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A Potential Role of Evolution in Shaping Modern Human's Behaviors and Morals

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Abstract

Between eight and six million years ago there existed a common ancestor linking the human species with their great ape relatives. Following the arrival of this organism, a lineage of several different human species began to emerge around two to three million years ago in Africa. These species included *Homo rudolfensis, Homo habilis, Homo ergaster, Homo erectus, Homo floresiensis*, *Homo heidelbergensis*, *Homo neanderthalensis*, and *Homo sapiens*. By analyzing these species and the great ape relatives through literary research, it is possible to begin to investigate the potential role of evolution in constructing modern human behaviors and morals.

Keywords: Evolution, modern, human, behaviors, morals

A Potential Role of Evolution in Shaping Modern Human's Behaviors and Morals

Between eight and six million years ago there existed a common ancestor shared between humans and apes. It is this ancestor that most closely links us to our primate relatives. Despite the abundance of fossil and DNA evidence that confirms our close relationship to the great apes, exactly who our last common ancestor was remains a mystery. Some argue the ancestor was most like orangutans, while others argue it most likely resembled a chimpanzee (Barras, 2017). Regardless of this ancestor's physical appearance and the mystery that surrounds it, one thing remains clear: this ancestor was the splitting point that led to the formation of several new human species.

The History of Human Evolution

Around seven to six million years ago lived what is known as the *Ardipithecus* group. This clade consists of the earliest humans that are the closest link to the other primates. The *Ardipithecus* are part of the genus Hominidae, which is a group that includes all humans, but excludes the great apes. *Sahelanthropus tchadensis, Orrorin tugenensis, Ardipithecus kadabba*, and *Ardipithecus ramidus* are all part of this group. These ancient humans originated in Africa and evidence shows that most walked upright, with some also being able to climb trees. While not much detail is known about these early human relatives, it was the *Ardipithecus* group that led to the development of the Australopithecines around four million years ago.

The first known member of the Australopithecines was *Australopithecus anamensis*, which lived around 4.2-3.8 million years ago. This organism has combinations of both human and ape traits and was bipedal. *Au. anamensis* contained an ankle joint that was oriented in a humanlike manner (Smithsonian Institution, 2020). The orientation of this ankle joint is what made it possible for them to regularly walk upright. It is this species' extended and narrow braincase, as well as their outward protruding cheekbones, that emphasize their ancestral ape traits. The next known member was *Australopithecus afarensis*. Thanks to the abundance of fossil evidence that exists for this species, we can learn a lot more from them. *Au. afarensis* was one of the longest surviving human ancestors, and this species lived for nearly 900,000 years. Members of this group were bipedal and had significantly faster growth rates than modern humans, much like chimpanzees. This species also had less parental guidance and socialization during childhood. *Au. afarensis* also had both ape and human characteristics. Their flat noses, protruding lower jaws, small brain cases, and long arms with curved fingers are all apelike traits. The curved fingers would have been used to climb trees, just as the apes do today. As for human characteristics, this species possessed small canine teeth, stood upright, and was not only capable of walking upright, but would regularly do so. Their ability to walk upright as well as climb trees is what helped keep them alive all those years as their environment and climate changed.

Today, there exists a 40% completed skeleton of a 3.2-million-year-old *Australopithecus afarensis* named Lucy. In 1974, 47 bones from Lucy were found in northeastern Ethiopia (Hendry, 2018). These bones revealed the skeleton of this hominin ancestor, and they also revealed a multitude of other significant insights about the history of human evolution. Based on these fossils, it was estimated that Lucy stood around 3.5 feet in height and would have weighed approximately 62 pounds (Hendry, 2018). Due to evidence of bone fusion and the presence of a wisdom tooth, scientists believe Lucy was an adult when she died. While the term “adult” refers to modern humans starting at the age of 18 years, Lucy is speculated to have only been 12 years old when she died. This assumption stems from the evidence that suggests *Au. afarensis’* brains reached their full size significantly earlier than the brains of modern humans (Hogenboom, 2014).

The cause of Lucy's death is vital in understanding these early species and how they relate to human evolution. Given the placement of her bone injuries, scientists hypothesize that Lucy died as a result of falling from a significant height (Kappelman et al. 2016). We know that *Au. afarensis* had the ability to both climb trees and walk upright, and while this may have initially facilitated their survival, it may have eventually led to their extinction as well. If bipedalism was becoming more prominent in the species, it is possible that *Au. afarensis'* ability to successfully climb trees started to diminish. The question then remains: what prompted Lucy, and others of her species, to start walking upright on a more regular basis? One possible explanation for this adaptation is a change in diet. Researchers discovered remnants of food on preserved hominin teeth that indicate Lucy and her kind may have expanded their diet further from the fruits they found in trees. This would include grass, sedges[1], and conceivably meat (Hogenboom, 2014). By expanding their diet, Lucy would have needed to broaden her foraging grounds and that may have favored bipedalism over tree climbing. By becoming more comfortable in upright walking and less comfortable in tree-climbing, this would have made Lucy more prone to falling from significant heights. Indeed, Lucy likely did fall to her death, and these diet and environmental changes offer one explanation on the fate of this species.

Figure 1: A reconstruction of Lucy's face created by Tim Boyle.

The remaining two members of the *Ardipithecus* group known as *Australopithecus garhi* and *Australopithecus africanus*, existed around 2.5 million years ago, however, there is not much

[1] Grass-like flowering plants

that remains of these *Australopithecus* members. Despite this, there is still some evidence that suggests *Au. garhi* began to take longer bipedal strides. The emergence of long strides is important because it allowed species to hunt a wider range of grounds and to move for a longer period of time. This adaptation was likely key for the survival of species, explaining why long strides and bipedalism took over, and why our species is able to run. Due to the need for food and a way to escape from predators, *Au. garhi* had to adapt to their environment by using longer strides (Schulkin, 2016). *Au. africanus'* anatomy was comparable to that of *Au. afarensis,* and it could walk upright as well as climb trees. As bipedalism became more and more prominent, the anatomy of these species' feet changed. Specifically, *Au. afarensis* had a cuboid-metatarsal[2] joint morphology similar to that of humans (Holowka and Lieberman, 2018). This adaptation was believed to have likely influenced why humans today are able to run efficiently. However, as further research was conducted, bipedal kinematic data displayed no significant differences in midfoot mobility between humans and chimpanzees (Holowka and Lieberman, 2018). This led to the conclusion that midfoot mobility is not a valid indicator of arboreal locomotion[3]. Finally, between three and two million years ago, the *Homo* group emerged.

