

New study has scientists re-evaluating relative brain size and mammalian intelligence

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A rendition of the brain sizes in mammals of various sizes shows variation and similarities despite intelligence levels. Credit: Javier Lazaro

Scientists from Stony Brook University and the Max Planck Institute of Animal Behavior have pieced together a timeline of how brain and body size evolved in mammals over the last 150 million years. The findings, published in *Science Advances*, show that brain size relative to body size—long considered an indicator of animal intelligence—has not followed a stable scale over evolutionary time.

The international team of 22 scientists, including biologists, evolutionary statisticians, and anthropologists, compared the [brain](#) mass of 1400 living and extinct mammals. For the 107 fossils examined—among them ancient whales and the most ancient Old World monkey skull ever found—they used endocranial volume data from skulls instead of brain mass data. The brain measurements were then analyzed along with [body size](#) to compare the scale of brain size to body size over deep [evolutionary time](#).

"A big surprise was that much of the variation in relative brain size of mammals that live today can be explained by changes that their ancestral lineages underwent following the mass extinction and other cataclysmic events," says Jeroen Smaers, an evolutionary biologist, Associate Professor of Anthropology at Stony Brook University, and first author on the study. "This includes evolution of the biggest mammalian brains, such as the dolphins, elephants, and great apes, which all evolved their extreme proportions after the climate change event 23-33 million years ago."

According to the study, "big-brained" humans, dolphins, and elephants, for example, attained their proportions in different ways. Elephants increased in body size, but surprisingly, even more in brain size. Dolphins, on the other hand, generally decreased their body size while increasing brain size. Great apes showed a wide variety of body sizes,

with a general trend towards increases in brain and body size. In comparison, ancestral hominins, which represent the human line, showed a relative decrease in body size and increase in brain size compared to great apes.

The authors say that these complex patterns urge a re-evaluation of the deeply rooted paradigm that comparing brain size to body size for any species provides a measure of the species' intelligence.

Smaers points out: "At first sight, the importance of taking the evolutionary trajectory of body size into account may seem unimportant. After all, many of the big-brained mammals such as elephants, dolphins, and great apes also have a high brain-to-body size. But this is not always the case. The California sea lion, for example, has a low relative brain size, which lies in contrast to their remarkable intelligence."

By taking into account [evolutionary history](#), the current study reveals that the California sea lion attained a low brain-to-body size because of the strong selective pressures on body size, most likely because aquatic carnivores diversified into a semi-aquatic niche. In other words, they have a low relative brain size because of selection on increased body size, not because of selection on decreased brain size.

"We've overturned a long-standing dogma that relative brain size can be equivocated with intelligence," says Kamran Safi, a research scientist at the Max Planck Institute of Animal Behavior and senior author on the study. "Sometimes, relatively big brains can be the end result of a gradual decrease in body size to suit a new habitat or way of moving—in other words, nothing to do with intelligence at all. Using relative brain size as a proxy for cognitive capacity must be set against an animal's evolutionary history and the nuances in the way brain and body have changed over the tree of life."

The study further showed that most changes in brain size occurred after two cataclysmic events in Earth's history: the mass extinction 66 million years ago and a climatic transition 23-33 million years ago.

The authors conclude that efforts to truly capture the evolution of intelligence will require increased effort toward examining neuroanatomical features, such as brain regions known for higher cognitive processes.

"Brain-to-[body](#) size is of course not independent of the evolution of intelligence," emphasizes Smaers. "But it may actually be more indicative of more general adaptations to large scale environmental pressures that go beyond intelligence."

More information: J. B. Smaers et al. The evolution of mammalian brain size, *Science Advances* (2021). [DOI: 10.1126/sciadv.abe2101](https://doi.org/10.1126/sciadv.abe2101)

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