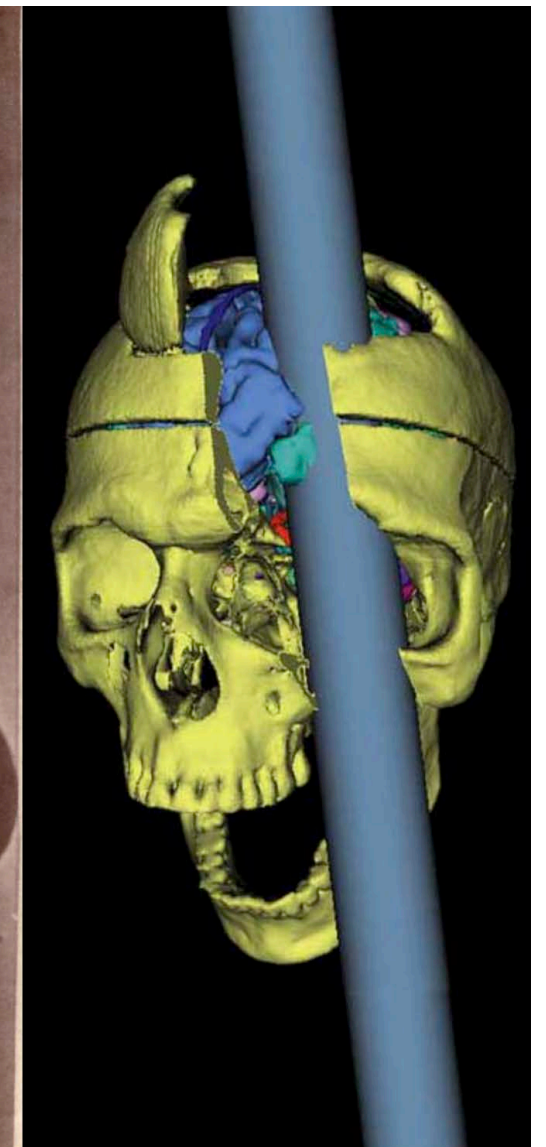
On that fateful day in 1848, Gage and his crew were laying railroad track near the town of Cavendish, Vermont. Gage was in the process of using a heavy metal rod called a tamping iron to pack an explosive powder charge in a massive rock. The tamping iron was about one meter long and weighed 6.1 kilograms. The rod was about 3.2 cm in diameter and tapered to a point at one end. In order to tamp down the charge, Phineas would lift the tamping iron and then pound it in the hole to press down the powder. While Gage was tamping down the charge, the powder exploded prematurely.

What happened next can only be described as a medical miracle. The force generated by the explosion drove the tamping iron, point first, into Gage's face under his left cheekbone. The rod exited through the top of his head and traveled a distance of over 25 yards before landing. In the process, most of the left side of Gage's frontal lobe, the portion of the brain directly behind the forehead, was destroyed.

Whether or not Gage lost consciousness is not clear, but it is known that his injury was treated successfully. So successfully, in fact, that Gage returned to work several months later. In addition, immediately after the injury Phineas was alert and able to walk, talk and describe to his doctor how the injury occurred.