The Ancient Humans

Because the earliest *Homo* fossils are all from Africa, it is believed that the genus *Homo* emerged in Africa. In order to distinguish *Homo* fossils from other species, scientists identified specific anatomical traits that indicated a specimen belonged to the *Homo* group. In the past, the first characteristic was a brain size of over 600 cubic centimeters (Dunsworth, 2010). This distinguished the fossils from australopiths because they all had smaller brain sizes. Furthermore,

[2] The cuboid is one of seven tarsal bones of the foot and connects the foot and ankle while also providing stability.
[3] The movements of animals in tree habitats.

australopiths possessed crests in their skull bones, immediately distinguishing them from round and smooth skulls that *Homo* members possessed (Dunsworth, 2010). However, given the amount of fossils that have emerged over the years, scientists needed to develop new ways of distinguishing species. One of the most common fossil finds and identification methods involve teeth analysis. When studying teeth, if they are more human-like than ape-like, scientists can confirm that they came from the genus *Homo.* But, what determines if the teeth or jawbone is human-like? In order to be identified as *Homo*, the teeth must be small, have smaller molars and premolars than incisors, and they must have reduced canines and thick enamel (Dunsworth, 2010). Furthermore, the teeth must form a parabola, rather than a v-shape as seen in nonhuman apes. In addition to brain size and teeth specificities, other general characteristics of the genus *Homo* include an erect stance, bipedalism, opposable thumbs, and precision grip capabilities.

Within the *Homo* clade exists modern humans and our extinct ancestors. Members of this classification include *Homo rudolfensis, Homo habilis, Homo ergaster*, *Homo erectus, Homo floresiensis, Homo heidelbergensis, Homo neanderthalensis*[4], and *Homo sapiens. Homo rudolfensis* existed around 1.8 million years ago and only one high quality fossil from this group has been discovered. This species is known for its large braincase size of 775 cubic centimeters, which suggests a large cranial capacity. *Homo rudolfensis* also had large, wide molars, and it is possible they used stone tools to prepare their food. Another member of this group is *Homo habilis,* which originated between 2.4 and 1.4 million years ago. *Homo habilis* had thick tooth enamel and strong jaws, indicating that they had the ability to chew hard foods. This species was given the nickname “handy man” because of its ability to make stone tools. However, new evidence suggests the emergence of the first stone tools predate *H. habilis.*

[4] May have been a subspecies of *Homo sapiens*

Stone artifacts in northern Kenya indicate that the use of stone tools may have occurred 3.3 million years ago. Tools found at the LOM3 excavation site predate the genus *Homo*, and there are only a few known hominin species that may have been living in the region at that time. These species include *Au. afarensis*, *K. platyops*, and *Au. deyiremeda* (Lewis & Harmand, 2016). *K. platyops* is a hominin species from 3.5 to 3.2 million years ago, while *Au. deyiremeda* is a younger species that researchers discovered in Ethiopia. *Au. deyiremeda* displayed both *Australopithecus* traits and *Homo* morphology, (Lewis & Harmand, 2016) and based on the percussion marks on the stones, researchers theorize that these tools may have been used to process plant food. One of our closest relatives, the chimpanzee, participates in such percussion behaviors. Given this, it is not unreasonable to propose that the use of stone tools began much earlier and in a much simpler manner. Stone knapping may have originated with the Pliocene hominins from old pounding behaviors (Lewis & Harmand, 2016). The fossils found at LOM3 shed light onto the idea that the use and creation of stone tools may have been present in other species besides *Homo*.

The next member of this classification is *Homo erectus* which lived between 1.8 million and 110,000 years ago. This group is significant because they are believed to be the oldest early humans to contain similar body proportions to that of a modern human. It is believed that *H. erectus* developed this body structure as a result of adapting to life on the ground as they moved away from the tree climbing seen in our earlier ancestors. Footprints of *H. erectus* point to an adducted hallux, which is to say, *H. erectus* started to display signs of non-opposable big toes (Holowka and Lieberman, 2018). Furthermore, *H. erectus* was found to possess a high longitudinal arch, which is believed to have saved energy during running. Fossil evidence of this species suggests that *H. erectus* cared for old and weak individuals, much like modern humans today. During the time period in which *Homo erectus* lived, there exists evidence of campfires that may have been used for cooking and sharing food, as well as socializing.

Although cooking may seem like a simple task for modern humans, some scientists believe that it may have played a significant role in human evolution. Fossils of *Homo erectus* have been found that show a decrease in the size of the teeth and the digestive tract, as well as an increase in brain size (Rosati, 2018). This evidence suggests that *Homo erectus* and other early ancestors started eating softer and higher-quality foods. In addition, cooking with fire enabled these early ancestors to conserve energy during digestion (Ko, 2016). The use of fire also changed previously inedible foods such as roots, thick stems, large leaves, and seeds, into new nutritional resources for the hominin diet (Ko, 2016). It is believed that this increase in nutritional resources is linked to the increase in hominin brain size over time (Ko, 2016). This is due to the fact that high-quality foods provide the necessary fuel a larger brain needs for energy (Burini & Leonard, 2018). A more nutritious diet may have also facilitated more advanced behaviors. It is important to acknowledge the role that fire played in evolution, because in doing so, we can better understand ourselves. French gastronomist Jean-Anthelme Brillat-Savarin argued that cooking increased the value of meat, therefore generating a stronger importance for hunting (Wrangham, 2009). Perhaps this is the reason that *Homo erectus* was believed to be the first to use sophisticated hunting and gathering methods approximately 1.8 million years ago.

The next species to emerge in the genus *Homo* was *Homo heidelbergensis* which lived around 700,000 to 200,000 years ago. According to most scientists, *Homo heidelbergensis* is likely the common ancestor of Neanderthals and modern humans (McHenry, 2019). There are several significant items to note about this species. *Homo heidelbergensis'* were the first early humans to live in cold climates, and in fact, their wide and shorter bodies were most likely adaptations that allowed them to conserve heat. *H. heidelbergensis* lived during the age of the first known use of controlled fire, wooden spears, and animal hunting. This species was also the first to build shelters out of wood and rock. Another member of the genus *Homo* is *Homo floresiensis* which lived between 100,000 and 50,000 years ago. This species is known for their small frame of 3’6”, tiny brains, large feet, and short legs. It is believed that *Homo floresiensis* developed their anatomy due to island dwarfism. This is an evolutionary process that occurs from significant isolation on a small island with few food resources and very few predators.

