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Male chimpanzees signal their aggression when they display their big canines, in contrast with humans, who show small canines when they smile. SERGEY URYADNIKOV/SHUTTERSTOCK.COM

Dopamine may have given humans our social edge over other apes

language, and make small talk with strangers on a packed bus. (Put chimpanzees in the same situation and most wouldn't make it off the bus alive.) A new study suggests that the evolution of our unique social intelligence may have initially begun as a simple matter of brain chemistry.

Neuroanatomists have been trying for decades to find major differences between the brains of humans and other primates, aside from the obvious brain size. The human brain must have reorganized its chemistry and wiring as early human ancestors began to walk upright, use tools, and develop more complex social networks 6 million to 2 million years ago—well before the brain began to enlarge 1.8 million years ago, according to a hypothesis proposed in the 1960s by physical anthropologist Ralph Holloway of Columbia University. But neurotransmitters aren't preserved in ancient skulls, so how to spot those changes?

One way is to search for key differences in neurochemistry between humans and other primates living today. Mary Ann Raghanti, a biological anthropologist at Kent State University in Ohio, and colleagues got tissue samples from brain banks and zoos of 38 individuals from six species who had died of natural causes: humans, tufted capuchins, pig-tailed macaques, olive baboons, gorillas, and chimpanzees. They sliced sections of basal ganglia—clusters of nerve cells and fibers in a region at the base of the brain known as the striatum, which is a sort of clearinghouse that relays signals from different parts of the brain for movement, learning, and social behavior. They stained these slices with chemicals that react to different types of neurotransmitters, including dopamine, serotonin, and neuropeptide Y—which are associated with sensitivity to social cues and cooperative behavior. Then, they analyzed the slices to measure different levels of neurotransmitters that had been released when the primates were alive.

Compared with other primates, both humans and great apes had elevated levels of serotonin and neuropeptide Y, in the basal ganglia. However, in line with another recent study on gene expression, humans had dramatically more dopamine in their striatum than apes, they report today in the *Proceedings of the National Academy of Sciences*. Humans also had less acetylcholine, a neurochemical linked to dominant and territorial behavior, than gorillas or chimpanzees. The combination "is a key difference that sets apart humans from all other species," Raghanti says.

Those differences in neurochemistry may have set in motion other evolutionary changes, such as the development of monogamy and language in humans, theorizes Kent State paleoanthropologist Owen Lovejoy, a co-author. He proposes a new "neurochemical hypothesis for the origin of hominids," in which females mated more with males who were outgoing, but not too aggressive. And males who cooperated well with other males may have been more successful hunters and scavengers. As human ancestors got better at cooperating, they shared the know-how for making tools and eventually developed language—all in a feedback loop fueled by surging levels of dopamine. "Cooperation is addictive," Raghanti says.

Lovejoy thinks these neurochemical changes were already in place more than 4.4 million years ago, when *Ardipithecus ramidus*, an early member of the human family, lived in Ethiopia. Compared with chimpanzees, which display large canines when they bare their teeth in aggressive displays, *A. ramidus* males had reduced canines. That meant that when they smiled—like male humans today—they were likely signaling cooperation, Lovejoy says.

However, it's a big leap to prove that higher levels of dopamine changed the evolution of human social behavior. The neurochemistry of the brain is so complex, and dopamine is involved in so many functions that it's hard to know precisely why natural selection favored higher dopamine levels—or even whether it was a side effect of some other adaptation, says evolutionary geneticist Wolfgang Enard at Ludwig Maximilian University of Munich in Germany. But he says this painstaking research to quantify differences in neurochemistry among primates is important, especially as researchers study differences in gene expression in the brain. Raghanti agrees and is now writing a grant to study the brain tissue of bonobos.

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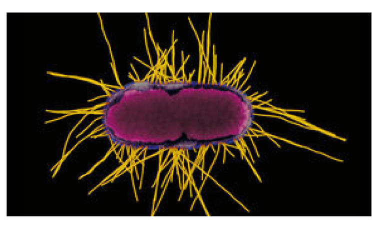

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