SAPIENT

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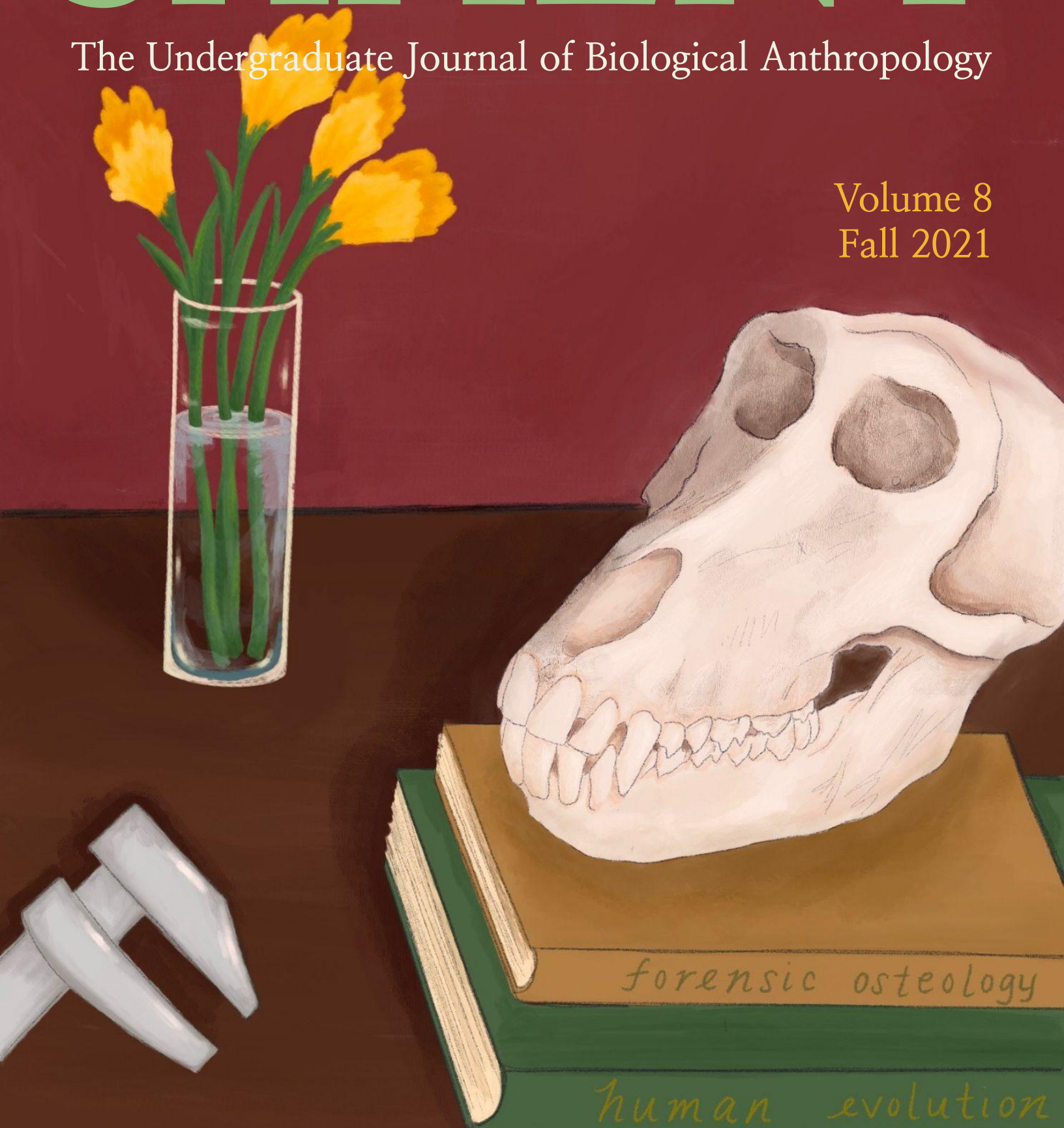

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Sapient is Columbia University's peer-reviewed journal of biological anthropology. It was founded in 2012 to give undergraduates from Columbia a place to share and reflect on bioanthropological work of academic and artistic merit. For questions, comments, or to get involved, visit sapientjournal.com.

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Front cover by Aeja Rosette
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The editors of *Sapient* extend our gratitude to the Columbia University Department of Ecology, Evolution, and Environmental Biology for its support. We specifically would to thank Professor Shahid Naeem, Department Chair; Kyle Bukhari, Director of Administration and Finance; Alexandra Vamanu, Financial Assistant; and Professor Jill Shapiro, Director of Undergraduate Studies for the Evolutionary Biology of the Human Species program.

Emma Gometz

LETTER FROM THE EDITOR

Dear reader,

On behalf of the editorial board and our faculty advisor Dr. Jill Shapiro, I am proud to share the eighth volume of *Sapient*, Columbia University's Undergraduate Journal of Biological Anthropology. The papers included in our Fall 2021 edition showcase impressive and thought-provoking research by undergraduate biological anthropology students from Columbia and other institutions around the country.

Nine years ago, the founding editors of *Sapient* set out to encourage intellectual curiosity in biological anthropology, with a particular focus on four specific domains: human variation and genetics; evolutionary history and theory; primate behavior and ecology; and paleoarchaeology and morphology. *Sapient*'s goal has always been to include compelling papers on a wide range of topics, and we hope that this issue does so as well as previous volumes have.

Unlike the editions before it, *Sapient*'s eighth volume is the product of more than a year of working exclusively online—virtually holding meetings, editing papers, and reviewing the issue's visual art. Despite the imperfections of running a campus journal remotely, *Sapient* has seen a number of successes in the last year, including receiving the greatest number of written submissions in the journal's recent history. This abundance of interest has made for an excellent edition, and I am proud to publish every work in this volume.

As *Sapient*'s longest-running editor in chief, I am also proud of how the journal has grown since the beginning of my tenure. In the last two and a half years, *Sapient* has published two volumes, held two in-person events for Columbia's EBHS community, introduced a new focus on visual art, updated its website, and created stickers to promote the journal. None of these developments would have been possible without the creativity and enthusiasm of Emma Gometz and Aeja Rosette, to whom I am extremely grateful. I am eager to see how the journal flourishes under Aeja's leadership this year.

To those reading this volume: thank you for making our work worthwhile. We hope you appreciate the eighth edition of *Sapient* as much as we enjoyed creating it.

Ruby Mustill
Editor-in-Chief

Emma Gometz

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Madeline Cheshire, Johns Hopkins University

Introduction

Swiss writer Johann Caspar Lavater (1741-1801) defined physiognomy as "the science or knowledge of the correspondence between the external and internal man, the visible superficies and the invisible contents" (Lavater, 1850). Although physiognomic analysis was first performed in Ancient Greece, it peaked in popularity in Europe between the late 18th century and early 19th century, following the publication of Lavater's *Essays on Physiognomy: Designed to Promote the Knowledge and Love of Mankind*. Focusing strictly on the qualities of the head and facial structure, Lavater proposed a system of understanding human faces as a reflection of the inner soul. The soul, in Lavater's mind, was inextricably connected to God, and thus the face represented a person's inner spirituality (Lavater, 1850). A physiognomically favored face would represent a soul of the greatest moral worth, externalized in features close to the divine ideal. Lavater's ideas spread across Europe, translated into many languages and expanded upon by other thinkers with a religious bent (Graham, 1961). Through its simultaneous claim of scientific legitimacy and reliance on classic religious tenets, physiognomy served as a transitional science, uniting theologism with the biological developments of the 18th century.

Despite the supposed objectivity of physiognomy, physiognomic classifications were markedly ambiguous and contradictory, relying heavily on racial biases rather than true scientific evidence. Published physiognomic analyses asserted that there was a scientific basis for the inferiority of certain classes and races, amplifying existing biases held by the European upper class. Lavater's physiognomy—and the consequential spread of physiognomic thought across Europe—uniquely succeeded because of its accessibility to the general European public, who were reluctant to accept modern materialist sciences over an orthodox perception of humanity (Hartley, 2010). Physiognomy allowed pseudo-scientists to legitimize the existing social hierarchies of Europe, encouraging the subjugation of the marginalized through the act of likening minority races to beasts (Walker, 1834; White, 1799). Physiognomy's acceptance into the European consciousness ultimately allowed for the rise of more objective scientific theories, such as Darwin's theory of evolution (Jann, 1992).

Beginnings

One of the first recorded instances of physiognomic analysis is the Greek treatise *Physiognomonica,* attributed to Aristotle but more recently believed to be the work of an unknown author from around 300 BC (Brennan, 2006). The author asserted that the facial features of animals and humans alike could reflect the inner soul and spirit, and proposed a schematization of nature based on physiognomic principles (Jann, 1992). As a consequence of the treatise, physiognomy became popular in the Classical era, with many famous thinkers accepting physiognomic principles; for example, mathematician Pythagoras apparently used physiognomy to determine which students to take on (Shortland, 1986). Physiognomic study continued scarcely in Europe through the centuries, with a small spike in popularity during the Renaissance (Hartley, 2010). It was not popularly considered a legitimate scientific discipline, however, until the publication of Lavater's *Essays* (Hartley, 2010).

Physiognomic study offers a unique conception of human nature. Lavater, a poet and theologian, placed great value on the "art" of physiognomy, casting the face as a representation of "the origin of all human decisions, efforts, actions, expectations, fears, and hopes" (Lavater, 1850, p. 6). Lavater saw the face as an externalization of the morality and spirituality of every human (Stemmler, 1993). From his perspective, each man is made of three primary components: "the animal, the intellectual, and the moral" (Lavater, 1850, p. 6). The three are united within the body, forming one whole; however, each part of the self resides in a different part of the material body (Lavater, 1850, p. 9). The animalistic or "physiological" component is ubiquitous throughout the body, but most prominent in the limbs (Lavater, 1850, p. 9). The "intellectual life, or the powers of the understanding and the mind" are most visible through the circumference of the head and qualities of the skull (Lavater, 1850, p. 9). Finally, the moral life of man "reveals itself in the lines, marks and transitions of the countenance" (Lavater, 1850, p. 9). Lavater's ultimate goal in publishing *Essays* was to provide a normative scale of human physiognomy and to spread his blend of science and religion (Hartley, 2010).

Physiognomic analysis

Physiognomists devised extensive classification schemes for human appearances based on physical characteristics. Although Lavater focused on qualities of the head and face, there were three general forms of physiognomic analysis practiced in the 18th and 19th centuries: first, the study of the form, including lengths of limbs and sizes of muscles; second, the study of the surfaces, including hair, nails, and skin; and finally, the study of the head and face (Cope, 1883). The entirety of the body and face—including the eyes, lips, jaw, and eyebrow ridges—were highly scrutinized by physiognomic texts. In classifying cranial and facial qualities, physiognomists relied heavily on growing research into the localization of function within the brain, differentiating regions of the skull based on the corresponding brain regions they covered (Jann, 1992). The frontal region of the brain was known to perform important cognitive functions, while the hindbrain (cerebellum) was known to control motor functioning (Jann, 1992). Thus, physiognomists judged humans by the relative sizes of their foreheads and hindheads. The nose was also considered a direct reflection of the mind, as the bridge of the nose was thought to develop as a consequence of the development of the front of the cerebral part of the skull (Cope, 1883). These physical features could supposedly reveal not only the intelligence of an individual, but also their character; for example, some physiognomists posited that the arched and strong Roman nose reflected a well-developed cerebellum, indicating the "strength of will and energy" rather than intellectual prowess (Scientific American, 1857, 142). In contrast, the straight Greek nose was thought to indicate a more well-developed frontal lobe, and consequently a "refinement of character" and "love for the fine arts" (Scientific American, 1857, 142). By inferring personal traits based on physiological differences, physiognomists departed from the realm of objective science.

European rise

Following the publication of Lavater's *Essays* in 1776, the study of physiognomy exploded in popularity. Although the text was originally intended for only an upper-class, educated European audience, it eventually permeated into

greater European society (Graham, 1961). The original edition, published only in German, was expensive and thus purchased mainly by the aristocracy (Stemmler, 1993). The elaborately carved book was seen as a symbol of status and proudly displayed as such (Pearl, 2010). Knowledge of Lavater and his work initially spread very slowly: by the 1770s, only five editions of the book had been published, but by 1810, fifty-five editions had been published in six different languages (Graham, 1961). Lavater quickly became a celebrity in Europe, well-liked by the citizens of his home in Zurich. In the 1780s, he even discussed his principles of physiognomy with powerful leaders such as Emperor Joseph II and influential aristocrats like the Grand Duke of Russia and Prince Edward of England (Graham, 1961). Lavater remained a famous and influential figure in Europe until his death in 1801.

Physiognomy was quickly accepted into the collective European consciousness because of its incorporation of both religious and materialist principles (Hartley, 2010). The layperson could easily accept physiognomy, as it acknowledged the increasingly popular scientific study of human instincts while still bolstering the concept of divine creationism. The public perceived physiognomy as scientific because it suggested that the mind was integrated within the body, a materialist perspective (Hartley, 2010). At the same time, religious physiognomists like Lavater could assert that physiognomy was evidence of an active creator, who purposefully created a reflection of the mind through the face (Pearl, 2010). An 1868 article even claimed that "the Old Testament is a vast essay on physiognomy, for there the external prefigures the characteristics of the internal," portraying physiognomy as a long-held religious discipline (Anthropological Review, 1868, p. 136). This perspective greatly contrasted with that of physiological researchers, who suggested that the mind was fully integrated within the body and disconnected from spirituality. Despite the attempts of some scientific circles to explain facial expressions on a neural-muscular level, the general public was reluctant to accept the heterodox implications of physiology, instead turning to physiognomy (Hartley, 2010). Lavater was praised by the public as a "modern man" who settled the tension between materialism and theologism; rather than studying science at the expense of long-held religious principles, Lavater uniquely advocated for a study of science at the service of religion (Graham, 1961, p. 563).

The rise of physiognomy can be partially attributed to the volatile state of the European scientific community in the late 18th century. Lavater's *Essays* emerged at a key time in European scientific development, during which the scientific community engaged in extensive debate over the natural order of the world and questioned how nature affected human behavior (Hartley, 2010). At the same time, rapid industrialization and development in Europe spurred the growth of several socioeconomic classes. Physiognomy emerged as a way to bring order to a chaotic world, providing a moral framework for life based in scientific classifications (Lavater, 1850). Although the public perceived physiognomy as an objective science, it was still widely accessible; as Lavater argued, all humans judge others based on facial appearance, so all humans are capable of performing physiognomic analysis (Lavater, 1850).

Physiognomists aimed in part to reassure Europeans of humanity's inherent superiority over animals using objective measurements and classifications. Early physiognomic work highlighted the similarities between humans and animals. In 1622, *Fisonomia naturale* by Giambattista

della Porta schematized the connection between animal and human physiognomies, claiming that the character of a human could be understood based on his resemblance to certain animals (Jann, 1992). Charles LeBrun (1619-1690) similarly drew out portraits comparing men and wild animals such as lions, contending that brutish or beast-like features indicated that a human was morally unsound (Jann, 1992). Later, during the 18th century, some Europeans became offended by the growing scientific voice acknowledging the biological similarities between humans and animals, holding firmly to the orthodox view that God created humans to be superior to animals in both spirituality and intelligence (Jann, 1992). The science of physiognomy seemingly challenges this concept; if human character is biologically intertwined with animality, then the line between man and animal is blurred. Lavater reconciled the two perspectives, however, by claiming that humans had a God-given superiority over animals. He wrote, "Of all earthly creatures, man is the most perfect, the most imbued with the principles of life" (Lavater, 1850, 6). At the same time, he advocated for the study of the human face from a biological perspective, and even cited physiognomic principles as evidence of creationism. Lavater pointed out several physiological differences between humans and animals, including the monkey's lack of eyebrows, lips, and forehead (Jann, 1992). He concluded that without these characteristics, the non-human primate could never gain a human level of intelligence or spirituality (Jann, 1992). Lavater also noted a difference in facial angles between humans and animals based on the work of Dutch physician Petrus Camper (Jann, 1992). Camper had quantified facial angles, claiming that the angle created between a line drawn from the nose to the ear and a line drawn from the eye to the mouth was less than seventy degrees among animals and above eighty degrees in humans (Jann, 1992). The "ideal" facial angle was ninety degrees, attained only by the most ideal Greek heads. Lavater included the concept of facial angle in his *Essays* as proof that God structured all species hierarchically, with the increasing facial angle representing a continuum from primitive animal to ideal human (Lavater, 1850). Once the hierarchy of nature was established, and readers were assured that animals could never rival human intelligence, physiognomists were free to draw comparisons between animals and humans.

Many physiognomists classified humans based on their generalized "animalistic" nature rather than comparing humans to any particular animal (Cope, 1883). Broadly, animals were thought to house larger cerebellar regions and smaller frontal regions; thus, any human with a small forehead or large hindhead was labeled animalistic (Cope, 1883). Other physiognomists focused on the similarities between human traits and specific animals. For instance, published in 1887— relatively late for a physiognomic text—Dr. Joseph Simms's *Physiognomy Illustrated* compares several human faces to animal faces and explains how dozens of personality traits manifest within the face. In describing the trait of "demolitiousness" (the impulse to destroy), he points out the similarity in facial structure between the murderer John Webster and a tiger (Simms, 1887). In his comparisons, Simms references dozens of animal species to explain a diverse set of personality traits, from decisiveness to propensity for polygamy (Simms, 1887).

Outside of the scientific community, physiognomy was a popular yet controversial subject in contemporary media. Satirical discussions of physiognomy were published repeatedly in *The Gentleman's Magazine* (Graham, 1961).

Several fictional works of the late 18th century and the Victorian era speak of Lavater positively and incorporate physiognomic principles (Benedict, 1995). Notably, the works of author Charlotte Turner Smith contain protagonists who engage in physiognomic analysis and call themselves "Lavaterians" (Graham, 1961). The permeation of physiognomic principles in popular literature ensured that the majority of literate Europeans were familiar with Lavater's work.

Implications

The logic behind the physiognomic connection between human and animal was extended to explain the distinction between different "classes" of humans. Through physiognomy, scientists and thinkers could "objectively" distinguish the intellect and morality of Caucasians from those of the so-called "lower races." They could present humanity as a spectrum, with the socially marginalized relegated to one extreme, biologically closest to the animal. Charles White, a well-known British physician, wrote extensively on the supposed gradation of humanity, connecting man to ape:

> "Comparing the classes of mankind... they may be so arranged as to form a pretty regular gradation, in respect to differences in the bodily structure and economy, the European standing at the head, as being farthest removed from the brute creation... the African... approaches to the ape" (White, 1799, p. 83).

In justifying this gradation, White highlights several facial features he claims are shared between Africans and apes, including flattened noses and long jaws. White also asserts that "lesser races" (p. 83) and wild animals all have sharper facial angles than those of Europeans. Similarly, Scottish physiologist Alexander Walker's *Physiognomy founded upon Physiology* (1834) attempted to prove a close link between animals and minority races by claiming that both possessed smaller cerebrums and larger cerebellums. This idea of a spectrum of humanity allowed physiognomists to compare humans to animals without offending their upper-class European audiences.

Using paleontological classifications, physiognomy bolstered the existing social hierarchies of the Victorian era, advancing racism under the veil of science. Physiognomists like Lavater and the British physician James Cowles Prichard created extensive schemes of racial classifications based on head shape and size, in an attempt to prove the superiority of white Europeans over minorities. Specifically, black people, Mongols, and Aboriginal populations were referred to as "subspecies" by contemporary scientific journals. Physiognomists commonly claimed that all black Europeans and Mongols had a prominence of the jaw (prognathism), likening them to primates (Cope, 1883). Noses were also scrutinized: the bridgeless noses observed among some black populations were compared to those of primates, while Jewish noses, perceived as "hawk-like" (p. 142), were said to indicate shrewdness (*Scientific American*, 1857). In these instances and many others, physiognomic texts fueled Europeans' existing biases while dangerously masquerading as a scientific perspective.

Physiognomy's legitimization of racial bias had grave implications. Notably, English psychometrician Francis Galton combined both Darwinian and Lavaterian logic to justify physiognomy-based eugenics (Hartley, 2010). He believed that humans with the most "noble qualities" (p. 187), especially high intelligence, should be encouraged to reproduce more frequently in order to improve mankind over time (Hartley, 2010). The best way to evaluate intellect, he contended, was by studying the

face. He attempted to develop a physiognomic tool of measurement that would help track the heritability of intellect. Although Galton's eugenic plan never came to fruition, his message encouraged the continued subjugation of minorities by portraying them as biologically subhuman. Physiognomy also had applications in criminology: physician and criminologist Cesare Lombroso (1835-1909) used physiognomy to advance the idea of atavism, the notion that criminal behavior represents a reversion to "primitive" humanity (Devroye, 2010). Published in 1876, his book *The Criminal Man* had a widespread audience, with five editions translated in several European languages. Lombroso studied Italian prisons, conducting post-mortem examinations on the brains of inmates, and claimed to have discovered an opening in the skull of some criminals that had previously only been seen in animals. He viewed criminals collectively as a human subspecies, or "throwbacks" (p. 12) to an inferior version of humanity, with unique physical characteristics mirroring internal aggression and degeneracy (Devroye, 2010). Lombroso specifically implicated facial asymmetry, unusually sized cranium and ears, and swollen lips in criminality. He also distinguished between abnormal nasal structures, claiming that thieves possessed flattened noses, while murderers possessed beaklike noses (Devroye, 2010). Lombroso's research, although quickly disproven, was taken as fact by some members of law enforcement and used in criminal investigations and trials (Rafter *et al.,* 2016). The physiognomic view of criminality was especially problematic because it discouraged rehabilitation of criminals or mechanisms of deterrence, instead proposing that some humans are simply destined to be criminals and are thus incurable and undeterrable (Rafter *et al.,* 2016).

