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No need to shrink guts to have a larger brain

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Brain tissue is a major consumer of energy in the body. If an animal species evolves a larger brain than its ancestors, the increased need for energy can be met by either obtaining additional sources of food or by a trade-off with other functions in the body. In humans, the brain is three times larger and thus requires a lot more energy than that of our closest relatives, the great apes. Until now, the generally accepted theory for this condition was that early humans were able to redirect energy to their brains thanks to a reduced digestive tract. Zurich primatologists, however, have now disproved this theory, demonstrating that mammals with relatively large brains actually tend to have a somewhat bigger digestive tract.

The so-called expensive-tissue hypothesis, which suggests a trade-off between the size of the brain and the size of the digestive tract, has been challenged by researchers at the University of Zurich. They have shown that brains in mammals have grown over the course of evolution without the digestive organs having to become smaller.

Ana Navarrete, the first author on the study published today in *Nature*, has studied hundreds of carcasses from zoos and museums. "The data set contains a hundred species, from the stag to the shrew," explains the PhD student. The scientists involved in the study then compared the size of the brain with the fat-free body mass. Senior author Karin Isler stresses that, "it is extremely important to take an animal's adipose deposits into consideration as, in some species, these constitute up to half of the body mass in autumn." But even compared with fat-free body mass, the size of the brain does not correlate negatively with the mass of other organs.

More fat, smaller brain

Nevertheless, the storage of fat plays a key role in brain size evolution. The researchers discovered another rather surprising correlation: the more fat an animal species can store, the smaller its brain. Although adipose tissue itself does not use much energy, fat animals need a lot of energy to carry extra weight, especially when climbing or running. This energy is then lacking for potential brain expansion. "It seems that large adipose deposits often come at the expense of mental flexibility," says Karin Isler. "We humans are an exception, along with whales and seals – probably because, like swimming, our bipedalism doesn't require much more energy even when we are a bit heavier."

Interplay of energetic factors

The rapid increase in brain size and the associated increase in energy intake began about two million years ago in the genus Homo. Based on their extensive studies of animals, the Zurich researchers propose a scenario in which several energetic factors are involved: "In order to stabilize the brain's energy supply on a higher level, prehistoric man needed an all-year, high-quality source of food, such as underground tubers or meat. As they no longer climbed every day, they perfected the art of walking upright. Even more important, however, is communal child care," says Karin Isler. Because ape mothers do not receive any help, they can only raise an offspring every five to eight years. Thanks to communal care for mothers and children, humans can afford both: a huge brain and more frequent offspring.

More information: Ana F. Navarrete, Carel P. van Schaik, and Karin Isler. Energetics and the evolution of human brain size. *Nature*.

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