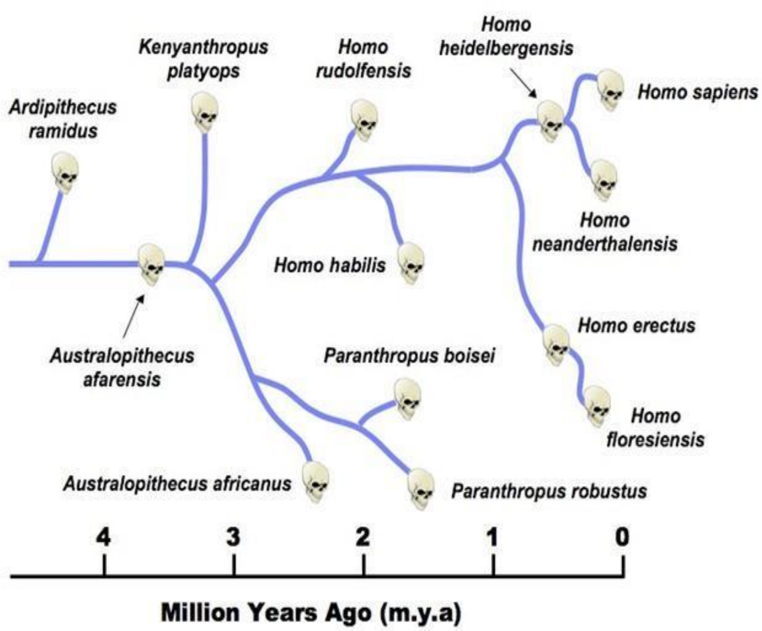

Figure 2. Depiction of the human lineage displaying the connection between modern humans and their early ancestors and relatives. Timeline is constructed through fossil evidence and fossil dating techniques. Retrieved from BioNinja.

Despite this, evidence shows that *Homo floresiensis* utilized stone tools and were capable of hunting animals. With this being said, it is important to note the controversy that surrounds this particular species. Although some scientists believe it is most closely related to *Homo habilis,* others rejected the validity of this species altogether (Groves, 2007). When evidence surfaced of the new species in 2004, some people argued that the *H. floresiensis* species was really just *H. erectus*. What these individuals believed is that the fossils were actually from a human suffering from “microcephaly”. This is a condition that causes the brain to be underdeveloped, although it is very rare. In 2005, scientists discovered more remains of *Homo floresiensis,* some of which were found to date back between 74 and 95 thousand years ago

(Groves, 2007). Using the new evidence, most researchers now believe that *Homo floresiensis* lived for a period of over 60,000 years. With this new information, doubts about the species also quieted, as it became increasingly unlikely that they were microcephalic individuals from another species.

About 300,000 to 30,000 years ago *Homo neanderthalensis* existed (Szalay, 2017). This species is thought to be our nearest human relative and have the closest brain size to our own. With that being said, there is a question as to whether the species is a subspecies of *Homo sapiens*. The reason some researchers believe Neanderthals may be a subspecies of modern humans is because according to a study from 2010, *Homo sapiens* and *Homo neanderthalensis* share 99.7% of identical DNA. Supporting this study is an abundance of information regarding Neanderthals, their habits, and their social structure. Neanderthals were known to use a variety of tools, controlled fire, shelters, and clothing. They were also highly capable of hunting large animals and were also known to eat plant foods. Even more telling of their behavior is the belief that Neanderthals buried their deceased in a deliberate manner, at times even marking graves with flowers. This is comparable to modern day humans and our funeral rituals. Furthermore, discoveries of elder and deformed skeletons suggest that the species cared for their sick and those who could not care for themselves (Szalay, 2017). The skeletons discovered contained minor to moderate injuries but were not the cause of death. This led scientists to the conclusion that Neanderthals must have provided some level of care for the sick and injured (University of New York, 2018). Even more astonishing are data indicating that *Homo sapiens* and Neanderthals mated with each other due to similarities in both their behavior and their biology. However, it is believed that the presence of modern humans in Europe may have hindered the

Neanderthals ability to move back to their favored areas, and in fact, it may have been the cause of their extinction nearly 30,000 years ago.

Expanding on this idea is a study from 2016 that suggests Neanderthals went extinct because they had to compete with modern humans (Gilpin, Feldman, & Aoki, 2016). Using the Lotka-Volterra[5] model, researchers analyzed how the cultural and demographic differences present between *Homo sapiens* and Neanderthals may have affected that competition. A significant fact presented in this study is that at the time humans invaded Neanderthal territory, their population would have been smaller than the Neanderthals. With this being the case, how is it possible that a smaller group of modern humans took over a large population of Neanderthals? The results of the Lotka-Volterra model indicate that competition is likely to have occured when the coefficients of the model are dependent on cultural differences between the species. These cultural differences generated moderate levels of competition that Neanderthals likely lost due to different cognitive abilities (Gilpin, Feldman, & Aoki, 2016). This suggests that while Neanderthals had a larger brain than most primates and one close in size to modern humans, they were not necessarily equally intelligent to *Homo sapiens*. This begs the question: what is the significance of brain size in modern humans and their extinct ancestors?

Brain Analysis

The genus *Homo* contains the most prominent increase in cranial capacity between species. Some of the earliest humans such as *H. habilis* and *H. rudolfensis,* had average cranial capacities of only 612 cc and 752 cc respectively. As the humans continued to evolve, their cranial capacities increased to higher levels, all the way to an average of 1456 cc with *H. neanderthalensis.* When comparing this species capacity to modern humans, *Homo sapiens*

[5] Predator-prey equations used to describe structures of biological systems in which prey and predator species interact with each other

actually contain a smaller average cranial capacity of around 1350 cc. In other words, the majority of Neanderthals possessed a cranial capacity nearly 7.9% times larger than modern humans. Despite this difference, *Homo sapiens* prevailed, further suggesting that brain capacity is not the only factor at play when it comes to determining intelligence. Brain organization may be the reason that *Homo sapiens* survived and Neanderthals did not. One specific brain feature known as petalias[6] appeared during hominin evolution. *Homo sapiens* are found to contain a left occipital and right frontal petalial pattern (Schoenemann, 2013). This very same pattern has also been found in *Homo erectus* and Neanderthals; a significant discovery due to the fact that asymmetries in the brain are believed to have a connection to handedness and cognitive functions (Balzeau, Giliseen, & Grimaud-Hervé, 2012). While there is not enough evidence to make a definitive connection between this brain pattern and hominin behavior, the fact there is a pattern suggests a possible explanation for the emergence of certain behaviors such as language, complex thoughts, and formation of relationships.

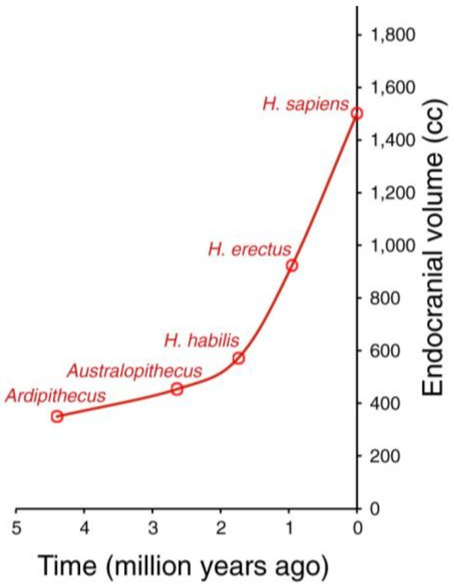

Figure 3. Graph depicting endocranial volume of different human species over time (Montgomery, 2018). Retrieved from ScienceDirect.

