Diet And Human Evolution

Blithering Genius

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1 The Main Differences Between Humans And The Great Apes

In this essay, I will argue that human evolution was primarily the evolution of a new diet. The key traits that set us apart from other great apes (bipedalism, tool use, social organization, and a larger brain) are all linked to diet.

Our last common ancestor with chimpanzees lived sometime between 6 and 4 million years ago. It was probably similar to a chimp in appearance and behavior. Like a chimp, it ate mostly plant

foods, with some animal foods. Although we are closely related to chimps, the human form has diverged from that ancestral from in many ways. The important differences are:

- Bipedalism.
- Hands shaped for tool use.
- Bigger brains.
- Language and more complex social organization.
- Smaller jaws and teeth.
- A smaller gut relative to body size.

When we think of the differences between ourselves and the other apes, or other animals, a small gut is not what usually comes to mind. Neither is small teeth. We tend to focus on the dramatic differences in behavior and intelligence, and those are what make us unique. We're the only species that makes airplanes, writes essays and does mathematics. But how did those differences evolve? And why?

2 Life Is All About Energy

Most people assume that our superior intelligence and complex behavior require no explanation. They believe that evolution naturally increases those traits over time, and that humanity is the crowning pinnacle of evolution. But that is a misconception. Evolution is not a ladder of progress. Increased intelligence will only evolve if it is adaptive. The human brain is an anomaly that requires an explanation. Why did our ancestors evolve greater intelligence and more complex behavior?

Life is all about energy. Organisms have to get energy from the environment to survive and reproduce. A viable life strategy extracts more energy from the environment than it uses. The energy profit is then used to reproduce.

Animals get energy by eating food. Eating is an energetic trade-off. It has energetic costs and benefits. It takes energy to get food, and it takes energy to digest food. Some foods have more energy per unit of volume or mass. Such foods are energy-rich. They have high energy density. Other foods have low energy density. They are energy-poor.

Energy is relative. Gasoline has high energy density as a fuel for cars, but no energy density as a food for humans. The energy we are concerned with is the energy that can be used by the organism. Food has to be converted from its original form to the molecules that organisms need to build and repair their bodies, and (most importantly) the molecules that organisms burn as fuel. Essentially, animal fuel consists of sugars, starches (sugar-chains), fats and proteins. Food, such as grass (for a cow) or a salmon (for an eagle), has to be converted into the molecules that the eater can use for building materials and fuel.

3 Energy And Digestion

Digestion is a huge part of the energetic trade-off. A cow consumes a large amount of energy-poor food (grass). This food is energy-poor because it requires a lot of energy to break down into simple molecules. Grass is mostly cellulose and water. A cow has a very large and complex stomach

(sometimes called 4 stomachs), in which bacteria help to break down cellulose into sugar. A cow has to eat most of the time, and its body uses a huge amount of energy to digest its food. A cow spends most of its time and energy eating and digesting its food. It makes a small energy profit from that process. Over time, that profit accumulates in the body of the cow, and can be used to create offspring.

A carnivore, such as a wolf, consumes meat, which is more energy-rich than grass, mostly because it is easier to digest. A wolf does less work to digest its food than a cow, but it does more work to get its food. It has to locate, pursue and kill prey. It does more work outside its body, and less work inside its body. Like the cow, it makes a small energy profit from that process: just enough to survive and reproduce.

Life is about making an energy profit on your energy investment. With that in mind, let's reconsider the differences between a human and a chimp.

4 How Humans Process Food

The reductions in the jaws, teeth and gut size of humans are linked to diet. Specifically, they indicate an energy-rich diet. To be even more specific, they indicate a diet that is energy-rich when it goes into the mouth. It could require a lot of energy to acquire that food, but once it is acquired, it is easy to digest. Like the wolf, humans do work outside their bodies to acquire energy-rich food, rather than doing work inside their bodies to digest energy-poor food, like the cow.

We not only do work to acquire food, we also do a lot of work outside our bodies to process food before ingesting it. With our hands (adapted to hold objects), we can use tools to cut or crush food before eating it, and to separate energy-rich parts from energy-poor parts. We do work outside our bodies to acquire and process food before eating it. What goes into our mouths is very energy-dense, compared to what a cow eats or even what a wolf eats.

5 Bipedalism

Bipedalism is linked to diet in two ways. Bipedalism enables us to travel efficiently to get energy-rich food. Walking on two legs is more energetically efficient than walking on four legs, and much more efficient than knuckle-walking. It also frees our hands to use tools and carry food. So, bipedalism enables an energy-rich diet. It is also enabled by that diet. A small gut makes it easier to stand erect on two legs. If we had gorilla guts, we couldn't run or walk very well. We'd be tipping forward all the time. The reduction in the jaws and teeth also makes it easier to maintain an erect head posture.

6 Fire

Fire is another key part of the human adaptation, although it evolved much later than bipedalism. The use of fire is both a biological and cultural adaptation. Fire can keep you warm at night and protect you from predators. It can also cook your food. Cooking is a way of predigesting food. It breaks down complex molecules into simpler ones. It converts starches to sugars. It denatures proteins, unraveling them so they are easier to break into amino acids. Cooking increases the energy-density of food by making it easier to digest.

