

Humans aren't naturally inclined to be vegetarians

Gorillas' vegan diet stunted development of their brains

BY CHRISTOPHER WANJEK
LiveScience

Vegetarian, vegan and raw diets can be healthful, probably far more healthful than the typical American diet. But to call these diets "natural" for humans is a bit of a stretch in terms of evolution, according to two recent studies.

Eating meat and cooking food made us human, the studies suggest, enabling the brains of our prehuman ancestors to grow dramatically over a few million years.

Although this isn't the first such assertion from archaeologists and evolutionary biologists, the new studies demonstrate that it would have been biologically implausible for humans to evolve such a large brain on a raw, vegan diet and that meat-eating was a crucial element of human evolution at least a million years before the dawn of humankind.

Calories to grow our brains

At the core of this research is the understanding that the modern human brain consumes 20 percent of the body's energy at rest, twice that of other primates. Meat and cooked foods were needed to provide the necessary calorie boost to feed a growing brain.

One study, published last month in the Proceedings of the National Academy of Sciences, examined the brain size of several primates. For the most part, larger bodies have larger brains across species. Yet humans have exceptionally large, neuron-rich brains for our body size, while gorillas — three times as massive as humans — have smaller brains with one-third the neurons. Why?

The answer, it seems, is the gorillas' raw, vegan diet (devoid of animal protein), which requires hours upon hours of



BIGSTOCK

eating to provide enough calories to support their mass.

Researchers from Brazil, led by Suzanaerculano-Houzel, a neuroscientist at the Federal University of Rio de Janeiro, calculated that adding neurons to the primate brain comes at a fixed cost of approximately six calories per billion neurons.

For gorillas to evolve a humanlike brain, they would need an additional 733 calories a day, which would require two more hours of feeding, the authors wrote.

A gorilla already spends as much as 80 percent of the tropics' 12 hours of daylight eating.

Similarly, early humans eating only raw vegetation would have needed to munch for more than nine hours a day to consume enough calories, the researchers calculated. Thus, a raw, vegan diet would have been unlikely, given the danger and other difficulties of gathering so much food.

Cooking makes more foods edible year-round and releases more nutrients

and calories from both vegetables and meat, Herculano-Houzel said.

"The bottom line is, it is certainly possible to survive on an exclusively raw diet in our modern day, but it was most likely impossible to survive on an exclusively raw diet when our species appeared," Herculano-Houzel told LiveScience.

The study puts an upper limit on how big a brain is able to grow while on a premodern raw, vegan diet. But the researchers could not determine when daily cooking began. Was it about 250,000 years ago, when humans were nearly fully evolved with big brains, which is supported by archaeological findings? Or was it about 800,000 years ago, when prehumans began their most dramatic brain-growth spurt, an era for which there is little archaeological evidence of controlled fires for cooking?

Meet the meat-eater

If cooking wasn't routine before the dawn of modern humans, eating meat certainly was.

The second study, published in October in the journal PLoS ONE, examined the remains of a prehuman toddler who died from malnutrition about 1.5 million years ago. Shards of a skull found in modern-day Tanzania reveal that the child had porotic hyperostosis, a type of spongy bone growth associated with low levels of dietary iron and vitamins B₉ and B₁₂, the result of a diet lacking animal products in a species that requires them.

The child was around the weaning age. So either the child's mother's breast milk lacked key nutrients or the child himself did not consume enough nutrients directly from meat or eggs.

Either way, the finding implies that meat must have been an integral, and not sporadic, element of the prehuman diet more than 1 million years ago, said the study's lead author, Manuel Dominguez-Rodrigo, an archaeologist at Complutense University in Madrid.

This supports the theory that meat fueled human brain evolution because meat — from arachnids to zebras — was plentiful on the African savanna, where humans evolved, and is the best package of calories, proteins, fats and Vitamin B₁₂ needed for brain growth and maintenance.

"Carnivore animals, whether terrestrial or aquatic, are bigger-brained than herbivores," Dominguez-Rodrigo told LiveScience. He added that "there is no [traditional] society that live as vegans," essentially because it wouldn't be possible to get Vitamin B₁₂, which is only available in animal products.

Vegetables still healthful

Both sets of researchers said their conclusion — that cooked food and meat were necessary for human brain development — is not a statement of how the human diet must have been but rather how it likely was in order to make humans "human."