In order to better understand the significance of brain organization, it is important to analyze the difference between the brains of modern humans and Neanderthals. As previously mentioned, Neanderthals share around 99.7% of *Homo sapiens* genetic identity. Included in these shared genes are those that are significant to brain expansion and language (Alex, 2018). It is believed that these two species initially mated with each other in the Middle East (Ko, 2016).

[6] The protrusion of one cerebral hemisphere compared to the other

Although the size of Neanderthal brains may have been incredibly close to *Homo sapiens* when the two species were sharing the planet, Neanderthals most likely had different brain organization. One theory is that due to their larger body proportions, Neanderthals may have required more brain volume in order to expend energy, thus resulting in fewer cognitive functions (Alex, 2018). Adding to this theory is the idea that Neanderthal brains were focused on vision and body control (Stromberg, 2013). Due to this, Neanderthals may not have had much space in their brains for structures required for higher-level thinking and social behaviors. In order to take these factors into account, scientists developed a model for better understanding the structure of the Neanderthal brain. This new model allowed researchers to take into account that Neanderthals' brains were in control of differently sized bodies than those of early *Homo sapiens*. Because Neanderthals had less brain volume leftover for other tasks and functions, the model estimated that their brain was comparable to a 1133.98 cc *Homo sapien* brain (Stromberg, 2013). Some believe that this difference in capacities for high-level thinking may have resulted in the extinction of Neanderthals and the survival of modern humans.

Homo Sapiens

Finally, around 300,000 years ago emerged the first *Homo sapien* who would eventually evolve into today's modern humans. A key distinguishing feature between *Homo sapiens* and other early humans is the shape of their skull. *Homo sapiens* have a rounded skull in the back with a projecting nose bone, small brow ridge, tall forehead, and round eye sockets (Dorey, 2018). When it comes to the jaw and teeth, one indicative factor of modern humans is the protruding chin. In fact, *Homo sapiens* are the only ones to have a chin. Because they have a shorter jaw, their teeth formed in a parabolic structure, rather than forming outwards as seen in the earlier human ancestors. Both the teeth and limb bones were also found to be thinner than in earlier humans. When it comes to the evolution of the human brain, fossil evidence from around only 35,000 years and later displays the current globular shape seen in modern humans today. This shape, however, holds great significance for understanding the evolution of the modern

Figure 4. Reconstructed models by Adrie and Alfons Kennis (2014). Depicted is a Belgian Neanderthal (left) and an early *Homo sapien* (right).

human brain. Two key features that stand out to scientists are parietal and cerebellar bulging (Neubauer, Hublin, & Gunz, 2018). The parietal areas of the brain are associated with attention, orientation, perception, self-awareness, long-term memory, number processing, and tool usage (Neubauer, Hublin, & Gunz, 2018). The cerebellum also has a number of functions including language, social cognition, balance, and other motor skills. It is believed that the expansion of these areas is connected to the advanced cognitive behaviors *Homo sapiens* possessed over their earlier ancestors, and the evolution of brain globularization has been tied directly to the emergence of modern behaviors. So, when did *Homo sapiens* start displaying modern behaviors and traits and how does the evolution of the human species contribute to modern behavior and morals?

Potential Origins of Human Behavior and Morals

Homo sapiens have evolved into the complex, intelligent, and highly functioning modern humans of today that possess intense moral codes. The question then remains, how did modern humans acquire these behavioral and mental capabilities? One theory regarding the beginning of human morals is that they emerged through a form of psychological altruism[7] amongst hominid groups (Kitcher, 2011). A popular belief regarding moral evolution is that some behaviors and morals stem from social interactions and situations of our extinct human ancestors. Modern humans and their extinct ancestors are social beings that benefited from cooperation with others, and they struggled when cooperation failed. According to evolutionary theorists Sam Bowles and Jung Kyoo Choi, conflicts between groups of our ancestors arose due to scarce resources. Bowles and Choi used mathematical models to prove that these conflicts were required for parochialism[8] and altruism to emerge in the human species (Christakis, 2019).

Genetic Influences

Author Nicholas A. Christakis in his book, *Blueprint: The Evolutionary Origins of a Good Society*, claims that genes are the source of our common humanity. Christakis also states that genes affect the structure and function of our bodies, minds, and behaviors. It is known that genes carry specific genetic codes to construct proteins and that these proteins are responsible for regulating the functioning of the body's tissues and organs. Beyond this, however, is the ability for genes to indirectly influence the personality traits and behaviors of humans. Due to the connection between genes and both physical and psychological aspects of humans, DNA analysis has become a new way for researchers to analyze the origins of *Homo sapiens*. As previously mentioned, although Neanderthals share most of their DNA with *Homo sapiens*, they did not prevail.

It has been found that Neanderthal genomes imparted both advantages and disadvantages for survival. Because Neanderthals and *Homo sapiens* interbred, there exists a small percentage of Neanderthal DNA in the population today, and since these genes have continued throughout

[7] Acting with concern for the well-being of others.
[8] Hostility towards individuals who do not belong to one's own racial, ethnic, or other group

the years, they must have important advantageous qualities. For example, early humans were hunter-gatherers and some Neanderthal genes may have helped them cope with starvation. Now, however, modern humans have more access to calorie rich foods, making the purpose of these specific genes unnecessary for some. However, not all humans have access to such foods and nearly 795 million people in the world are going hungry. According to the Food Aid Foundation, Africa has the highest prevalence of hunger and Sub-Saharan Africa has the highest percentage in their population of people going hungry. Data shows that in this region, one in every four humans is undernourished. Interestingly, one research study found that 0.3% of an African's genome is made up of Neanderthal DNA (Price, 2020). Evidence showed that Neanderthal genes may actually have been selected upon entering the genome. One of these genes boosts the function of the immune system (Price, 2020) and it makes sense that individuals suffering from hunger would have these Neanderthal genes, because it is known that these genes were useful to fight starvation in the past. As hunter-gatherers, it was typical of ancient humans to go a few days without food. Once achieving a successful hunt, they would make this food last for days (Hogenboom, 2015).

