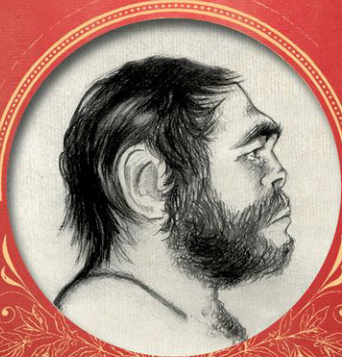


How to

THINK

Like a

NEANDERTAL



Thomas Wynn *and*
Frederick L. Coolidge

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THOMAS WYNN
AND
FREDERICK L. COOLIDGE

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Printed in the United States of America
on acid-free paper

*To our brothers, Tim Wynn and Tom Coolidge,
who inspired, encouraged, and tolerated us our entire lives.*

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Preface

THIS IS NOT a “how to” book for adolescent boys (of any age), nor is it a manual for survivalists who fear an imminent apocalypse. And it is not a satirical account of any political party, individual, or ideology, however deserving. It is a serious attempt to describe the thinking of a vanished and often maligned population of prehistoric people, the Neandertals.

Neandertals hold the distinction of being the only fossil human to have become a part of the standard vocabulary. Everyone who has had exposure to modern media has heard or seen the term, and most people carry some idea of who Neandertals were, though more often than not it is a caricature drawn from modern cinema or television: *Iceman*, *Encino Man*, *Caveman*, *Quest for Fire* (our favorite). There have been many fine academic books on the subject of Neandertals, some of which have been written for a general audience. They are thorough, and often a bit dull. Old bones and stone tools quickly lose their charm for the nonspecialist. What is often missing from serious accounts of Neandertals is any discussion of the questions many people find most interesting: What was it like to be a Neandertal? How were their lives similar to or different from ours?

This is the task we have taken on: to provide an account of the mental life of Neandertals, to the extent that it can be reconstructed from the fossil and archaeological remains. We are an archaeologist (TW) and a psychologist (FLC) who have been working together for a decade on topics in the evolution of cognition. Our approach uses established concepts in cognitive science to interpret paleoanthropological remains. We will describe specific archaeological remains, use explicit descriptions of cognitive abilities, and occasionally ask readers to accompany us on thought experiments. As we hope to show, it is in fact possible to describe some of the ways Neandertals thought about their world. In the process of painting this picture we will present some interesting but little appreciated

insights into cognition in general. In the end, our account of Neandertal cognition should provide a perspective from which to view our own cognition, much of which we share with Neandertals, but some of which we do not.

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How to Think Like a Neandertal

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*True Grit**Who Were the Neandertals?*

Neandertals were prehistoric people who evolved in Europe and flourished between about 200,000 and 30,000 years ago. Right off the bat, with this seemingly innocuous sentence, we run into controversy. Referring to Neandertals as “people” is in fact a bit risky. Some in anthropology and psychology would prefer to reserve the term “people,” and especially the term “human,” for individuals and groups indistinguishable in all respects from people living today, at least biologically indistinguishable. They would prefer that we use the term “hominin” or “hominid,” which encompass living people and our ancestors and a number of bipedal cousins, going all the way back to our evolutionary split from apes some eight million years ago. They have a point: the terms “human” and “people” are certainly loaded with implications about behavior and cognition. This is precisely why we choose to use them. Neandertals were so similar to us anatomically and genetically that we believe the default position—the null hypothesis, for readers familiar with scientific method—should be that Neandertals were no different. We must then present sound arguments for any differences we propose. Our initial sentence contains a second controversy: “Neandertal” or “Neanderthal”? My word processor, for example, prefers the latter. When the first Neandertal was recognized and described in the 1850s, the German word for valley was spelled *thal*, and the find was made in the Neander Valley, hence Neanderthal. In the twentieth century the German spelling for *thal* changed to *tal*. Following an adherence to Linnaean rules for biological naming, some scholars argue that the original spelling has priority. Those who favor separate species status for Neandertals are also likely to take this stance, because the formal species name for Neandertals, if Neandertals were a separate species, is

Homo neanderthalensis, a term introduced in the nineteenth century. Others argue that “Neandertal” is not a formal scientific label, and that we should follow current German usage. Take your pick; the terms are pronounced identically (i.e., no English “th” sound).