Phineas Gage



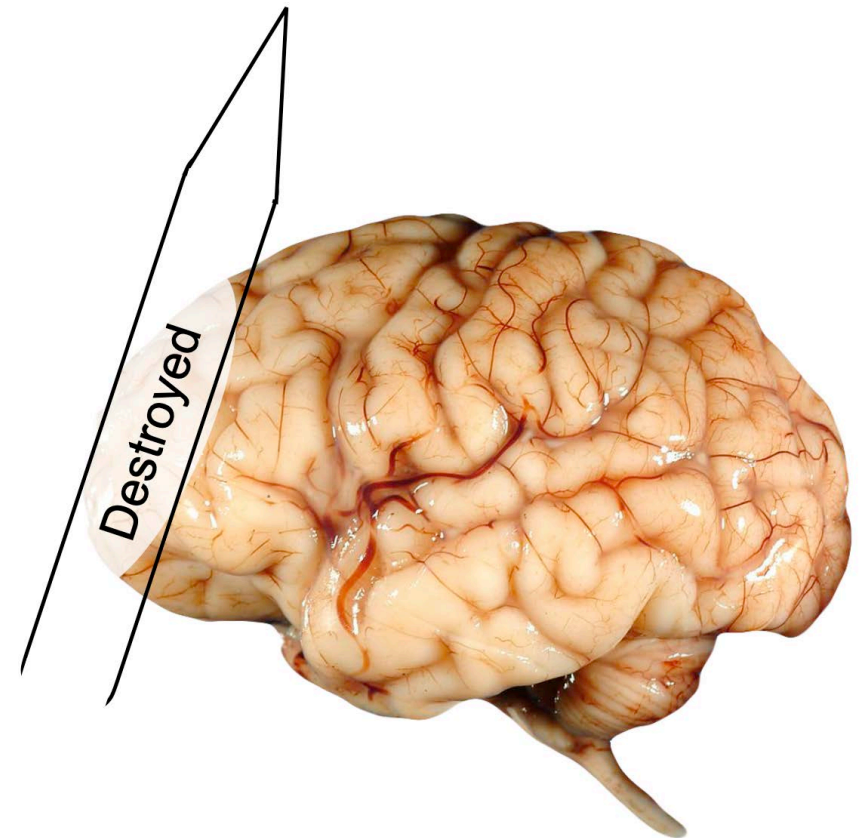
Path of tamping rod

New England Journal of Medicine
<https://www.nejm.org/doi/abs/10.1056/NEJM031024>

2.1 Background Research (continued):

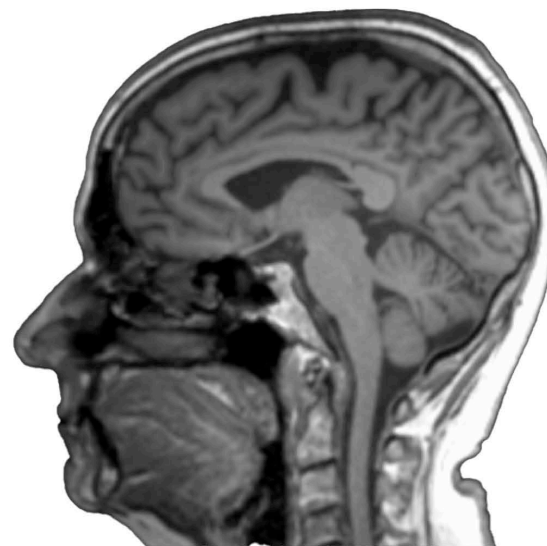
Initially his injury was not thought to have had any effect. Physically, he was fine. Mentally, he could talk, read, add and subtract. However, later his physician wrote that unfortunately, the damage to his brain had a lasting effect on Gage's personality. Before the accident, he was friendly, considerate, efficient, and considered to be a smart businessman. After the accident, his personality changed significantly. He was rude, disrespectful, stubborn, and used foul language. He lost the ability to follow through on plans he had made. These personality changes left him unable to continue serving as crew foreman for the railroad, and he sought employment elsewhere. It has been reported that his friends said he was "no longer Gage."

The Gage case, as well as many other brain injuries - often based on head injuries received in wars - where bullet injuries often cause damage to very specific brain structures, thereby permitting the identification of brain regions that are responsible for specific functions.

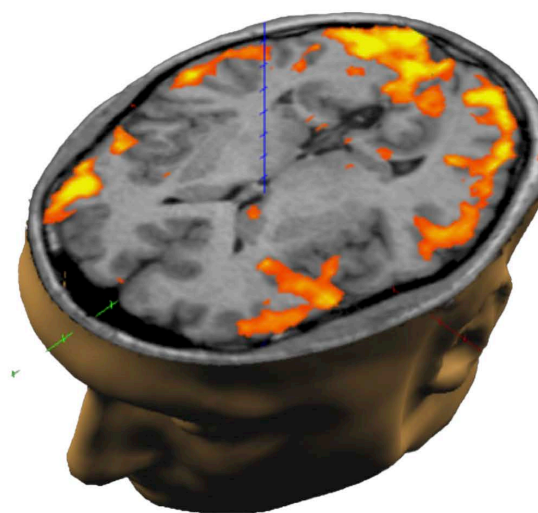


Modern radiological brain imaging

Fortunately, modern medicine, particularly radiological imaging such as Magnetic Resonance Imaging (MRI) and functional Magnetic Resonance Imaging (fMRI), have allowed researchers to examine fine structure and function of healthy, non-injured individuals. fMRI is particularly useful as it allows real-time imaging of active brain areas while the patient is engaged in various cognitive activities such as math problem-solving, reading, speaking, smelling, and so on.