Although some humans may benefit from Neanderthal DNA, this is not always the case. For modern humans living in Western societies, it is more likely that Neanderthal genes make them more prone to diseases such as Crohn's, Type II diabetes, and urinary tract disorders (Vince, 2017). This is due to the fact that these Neanderthal genes did not evolve for humans who have access to plentiful food on a daily basis. Because of this, these genes turn into disadvantages because there is no use for their original purpose. While genes are not always a direct cause of disease, some can make individuals who possess them more susceptible to their pathology.

Pair-Bonding

While monogamy is a well known practice for many modern humans, it is not as common in other animal species. In fact, of 5000 mammalian species, only 3-5% are known to form permanent pair-bonds[9] (Than, 2006). One explanation for why pair-bonding emerged, is that humans co-parent. A human pair-bond is often seen as a parental partnership (Chapais, 2008). With two parents working together, the work involved in raising offspring is shared, rather than bared solely by the mother. This became a necessary adaptation for early humans as more investment was needed to raise children (Fletcher, Simpson, Campbell, and Overall, 2015). As evolution further advanced the human species, it would follow that children would need more intense care than those of our chimpanzee relatives, for example. It is also believed that pair-bonding facilitated social intelligence and cooperative skills (Fletcher, Simpson, Campbell, and Overall, 2015). In addition, pair-bonding also decreased the need for mate competitions and mate-search mechanisms, which is clear today in modern human society.

Although long-term relationships are more common today, it was not always the case for species to form lifelong partnerships. Another claim regarding the switch to monogamous relationships is that they may have been a result of environmental pressures and variability in food sources (Christakis, 2019). Further insight into this matter deals with a concept known as “exaptation[10]”. In several species outside of humans, parents hold a special bond with their offspring. Some of these species include wolves, elephants, lions, and our chimpanzee relatives. According to Jane Goodall’s research, nurturing and comforting others is a natural chimpanzee instinct (Najarian, 2018). Chimpanzees display strong bonds with not only their own offspring,

9 A scientific term used to describe mating patterns that are typically permanent in nature.
10 The evolutionary process in which a trait evolves for one purpose, eventually coming to serve other purposes.

but with orphans as well. Studies show that chimpanzees sometimes take orphaned chimps in as their own. This is highly comparable to modern humans adopting children. Using the theory of exaptation, the pair-bond between mother and child may have evolved further into pair-bonding between mates (Christakis, 2019). The similar parenting patterns between chimpanzees and humans further supports the claim that evolution plays a role in modern human's relationships with others.

One of the most universal feelings felt around the world is love. It is believed that this feeling emerged from the ancient and natural disposition to form pair-bonds (Christakis, 2019). This desire to form pair-bonds is believed to stem from the fact that love is connected to commitment. Temper tantrums are a common occurrence amongst children today and are expressed as a result of not having their needs met. Similarly, chimpanzees and other primates have been known to show anger and then look towards their mother or caretaker in order to gage a possible reaction or level of attention (Wright, 1994). In response to these actions, it has been observed that chimpanzee mothers comfort their babies just as human mothers do. Psychology analyzes tantrums as a display of conflict that the baby feels towards its mother, and it is believed that this conflicted feeling is a crucial step in child development (Yoshihara, 1991). The significance of this is the connection it establishes between modern humans and their early ancestors. If both chimpanzees and humans display certain similar traits, it leads to the plausible notion that their common ancestor must have practiced similar behaviors, or, possessed certain genes that could facilitate them through evolution.

For both physical and behavioral traits, natural selection plays a significant role. Genes that influence human behavior have been passed on by the human ancestors through generations, and the environment can affect genes in several different ways. Specifically, events in the nucleus of a cell have an impact on how genes become translated into different proteins. These proteins can then be influenced by the cellular environment located outside of the nucleus, and this cell environment can affect how specific proteins function. Even the environment in which *Homo sapiens* and other species live can change how genes are expressed or activated (Christakis, 2019). Referring back to the concept of pair-bonding, one study found that a neurotransmitter known as vasopressin may influence a species' decision to form pair-bonds. AVPR1A, otherwise known as arginine vasopressin receptor 1A, is a protein coding gene. A study involving twins and their spouses revealed that an allele variant called 334 in the vasopressin-gene receptor, corresponds to decreased pair-bonding in men. In this study, men who did not possess allele 334 had stronger feelings towards their spouses, as well as fewer marriage problems. In fact, it was found that possessing allele 334 doubles the risk of facing a marriage crisis. While other genes likely play a role in pair-bonding behaviors as well, this study demonstrates the link between genes and the evolution of pair-bonding and other social behaviors.

In addition to love, the formation of friendships is another important aspect of being human. *Homo sapiens*, however, are not the only species who display acts of friendship. Some of our closest living relatives, the chimpanzees, have been found to display friendly behavior and they can form life-long friendships. Typical displays of friendly behavior in chimpanzees involve grooming, sharing food, and protecting territories. Long-term observation of a group of nearly 50 chimpanzees in Uganda, revealed the formation of bonds between unrelated chimps. Because displays of friendship in other animal species are rare, it is significant that a species humans share 98.8% of their DNA with, are one of the few to possess such a behavior. In his book, Christakis explains that forming friendships is a way of forming morals as well. When thinking of a best friend, feelings of happiness, commitment, love, and respect come to the surface. The ability to express service, love, kindness, and happiness towards others are defining characteristics of morality. In this way, friendship also helps pave the way for morality (Christakis, 2019).

One explanation for modern social behavior involves how the early humans obtained and consumed food. In contrast to the ape relatives, early humans hunted and gathered food in groups, rather than alone. In fact, fossil records reveal that as far back as 400,000 years ago, humans worked together to obtain food. This behavior evolved into farming and cooking with companions. Today, cooking is very much a social behavior and is often done with a friend or in groups, which is the same habit exhibited by our early ancestors. It is believed early *Homo sapiens* developed shared cooking behaviors out of necessity due to a lack in fruits and vegetables (Smith, 2015) but, in the end, regardless of whether this social behavior emerged from necessity or choice, it still played a role in shaping the social behaviors of *Homo sapiens* today.

Artifacts that Provide Insight into Human Behavior

Another way to study the origins of modern human behaviors is to analyze different tools and artifacts from past times. Researchers typically characterize modern behavior as including language, art, creative and innovative culture, religion, and technology (Wurz, 2012). One of the strongest indicators of the beginning of modern behavior is the use of symbolism. It is believed that the origin of creative thought emerged in Africa and expanded from there (Jabr, 2014). On the southern coast of South Africa, located at Blombos cave, scientists discovered shell beads. These beads are significant because evidence shows they were used for personal ornaments between 100,000 and 70,000 years ago (Wurz, 2012). Also found in the Blombos cave was a

100,000-year-old paintbrush made from animal bones and abalone shells used for paint palettes (Jabr, 2014). Along with this was an ocher[11] slab that contained geometric engravings thought to be 75,000 years old. Further evidence of modern behaviors was also located in a cave at the southern point of Africa. The evidence revealed that humans had been turning animal bones into awls[12] and had polished weapon points over 70,000 years ago (Wilford, 2002). The significance in this discovery is that the making of these particular stone tools required an advanced level of intelligence and skill than the making of more basic stone tools. These cave finds were significant because they shed light on the origins of modern human creativity. Creativity plays a major role in the lives of *Homo sapiens* today in our hobbies, passions, or careers, and is a key trait of being human. So, early *Homo sapiens* displayed signs of intelligence and possibly symbolic thinking, but how did they evolve into the highly social humans of today? Being able to narrow down the time frame in which modern behaviors started appearing allows scientists to further their investigation into the evolution of modern behavior.

