Comparing the Skeletal Anatomy, Technology and Culture of *Homo neanderthalensis* and Early Modern Humans

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Abstract: This paper will compare the overall differences in skeletal anatomy, along with the technological and cultural adaptations, between Homo neanderthalensis and early modern humans, and will show that the Neanderthals were, at least physically, very well adapted to their harsh environmental conditions and physically strenuous lifeway. Several studies have shown that the shorter, stockier and more robust body shape of the Neanderthals was advantageous for maintenance of body temperature in the cold climate of the last glacial period (Porter, 1999). Also, due to a lower centre of gravity, locomotion on the uneven, snow-covered terrain of their territories would have been enhanced (Polk, 2004; Steudel-Numbers and Tilkens, 2004). According to Holliday (1997), the overall Neanderthal body shape falls "at the extreme end of modern higher latitude groups", and suggests that they were more similar to modern "Eskimos" than any other group. The Neanderthals were both morphologically and physiologically well suited to their environment, as evidenced by their skeletal adaptations (Holliday, 1997), and hunting skills (Hoffecker & Cleghorn, 2000). With the exception of peoples inhabiting the Earth's polar regions, as mentioned above, modern humans generally show few morphological or physiological adaptations to a cold climate, other than a slightly reduced overall skin surface area, but there is ample evidence (Hoffecker, 1999), that early modern humans were better prepared, both culturally and technologically, compared to the Neanderthals, to survive and flourish in a harsh, physically demanding environment.

Skeletal Anatomy

Cranial Evidence

Many studies have shown that the Neanderthal skeleton, although very similar in most respects to that of the early modern human, shows several unique differences. Neanderthal cranial capacity was similar to, even slightly larger than, that of early modern humans. Neanderthal skulls also show a somewhat elongated skull shape, thickened cranial bones and occipital bunning - traits that are not present in modern humans (Churchill, 1998:46). The Neanderthal nasal aperture was very large and oval-shaped with large paranasal sinuses in place of the narrower, triangular-shaped and smaller sinuses seen in modern humans (Tattersall & Schwartz, 1998:114; Churchill, 1998:46). This may have been advantageous to the Neanderthals in that an increased surface area within the nasal cavity could more efficiently heat and humidify the cold, dry glacial air. Neanderthals also had large supraorbital ridges, a very robust mandible, prognathic facial bones, and they lacked the modern human chin (Churchill, 1998:50; Tattersall & Schwartz, 1998:114). Bailey (2002:150) studied samples of teeth from 26 Neanderthal remains from Europe and Western Asia, and identified several unique dental traits, including marked shoveling and labial convexity of the incisors, the presence of lingual tubercules, and enlarged pulp chambers in the molars.

Post Cranial Evidence

All Neanderthal limb bones, both proximal and distal, were slightly bowed, thick-walled and generally robust (Churchill, 1998:47; Del Prete, 2001:152), whereas those of early modern humans were straighter, thinner-walled and overall more gracile (Porter, 1999). Neanderthal clavicles were longer and their scapulae were broader (in keeping with their shorter and wider torsos, see below), compared to those seen in early modern humans (Churchill, 1998:47; Steegman, Cerny & Holliday, 2002:576). The Neanderthal rib cage was cone-shaped (narrower at the top and wider at the bottom than a modern human rib cage), giving their torsos a wider, more stocky appearance, which reduced overall body surface area and might have been a means of limiting heat loss to the surrounding atmosphere (Porter, 1999:54; Steegman *et al.*, 2002:577). The Neanderthal pelvis was much wider than that of the early modern human, with flaring iliac crests and large femoral heads (Holliday, 1997:254; Steegman *et al.*, 2002:577) which, along with the shortened torso, likely provided a lower centre of gravity and thus better balance on uneven ground (Holliday, 1997:254; Steegman *et al.*, 2002:577). Distal limb bones (radius and ulna in the arm, and tibia and fibula in the leg), were relatively shorter than proximal limb bones (humerus in the arm, and femur in the leg), resulting in low brachial and crural indices, respectively (Steegman *et al.*, 2002:576; Holliday, 1997:246).