MRI



fMRI

2.2 Response to Your Research: Answer the question(s) then list **three new facts** you learned from your research.

1.1. In your own words, explain the four lobes of the human cerebrum. What is the function of each?

2. List and briefly explain three new/interesting facts you have learned from your background research.

2.3 Experiment-Materials:

- ☐ Chromebook Laptop (or SDR)
- ☐ Human brain model
- ☐ Dissection pads
- ☐ Sheep brain (whole)
- ☐ Sheep brain (sectioned)
- ☐ Dissection probe
- ☐ Bathing cap (one per student)
- ☐ Sharpie lab marker

2.4 Experiment-Protocol: Sheep Brain

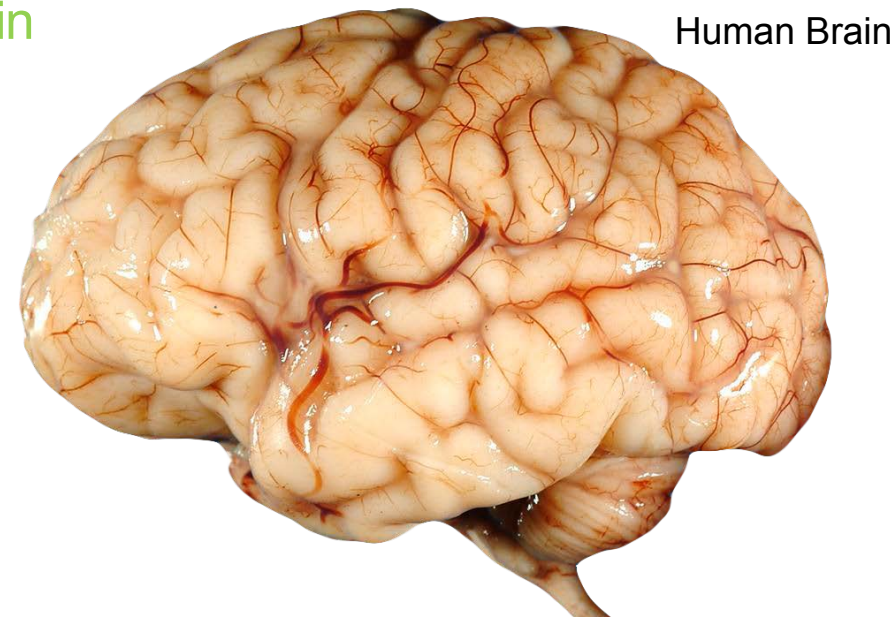
Sheep Brain Dissection

Three main functions of the brain:

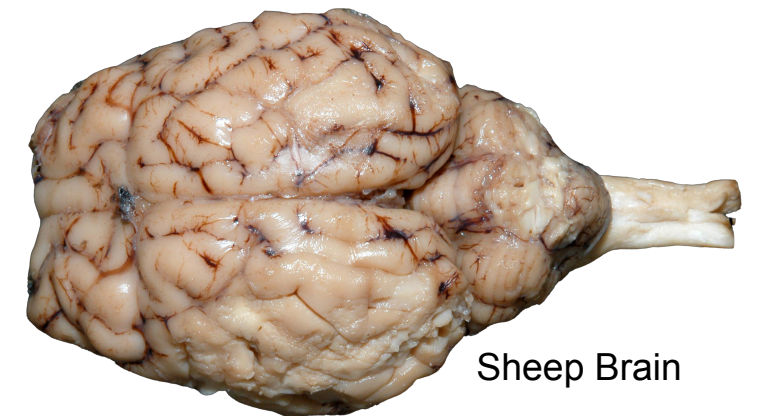
- Sensory input and motor output
- Information Processing
- Learning and memory

The brain can be divided into three parts:

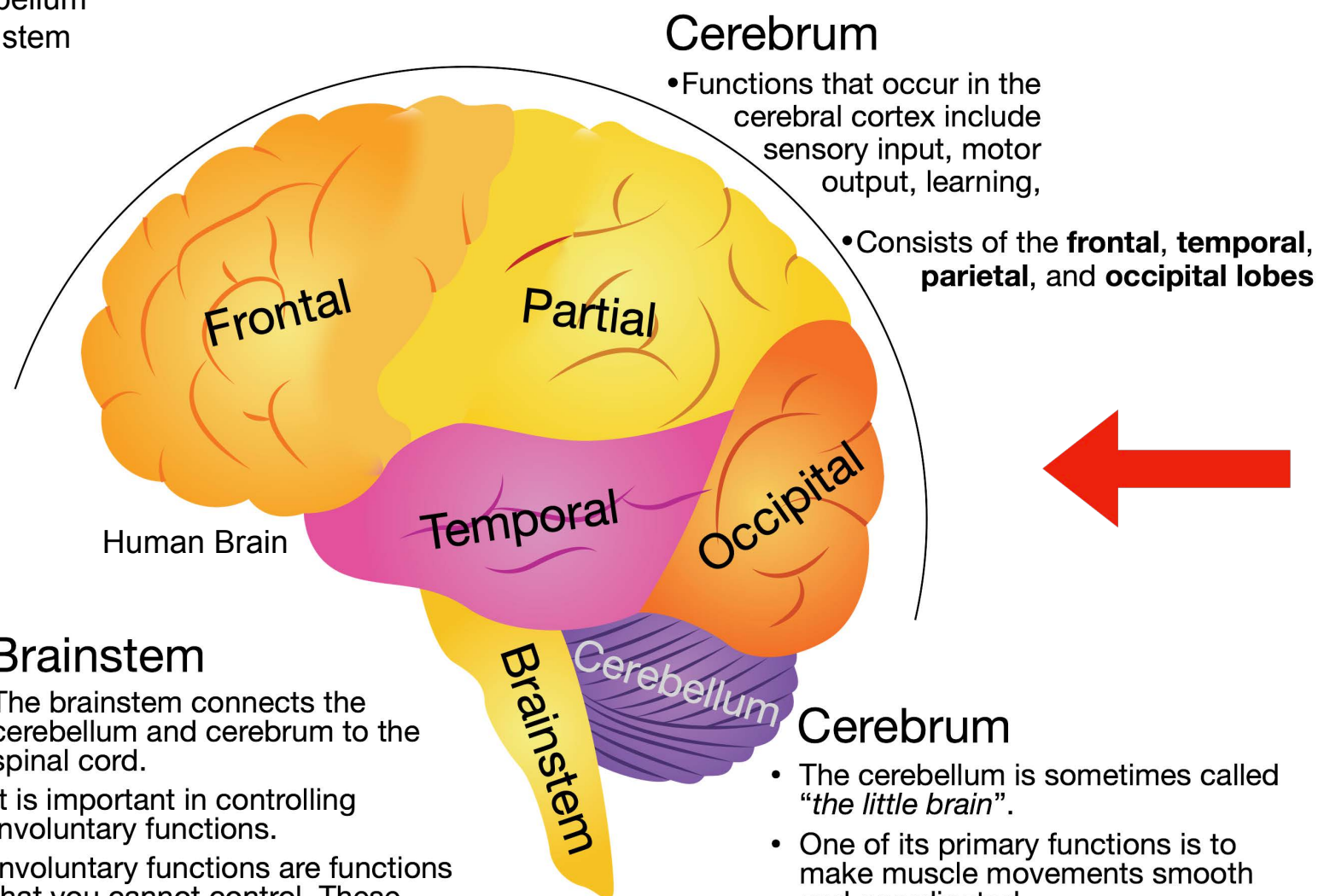
- cerebrum
- cerebellum
- brainstem



Human Brain



Sheep Brain



Cerebrum

- Functions that occur in the cerebral cortex include sensory input, motor output, learning,
- Consists of the **frontal**, **temporal**, **parietal**, and **occipital lobes**

Brainstem

- The brainstem connects the cerebellum and cerebrum to the spinal cord.
- It is important in controlling involuntary functions.
- Involuntary functions are functions that you cannot control. These functions include

Cerebrum

- The cerebellum is sometimes called "*the little brain*".
- One of its primary functions is to make muscle movements smooth and coordinated.
- The cerebellum also helps to control your gait (the way you walk).

Locate the parts of the brain using the sheep brain and this key.

2.4 Experiment-Protocol (Continued)

- ☐ 1. Examine the human brain model and identify the structures below.

