Neanderthal DNA: Our Closest Cousins Reconsidered

By Isabella Mavourneen

They are the butt of our jokes and a caricature of crudeness in our movies and TV, but what do we really know about our long-lost cousins, the Neanderthal?

Introduction

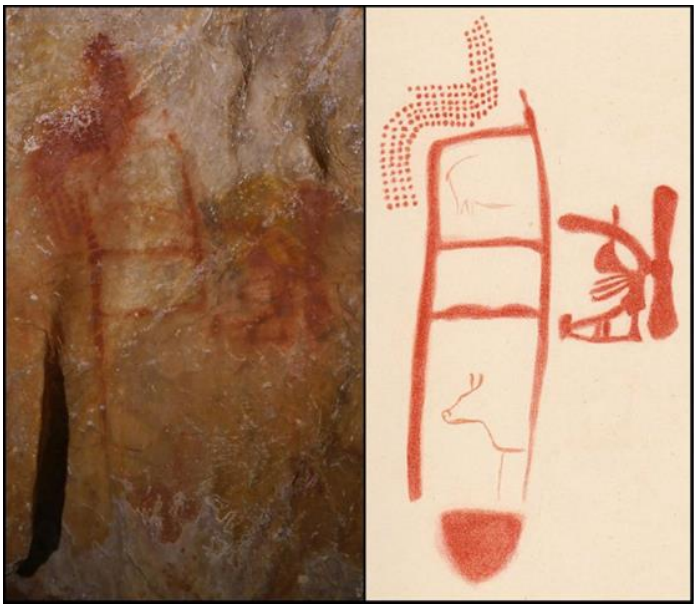
Neanderthals are possibly the most well-known and discussed hominin relatives of humans, and are depicted in many forms of media, such as *Ghosts, Encino Man*, and *The Inheritors* by William Golding. Whether or not these are accurate depictions, they show how modern society is enamored with these extinct individuals. We even use the term "Neanderthal" as an insult, by saying someone is rude and not very intelligent. But why? Were Neanderthals *really* as stupid and rude as modern society views them? Or were they more intelligent, artistic, and kind than we thought they were? This paper will discuss the physical and social characteristics of Neanderthals, the history of their DNA, and their relationship to modern humans.

Homo sapiens neanderthalensis (Neanderthals) and *Homo sapiens sapiens* (modern humans) became genetically divergent around 600,000 years ago. Most Neanderthals lived between 130,000 and 40,000 years ago, with the oldest Neanderthal fossils dating back around 430,000 years (Hendry, 2018). When they were first discovered in 1829 in the Neander Valley of Düsseldorf, Germany, scientists did not believe that they were relatives to humans, due to physical differences. After conducting DNA analysis in 2005, we soon found that they were our closest relatives in the human family tree (Scarre, 2003). Including modern-day Germany, they also lived in Spain, France, Italy, Central Europe, Eastern Europe, and West Asia, and in Russia. Since *Homo sapiens sapiens* became their own separate species around 200,000 years ago, we lived alongside Neanderthals before they went extinct. Due to interbreeding, some people alive today are related to Neanderthals, with up to 2% of their DNA being Neanderthal DNA (Green, 2010).

Despite the negative connotation their name carries, Neanderthals were not "stupid" or "rude" and showed signs of both mental and emotional intelligence. When a member of their group died, they would bury them, sometimes even with adornments such as flowers, shells, and paint, and would often place them in positions that showed care and love (Hunt, 2023). They used fire to cook their food, which has been proven to reduce vulnerability to disease and help increase energy by allowing for

better digestibility (Berlioz, 2023). To hunt their food, they used Mousterian tools, which consisted of rocks chipped into points for stabbing and cutting. They also built shelters and lived in caves, instead of living on the plains and grasslands like the Australopithecus and other hominins of the past. One example of this is the Combe-Grenal in southern France, a collapsed cave that, upon excavation, revealed human remains, animal bones, and stone tools. They adapted to their environment through creation and problem-solving, much like modern humans (Berlioz, 2023).

One of the most important things that we have learned about Neanderthals is that they created art, just like us. The oldest known example of Neanderthal art is located in the La Pasiega Cave in Spain. Using uranium-thorium dating, scientists calculated that the art is over 64,000 years old. Since *Homo sapiens* had not yet made their way into Western Europe, this artwork was definitively made by Neanderthals (Pike, 2018). The meaning of the painting remains unclear to this day, but due to its placement in the cave, with limited availability of light and the use of ochre paint being a valuable resource, this art must have held some significance for whoever created it.