Figure 6. First known complex compound of abalone shells and bones believed to have held paint (Science/AAAS).

Humanity's Great Leap

An evolutionary concept known as the Great Leap Forward is used to describe the period in which early human capabilities and consciousness abruptly developed at a significant rate around 40,000 years ago (Diamond, 1992). It is believed that during this leap, a sudden change occurred that resulted in the transition from ancient to modern *Homo sapiens*. Evidence of such

[11] A natural earth pigment made from ferric oxide, clay, and sand. Can be yellow, deep range, or brown.
[12] A small pointy tool used for piercing holes, especially in leather.

an event includes paintings, tools, and fossils. A change in behavior is a likely contender for this leap to modern and innovative humans (Diamond, 1992). Specifically, this behavioral change may have emerged as a result of enhanced language. The ability for humans to use complex language likely arose as a result of genetic changes that influenced developments in the larynx, tongue, and vocal tract (Diamond, 1992). It is the evolution of language that is believed to have been a vital attribute to the development of cognitive functions in *Homo sapiens* (Lewin, 1998). Complex language is a defining factor of being human, and it can be theorized that because humans developed these unique traits, they survived conditions our early human ancestors could not.

The Generalist Specialist

It is also known that humans used stone tools and controlled fire, however, as previously noted, the same is known for other early human ancestors as well. One of the most telling pieces of evidence in addition to language, is the ability for *Homo sapiens* to adapt to a significant number of different environments and climates. This theory caused scientists to nickname *Homo sapiens* as "Generalist Specialists" (Tarlach, 2018). Displayed in figure 5 is a map created by two scientists, Roberts and Stewarts (2018). This map is meant to project the hypothesized ranges of archaic humans across the globe. The significance of this is how much land *Homo sapiens* were able to cover. In the arctic, the

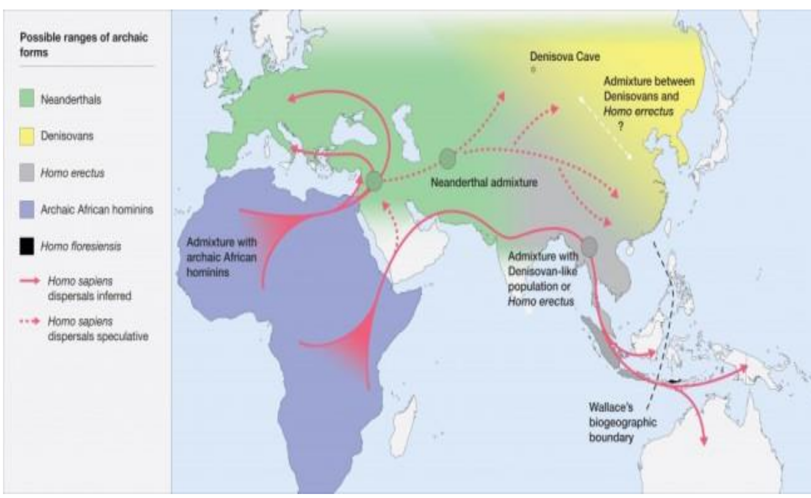

Figure 5. Generated map of the possible ranges of archaic forms across the globe (Roberts & Stewart, 2018).

deserts, treeless high-altitude plateaus, and dense tropical rainforests, *Homo sapiens* appeared (Tarlach, 2018). The fact that *Homo sapiens* were able to adapt to an array of challenging and different environments is likely the reason they survived while other early humans went extinct when their climates or environments changed. Furthermore, this “generalist specialist” quality has clearly persisted to today. Currently, *Homo sapiens* are able to move around the world by their own will and successfully adapt to different environments and climates. Without this ability, it is likely there would be no modern humans.

Conclusion

Around 2.3 to 1.4 million years ago, *H. habilis*, the earliest species of the *Homo* clan, emerged and paved the way for the remaining early humans. The genes, anatomy, and behaviors of this species played a role in the development of modern humans today. However, there are many factors that influence the morals and behaviors of modern *Homo sapiens* such as psychology, sociology, and religion. The ability for current humans to practice religion, have complex thoughts, and cultures, all stems from the evolution of our species. Fossil evidence and bone discoveries prove that early humans evolved to become the very people who inhabit today’s Earth.

Our morals and behaviors are influenced by a combination of several factors. Social interactions between parents and children or parents and other people have been influenced by evolution. The social situations that early humans faced, the climates that they were forced to adapt to, and the bonds they made with each other all facilitated the formation of the physical and psychological traits that exist in modern humans. The study of evolution provides insight into a very long story of how the world’s modern *Homo sapiens* became the people they are today.

References

Alex, B. (2018). *Neanderthal brains: Bigger, not necessarily better*. Discover Magazine. https://www.discovermagazine.com/planet-earth/neanderthal-brains-bigger-not-necessarily-better

Balzeau, A., Gilissen, E., & Grimaud-Hervé, D. (2012). Shared pattern of endocranial shape asymmetries among great apes, anatomically modern humans, and fossil Hominins. *PLoS ONE*, *7*(1). NCBI. https://doi.org/10.1371/journal.pone.0029581

Barras, C. (2017, May 18). *We have still not found the missing link between us and apes*. BBC Earth. http://www.bbc.com/earth/story/20170517-we-have-still-not-found-the-missing-link-between-us-and-apes

Brunet, M., Guy, F., Pilbeam, D., Mackaye, H. T., Likius, A., Ahounta, D., Beauvilain, A., Blondel, C., Bocherens, H., Boisserie, J.-R., De Bonis, L., Coppens, Y., Dejax, J., Denys, C., Duringer, P., Eisenmann, V., Fanone, G., Fronty, P., Geraads, D., & Zollikofer, C. (2002). A new hominid from the upper miocene of Chad, central Africa. *Nature*, *418*(6894), 145–151. https://doi.org/10.1038/nature00879

Burini, R. C., & Leonard, W. R. (2018). The evolutionary roles of nutrition selection and dietary quality in the human brain size and encephalization. *Nutrire*, *43*(1). Springer Link. https://doi.org/10.1186/s41110-018-0078-x