Cerebral Anatomy

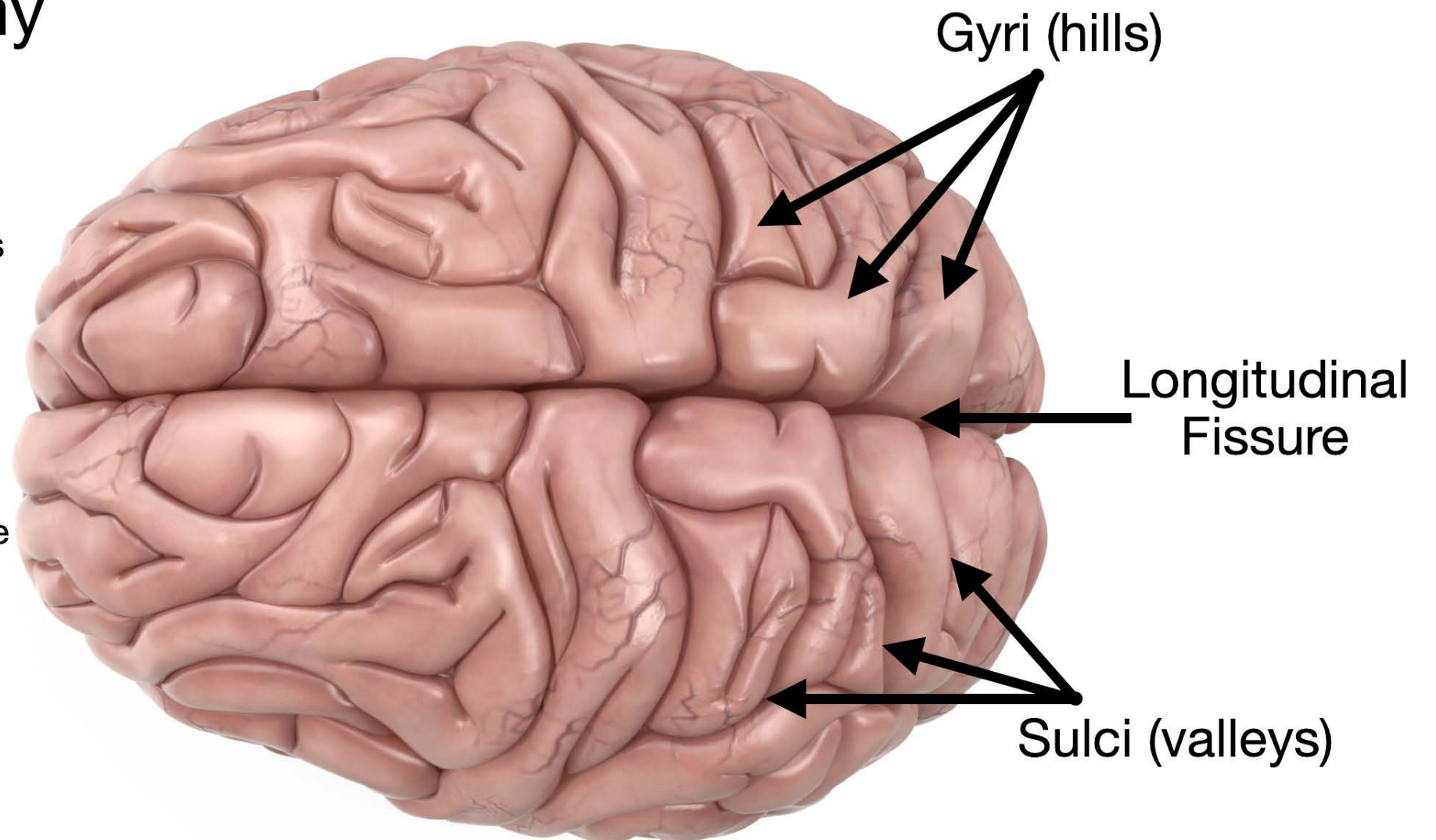
The cerebrum is the largest part of the brain.

longitudinal fissure - separates the left and right sides of the cerebrum

gyri (JY reye)- “hills” of the cerebrum

sulci (SUL keye)- “valleys” of the cerebrum

cerebral cortex- the outer layer (gray matter) that is responsible for sensory input, motor output, learning, and memory.



