THE BRAIN

The human brain is a marvelous machine. It weighs only about 2% of our entire body weight, yet because it is a "high maintenance" structure, it takes about 20% of our metabolism to run it. However, size is not the most important characteristic of the human brain—it is the elaboration and growth of certain parts of the brain that are so important in human evolution.

Key areas that are especially important in the evolution of the human brain are (1) the frontal lobes, (2) the association cortex, and (3) the extent of lateralization of the two hemispheres.

1. **The frontal lobes** — for personality factors, for social awareness, and for planning ahead. Chimps have difficulty paying attention to more than one thing at a time. Humans can bring a lot of information together and access more memory to guide voluntary motor responses.

2. **The association cortex** — putting things together, constructing, and synthesizing. Primates have larger and more complex brains than most other mammals, especially in the visual and association areas of the neocortex. This area is where information from the senses is integrated. The brains of many species of primates, especially humans, have expanded in regions involved with the sensory and motor skills of the hand.

3. **Hemisphere lateralization** — the extent of differences between the right and left hemispheres of the brain. Other animals also have lateralized brains, but the human brain has elaborated upon this ancient foundation. There is a strong left-side bias for analytical processing, language, the right hand, time sequencing, and the right visual field. The right side tends to specialize in global processing, the left hand, spatial skills, recognizing faces, tone of voice, musical ability, emotions, humor and metaphor, and the left visual field.

The brain from the top, showing left and right hemispheres

Cross section of the brain

At what point in human evolution did these three elements of the brain begin to elaborate and enlarge? We know that walking upright preceded the enlargement of the brain, but bipedalism undoubtedly paved the way for brain expansion. New discoveries hint that hominids may have begun walking upright at least 6 million years ago. About 4 million years ago, hominids we call the australopithecines had small brains, just slightly larger than those of chimpanzees. It was not until *Homo rudolfensis*, about 2 million years ago, that the brain nearly doubled in size. This expansion occurred near the time when stone toolmaking appears in the archaeological record. The second great expansion of the brain occurred about 1.8 million years ago at the time of *Homo ergaster*, more than doubling the size of a chimpanzee brain. The next expansion began over a million years later, leaving modern humans with a brain more than three times as large as that of our nearest primate relative. Having a larger brain meant that early hominids needed enough protein in their diet to feed it, the physiology to cool it, and the pelvic girdle that could accommodate the birth of an infant with a large head.

The large brain was greatly facilitated by meat eating, probably first by scavenging and then by hunting. An examination of two-million-year-old animal bones from Olduvai Gorge shows that bones had been smashed and cut with stone tools. Some of these had animal tooth marks under the stone tool marks, indicating hominids were scavenging kills made by other predators.

Another constraint on the early hominids was keeping the brain cool. The hot African sun, especially on the savanna, could be dangerous to a biped with a large brain. As anyone knows who has suffered a high fever, overheating the brain makes it difficult to think.

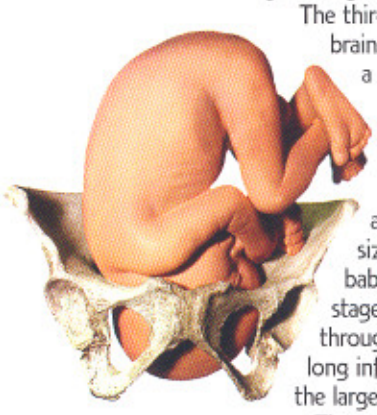
During this time, the loss of a thick coat of hair may have evolved. If human skin is viewed through a microscope, the number of hair follicles per square inch is about the same as that of a chimpanzee, but much of the hair in humans is not developed. Another difference is in the number of sweat glands—chimps have few, but humans have thousands, giving us the greatest capacity for sweating of any animal.

Left side of the human brain

Sagittal section of the human brain

These attributes—hairlessness and the ability to cool the body by perspiring—allow the skin to act as a radiator to cool the blood, which in turn cools the brain. Having a body which could be cooled allowed the brain to grow larger.

The third consideration in having a large brain is birth. A large-brained baby has a difficult time squeezing through the mother's pelvic girdle. In modern humans, a baby's brain is about one-fourth the size it will be at adulthood. Other primates are born with brains half their adult size. Somewhere in our evolution, babies began to be born at an earlier stage of development in order to pass through a tight-fitting birth canal. A long infant dependency allowed time for the large brain to develop and learn.



These three traits were part of a complex of characteristics that allowed selection for a large-brained hominid with an elaboration of brain functions. These elaborations eventually gave rise to stone tools, Michelangelo's "David," the atomic bomb, and everything we today regard as distinctly "human."