Halloween Special: The science behind Frankenstein

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A photo of Boris Karloff from the film "The Bride of Frankenstein" as Frankenstein's monster. Credit: Universal Studios

It has all the makings of a great monster story: an attempt to draw lightning from the sky, a scientist passionate to show that electricity held the secret of life, body parts and, of course, reanimation of the dead.

The science that inspired Mary Shelley to write "Frankenstein" is nearly as strange as the novel itself. Written in 1818, the book was influenced by a scientific feud that ushered in the first battery and our modern understanding of electricity.

The story begins in the mid-18th century. Electricity had captured the imaginations of many of Europe's top scientists, and at that time very little was understood about the nature of electricity. Scientists could generate static electricity using spinning machines, but it was not until Benjamin Franklin's famous kite experiment in 1752 that they proved that lightning was of the same essence.

At the University of Bologna in Italy, noted surgeon Luigi Galvani was investigating the effects of electricity on animals. It was not an unusual line of inquiry. Researchers knew electrical shocks produced violent spasms and speculated that electricity might cause muscular contractions.

On January 26, 1781, while dissecting a frog near a static electricity machine, Galvani's assistant touched a scalpel to a nerve in its leg, and the frog's leg jumped. Galvani repeated this and several other experiments, observing the same violent muscle spasms. He also noticed that frog legs occasionally twitched when they were hung from a brass hook and allowed to touch an iron trellis, so Galvani joined a length of each metal together to form a brass and iron arc that made the leg muscles contract when touched.

But where did the electricity come from?

Galvani, who called it "animal electricity," believed it resided in the frog itself. He thought that the bimetallic arc merely conducted the electricity from one part of the frog to the nerve, causing the leg to jump. He published his findings in 1791 and, as the story goes, came to be known

as the frog dancing master.

One of Galvin's earliest readers was Italian physicist Alessandro Volta. Volta already had earned an imposing reputation as the discoverer of electrical capacitance, potential, and charge, and also discovered and was the first to isolate methane gas. He replicated Galvani's experiments and helped popularize his work.

Yet Volta reached very different conclusions. He believed the electricity came from the two metals used in the arc, and that the frog was acting as the conductor. Within the year, he replaced the frog's leg with brine-soaked paper, detected a current, and challenged Galvani.

The scientific world divided into two camps, animal electricity versus dissimilar metals. The feud became bitter. At one point, Volta wrote to a friend that his opponents wanted him dead. "I'll be damned if I'll oblige them," he added.

In 1799, Volta invented the voltaic pile, a stack of discs of two different metals separated by brine soaked paper. The galvanic or voltaic cell was the world's first battery, and the progenitor of automotive lead-acid batteries.

Today, we know that Volta's stack worked because dissimilar metals transferred electrons in an oxidation-reduction reaction, and the frog legs moved because electricity plays a role in muscular contractions. Of course it would take many decades to work out the details to reach this level of understanding.

So how did this influence a young Mary Shelly and lead her to compose one of the most widely read novels of all time, "Frankenstein; or, The Modern Prometheus"?

Galvani's nephew, Giovanni Aldini, was a fierce partisan of animal electricity, yet he did not ignore Volta's pile. Aldini used it to tour the capitals of Europe and demonstrate the medical benefits of electricity -- or not. His demonstrations involved jolting corpses with electricity and making decapitated criminals sit upright.

Aldini's most famous exhibition took place in 1803 at the Newgate Prison in London, U.K. He inserted metal rods into the mouth and ear of the recently executed corpse of murderer George Foster. "The Newgate Calendar," a book about the criminals of Newgate Prison, described what happened next: "On the first application of the process to the face, the jaws of the deceased criminal began to quiver, and the adjoining muscles were horribly contorted, and one eye was actually opened. In the subsequent part of the process the right hand was raised and clenched, and the legs and thighs were set in motion."

Not surprisingly, some observers thought Aldini was bringing Foster back to life.

Mary Shelley knew all about Galvani, Volta and Aldini. Humphry Davy and William Nicholson -- the era's leading electrical researchers -- were friends of her father. In 1816, at age 19, she spent the summer in Geneva, Switzerland with Lord Byron and her future husband, Percy Shelley. The season was cold and rainy, and they spent many evenings around the fire, reading German ghost stories and discussing electricity's potential to reanimate corpses.

It must have seemed like she was merely peering into the near future to imagine that one day, a Victor Frankenstein might succeed in reanimating an assembly of body parts.

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