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Rivalry leaves its mark on primate brains

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NewScientist.com news service
Roxanne Khamsi

Brain structures in primates have developed due to different pressures on males and females to keep up with social or competitive demands, a new study suggests.

A comparison of brains from 21 primate species, including gorillas and chimps, suggests that those with greater male-on-male competition have more brain matter devoted to aggression and coordination. Whereas those species in which there is more social mixing between males and females have evolved bigger brains with higher-level thinking.

Competition for status and mates among primates might have influenced brain evolution, the researchers say. They add that contrasting brain types resulting from behavioural differences between the sexes might be a factor in other branches of mammalian brain evolution beyond anthropoid primates.

In the early 1980s, a group of researchers published information about the brain anatomy of 21 different primate species – which included gorillas, chimps and rhesus monkeys, but not humans.

The team took each brain and cut it into thin slices. They photographed each slice and marked the boundaries of the brain structures they saw. By measuring the areas of these marked regions, the scientists were able to reconstruct various brain structures and estimate their volume.

Competitive disparity

Fast-forward a quarter of a century to the new study by a different group, led by Patrik Lindenfors at Stockholm University in Sweden. They decided to find out if different types of behaviour could explain the variations in brain anatomy seen in the 21 primate species.

Lindenfors wanted specifically to know whether those species in which males competed heavily amongst themselves had any unique brain attributes. Greater male-on-male competition in primates is liked to greater disparity between male and female body size. So his team used this disparity as a proxy measure for male competition.

For example, gorillas are considered as a highly competitive because females weigh about 80 kilograms on average, whereas males weigh roughly 150 kg. "Gorillas have a big size difference, and the males compete pretty heavily because they have a sort of harem system" in which the most dominant males get the majority of the female mates, explains Lindenfors.

By comparison, female and male chimpanzees weigh about 40 and 50 kilograms, respectively, making this species appear less competitive. While dominant male chimps have more female mates, low-ranking males still have a reasonable shot at finding a mating partner.

There is almost no difference between male and female body size when it comes to gibbons, a type of small ape found in Asia. Gibbons form monogamous mating pairs, so there is very little competition among males for females.

Coordinating violence

Lindenfors conducted a complex statistical analysis comparing the volumes of the brain structures and levels of male competitiveness across the 21 species.

Even after taking into account the fact that primates with bigger bodies generally tend to have bigger brains, the analysis found a link between greater competitiveness and an increase in the size of brain regions that can trigger aggressive behaviours and coordinate movement.

Species with more competitive males tended to have larger medulla and midbrain structures – which help with coordination – relative to their overall brain size than those species with easygoing males.

The competitive species might have evolved this trait because it gave an advantage in physical confrontations, Lindenfors speculates. "You have to have body control and strength to be a dominant male," he explains.

Social skills

There was a similar pattern found for a brain structure known as the amygdala, which is involved in aggression. While this made up about 0.4% of the chimpanzee brain, it constituted 0.6% of the brain in gorillas, which are more competitive.

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In previous research, Lindenfors' group has shown that primate species that have groups with many females also tend to have larger neocortex brain regions, which help in higher-level thinking and emotions.

Primates with the most sociable females evolved a larger neocortex, suggesting that female social skills may yield the biggest brains for the species as a whole. Plus, social demands on females and competitive demands on males require skills handled by different brain components, Lindenfors suggests.

However, Lindenfors stresses one potential problem with his analyses: the study published in the early 1980s did not specify whether the brains came from female or male primates. So he can only make rough generalisations on a species level until another, more specific primate brain survey is conducted.

While many people would be curious to know how humans fit into the picture, Lindenfors says that comparing our brain structures to those of other primates is "too messy" because our brains are radically different from those of our primate cousins.

The study appears online in the journal *BMC Biology*