What shapes a bone?

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Researchers at Johns Hopkins found that use over time and not just genetics informs the structure of jaw bones in human populations. The researchers say these findings may be used to predict the diet of an ancient population, even if little evidence exists in the fossil record. It can also make it easier for scientists to pinpoint the genetic relationship between fossils.

Their results were published online June 23 in the American Journal of Physical Anthropology.

"Our research aimed to see how much of the mandible's—or jaw bone's—shape is plastic, a response to environmental influences, such as diet, and how much is genetic. We used archaeological jaw bones from two different regions to answer that question," explains Megan Holmes, graduate student at the Johns Hopkins Center for Functional Anatomy and Evolution, and lead author of the paper. "Before we can make inferences about what the shape of a bone tells us, like what environment the individual lived in, who it's related to or what it ate, we have to understand what creates that shape. The idea that function influences the shape of jaw bones is great for the archeological record in terms of discovering the diet of a population, and it's also really useful for reconstructing the fossil record—finding which fossils are related to which, and how."

The group chose to study the Arikara and Point Hope American Indian populations, since they were genetically isolated from other groups and ate different diets. They investigated bones from the regions dating back

to the 1600s and 1700s, times for which the diets are known from other records. The Point Hope population in Alaska ate a "hard" diet that included tough dried meat. They also used their teeth for a variety of nonfood-related tasks, such as stripping leather. The Arikara, from the Dakota area of the United States, ate a softer diet, which consisted of farming supplemented with light hunting.

The researchers precisely measured jaw bones from 63 members of the Point Hope population and 42 individuals from the Arikara population using an X-ray gun as well as calipers, and they used those measurements to extrapolate the proportions of the entire jaw. "The jaw bones were similar in children before they were old enough to start chewing, but different in adulthood, which implies that this divergence is likely a functional result of their diet and the use of their jaw, rather than genetics," says Holmes.

The changes to the jaw bones were explained using a theory drawn from engineering, which directly relates the geometry of a bone to the stresses put on it during use. The team was able to investigate very specific parts of the jaw bones and relate them to specific dietary habits. In the Point Hope population, for example, they found round, wide jaw bones—a result of having to exert more force to chew a harder diet. The Arikara, on the other hand, did not show this expansion, which they attributed to the lighter chewing requirement of a softer diet.

"Genetics creates a blueprint of the bone, but a lot of things influence the bone's construction," says Holmes. "Mechanical pressure from muscle stress and strain from day-to-day activities can remodel the bone's surface and internal structure. Knowing how much the shape of a mandible we find is related to diet and how much genetically connects it to fossils found elsewhere can really help us parse out the family tree."

Provided by Johns Hopkins Medical Institutions

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