Essential Question: Why is the case of Phineas Gage important to understanding the brain?

Localisation: How the Brain Functions

“How does the brain actually work? This has been one of the many questions that has bewildered scholars and scientists for centuries. Yet, due to research in the 20th century, we now know much more about the brain than ever before. One of the major theories that has helped explain how the brain functions is called localisation. Localisation simply implies that certain areas and components of the brain are responsible for certain tasks. For instance, we now know that the hippocampus stores memories and helps us remember the location of items. Another area of the brain called the frontal lobes is responsible for tasks like decision making and controls unacceptable emotions and language. Despite years of research proving this theory, some scientists today argue that localisation is overstated and that many parts of the brain interact to produce specific behaviors. Nevertheless, most psychologists agree with some combination of these two viewpoints when discussing the functioning of the human brain. But how did the theory of localisation originate in the first place? For the most part, it started with a man named Phineas Gage. Perhaps one of the most famous case studies in psychology history, Gage had an iron rod shoot straight through his head and lived to not only tell the story but be studied.
Directions: While listening to the recording about the photo of Phineas Gage, answer the questions below in complete sentences.

1. Initially, what did Jack Wilgus and his wife Beverly think was depicted in their old photo? What was the truth?

2. Describe the story of Phineas Gage’s accident in at least three sentences.

3. What kind of symptoms did Phineas Gage display after the accident?
Phineas Gage: An Astonishing Case of Brain Injury

If you've taken a psychology class, or ever had a passing interest in psychology, then you have probably at least heard of Phineas Gage. As the popular story goes, Gage was seriously injured when a metal rod pierced through his skull, destroying a large section of his brain. Miraculously, the man survived, but the accident left him a changed man, a shadow of his former self. Or at least, that's how the popular story goes.

How much of this is myth and how much of this is reality? Let's take a closer look at Gage's story in order to sort out the fact from the fiction.

Who Was Phineas Gage?

Phineas Gage is often referred to as one of the most famous patients in neuroscience. He suffered a traumatic brain injury when an iron rod was driven through his entire skull, destroying much of his frontal lobe. Gage miraculously survived the accident, but was so changed as a result that many of his friends described him as an almost different man entirely.

The Accident

On September 13, 1848, the then 25-year-old Gage was working as the foreman of a crew preparing a railroad bed near Cavendish, Vermont. He was using an iron tamping rod to pack explosive powder into a hole. Unfortunately, the powder detonated, sending the 43 inch long and 1.25 inch diameter rod hurtling upward. The rod penetrated Gage's left cheek, tore through his brain, and exited his skull before reportedly landing some 80 feet away.

Shockingly, Gage not only survived the initial injury but was able to speak and walk to a nearby cart so he could be taken into town to be seen by a doctor.

Dr. Edward H. Williams, the first physician to respond later described what he found:

"I first noticed the wound upon the head before I alighted from my carriage, the pulsations of the brain being very distinct. Mr. Gage, during the time I was examining this wound, was relating the manner in which he was injured to the bystanders. I did not believe Mr. Gage's statement at that time, but thought he was deceived. Mr. Gage persisted in saying that the
bar went through his head… Mr. G. got up and vomited; the effort of vomiting pressed out about half a teacupful of the brain, which fell upon the floor."

Soon after, Dr. John Martyn Harlow, took over the case. It is through Harlow's observations of the injury and his later descriptions of Gage's mental changes that provide much of the primary information that we now know about the case. Harlow described the initial aftermath of the accident as "literally one gore of blood."

Later in a published description of the case, Harlow wrote that Gage was still conscious later that evening and was able to recount the names of his co-workers. Gage even suggested that he didn't wish to see his friends, since he would be back to work in "a day or two" anyways.

After developing an infection, Gage then spent September 23 to October 3 in a semi-comatose state. On October 7, he took his first steps out of bed and by October 11 his intellectual functioning began to improve. Harlow noted that Gage knew how much time had passed since the accident and remembered clearly how the accident occurred, but had difficulty estimating size and amounts of money. Within a month, Gage was even venturing out of the house and into the street.

The Aftermath

In the months that followed, Gage returned to his parent's home in New Hampshire to recuperate. When Harlow saw Gage again the following year, the doctor noted that while Gage had lost vision in his eye and was left with obvious scars from the accident, he was in good physical health and appeared recovered.

Unable to return to his railroad job, Gage held a series of jobs including work in a livery stable, a stagecoach driver in Chile, and farm work in California. Popular reports of Gage often depict him as a hardworking, pleasant man prior to the accident. Post-accident, these reports describe him as a changed man, suggesting that the injury had transformed him into a surly, aggressive drunkard who was unable to hold down a job.

So how true are these reports? How much did Gage's astonishing brain injury really change his personality and overall functioning?

The myths surround the effects of Gage's injury seem to have grown after his death, and many of these claims are not supported by any direct evidence from primary sources. Neither Harlow nor any others who had actual contact with Gage reported any of these behaviors.

"Phineas' story is worth remembering because it illustrates how easily a small stock of facts becomes transformed into popular and scientific myth," explains psychologist Malcolm Macmillan, author of An Odd Kind of Fame: Stories of Phineas Gage.