Skepticism

As physiognomy spread across Europe, periodicals and scientific journals were reluctant to outwardly support or reject the pseudoscience. Scientists skeptical of the objectivity of physiognomic scales avoided vocal dissent; the public support for Lavater and other physiognomists' work was undeniable, thus motivating publishers to discuss the arbitrary classifications (Graham, 1961). During the 1840s and 1850s, scientists expressed their discontent with—but nonetheless continued to spread—Lavater's message. For example, an 1857 issue of *Scientific American* openly acknowledged the flimsy nature of physiognomic assertions:

> "All that has yet been written on the subject, is more curious than useful, because of the infinite variety of form and expression in the human countenance, and which never can be reduced to rule nor system. However, some of the rules which have been laid down by the ablest writers on physiognomy, for judging of persons, will be of general interest to all" (*Scientific American*, 1857, 142).

Following its acknowledgement of the unreliability of physiognomy and the many exceptions to physiognomic rules, the article continues to describe several specific characteristics of the human hair, face, and nose and their purported implications for the state of mind of their bearers (*Scientific American*, 1857). The continued proliferation of physiognomic principles, even by skeptics, ensured that Lavater's legacy was kept alive throughout the 19th century.

Despite the widespread popularity of physiognomic study across Europe, the physiognomic movement was weakened by a lack of cohesion among its subscribers. Although Lavater's original presentation of physiognomy in *Essays* was decisively

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intertwined with the concept of creationism, atheist physiognomists vocally rejected the religious aspects of his texts (Stemmler, 1993). Translators often inserted their own distinct views on physiognomy in their versions of *Essays* (Stemmler, 1993). For example, atheist poet Thomas Holcroft performed the most popular English translation of Lavater's text, which dramatically secularized the original work and was eventually republished four times (Stemmler, 1993). As a result, Lavater's message was dulled as Holcroft's version spread throughout Europe (Stemmler, 1993). Another source of disagreement was the question of physiognomy's niche within the scientific community at large; while Lavater's *Essays* only focused on the shape and size of the skull, other physiognomists focused on the manifestations of human expression and facial features. Lavater disagreed with the inclusion of expression analysis under the term "physiognomy" (Lavater, 1850). He classified the study of the moving face as "pathognomy," with "physiognomy" reserved for the study of humans at rest (Lavater, 1850). Analysis of facial expressions nevertheless grew to dominate groups of physiognomists, who would create elaborate schematizations of active facial features and structures; for example, popular surgeon Charles Bell claimed in 1807 that the ability to express emotion, through physical cues such as blushing, uniquely defined humanity (Jann, 1992). Additionally, translations of Lavater's work included vastly different illustrations and text, portraying the role of environment in human expression differently in every iteration (Shortland, 1986).

A favorable replacement?

The work of 18th- and 19th-century physiognomists both encouraged widespread discussion of the roots of human behavior and increased awareness of the field of science throughout Europe (Hartley, 2010). Although physiognomy's religious overtones were diametrically opposed to the theory of evolution, the popular understanding of physiognomy helped prime the European public for the acceptance of Darwin's theory and his focus on physiology (Jann, 1992). Physiognomic study signaled the beginning of modern popular psychology, thus increasing the public's attention to the sciences and creating a more tolerant environment for Darwin's research.

Darwin's own relationship to physiognomy is complex. Although he outwardly rejected the pseudoscience, some of his research into facial expression and the basis of emotions drew inspiration from physiognomic tenets (Jann, 1992). In his work *The Descent of Man* (1889), Darwin incorporated physiognomic principles in contrasting humans with animals; for example, he likened individuals with microcephaly to monkeys and "barbarous races" (p. 87). Further, Darwin asserted that black individuals lack a certain ear lobule that distinguishes humans and gorillas, clearly playing into prejudiced physiognomic distinctions between races (Darwin, 1889). At the same time, he justified the science of facial analysis using a physiological rather than physiognomic basis (Darwin, 1889). Darwin did not reference any of physiognomy's religious connotations in explaining his claim that facial structure differed based on race (Jann, 1992). Instead, he noted that it is probably disuse rather than divine intervention that accounts for the differences in facial or cranial sizes between races (Jann, 1992). Darwin also claimed that facial expressions exist due to the adaptation of specific physiological responses rather than being an expression of human morality (Hartley, 2010), and that animals and humans have similar physiognomies simply because of

common evolutionary backgrounds (Jann, 1992). Despite the marked differences between physiognomy and Darwin's theory of evolution, physiognomy's popularity ultimately enabled the rise of Darwin's evolutionary perspective, as it allowed him to use the widely accepted physiognomic understanding of race to his advantage (Jann, 1992). As summarized by scholar Rosemary Jann in *The Victorian Review,* "Positioning savages as the missing link between animal and human helped make Darwin's argument for continuity more plausible" (Jann, 1992).

As a result of the rise of the theory of evolution, as well as the emphasis on physiology promoted by Darwin and other modern scientists, physiognomy slowly fell out of the public eye. By the mid-19th century, a growing number of scientific publications discredited physiognomy, with many likening it to the discredited popular science of phrenology (Hartley, 2010). Lombroso's physiognomic criminal theory was abandoned once and for all at a 1912 meeting of the American Institute of Criminal Law and Criminology, where Nathan William MacChesney proclaimed that "one of the most abominable heresies we have had to face in this country for some years, is the growth of the Lombroso theory, and I thank God it has been broken down and the public has repudiated it" (Devroye, 2010). Although the biases bolstered by physiognomy certainly persisted in Europe and eventually contributed to the rise of race-based eugenics, public interest in physiognomy itself dissolved by the end of the 19th century. Europe instead turned towards the physiological and evolutionary perspective proposed by Darwin and his contemporaries.

Conclusion

Physiognomic analysis of the 18th and 19th centuries objectified qualities of the mind in service of both religious and racist goals. The rise of this pseudoscience can be attributed to its entanglement with Christian theology, including creationism and the notion of human superiority over animals. Through extensive comparisons between the so-called "lesser races" and non-human animals, physiognomic analysis was ultimately used to strengthen the existing European social hierarchy. Counterintuitively, public support of physiognomy led to the acceptance of the theory of evolution, which ultimately caused the downfall of physiognomy itself. Today, most researchers subscribe to a physiological understanding of the face, studying facial expressions on a muscular level. Contemporary scientists generally agree that one's appearance is determined by genetics, rather than divine intervention. Lastly, the dominant sociological model of the relationship between mind and body is that humans assume certain personas based on their external features, molding their personalities based on social perceptions of their face (Stemmler, 1993). As such, the face may shape one's internal state, rather than the other way around.

Although physiognomy has been largely repudiated, remnants of physiognomic thought still remain in the public and scientific consciousness. Several modern researchers have attempted to identify a connection between facial features and aggressive behavior, just as physiognomists like Charles White did in the 19th century. In a 2008 study of male hockey players, Carré and McCormick (2008) reported a positive correlation between aggression and facial width-to-height ratio, quantified based on numbers of penalties received during games. Although not explicitly classifying the experiment as physiognomic analysis, the article concludes that facial structure can serve as an "honest signal" (p. 2651) of

aggressive behavior, a physiognomic claim. Another example of contemporary physiognomy is the investigation into the physical manifestations of sexual orientation; several articles published in the early 2000s attempt to correlate direction of hair whorl and homosexuality in men (Klar, 2004). Ultimately, the theory that hair growth could reflect sexual orientation was disproven (Rahman *et al.*, 2009). Although very few modern scientists proclaim themselves "physiognomists," vestiges of Lavater's pseudoscience still exist today.

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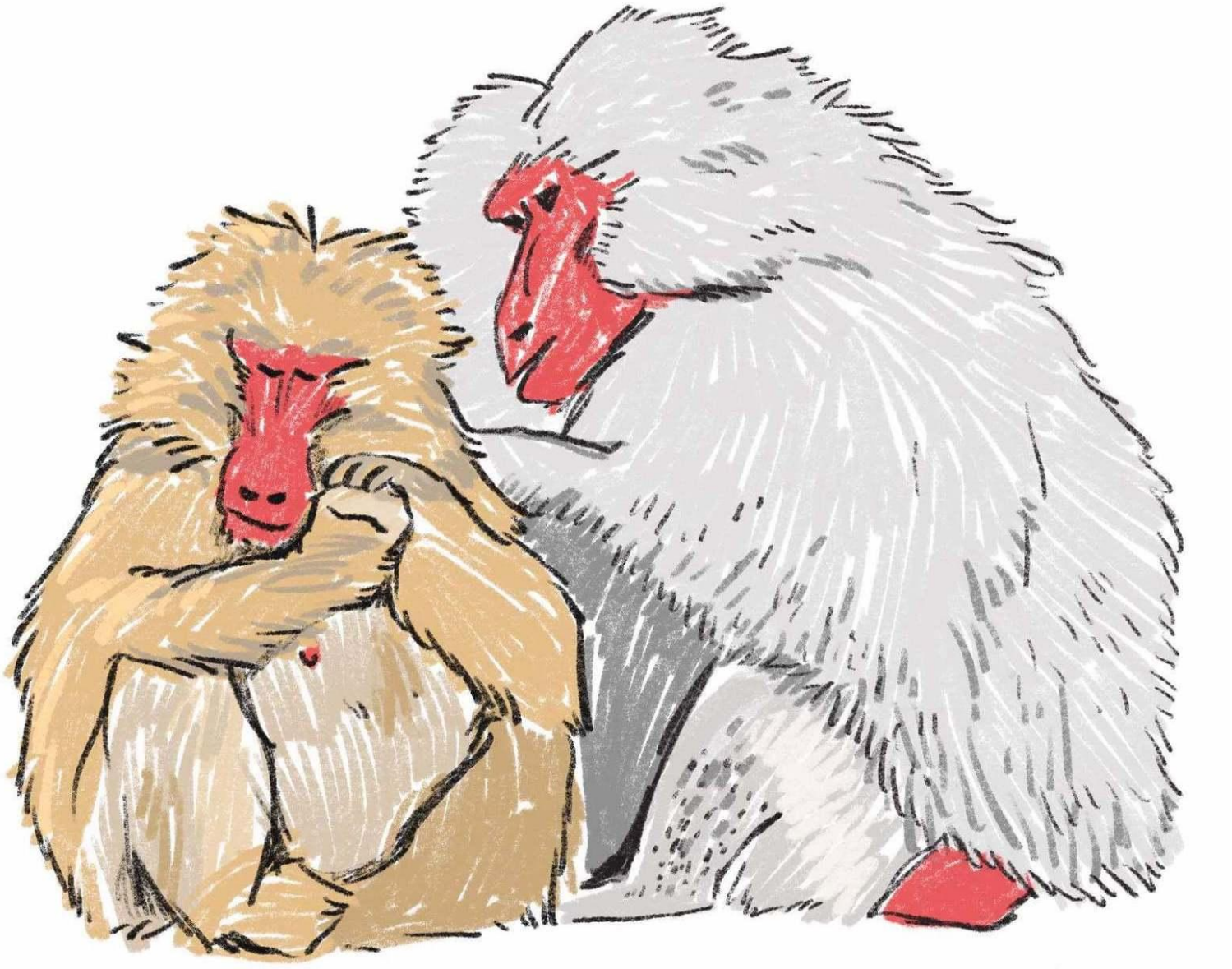

Emma Gometz

The Diversity, Costs, and Benefits of Mate Guarding in Primate Social Groups

Emma Gometz, Columbia University

Introduction

Mate guarding is a sexual behavior found in many members of the animal kingdom. Although its methods are varied, a general umbrella definition is as follows: mate guarding constitutes behaviors exhibited by a certain animal that prevent its potential mates from copulating with other partners (Alberts *et al.*, 1996; Girard-Buttoz *et al*., 2014; Muller and Wrangham, 2009). Mate guarding is more commonly exhibited by males because male reproductive success varies widely, ranging from very limited access to females to complete monopolies (Girard-Buttoz *et al*., 2014; Muller and Wrangham, 2009). A male's mating success is therefore dependent on his behavior, female choosiness, and opportunistic mating strategies, while a female's success may depend on her ability to avoid mating interactions with certain males, despite their advances (Muller and Wrangham, 2009). According to Muller and Wrangham (2009), "The result is an evolutionary arms race between the sexes, in which strategies and counterstrategies are selected to minimize reproductive costs imposed by the opposite sex" (p. 4).

Outside of the order Primates, mate guarding can take any form. The prolonged copulations of stink beetles (*Megacopta punctatissima*) during female fertile periods, for instance, ward off other mates from copulating effectively (Hosokawa and Suzuki, 2001). In crabs, male-male competition sparks an intensive time-based guarding strategy, in which males corner and sequester females away from other males during and before their short receptive periods, thus preventing other males from successfully mating (Jormalainen, 1998). Depending on the female's ability to control her access to males and the availability of males surrounding her, male mate guarding behaviors and sexual monopolization become more common strategies to increase male reproductive success in a competitive mating environment. The costs and benefits of mate guarding have been weighed in the literature, but behavioral evidence suggests that the reproductive success gained by certain males due to mate guarding behavior does not always outweigh what is lost (Alberts *et al.*, 1996).

Among highly social primates, mate guarding tactics can be more than just physical guarding. Sexual coercion is another type of guarding that primates use to control their partners. Some male primates force females to mate, or punish their refusal to mate—thus controlling female behavior and inter-sexual relations that directly affects mating success (Clutton-Brock and Parker, 1995). But females can occasionally lead the effort to mate: female bonobos, for instance, initiate mating and consequently lower rates of male conflict (Surbeck *et al.*, 2012). Mate guarding can be affiliative or aggressive, with different results. In the following section, I will discuss how the social organization of a primate species influences its mate guarding tactics.

Primate social groups: effects on mate guarding patterns

Mate guarding is an essential component of monogamous primate society. Even though many monogamous primates mate outside of their social partnership, their social dyads function to create *restrictive mating access* between the pair and allow for the benefits that accompany assured

paternity and shared territory defense (Diaz-Munoz, 2015). Among such primate species, reactions towards intruding animals, especially sexual competitors, is a crucial component of social behavior (Caselli *et al.*, 2015; Cavanaugh *et al.*, 2018). For example, Cavanaugh *et al.* (2018) showed that monogamous marmosets aggress against an extra-pair animal of the same sex faster and for longer when their mate is present than when their mate is absent. A study on black-fronted titi monkeys found that in 79% of cases, members of monogamous pairs duetted together in response to a rival's call (Caselli *et al.*, 2015). As such, mate guarding may strengthen and preserve pair-bond relationships among monogamous primates, and strategies against invaders often relate directly to the proximity of the animal's partner.

For the majority of primates living in multi-male, multi-female (M-M, M-F) social groups, politics, group size, and habitat can influence mate guarding tactics (Beehner, 2005). To further contextualize my cost-benefit analysis of primate mate guarding, I will now discuss the guarding strategies of several M-M, M-F group-living primate species.

Baboons are highly sexually dimorphic, with males outweighing females by up to 70% (Muller and Wrangham, 2009). Male hamadryas baboons (*Papio hamadryas*) are widely known to use violence to assert control over females, and to have a particularly rigid male dominance hierarchy that directly determines their ability to mate with females (Swedell, 2014). In other baboon species, there is high competition between males for mates (Swedell, 2014). Attacks between males are thought to occur in an attempt to assert dominance (which directly corresponds to access to females), while aggression between males and females may function to directly coerce the female into sexual submission (Smuts and Smuts, 1993). Among some baboons, sexual partnerships can turn over in a matter of days, making the male's active pursuit and maintenance of dominance essential to his efforts to sire the greatest number of successful offspring possible (Seyfarth, 1978). In the genus *Papio*, violent male takeovers of large troops stress the importance of male interactions, leading to forceful coercion of females and aggressive mate guarding against other males (Swedell, 2014).

In chimpanzees, fission-fusion social systems allow for a broad range of guarding methods. Females are as likely as males to fall victim to male aggression (Muller and Wrangham, 2009), and there is a higher likelihood of male-to-female aggression when females are in estrus or have a higher probability of conception (Muller and Wrangham, 2009; Stumpf and Boesch, 2010). In fact, when a male chimpanzee is cuckolded, the male is more likely to retaliate violently against the female than the rival male (Smuts and Smuts, 1993). There are ample opportunities for more covert sexual encounters between lower-ranking males and females, however, and sexual coercion is commonly used to facilitate these interactions (Smuts and Smuts, 1993). Direct coercion is somewhat rare among male chimpanzees. In Stumpf and Boesch (2010), around 12% of sexual male-female encounters involved coercion. Chimpanzees also have diverse sexual relationships, including promiscuous and freestyle mating; attempts at monopolization of a female through coercion, guarding, or violence; and weeks-long consortships between one male and one female (Smuts and Smuts, 1993). Because consortships are non-violent, they may function as a form of amiable mate-guarding. For chimpanzees, there is no one way to prevent females from engaging with other males, and abstaining from

agonistic behavior altogether is also an option.

In M-M, M-F macaque societies, dominance rank can determine access to females. High-ranking males are the most frequent perpetrators of mate guarding (Girard-Buttoz *et al.*, 2014), meaning that they reliably enjoy the highest mating success per mating season (Matsubara, 2003). There is conflicting evidence as to whether low-ranking males have developed cryptic mating strategies to defy this pattern, without needing to dominate females or guard them from other males (Ostner *et al.*, 2011; Soltis *et al.*, 1997). Macaques and chimpanzees also make use of copulatory plugs—a passive form of mate guarding in which a male's coagulated ejaculate temporarily seals a female's vaginal tract—because females of these species have a fertile period of over four days (Soltis *et al.*, 1997). The use of copulatory plugs has been attributed to high population density combined with both species' relatively low sexual dimorphism, meaning that socially aggressive means of controlling females are more difficult and costly to males (Dunham and Rudolf, 2009).

Benefits of mate guarding in primates

The most obvious benefit of mate guarding across species is that it ensures a male's paternity of as many offspring as possible (Muller and Wrangham, 2009). Opie *et al.* (2013) used phylogenetic analysis to suggest that the origins of primate monogamy—the most complete form of mate-guarding— may have been an anti-infanticide tactic. For instance, a small study of white-handed gibbons showed that 83% of infant deaths occured when a new male entered a family unit (Borries *et al.*, 2010). Even in polygynous species like the gorilla, infanticide is a selective force in group-living societies (Smuts and Smuts, 1993). Without the protection of a silverback, infants are likely to be killed by other males (Smuts and Smuts, 1993). The presence of mate guarding and possessive behavior allows males safety in their knowledge of paternity, and may also potentially allow for paternal care (Smuts and Smuts, 1993).

Another benefit of mate guarding is the potential for social bonding through cooperation, which has been seen in chimpanzees (Watts, 1998). Much like how Cavanaugh *et al.* (2018) asserts that members of monogamous species preserve their bonds by mate guarding one another, male chimps can form coalitionary groupings to monopolize the majority of a group of females, while also tolerating each other's mating activities (Watts, 1998). In fact, this may be a more successful mating strategy for chimps in larger social groups than individual male-male agonism (Watts, 1998). Although it would be impossible for one male to monopolize more than 50% of females in his group, suddenly exclusive access to over half of them is opened up to him if he adds a single male partner to his team (Watts, 1998).

Mate guarding in chimpanzees may also help to circumvent the intense post-copulatory sperm competition between chimpanzee males and receptive females (Wroblewski *et al.*, 2009). In the context of sperm competition, young and low-ranking males have a higher likelihood of impregnating female partners (Wroblewski *et al.*, 2009). Mate guarding, then, may allow a high-ranking male to maintain his status and increase his reproductive success without relying on the quality of his sperm against socially subordinate animals. According to the *male-male competition hypothesis* of male-female sexual aggression, mate guarding behaviors communicate rank and status to other males, not necessarily to the female they aggress against (Muller and Wrangham, 2009).

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Costs to mate guarding in non-human primates

Although mate guarding may seem like an effective tactic to ensure male reproductive success, it is also costly to the females involved. Guarding frequently rewards males alone, as the reproductive interests of males and females are often at odds (Muller and Wrangham, 2009). If one male prevents all females from mating with other male suitors, he ensures his genetic material will be passed on—but only until another male arrives and kills any infants he knows he has not sired. In M-M, M-F groups, it is in the female's interest to *confuse* paternity as much as possible (Muller and Wrangham, 2009). This discourages infanticide, thus preventing the female's efforts towards growing and rearing her infant from going to waste (Muller and Wrangham, 2009). Females can lose much of their own reproductive success at the expense of male mate guarding tactics: in the extreme case of hamadryas baboons, 67% of routine male group takeovers (and consequent repossession of females) resulted in increased infant mortality and longer interbirth intervals among females (Swedell *et al.*, 2013). This may explain why pregnant and lactating chacma baboon females were found to have higher glucocorticoid levels amidst a troop takeover (Beehner *et al.*, 2005).

Mate guarding also has its costs for males. For example, the conflict involved in monopolizing females is stress-inducing for alpha males (Gesquiere *et al*., 2011). In a study of the relationship between stress and dominance rank in yellow baboons, Gesquiere *et al*. (2011) found that the alpha male has increased stress levels in comparison to his higher-ranked subordinates. Baboon alpha males are challenged frequently and experience higher levels of agonism, and when they fail to monopolize their troop's females, can be turned over quickly (Gesquiere *et al*., 2011). Stress can also inhibit testicular function in baboons (Sapolsky, 1985), thus hindering the reproductive advantage they may have gained by monopolizing a group's females for even a short period of time.

There is also the question of how much energy males expend by mate guarding. Although there is no conclusive evidence that mate guarding can create an energy deficit, unsuccessful guarding does not make up for the energy lost in attempting to secure access to a female (Girard-Buttoz *et al.*, 2014). Furthermore, males who mate guard feed less than males who do not (Alberts *et al.*, 1996; Girard-Buttoz *et al.*, 2014), and male baboons who were consorting with females were found to travel and feed less than males outside of exclusive consortships (Alberts *et al.*, 1996). Similarly, in long-tailed macaques, the male's amount of time spent mate guarding had a significant inverse relationship with his amount of time spent feeding (Girard-Buttoz *et al.*, 2014). This evidence indicates that mate guarding is energetically costly to the males involved.