The campfire was the first technology powered by an external energy source. A spear is powered by human muscles. So is an axe or a hammer. Those tools increase the efficiency of human action, but ultimately they are powered by food. Wood is an abundant energy source, but we can't eat it. However, we can convert wood's energy to heat in a fire, and that heat can do work for us. A campfire not only provided our ancestors with light, warmth and protection, it also did work at a molecular level to make food more digestible.

7 How These Human Adaptations Helped Each Other

Controlling fire requires both hands and intelligence. You need hands and bipedalism to gather wood and bring it back to a campsite. You need hands to make and feed a fire. You need intelligence to predict and control fire. The ability to use fire is cultural, but that cultural innovation was linked to biological changes. It was enabled by increased intelligence and bipedalism. It also enabled those traits. Cooking freed more calories to support the brain instead of the digestive system. A large brain requires a lot of energy. It also requires a large birth-canal and an extended childhood. Without knowledge, a big brain isn't very useful. So, a large brain requires a campsite where women can tend children when they are young and vulnerable. Fire makes a campsite safer and more comfortable.

The big brain, bipedalism, tool use and fire use were a package. They evolved together, and they evolved with a new diet.

8 Human Meat Consumption

Meat consumption is another part of the human adaptation. Chimps are known to hunt and eat meat, but it is not a major part of their diet. With hands free, human hunters could use weapons to kill prey. Then they could carry their kills back to the campsite, to be butchered and cooked. A dead antelope is a convenient package of food that can be slung over one's shoulder and carried. That is much more efficient than the way lions or leopards drag food on the ground. Bipedal humans could walk long distances to find prey, and then walk long distances back with their catch.

Hand-held tools and fire were used to do work that other animals do with their teeth and stomachs. Instead of tearing meat off bones with their teeth, as a wolf does, our ancestors used stone blades to cut it. Instead of chewing through bones like a hyena, they used stones to break bones and extract marrow. They used tools to separate the energy-rich parts of a carcass, such as bone marrow, from the energy-poor parts, such as bones.

Meat consumption encouraged social and family cooperation. Men could cooperate to hunt animals. Then they could bring the food back to a campsite and share it with others.

9 Human Cooperation

Instead of roaming the landscape looking for food and consuming it where it is found, our ancestors had a home base, with (eventually) a campfire, and probably some defensive barriers, such as thorn bushes or stone piles. Women and children stayed at or near the campsite, while men ranged further afield, hunting and gathering food. The people at the campsite would keep the fire

going and do work to prepare food, while others searched for food to bring back to the campsite. Cooperation makes labor more efficient.

Sexual cooperation is an important part of the human adaptation. The extended childhood required a greater parental investment in caring for children. The expanded birth canal made women worse at running and walking than men. Females and children could not roam the landscape, eating food where they found it, as chimps do. They had to stay close to home most of the time. Although our proto-human ancestors are often portrayed as nomadic, they were much more sedentary than chimps or gorillas. Increased sexual cooperation both required and enabled a more sedentary lifestyle.

This new way of life involved greater social cooperation, with a complex division of labor. Men could kill large animals by cooperating and using weapons. This was important for defense and food acquisition. Women could cooperate to take care of children and prepare food. Old or injured men could stay at the campsite to defend it, and make tools and weapons, while fit young men wandered the landscape, searching for food.

Tools and cooperation make humans the most dangerous animal. Our bodies are not physically impressive. The strongest man is no match for a gorilla. We don't have big canines or sharp claws. Even if you had a simple spear, you wouldn't stand much chance against a lion or a wolf pack by yourself. Neither did our ancestors. In groups, however, humans are deadly. Our proto-human ancestors, such as Homo erectus, could already kill the largest animals, such as elephants, and defend themselves against the most fearsome predators, such as lions and saber-toothed cats. As Homo sapiens spread throughout the world, large animals went extinct or evolved to avoid conflict with our species.

Cooperation is an essential part of the human adaptation. We often take it for granted, but it is not easy to create cooperation. It requires solving game-theoretic problems of cooperation, epitomized by the prisoner's dilemma, the tragedy of the commons, and the free-rider problem.

Complex cooperation requires complex communication. Language is another unique human adaptation. Many animals communicate emotions, and some can communicate simple ideas, such as "predator!", but only humans can communicate complex ideas. (Whales might be able to communicate complex ideas, but it's not clear.) Wolves and lions have group-hunting behaviors that are pretty effective, but the complexity of their group behavior is very limited. Language makes it possible for humans to act together in complex ways. We use language to negotiate and plan cooperation. Even in small groups, humans have much more group agency than wolves, lions or elephants.

