Ten years. That’s how long it takes for the modern human brain – that of Homo sapiens – to reach maximum performance. But this was not always the case: the offspring of Homo erectus, who lived approximately two million years ago, had almost adult-sized brains just a year after birth. Director Jean-Jacques Hublin and his team of researchers at the Max Planck Institute for Evolutionary Anthropology in Leipzig have been looking into the facts.

Compared with all other primates, human beings exhibit one particularity: their offspring go through a distinct infancy and childhood. This phenomenon is still relatively new in the history of mankind. That is the conclusion reached by the team working with Jean-Jacques Hublin and Hélène Coqueugniot (University of Bordeaux 1) in an article published by the British journal Nature (September 16, 2004). The scientists examined an approximately 1.8-million-year-old skull, the only known example from a child of our direct ancestor, Homo erectus. The skull of the “Mojokerto child” was discovered in the Mojokerto region of Java in 1936 by an excavation team led by German anthropologist Gustav Heinrich Ralph von Koenigswald. The completely preserved skullcap is particularly well suited to scientific examination.

Changes in bodily maturation throughout human evolution are documented by analysis of dental material. The growth patterns and long adolescent phase typical for modern Homo sapiens emerged relatively late in human developmental history. Based on the growth pattern of the teeth of Homo erectus, it can be assumed that the maturation process was faster than that of today’s humans. The question regarding the brain growth of Homo erectus, however, has remained unanswered. Did his brain mature after birth for as long as Homo sapiens’ did?

To date, the question of when, during the approximately six-million-year-long evolution of humans, the protracted post-natal brain growth – the “secondary altriciality” – emerged has been disputed. Fossilized human skulls, especially those of children, are very rare. The Mojokerto skull has brought new insights: with the help of computer tomography (CT), Hublin and his team were able to examine this find right down to the tiniest detail. Virtual paleoanthropology calls this the “touchless” method, which differs from earlier procedures in that it does not damage the fossils in any way. “Computer tomography facilitates our work considerably, since the Mojokerto skull is completely filled with sediment,” explains Jean-Jacques Hublin. “Thanks to the CT data, we were able to clearly distinguish the sediment from the bone remains and could thereby precisely determine the brain volume.” Hublin describes this method of separating rock and bone material as “virtual cleaning.” For this, the Mojokerto skull was scanned by computer tomography (CT) supplements conventional photo techniques: Left, the Mojokerto child’s skull from above; right, spatial CT views in which the bone material appears smooth and sediment is betrayed by its grainy structure.
puter tomography in single layers. “Computer tomography scatters X-rays differently on skull particles and rock,” says Jean-Jacques Hublin. “This enables the rock to be removed in the same manner.” After virtually “cleaning” the individual images in this way, the researchers superim- posed them, deriving a complete three-dimensional image of the skull.

Further analysis revealed that the child was most likely no more than one year old at the time of death – contrary to previous estimates that had put the death of the Mojokerto child at between the ages of four and six. The new estimation of the age at death resulted from the analysis of the state of ossification of different skull parts: the Pars tympanica, one of the bone plates at the front of the auditory canal, the anterior fontanella in the bregma, and the subarcuate fossa, a cavity in the re- gion of the petrosal bone, which closes during childhood. Finally, the scientists compared this data with modern human skulls of 159 children between the ages of 0 and 8, and with 201 skulls of young chimpanzees and bonobos.

In doing so, it became apparent that the tympanic part of the Mojokerto child was completely ossi- fied. On the other hand, the bregma and the subarcuate fossa were not fully developed. Furthermore, the examination of the bregma showed that spongiosa, a porous substance between the two cranial plates, had only started to accumulate. Howev- er, the os parietale were not fully formed; there was still a gap of 3.5 millimeters between them that sug- gested a partly closed anterior fontanella or even post-mortum dam- age. A further criterion for age de- termination was provided by the de- grade of subarcuate fossa closure. Comparison with corresponding finds in young modern human beings and young chimpanzees showed that the Mojokerto child must have been about a year old at the time of death.

**COMPARISON SHEDS LIGHT**

Computer tomography provided yet another surprise: the infant already had an endocranial capacity of be- tween 70 and 84 percent of that found in various samples of Homo erectus. In a second step, the re- searchers compared the Mojokerto skull – which encompassed a brain volume of 663 cubic centimeters – with other skulls of Homo e- rectus. The result: post-natal brain growth of the Homo erectus child was more similar to that of chim- panzees than to that observed in ex- tant humans. “The data indicates that the time during which the brain of the Homo erectus child could ma- ture after birth was very short,” says Jean-Jacques Hublin.

Significant differences became ap- parent in a comparison with modern humans, who are born relatively immu- nate: at birth, they possess only about 25 percent of their later brain volume of approximately 1,350 cu- bic centimeters. During the first year of life, their brain grows at the same speed as before birth and reaches about 50 percent of its ultimate vol- ume one year after. Modern man’s brain is full-grown only after the tenth year. This means that it ma- tures much more slowly and for a longer period than all other primates. “This maturation period, or sec- ondary altriciality, gives Homo sapiens significant advantages compared to his earlier relatives,” explains Hublin, referring to the development of cognitive abilities of children dur- ing the first ten years. “During this time, the young brain is exposed to innumerable environmental stimuli. That gives rise to intense interplay between the somatic and sensomo- toric regions of the brain.”

However, it’s unlikely that sec- ondary altriciality was initially select- ed for this reason. A small, still im- mature brain at birth gives mothers a decisive advantage during child rearing. Homo sapiens require large amounts of energy to maintain brain functions. A human adult uses about 20 percent of his energy for thinking and to keep his brain at “operating temperature.” Hublin explains, “In the case of an inter-uterus embryo it is even 50 percent. Therefore, in a species with very large brains, it is easier for mothers to provide their children with this large amount of energy after birth in the form of food, rather than providing it with their own body during pregnancy.”

And there is a physiological ad- vantage for women. Since the heads of their babies haven’t reached their final volume at birth, even mothers with a narrow pelvis can give birth. According to Hublin, “A narrower pelvis increases a woman’s mobility significantly. This was important in times when people moved about a great deal.” Secondary altriciality must also have played an important role in the development of language. The Leipzig scientist is convinced that Homo erectus already possessed communicative abilities; however, the generally smaller brain volume and the lack of secondary altriciality must have severely limited the cog- nitive abilities of early man and made complex language and under- standing impossible. “We can as- sume that complex language, par- allel to secondary altriciality, did not develop until relatively late in human evolution,” believes Jean- Jacques Hublin.

With their study, the Max Planck researchers were able to further narrow down the time period in which the typically human charac- teristic of secondary altriciality was developed. “The immediate predeces- sors of Homo sapiens and Homo neanderthalensis already possessed relatively large brains,” says Hublin. “Consequently, the lengthy brain maturation must have developed within the timeframe between 1,000,000 and 500,000 years ago.”

**THE ANDOYO FIND**

The skull of the Mojokerto child was found in 1936 by Andoyo, an employee of the Dutch Geological Service. At that time, Gusa- tav Heinrich Ralph von Koenigswald was also working at the Or- thological Service. His assignment was to identify fossil homi- nins, describe them, and compile a classification of the Pleio- tecene-based hominids. He only first received the skull in Bandung (West Java) in 1937, the description was part of his work of field. Koenigswald remained in Java from 1930 to 1946, but was imprisoned twice: by the Dutch for several months following the German invasion of Holland, and following the Japanese occupation of Java. Koenigswald died on July 10, 1982 at the age of 80.