Finally, the evidence on the effectiveness of aggressive mate guarding in M-M, M-F primate groups varies. In a study of chimpanzees, direct sexual coercion towards females prompted resistance in over half the females approached, and nearly 75% resisted intimidation after refusing copulation (Stumpf and Boesch, 2010). In less extreme cases of male-female sexual aggression, male aggression towards females is not directly related to their proceptivity, and is not guaranteed to ensure male reproductive success unless the male can achieve a total monopoly. If that monopoly is achieved, the stress of its maintenance and the consequent inability to prioritize other aspects of health will also be costly (Stumpf and Boesch, 2010).

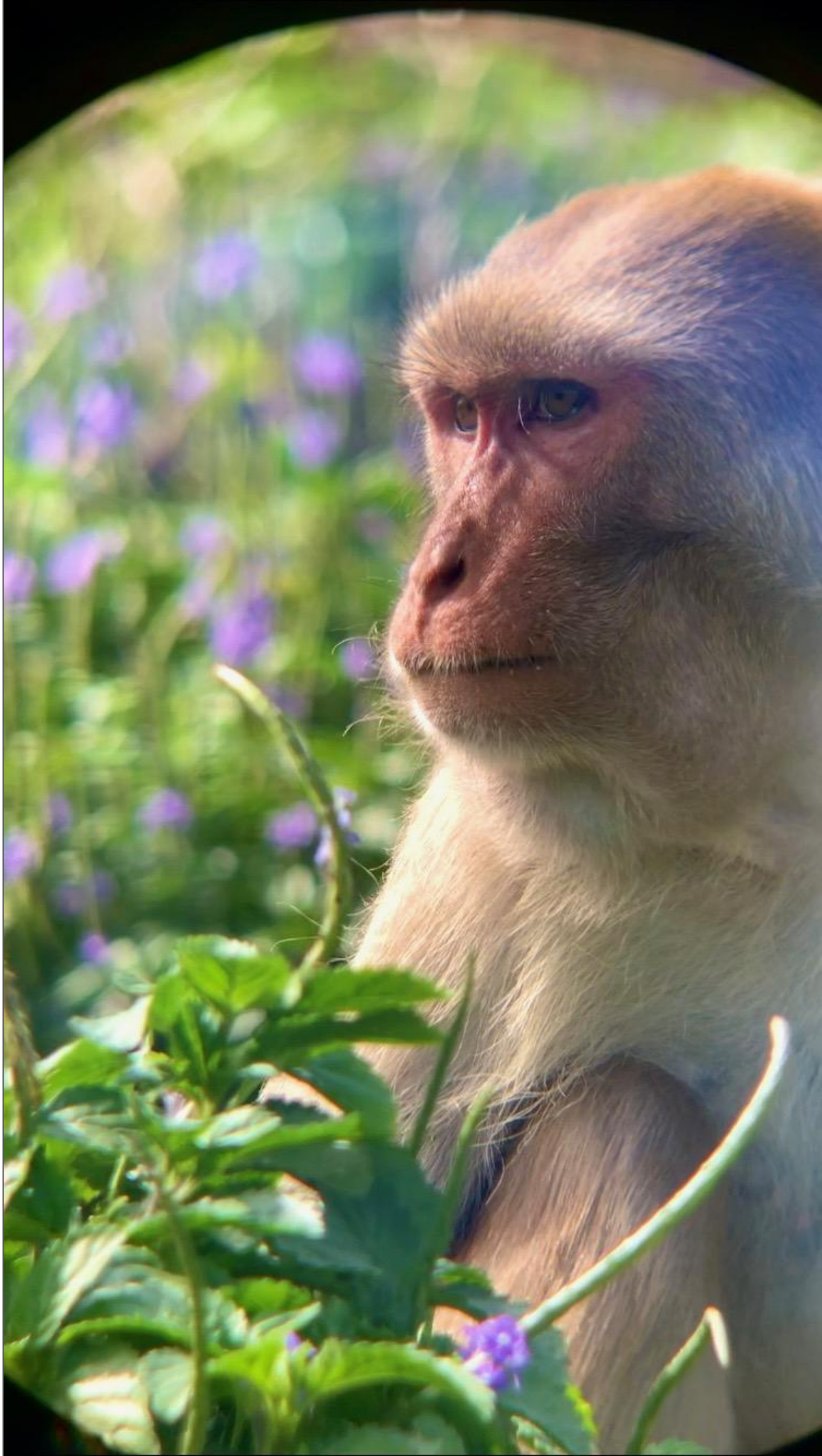
Mate guarding in humans

Like other monogamous primates, humans exhibit mate guarding behavior. Because of the complexities of human society and communication, the reasoning and methods behind human mate guarding are more elusive to researchers. There are still markers in human behavior that imply the existence of passive mate guarding. For instance, when women are at their peak fertility in their menstrual cycles, they report their male partners to behave jealously and act possessive towards them (Haselton and Gangestad, 2006). If there is not a certain degree of mate guarding in human monogamous relationships, the man involved may experience the reproductive and genetic consequences of cuckoldry (i.e., his partner giving birth to another man's offspring)—or the permanent defection of his partner, losing access to her reproductive potential (Buss, 2002). A threat to reproductive partnership that manifests often in humans (and a strong case for the necessity of mate guarding) is mate-poaching (Schmitt, 2001). According to survey statistics, 60% of men and 53% of women reported having attempted to break up an existing couple to mate with one of the partners (Schmitt, 2001).

Unlike most other primates, human mate guarding between the sexes is fairly even. Human females can increase their own attractiveness (through hair, clothing, and makeup) as a form of guarding around their partner (Buss, 2002). Early research suggests that females are most likely to guard males with access to resources, while males tend to guard females with the highest reproductive potential (Flinn, 1988).

Human mate guarding tactics can range from "vigilance to violence" (Buss, 2002, p. 23). This includes asking questions to ensure that one's partner is not sleeping with other mates, but human guarding behaviors may also escalate to violence against rivals or even violence against one's partner (Buss, 2002). In 1982, Daly *et al.* found that sexual jealousy was the leading cause of social conflict homicides in Detroit. Coercive violence against women is both extremely common and strongly culturally associated with feelings of jealousy or possession in the male aggressor (Muller and Wrangham, 2009).

Is anything gained from human mate guarding? In humans, having a mate does not deter suitors from advancing or partners from defecting, so there is speculative evidence that mate guarding behavior in humans has been sexually selected for as a means of guaranteeing access to the reproductive potential of both partners (Buss, 2002). Mate guarding in the form of monogamy, however, may reduce inter-partner aggression: in a study population in rural Trinidad, exclusive monogamous relationships were found to have a lower likelihood of escalating to violence than polyamorous ones (Flinn, 1988). Thus, vigilantly maintaining exclusive monogamous partnerships may help humans avoid the violence, stress, and energetic costs of competing to monopolize multiple females. According to the evidence surveyed in this paper, mate guarding is an effective method of ensuring reproductive success and comes with the least risk among monogamous primates. But regardless of social structure, morbid jealousy and possession do not prevent violence—they create it.



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Beasts with Bared Teeth to Sculptures with Soul: A Short History of Neandertal Representation

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Introduction

Neandertals have been maligned since their discovery. Originally conceived of as stooped, apelike, and uncivilized creatures without culture or humanity, a perspective partly resulting from 19th-century social evolutionary ideas around race, they quickly became a synonym for stupidity and backwardness (Drell, 2000; Trinkaus and Shipman, 1993). Although numerous studies since the 1950s have shown Neandertals to be quite the opposite, inaccurate and unfair stereotypes about their behavior and cognitive abilities remain.[1] This paper explores the history of Neandertal representation, beginning in 1856 with the discovery of the Neander Valley bones and ending in the present day. It describes how conceptions of our evolutionary cousins have changed, both in the scientific realm and in pop culture, identifying how the two have intersected and diverged over time. After giving a relatively brief history of Neandertal research and imagery from the 19th century to the mid-20th century, this paper focuses mainly on how contemporary depictions depart from tradition, as well as how they allow old tropes to linger at the back of the collective imagination. It describes how, in both the past and present, there exists a tension between two competing urges: one to accept the Neandertals as one of several ways of being truly human, and the other to keep them—and the questions they make us ask about ourselves—at a comfortable distance. Finally, the paper concludes by wondering what form future Neandertal portrayals will take, and how far modern humans are willing to go in granting them personhood.

Origins

On an August day in 1856, sixteen bone fragments[2] were discovered in the Feldhofer Cave of the Neander Valley (Drell, 2000). Thought to be the bones of a cave bear, they were promptly turned over to Johann Karl Fuhlrott, a local schoolteacher with an interest in natural history (Trinkaus and Shipman, 1993). He and Hermann Schaaffhausen, a professor of anatomy at the nearby University of Bonn, quickly recognized them as an ancient kind of human, "a natural conformation hitherto not known to exist" (qtd. in Trinkaus and Shipman, 1993, p. 6). But not everyone was so convinced. In fact, the finding ignited a decades-long debate over whether the remains should be accepted as evidence of a new type of human predecessor or deemed modern, pathological, and undeserving of further study (Drell, 2000).

On both sides of this argument were misinterpretations based on not just science, but also "a complex web of moral, historical, and political circumstances" (Drell, 2000). Among the scientists skeptical of Fuhlrott and Schaaffhausen's specimens was the pathologist Rudolf Virchow, who was strongly opposed to Darwin's ideas and the notion of human evolution more broadly (Trinkaus and Shipman, 1993). Trinkaus and Shipman (1993) argue that Virchow's skepticism stemmed from his Marxist ideology: "…in Virchow's view, the organism, like the state, was made up of individual units that carried out their own

[1] You couldn't insult someone today, for instance, by calling them a *Homo habilis*.

[2] Skull cap, right shoulder blade fragment, rib bones, two femora, three right arm bones, two left arm bones, and the ileum (Drell, 2000).

life-functions and also cooperated—through a division of labor, each carrying out the task for which it was best fitted—in the formation of a higher, collective being" (p. 57). Drell (2000) argues, however, that it was actually Virchow's attitude towards race that made him hesitant to accept Darwin's ideas and the existence of a supposedly less-evolved human ancestor. Unlike his contemporaries, whose prejudiced beliefs about the differences between modern human races made them willing to accept the existence of 'primitive' human ancestors, Virchow believed that no one race was inherently superior to another (Drell, 2000). In 1872, he wrote the following: "surely no one will be allowed to maintain [that] among the living races was one which would not need to be viewed as fully human" (qtd. in Drell, 2000, p. 5). Schaaffhausen, on the other hand, was willing to imagine a world in which the so-called inferior races showed that humans had evolved from savagery to civilization (Drell, 2000; Trinkaus and Shipman, 1993).

These ideas about progress were echoed by a number of contemporaneous scientists and ethnographers, including Edward Tylor, John Lubbock, and Henry Morgan (Drell, 2000).[3] Even those who asserted that Neandertals were prehistoric humans and not modern, pathological ones—like Schaaffhausen—kept them at a "comfortable distance" (Drell, 2000, p. 5) by describing them as primitive and ferocious. As other remains were discovered and debated, depictions of Neandertals, some of them beastlike, began to find their way into popular culture (Moser, 1998). One prime example of this is the first artistic illustration of a Neandertal, which was published on the front page of an 1873 edition of *Harper's Weekly*.[4] The accompanying article describes the newly-discovered Neandertal as a successful hunter—but also savage, uncivilized, and driven by innate urges for food and survival:

> "A more ferocious-looking, gorilla-like human being can hardly be imagined. The savage stands, almost in the attitude of an ape, before his den, where his female companion is seen slumbering, enveloped by shaggy furs. Always ready for attack or defence, he holds in his hand a hachet of primitive character, consisting of a chipped flint set in a wooden handle; his spear, likewise armed with a flint blade, leans against the rock. A bull's skull and other bones, one of them a split-marrow bone, attest the wild man's success as a hunter. Thus is supposed to have lived the contemporary of the mammoth!" (qtd. in Trinkaus and Shipman (1993, p. 109) and Moser (1998, p. 137)).

"The Neanderthal Man." Illustration from *Harper's Weekly*, July 19, 1873. Image taken from Moser (1998, p. 138).

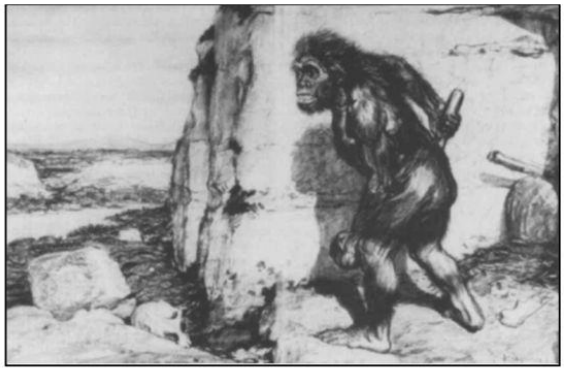
The *Harper's* Neandertal is considerably more apelike than previous depictions of early humans, but at the time

[3] Morgan's most influential book was titled *Ancient Society; or Researches in the Lines of Human Progress from Savagery through Barbarism to Civilization*.

[4] There had been depictions of ape-like human ancestors as early as 1861, but none had explicitly intended to depict the Neanderthal until the 1873 *Harper's* cover (cf. Moser, 1998, p. 133-137). It's worth mentioning that *Harper's Weekly* was subtitled *A Journal of Civilization* (Trinkaus and Shipman, 1993).

of its publication, Neandertals had not even fully reached their peak as symbols of beastliness (Sommer, 2006). While the description above describes the Neandertal man as "ferocious" and "gorilla-like," the image still grants him a recognizably human face, a hairless body, a dog, an understanding of fire, and the ability to create stone tools. Sommer (2006) writes that in this drawing, the artist "envisioned Neanderthal clearly within the imaginable range of human beings" (p. 226)—but this would not always be the case.

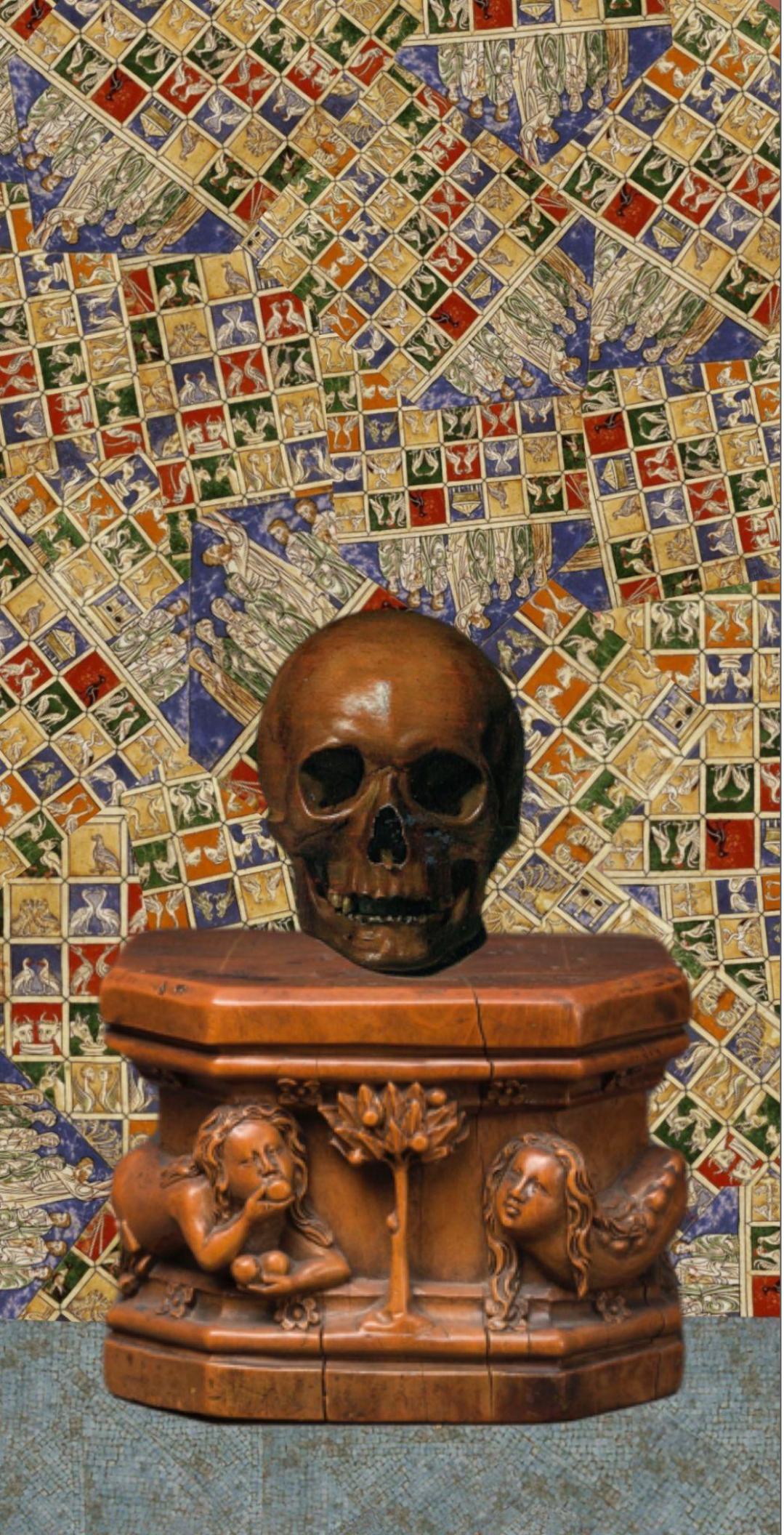
In 1886, two Neandertal skeletons were discovered in Spy d'Orneau, Belgium. Earlier finds, including a child's cranium found in Belgium and a woman's skull from Gibraltar, were re-evaluated. People began to consider more seriously the possibility that Neandertals were not merely modern specimens with rickets or arthritis (Trinkaus and Shipman, 1993). Study of the Spy d'Orneau bones led scientists to write that Neandertal jaws possessed "brutal depth and solidity" (qtd. in Trinkaus and Shipman, 2003, p. 129) and that they walked with bent knees, making them more ape than human. Twenty-two years later, in 1908, a nearly complete Neandertal skeleton was unearthed in France, at La Chapelle-aux-Saints (Hammond, 1982). By this time, Neandertals had gained more acceptance as a new species of fossil human, which led to intensified public interest in how they looked and lived (Trinkaus and Shipman, 2003). Paleontologist Marcellin Boule, professor at the Parisian Muséum d'Histoire Naturelle, was the first to reconstruct the "Old Man" from La Chapelle (Hammond, 1982). In a 1908 presentation to the Académie des Sciences, he proposed that Neandertals were bipedal, but had a stooped posture and a shuffling gait (Hammond, 1982). Boule's ideas were appealing both to the international paleontology community and the public, and his caricature of the Neandertal as a "slouching cave brute [who] could not be ancestral to modern man" (Hammond, 1982, p. 1) gained popularity as drawn reconstructions inspired by his work appeared in newspapers. Compared to the *Harper's Weekly* image, these newer illustrations afforded Neandertals even less humanity.



Franz Kupka's "*The Man of La Chapelle-aux-Saints: An accurate reconstruction of the Prehistoric Cave-Man whose skull was found in the Department of Corrèze*." Published in *L'Illustration* and *The Illustrated London News* in 1909. Taken from Moser (1992).

One such example is a reconstruction drawn by Franz Kupka, which was published in *L'Illustration* and *Illustrated London News* in 1909. Created in collaboration with Boule, the depiction is of a "stooped, hairy, beast-like figure standing at the entrance of a cave. Holding a club in one hand and a boulder in the other, the salivating brute bares a set of fanged teeth as he looks out across the landscape" (Moser, 1992, p. 836). Kupka's illustration is not of a being that readers would have recognized as human, and intentionally so, as its purpose was to subtly suggest that modern humans could not have descended from Neandertals. The picture was asserted to be scientifically accurate, a drawing not just of *any* Neandertal but *the* Chapelle-aux-Saints skeleton, and was presented to viewers as a factual depiction (Reichart, 1909).[5]

[5] The scientific value of the image was stressed: "It is not the artist's intention to depict merely a type of



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But it was also clearly created with shock value in mind, with the intent to be unsettling, uncanny, and to elicit grisly interest from the public, at the cost of scientific validity. It succeeded in being a striking image, and its inaccuracies quickly became lodged in the collective imagination, shaping the public understanding of what it meant to be Neandertal (Sommer, 2006; Trinkaus and Shipman, 1993). It did not help that phrenology was in vogue at the turn of the century, so what once would have only been seen as evidence that Neandertals were apelike was now proof that they were both apelike *and* immoral (Trinkaus and Shipman, 1993). As Trinkaus and Shipman (1993) put it: "Upright, proud, striding posture was what honest, decent humans engaged in; hunched, bent-kneed, shuffling postures were for the dark, the troglodytic, the bestial ancestors" (p. 131). Thus, the image of the Neandertal as brutish, savage, stupid, vicious, and primitive was firmly established. This reputation would prove tenacious, taking almost 70 years to correct.

The mid-20th century: a turning point

The perception of Neandertals underwent a transformation beginning during the latter half of the 20th century, when scientists began to re-evaluate Boule's ideas (Sommer, 2006). In 1955, paleontologist Etienne Patte wrote *Les Néandertaliens*, in which he rejected Boule's apelike reconstruction of the La Chapelle specimen. Based on his own measurements of Neandertal and modern human skeletons, he wrote that differences between the two had previously been overestimated (Drell, 2000). Pop culture representations began to shift as well: William Golding's *The Inheritors*, a story following the last group of Neandertals and their interactions with modern humans, was published in the same year as *Les Néandertaliens*. Unlike older works of Neandertal-focused fiction—like H. G. Wells's 1921 *The Grisly Folk*, which begins by detailing the differences between the "ugly, strong, ungainly, manlike animal and mankind" (Wells, 1921)—*The Inheritors* was notable because it portrayed Neandertals as being childlike, gentle, and capable of having internal lives. In Golding's fictional prehistory, Neandertals were still intellectually inferior to modern humans, unable to create fire or communicate beyond basic sentences. But they were strikingly more human than ever before. No longer brutish or feral, Golding's Neandertals had names,[6] buried their dead, and held spiritual beliefs (Golding, 1955).