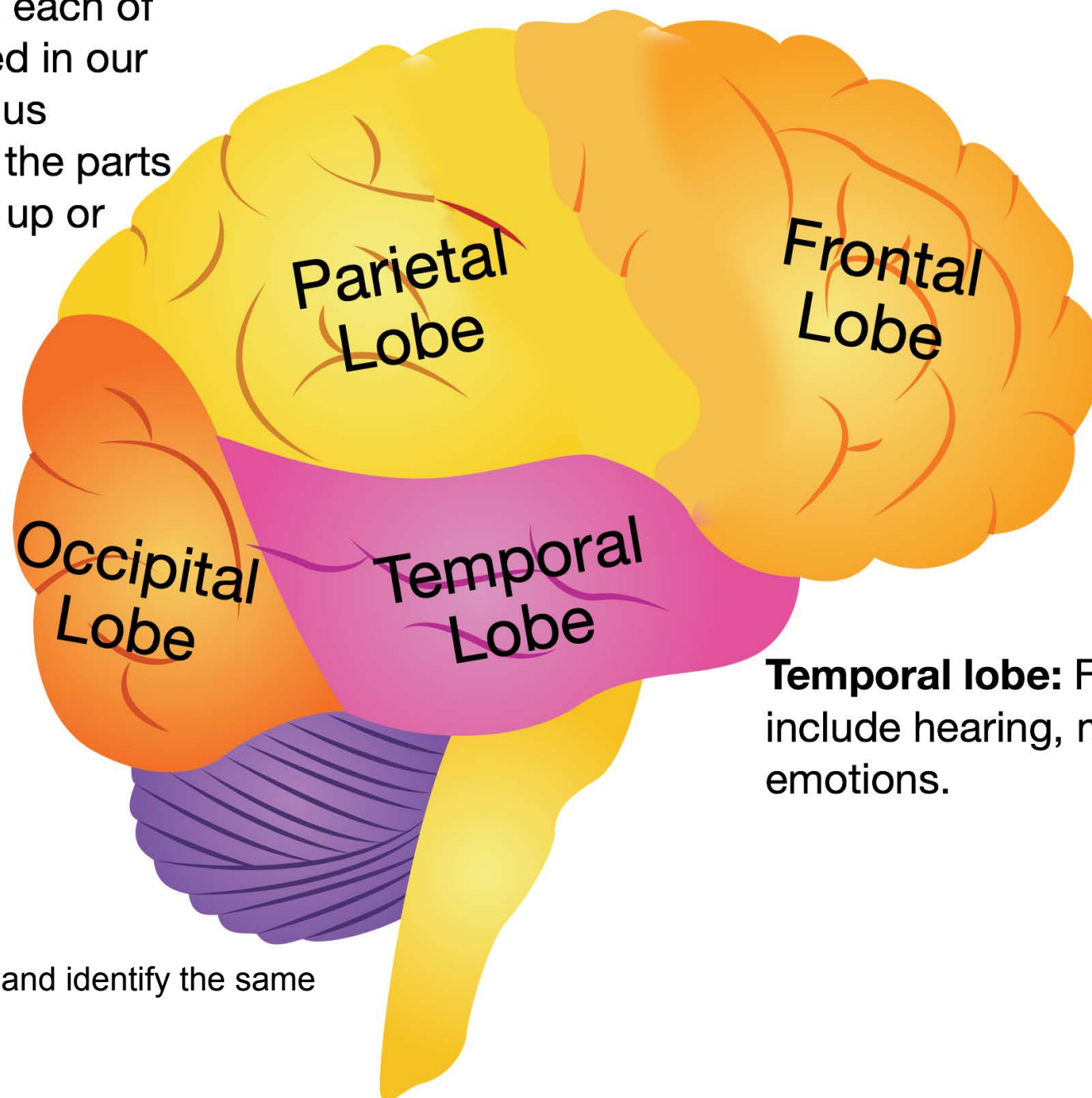
- ☐ 2. Find the **cerebrum**, **gyri**, **sulci**, and **cerebral cortex** on the sheep brain.

2.4 Experiment-Protocol (Continued)

- ☐ 3. Examine the human brain model and identify the structures below.

Parietal lobe: This area is in charge of integrating information from each of the senses. It is also involved in our spatial orientation - it helps us understand, know, or “feel” the parts of our bodies. Are our arms up or down? Are our legs raised?

Occipital lobe: This area is responsible for vision.



Frontal lobe: The frontal lobe is responsible for cognition (thinking), control of behavior, and emotion.

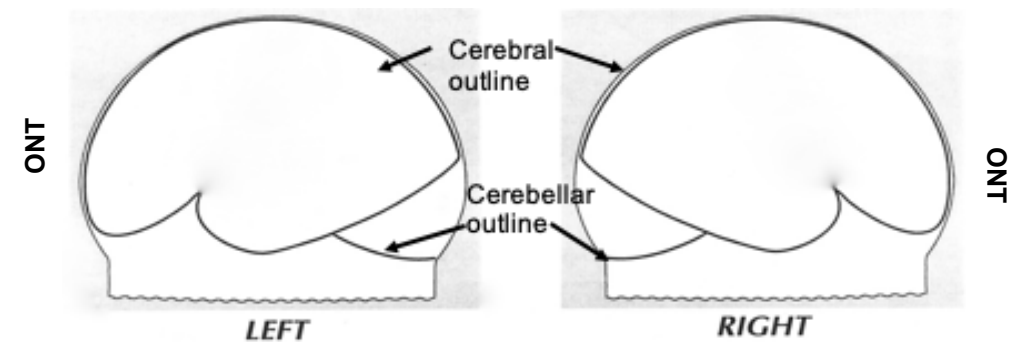
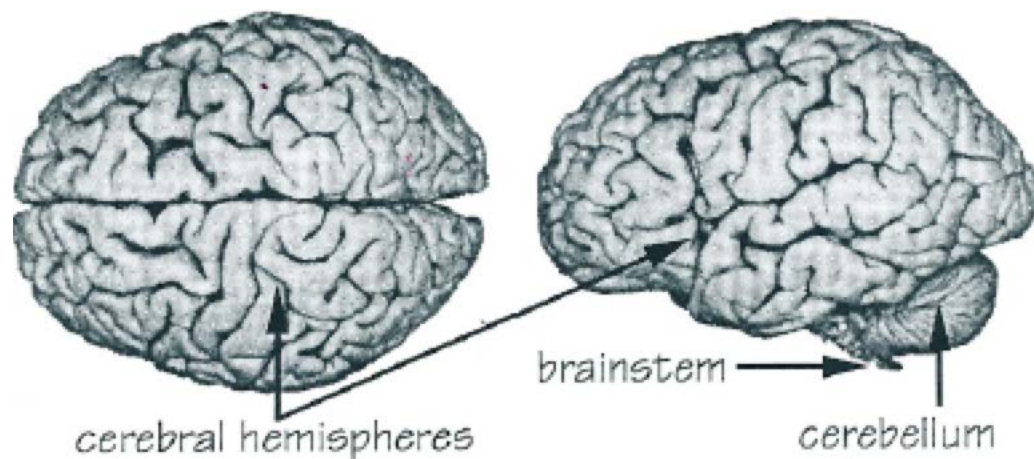
Temporal lobe: Functions of this lobe include hearing, memory and emotions.