So was Gage's personality as changed as some of the reports after his death have claimed? Recently, Macmillian has suggested that the most marked changes in Gage may have been limited to the period of time immediately after the accident. Evidence suggests that many of the supposed effects of the accident were exaggerated and that he was actually far more functional than previously reported.
In 1968, Harlow presented the first account of the changes in Gage's behavior following the accident:

"The equilibrium or balance, so to speak, between his intellectual faculties and animal propensities, seems to have been destroyed. He is fitful, irreverent, indulging at times in the grossest profanity (which was not previously his custom), manifesting but little deference for his fellows, impatient of restraint or advice when it conflicts with his desires, at times pertinaciously obstinate, yet capricious and vacillating, devising many plans of future operations, which are no sooner arranged than they are abandoned in turn for others appearing more feasible. A child in his intellectual capacity and manifestations, he has the animal passions of a strong man. Previous to his injury, although untrained in the schools, he possessed a well-balanced mind, and was looked upon by those who knew him as a shrewd, smart businessman, very energetic and persistent in executing all his plans of operation. In this regard his mind was radically changed, so decidedly that his friends and acquaintances said he was 'no longer Gage.'"

Since there is little direct evidence of the exact extent of Gage's injuries aside from Harlow's report, it is difficult to know exactly how severely his brain was damaged. Harlow's accounts suggest that the injury did lead to a loss of social inhibition, leading Gage to behave in ways that were seen as inappropriate. Others, like Macmillian believe that the stories about Gage's dramatic shift in personality are largely the stuff of legend.

**Just How Severe Was the Damage?**

In a 1994 study, researchers utilized neuroimaging techniques to reconstruct Gage's skull and determine the exact placement of the injury. Their findings indicate that he suffered injury to both the left and right prefrontal cortices, which would result in problems with emotional processing and rational decision-making. Another study conducted in 2004 that involved using three-dimensional, computer aided reconstruction to analyze the extent of Gage's injury found that the effects were limited to the left frontal lobe. In 2012, new research led by Jack Van Horn of UCLA's Laboratory of Neuroimaging (LONI) reanalyzed the high-resolution scans from the 2004 study to re-estimate the path of the projectile as it passed through Gage's skull. They then utilized data from 110 healthy individuals from their data archive to produce a generalized map of the brain in order to better understand the connections that would have been impacted. Based upon this research, Van Horn and his colleagues estimate that the iron rod destroyed approximately 11-percent of the white matter in Gage's frontal lobe, and 4-percent of his cerebral cortex.

**Recent Discoveries**

Until recently, there were no known photographs depicting Gage. In 2009, a 19th-century daguerreotype owned by vintage photo collectors Jack and Beverly Wilgus was identified as that of Gage. The photo depicts a handsome, obviously injured man holding a metal rod. The Wilgus's had initially assumed the image might be that of an injured whaler holding a harpoon when
they posted the image to the social image sharing site Flickr. A reader commented that the image might actually be of the famous Phineas Gage, and researchers later confirmed that the photo indeed depicted Gage holding what might be the infamous tamping iron that caused his injuries.

In 2010, a second image owned by members of Gage's family was also discovered and made public.

**Gage's Influence on Psychology**

Obviously, Gage's case had a tremendous influence on early neurology. The specific changes observed in his behavior pointed to emerging theories about the localization of brain function, or the idea that certain functions are associated with specific areas of the brain. Today, scientists better understand the role that the frontal cortex has to play in important higher order functions such as reasoning, language, and social cognition. In those years, while neurology was in its infancy, Gage's extraordinary story served as one of the first sources of evidence that the frontal lobe was involved in personality.

**What Happened to Phineas Gage?**

After the accident, Gage was unable to return to his previous job. According to Harlow, Gage spent some time traveling through New England and Europe with his tamping iron in order to earn money, supposedly even appearing in the Barnum American Museum in New York. Like many aspects of Gage's case, however, this is difficult to verify.

He worked briefly at a livery stable in New Hampshire and then spent seven years as a stagecoach driver in Chile. He eventually moved to San Francisco to live with his mother as his health deteriorated. After suffering a series of epileptic seizures, Gage died on May 20, 1860, almost 13 years after his accident.

Seven years later, Gage's body was exhumed and his skull and the tamping rod were taken to Dr. Harlow. Today, both can be seen at the Harvard University School of Medicine.

**Final Thoughts**

While many reports of Gage's functioning in the aftermath of his mishap are often grossly exaggerated, the available evidence does suggest that he did experience at least some significant personality changes as a result of his injury. Unfortunately, we will never know the exact extent of Gage's brain damage or precisely how his behaviors changed after the accident.

You can also learn more in this illustrated tour of Phineas Gage's life, including images of Gage himself and illustrations depicting his injury.
Obituary Activity

Now, using twelve of the words you have gathered from the article, you will be creating an obituary for Phineas Gage with the form below. Underline each word from the article you use and follow the format as suggested below.

**Obituary of Phineas Gage**

*(1823-1860)*

**Announcement of Death**

In at least three sentences, include age at death, place of residence, day and date of death and cause of death.

**Legacy**

In at least eight sentences include hobbies, employment, memorable stories, and how people will remember the individual.

**Impact on Psychology**

In at least three sentences, explain the impact that Gage had on the field of brain psychology.