In 1957, William Straus and A. J. E. Cave published "Pathology and the Posture of Neanderthal Man," delivering further evidence against Boule's ideas. The two authors criticized Boule for failing to notice that La Chapelle was arthritic and for paying "scant attention" to the reconstruction of the skeleton's spine (p. 356). They concluded that "there exists no valid reason for Boule's assumption that the man of La Chapelle-aux-Saints differed fundamentally from modern man in his cervical curvature and the carriage of his head" (p. 356). If this was not enough to convince readers of the similarity between Neandertals and modern humans, Straus and Cave also ended their discussion of La Chapelle with the following, which has since become a ubiquitous reference in pop-scientific

prehistoric man, but the actual man whose skull was found recently in the Department of Correze. Taking the bones of this skull, and recognising to the full the laws of anatomy, Mr Kupka has…given the face the expression it must have worn…our drawing can fairly claim to be the first that has shown with any scientific certainty prehistoric man in his habitat as he lived" (Reichart, 1909, p. 313).

[6] Drell (2000) points out that in *The Inheritors*, Neanderthals had monosyllabic names (Lok, Fa, Nil, Ha, and Mal) while "humans" had more complex, multisyllabic names (Tuami, Marlan, Vakiti, Vivani).

documentaries and articles[7] about Neandertals:

> "He cannot, in view of his manifest pathology, be used to provide us with a reliable picture of a healthy, normal Neanderthalian. Notwithstanding, if he would be reincarnated and placed in a New York subway—provided that he were bathed, shaved, and dressed in modern clothing—it is doubtful whether he could attract any more attention than some of its other denizens" (p. 359).

Research insisting on the anatomical humanity of Neandertals laid the groundwork for newer arguments about Neandertal behavior. Between 1951 and 1960, Ralph Solecki and a team from Columbia University excavated Shanidar Cave in northern Iraq (Pomeroy *et al*., 2017; Stewart, 1977). In a trench 14 meters deep, they uncovered the remains of ten Neandertals, eight adults and two children, including six that are thought to have been intentionally buried (Pomeroy *et al*., 2017; Stewart, 1977). Two of the skeletons in particular, Shanidar 4 and Shanidar 1, have since been used as evidence for Neandertal humanity.

In the 1970s, Solecki used soil analysis showing the presence of considerable quantities of wildflower pollen around Shanidar 4 to propose that the skeleton had been buried on a bed of flowers that included yarrow, hyacinth, and St. Barnaby's thistle (Sommer, 1999). He went on to argue that the flower burial provided evidence that Neandertals were behaviorally modern, dubbing them "The First Flower People" (Solecki, 1971). As Solecki wrote in 1975, the "discovery of the pollen grains around the Neanderthal burial was in itself unusual and without precedent to our knowledge, but to find flower pollen, and in quantity, was an added extraordinary dividend. The association of flowers with Neanderthals adds a whole new dimension to our knowledge of his humanness, indicating that he had 'soul,'" (p. 880).[8]

More support for Neandertals' behavioral modernity comes from the remains of Shanidar 1, who, in his youth, experienced a debilitating blow to the head that likely blinded him, damaged his brain, and disabled the right side of his body (Wayman, 2012). Although he likely could not have survived without the care of others, it is estimated that Shanidar 1 lived to about 35-45 years old, which would have been a long lifespan at the time (Wayman, 2012). Solecki claimed this indicated that Neandertal social groups provisioned and took care of the sick and infirm—a testament to their compassion and empathy—and by the 1970s, his view of Neandertals "as human, humane, compassionate, and caring was accepted widely and with remarkably little demur" (Trinkaus and Shipman, 1993, p. 341).

Despite some considerable changes in the way Neandertals were perceived, narratives about their intellectual inferiority and crudeness persisted into the 1980s and 1990s. The 1980 book and 1986 film *The Clan of the Cave Bear* shows how older negative stereotypes and new scientific theories about Neandertal behavior simultaneously influenced pop culture. The film follows a modern human main protagonist named Ayla, who conforms to the blonde, fair-skinned Western ideal and is adopted as a child by a clan of swarthy, hairy Neandertals. Although stockier and more muscular, the Neandertals are

[7] Including the British Channel Four documentary *Neanderthals* and the two-part series *Neanderthal* on PBS, and in articles published in *Sapiens*, *The New Yorker, The New York Times,* and *The Atlantic*.

[8] Sommer (1999) points to evidence of burrows around the Shanidar remains to argue that the flower pollen found near Shanidar 4 was most likely the result of rodent activity, and thus cannot be used convincingly to support the theory that Neanderthals were capable of advanced and symbolic cognition.

approximately human-looking and several of them treat Ayla with kindness. Their communication, however, is simplistic and mostly takes place through sign language. They rarely laugh, smile, or cry; can only count to ten; and are shocked and confused when Ayla shows emotion and is capable of counting to 20. Women of the clan are punished by death for touching hunting weapons; a brutal rape scene harkens back to the 1952 film *Neanderthal Man*, which was meant to elicit fear and disgust towards Neandertals by depicting them as sexually aggressive (Trinkaus and Shipman, 1993). The movie ends when Ayla decides that she and the members of the clan are irreconcilably different, and tearfully leaves in search of other anatomically modern humans (AMHs).

A close-up of Creb, the Neandertal shaman of *Clan of the Cave Bear*, who was likely based on the Shanidar 1 skeleton.

The Clan of the Cave Bear demonstrates a tension that has existed since the Neander Valley remains were discovered in the 19th century: the desire to simultaneously pull Neandertals closer and push them away. When paleontologists first began to analyze Neandertal bones, even those who believed they were fossil humans and worthy of study kept them at arm's length with theories about their inferior intelligence and morality. Later, as it became clear that Neandertals had once shared the earth with AMHs, people assumed that the two must have been at war. It seemed implausible that *we* and the *other* could have been similar enough to live together peacefully. At the same time, stereotypes about Neandertal anatomy and behavior also began to form. Influenced by scientific authorities like Boule, pop-cultural artifacts cemented Neandertals' reputation as unsophisticated and violent brutes, easily identifiable by their bared teeth and stooped posture (Hammond, 1982; Sommer, 2006; Trinkaus and Shipman, 1993).

Poster for the 1953 film *The Neanderthal Man*. Trinkaus and Shipman (1993) describe the poster as demonstrating "fear of the rampant sexuality that was equated with physical primitiveness" (p. 406).

Even after archaeologists like Solecki claimed that Neandertals were compassionate flower people, this did not prevent pop culture from continuing to present them as less intelligent, less emotional, and less human than modern *Homo sapiens*. This pattern remains true of Neandertal studies in the 21st century. As evidence for Neandertal behavioral modernity builds, new questions, doubts, and controversies surface to prevent them from being conceived of as truly human.

Neandertals since 2010: contemporary findings and representations

Recent decades have seen a "renaissance" (Sykes, 2020, p. 14) in Neandertal research. During the last ten years in particular, shocking and previously hard-to-imagine findings have commanded the covers of science magazines like *National Geographic*, *Smithsonian*, and *Scientific American*. Perhaps the biggest bombshell came in 2010, when a team led by geneticist Svante Pääbo of the Max Planck Institute for Evolutionary Anthropology created a draft sequence of the Neandertal genome, finding that Neandertals share more of their genetic markers with present-day humans in Eurasia than with those in sub-Saharan Africa (Green e*t al*., 2010). The implication of this is that modern humans must have had sex with Neandertals (and Neandertals with modern humans, if we are being careful to give each equal agency) as they exited Africa and spread around the world.

The finding that Neandertals and AMHs interbred once again throws their humanity, or lack thereof, into question. In her 2011 *New Yorker* profile of Svante Pääbo, Elizabeth Kolbert writes, "Neanderthals were very closely related to modern humans—so closely that we shared our prehistoric beds with them—and yet clearly they were not humans." But is this true? According to the biological species concept, two organisms belong to the same species if they can produce fertile offspring (Mayr, 2000). What defines a species is contentious, of course, and becomes even muddier when humans are involved. Still, this shows that Kolbert's confident assertion that Neandertals *clearly* can't be human comes not from a scientific perspective, but from a visceral desire to maintain a boundary between *us* and *them*. With evidence of interbreeding widely accepted, the focus of Neandertal studies turned to behavioral differences in an effort to reestablish what makes us—and only us—human.

Since 2010, possibly the most discussed distinction between modern humans and Neandertals has been the ability to think symbolically. Although modern humans left behind jewelry, cave paintings, and small sculptures like the Woman of Willendorf—all of which constitute evidence of symbolic thought—it was widely believed that nothing of the sort could have been created or used by Neandertals (Wong, 2010). Symbolism, then, became a keystone in the argument that Neandertals were not real humans, that only *we* have earned that title. But evidence to the contrary has begun to accumulate. In Spain, Neandertals dyed shells and mixed body paint, likely for aesthetic reasons (Zilhão *et al.*, 2010). They played flutes made from the bones of cave bears in the Divje Babe cave of Slovenia (D'Errico *et al*., 1998), and etched a pound sign into the rocky wall of another cave in Gibraltar (Rodríguez-Vidal *et al*., 2014). Research at sites in Croatia and elsewhere in Europe has shown that Neandertals wore eagle talons as jewelry (Radovčić *et al.*, 2015). New studies at La Chapelle, which ironically had been the source of early stereotypes about Neandertal beastliness, has provided further evidence that Neandertals buried their dead (Rendu *et al.*, 2014). And in 2018, a team of archaeologists dated three cave paintings from Spain to at least 64,800 years ago—20,000 years before modern humans were in the area (Hoffman *et al.*, 2018).

Of course, these findings have not done much to limit Neandertal discourse. If anything, they have reignited new controversies around what Neandertals were and were not capable of. With every new finding comes new doubts and suspicions, further evidence of our competing urges to accept Neandertals as our large-brained

cousins and to establish a comfortable distance between *us* and *them*. Some academics believe that these finds say nothing about Neandertals, and instead that they indicate modern humans reached certain parts of the world earlier than the fossil record shows (Wong, 2015). Others, like Thomas Higham of Oxford, believe that modern humans spreading into Europe are responsible for apparent Neandertal symbolism— that Neandertals merely imitated AMH behaviors (or, worse, scavenged their belongings) without understanding their purpose (Wong, 2015). When painted shells were attributed to Neandertals, many argued that there had been a mix-up between Neandertal and modern human deposits. When 65,000 year old cave paintings suggested that Neandertals may have created art, a number of studies published contradictory results about the reliability of the dates, throwing the finding into question (Aubert *et al.*, 2018). Even among researchers who believe that Neandertals were capable of symbolism, jokes comparing the artistic quality of Neandertal and modern human artifacts are plentiful (Wong, 2010).

And Neandertals haven't only been dismissed as inferior—their name is also used as an epithet to insinuate brutishness, backwardness, and stupidity. As science writer Kate Wong put it in 2015, "Neandertals are the Rodney Dangerfields of the human family—they don't get no respect." In 2016, an Austrian politician faced controversy after he described refugees as "Neanderthals who trample under foot the rights of women" (Nasralla, 2016). The Velvet Underground's 1968 track "The Gift" describes protagonist Waldo in tears "as he pictured [his girlfriend] Marsha, her sworn vows overcome by liquor and the smooth soothings of some Neanderthal, finally submitting to the final caresses of sexual oblivion." And a single Twitter search for the word pulls up dozens of recent tweets like, "I wasn't paying attention and almost microwaved my Cinnamon Toast Crunch like a Neanderthal," "There's nothing more humbling than trying to wrap presents and remembering I'm a fucking Neanderthal," and "These Neanderthal Republicans must be voted out."

Still, there are many scientists who strongly believe that Neandertals deserve more respect, that they invented their own symbolic and cultural traditions without outside help from modern humans, and that their anatomical differences aren't enough to dismiss them as cognitively inferior. University of Barcelona professor João Zilhão, who led the discovery of Neandertal jewelry and body paint in Spain, is one such researcher:

> "The one thing these finds make clear is that Neandertals were behaviorally modern. They were not like early modern humans anatomically, but they were cognitively as advanced or more so…Either modern cognition and modern behavior emerged independently in two different lineages, or they existed in the common ancestor of Neandertals and anatomically modern humans; or the groups we call Neandertals and modern humans were not different species and therefore we should not be surprised that despite the anatomical differences there are no cognitive differences, which is the conclusion I favor" (Wong, 2010, p. 75).

This intense debate raises a number of questions. With so many opinions still flying around about how Neandertals lived and the degree to which they fit into the working definition of "human," how should they be represented to the public? How are modern depictions incorporating new findings about sophisticated Neandertal behaviors? Where are old, prejudiced stereotypes still evident? And does the tension between pushing Neandertals away

and pulling them in still linger in scientific articles and popular culture? The short answer to this is yes.

When it comes to modern Neandertal representation, the 2020 children's movie *The Croods 2: A New Age* is surprisingly ripe for analysis. The cartoon follows a Neandertal ("caveman") family, the Croods, as they leave their cave in search of a safer place to live. The Croods are muscular and stocky, draped in animal furs, and ride a saber-toothed tiger named Chunky as their main mode of transportation. But unlike most pop culture Neandertals, past or present, they can speak—and their voices and vocabulary sound exactly like those of modern-day people. They are clearly human, as evidenced through their tight family bonds, playful banter, and sarcastic sense of humor. But they are also different from modern humans, which becomes a source of tension when the Croods stumble across a farm—"Isn't it weird how this food grows in perfectly straight lines?"—and end up face-to-face with a *Homo sapiens* couple, the Bettermans.

Their meeting is written with an awareness of Neandertal stereotypes and an acknowledgement that they are unfair. "We...happy...to...meet...you..." says Phil Betterman in an unnecessarily loud and slow voice. He comes across as foolish when Grug, the Crood patriarch, plainly says "Uh, thanks." After introducing themselves in a way that calls attention to their modern human smugness ("Emphasis on the better!"), the Bettermans invite the Croods to their lushious, extravagant treehouse. It's a far cry from the dark and dangerous caves that the Croods have been living in. Soon, the two families have to learn how to coexist.

A still from *The Croods 2: A New Age* (2020), showing the first meeting of the Croods and the Bettermans.

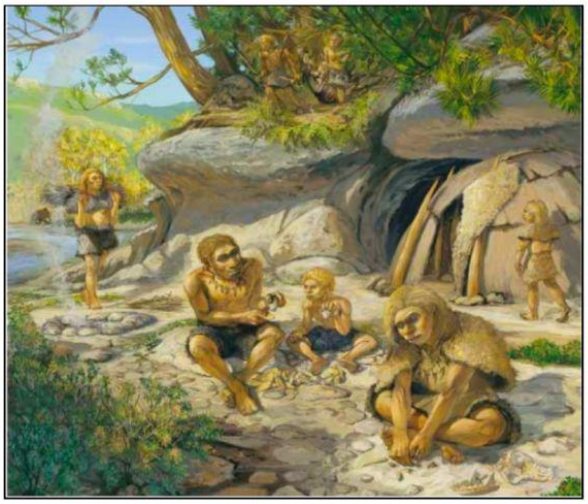
There are many things that *The Croods 2: A New Age* does right by Neandertals. For one, the Neandertals are the story's protagonists, and they have identities and personalities that are far more complex than those afforded to the Neandertal characters of *Clan of the Cave Bear*, for instance. A number of details are clearly influenced by recent findings, like teenage Eep's red hair and impressive collection of scars. Flouting the old trope of warring human clans, the Croods and the Bettermans become close despite their disagreements. "You're just like me," Eep remarks to her new human friend Dawn, realizing that they both are restless living under the strict supervision of their parents. The two families are ultimately presented as equally human, but with different ways of life.

Still, the writers of *A New Age* place are careful to keep some distance between the Neandertal Croods and AMH Bettermans. Although they usually walk upright, the frame included above shows the Croods crouching in response to the surprise of meeting their new neighbors. The Bettermans, meanwhile, remain on two feet. They also wear sleek, brightly colored fabrics and flashy jade pendants, while the Crood family is stuck with traditional drab brown furs. Later, as the families are learning to live together, Grug becomes frustrated that his children are abandoning their traditional ways in favor of adopting

some of the Bettermans' new-fangled technologies, like flashy flip flops and jewelry—a nod to the theory that Neandertals must have copied human cultural practices rather than devising similar ones on their own. Lastly, like in *The Inheritors*, the Croods have primitive-sounding names (Grug, Eep, Guy, Gran, and Thunk), while their AMH counterparts are Dawn, Hope, and Phil.

The most noticeable difference between early and contemporary Neandertal discourse is that current movies, books, and articles all make a point of signaling their awareness of the unfair Neandertal stereotypes of the past. If there is one thing that unifies all contemporary Neandertal reporting, it is the characteristic introduction that sounds something like this: "In their original incarnation, Neanderthals were viewed as the primitive, backward cave dwellers of Eurasia, far less complex than the sophisticated Homo sapiens who used language and developed sophisticated art… But new studies are making it much harder to draw a clean line between us and them" (Zielinski, 2012). Even in the 1990s, *Saturday Night Live* acknowledged and parodied the trope of the primitive Neandertal with "Unfrozen Caveman Lawyer." Keyrock, the law school-educated caveman in question, won his cases by massaging the egos of the jury in disingenuous displays of intellectual inferiority: "Ladies and gentlemen of the jury, I'm just a caveman. Your world frightens and confuses me. Sometimes the honking horns of your traffic make me want to get out of my BMW and run off into the hills, or whatever. Sometimes when I get a message on my fax machine, I wonder, 'Did little demons get inside and type it?' I don't know! My primitive mind can't grasp these concepts."

In more scientific contexts, the groundbreaking findings of the last decade have resulted in a new type of representation, one that brings Neandertal personhood to the forefront. Rather than doing things the older way—illustrating Neandertals as parts of their landscape, as you would a non-human animal—magazines and museums are now relying on more detailed digital reconstructions that indulge in the idea that Neandertals had souls like ours.



Neandertal reconstructions from two *Scientific American* articles, one from 2000 (above) and one from 2010 (below), which demonstrate the vast differences between more recent Neandertal depictions and those made only a few years before, at the beginning of the 21st century.

In the first chapter of his book *Smart Neanderthal* (2019), Clive Finlayson stresses the importance of including "life-like sculptures with personality" in museums, whose "faces and expressions speak of humanity" (p. 5). Nana and Flint, the detailed sculptures Finlayson describes, are just two examples of the wider trend towards Neandertal portraiture. Newer Neandertal depictions (like the above right image) are more like portraits in that they tend to focus on one individual at a time, allowing viewers to get up close and personal with them and so as to hint at their subjects' personalities and souls. At the Neanderthal Museum in Mettmann, Germany, they are "imbued with cheerful dignity…presented as living in tepees, wearing what look like leather yoga pants, and gazing contemplatively over the frozen landscape" (Kolbert, 2011). Included in the *New Yorker* profile of Svante Pääbo is a Neandertal sculpture by the artist Elisabeth Daynes, who specializes in hyper-realistic "paleoart." The muscular male figure is attractive in Neandertal terms, if slightly unkempt: he has wide shoulders, high cheekbones, and a full beard. But the most arresting thing about him is his intense and thoughtful gaze, which gives the sense of interacting with him, of staring him down. Daynes's Instagram page is filled with sculptures like these. She bestows her subjects with the emotion, personality, and humor they likely had while alive. The most recent is a spirited reconstruction of the 8-year-old Scladina Neandertal girl, who wears an amused smile as a butterfly perches on top of her index finger. Her expression is familiar, relatable, and undeniably human.

Like *The Croods* and *Saturday Night Live*'s "Unfrozen Caveman Lawyer," these new reconstructions also speak of an awareness of past Neandertal tropes, only in a more subtle way. They go out of their way to correct the inaccurate cliché of the caveman, to give Neandertals intelligence, personhood, and humanity, and, in doing so, remind viewers of exactly the stereotypes they are trying to eschew. In spite of the science that goes into creating them, their uncanniness makes them seem fictional, hard to believe, and possibly too much like *us*. This will probably remain unavoidable for as long as the Bouleian image of the Neandertal lingers in the back of our minds. And it does: the new card game "Poetry for Neanderthals," for instance, challenges participants "to speak good" —i.e., to only use monosyllabic words—"or get hit with stick."

Conclusion: the future of Neandertal portrayals

What does it mean that the notion of the unintelligent, inarticulate caveman remains influential, despite the efforts of scientists and science communicators to replace the image of the "prehistoric Rambo" (Kolbert, 2011) with one of Neandertals as sophisticated and benevolent? Why, after more than 50 years of headlines about their cognitive abilities and behavior, do people on Twitter still choose the word "Neanderthal" to insult each other and their least-favorite politicians? Above all else, this shows that the two paradigms are not mutually exclusive: the acceptance of one does not necessitate the disappearance of the other. If these two modes of representation are what allow us to bounce back and forth between approaching Neandertals and alienating them, will they exist forever? What is the future of the image of the Neandertal?

Perhaps the only way of eliminating the tension described above is by reframing how Neandertal personhood is measured. We modern humans have been unwilling to accept Neandertals as *us* and unable to justify dismissing them as the *other*, but it is

possible that merely bringing them to our side of this dichotomy shouldn't even be the goal. Instead of measuring Neandertals against our definition of humanity, and thus anthropocentrically defining *them* and *their* behavior in relation to *us* and *ours*, it would be more productive to do away with this binary completely.

Accepting that there exist different but equally valid ways of being human has not historically been a strong suit of *Homo sapiens*. As Trinkaus and Shipman write: "We still struggle in confusion—bitterly, poignantly—to recognize and evaluate the differences and resemblances among [modern] humans" (1993, p. 410). But acknowledging our shortcomings in accepting differences without ascribing relative value to them—and giving Neandertals personhood in their own right, regardless of whatever resemblances they bear to modern humans—is a necessary step towards representing Neandertals as they were. Until then, we will continue to oscillate between seeing them either as versions of *us* or as the primitive *other* we think they should have been.