The painting found in the La Pasiega Cave in Spain, dated 64,000 years ago, seemingly depicting a ladder, a cow, a pig, several dots, and other designs (Source: Pike and Standish, 2018)

Neanderthals vs. Modern Humans

There are many differences between Neanderthals and ancient *Homo sapiens*. Some physical bodily differences include Neanderthals having a longer clavicle bone, a wider scapula, a larger rib cage, a shorter forearm, wider fingertips, a thicker tibia, larger ankle joints, and wider hips (Scarre, 2005). There were also differences between modern humans and Neanderthals. Neanderthals had an occipital bun, called a chignon, located at the bottom of the skull, resulting in a longer overall skull (Gunz, 2007). They also had prognathic faces with large noses, big incisors, and the absence of a true chin. These differences may be related to Neanderthals having needed to conserve heat and have more power when hunting. Since Neanderthals were smaller and stockier, they had less skin surface area to hold onto heat better in colder environments. They may have also been more adapted for "close-range ambushes" when hunting, and their limbs were stronger and powerful than *Homo sapiens* (Hendry, 2018).

There are also similarities between *Homo sapiens* and Neanderthals. Along with having a movable mandible with teeth, they both possessed a larynx, tongue, and a hyoid bone, all of which play a role in verbal speech and communication. A study done in 2022 by Ambrosio Bermejo-Fenoll compared Neanderthal, human, and chimpanzee mandibles to "analyze different morphometric variables of *Homo neanderthalensis*, modern human, and chimpanzee mandibles, in order to try to understand how spoken language evolved in our lineage". Since humans have emphatically succeeded in creating a global way of communicating, they wanted to see how our closest relatives, both living and extinct, compare in morphological terms. They measured the structures of the mandible of several Neanderthal fossils and compared them to chimpanzees and modern *Homo sapiens.* They looked at three main factors in humans to use as their control: oral habits, genetics, and bipedalism. They found that Neanderthals had "significantly different mean values for the condylar angle and external slope of the mandibular symphysis", to which Bermejo-Fenoll concluded that

Neanderthals had “plausible phylogenetic evolution” in the ability to create some kind of verbal communication. They were more genetically similar to humans than chimpanzees in that regard, but more studies are needed to compare more Neanderthal jaws (Bermejo-Fenoll, 2022).

The team also stated that other scientists have come to separate conclusions on Neanderthal communication. A study done in 2013 by Sverker Johansson said that Neanderthals did come up with a form of “proto-language with lexical semantics”. Lexical semantics is the study of word meanings, and tells us that “bear” can mean a large furry mammal that lives in the woods, or the action of carrying weight (Geeraerts, 2017). Johansson also made the distinction that speech can equate to language, but language does not have to equate to speech. After anatomical and fossil comparisons, including observing the larynx, skull base, brain, hyoid bone, and ear bones, he found that Neanderthals had the physical capacity for speech. He also made genetic and DNA comparisons between *Homo sapiens* and Neanderthals. He found that since both species share the FOXP2 gene, which is known as the “language gene”, Neanderthals had the capability of understanding language. Lastly, Johansson explored the archeological evidence of symbolism in art (involving semantics) and the cognition and planning needed when creating traps, meaning that there must have been a Neanderthal language to communicate with others, through “grained vocal distinctions.”

A study published in 2021 by Mercedes Conde-Valverde furthered Johansson's conclusion, and found that Neanderthals had “a vocal communication system as efficient as modern human speech”. Conde-Valverde had compared the ear cavities and bones of Neanderthals to those of modern humans, and found that there was no statistical significance between the auditory capacity and “oral communication systems (Conde-Valverde, 2021)”, concluding that Neanderthals could communicate orally and listen effectively in order to respond, just like us. Contradicting both previous studies, a book published in 2016, titled *Why Only Us* by Robert Berwick, came to the conclusion that Neanderthals did not possess any form of language whatsoever. He says that Neanderthals, Denisovans, and modern humans all share an identical FOXP2 gene, which might have led to simple vocalizations, but Neanderthals didn’t have the complex physiology and neurology to lead to a sophisticated language or speech pattern. Berwick specifies, “There is no reason at present to move to the more radical conclusions that Neandertals possessed anything like the basic property, or even the rudiments, of symbolic language” (Berwick, 2016). We currently still do not have the answer to whether or not Neanderthals spoke or were able to communicate through complex language.

"Sapiens Neanderthal Comparison en Blackbackground." *PNG file*. Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Sapiens_neanderthal_comparison_en_blackbackground.png.

Neanderthal DNA

Before the more recent methodical advances in genetics, researchers focused on the difference in culture and physiology between Neanderthals and *Homo sapiens*, both modern and ancient. While studying these aspects was important, as they were the first comparisons made to show how similar we are to our hominin relatives, it was limiting, considering that scientists were unable to compare them at the microscopic level. Now with new techniques, namely Polymerase Chain Reaction (PCR), DNA sequencing, and mitochondrial DNA (mtDNA), researchers were able to do a deep dive into Neanderthal DNA and look at the genetic similarities and differences between Neanderthals and *Homo sapiens,* and discover just how similar we really are.

