

Beethoven's DNA decoded from locks of hair saved by his fans



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In 1802, German composer Ludwig van Beethoven wrote a heart-wrenching letter to his brothers, describing the deafness that forced him to “live like an exile” and yearn for death. Beethoven kept going for another 25 years, propelled by his music, but he begged them to have his hearing loss studied and publicized, so that “so far as possible, the world may be reconciled to me after my death.”

Two centuries later, a team of international researchers has answered that plea by sequencing Beethoven's DNA, preserved in locks of his hair that collaborators and fans collected as treasured keepsakes.

The central ailment of Beethoven's life was his hearing loss, which began in his mid-20s. He also suffered from debilitating gastrointestinal symptoms and attacks of jaundice. An autopsy revealed that he had cirrhosis of the liver, pancreatitis and a swollen spleen. Medical biographers have debated what killed him at the age of 56 and whether his liver disease was the result of excessive drinking or some other cause.

The scientists studying his DNA did not discover a clear explanation for Beethoven's deafness. But they identified genetic risk factors for liver disease, and they found signs he had a hepatitis B infection that could have contributed to his cirrhosis. They also found evidence that one of Beethoven's relatively recent ancestors had a child with someone other than their spouse.

The study, published Wednesday in the journal Current Biology, illustrates the power of DNA to explore fundamental questions about life in the distant past. But most diseases are not purely genetic, so the data is limited in what it can reveal.

“I love this paper. Zeroing in on one extraordinarily famous individual — it feels a little bit like time travel,” said Robert C. Green, a medical geneticist at Brigham and Women’s Hospital in Boston who was not involved in the research. “It isn’t so much the specific questions they answered as the fact that they ruled a few things out, searched for others, and made some truly original findings.”

The goat vs. Beethoven’s curls

Exploring the lives of historical celebrities using DNA analysis is still a relatively scattershot enterprise, in part because of a lack of well-preserved samples and the murky ethics involved.

Beethoven’s fame during his lifetime presented researchers with an opportunity: relatively easy access to many sources of putative DNA. Friends and admirers famously kept locks of his hair as mementos, many of which have been preserved over the years by private collectors and museums.

But first, they had to prove the hair came from Beethoven, a feat the composer himself made more challenging. The year before Beethoven died, the wife of a colleague earnestly wanted a lock of his hair, but she became the victim of a prank. Beethoven and his secretary instead sent a coarse snip of a goat’s beard, similar in texture and color to his own curls.

“The lady was overjoyed at possessing this supposed memorial of her saint, proudly showing it to all her acquaintance; but when her happiness was at its height, some one, who happened to know the secret, made her acquainted with the deception that had been practised on her,” according to an 1840 biography by Anton Schindler. When Beethoven learned of the lady’s humiliation, he sent a lock of his own hair that is today known as the Halm-Thayer lock. It was one of the samples that the researchers studied.

The team had a second essential element: consent from Beethoven himself, in the form of the written pleas to his brothers for his hearing loss to be studied.

“That’s as good as it goes, from getting consent from a person in the past to be studied,” said Johannes Krause, an expert on ancient DNA at the Max Planck Institute of Evolutionary Anthropology who leads the lab where the composer’s genome was sequenced.

In total, researchers extracted DNA from short strands of hair pulled from eight tufts. Under clean-room conditions, they decontaminated the hairs and prepared them for analysis.

Five of the samples matched the same male with more than 99 percent European ancestry — a strong sign they came from Beethoven. A genome constructed from the most intact lock matched closely with populations linked to the North Rhine-Westphalia area in Germany.

Scientists also determined that one particularly famous lock of Beethoven's hair, the Hiller lock, was actually from a woman of Ashkenazi Jewish ancestry. A study of the Hiller lock more than two decades ago suggested that the composer was afflicted by lead poisoning, which could have explained some of his illnesses.

Christian Reiter, an expert on forensic pathology based in Vienna, said the researchers made a convincing case that the five samples were from Beethoven. But Reiter, who has studied the Hiller lock, added that he would use "caution and restraint" in interpreting those results, noting that there are great risks of contamination in analyzing historical samples. Ferdinand Hiller, the teenager who collected the lock of hair, was of Jewish descent, and Reiter said it's possible his mother helped preserve the curls.

Despite this, Reiter said the paper was "a significant further step in exploring the suffering of this important composer with the most modern methods."

Genetic clues to Beethoven's maladies

Because the DNA in the strands of hair was degraded, the scientists were able to reconstruct only about two-thirds of Beethoven's genome. When they scoured that DNA looking for purely hereditary causes of illness, they did not find any. They then used "polygenic risk scores," which examine the risk for diseases that may have a genetic contribution but can also have environmental causes.

They did not find any clear elevated risk signals for hearing loss or a number of gastrointestinal illnesses, but they did find that he had a higher propensity for liver disease. The team also found genetic material from the hepatitis B virus, though it's unclear whether the disease was chronic or a recent infection.

The scientists concluded that his elevated genetic risk, coupled with alcohol consumption and hepatitis B, probably explained the liver disease that is likely to have contributed to his death.

"Honestly, I think we just have to be grateful for what we got," said team leader Tristan Begg at the University of Cambridge. He added that scientific understanding of genetic components in complex diseases is evolving and "hopefully these fields may catch up."

The analysis also yielded a surprise: Beethoven's Y chromosome didn't match those from living relatives. The common relative they all share was Aert van Beethoven, who lived in the 16th century. Somewhere in the seven generations between Aert and Ludwig van Beethoven, a woman in the family tree had a child with an unknown man, and Beethoven seems to be a descendant of that pairing.

Jeremy Yudkin, a musicologist and co-director of the Center for Beethoven Research at Boston University, said the paper was interesting, adding that there is evidence that the composer's physical health shaped his music.

Yudkin points to a late string quartet in which the third movement alternates between slow, chorale-like passages and more upbeat major-key passages. Beethoven composed the piece in 1825 after going to the countryside to recover from a gastrointestinal illness. It was inscribed with words that translate roughly to, “Holy song of thanks from a person who is recovering to the divinity.”

But Yudkin argues that there are much deeper ways to understand Beethoven than his genetic code and his medical ailments.

“This is the musicologist in me speaking,” he said, “but most importantly of all, irrespective of his swollen abdomen, there survive hundreds of musical works by him which are profound and transcendent.”