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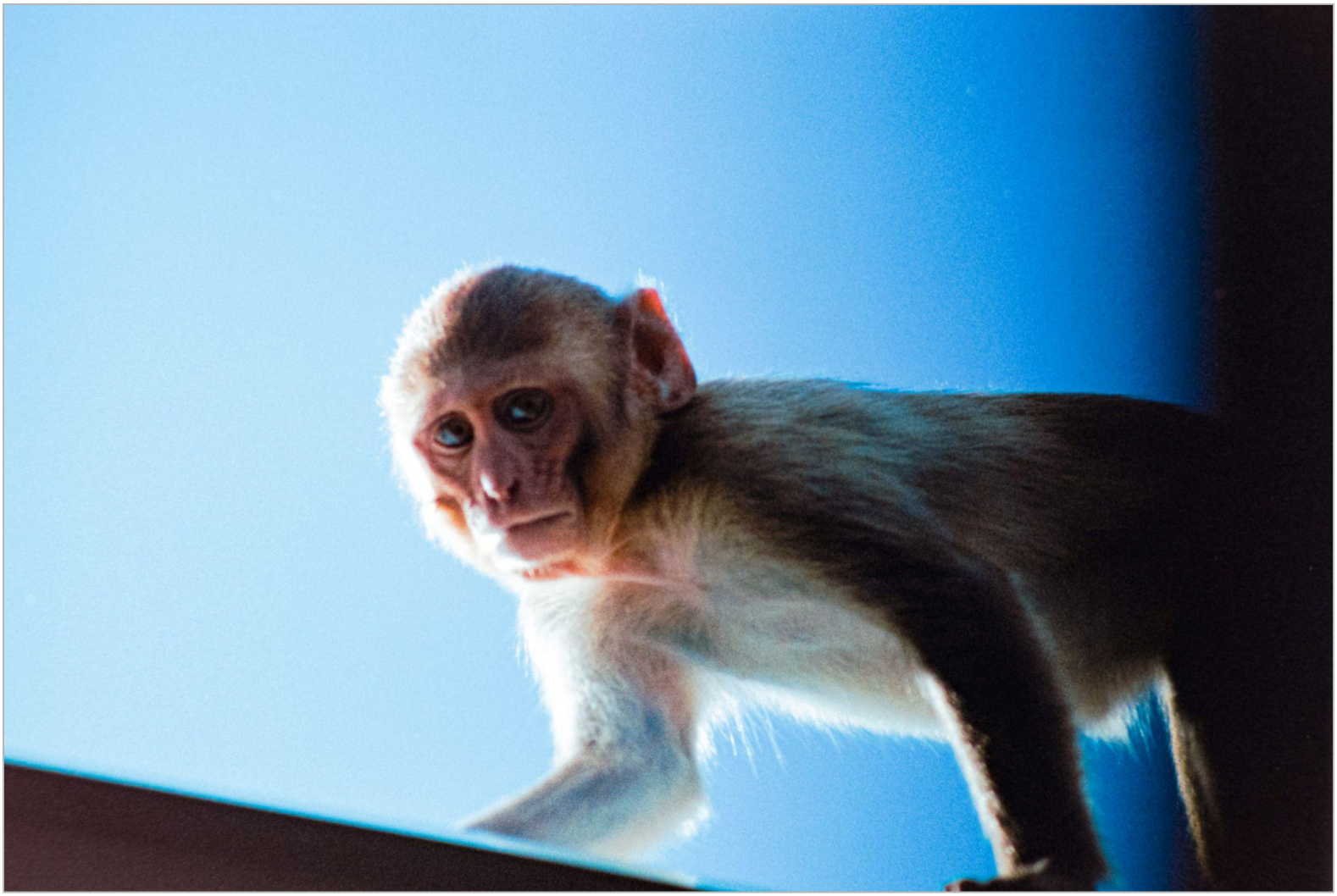
Patricia Cacho



Patricia Cacho

The Modern Western Diet Versus the Thyroid: How Nutritional Deficiencies Affect the Homeostasis of the Human Body

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Introduction

The Western diet is associated with nutritional deficiencies and poor thyroid health in adults (Muskiet and Kuipers, 2010). The thyroid is crucial in regulating many systems in the human body and for maintaining homeostasis (Warner and Mittag, 2012). Thyroid malfunction may lead to serious physical and mental health consequences, including heart disease, high blood pressure, sleep disorders, depression, and anxiety (Bauer *et al.*, 2008; Berta *et al.*, 2019). In this paper, I will review the effects of the modern Western diet on the function of thyroid hormones, including how nutritional deficiencies impede homeostasis in both the human mind and body. Through a detailed explanation of thyroid function, I will discuss homeostatic disruption in Westerners and propose research on how nutritional deficiencies affect the thyroid. Finally, I will conclude with suggestions for further research to broaden our understanding of thyroid behavior under contemporary foodways in the developed world.

The thyroid

The thyroid gland is an integral source of gland specific hormones in all vertebrate bodies (Maenhaut *et al.*, 2015). It produces the hormones thyroxine (T4) and triiodothyronine (T3), which work within and outside of the gland to contribute to cellular metabolism, thermoregulation, and the development of the brain and body (Venturi and Bégin, 2010). The two aforementioned hormones also interact with a suite of enzymes to conduct processes such as deiodination, where iodine is removed from a hormone before it makes its extracellular contributions (Kelly, 2000). Because T3 and T4 are structurally similar (T4 has one additional atom of iodine) and work together to carry out the functions of the thyroid, they will be described collectively as "thyroid hormone" in this paper (Venturi and Bégin, 2010).

Thyroid hormone is responsible for regulating many cellular processes (Maenhaut *et al.*, 2015). Because it regulates enzymatic and hormonal activity via central and peripheral actions, the hormone is crucial to maintaining homeostasis in the human body (Warner and Mittag, 2012). Although thyroid hormone is thought to play a significant role in thermogenesis, some research suggests that the thermoregulatory response within cells following thyroid hormone interactions evolved as obligatory thermogenesis (Silva, 1995). That is, this response is inextricably linked with cell metabolism—even if the thyroid is still partly responsible for thermoregulation (Silva, 1995). Venturi and Bégin (2010) argue that deficiencies of certain nutrients, such as iron, inhibit the thyroid hormone and so reduce the body's ability to conserve heat. As a result, anemic individuals may experience cold extremities (Venturi and Bégin, 2010).

Thyroid hormone also contributes to brain development (Venturi and Bégin, 2010). One example of the hormone's consequences for brain growth comes from Borensztejn (2005), who reported that tadpoles subjected to a graft of an additional thyroid suffered from burst crania (cited in Venturi and Bégin, 2010). Thyroid hormone is similarly involved in the brain development of human fetuses, as emerging brain cells are controlled by thyroid

hormone in a "time and dose dependent manner" (Venturi and Bégin, 2010, p. 106). This suggests that the thyroid is not only important to the routine maintenance of the body, but that its hormones have important implications for development in both human and non-human animals.

Outside of the realm of development, the thyroid plays an important role in the brain functioning of human adults (Venturi and Bégin, 2010). Thyroid hormone is critical to neural communication, as it is involved in synapse firing and controls a number of genes specific to brain function (Venturi and Bégin, 2010). Brain function is dependent on the interactions between the thyroid, the pituitary gland, and the hypothalamus, which is known as the hypothalamic-pituitary-thyroid (HPT) axis (Bauer *et al.*, 2008). To function correctly, the HPT in turn relies on nutrients like iodine, selenium and iron (Bauer *et al.*, 2008). Without a functional HPT axis to induce the production of thyroid hormone, proper brain and bodily function is impossible, so seemingly minor issues like insufficient nutrient consumption can prevent the thyroid from regulating other body systems (Venturi and Bégin, 2010). As such, a diet that fails to meet the body's nutritional needs can lead to HPT and thyroid malfunction (Cunnane, 2010).

Diet-gene mismatch

The human diet has varied widely across evolutionary history (Lucock *et al.,* 2013). Ancestral hominins like *Homo neanderthalensis* consumed mostly raw and unprocessed foods before the use of fire and cooking became regular occurrences with early *Homo sapiens*. It is hypothesized that Neandertals consumed protein in the form of fish and meat, and that starchy plant matter provided the majority of their other nutrients (Power *et al.*, 2017; Richards *et al.*, 2005). The contemporary Western diet, however, reflects the modern emphasis on convenience and indulgence. It is characterized by the consumption of high amounts of saturated fats and sucrose through foods like red meat, pre-packaged snacks, fried food, and candy (Statovci *et al.*, 2017). In America specifically, the standard diet is calorie-dense, with high levels of trans fats and added sugars, and low amounts of whole grains and vegetables (Grotto and Zied, 2010). With the understanding that wide availability of pre-packaged foods was not among the conditions under which modern humans evolved, nutrient-gene research seeks to understand how the modern diet and genes can be mismatched, thus resulting in obesogenic environments and negative health outcomes, including thyroid disease (Lucock *et al.,* 2013).

Health consequences

Because the Western diet provides little iodine—one of the most important nutrients for thyroid function, alongside iron and selenium—the thyroid is highly susceptible to issues arising from this dietary pattern (Venturi and Bégin, 2010). More than 12% of Americans are affected by a thyroid condition during their lifetime (ATA, 2021). Coincidentally, according to Venturi and Bégin (2010), about 12% of Americans also suffer from an iodine deficiency. One explanation for the prevalence of chronic thyroid ailments in the United States is the discrepancy between the contemporary American diet and the dietary choices necessary to maintain proper thyroid function (Bianchi *et al.*, 2003).

A cascade of physical and mental health problems may stem from thyroid dysfunction (Bauer *et al.*, 2008; Berta *et al.*, 2019). For example, an underactive thyroid can cause cold sensitivity, lethargy, and weight gain, which may lead to obesity in an obesogenic environment (Venturi and Bégin,

2010; Cunnane, 2010). An overactive thyroid can cause heat sensitivity, hyperactivity, mood swings, and unintentional weight loss (Bauer *et al.*, 2008). Bianchi *et al.* (2003) found subjects that had a thyroid issue—whether asymptomatic (e.g., thyroiditis) or symptomatic (e.g., hypothyroidism)—reported a lower overall perception of their health. Other research found that thyroid disorders may have negative effects on mood and cognitive ability, possibly as a result of the thyroid's relationship with the brain (Bauer *et al.*, 2008).

Proposed research

The following research proposal offers guidelines for a potential study addressing the connections between diet and thyroid health. The study will involve participant collection of data through electronic devices. At the end of the data collection period, subjects will be given a survey with questions about their perceptions of their physical and mental health.

Participants

My study will focus on 100 American males between the ages of 25 and 35. One group of subjects (n=50) will include individuals who have been diagnosed with thyroid ailments. Thyroid function within this group is expected to vary widely, ranging from severe diseases like Hashimoto's disease to subclinical hyper- or hypothyroidism. The control group (n=50) will include individuals with no diagnosed thyroid diseases. Only adult males will be eligible for participation in the study to negate confounding variables related to age and sex. For example, women and children are more vulnerable to iodine and other nutrient deficiencies (Cunnane, 2010; Zimmerman and Köhrle, 2002). Similarly, the interaction between estrogen, progesterone, and thyroid hormones may lead to greater variability in overall health and perceptions of one's health in women (Unuane *et al.*, 2011). Because such confounding factors related to life stage, lifestyle, and hormones could bias the results of the study, it is best to exclude women and male participants outside of the 25-35 age bracket. I expect individuals in the thyroid ailment group to have poorer diets and lower levels of physical activity, as well as more negative responses to survey questions on mental health and perceptions of their health overall.

Thyroid stimulating hormone

In this study, thyroid stimulating hormone (TSH), T3, T4, and urinary iodine will be measured in urine following Sheehan (2016) as a general measure of hormone levels to compare against euthyroid individuals. Levels of free TH will also be measured by equilibrium dialysis instead of urinary iodine levels or a blood thyroid test, as this technique offers a more precise estimate of T4 which gives a more precise look into the status of thyroid function (Dunlap, 1990).

Procedure

Using an easily navigable phone application, participants will self-report their food intake each day for one week. The application will require subjects to use Nutrition Facts labels to estimate the total macro- and micronutrients consumed in each meal. Exercise will also be recorded: at the beginning of the study, participants will be provided a fitness tracker capable of recording sleep and exercise data. Subjects will also be restricted to eating only home cooked food. This stipulation does not restrict participants to only unprocessed foods, but rather they must eat from home to

record nutrient content from Nutrition Facts labels.

After each subject has recorded seven days of diet and exercise data, he will receive a survey including questions about physical health, mental health, and diet perceptions. Following Bianchi *et al.* (2004), the surveys will be self-administered, but trained personnel will check for completeness of data and interview participants about missing information without forcing answers. Also similar to Bianchi *et al.* (2004), the survey will ask about symptoms usually present in patients with thyroid diseases, including other associated diseases, muscle cramps, fatigue, and sleep disturbances. For the purposes of this study, a sleep disturbance will be defined as an instance of falling asleep late, waking up frequently at night, or awakening unusually early.

Measures

I will compare each participant's levels of thyroid hormone and urinary iodine, with the expectation that subjects with lower thyroid hormone levels will also have lower levels of iodine and other dietary nutrients. Using previously established methods (Pontzer *et al.*, 2012), I will measure total energy expenditure (TEE) in kcal/day using the doubly labeled water (DLW) method, which allows for the measurement of metabolism and water loss throughout regular daily activity (Pontzer *et al.*, 2012). TEE will be calculated daily during the same week participants self-report their diet and exercise. Physical activity level (PAL) will be calculated as TEE /estimated BMR for each subject (Pontzer *et al.*, 2012). To assess health in general, I will compute two scores—physical and mental—for each subject based on his survey responses (Bianchi *et al.*, 2004). I will then compare the results found in the thyroid ailment group and the control group.

Expectations

Individuals with diagnosed thyroid conditions are expected to have a less active lifestyle and a less nutritious diet compared to those in the control group. Because of the thyroid's connection to mood and mental health, I also predict that the diagnosed thyroid ailment group will have a greater number of subjects who report having mental health conditions or perceive their mental health negatively.

Conclusion

Much remains to be known about the thyroid, its hormones, and its role in human evolutionary history. My research will approach the study of thyroid function from one perspective—how the modern Western diet's effects on the thyroid may lead to a cascade of other health consequences—thus leaving many questions to be answered. These questions include how the thyroid mediates the effect of nutritional deficiencies on brain development in children, whether the effects of a poor diet early in life can be corrected in late childhood and adolescence, and how socioeconomic status impacts thyroid health throughout the lifespan. This research will have critical implications for the health of neglected children and low-income families.

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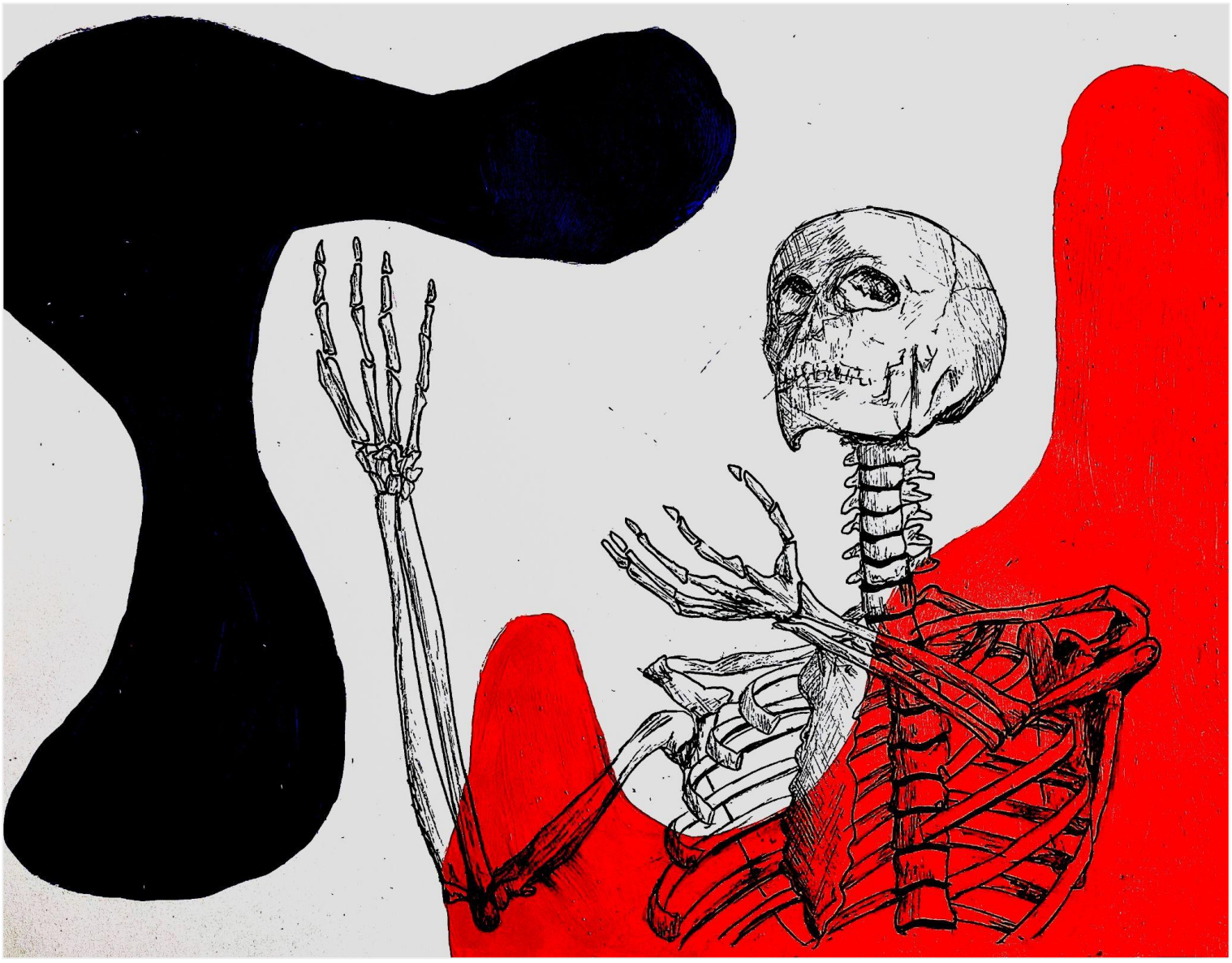

Lizzie Clark

Bone Theory

Julian Pecht, Columbia University

Author's note: The following is the excerpted first half of my senior thesis, *Bone Theory: Life, Death, and Life Again in Virgil's* Ossa. In this part of the paper, I isolate patterns in Virgil's mentions of bones, and I argue that Virgil uses ideas and language borrowed from Lucretius to turn bones into symbols of fluctuations of life. In the non-excerpted second half, I expand the consideration of bones in the *Aeneid* with regard to physiologies and customs beyond Lucretius, to better understand why bones are a natural source for symbolism of death and rebirth.

1

Although the *Aeneid* has been covered seemingly endlessly in modern scholarship, the topic of bones in the *Aeneid* has not quite been beaten to death. This paper seeks to explore the significances attributed to bones within Virgil's poem, drawing from close readings of the *Aeneid*, comparisons with other texts, and cultural/scientific associations with bones in classical antiquity. It seeks to prove that, within the *Aeneid*, Virgil exploits the strong links bones have to both death and life, thus creating a series of parallels whereby both literal and metaphoric bones signify the life that comes after death. This metaphor of bones is introduced in the *Aeneid* to support a larger theme found across Virgil's works, as argued by Llewelyn Morgan, that destruction is at times necessary for the creation of new life (Morgan, 1999).

The standard word for bones in Latin is *ossa*. *Ossa* and its declined forms appear 32 times in the *Aeneid*, always in the plural (McMenomy, 2016). Not all mentions of *ossa* in the *Aeneid* are relevant to the argument ahead, but, for the sake of this paper, *ossa* can be seen as falling into four thematic groups. The first irrelevant thematic grouping is the four mentions of *ossa* as being broken during battle sequences across Books Ten and Eleven. These uses of *ossa* add gory detail to the fights, such as when at 10.415-6 the warrior Halaesus *saxo ferit ora Thoantis / ossaquae dispersit cerebro permixta cruento* ("With a stone he shattered Thoas's face and scattered the bones mixed with bloody brain").[1] Five occurrences of *ossa* seem to be mostly random, and might be thought to make up an athematic group. For example, in a song about Hercules, the figure of the *ianitor Orci / ossa super recubans antro semesa cruento* ("doorkeeper of Orcus lying above half-eaten bones in a bloody cave") is invoked (*Aen.* 8.296-7). There is also Entellus, the boxer of the funeral games, who *magna ossa lacertosque / exuit* ("stripped his great bones and arms") (5.425-6). These athematic *ossa* clearly have little connection with each other, and, alongside the bones in battle, are mostly not worth exploring further.[2] The other two thematic groupings are the focus of this paper, and will henceforth be referred to as "living bones" and "dead bones." The grouping of living bones involves, to varying degrees, emotions and temperature interacting with *ossa* in living bodies; these occur 13 times in the *Aeneid*. The grouping of dead bones revolves around bones in specifically funerary contexts, and occurs ten times.

Living bones appear in scenes that link together *ossa*, specific emotions, and temperature. The grouping can be further

[1] The other instances of such *ossa* can be found at 10.384, 11.696, and 11.816.

[2] The other athematic occurrences of *ossa* are 4.625, 5.480, and 5.865. Although 4.625 is included with the athematic bones, it will eventually become relevant to this paper's findings.

divided into two categories: *ossa* with hot emotions, and *ossa* with cold emotions. The very first appearance of *ossa* in the *Aeneid* occurs in a scene of hot emotions, when Venus plots that Cupid *...donisque furentem / incendat reginam atque ossibus implicet ignem* ("shall kindle the raging queen with gifts and entangle fire within her bones") (1.659-60). Venus's plan is for Cupid to make Dido fall in love with Aeneas. As a means of illustration, Virgil brings in *ossa*: kindled, desirous of Aeneas, Dido has her very bones mixed with fire as a way to show how deep this love will reach. In Book Four, Venus's plan takes full effect, when Juno tells her *...habes, tota quod mente petisti: / ardet amans Dido traxitque per ossa furorem* ("you have everything which you had in mind: Dido burns in love and trags a fury through her bones") (4.100-1). In Book One, Venus wanted Dido to burn and become *furentem* because of her love; in Book Four Dido burns, is described as *amans*, and drags *furor* itself through her *ossa*. The effects of *amor* and *furor* are described with words signifying fire and heat, and those effects are located in the *ossa*. Another instance of hot *amor* affecting bones comes when Venus embraces Vulcan. Virgil writes, *ille repente / accepit solitam flammam, notusque medullas / intravit calor et labefacta per ossa cucurrit* ("he suddenly accepted the accustomed flame, and heat entered and ran through his weakened bones") (8.388-90). Venus's love causes *solitam flammam*, and this is marked in Vulcan's body through heat (*calor*) entering his marrow (*medulla*) and running through his *ossa*. Once more, bones are marked as the recipients of intense, hot emotion. Both Dido and Vulcan, pushed into love, feel the effects in their *ossa*, effects which are coded in hot and fiery language.