- ☐ 4. Examine the sheep brain model and identify the same structures.

2.4 Experiment-Protocol (Continued)

Brain Anatomyp

- ☐ 1. Create a model of your brain that you can wear. Locate the swimming caps on your table. Choose one person to wear the swim cap.
2. Focus on the brain features below.
 - ☐ a. Place the swim cap on your head.
 - ☐ b. Ask your partner outline the cerebral hemispheres and the cerebellum.
 - ☐ c. Mark both sides. Remember to reverse the orientation for the other side.



Cerebral hemispheres: These are large, paired structures that are divided by the longitudinal fissure.

Cerebellum: The “little brain.” It is a smaller structure under the base of the cerebral hemispheres, at the back of the brain.

Brainstem: The brainstem consists of three major divisions the midbrain, pons and medulla. The brainstem extends from the base of the brain into the spinal cord.

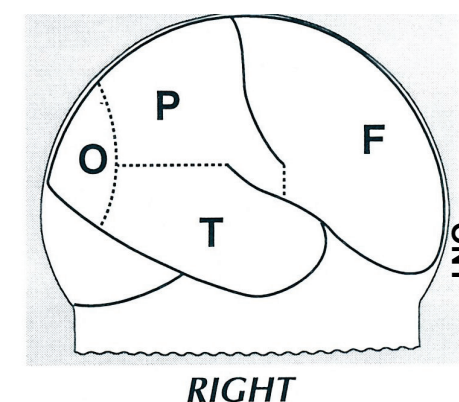
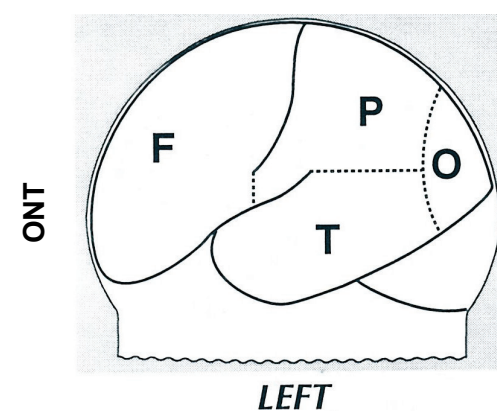
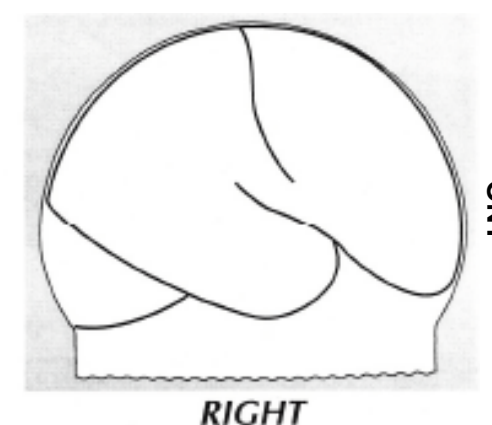
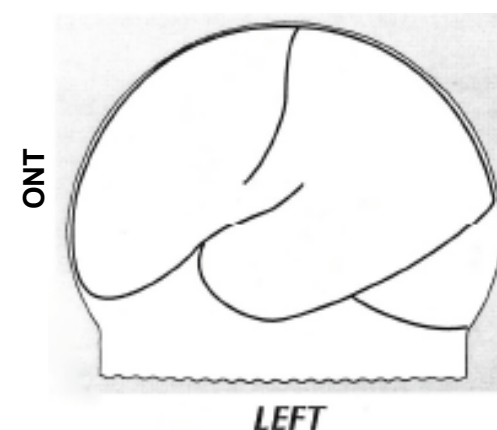
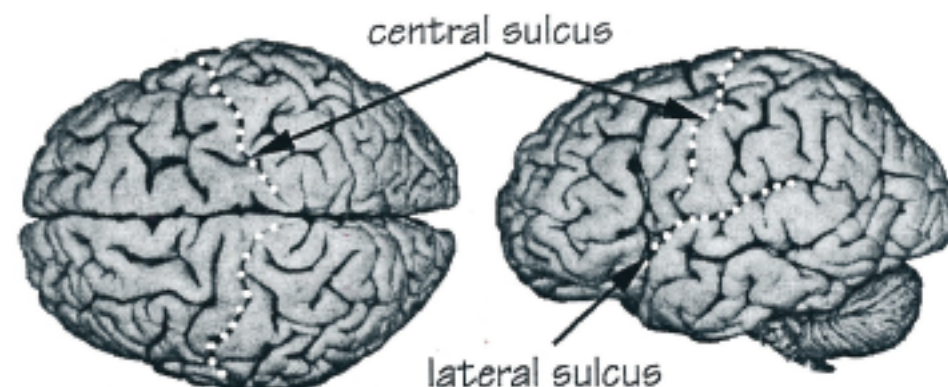
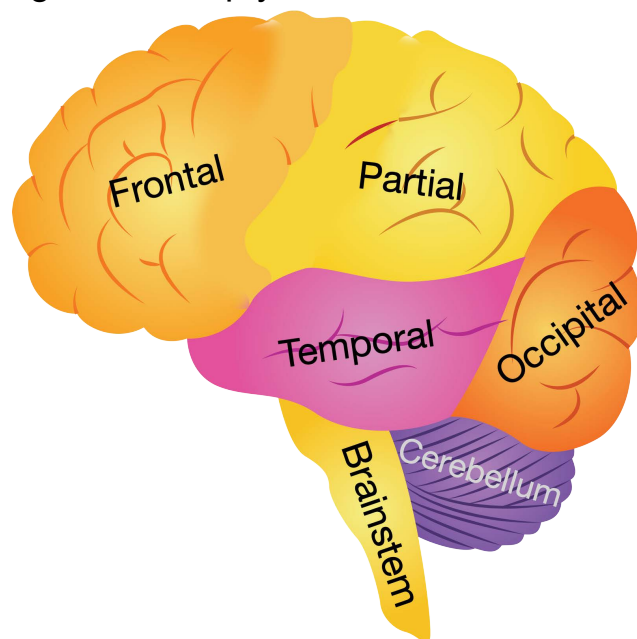
2.4 Experiment-Protocol (Continued)

Brain Anatomy

3. Add the following features to the swim cap

- ☐ a. **Longitudinal fissure** deep groove that divides the brain into left and right sides.
- ☐ b. **Central sulcus** groove that runs from midway along the longitudinal fissure in a vertical direction over the cerebral hemispheres.
- ☐ c. **Lateral sulcus** groove that runs horizontally along both cerebral hemispheres