These skeletal adaptations would have provided a mechanical consequence involving a slower walking speed, but increased power - an advantage when hunting large animals (Steudel-Numbers & Tilkens, 2004:106; Polk, 2004:250). This evidence of shorter extremities among the Neanderthals follows Allen's Rule for organisms living in cold climates (Holliday, 1997:2454). The latter two adaptations might also have provided a stronger frame overall for carrying heavy loads such as animal carcasses (Steegman *et al.*, 2002:577), as well as serving to reduce overall body surface area, thus limiting the loss of body heat (Holliday, 1997:254; Porter, 1999:54). Porter, (1999:66) however, believes that the distal limb abbreviation seen in the Neanderthals probably has more of a biomechanical explanation, as mentioned above, than a thermoregulatory one.

Interestingly, Steegman *et al.* (2002:579) suggest that the distal limb abbreviation seen in Neanderthals may not only have been a physical adaptation to cold stress, but may actually have been *caused* by continual exposure to cold. Steegman *et al.* (2002:579) propose that vasoconstriction (a natural mammalian response to cold conditions), may have resulted in slowed tissue growth in the distal portions of the limbs, those portions most affected by the cold. This trait, and other skeletal differences, might have become selected for during the Neanderthals' long evolution and adaptation to their cold environment (Steegman *et al.*, 2002:571). Steegman *et al.* (2002:571) also estimate that, among a sample of male Neanderthals, the mean height was 167 cm (almost 5 feet, 6 inches), and the mean weight was 80.8 kg (178 pounds), resulting in a higher body mass index (28.9 kg/m^2), than is seen in average modern humans (Holliday, 1997:255). This follows Bergmann's rule for homeothermic animals living in cold regions (Holliday, 1997:245).

Technology

The Neanderthals are well known for their Mousterian tool culture, which included basic stone sidescrapers, points and biface tools (Hoffecker, 1999:134). These tools were probably multi-purpose and could have been used for hunting and simple butchering of animal carcasses (Hoffecker, 1999:134). There is no evidence that the Neanderthals made use of bone, antler, or ivory when manufacturing tools (Hoffecker, 1999:134). In contrast, the addition of a more refined and delicate toolkit, containing such items as punches and awls, and later, bone and ivory needles, is only found to be associated with the early modern human populations of the Upper Paleolithic (Jurmain, Kilgore, Trevathan & Nelson, 2003:355). These tools would have been better suited to more precise and detailed activities, such as the manufacture of warm, tailored clothing and shelters made from animal skins.

Little evidence has been found that would suggest that the Neanderthals constructed living shelters (Hoffecker, 1999:135; Holliday, 1997:255). Most evidence points to their use of caves and ready-made rock shelters for winter residences, and of open-air sites during warmer periods (Hoffecker & Cleghorn, 2000:376). Neanderthals probably relied heavily on hunting mammoth, bison, deer, horse, sheep, goat etc., to provide a rich source of red meat to compensate for their high caloric requirements (Hoffecker, 1999:135; Hoffecker & Cleghorn, 2000:376).

Because the Neanderthals' "home bases" were generally fixed, their hunting expeditions were limited in range, especially during the winter months (Hoffecker & Cleghorn, 2000:376). An extended hunting trip into a new territory would have entailed moving the entire group to a new, pre-selected location (Hoffecker, 1999; Hoffecker & Cleghorn, 2000), as the hunters could probably not survive many nights spent in the open with no fire or shelter during the winter months. Also, the fixed size of a cave or a rock shelter would limit the number of occupants it could comfortably hold, perhaps to ten people, or even fewer (Hoffecker, 1999:135; Hoffecker & Cleghorn, 2000:376).

In order to introduce new genetic material into their gene pool, and thus preserve their unique morphological and physiological adaptations, Neanderthals would have had to travel great distances to meet up with others of their kind (Steegman *et al.*, 2002:578). On the other hand, there is ample evidence of shelter construction by early modern humans (Jurmain, Kilgore, Trevathan & Nelson, 2003:355). They, too, frequently used ready-made caves and rock shelters, but they were also technologically capable of constructing their own shelters. The ability to construct warm, insulated, temporary shelters would have enabled them to cover a larger territory while hunting and foraging. This would have been especially important during the lean winter months. In turn, higher quantities of a more varied diet would have enabled modern humans to support larger living groups, thus increasing genetic variation. Early modern humans' more advanced tool technologies, such as awls and needles, also allowed them to produce warm, tailored clothing and to construct sturdier, warmer, shelters from animal hides (Jurmain, Kilgore, Trevathan & Nelson, 2003:355).