The first studies examining Neanderthal DNA focused on mitochondrial DNA (mtDNA), which is

passed down through female lineages (Chadwick, 2025). In 2005, a study was published by Carles Lalueza-Fox, which studied mtDNA from Neanderthals in the El Sidrón Cave. At the time of the research, there had been mtDNA retrieved from eight Neanderthals, but none of them had been done on a specimen from the Iberian Peninsula, which "represents the Southwestern European edge of neanderthal distribution" and was "home to some of the last surviving Neanderthals." The reason these fossil remains were so important was that the area of Europe where Neanderthals lived coincided with the route modern humans eventually took, which could have led to the hybridization of the two species. The collection of fossils from the cave was also the largest collection of Neanderthal remains in Spain, comprising bones of mammals, gastropods, and approximately thirty artifacts, including axes, scrapers, and other stone tools. Three ancient human samples, two teeth and one bone, were analyzed using mass spectroscopy to find the age of each sample to compare to the Neanderthal samples. The Neanderthal samples were analyzed using high-performance liquid chromatography. After extracting the DNA of the Neanderthal remains, they amplified and sequenced the fragments through PCR, and determined that the Neanderthal individuals were "dated to 40,000 years ago". They also found that the mtDNA sequence they surveyed was common in other Neanderthals found in Europe, signifying that the females of this location "were closely related to other Neanderthals". They finally found that "Neanderthal mtDNA variation predates the 130,000 years ago glacial maximum" and that the "genetic history of the Neanderthals was not shaped by a dramatic bottleneck associated with the glacial episode". Using the information found in this study supports *Homo sapiens neanderthalensis* evolved separately from modern humans, through speciation around 250,000 years ago, and the DNA found can be used to "provide important additional specimens for ancient DNA analysis" (Lalueza-Fox, 2005).

One of the pioneers in anthropology and Neanderthal DNA is Svante Pääbo. In 2008, he and his team further advanced the work done by Lalueza-Fox in 2005, sequencing the first complete mitochondrial DNA (mtDNA) genome from a Neanderthal from Croatia (Green, 2008). The genome was reconstructed from a 38,000-year-old bone sample of the Neanderthal individual in question. They concluded that "Neanderthal mtDNA falls outside the variation of extant human mtDNA and allows an estimate of the divergence date between the two mtDNA lineages of 660,000 ± 140,000 years" (Green, 2008). Using DNA sequencing, evolutionary analysis, and a technique called 454 high-throughput sequencing, the information found confirms the dates of the Neanderthal era and the differences in *Homo sapiens neanderthalensis* and *Homo sapiens sapiens* DNA. In 2009, Pääbo completed five more Neanderthal mtDNA sequences from five other individuals from Germany, Croatia, Russia, and Spain. The individual from Spain was found in the El Sidrón Cave, the same site studied in 2005 by Lalueza-Fox (Briggs, 2009).

In 2010, Pääbo continued his work and was then able to create the first complete transcription of a Neanderthal genome, which awarded him the Nobel Prize in Physiology "for his discoveries concerning the genomes of extinct hominins and human evolution" (Nobel, 2022). He was able to prove that, based on the similarity of their genome to ours, modern humans did interbreed with Neanderthals before they went extinct. He and his colleagues used high-throughput sequences to create the full genome. They made sure to avoid contaminants that could change the genome to look identical to that of a modern human. They used a "total of 21 Neandertal bones from Vindija Cave in Croatia" to construct a library of the genomic material, enriched said material with enzymes, and aligned the DNA. They concluded from this information that since Neanderthals and modern people did interbreed, Neanderthals have played a role in our genetic makeup. The traits we share can show us examples of "positive selection early in modern human history, for example, those involved in cognitive abilities and cranial morphology" (Green, 2010).

The Fate of the Neanderthal

As of 2024, one of the most recent findings about Neanderthal DNA includes studying the Neanderthal genome in terms of susceptibility to the COVID-19 virus and its severity on individuals. The findings

concluded that future studies need to look at molecularly individual traits. They should investigate if certain loci associated with the Neanderthal genome make people more susceptible to COVID-19 and other chronic diseases, such as coronary heart disease (Yaghmouri, 2024). Another recent publication included the "reconstruction of DNA methylation maps in ancient populations" and found that using DNA methylation maps could help us understand the environments that past peoples lived in (Barouch, 2024). This would allow us to separate populations to provide a more accurate look into past groups and societies. These two publications show that in anthropology today, we are looking into more accurate ways to determine how Neanderthals lived and died, and how humans today are affected by having lived alongside them for thousands of years.