Neandertals evolved in Europe from an earlier hominin known as *Homo heidelbergensis*. We “modern” humans also evolved from *Homo heidelbergensis*, but in Africa. Fossil and genetic evidence indicates that these two groups separated from one another about half a million years ago, long enough for differences to evolve, but perhaps not long enough for them to become separate species, which would require that they not be able to breed and produce fertile offspring. At first Neandertals’ ancestors were restricted geographically to Europe, but by the time true Neandertals appeared about 200,000 years ago they had begun to move into western Asia. Eventually they moved as far east as Uzbekistan (north of Afghanistan) and throughout much of the Middle East. The last Neandertals appear to have been restricted to the Iberian Peninsula (modern Spain and Portugal), where the last one died sometime after 30,000 years ago. Modern humans, who evolved in Africa, moved into western Asia after 60,000 years ago and into Europe by 40,000 years ago. Most paleoanthropologists believe that modern humans were somehow implicated in the disappearance of the Neandertals, but exactly how this happened is unclear and the source of much controversy in the field.

So what were Neandertals like? If they were as similar to us as the evidence suggests, would it even be possible to recognize one if he or she were dressed in modern clothing, sitting or standing at a bus stop? The answer is yes, but you might have to look closely, risking a socially awkward moment. You would first notice the face. Our transit passenger would have a large face that was especially long from the top of the forehead to the chin. He (for simplicity’s sake we will refer to him as a he; the features apply to Neandertal women as well) would also have pronounced brow ridges, which are swellings of bone immediately above the eye orbits, and his nose would be longer and broader than is typical of modern people. Indeed the whole middle part of his face would appear to be pulled forward. He would lack a protruding chin, largely because his teeth would be larger, on average, than ours and the tooth row longer. If he smiled, you would probably notice that his front teeth (his incisors) were heavily worn down. There are several other distinctive features of his face that anthropologists would recognize on his skull, but that would not be obvious on a living individual (e.g., a retromolar space between his third molar and the ascending part of his jaw; and speaking of third molars, his large jaw would have plenty of room for these wisdom teeth). Such features help anthropologists identify

fragmentary remains as Neandertals and can be involved in technical arguments in paleoanthropological circles concerning who is related to whom, but they are not particularly relevant to our current theme. One distinctive feature that you might or might not notice on our bus stop Neandertal would be the size and shape of his brain case, the part of the skull that holds the brain. It would be large, probably larger than yours. It would be longer than yours, and it would be widest midway between the base and the top, so that from the rear it would appear round. (Your widest point is much closer to the top.) If you accidentally picked up his hat, it would almost certainly fall down over your eyes. Neandertal brains were about 10 percent larger, on average, than modern brains, and so were their heads. So, on the whole, our Neandertal would have an unusual face and head, but it probably would not be so unusual that you would consider walking on to the next stop.¹⁻⁴

Below the head our Neandertal would not appear at all unusual if he were sitting at the bus stop. But if you followed him to the gym, you would probably notice some impressive differences. He would be fairly short, about the same height as President Sarkozy of France or Jon Stewart of *The Daily Show*. But he would be much more massively built. His torso would be broad and deep, with wide hips and a barrel chest. He would be heavily muscled and would likely resemble the bodybuilders at the gym, or perhaps the competitive weight lifters. But he wouldn't have had to invest nearly the time or reps to get his physique; he was by nature very muscular. The muscles of his neck, shoulders, chest, back, arms, and legs would be well-developed—perhaps not the sculpted look of the competitive bodybuilder, but certainly the mass. His arms and legs would be a bit short for his stature, especially his forearms and lower legs. This body type is ideal for power. If he finally noticed that you were checking him out, and challenged you at the bench press or to arm wrestle, you would be wise to decline. It is unlikely that any but the strongest of modern people could match him (Figure 1-1). As with the head and face, Neandertals had a number of less obvious characteristics in their bones that anthropologists use for identification, but these need not concern us here.