Love is not the only emotion joined to both heat and bones. During the ship race in Book Five, Gyas becomes agitated in the performance of his ship and crew. Virgil writes, *tum vero exarsit iuveni dolor ossibus ingens* ("then truly a huge pain burned in the bones of the youth") (8.172). This time it is *dolor*, an angry pain, that burns in *ossa*. Likewise, when Turnus approaches the walls of the Trojan camp much later in the poem, Virgil writes, *haud aliter Rutulo muros et castra tuenti / ignescunt irae, duris dolor ossibus ardet* ("hardly otherwise wraths burned in the Rutulian looking upon the walls and the camps, pain burns in his hard bones") (9.65-6). Anger is linked to the *ossa* here, with the phrases *ignescunt irae* and *dolor...ardet* providing the mix of emotion and heat. And another instance of burning bones separates the idea of *furor* from *amor*, which are found linked in Dido's burning *ossa*. In Book Seven, the fury Allecto stirs up trouble among the Latins, going first to Amata. She sends a snake to poison Amata, and Virgil writes,

> ac dum prima lues udo
> sublapsa veneno /
> pertempat sensus atque
> ossibus implicat ignem /
> necdum animus toto percepit
> pectore flammam, /
> mollius et solito matrum de
> more locuta est
> (*Aen*. 7.354-7)

> And while first the
> pestilence, slipping in with
> wet poison, tries her senses
> and wraps fire into her bones,
> not yet has her spirit fully
> taken the flame in her chest,
> and she spoke softly, in the
> way customary of mothers...

Once again, fire is joined to bones. In fact, the clause *ossibus implicat ignem* is nearly identical to 1.660, where Cupid *ossibus implicet ignem*. The imagery of fire being

wrapped into bones is repeated, and once again affects a queen. But Amata does not appear to be affected in the same way as Dido. A few lines earlier, Allecto *[in] sinum praecordia ad intima subdit, / quo furibunda domum monstro permisceat omnem;* that is, "she places the snake onto Amata's lap, towards her innermost heart, so that, maddened by this monster, [Amata] may disturb the entire house" (7.347-8). The word *furibunda* links Amata with *furor*, and likewise in line 350 Amata is described with the word *furentem*. But her actions are decidedly not frenzied. She talks, and talks softly (*mollius*) at that. The fire is joined to her bones, but it does not have the same result as in the other examples. Unlike Dido, she does not rage; the *furor* is present in name, but not yet in action. Once she stops speaking, however, the *furor* begins. Virgil describes the scene as follows:

> His ubi nequiquam dictis
> experta Latinum /
> contra stare videt, penitusque
> in viscera lapsum /
> serpentis furiale malum
> totamque pererrat, /
> tum vero infelix ingentibus
> excita monstris /
> immensam sine more furit
> lymphata per urbem
> (*Aen*. 7.373-7)

> When having tried in vain
> with these words she sees
> that Latinus stands opposing,
> and fallen deep within her
> organs the serpent's furied
> evil roams through her
> entirely, then truly
> misfortunate and roused by
> great monstrosities she
> frantically rages without
> delay through the vast city.

After having spoken, Amata is now described as *lymphata*, and she finally embraces *furor* in the form of *furit*. Why exactly it takes this long for Amata's *furor* to set off—as compared to the previous instances of hot emotions in *ossa*, which all appeared to have instantaneous effects—can be found in the physiological process Virgil ascribes to Allecto's poison. In line 7.356, Virgil is clear to note that although Amata's bones were wrapped in fire, *necdum animus toto percepit pectore flammam*. The poison is in Amata's *ossa*, but not in her *animus* or *pectora*. By the time she has finished speaking, however, the poison is in her *viscera* and goes through all (*totam*) of Amata. The poison is in her whole body, including her *animus*, and she now is able to rage. The effects of the poison are dependent upon where in the body it reaches. The realization of *furor* in Amata is thus the result of a process based in some kind of physiology. This physiology, however, does not come from Virgil himself. Instead, the physiology that characterizes the effect of emotions in living bones comes from the writings of Lucretius.

2

The mechanisms of emotional *ossa* found within the *Aeneid* appear to be derived from Lucretius's *De Rerum Natura*, specifically Book Three. This book is not about bones, but broadly about the nature of the *animus* and the *anima* within the body at large. Lucretius notes that the *animus* and the *anima* are *coniuncta teneri / inter se atque unam naturam conficere ex se, / sed caput esse quasi et dominari in corpore toto / consilium quod nos animum mentemque vocamus* ("[the *animus* and the *anima*] are held as joined among themselves and make up one nature from themselves, but what we call the spirit [*animum*] and mind is the head, as it were, and the counsel that rules in the whole body") (*DRN* 3.136-9). The two

are joined and of one nature, but still the *animus* is specifically what controls the body. The *animus* is located *media regione in pectoris* ("in the middle part of the chest") (3.140), while the *anima* is located throughout the body itself: *ergo animam totam perparvis esse necesset / seminibus, nexam per venas viscera nervos* ("therefore it is necessary that the whole animus is in tiny seeds, bound through veins, organs, sinews") (3.216-7). Yet the *animus* and the *anima* are connected to *ossa*; Lucretius makes this clear by writing, *sic anima atque animus per se nil posse videtur, / nimirum quia per venas et viscera mixtim, / per nervos atque ossa, [primordia] tenentur corpore ab omni* ("thus the *anima* and the *animus* seem to capable of nothing through themselves, but no matter, since mixed through veins and organs, through sinews and bones, their first elements are contained in the whole body") (3.565-7).[3] The origin of the *animus* and *anima* are related to the *venae*, the *viscera*, the *nervos*, and the *ossa*, and cannot be separated from those parts of the body. Still, there appears to be some form of distance between *ossa* and the *animus* and *anima*. In fact, *ossa* appear to be the least connected part of the body to the *animus* and the *anima*. When describing how the *animus* directs the body in sensation, Lucretius writes,

> sensiferos motus quae didit
> prima per artus, /
> prima cietur enim, parvis
> perfecta figuris; /
> inde calor motus et venti
> caeca potestas /
> accipit, inde aer; inde omnia
> mobilitantur: /
> concutitur sanguis, tum
> viscera persentiscunt /
> omnia, postremis datur
> ossibus atque medullis /
> sive voluptas est sive est
> contrarius ardor
>
> (*DRN* 3.245-51)

> ...and this first distributes the
> sense-giving motions through
> the limbs. For this is first set
> in motion, being composed of
> small shapes; after that, heat
> takes on the movement, and
> the unseen power of wind,
> then the air; after which all is
> set in movement, the blood is
> agitated, the flesh is all
> thrilled through with feeling,
> last is communicated to bone
> and marrow it may be the
> pleasure, it may be the
> opposite excitement.
>
> (Rouse, 1924, p. 207)

There is a mix of *calor* and *ventus* and *aer* that leads to the stimulation of *sanguis*, *viscera*, and then finally *ossa*. What starts in the *animus* finishes in the *ossa* and the *medulla*. There is thus a connection between the *animus* and the *anima* and *ossa* and *medulla*, even though to Lucretius the latter seem to be the furthest away from *animus* and *anima*.

The action stimulated by the Lucretian interplay of *animus* and *anima* and *ossa* takes the temperature-emotion coding that Virgil uses. In the passage above about *sensiferos motus*, one of the key elements is *calor*. As Lucretius goes on to write,

> Est etiam calor ille animo,
> quem sumit, in ira /
> cum fervescit et ex oculis
> micat acrius ardor; /
> est et frigida multa comes
> formidinis aura, /

[3] According to Pliny, the *pectus* was also considered *ossa* (*pectus, hoc est ossa*, *NH* 11.82.207).

quae ciet horrorem membris
et concitat artus
(*DRN* 3.288-91)

The mind has also that heat,
which it takes on when it
boils in wrath and fire flashes
more fiercely from the eyes;
it has also abundance of that
cold wind, fear's comrade,
which makes the limbs shiver
and stirs the frame…
(Rouse, 1924, p. 211)

Lucretius makes a clear distinction between the *calor* and the *frigida aura* in the *animus*. *Calor* is related to *ira* and *ardor*, all of which relate directly back to the hot emotions in the *Aeneid*. At *Aen.* 8.390, it was *calor* that entered Vulcan's bones when he is tempted by Venus. At 9.65, *irae* burn inside Turnus just as *dolor* burns—*ardet*—his bones. *Ardor* itself shares its root with *ardeo*, a verb which also appears in line 4.101 with *amans* Dido as subject, and in 5.172 with *dolor* as subject and Gyas's *ossa* as indirect object. Virgil thus clearly has picked up on the Lucretian vocabulary and framework in choosing either the exact same, or etymologically-related, words. He has pulled the mix of heat and passionate emotions directly from Lucretius, and then deployed them specifically into *ossa*-focused imagery.

Equally important is the reference to the *frigida aura*, which leads into the second subset of living bones: *ossa* with cold emotions. Once again, Lucretius had written *est et frigida multa comes formidinis aura, / quae ciet horrorem membris et concitat artus* (*DRN* 3.290-1). The *aura* is both *frigida* and a *comes formidinis*, a companion of fear. When Lucretius says fear can cause shuddering (*hororem*), and can agitate (*concitat*) the body, these shivering motions appear to play off the idea of being cold. Fear and cold, emotion and temperature, are thus linked. But there is another important aspect to how this cold emotion plays out: afraid bodies are described as being nonfunctional, almost dead. Lucretius describes in detail what happens when a person becomes too afraid:

verum ubi vementi magis est
commota metu mens, /
consentire animam totam per
membra videmus /
sudoresque ita palloremque
existere toto /
corpore et infringi linguam
vocemque aboriri, /
caligare oculos, sonere auris,
succidere artus, /
denique concidere ex animi
terrore videmus /
saepe homines...
(*DRN* 3.152-8)

But when the intelligence is
moved by more vehement
fear, we see the whole spirit
throughout the frame share in
the feeling: sweatings and
pallor hence arise over the
whole body, the speech falters,
the voice dies away, blackness
comes before the eyes, a
sounding is in the ears, the
limbs give way beneath; in a
word we often see men fall to
the ground for mental terror...
(Rouse, 1924, p. 201)

Cold imagery is an appropriate coordinate with fear, because becoming afraid makes one figuratively frozen. One cannot speak, see, or even stand up; the mind and body are not functional. Lucretius has described a person shutting down, likely fainting from fear; the body barely seems to work, as if the *animus* no longer has control. For Lucretius,

emotions of fear are linked to coldness and impact the body in a way that prevents action, almost recalling death.

Naturally, an examination of cold emotions in living *ossa* reveals that Virgil once again picks up on the physiology Lucretius has put forth. In Book Two of the *Aeneid*, Aeneas quotes the Greek soldier Sinon as saying about a group of Greeks terrified by a prophecy, *obstipuere animi, gelidusque per ima cucurrit / ossa tremor* ("their spirits were stunned, and a cold trembling ran through their innermost bones") (2.120-1). Their *animi* were stunned, and a frozen *tremor* ran through their bones. This mimics both Lucretius's paralyzing, almost deadening description of fear, as well as the tendency of fear to cause shivering. Similarly, in Book Six, Aeneas goes to consult the Sibyl, who notes that Aeneas says nothing and criticizes him for being inactive, asking, *cessas in vota precesque, / Tros...Aenea? Cessas?* ("Do you cease in offerings and prayers, Trojan Aeneas? Do you cease?") (6.51-2). In turn, Virgil writes, *gelidus Teucris per dura cucurrit / ossa tremor, funditque preces rex pectore ab imo* ("a cold trembling ran through the hard bones of the Trojans, and the king poured prayers from his innermost chest") (6.54-5). First, in the perfect tense, a cold *tremor* goes through the bones like in Book Two; then, in the present tense, Aeneas speaks. The *gelidus tremor* has once again reappeared within the *ossa*, and with it returns the Lucretian idea of a shaky fear that shuts down the body. In both instances, fear is linked to a freezing up localized within *ossa*; people who experience such a fear are not able to do anything. It is only when the fear passes that action can resume. A *gelidus tremor* runs through *ossa* once more much later, when Aeneas charges in battle and *videre Ausonii, gelidusque per ima cucurrit / ossa tremor* (the Ausonians saw, and a cold trembling ran through their innermost bones") (12.447-8). There is no explicit mention of the Ausonians becoming immobile, but the same phrasing of a *gelidus tremor* running through their *ossa* is used, so the idea of becoming paralyzed by fear is not far away.

The similarity between death and the state of fear becomes clearer when the Lucretian conception of dying is examined. When a person dies, Lucretius's physiology teaches that the *animus* and the *anima* leave the body: he states *sic animi atque animae naturam corpore toto / extrahere haud facile est, quin omnia dissoluantur* ("Thus it is hardly easy to draw out the nature of the *animus* and the *anima* from the whole body, since everything would be dissolved") (*DRN* 3.329-30). The *animus* and the *anima* must be in the body; if they should leave, life will end. The fatality of the *animus* leaving a body is clarified when Lucretius writes, *atque eadem [vita] rursum, cum corpora pauca caloris / diffugere forasque per os est editus aer, / deserit extemplo venas atque ossa relinquit* (3.121-3). This translates to "...and again when a few particles of heat have dispersed abroad and air is driven out through the mouth, the same life in a moment deserts the veins and leaves the bones" (Rouse, 1924, p. 197). Lucretius further elaborates, *est igitur calor ac ventus vitalis in ipso / corpore qui nobis moribundos deserit artus* ("there is therefore heat and a vital wind in the same body, which leaves our limbs when we are about to die") (3.128-9). *Calor*, *ventus*, and *aer* are the three components of the *animus* that initially drive motion in 3.245-51. When they leave the body, the body dies; likewise, when a body dies, they leave the body. Thus, for Lucretius, life within the *animus* is tied to heat, and death is characterized by the hot *animus* leaving the body. The *gelidus tremor* that runs through *ossa* paralyzes people in the *Aeneid* because, in Lucretian physiology, cold is deeply related to death, and the cold

emotion of fear thus brings one to a state of near death.

But the *gelidus tremor* is not the only example of cold emotions with *ossa* in the *Aeneid*. When Andromache sees Aeneas and other Trojans approaching in Buthrotum, Virgil narrates *magnis exterrita monstris / deriguit visu in medio, calor ossa reliquit, / labitur et longo vix tandem tempore fatur* ("terrified by the great omens, she grew stiff in the middle of the sight, heat left her bones, she falls and at last, after a long time, scarcely she speaks") (3.307-9). Andromache is afraid, she stiffens, *calor ossa reliquit*, and she seems to faint, such that it takes some time until she is able to speak. This form of fear is not linked to a coldness like the *gelidus tremor*, but rather it is signalled by the loss of heat (*calor*) from her *ossa*. The phrase *calor ossa reliquit* reappears in Book Nine, when Euryalus's mother learns of her son's death. Virgil writes, *at subitus miserae calor ossa reliquit, / excussi manibus radii revolutaque pensa* ("but suddenly heat left the bones of the wretched woman, the shuttles were shaken from her hands and the wool unwound") (9.475-6). Again, heat leaves the bones of a person experiencing a traumatic, emotional moment. No explicit form of fear is invoked (although the city she is in is described as a *pavidam...urbem* at 9.473), yet all the same the lack of heat combined with the disruption of her weaving can be interpreted as the cessation of action that results from cold emotion. In both instances of *calor ossa reliquit*, the disappearance of heat leads to inaction—a state which rather resembles death. Recall Lucretius's lines, *atque eadem [vita] rursum, cum corpora pauca caloris / diffugere forasque per os est editus aer, / deserit extemplo venas atque ossa relinquit* (*DRN* 3.121-3). When the *calor* is gone, *vita...ossa relinquit*. *Calor* is deeply tied up with the *animus*, and thus with living and ability to function. With the phrase *calor ossa reliquit*, Virgil echoes the Lucretian language of death, but substitutes *calor* for life itself; after all, the owners of these *ossa* do not actually die, but enter a state near death. The phrase *calor ossa reliquit* is a simplification of *DRN* 3.121-3, but the simplification specifically emphasizes *calor* and *ossa*. Cold fear in one's *ossa* inhibits the *animus*'s ability to cause action and brings about a death-like state in the *Aeneid* because, as found in Lucretius's physiology, losing heat in one's *ossa* is a mark of death—the loss of the *animus*. Throughout the *Aeneid*, then, Virgil links coldness or the loss of heat with *ossa* to signify that whoever experiences such a cold emotion becomes almost dead.

3

By contrast, we can now see that associating *ossa* with the fiery, hot emotions of *amor*, *furor*, and *dolor* is, in Lucretian terms, a way of linking those *ossa* with life. The *animus* and *anima* are linked with heat, and as long as that heat is within one's body that person is alive. Each instance of someone burning in their *ossa* is an affirmation of the life within said person. This life is connected to pain and anger and madness, but it is life all the same. Still, there is more to heat and *ossa* than just that. In addition to the phrase *calor ossa reliquit*, Virgil also has another temperature/emotion pairing leaving bones: *pavor*. When Aeneas comes across the mutilated body of Polydorus, he says, *postquam pavor ossa reliquit, / delectos populi ad proceres primumque parentem / monstra deum refero et, quae sit sententia, posco* ("after fear left my bones, I relate the omens of the gods to the chosen chiefs of the people and to my father, and I ask what their opinion is") (3.57-9). Although Aeneas had been afraid, the *pavor* leaves his bones, and after that he is able to act. This mirrors the framework established by the cold emotions that inhibit

action: after the fear, a typically cold emotion, passes, the no-longer afraid person can act. *Pavor ossa reliquit* thus acts as the opposite to *calor ossa reliquit*. In the latter phrase, heat leaves and the fearful, cold body becomes immobilized. In the former phrase, fear—a cold emotion—leaves, and the body is able to act. Whereas *calor ossa reliquit* is a sign that a body is closer to death, *pavor ossa reliquit* is a sign of a body more alive than before. When heat leaves bones, the bodies become closer to death, and when cold leaves bones, the bodies become closer to life.

By adding in the phrase *pavor ossa reliquit*, Virgil has taken the framework of Lucretian physiology, but has made a leap beyond what Lucretius does: through the application of heat, bones and bodies can become more animated than they had just been. A close reading of one *ossa*-related example in Book Seven shows how this works in miniature. After the fury Allecto has visited Amata and disturbed the queen, she visits a sleeping Turnus in his dreams. Virgil writes, *Talibus Allecto dictis exarsit in iras. / at iuveni oranti subitus tremor occupat artus, / deriguere oculi* ("With such words spoken, Allecto burned in wrath. But a sudden trembling takes up the limbs of the praying youth, his eyes have become rigid") (*Aen.* 7.445-7). Allecto burns, but fear still takes hold of Turnus. Although Allecto is coded in hot emotions, Turnus is afraid, a cold emotion. The heat, and thus life, is in Allecto; Turnus, separated by the conjunction *at*, is in the deader, colder state. Allecto is then described as *flammea torquens / lumina* ("twisting fiery eyes"), while Turnus is *cunctantem et quaerentem dicere plura* ("delaying and looking for more to say") (7.448-9). She is heated and mobile; he still cannot fully act. But then Allecto goes further:

> Sic effata facem iuveni
> coniecit et atro /
> lumine fumantis fixit sub
> pectore taedas. /
> olli somnum ingens rumpit
> pavor, ossaque et artus /
> perfundit toto proruptus
> corpore sudor. /
> arma amens fremit, arma toro
> tectisque requirit; /
> saevit amor ferri et scelerata
> insania belli, /
> ira super:
>
> (*Aen*. 7.456-62)

> Thus having spoken she
> threw the torch at the youth
> and fixed under his chest the
> torches smoking with black
> light. A huge terror breaks his
> sleep, and sweat drenched his
> bones and limbs, bursting
> from his entire body. Mad he
> roars for arms, he seeks arms
> in the couch and rooms; love
> of iron rages, and the wicked
> madness of war, and wrath
> beyond.

On the surface, this is a confusing usage of *pavor*. Throughout the rest of the poem words of fear are linked to coldness and inaction, but here Turnus is immediately spurred into action. It seems like a contradiction that here *pavor* is phrased as if it were a hot emotion. What this scene really shows, however, is the power of hot emotions overcoming a cold emotion. When Virgil notes that a *sudor* covers Turnus's *ossa* and *artus*, he is again echoing Lucretius's description of fear-induced fainting quoted earlier: *sudoresque ita palloremque existere toto / corpore* (*DRN* 3.154). The fear does bring Turnus to this near death state. Still, the heat is enough to bring him directly out of it. Allecto pierces

him with a torch, a quite literal bringer of heat. After the *pavor* comes *amor* and *ira super*—two emotions previously connected to heat. It is not the *pavor* that stirs Turnus to arms, but the overwhelming amount of hot emotion that surpasses the *pavor*. The heat is able to overcome the deathlike trappings of cold emotions and bring Turnus firmly into the realm of the living. This scene is an extended version of *pavor ossa reliquit*. In both instances, through the fluctuations of temperature, a body becomes more alive the hotter it gets. Heat applied to cold *ossa* will bring a stronger presence of life.