With supermarkets and refrigeration, humans today can and increasingly do eat a vegetarian or vegan diet year-round. And given the amount of heart-stopping saturated fats in factory-produced animal products, a plant-based diet can be more healthful.

Yet both extremes of the meat argument — the unapologetic meat-eater and the raw vegan — should remember that few of today's so-called natural foods were around as little as a few hundred years ago, from the modern invention called corn-fed beef to genetically altered strains of Queen Anne's lace called the carrot.

There are many reasons to go vegetarian, go vegan and even go raw, but evolution isn't one of them.

Wanjek is the author of "Hey, Einstein!," a comical nature-vs.-nurture tale about raising clones of Albert Einstein in less than ideal settings. His column, Bad Medicine, appears regularly on LiveScience.



HERWIG PRAMMER/REUTERS

Captive chimpanzees and orangutans show the same ebb in emotional well-being at midlife that some studies find in people, according to new research. This suggests that discontent in adult humans may have an evolutionary basis.

Midlife crises may not be unique to humans

Study finds that apes are also subject to shift in mood

ASSOCIATED PRESS

Chimpanzees going through a midlife crisis? It sounds like the setup for a joke. But there it is, in the title of a report in the Proceedings of the National Academy of Sciences: "Evidence for a midlife crisis in great apes."

So what do these apes do? Buy red Ferraris? Leave their mates for some cute young bonobos?

Well, no. But researchers report that captive chimps and orangutans do show the same ebb in emotional well-being at midlife that some studies find in people.

That suggests the human tendency toward midlife discontent may have been passed on through evolution rather than resulting from the hassles of modern life, said Andrew Oswald, an author of the study and a professor of economics at the University of Warwick in Britain.

Several studies have concluded that happiness in human adults tends to follow a certain course between ages 20 and 70: It starts high and declines to reach a low point in the late 40s, then turns around and rises to another peak at 70. On a graph, that's a U-shaped pattern. Some researchers question whether that trend is real, but to Oswald the mystery is what causes it.

"This is one of the great patterns of human life. We're all going to slide along this U for good or ill," he said. "So what explains it?"

When he learned that others had been measuring well-being in apes, "it just seemed worth pursuing the hunch that the U might be more general than in humans," he said.

He and co-authors assembled data on 508 great apes from zoos and research centers in the United States, Australia, Canada, Singapore and Japan. Caretakers and other observers had filled out a four-item questionnaire to assess well-being in the apes. The questions asked such things as the degree to which each animal was in a positive or negative mood, how much pleasure it got from social situations and how successful it was in achieving goals. The raters were even asked how happy they would be if they were the animal for a week.

Sounds wacky? Oswald and his co-authors say research suggests it's a valid approach. And they found that the survey results produced that familiar U-shaped curve, adjusted to an ape's shorter life span.

"We find it for these creatures that don't have a mortgage and don't have to go to work and don't have marriage and all the other stuff," Oswald said. "It's as though the U shape is deep in the biology of humans" rather than a result of uniquely human experiences.

Yes, apes do have social lives, so "it could still be something humanlike that we share with our social cousins," he said. "But our result does seem to push away the likelihood that it's dominantly something to do with human life."

Oswald said it's not clear what the evolutionary payoff might be from such discontent. Maybe it prods parents to be restless, "to help find new worlds for the next generation to breed," he said.

Frans de Waal, an authority in primate behavior at Emory University in Atlanta, cautioned that when people judge the happiness of apes, there may be a "human bias." But in an e-mail he called the results "intuitively correct" and said the notion of biological influence over the human pattern is "an intriguing possibility."

Weapons point to a refined production system

TERRA COTTA FROM EI

While archaeologists who have studied the terra cotta army have long thought that a form of mass production must have been in operation, this is the first time that this assumption has been backed up with such precise data.

The scientists came to their conclusion through metallurgical analysis of the weapons and a statistical analysis of where they were found.

First, they studied some of the 37,348 arrowheads found in 680 locations, using a portable X-ray fluorescence spectrometer, a hand-held tool that determines an object's precise chemical content.