Taken individually, none of the characteristics we have just mentioned would be outside the range of modern human variation. There are modern people with long faces, others with large noses or big heads (literally and metaphorically), and still others who have relatively short, massive bodies (the Bulgarian Olympic weight-lifting team comes to mind). Some of the minutiae of anatomy are unique to Neandertals, but surprisingly few. One of us (TW) has occasionally sent his beginning-level students out to identify Neandertal-like traits possessed by esteemed professors on campus, an exercise

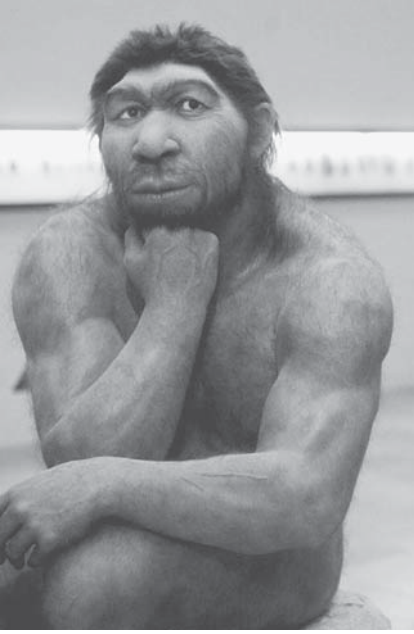


FIGURE 1-1 A modern human made up to resemble a Neandertal. Sebastian Willnow/Getty images. Used with permission.

that invariably leads to mirth. (And yes, TW and FLC have occasionally appeared on the list.) What set Neandertals apart from us anatomically are not the individual features, but the combination, the package of traits, if you will.⁵

But wait. Our gym example has probably prompted some of you to ask a very important question: If Arnold Schwarzenegger can go to a gym, work out, and develop a well-muscled, powerful physique, how were Neandertals any different? Maybe their daily lives required them to do a lot of heavy physical labor (it did), and this is what we see in their skeletons, not some innate biological difference.

An adult's anatomy and physiology are the result of a complex interplay of genes and the environment of development, and it is rarely the case that one or the other is the sole determining factor. One of us (TW) has identical twin daughters who are far from being identical. Even at birth there were subtle differences in anatomy. Yet they had the same genes and had developed in the same uterus. As it turns out gene expression is a complex phenomenon. In this case, even though the girls shared the same placenta, they did not receive exactly the same nourishment. Moreover genes are not as narrowly deterministic as science once thought. Even the transcription of DNA to RNA, the first step in protein synthesis, is affected by the features of the nuclear environment, including the presence of proteins that have entered the nucleus from outside. The cell environment can actually alter how DNA is transcribed; that is, the external environment can alter gene expression at this very fundamental level, and the effect can then be passed down through multiple cell divisions, a process termed "epigenetic inheritance." Some of these epigenetic factors work in probabilistic ways, so that an identical DNA sequence might come to be expressed differently in separate groups of cells or individuals. Thus it is not a surprise that identical twin girls are in fact different. Even more significant to their adult anatomy, and more pertinent

to our Neandertal discussion, were their differing experiences as children. One girl chose soccer, the other ballet. They exercised muscles differently and stressed bones differently, and this difference had a permanent effect on how their bodies grew. So when we describe Neandertal body types as different from that of modern humans, we must acknowledge that this difference was a complex result of different physical environments, different experiences growing up, and differences in genes.⁶

So what about Neandertals? Take their barrel chests. There are people in the world today who have chests shaped very much like the barrel chests of Neandertals. These are people who have lived their entire lives at altitudes above 3,000 meters (10,000 feet). Because of the reduced oxygen pressure at high altitude, these people develop larger lung capacities and larger chests (and even slightly larger hearts). Little, if any, of this is determined by their genes. Instead their individual bodies have changed to adjust to local conditions. Few, if any, Neandertals lived at high altitude, so this specific explanation will not work. But perhaps their lives of heavy exertion led to enlarged chests; heavy exertion also puts stress on an individual's ability to process oxygen. Similarly, Neandertals' large jaws may in part result from use. Many Neandertals have heavily worn incisors, suggesting habitual, heavy use, perhaps as a kind of third hand. Add such use to heavy chewing, and the jaw will become more massive as one grows up. Modern people who do a lot of heavy chewing have larger jaws (and less orthodontia) than those who don't. It is not a genetic difference; it is a difference in their way of life.