Within living *ossa*, then, approaching death is not categorical, but rather part of a spectrum. Fiery bones might mean a person is especially alive, driven by *amor* or *furor* or *dolor*, but the *calor* can always leave the *ossa*. Likewise, despite being able to enter a cold, deathlike state, *ossa* can always become more alive through heat. The fact that this is done under the guise of strong Lucretian influence is fitting: by using the physiological framework established in *De Rerum Natura* Book Three, Virgil has created a typical "Virgilian *transposition* or *inversion* of Lucretian themes," which Philip Hardie argues appears all throughout the *Georgics* and the *Aeneid* (Hardie, 1986, p. 159). After all, despite the intense amount of influence Lucretius exerted on Virgil, Virgil does not always agree with Epicurean ideas. As the opening 93 lines of *De Rerum Natura* Book Three make clear, the point of that book is to dispel the fear of death from the living, and after proving that the soul does not live on after death, Lucretius concludes at 3.830, *Nil igitur mors est ad nos neque pertinet hilum* ("Therefore, death is nothing to us, nor does it matter one bit"). In proving that there is no afterlife, that death is final and nothing beyond it matters, Lucretius hopes to rid people of their fear of it. Virgil's usage of Lucretian physiology from Book Three as the model for his *ossa* that fluctuate between life and death is thus incredibly pointed. As Hardie writes, "Radical inversion is a powerful type of imitation, which directs our attention to the relationship between the earlier and the later works even more forcibly than do simpler forms of imitation" (Hardie, 1986, p. 167). Virgil thus invokes Lucretius in the emotional bones to bring Lucretius's ideas of mortality to mind, but then subverts those ideas by using the emotional bones to show how *ossa* are not quite as straightforward as that. Of course, the people whose *ossa* act as conduits of emotion are never actually dead. But the fluctuation of temperature, emotion, and closeness to life and death within these *ossa* is a signal that life and death are not as static for *ossa* as it initially might seem.

Thus far, in the case of *ossa* that are found in living bodies, it can be concluded that Virgil has used Lucretian physiology as a framework by which life and death fluctuate within *ossa*. When *ossa* burn in the context of *amor, furor*, *ira*, or *dolor*, they signal action and life by virtue of Lucretian physiology; when *ossa* are affected by cold fear, they signal inaction and death by the same physiological underpinnings. Through the balance of *calor ossa reliquit* and *pavor ossa reliquit*, however, Virgil purposefully expands on Lucretian physiology, such that in addition to the possibility of warmth leaving living *ossa* to draw them closer to death, warmth can be added to nearly dead *ossa* as a way to restore life. But what about when *ossa* are not nearly dead, but actually dead?

4

The second relevant grouping of *ossa*, as mentioned at the beginning of this paper, is dead bones. These are the *ossa* that are invoked specifically as bones which have been cremated in a funeral. This

grouping first appears in Book Five, when Aeneas and the Trojans change their course to Sicily, where Anchises died. Aeneas exclaims, *...an sit mihi gratior ulla, /...quam quae Dardanium tellus mihi servat Acesten / et patris Anchisae gremio complectitur ossa*' ("what would be more pleasing to me, than the land which protects Dardanian Acestes for me and holds the bones of my father Anchises in its lap?") (*Aen.* 5.28-31). Shortly after, Aeneas remarks that it has been a year *ex quo reliquias divinique ossa parentis / condidimus terra*... ("since we stored the relics and bones of my divine father in the earth") (5.47-8). And, one more time, Aeneas emphasizes that he and his men are present *ad cineres ipsius et ossa parentis* ("at the ash and bones of my very father") (5.55). The *ossa* and *cineres* held together in Sicily represent Anchises's post-burial state after having been burned in a pyre and honored according to the common funerary practice. Virgil provides a clearer picture of what these practices entailed through the funeral of Misenus. The Trojans set up a pyre, place Misenus's body, and *postquam conlapsi cineres et flamma quievit, / reliquias vino et bibulam lavere favillam, / ossaque lecta cado texit Corynaeus aëno* (after the ashes fell and the flames quieted, they washed the relics and thirsty ash with wine, and Corynaeus covered the collected bones in a bronze jar") (6.226-8). Once again, the *ossa* here are the marker of the dead body, of what is left behind. This language is echoed later in the poem when the Latins perform mass funerals: *maerentes altum cinerem et confusa ruebant / ossa focis tepidoque onerabant aggere terrae* ("grieving, they went through the deep ash and the intermingled bones in the fireplaces and piled above them a warm mound of earth") (11.211-2). The Latins separate ashes and bones from the fires, and then cover them with earth. In these instances, *ossa* appear as the direct product of funerals and thus as a marker for a body having died. The bones in this grouping are not indicators of any kind of living, but rather are symbols for the opposite: death.

But tied up within dead bones is a new term: *reliquiae*. Literally meaning something left behind, *reliquiae* is a catch-all term that often refers to the collection of bones and ash after cremation (Lewis and Short, 1879). At 5.47, Aeneas had mentioned *reliquias...ossaque*, but lest this be understood that *reliquiae* means only ash, at 6.226-8, Virgil mentioned in succession *cineres*, *reliquiae*, *favilla*, and *ossa*. Thus *reliquiae* are the collection of both *ossa* and ash.[4] *Reliquiae* as referring to the dead occur twice else in the *Aeneid*, first at 4.342-3 when Aeneas tells Dido he wished *urbem Troianam primum dulcisque meorum / reliquias colerem* ("I were tending first to the city of Troy and the sweet relics of my ancestors"), and again at 8.356, when Evander says to Aeneas, *reliquias veterumque vides monumenta virorum* ("You see the relics and monuments of older men"). But *reliquiae* have another meaning within the *Aeneid*.

As it turns out, *reliquiae* is commonly found in the *Aeneid* to refer to Aeneas and the surviving Trojans

[4] Although this paper is concerned primarily with the *ossa* component of *reliquiae* and how that connects to new life, it is worthwhile to note cursorily that ash can also have connections to creating life. Wood ash was used as a fertilizer by Roman farmers (White, 1970, p. 141-143). Virgil himself advocates for the use of ash fertilizer and even recommends burning down fields to increase fertility in *G.* 1.81-93; intriguingly, he seems to be the only extant author who recommends the latter practice (White, 1970, p. 141). Roman funerary inscriptions sometimes link being cremated with becoming one with the earth and retaining a kind of life; Toynbee notes an inscription *cinis sum cinis terra est terra dea est ergo ego mortua non sum* ("I am ash ash is earth earth is a goddess therefore I am not mortal"), as well as "imagery of bones or ashes giving birth to flowers" (Toynbee, 1971, p. 37).

themselves. Early in Book One, Juno is described as preventing the Trojans from reaching Latium; the Trojans are specifically referred to as *Troas, reliquias Danaum atque immitis Achilli* ("Trojans, leftovers [*reliquias*] of the Greeks and cruel Achilles") (1.30). Aeneas himself uses the phrase *reliquias Danaum* when he first meets Dido (1.598). These Trojans have escaped the slaughter of the Greeks. They are *reliquiae* in the sense that they alone survived compared to the rest of Troy—they did not leave behind life, but rather death. Virgil even calls attention to these opposing notions of *reliquiae* when he writes, *non media de gente Phrygum exedisse nefandis / urbem odiis satis est, nec poenam traxe per omnem / reliquias Troiae; cineres atque ossa peremptae / Insequitur* (5.785-8). This translates to "It is not enough that from the middle of the race of Phrygians [Juno] has devoured the city with unspeakable hatred, nor that she drags the remnants of Troy through every punishment: she seeks the ash and bones of destroyed Troy." Juno has punished the *reliquias Troiae*, but she will not stop until she reduces them to literal *cineres* and *ossa*. Juno pursues the living *reliquiae*, wishing for them to become dead *reliquiae*. Through this double invocation of *reliquiae*, Virgil calls attention to the fact that the word itself connotes both life and death, depending on the circumstances. Sometimes *reliquiae* are dead, and sometimes they are alive.

A connection becomes apparent between the emotion-affected living bones and *reliquiae* as both a blanket term for dead bones and a metaphor for the surviving Trojans. *Ossa* in living bodies can become more dead or alive depending on whether they burn. *Reliquiae* are the result of burning dead bodies until only *ossa* and ash are left, but also a word that signifies the survivors of a destructive event. Not only that, but fire plays just as large a role in destroying Troy as do the Greeks: for one example out of many, in his retelling of the end of the Trojan War, Aeneas says, *Tum vero omne mihi visum considere in ignis / Ilium et ex imo verti Neptunia Troia* ("Then truly all of Ilium and Neptunian Troy seemed to me to fall into fire, even from the highest roof") (*Aen.* 2.624-5). *Reliquiae* make a fitting metaphor for the Trojan survivors because the fall of Troy is analogous to a funeral pyre: it burns down and takes the dead with it, but leaves behind survivors as living *reliquiae*. These living *reliquiae* have experienced the flames of a pyre in the form of Troy, but they come through alive. Furthermore, the word *reliquiae* clearly brings to mind the word *reliquit* (the two are etymologically related), which was precisely the operative word in the dual phrases of *calor ossa reliquit* and *pavor ossa reliquit*. Just as the word *reliquit* was at the heart of the fluctuation between life and death within *ossa*, and the ability for life to return to nearly dead *ossa*, the word *reliquiae* is at the heart of a metaphor whereby living humans are equated to burnt bones. There is thus a correspondence within both the living *ossa* and the living *reliquiae*, where fire is the operative mode of restoring life. The task now is to understand how these two conceptions of burnt bones, the first literal and rooted in Lucretian physiology, and the second more straightforwardly metaphorical, are in fact related.

It has previously been noted that in importing Lucretian physiology into the *Aeneid* with the emotional bones, Virgil has given *ossa* an outsized prominence in comparison to how Lucretius treats them, all to invert Lucretius's point about the finality of death. In considering the relationship between the *Georgics* and *De Rerum Natura*, Philip Hardie considers several important points of Lucretius's influence on Virgil. One is especially relevant:

> In both Virgil and Lucretius a deliberate and sustained parallelism is established between different levels or spheres of reality, for example between the inanimate natural world and the animal world, or between the natural world (taken as a whole) and the human world.
> (Hardie, 1986, p. 167)

Turning to the *Aeneid* itself, Hardie notes that there is an "*equipollence of levels,*" whereby "the action is carried on simultaneously on a number of levels which can largely be translated into each other's terms" (Hardie, 1986, p. 223). Another crucial influence of Lucretius on Virgil is that, per Hardie, "Virgilian use of imagery is largely dependent on a *scientific* use of analogy" (Hardie, 1986, p. 231).The result is that even though Virgil does not always write with Epicurean physics in mind, both he and Lucretius "abolish the disjunction between scientific and poetic ways of recording phenomena" (Hardie, 1986, p. 223). As a result, we might expect to see a similar type of scientific-based analogy at play within the imagery of *reliquiae* as survivors, as in the case of the emotional *ossa*. Considering that Virgil has already played up Lucretian ideas in his emotional *ossa*, and considering the strong links already existing between those *ossa* and the *reliquiae* qua Trojan survivors, it is not a leap to recognize a Lucretian-influenced parallelism between the *ossa* and the *reliquiae*. Already we see a broad parallelism in the mix of fire, bones, and life. But it will prove even more illuminating to examine *reliquiae* both metaphorically and scientifically, and see how that relates to the way emotional *ossa* undercut the finality of death as propounded by Lucretius.

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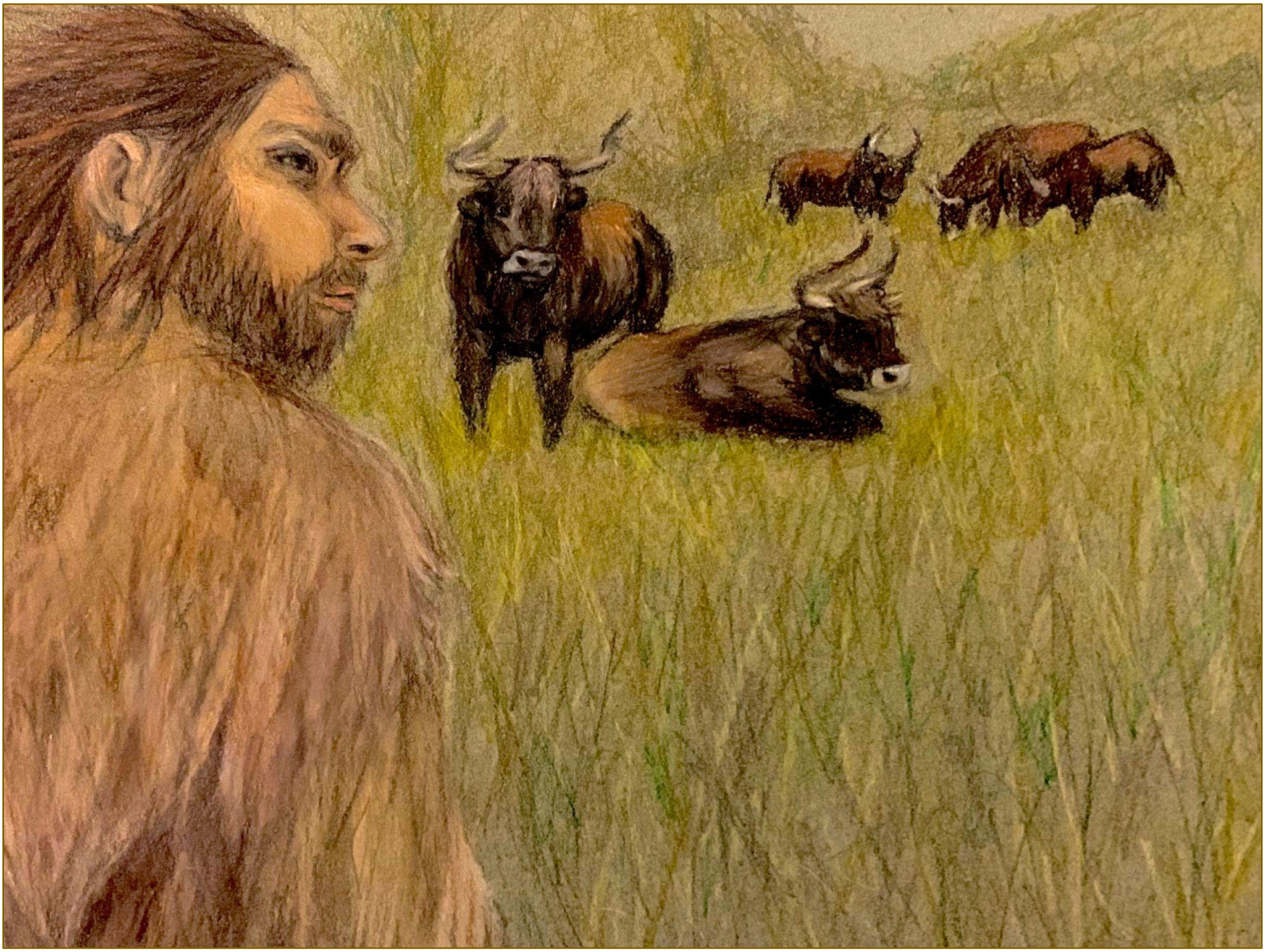

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Maximal Speculation: *Neandertal the Mobile-Herder* as a Test Case for a New Paleoarchaeological Methodology

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Introduction

The unfavorable preservation bias at Paleolithic time-depth encourages risk-averse interpretations, the use of calcified vocabulary, and an avoidance of research where evidence is thin. Within the academic literature there is a relentless pressure to propose only the most likely ideas from fear that any hypothesis without clear and concrete evidence is unjustified. But what is the alternative? Maximizing speculation in the creation of new hypotheses allows for greater opportunities to explore human experience in the remote past in new ways, and it can overturn the fossilized linguistic and theoretical conventions entrenched in paleoarchaeology. This paper attempts to apply a new risk-seeking approach to hypothesis development in contexts with weak archaeological preservation.

I propose a new methodology that I call *Maximal Speculation,* which asks, "What is the widest possible range of interpretations?" and "Can any of these be disproven or proven less likely?". By only requiring proof of impossibility rather than of possibility, this approach prevents more radical interpretations from languishing unexamined. Rather than attempting to *prove* a given hypothesis, an opposite statement is crafted with the goal of *disproving* a null hypothesis. This distinction allows researchers to build a body of indirect evidence when direct evidence is not available.

In Paleolithic archaeology, there is a reflex to advance only the most parsimonious hypotheses. This seems to stem from the axiomatic rationale that the simplest explanation is the most likely. Reality, however, is rife with complication. By allowing ourselves to gravitate towards explanations we perceive as simpler or more efficient, we actively overlook evidence that falls outside of our personal definitions of these ideas. The simplest explanation from the archaeologist's perspective cannot be the most likely, as it is inevitably based on incomplete information. Instead, taking the *Maximal Speculation* approach actively invests in including the outer limits of the possible in the discussion. This endeavor can feel infinite and unachievable, but it is not. The intent is not to exhaustively identify all possible explanations, but rather to discourage avoidance of the most extreme explanations.

Methodology

The first step is breaking all the rules. Consider measurements or artifacts without their researched contexts. Allow room for drawing wild and unfounded connections. Then test these extreme hypotheses with the available evidence to see whether they can be disproved. Any hypotheses that cannot be invalidated provides a valid avenue for future research.

Controversies born out of a lack of direct evidence can provide ideal opportunities for testing the methodology I am proposing. The treatment of Neandertals[1] as behaviorally human[2] despite their

[1] The common name Neandertal will be used interchangeably with *Homo sapiens neanderthalensis*.

[2] *Human* and *humanity* are used inclusively of all *Homo* species, subspecies, and lineages, except when they are specifically used to explain alternative uses of these labels.

taxonomic inclusion in the *Homo*[3] genus is a highly contentious topic and an ideal test case. Specifically, considering Neandertal mobility and subsistence, I will ask what alternative conclusions might be drawn from Neandertal evidence if it were assumed to come from the contexts of Anatomically Modern Humans[4] (AMHs). The literature on Neandertal sites points to short-term occupation (Moncel and Rivals, 2011; Picin *et al*., 2020); site reuse (Bargalló *et al*., 2020; Real *et al*., 2019; Sánchez-Hernández *et al*., 2014); big game hunting (Germonpré *et al*., 2014; Hortolà and Martínez-Navarro, 2013; Smith, 2015); and small community ranges (Moncel *et al*., 2019; Spinapolice, 2012; Turq *et al*., 2017) as characteristic of Neandertals. Archaeological evidence supporting these features includes shallow but repetitive stratigraphy (Real *et al*., 2019); extensive kills of herd animals and other large prey (Jarman *et al*., 1976; Smith, 2015); and lithic and isotopic markers that are often close to where tools and remains are found (Moncel *et al*., 2019). In an AMH context, frequent moves, site reuse, and a heavy reliance on herd species are remarkably reminiscent of the nomadic herding practices of mobile pastoralists (Barnard and Wendrich, 2008; Beach and Stammler, 2006; Berelov, 2006; Bernbeck, 2008; Goldstein, 2019; Jarman *et al*., 1976; Kelly, 1992). I will use this same evidence to build an unconventional hypothesis I have titled *Neandertal the Mobile-Herder*.

The next step in *Maximal Speculation* is to list the reasons that this hypothesis would typically be rejected without further testing. The most obvious may be the argument 1) that it is not appropriate to use *Homo sapiens sapiens* contexts as close analogies for interpreting Neandertal sites (Schörle, 2013; Speth and Tchernov, 1998; Turq *et al.*, 2017). The next is 2) the presumed *homebody*[5] lifestyle of Neandertals seems in direct conflict with a mobile pastoralist lifestyle of long-distance travel for seasonal fodder. A more indirect objection against my hypothesis is 3) that herding as a subsistence strategy arose out of domestication (Russell, 2002), and suggestions that it was invented or used outside of that context or timeline are seen as untenable. The final objection I'll address is 4) that because material lost from the archaeological record cannot be quantified, it should not be included in evidentiary arguments (Bruck *et al.*, 2012; Crossland, 2020; Sterling, 2015). This last point is a theoretical argument against the methodology itself, and although it is not restricted to the evidence of this particular case study, it can still be tested here. This list of objections is far from comprehensive, but it provides a sample of the ways that radical proposals, like *Neandertal the Mobile-Herder*, tend to be dismissed without examination. These four objections will be used to explore the literature and to attempt to disprove the null hypothesis that Neandertals could not have engaged in mobile herding.

[3] Living humans and our direct ancestors, when referenced collectively, and differentiated from other *Homo* species and subspecies, will be identified specifically as *Homo sapiens sapiens*.

[4] The term AMH (Anatomically Modern Human) will be used in this paper only to identify prehistoric human populations specifically designated as such in the literature. This label, however, is problematically speculative because it presumes unsubstantiated behavioral or cognitive differences between those prehistoric populations and living humans. I do not believe this is a productive distinction and I do not support subdivisions of any *Homo* species or subspecies based on behavioral categories.

[5] *Homebody* is my shorthand for the general idea of Neanderthal communities having compact ranges or territories (approximately one to two days of walking in diameter).

The *no analogy* objection

The first objection to address is the controversial position that it is misleading or even inappropriate to use AMH behaviors as interpretive analogies for Neandertal contexts (Benazzi *et al*., 2011; Mellars, 1999; Nowell, 2016; Otte, 2019; Speth, 2004; Sterling, 2015; Villa and Roebroeks, 2014; Wißing *et al.*, 2019; Wynn and Coolidge, 2004). This objection is justified as a general critique against taking evidence out of context. It is telling, however, that this complaint only runs in one direction: that of AMHs being used as analogy for Neandertals, but never over Neandertals being used as analogy for AMHs. By unspoken consensus, this second option never happens. There appears to be a persistent intent to rank Neandertals as somehow less human than *Homo sapiens sapiens*. This is done by segregating biology and behavior, and then treating a lack or low volume of evidence for specific behaviors, such as speech, art, symbolic expression, and ritual, as equivalent to evidence against behavioral and cognitive "modernity" (Schörle, 2013; Speth and Tchernov, 1998; Turq *et al*., 2017). How "modernity" is defined in these contexts seems chronically and intentionally vague, yet it is always attributed to the conveniently labeled Anatomically Modern Humans when they are compared to Neandertals (Benazzi *et al.*, 2011; Nowell, 2016; Villa and Roebroeks, 2014; Wißing *et al.*, 2019).