Chapais, B. (2009). Primeval kinship: How pair-bonding gave birth to human society. In *Google Books*. Harvard University Press. https://books.google.com/books?hl=en&lr=&id=Iyuldm37mEUC&oi=fnd&pg=PR7&dq=pair-bonding+in+great+apes&ots=SN-

PNvUWjb&sig=XiJ2x8I2HSLSKgFVHpaZaLtozjg#v=onepage&q=pair-bonding&f=false

Choi, C. Q. (2017, August 10). Fossil reveals what last common ancestor of humans and apes looked liked. *Scientific American*. https://www.scientificamerican.com/article/fossil-reveals-what-last-common-ancestor-of-humans-and-apes-looked-liked/

Choi, J.-K., & Bowles, S. (2007). The Coevolution of Parochial Altruism and War. *Science, 318*(5850), 636–640. ResearchGate. https://doi.org/10.1126/science.1144237

Christakis, N. A. (2019). *Blueprint* (pp. xxi, 131, 172, 182, 183, 188, 239, 273). Hachette Book Group.

Department, A. (2019). *Homo rudolfensis*. Efossils.Org; eFossils Resources. http://www.efossils.org/species/homo-rudolfensis

Diamond, J. (1992). *The Third Chimpanzee*. HarperCollins Publishers.

Dunsworth, H. M. (2010). Origin of the Genus Homo. *Evolution: Education and Outreach*, *3*(3), 353–366. Springer Link. https://doi.org/10.1007/s12052-010-0247-8

Emily Esfahani Smith. (2015, December 2). *Is human morality a product of evolution?* The Atlantic; The Atlantic. https://www.theatlantic.com/health/archive/2015/12/evolution-of-morality-social-humans-and-apes/418371/

FitzPatrick, W. (2016). *Morality and evolutionary biology* (E. N. Zalta (ed.)). Stanford Encyclopedia of Philosophy; Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/entries/morality-biology/#ExpOriMorPsyAltEvoNorGui

Fletcher, G. J. O., Simpson, J. A., Campbell, L., & Overall, N. C. (2015). Pair-Bonding, romantic love, and evolution. *Perspectives on Psychological Science*, *10*(1), 20–36. NCBI. https://doi.org/10.1177/1745691614561683

Food Aid Foundation. (2019). *World hunger statistics*. Food Aid Foundation. https://www.foodaidfoundation.org/world-hunger-statistics.html

Fran, D. (2018). *Homo sapiens – modern humans*. The Australian Museum. https://australianmuseum.net.au/learn/science/human-evolution/homo-sapiens-modern-humans/

Garvey, B. (2018). The evolution of morality and its rollback. *History and Philosophy of the Life Sciences*, *40*(2). NCBI. https://doi.org/10.1007/s40656-018-0190-5

Genetics Home Reference. (2002). *What are proteins and what do they do?* Genetics Home Reference; NIH. https://ghr.nlm.nih.gov/primer/howgeneswork/protein

Gilpin, W., Feldman, M. W., & Aoki, K. (2016). An ecocultural model predicts Neanderthal extinction through competition with modern humans. *Proceedings of the National Academy of Sciences*, *113*(8), 2134–2139. https://doi.org/10.1073/pnas.1524861113

GROVES, C. (2007). The Homo floresiensis controversy. *HAYATI Journal of Biosciences, 14*(4), 123–126. ScienceDirect. https://doi.org/10.4308/hjb.14.4.123

Harris, S. (2010). *The Moral Landscape* (pp. 65). Simon & Schuster, Inc.

Hendry, L. (2018). *Australopithecus afarensis, Lucy's species*. Natural History Museum. https://www.nhm.ac.uk/discover/australopithecus-afarensis-lucy-species.html

Hendry, L. (2019). *Bringing a Neanderthal to life: the making of our model*. Natural History Museum. https://www.nhm.ac.uk/discover/bringing-a-neanderthal-to-life-the-making-of-our-model.html

Hill, K., Barton, M., & Hurtado, A. M. (2009). The emergence of human uniqueness: Characters underlying behavioral modernity. *Evolutionary Anthropology: Issues, News, and Reviews*, *18*(5), 187–200. https://doi.org/10.1002/evan.20224

Hogenboom, M. (2014). *The "Lucy" fossil rewrote the story of humanity*. BBC. http://www.bbc.com/earth/story/20141127-lucy-fossil-revealed-our-origins

Hogenboom, M. (2015). *What did the Neanderthals do for us?* Bbc.Com; BBC. http://www.bbc.com/earth/story/20151116-what-did-the-neanderthals-do-for-us

Holowka, N. B., & Lieberman, D. E. (2018). Rethinking the evolution of the human foot: insights from experimental research. *Journal of Experimental Biology*, *221*(17). The Company of Biologists. https://doi.org/10.1242/jeb.174425

Hominid brain evolution. (2013). In *A Companion to Paleoanthropology* (pp. 136–159). Blackwell Publishing Ltd. https://www.iu.edu/~cogevol/pdfs/Research_Publications/schoenemann-hominid-brain-evol-2013.pdf

Homo (genus) - New World Encyclopedia. (n.d.). Www.Newworldencyclopedia.Org. https://www.newworldencyclopedia.org/entry/Homo_(genus)

Jabr, F. (2014, December 5). Hunting for the origins of symbolic thought. *The New York Times*. https://www.nytimes.com/2014/12/07/magazine/hunting-for-the-origins-of-symbolic-thought.html

Kappelman, J., Ketcham, R. A., Pearce, S., Todd, L., Akins, W., Colbert, M. W., Feseha, M., Maisano, J. A., & Witzel, A. (2016). Perimortem fractures in Lucy suggest mortality from fall out of tall tree. *Nature*, *537*(7621), 503–507. https://doi.org/10.1038/nature19332

Ko, K. H. (2016). Hominin interbreeding and the evolution of human variation. *Journal of Biological Research-Thessaloniki*, *23*(1). NCBI. https://doi.org/10.1186/s40709-016-0054-7

Lewin, R. (1998). *Review : The great leap forward*. NewScientist; New Scientist. https://www.newscientist.com/article/mg15721225-200-review-the-great-leap-forward/

Lewis, J. E., & Harmand, S. (2016). An earlier origin for stone tool making: implications for cognitive evolution and the transition to Homo. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *371*(1698). NCBI. https://doi.org/10.1098/rstb.2015.0233

Martin, A. (2017, February 23). *DNA research shows modern Humans benefit from Neanderthal DNA.* San Francisco CBS. https://sanfrancisco.cbslocal.com/2017/02/23/dna-research-show-modern-humans-benefit-from-neanderthal-dna/

