

## **P » Phineas Gage**

Phineas P. Gage (1823 - May 21, 1860) was a railroad construction worker who suffered an unusual kind of traumatic brain injury which inflicted severe damage to parts of his frontal brain during a work accident. Gage reportedly had significant changes in personality and temperament, which provided some of the first evidence that specific parts of the brain, particularly the frontal lobes, might be involved in specific psychological processes dealing with emotion, personality and problem solving.

### **Gage's injury:**

On September 13, 1848, Phineas Gage was working outside the small town of Cavendish, Vermont on the construction of a railroad track where he was employed as a foreman. One of his duties was to set explosive charges in holes drilled into large pieces of rock so they could be broken up and removed. This involved filling the hole with gunpowder, adding a fuse, and then packing in sand with the aid of a large tamping iron. When Gage was momentarily distracted, the tamping iron sparked against the rock and ignited the gunpowder, causing the iron to be blown through Gage's head with such force that it landed almost thirty meters behind him.

Life cast and skull of Phineas Gage  
The 1.09m long tamping iron (diameter of 3.17 cm, weighing 6 kg) entered his skull below his left cheek bone and exited after passing through the anterior frontal cortex and white matter. Whether the lesion involved both frontal lobes, or was limited only to the left side, remains a matter of controversy. Remarkably, after such a dramatic accident, Gage regained consciousness within a few minutes, was able to speak, and survived a 45-minute ride back to his boarding house sitting in a cart.

As the doctor arrived, he was reportedly conscious, and had a regular pulse of about 60 beats per minute, suggesting that he only suffered minimal blood loss. His left pupil was still reacting to direct light (and stayed that way for the following 10 days), which indicates that the left optic and oculomotor nerves were still functioning, supporting the hypothesis that the tamping iron must have passed laterally to the left optic nerve. After a seemingly complete recovery from such a serious injury, Gage was soon back at work.

While early studies by Antonio Damasio and colleagues<sup>1</sup> suggested a bilateral damage to the medial frontal lobes, a recent study by Ratiu and colleagues<sup>2</sup>, based on a CT scan of Gage's skull suggests that the extent of Gage's brain injury must have been more limited than previously thought.

In light of modern medical science, a bilateral damage of the frontal brain by a projectile measuring 3.1 cm in diameter and weighing ca. 6 kg, appears to be incompatible with survival, since this would imply an extensive damage to vital vascular structures, such as the superior sagittal sinus. Nevertheless, Gage survived the traumatic event and reportedly developed personality changes.

### **Effect on Gage:**

According to Gage's physician, Dr J.M. Harlow, whereas previously he had been hard-working, responsible, and popular with the men in his charge, his personality seemed to have been radically altered after the accident. His physician reported that:

Gage was 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'.<sup>3</sup>

After his injury, Gage lost his job with the railroad construction company. When he was well enough again in or around 1850, he spent about a year as a sideshow attraction and at P. T. Barnum's New York museum, putting his injury, and the tamping iron which caused it on display, to anybody willing to pay for the show. He then worked as an assistant in New Hampshire and, for nearly seven years, as a coach driver in Chile. When his health started to fail in 1859, he returned to San Francisco, where he lived with his mother and,

for some months before his death, was employed as a farm worker.

### **Significance for Neuroscience:**

Gage's case is cited as among the first evidence suggesting that damage to the frontal lobes could alter aspects of personality and affect socially appropriate interaction. Before this time the frontal lobes were largely thought to have little role in behaviour.

Neurologist Antonio Damasio has written extensively on Gage, as well as on various patients he has studied which, in his personal view, had similar brain injuries. In a theory he calls the 'somatic marker hypothesis', Damasio suggests a link between the frontal lobes, emotion and practical decision making. He sees Gage's case as playing a crucial role in the history of neuroscience, arguing that Gage's story "was the historical beginnings of the study of the biological basis of behavior".

It is occasionally suggested that Gage's case inspired the development of frontal lobotomy, a now-obsolete psychosurgical procedure that lead to a blunted emotional response and personality changes. However, historical analysis does not seem to support this claim. It seems that consideration of Gage's injury had little influence on the development of this practice.

There is no doubt that Gage suffered the accident, and that it had a dramatic impact on his life. However, in his book "An Odd Kind of Fame: Stories of Phineas Gage", Australian psychologist Malcolm Macmillan casts serious doubts on the accuracy of the account that entered both scientific and popular discourse. First, very little is known about Gage's personality and habits before the accident; second, the post-traumatic psychological changes reported while Gage was still alive were much less dramatic than later reports assert.

Within twenty four hours of the accident, a first report was (anonymously) printed in the Ludlow, Vermont Free Soil Union. Having described the accident, the paper reports that "the most singular circumstance connected with this melancholy affair is, that he was alive at two o'clock this afternoon, and in full possession of his reason, and free from pain."

Harlow mentioned very few psychological changes in his initial report of 1848. Henry Bigelow, Professor of Surgery at Harvard University, wrote in 1850 that Gage was "quite recovered in faculties of body and mind." It was Harlow's account from 1868, years after Gage's death, that introduced the now-textbook changes. Later writers began to embellish even more, adding drunkenness, braggadocio, a vainglorious tendency to show off his wound as part of Barnum's Traveling Exhibition and an utter lack of foresight - all unmentioned by Harlow.

Gage's skull is currently part of the permanent exhibition at Harvard Medical School's Warren Anatomical Museum in Boston, Massachusetts.

### **Similar cases:**

On August 15th, 2003, Ron Hunt - a construction worker living in Truckee California - survived an 18 inch long, 1.5 inch wide drill bit which entered his skull through his right eye socket, and exited behind his right ear. The drill bit actually pushed his brain to the side slightly, which enabled him to survive such an injury. Other than the loss of sight in his right eye, he has made an almost full recovery.

In 2005 a 47 year Danish women from Samsø got a 110 centimeter long iron rod through her head from ear to ear. The woman was conscious after the accident. It was not reported whether the iron rod hit the brain.