Although the polished arrowheads seem identical to the human eye, X-ray fluorescence revealed that discrete batches of the copper-tin alloys bore unique chemical signatures. Each batch bore its own mix of copper, tin and lead. Different batches were found throughout the site, suggesting that multiple workshops were operating at the same time.

Then the researchers positioned each artifact and warrior on a digital map based on the detailed records created in the 1970s and 1980s by the Chinese archaeologists who first excavated the site.

An illuminating picture emerged. Each quiver seems to have been produced and assembled by a single workshop. The arrowheads were probably made in batches, tied with linen to bamboo shafts, finished with feathers, bundled into 100-arrow quivers of leather and hemp and placed with terra cotta archers armed with crossbows. (The bows' organic material hasn't survived the centuries, but 220 bronze crossbow triggers were found.)

A surprising find

The archaeologists had expected that the quivers' components would have been produced at a variety of locations and then assembled later. But if that were the case, the arrowheads found together shouldn't bear the same chemical signature. They should be all mixed up, but they are not.

Finding evidence that the weapons weren't made in an assembly-line fashion "was a bit of a surprise for us," Martinon-Torres said. "It was only when we saw this in the terra cotta army that we started to look for modern parallels and found Toyotism."

"What they did is very sophisticated and convincing," says Toyotism expert Jeffrey Liker, referring to the researchers. Liker is a professor of industrial and operational engineering at the College of Engineering at the University of Michigan and has written five books on Toyotism.

However, Liker said, the distinction between Fordism and Toyotism in Qin's weapons workshops was less notable than the fact that characteristics we associate with modern mass production — standardization, quality control, flow — were present at all.

Archaeologists believe that the tomb-outfitting teams were composed of artisanal groups, each of which worked under a master craftsman, with a foreman overseeing quality control. They have identified the seals or signatures of at least 87 foremen on warriors' backs, indicating a form of personal accountability for the quality of each statue.



IMPERIAL LOGISTICS PROJECT

Marcos Martinon-Torres uses an optical microscope to examine arrowheads that were buried along with the terra cotta army of a Chinese leader in 210 B.C.

No room for error

The statues seem to have been placed in the pit fully outfitted with weaponry because they were so tightly packed in the tomb that there was no room to maneuver around them. This means that the weaponmakers had to coordinate with statue workshops or the flow of work would have stalled, said Martinon-Torres.

Any production problems would probably have been bad news for workers, said Robert Murowchick, director of the International Center for East Asian Archaeology and Cultural History at Boston University. Qin leaders identified who was responsible for each step so that problems in quality or consistency could be tracked to their source "and no doubt punished harshly, as the Qin culture was big on the carrot-and-stick model of management," he said.

However advanced the Qin manufacturing system was, other modern ideas — such as, say, don't kill your employees — were absent.

The main historical record that archaeologists rely on for clues to the tomb's construction is a 1st-century B.C. account by Sima Qian, who wrote that 700,000 people labored to build Qin's mausoleum complex. Slaves, indentured servants, prisoners of war, foremen, masters, artisans — all were conscripted into a strict hierarchical system with brutal work conditions. Skeletons in iron shackles unearthed at the site back up this account.

Even if the weapons' makers had high status, it's likely that some suffered a

similar fate. "You don't want people to have the skills to make these very powerful Qin weapons and then have them disappear and go work for your neighboring state," said Murowchick.

Murowchick said the weapons production system for the tomb probably mirrored how the real Qin army sourced its weapons and was probably a factor in its battlefield success. "The Qin had a fantastically powerful military by ensuring a standardization of weaponry and also the ability to quickly replace and repair broken pieces on the battlefield," said Murowchick. "It makes perfect sense to have a cellular production model. If you're 200 miles from home and need more crossbow locks or triggers or arrowheads, you have teams that can produce things."

However efficient the Qin manufacturing machine was, Martinon-Torres doesn't romanticize the megalomania that drove it.

"This was a society ruled by a ruthless autocrat. The mausoleum is a celebration of that super-ostentatious, centralized personality through the sheer investment of manpower and resources," he said. "We can look at the mausoleum and say, 'Wow, look how powerful that emperor was.' But we can also try to reconstruct the hundreds of thousands of anonymous laborers who made it possible. In that sense, we are hopefully giving them a little bit of credit for what they're worth."

health-science@washpost.com

Pinkowski is freelance science journalist based in Brooklyn.