McHenry, H. (2019). Homo heidelbergensis | Height, Brain Size, & Characteristics. In *Encyclopædia Britannica*. Encyclopædia Britannica, Inc. https://www.britannica.com/topic/Homo-heidelbergensis

McKie, R., & editor, O. science. (2017, November 19). How a DNA revolution has decoded the origins of our humanity. *The Observer*. https://www.theguardian.com/science/2017/nov/19/human-evolution-dna-revolution-mapping-genome

Middleton, A. (2016). *Lucy's bone scans point to life in the trees*. Cosmos: The Science of Everything; Cosmos Magazine. https://cosmosmagazine.com/archaeology/lucy-s-bone-scans-point-to-life-in-the-trees

Modern human brain organization emerged only recently. (2018). Www.Mpg.De; Max Planck Institute for Evolutionary Anthropology. https://www.mpg.de/11883269/homo-sapiens-brain-evolution

Montgomery, S. (2018). Hominin Brain Evolution: The Only Way Is Up? *Current Biology*, *28*(14), R788–R790. ScienceDirect. https://doi.org/10.1016/j.cub.2018.06.021

Najarian, O. (2018, June 29). *The Unique and Fascinating Lives of Chimpanzee Moms*. Jane Goodall's Good for All News; Jane Goodall Institute. https://news.janegoodall.org/2018/06/29/the-unique-and-fascinating-lives-of-chimpanzee-moms/

National Academy of Sciences (US, Avise, J. C., & Ayala, F. J. (2010). *The difference of being human: Morality*. NCBI; National Academies Press (US). https://www.ncbi.nlm.nih.gov/books/NBK210003/

NCBI. (2020, March). *AVPR1A arginine vasopressin receptor 1A [Homo sapiens (human)] - gene - NCBI*. Www.Ncbi.Nlm.Nih.Gov; NCBI. https://www.ncbi.nlm.nih.gov/gene/552

Neubauer, S., Hublin, J.-J., & Gunz, P. (2018). The evolution of modern human brain shape. *Science Advances*, *4*(1), AAAS. https://doi.org/10.1126/sciadv.aao5961

New World Encyclopedia. (n.d.). *Human evolution - New World Encyclopedia*. Www.Newworldencyclopedia.Org. https://www.newworldencyclopedia.org/entry/Human_evolution

Origins of man. (n.d.). BioNinja; BioNinja. http://www.vce.bioninja.com.au/aos-4-change-over-time/hominid-evolution/origins-of-man.html

Pappas, S. (2011). *Oldest human paint-making studio discovered in cave*. Live Science. https://www.livescience.com/16538-oldest-human-paint-studio.html

Phillips, K. A., & Sherwood, C. C. (2007). Cerebral petalias and their relationship to handedness in capuchin monkeys (Cebus apella). *Neuropsychologia*, *45*(10), 2398–2401. NCBI. https://doi.org/10.1016/j.neuropsychologia.2007.02.021

Price, M. (2020, January 30). *Africans carry surprising amount of Neanderthal DNA*. Science Magazine; AAAS. https://www.sciencemag.org/news/2020/01/africans-carry-surprising-amount-neanderthal-dna#

Rosati, A. (2018, February 26). Food for thought: was cooking a pivotal step in human evolution? *Scientific American*. https://www.scientificamerican.com/article/food-for-thought-was-cooking-a-pivotal-step-in-human-evolution/

Schulkin, J. (2016). Evolutionary Basis of Human Running and Its Impact on Neural Function. *Frontiers in Systems Neuroscience*, *10*(59). NCBI. https://doi.org/10.3389/fnsys.2016.00059

Smithsonian's National Museum of Natural History. (2010, March). *Species*. The Smithsonian Institution's Human Origins Program. http://humanorigins.si.edu/evidence/human-fossils/species

Stromberg, J. (2013). *Science shows why you're smarter than a Neanderthal*. Smithsonian Magazine. https://www.smithsonianmag.com/science-nature/science-shows-why-youre-smarter-than-a-neanderthal-1885827/

Szalay, J. (2017, December 21). *Neanderthals: Facts About Our Extinct Human Relatives*. Live Science; Live Science. https://www.livescience.com/28036-neanderthals-facts-about-our-extinct-human-relatives.html

Tarlach, G. (2018). *The generalist specialist: Why Homo sapiens succeeded*. Discover Magazine; Discover Magazine. https://www.discovermagazine.com/planet-earth/the-generalist-specialist-why-homo-sapiens-succeeded

Than, K. (2006). *Wild sex: Where monogamy is rare*. Live Science. https://www.livescience.com/1135-wild-sex-monogamy-rare.html

Trinkaus, E. (2011). *Vindija | anthropological and archaeological site, Croatia*. Encyclopædia Britannica; Encyclopædia Britannica, Inc. https://www.britannica.com/place/Vindija

University of New York. (2018, October). *Neanderthal healthcare practices crucial to survival*. ScienceDaily; University of New York. https://www.sciencedaily.com/releases/2018/10/181004110042.htm

Vince, G. (2017). *Neanderthals live on in human genes—but we're only beginning to understand how they shaped us*. Quartz. https://qz.com/925971/neanderthals-live-on-in-human-genes-but-were-only-beginning-to-understand-our-ancient-ancestors/

What Was "Lucy"? Fast Facts on an Early Human Ancestor. (2018, January 16). National Geographic; National Geographic Staff. https://www.nationalgeographic.com/news/2006/9/lucy-facts-on-early-human-ancestor/

White, T. D. (2019, October 4). *Ardipithecus: The discovery of Ardipithecus*. Encyclopædia Britannica; Encyclopædia Britannica, inc. https://www.britannica.com/topic/Ardipithecus/The-discovery-of-Ardipithecus

Wilford, J. N. (2002, February 26). When humans became human. *The New York Times*. https://www.nytimes.com/2002/02/26/science/when-humans-became-human.html

Wrangham, R. (2009, May 23). 'Catching fire.' *The New York Times*. https://www.nytimes.com/2009/05/27/books/excerpt-catching-fire.html

Wright, R. (1995). *The Moral Animal* (pp. 167). Random House Inc. (Original work published 1994)

Wurz, S. (2012). *The Transition to Modern Behavior | Learn Science at Scitable*. Nature; Nature Education Knowledge. https://www.nature.com/scitable/knowledge/library/the-transition-to-modern-behavior-86614339/

Yoshida, H., Norikoshi, K., Kitahara, T., & Yoshihara, K. (1991). A study of the mother-infant relationships of chimpanzees (pan troglodytes) during the first four years of infancy in tama zoological park. *Japanese Journal of Animal Psychology*, *41*(2), 88–99. https://doi.org/10.2502/janip.41.88