So some Neandertal features can also be explained by their way of life. How can we tell which features were innate and which developed through use? There are clues. For one, if all Neandertals—men, women, and children, especially young children—have a particular feature, all of them would have had to be doing the same level of exertion and activity. And if Neandertals from different environments, for example Europe and the Middle East, all have it as well, then all Neandertals, everywhere, would have had to have the same level of exertion. A simpler solution in these cases is to conclude that the feature in question, say the barrel chest, was determined by genes.

Genes

We actually know some very specific things about Neandertal genes because science has been able to recover many of the genes themselves from bones that are not completely fossilized. Fossilization is a process in which minerals in the soil replace chemicals in the bone (or, rarely, soft tissues), literally turning

the bone to stone. But it is a process that can take thousands of years, and for many Neandertal skeletons complete fossilization has not occurred; there is still organic material in the bones. With the proper techniques, paleoanthropologists can extract DNA from this material, actually two kinds of DNA. The most abundant kind, and the easiest to recover, is not the DNA that controls our inheritance, which is found in the nucleus of every cell. It is the DNA found in the mitochondria, which are located outside of the nucleus in a cell's cytoplasm (hence mitochondrial DNA, or mtDNA). Mitochondria are organic structures in the cell (organelles) that help cells produce energy, and each mitochondrion has its own DNA that regulates its function. The curious thing about mitochondria is that sperm do not have them. All of your mitochondria came, ultimately, from your mother, and hers from her mother, and so on. Of course, men do have mitochondria; they just don't pass theirs on to their children. Sexual reproduction does not alter the DNA of mitochondria (unlike nuclear DNA, which is reshuffled during the formation of eggs or sperm), so your mitochondrial DNA is identical to that of your mother's, *unless there has been a mutation*. Mutations are nondirectional, chance changes to the DNA. Sometimes a mutation in mitochondrial DNA renders that mitochondrion unviable so that it no longer processes energy effectively, but more often a mutation has no physiological effect at all and is passed along with the mitochondria to a woman's sons and daughters, and her daughter's sons and daughters, and so on. If two daughters of the same woman go their separate ways and each successfully reproduces, and their daughters successfully reproduce, and so on, over time the two related lines will accumulate different sets of mutations in their mtDNA, and the longer they are apart, the more different their mtDNA will be. When we compare the mtDNA recovered from Neandertal skeletons to that of modern people, we find about three times as many differences (twenty-seven mutations versus eight) as we find when we compare the two most different modern people with one another. This tells us a couple of interesting things. First, Neandertals were at least three times more different from us, in terms of mtDNA, than any of us is from any other modern person. Second, if we apply a rate of change—that is, a rate at which mutations occur—we can estimate how long ago we and Neandertals separated. As you might guess, calculating a mutation rate is tricky, and there is much disagreement. But most paleoanthropologists are comfortable with a rate of change that places the split about 500,000 years ago.⁷

In 2010 Svante Pääbo and fifty-five colleagues of the Neandertal Genome Analysis Consortium published the first draft of their attempt to document the entire Neandertal genome (“genetic” DNA in the cell nucleus). They based

their analysis on archaic DNA recovered from the bones of three Neandertal women who died in Croatia about 45,000 years ago, which they compared to the DNA of modern people living in Europe, Asia, and Africa. The results were a bit of a surprise. The primary result demonstrated that 1 to 4 percent of the genes in modern Asians and Europeans had a Neandertal origin. The figure of 1 to 4 percent may not sound like much, but it confirms a suspicion held by many paleoanthropologists that Neandertals and modern humans could, and did, interbreed. Two other results were equally interesting: modern Africans have no Neandertal genes in their genome, and the Asian genome had just as many Neandertal genes as the European genome. The most likely explanation for this state of affairs is that the interbreeding occurred *after* modern humans had migrated out of Africa but *before* they dispersed into Europe and Asia. The most likely time frame for this, according to Pääbo and colleagues, was 60,000 to 80,000 years ago. This range of dates presents a paleoanthropological puzzle. There are Neandertal remains that date to this time frame in the Middle East, but as yet no anatomically modern remains. There are modern remains earlier than 80,000, and then again after 60,000. Given the imprecision of genetic dating by assumed mutation rates, this inconsistency should perhaps not worry us. What is important is that there was gene flow between Neandertals and our ancestors prior to our expansion into Europe and East Asia. But this gene flow, the term geneticists use for the transfer of genes from one population to another, was one-way; no specifically modern human genes were identified in the Neandertal genome.⁸ This apparent one-way gene flow inspires questions about how it actually played out in the lives of Neandertals and modern humans. How did they interact? Were there mixed groups? Or is violent interaction more likely? We will return to these issues in the final chapter.