10 How These Human Adaptations Helped Each Other

The human adaptation both requires and enables cooperation. Language allows us to coordinate action and negotiate agreements. The campsite and fire use creates regular interaction between members of a group, and gives the group a territory. Processing food outside our bodies creates more opportunities to cooperate through division of labor, such as a division between hunting, gathering, and processing food. The variability of hunting makes sharing more important to maintain a regular diet. Bipedalism enables food to be hunted or gathered and then brought back to the campsite for processing and distribution. Extended childhood makes the campsite and a sexual division of labor necessary. We evolved to cooperate, and we depend on it.

Cooperation both requires and enables the core human traits of bipedalism, big brains, tool use and language. These traits are all linked to an energy-rich diet, and to a lifestyle in which the ingestion of food, although an important event, occupies only a small part of the day.

11 Humans Versus Cows

Contrast the human way of life with the bovine way of life. Cows spend almost all of their time eating. We spend very little time eating. Cows do a lot of work with their teeth and guts to digest energy-poor food. We do work outside our bodies to acquire and prepare energy-rich food. Our complex behaviors require greater intelligence and cooperation. Cows wander around the landscape in herds. They eat food where it is found, and they do not cooperate very much. Humans have a home base. We live in organized societies with a complex division of labor. We depend on social and sexual cooperation.

12 Synergistic Human Adaptations

I have said "requires and enables" a few times. That bidirectional relationship is an important part of human evolution, and other processes of emergence. The human adaptation does not consist of one trait. It is a package of traits, each of which makes the others more adaptive. In other words, the traits are synergistic. Each creates selective pressure to increase the others.

For example, bipedalism enables the gut to shrink, because it makes searching for energy-rich foods more efficient. A smaller gut enables bipedalism, because it makes an erect posture more efficient. Those traits did not evolve independently. They evolved together.

The same is true for the other core human traits. Language and social organization evolved together. The sexual division of labor evolved together with fire use. Cooking allowed the gut and teeth to shrink further. Energy-rich food enabled the brain to expand. The larger brain enabled the acquisition of energy-rich food with cooperation, tool-use and fire use. And so on. The human adaptation is a cluster of synergistic traits that evolved together.

The human adaptation is all about doing work outside the body, with efficient walking, hands, tools, fire, and cooperation to produce an extremely energy-rich diet.

13 Agriculture And Pastoralism

The next big change in the human diet was due to agriculture and pastoralism. Instead of hunting and gathering, some people started herding animals and growing crops. These activities were more energy-efficient than hunting and gathering. They were also more predictable, and allowed for higher population densities. Higher population densities led to increased social complexity, including new forms of cooperation, such as civilization.

Agriculture and pastoralism also involved artificial selection: human-directed evolution of animals and plants. We started to select our food plants and animals for energy density and digestibility. We also selected food animals to be docile and easily controlled by us.

Our food plants and animals also affected our evolution. In some parts of the world, humans evolved lactose-tolerance, allowing them to digest milk into adulthood. Different ways of life caused

minor variations in human body shape to evolve. Walking bent over in a rice field is easier if you have relatively short legs and a less massive upper body. Digging up the ground with a hoe requires a muscular physique. Herders benefited from being tall. There were also internal adaptations to different local diets.

The evolution of the human diet has involved the biological evolution of the human body, the cultural evolution of human behavior, and the biological evolution of cultivated plants and animals.

14 The Increasing Energy Density Of Food

The trend of increasing energy density has continued into modern times. Today, we use machinery powered by other sources of energy to process our food before we eat it.

The Big Mac (which I love) is even more energy-rich than the food our ancestors ate a hundred years ago. The bun consists of wheat that has been ground up, soaked in water, slightly fermented by yeast, and then baked. The meat in the patty has been "pre-chewed" by a grinder, and then cooked. The condiments are mostly sugar, fat and water.

I don't buy fries or pop with my Big Mac, but many people do. Soda pop is flavored sugar water with a little carbon dioxide added to make it fizz. The sugar was extracted from a plant by a mechanical process. It requires almost no digestion. French fries are potatoes (a highly artificially-selected plant food). They have been partially cooked by boiling, and then deep-fried in plant oil. People often eat them with ketchup, which consists of cooked tomatoes, vinegar, sugar and spices. All of these foods are highly processed and extremely energy-dense. The energy is almost instantly available to the body after consumption.

I suspect that some of our modern health problems, such as diabetes, are caused by the extreme energy density of the modern diet. Even though our recent ancestors had a very energy-rich diet compared to what a cow, gorilla or wolf eats, they still did some internal work to digest it. Today, our jaws don't grow big enough to accommodate our wisdom teeth. Perhaps that is because we don't chew as much as our ancestors did. Instead of worrying so much about the precise mix of nutrients that we ingest, maybe we should be more concerned about the energy density and digestibility of our food. It might be a little too easy to eat.

From our chimp-like ancestor to the modern man eating a Big Mac, the story of human evolution is the story of a more and more energy-rich diet, and adaptations to create that diet by doing work outside the body. This new way of life produced a slightly bigger energy profit than the chimp way of life, and so it evolved. Every trait that makes us human is linked to an energy-rich diet.

Ultimately, life is all about energy.