There is little evidence that the Neanderthals made regular use of fire (Jurmain, Kilgore, Trevathan & Nelson, 2003:297). They probably only had access to it on an opportunistic basis, when natural forest fires caused by lightning strikes presented them with a convenient, ready-made source (Holliday, 1997:255). In contrast, there is evidence that modern humans in the Upper Paleolithic consistently constructed hearths and, presumably, were making fire as and when they required it (Holliday, 1997:255). This better control of fire provided them with many advantages. First, it provided them with an extra source of heat during the winter months. Second, it provided a source of light after darkness fell, allowing increased time for socialization. This increase in "free time" may eventually have led to the development of language (Jurmain, Kilgore, Trevathan & Nelson, 2003:237), which would have contributed to technological advancements and organizational skills. Third, it gave them the ability, especially important in the winter months, to both thaw and cook their food. This would have killed bacteria and parasites, and would also have made for a healthier, more palatable and more varied diet. Last, it provided them with a means of defending themselves against large predators, such as wolves and bears. All of these advantages, conferred by early modern humans' control of fire, would have contributed to higher survival rates.

Other Adaptations

In addition to a shorter distal limb length and an overall shorter, stockier body shape, Steegman *et al.* (2002:579) have suggested several other cold climate adaptations that the Neanderthals may have displayed. The first of these concerns the part that vasoconstriction plays in maintaining body heat; a decreased blood flow to the extremities immediately limits body heat loss, affording greater protection to the vital, internal organs. The adaptation second relates to skeletal evidence that the Neanderthals were considerably more heavily muscled than early modern humans (even in their hands and fingers), which in itself would provide a high degree of insulation from the cold, as well as the provision of an internal source of body heat, as more calories are burned by muscle than by fat during physical exertion. Third, Steegman *et al.* (2002:580) suggest that the Neanderthals may have experienced a genetic mutation that prompted the development of a mechanism that allowed them to deposit and maintain stores of brown adipose tissue (BAT). This would have allowed them to produce a greater amount of body heat by a key primate cold adaptation, known as non-shivering thermogenesis. This fat would also have acted as an effective insulator in and of itself in a manner even more effective than muscle tissue. All primates have deposits of brown adipose tissue during the neonatal period, but Steegman *et al.* (2002:580) suggest that these deposits were possibly carried through into adulthood. This adaptation may have been facilitated by a fourth mechanism - the release of high levels of norepinephrine from the sympathetic adrenal-medullary system - which would stimulate heat production by the brown adipose tissue and other body tissues (Steegman *et al.*, 2002:580). However, Steegman *et al.* (2002) also suggest that the extremely cold climatic conditions, and the strenuous physical activity of the Neanderthals, might have worked against the storage of any body fat at all, especially white, subcutaneous fat, and especially during the colder winter months. A fifth adaptation may have been a diet high in fat, obtained both from animal flesh and also from the marrow contained in animal long bones (Steegman *et al.*, 2002:571). High fat concentrations in their diet would have allowed the Neanderthals to make the most efficient use of their high protein intake from red meat (Steegman *et al.*, 2002:571).

On a different note, but also concerning fat, Erren & Erren (2004:346) suggest that a genetic mutation, relating to the phospholipase A_2 cycle, occurred in early modern humans around 150,000 - 130,000 years ago. This mutation may have impacted the way in which phospholipids allowed their neurons to form new and more complex connections with each other, thus increasing the "flexibility, creativity and inventiveness" of their brains (Erren & Erren, 2004:346). In other words, early modern humans may have received an evolutionary "gift" which was denied to the Neanderthals, and which allowed them to make the mental leaps necessary to not only survive, but to flourish, under adverse climatic conditions. By contrast, the Neanderthals' lack of flexibility could account not only for their abandonment of the central Eastern European Plain during the Last Glacial Period (Hoffecker, 1999:137), but also for their inability to survive in competition with the more technologically and culturally adaptable early modern humans. Unfortunately, with the exception of the evidence of large muscle attachments to bones, none of the possible physical adaptations to a cold and harsh environment described above have left any traces in the archaeological record, and are only put forward as possible suggestions to account for the Neanderthals' cold adaptation, and the successes of early modern humans.

Conclusion

Overall, it would seem that, despite having had a greater cranial capacity than modern humans, the Neanderthals lacked a certain neural sophistication, which reduced them to reliance on purely morphological and physiological adaptations in order to survive in their cold and harsh environment. Early modern humans, on the other hand, and perhaps serendipitously, were able to make the mental connections necessary in order to create a physical culture which allowed them to change their environment to suit their needs, rather than the other way around. It would appear then, that in the struggle to survive, the Neanderthals were simply out-competed by the more adaptable, and more mentally agile, early modern humans.

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