Pääbo's analysis was also able to identify seventy-eight genes found in the modern genome that were not found in the three Neandertal women. It is important to keep this in perspective; the Neandertal and modern genomes were 99.84 percent identical. But we have seen that Neandertals did differ from moderns anatomically, and that some of this difference was probably genetic. Some of the seventy-eight unique modern genes have been linked to known functions, but we must be cautious here. As we have seen, gene expression in anatomy is a complex process that involves the gene itself, other regulatory genes, and an individual's developmental environment. Curiously, of the seventy-eight genes in question, the biggest DNA differences were in genes linked to the skin. And some of the other different genes are those involved in energy metabolism, including a set that leads to Type 2 diabetes if a faulty variety is present. But for our purposes in this book, the most interesting

differences are in genes important in cognitive development. Modern humans have at least a few genes linked to cognitive development that Neandertals did not have. Unfortunately it is not entirely clear what these genes do. There were also some curiosities. One of the Neandertals tested by Pääbo had the gene for red hair, for example. This discovery was a surprise, but perhaps it shouldn't have been. The gene for red hair is related to genes controlling skin pigment, and anthropologists have long known that reduced UV radiation in high latitudes (e.g., Europe) selects for reduced skin pigmentation. Neandertals had lived in high latitudes for several hundred thousand years, far longer than modern Europeans, so evidence of reduced pigmentation should surprise no one. A more provocative gene identified for Neandertals is known as FOXP2. A variant of the FOXP2 gene is known to cause a speech impediment and difficulties in learning and using certain kinds of grammar. Neandertals have the normal variety. Does this mean that Neandertals had modern speech, just like you and me? Perhaps, but not necessarily. FOXP2 is not a gene *for* language or speech; rather it is a gene that is involved in modern speech. There are undoubtedly many other genes involved in modern spoken language that have not been identified. Neandertals may or may not have had them. But their possession of FOXP2 is certainly provocative.

At the end of the day, knowing a few, or even many Neandertal genes does not help us much in our quest to understand their lives, at least not yet. Archaic DNA from Neandertals is most useful for documenting how closely related we are to them and for estimating how long we have been apart. There are not single genes for brow ridges, or large noses, or barrel chests—at least not that we know of. Such features result from the interaction and timing of many genes over the course of an individual's lifetime, especially when we are young. So even when paleoanthropologists have described the entire Neandertal genome (and it is only a matter of time), most of our questions about Neandertal life will still remain. How, then, can we understand their unusual appearance?

Out in the Cold

Christian Bergmann and Joel Allen were nineteenth-century biologists (one German, one American) who are now forever linked as the discoverers of two “rules” governing the body shapes of mammals. Bergmann's rule states that for varieties of the same species, body mass will increase as latitude increases: those living in cold climates will have compact, massive, bodies, and those living in hot climates will have more linear body forms. It's simple physics. The ideal shape for retaining heat is a sphere; it has the least surface area to mass.

Mammals are endothermic, which means that they generate their own body heat, so in cold climates individuals who have a more spherical body shape retain heat better, use less energy to maintain body temperature, and reproduce better as a consequence. It's not only simple physics; it's simple natural selection. Allen's rule states that mammals living in cold climates will have shorter limbs relative to torso length than those who live in warm climates. Because arms and legs are narrow and linear, they lose heat faster than the torso, so shorter arms and legs lose less heat than long arms and legs. Modern humans follow both rules. The Inuit of northern Canada have short, compact bodies, with relatively short arms, and Sudanese from tropical Africa are tall and thin with relatively long arms and legs.