- ☐ Outline of the cerebral hemispheres
- ☐ Outline of cerebellum
- ☐ Central and lateral sulci and longitudinal fissure
- a. Identify the following lobes and then mark the lobes on your "brain cap." Use the figures to help you.

- ☐ Frontal lobe
- ☐ Parietal lobe
- ☐ Temporal lobe
- ☐ Occipital lobe



3.1 Conclusion:

1. **Question:** When comparing the difference between the human and sheep brain, you probably noticed that the brainstem exits the brain from different angles. In the sheep brain, the brainstem exits from the back of the brain, while the human brainstem exits from directly underneath the brain. Explain why you think this difference exists.

2. **Question:** Explain what you think might be the result of damage to the occipital lobe of the cerebrum. What about the the frontal lobe? What about the cerebellum? Explain your thinking.

3.2 Discussion:

1. **Question:** How did Phineas Gage's injury help scientists learn that different parts of the brain control different functions?

2. **Question:** Why do scientists today still talk about an injury that happened in 1848?

3. **Question:** What do the four lobes of the human cerebrum do, and why is it important to understand their different functions?

3.2 Discussion:

4. **Question:** What does it mean that the brain can be studied “in action” with tools like functional MRI (fMRI)?

5. **Question:** How do case studies like Phineas Gage and modern brain imaging work together to help us understand the human mind?