I see this is an attempt to use scientific classification to measure relative humanity (versus animality[6]) within the genus *Homo*, and to create and maintain a hierarchy of value that places living humans at the top. This argument also lays the groundwork for the racist practice of quantifying groups of living *Homo sapiens sapiens* as more or less animal. But the premise of this argument is scientifically unsupportable, because *Animalia* is a taxonomic classification within which we, as the genus *Homo,* fall. To be human is to be animal. No one would argue that humans are superior to organic life any more than they would argue a pin oak is less of a plant than a white oak, or zinc is more mineral than magnesium. No species or subspecies of *Homo* can be more or less animal than any other. Additionally, the list of supposed uniquely *Homo sapiens sapiens* traits and behaviors that have been documented across many animal species grows by the day. This list includes animal species with multiple dialects (Henry *et al.*, 2015), pop music in whale communities (Garland *et al*., 2017), dolphins having personal names (Barton, 2006), mongoose traditions (Müller and Cant, 2010), tactical deceit among chimps (Karg *et al.*, 2015), and even an archaeological record of changing stone tool use from monkeys (Falótico *et al.*, 2019).

Until we stop categorizing animal status as lesser than human and embrace this shared identification as useful, we will perpetually abuse it as a tool of discrimination: dividing humanity from itself, valuing some people over others. By actively rejecting false human-animal dichotomies and other unfounded but supposedly biological divisions like race, we also reject the accompanying opportunities for racism and bigotry. We embrace the potential to see ourselves more explicitly in our nearest evolutionary relatives, providing a rare and much needed point of access to their alterities.

What does this perspective mean for my *Neandertal the Mobile-Herder* hypothesis? It neutralizes the objection that *Homo sapiens sapiens* interpretations cannot apply to Neandertal evidence. This undermines the unspoken taboos against the application of ethnography and archaeology

[6] Within this paper any unqualified reference to animals applies equally to human and non-human animals.

from all *Homo sapiens sapiens* contexts to draw analogies for Neandertal research, and so grants theoretical permission to test whether the practice of mobile herding is applicable to Neandertals.

The *domestication chronology* objection

This second objection centers on the temporal relationship between the herding of non-human animals and the processes of domestication. It was previously thought that humans began domesticating plants for agriculture and later captured non-human animals to support farming, which eventually domesticated those animals as well; this was presumed to be the precursor to cities, then religion and culture, all leading to civilization (Braidwood, 1960). Although this theory has been overturned for a long time (Mannion, 1999; Schmidt *et al.*, 2010), herding still tends to be lumped with domestication activity, which leads to the presumption that domestication, or selective breeding more specifically, is a defining feature of herding activities or cultures (Jarman *et al*., 1976; Lega *et al*., 2016; Manning *et al.*, 2015; Marshall *et al*., 2014; Russell, 2002).

One of the results of selective breeding of domestic animals such as cattle, sheep, and pigs is that successive generations often become smaller than their wild counterparts (Manning *et al.*, 2015; Wilkins *et al.*, 2014). For this reason, archaeologists can use smaller relative bone size in animal carcasses to identify domesticated animals. This technique has been key to recognizing human activity where there is no evidence of constructed settlements, identifying the otherwise intangible presence of mobile herding communities (Manning *et al.*, 2015).

Biological changes have been heavily relied upon to identify domestication relationships between humans and non-humans. But domestication is a concept bound up in conflicting definitions of biological and behavioral parameters (Russell, 2002). It is important to clarify that behavioral domestication and biological domestication are not two halves of one whole. Behavioral domestication is the collection of behaviors within human/non-human relationships that has the potential to generate specific selective pressures, in turn leading to biological domestication (Russell, 2002). Biological domestication, in contrast, is a response to selective pressures that generates heritable phenotypic changes (Russell, 2002).

Recognizing these are separate processes, a necessary question is whether they always co-occur, or whether behavioral domestication can operate without giving rise to heritable biological change. Recent work has shown they do not always co-occur, as the morphological changes from biological domestication are specifically a result of the sexual selection of controlled breeding (Marshall *et al*., 2014). Although the intensive breeding practices of 19th century Europe prioritized reproductive isolation of domestic herds from wild individuals, prior to this period and elsewhere up to the present day, this has rarely been documented as a priority in herd management (Marshall *et al.*, 2014; Middleton, 2018). Evidence of a general unconcern for breed purity is particularly clear across donkey and camels herds around the world: domestic individuals are still regularly bred with wild ones, and wild stock is captured and tamed to fill out dwindling captive herds (Marshall *et al*., 2014). Although herding provides humans a platform for encouraging biological domestication, it does not require biologically domesticated animals or guarantee biological domestication. Thus, this invalidates the argument that Neandertals could not have engaged in

herding because domestic animals are not found in the Paleolithic record.

If domestication is not a requirement of herding, then what is? In this paper, herding is the intentional manipulation of herd animals, but this definition can be applied in different ways. As such, it is important to distinguish herding *practice* from herding *activity*. I define herding practice as a sustained interaction with a specific herd that does not terminate at slaughter. It is a means of managing an *ongoing relationship* with a herd. In contrast, I define herding activity as an individual act of managing a herd with an intention of immediate slaughter: in other words, it is a *technique of hunting*. This means that the relationship between hunting and herding can blur as much as that between herding and domestication, but discarded carcass assemblages at Neandertal sites provide a robust data set to evaluate the plausibility of herding as a part of the Neandertal repertoire of prey-animal management (Castel *et al*., 2014) by analyzing the kill patterns within them.

As already discussed, animals that have been only behaviorally and not biologically domesticated cannot be identified morphologically (Jarman *et al*., 1976; Manning *et al.*, 2015; Marshall *et al*., 2014; Russell, 2002). To compensate, methods of detecting behavioral domestication have been developed that look for patterns in the sex and age of butchered carcasses, on the basis that non-random kill patterns can be an indicator of herd management (Jarman *et al*., 1976). Thinking about how this might apply to Neandertal evidence, it is useful to know what specific kill patterns look like. In pastoralist societies that manage herds for meat, maintaining herd volume is a concern (Jarman *et al.*, 1976). As a result, herders must keep most of the females but only a few males for adequate reproduction (Jarman *et al.*, 1976). To maximize meat volume while minimizing time investment, the selected animals are slaughtered just as they reach maturity. This mix of priorities results in most of the slaughtered animals being young adults—referred to as "prime-age"—rather than immature or old individuals. A kill pattern of prime-age males yields the most meat, while having the least impact on the health and size of the rest of the herd (Jarman *et al.*, 1976).

What is particularly provocative is that this is the same kill pattern seen in intensive hunting of ungulates. If hunters need a high volume of kills or rely on an individual herd or species, regularly slaughtering whole populations will empty a landscape of that animal, thus precipitating a need for long-distance travel to find more (Jarman *et al*., 1976). Selective targeting of prime-age males preserves the herd population over time regardless of whether the species is wild or domestic (Jarman *et al.*, 1976). In contrast, if only a few animals are slaughtered at a time, or if the hunters are not relying on an individual herd or species, then they are free to kill more indiscriminately, prioritizing the easiest kill. This is called opportunistic hunting; it tends towards a different demographic pattern, typically the oldest and sickest individuals, or new mothers and their young (Jarman *et al.*, 1976). In opportunistic kill patterns, the only healthy and prime-age individuals hunted are usually females hampered with dependent young. Speth and Tchernov (1998) write that "Neandertals living in both Europe and the Near East after about 60,000 to 55,000 years ago were already effective hunters, preferentially targeting large, and potentially dangerous, prime-age adult prey. Thus, at least in this one critical behavioral dimension there is nothing demonstrably 'archaic' about the procurement practices of Levantine Neandertals" (p. 236). Based on this evidence, it is necessary to ask why

Neandertals are only ever credited with hunting, when we easily assume this same pattern in *Homo sapiens sapiens* contexts equates to herding.

Perhaps the species Neandertals were hunting were not conducive to herding practice. After all, cave bears and giant hyenas do not seem very likely to cooperate. But Neandertals did focus specifically on herds at times: "At Jonsac and La Pradelles hunting seems to have focused solely on reindeer for example" (Spikins *et al*., 2019, p. 109). And herd animals—specifically red deer, horses, and aurochs—were the preferred prey on the Iberian Peninsula (Picin and Carbonell, 2016). Additionally, at Spy Cave in Belgium, there is evidence that local Neandertals were regularly targeting baby mammoths based on the "high frequency of very young animals in the Spy age profiles" (Germonpré *et al*., 2014, p. 64). It is not yet understood, however, "how the Neanderthals at Spy managed to isolate nursing mammoth calves from their protective mothers" (Germonpré *et al*., 2014, p. 64). The mammoth example may sound like a pattern of opportunistic hunting, but mammoths, particularly babies of protective mothers, cannot be considered the easiest or quickest kill. This is a clear indication that Neandertals may not have taken an opportunistic hunting approach, since they were not killing the easiest available individuals.

Intensively targeted deer herds, in particular, seem to be a common thread across the Neandertal world (Castel *et al*., 2014). Could this actually be an indicator of more long-term, more intentional relationships with these herds? Nerissa Russel argues that "it is the wild, not domestication, that is problematic. When the wild is implicitly deemed as everything that is not domestic, we are left with a grab bag of [contradictory] human-animal relationships" (2002, p. 294). This begs the questions: what would it look like if Paleolithic humans *did* manage herds in ways that began to have biological impacts? Is domestication forever, or can once-domesticated species become feral again, leaving little or no evidence that domestication ever happened?

It sounds like fiction, but a feralized[7] species is one that, although directly descended from a domestic ancestor, has since evolved into a non-domestic organism, wild in both behavior and biology (Shao-jie *et al*., 2020). In contrast, wild species have no domestic ancestry or behavior (Shao-jie *et al*., 2020). Research into feralization has only been made possible with recent advances in genetic science, and only a handful of examples are known (Shao-jie *et al*., 2020). This process was presumed impossible prior to genetic studies, since the relative youth of most domestic species was thought to be insufficient time for evolution to reverse itself (Shao-jie *et al*., 2020). Domestic species' maladaptation to the behaviors needed for survival without human support was also thought to be an insurmountable barrier, since it has been repeatedly documented to cause population collapse before individuals could adapt behaviorally, let alone biologically (Shao-jie *et al*., 2020).

The ancestors of the modern dingo reached Australia roughly 8300 years ago, remaining completely isolated from wolves and other domestic dogs until only 200 years ago (Shao-jie *et al*., 2020). As a result, dingoes have evolved into a wild species, genetically and phenotypically distinct from their domestic ancestors and independent from human support for over eight thousand years (Shao-jie *et al*., 2020). The length of this isolation makes dingoes one of the clearest examples of feralization, although

[7] Feralized species are biologically rewilded, in contrast to feral individuals which are only behaviorally rewilded.

other partial examples have begun to come to light (Shao-jie *et al*., 2020). Based on this evidence, the dingo demonstrates that it is possible for a species which was previously biologically and behaviorally domestic to evolve into a fully feralized population. Dingoes also show that the feralization process can even mask domestic ancestry to all but the latest genetic techniques, since earlier genetic studies concluded that dingoes had no domestic ancestry (Shao-jie *et al*., 2020).

Given that feralization has been shown possible and the high Neandertal investment in deer species throughout Europe and northern Asia (Jarman *et al*., 1976), the modern descendants of these deer taxa should be investigated to determine if they may have some domestic ancestry. Red deer in particular should be studied, since domestication experiments have indicated that red deer are unusually adaptable to domestication (Jarman *et al*., 1976).

The *homebody* objection

Much of the literature on Neandertals argues that they did not typically range much further than they could travel round-trip in a day, sometimes two (Nowell and Horstwood, 2009; Richards *et al*., 2008). Two lines of evidence are the most cited for this objection. The first is that the material for stone tools found at Neandertal-associated excavations is almost entirely sourced within a 1- to 2-day radius of where it is found, and often much closer than that (Moncel *et al*., 2019). Second, isotopic analyses of Neandertal teeth show that the individuals studied grew up close to where these remains were found (Nowell and Horstwood, 2009; Richards *et al.*, 2008). Critically, the distances in the lithic and dental analyses are similar. If these findings are accurate, it directly undermines the potential for sustained Neandertal engagement with specific herds, since they would need to range a good deal further to maintain access to sufficient fodder, particularly as seasons changed.

Addressing the dental evidence first, it is important to note that analyses of this type can only inform us of an individual's diet from childhood, during the years when their body is building their teeth (Richards *et al*., 2008). The teeth recovered, however, are from the remains of adults laid to rest, not from children. Neandertal remains are repeatedly found in contexts that indicate intentional handling post-mortem, including remains being found in posed positions, in crafted pits, or in places that would have required active protection from scavengers to achieve the degree of preservation in which they were discovered (Pettitt, 2010). The bodies could have been intentionally brought to the place where they were raised as children. Isotopic evidence placing an individual's childhood and their burial within close proximity cannot prove anything about how far that individual traveled while they were alive. As Reinhard Bernbeck argues,

> "It is probable that the population staying year-round at a focal site included children and the elderly, with young adults moving out to more ephemeral sites. Thus, any person would go through an initial stage of life at a focal site, then live a more mobile life, and in old age again stay in such a focal site" (2008, p. 23).

Therefore, dental evidence cannot rule out the possibility that adults left their childhood landscapes to travel longer distances.

The lithic evidence, however, seems more compelling. An enormous percentage of known Neandertal stone tools are made from material sourced practically on the doorstep of where they are discarded, even when better material is available just slightly further away (Moncel and Rivals, 2011;

Picin and Carbonell, 2016; Turq *et al.*, 2017). Often, only a single object at a site will have been transported from a distance more than two days away (Turq *et al.*, 2017). The disproportionate amount of material evidence found within such small geographic ranges has been used to argue against the likelihood of Neandertals traveling beyond the range of their tool manufacturing (Picin *et al.*, 2020; Picin and Carbonell, 2016; Turq *et al.*, 2017). And yet, as silly as the question sounds, who would want to carry rocks further than absolutely necessary?

The movement of objects cannot be casually equated with the movement of individuals or even groups. A common adage among archaeologists is the reminder that pots are not people, and it is relevant here. People put things down, pass them off, discard them, and take them from others. Objects have their own journeys; their paths are separate from those of the people who transport them, even if they intersect. Broadly speaking, objects do not spend their entire lives physically with a single individual, held from birth to death. Perhaps one or two items may be handled this way, but that kind of care likely cannot apply to the vast piles of lithic debris found at many Neandertal sites. As argued with the isotopic analysis of Neandertal teeth, the locations of a person's childhood and burial do not limit the space they inhabit during the rest of their life. In the same way, the source location and discard location of stones cannot provide a limit on where that stone has been.

It is still important to ask, however, if the sheer volume of lithic material could have limited individual or group movements in a meaningful way. It is improbable that Neandertals were carrying massive loads of tools around on long journeys and then lugging them all back to where they made them. But if Neandertals were so tied to their quarries, why did they often choose closer, poorer quality stone over higher quality stone only a little further away? (Moncel and Rivals, 2011; Picin *et al.*, 2020; Picin and Carbonell, 2016; Turq *et al.*, 2017). The argument that this was to reduce effort by reducing travel distance seems inadequate, since it could be argued that having to make a new knife or scraper for every use is also an enormous effort. On the other hand, Neandertals regularly using what was most convenient at the cost of the longevity of a tool argues that they viewed stone tools as disposable. This would imply they created tools for immediate use, never intending to carry them further than needed in the moment. Based on this interpretation, the limited range of most Neandertal stone tools does not provide a convincing limit on total Neandertal movement, so there is still an evidentiary gap here for *Neandertal the Mobile-Herder* to squeeze into.

Despite the widespread assumption that Neandertals did not stray far from home, neither the lithic nor the dental evidence presented to support the *homebody* theory can prove any direct geographic or spatial limits on adult Neandertal mobility or range. Given the gaps in the evidence discussed so far, it is not unreasonable to imagine a Neandertal society that invests in communal raising of children in a small geographic area, while a larger, mobile portion of the adult community goes out to follow or relocate a specific herd, perhaps deer, that they support with protection from other predators. These Neandertal herders could have made low-impact camps and butchery sites close to well-known, perhaps traditional lithic sources, manufacturing all the needed scrapers and blades for the next days or weeks from fresh material or from pieces discarded in previous visits. The nursery community, meanwhile, could have subsisted off of the seasonally changing fauna in that more constrained space—without running the risk of herd

population collapse—because of the smaller number of individuals depending on those resources.

The *no direct material evidence* objection

Finally, if any Neandertals did practice herding, we must ask the following: what instruments are needed for herding practice that might be distinctive from other kinds of tools? And could something serving a similar set of functions still exist in the archaeological record? Unfortunately, the archaeological literature on herding does not address the idea of a herding toolkit. My research did not find any discussion of the essential functions, properties, manufacture, use, or preservation of objects like lassos, hobbles, or shepherd's crooks. But having worked around farm animals from time to time, three broad functions come to my mind that would be particularly useful for tools in herding practice. The first category includes signaling tools—both fixed and portable—used for inter-human communication and for startling, spooking. and/or directing herds. Another type includes prodding tools for physically interacting with the individual herd animals in close quarters. And the third group includes restraints: anything that could be wrapped around an animal to hold it. Lassos for catching targets in motion, hobbles for preventing motion, and harnesses for guiding motion all fall into this category.

In my experience, prodding tools require a balance of rigidity and flexibility, so as to balance reach with gentleness. The idea is to be able to push a strong individual without puncturing the skin. For this reason, sharp, rigid, or fragile materials like stone, shell, dried clay, or metal would not work well, but neither would soft materials like wool, fur, or plant fibers. Wood, bone, cane, and hardened leather, however, could meet the necessary balance. Working with restraint tools, I have seen that they interact with motion, so the materials used need strength and durability. Rigid materials should be avoided, however, since they are likely to lead to broken tools or injured animals. Plant and animal fibers, leather, animal gut, or tendon all fill these requirements.

In contrast, tools for signaling do not always require flexibility or portability to function. This means that larger and more durable materials like stone (and even the landscape itself) can be used. For instance, stone cairns have been used to mark points on a landscape for the reference of herders or to turn herds (Zedeño *et al.*, 2014). Clapping stones or dropped gravel could function as a herd-startle signal, and landscape features could be enhanced or altered to encourage or restrict herd movements (Zedeño *et al.*, 2014). All of these examples can be used to encourage convergence or separation of smaller groups within a herd (Zedeño *et al.*, 2014).

In the Northwestern Plains of North America, late Prehistoric bison hunters were masters of hunting massive and dangerous herds. Like the Neandertals, they managed it all on foot with only the landscape and their spears to manipulate groups of mega-bison (Zedeño *et al.*, 2014). Looking to these Prehistoric hunters, it seems worthwhile to investigate what kinds of geographic features most lend themselves to similar tactics; where in Neandertal geographies these features are found; and what herd-manipulating landscape alteration would look like after 40,000 years or more of weathering. Unlike the organic materials that best suit the flexibility needs of prodding and restraint tools, landscape alterations and stone tools potentially have the longevity necessary to still be detectable (Zedeño *et al.*, 2014). And because it is possible for route markers or landscape alterations to have survived, their absence from known Neandertal ranges would

contribute evidence against the possibility that these populations of Neandertals engaged in herding practice.

Conclusions and opportunities

As I pointed out at the beginning of this paper, much of what is known about Neandertals—including their frequent moves, site reuse, and heavy reliance on grazing herd species—is reminiscent of what is expected archaeologically of *Homo sapiens* mobile herders. Examining these parallels shows that a maximally speculative approach in Paleolithic contexts allows more robust discussions by approaching hypotheses as *relevant until proven not*. This, in turn, can help to offset the extraordinary preservation bias that exists in the archaeological record of the Paleolithic.

Looking at four key objections to the proposition that Neandertals may have engaged in herding practice, I have shown that my apparently absurd hypothesis, *Neandertal the Mobile-Herder,* not only cannot be concretely disproved, but that my *Maximal Speculation* methodology actually uncovered research opportunities with the potential to provide new evidence for or against this hypothesis. These research opportunities include taphonomic and geologic studies of what herding-centric landscape alterations from Neandertal geographies might look like today, surveys to search for potential remains of such alterations, and genetic research into deer species in Europe and northern Asia to test for partially domestic ancestry. Each of these avenues may deepen the discussion of my previously radical *Neandertal the Mobile-Herder* hypothesis. This is preferable to relying on supposition and circumstantial speculation.

What is the benefit in expanding our repertoire of hypotheses from the perceived probable to the overlooked possible? By addressing the outer bounds of what may be, rather than limiting ourselves to our theoretical comfort zones, we make space for alternative realities—for experiences to which we cannot relate and to motivations and actions for which we have no internal means of predicting. Zoe Crossland writes, "Knowledge cannot be conceptualized as a zero-sum situation, where we pile up what is known on the one hand while what is unknown decreases on the other…with [these] changes in knowledge come new understanding of what is not known" (2020, p. 79) By doing the work of making space for the unpredictable, we create opportunities to discover greater clarity of what we do not yet know. We write questions no one previously thought to ask, and in turn we inspire new technological, methodological, and theoretical methods of testing and answering those questions. In fact, this feedback loop is already visible at work in paleoarchaeology through the continually developing applications of genetic research. Applying a lens of the *possible* more broadly will propel our capacity for understanding forward with vigor.

It is the possibilities that seem utterly improbable in their remoteness that we have to pursue. The opportunity waits—if not to prove them directly, then at least to demonstrate their relative probability more accurately than our instincts can gauge. It is uncomfortable to forward a hypothesis with no direct evidence. It is uncomfortable to argue from a position outside the known or the familiar. But that is exactly why these arguments, in the context of Paleolithic people, are valid. Our access to and knowledge of them is fundamentally indirect. They are unknown, they are unfamiliar, and we cannot begin to approach a knowledge of their realities if we do not wrestle with that—not just in theory, but in archaeological practice.

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"How like us is that ugly brute the ape!" Quintus Ennius of Rome wrote.

An alternate translation reads "vilest of beasts."

There is a tension between humans and the vile beasts of Ennius's description.

I think it arises from the need to distance oneself from the thing that reminds them of themselves.

They say that mockery is a product of discomfort and the familiar.

Or, sometimes, a preventative measure against showing affection.

One could interpret Ennius's quote as a question:

How is that ape like us?

How could <u>he</u> be our relative?

But it also could be an observation. I like to consider it a cheeky reminder.

My, how like <u>us</u> is that ugly brute, the ape.

Emma Gometz

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