Neandertals also followed the rules. They evolved a classic body type for retaining heat: relatively short and compact, with short arms and legs. This explanation is so compelling that paleoanthropologists have tried to incorporate other Neandertal features into it, arguing that Neandertal noses evolved to warm and moisten cold air. However, recent research points to heavy chewing as a more likely explanation for the unusual features of the Neandertal face. The alert reader will also raise an objection concerning cold adaptation for Neandertal bodies. Few modern Europeans resemble Inuit. Indeed if one considers northern Europeans such as the Dutch, a more tropical body type would be a better match. More important, Europe is not a particularly cold place, certainly not arctic. So why should Neandertals have had body shapes like those of modern Inuit? The answer is that Europe hasn't always been as warm as it is today.

Ice Age

Global warming is on everyone's mind these days, at least the minds of those paying attention to world affairs. Most scholars now accept that this warming is caused by human actions. There are still a few skeptics (though very, very few among specialists on climate), who prefer to argue that the recent warming is just the latest in a long series of natural climate changes that the Earth has been experiencing for the past million years or so. At first consideration, they have a point. Earth's climate has been on a roller coaster for over a million and a half years, and if anything, the hills and valleys of this roller coaster—the times of extreme cold and warmth—have gotten more dramatic as the ride approached the present. We are currently in a trough of warm conditions, and have been for about 10,000 years. (And if past timing is any indication, and it is, we are due for cold, not dramatic warming.) But as recently as 20,000 years

ago Europe and North America were locked in an Ice Age. Immense continental-scale glaciers thousands of feet thick formed over Scandinavia and Hudson Bay, and the weight of ice pushed their margins as far south as central Germany and central Illinois. These huge volumes of ice had effects far beyond their margins. Intense cold over the glaciers caused high atmospheric pressure ridges to form, which in turn pushed the “normal” climatic zones to the south. As a result much of Europe was not only colder, but it was drier as well. The water that fell as snow over the glaciers stayed there, and ocean levels all over the world fell as much as 120 meters (400 feet), changing the shapes of continents. About 20,000 years ago you could have walked from Paris to London, or Alaska to Siberia. The European hardwood forests disappeared, replaced by treeless cold steppe terrain, which abutted the glaciers, scattering conifers farther to the south. The animals also changed. Instead of woodland mammals such as deer and elk, there were cold grassland mammals such as reindeer, musk ox, woolly mammoth, and woolly rhinoceros. Even the predators were different, with lions and hyenas added to the usual stock of wolves and bears. Europe was a very different place during an Ice Age.^{9,10}

By 20,000 years ago Neandertals were long gone, but this most recent major ice age was just the last in a long series. It lasted from about 30,000 to 12,000 years ago. A slightly less intense glaciation preceded it between about 70,000 and 60,000 years ago, and Neandertals were definitely around for that one. (Indeed many of our best preserved European Neandertals date to about this time.) Between 128,000 years ago and 180,000 years ago there was a very long, intense Ice Age, and it was during this one that the “classic” Neandertal anatomy evolved. Prior to 180,000 years ago there were several other Ice Ages, going all the way back to the time of Neandertals’ immediate ancestor, *Homo heidelbergensis*. These Ice Ages, and the intervening warm periods, were not uniformly cold or warm; climate during each period fluctuated wildly, from cold extremes to warm extremes, often over intervals of only a couple of thousand years. The average temperature during Ice Ages was lower than the modern average, and within each there were colder intervals and brief episodes of extreme cold lasting only a few thousand years. We know that Neandertals remained in Europe during the Ice Ages, but the archaeological evidence suggests that they abandoned many areas during the episodes of extreme cold; of course, so did modern people when they finally arrived 40,000 years ago. What is clear is that Neandertals evolved in Europe during a time of fluctuating climates that included several long, cold phases that lasted for tens of thousands of years, plenty of time for natural selection to follow Bergmann’s and Allen’s rules.