Big brains arose twice in higher primates

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Fossil Chilecebus from South America. Credit: John Weinstein, The Field Museum

After taking a fresh look at an old fossil, John Flynn, Frick Curator of Paleontology at the American Museum of Natural History, and colleagues determined that the brains of the ancestors of modern Neotropical primates were as small as those of their early fossil simian counterparts in the Old World. This means one of the hallmarks of primate biology, increased brain size, arose independently in isolated groups—the platyrrhines of the Americas and the catarrhines of Africa and Eurasia.

"Primatologists have long suspected that increased encephalization may have arisen at different points in the primate evolutionary tree, but this is the first clear demonstration of independent brain size increase in New and Old World anthropoids," says Flynn of the paper that appeared in the Museum's publication *Novitates* this June. Encephalization is the increase in brain size relative to body size. Animals with large encephalization quotients (E.Q.'s) are those with bigger brains relative to their body size in comparison to the average for an entire group. Most primates and dolphins have high E.Q.'s relative to other mammals, although some primates (especially apes and humans) have higher E.Q.'s than others.

At the heart of the new paper is the development of more accurate equations for estimating body size in platyrrhines, or New World "monkeys." Most fossils are fragments of skulls or teeth so, to help in estimating their body size (and then E.Q.), Flynn and colleagues collected 80 measurements of the skulls, jaws, and teeth of 17 different species of living New World monkeys that ranged across the full spectrum of body sizes. This study is one of the first to estimate body size with platyrrhines instead of their better-studied counterparts from the Old World, and this detailed analysis uses new statistical approaches to tease out which characteristics correlate best with body size. The goal is to apply this equation to fossilized specimens.

Chilecebus, found high in the Andes and described by Flynn and collaborators in 1995 in *Nature*, is one such fossil. The skull dates to 20 million years ago and is the oldest and most complete well-dated primate skull from the New World. In the *Novitates* paper, Flynn and colleagues more accurately estimate that *Chilecebus* weighed about 583 grams and had an E.Q. of only 1.11—a much smaller relative brain size than any living New or Old World anthropoid, which have E.Q.'s ranging from 1.39-2.44 (and even higher for humans).

"The result is clear: early fossil members of both the New World and Old World anthropoid lineages had small brain sizes, thus the larger brain sizes seen in both groups today must have arisen independently," says Flynn. "Documenting that large brains evolved separately several times within Primates will enhance understanding of the timing and pathways of brain expansion and its effects on skull growth and shape, and may lead to new insights into the genetic controls on encephalization."

Eric Delson, the Chair of Anthropology at Lehman College, City University of New York and a Research Associate at the Museum, concurs. "This work confirms that brain size increase may be one of the common characteristics of all primates," he says. "The relatively small brain of *Chilecebus* contrasts with that of the slightly younger (16.5 million years ago), larger brained fossil *Killikaike* found in Argentina and described two years ago. It is probable that brain size also increased independently in the lemurs of Madagascar, as well as in the apes (of which humans are the extreme case) and the cercopithecid monkeys of Africa and Asia."

Source: American Museum of Natural History