It is still being debated and researched how Neanderthals went extinct, but there are several current hypotheses. One of the first being that Neanderthals were killed off by *Homo sapiens,* possibly from competition for resources or from sheer violence. This hypothesis is unlikely and outdated because it perpetuates the obsolete idea of the "Killer Ape" view of extinct hominins. This example is illustrated in *2001: A Space Odyssey*, which incorrectly portrays how Australopithecines became violent as a means of evolution, and is based on the concept of "original sin" (Kover, 2017).

Another hypothesis for the extinction of the Neanderthals is the theory of catastrophism. Coined by French geologist Georges Cuvier, it describes "the differences in fossil forms encountered in successive stratigraphic levels as being the product of repeated cataclysmic occurrences and repeated new creations" (Britannica, 1998). This indicates that the Earth has undergone multiple cataclysms, which have impacted the evolutionary timeline of living organisms through extinction events. Fossils found in a lower stratigraphic level are not found in the layer above because they became extinct due to a large-scale event, such as a flood or volcanic eruption. One of the oldest hypotheses written was in 1964 by C. Loring Brace, who believed that Neanderthals could not be ancestors to modern man because "modern forms of man already existed as exemplified by the Grimaldi skeletons" (Brace, 1964). This has been disproven because we now know that Neanderthals are our closest extinct relatives, and modern humans did not appear after Neanderthals; instead, we lived alongside them for thousands of years. Catastrophism is also based on religious beliefs, and says these violent events in nature are considered "Acts of God" (Britannica, 1998), including the flood God sent to kill everyone on Earth besides Noah and his Ark. However, this hypothesis is also outdated and cannot be scientifically proven or evaluated.

It is also believed that environmental factors may have played a role in their extinction, as the great Ice Age was ending and the Earth was becoming warmer. With global temperatures becoming warmer, climates were changing accordingly. That could have meant less food was available, freshwater availability was decreasing, and there was less shelter (Hendry, 2018). However, the Neanderthals went extinct during the last glacial period when it was still cold in Europe, so this hypothesis is unlikely. There may have been some minor environmental changes, but they were not significant enough to cause a complete species extinction.

The most likely scenario was that *Homo sapiens* introduced diseases to the Neanderthals that they were not protected from. Neanderthals lived in a more specific environmental niche than humans, staying mostly within mainland Europe, with some Neanderthals also found in western Asia and Russia. Ancient *Homo sapiens* were more widespread and migrated to different areas of the globe when leaving Africa, including Europe and Asia (Hendry, 2018). Since ancient humans were more widespread and often interbred with one another, they were exposed to more diseases and illnesses than Neanderthals. (Wolff, 2010). When *Homo sapiens* migrated to Europe, they overlapped with the Neanderthals' niche, in places such as the Iberian Peninsula and Germany (Oxford, 2014). Then, as early *Homo sapiens sapiens* bred and interacted with Neanderthals, it is possible that they unintentionally killed them through disease. It is also possible that both disease and environmental factors contributed to the extinction of the Neanderthals, as it was a gradual process that occurred over thousands of years, rather than being sudden or immediate (Hendry, 2018). Hopefully, in

the near future, we will learn what exactly happened to the Neanderthals.

Conclusion

This study explored the biological similarities between Neanderthals and humans, as well as the social similarities, and continued to explore the history of Neanderthal DNA, when it was first researched, and the most recent discoveries about their DNA and how scientists were able to replicate their genome. These findings are important because they disprove negative social beliefs towards Neanderthals, namely that Neanderthals were not intelligent or that humans are not closely related to them. The conclusions drawn help provide a more in-depth understanding of Neanderthals in relation to modern humans, highlighting their similarities in social aspects, including funeral rituals, art, and food. They also provide a clear timeline for scientists to examine Neanderthal DNA and explore how this research can benefit us now. In the future, scientists can continue to investigate the Neanderthal genome and how it can be used to track human evolution and history using DNA comparison. Research can also be used to explore the health implications in people who share more DNA with Neanderthals than other human populations.

Neanderthals are our closest extinct hominin relatives, and they have helped us discover who we are today, both as animals and as people, in the context of human evolution. They were the first of our relatives to create art, and we might have learned to create art from them. They used stone tools to hunt and prepare food, and used fire to cook food. They created shelters to protect themselves from the elements and keep each other safe. One of the most important aspects we learned about them was their ability for love and care, shown to us through their burial techniques and art. So next time you want to call someone an imbecile or moron, don't bring the Neanderthals into it.

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