

A Costly Triumph



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The Earth has been home to many species of plants and animals. More than 99% of them are now extinct, though it seems all of them had at least some short period of evolutionary prosperity. How is it that we humans have enjoyed such success, rather than any of the other closely related species that occupied the same or a similar ecological niche?

The evolutionary triumph of our species is undeniable. There are now more than 7.2 billion of us, and for some time that number will continue to rise. But there is no doubt that success does not last forever. Our phylogenetic road to triumph led through many stages, taking many turns and passing some narrow points. For example, humanity nearly went extinct after the Toba supervolcano eruption in Sumatra around 73,000 years ago – it is thought that only a few thousand individuals survived. That natural catastrophe was therefore probably a “bottleneck” that humanity barely managed to slip through.

The success of *Homo sapiens*, which despite various perturbations has continued for many thousands of years, can be evaluated from the standpoint of how various adaptations that occurred along our evolutionary line contributed to it (many of them long before the appearance of modern man). But we should remember that almost every success came at a certain price.





J. Kubo / Oshatowski

“Nature is always quite a fair mother: she gives with one hand, but then takes with the other.”

The burden of two legs

The first step in our evolutionary history that is treated as a first adaptive springboard is the adoption of an upright body position, which among other things made it possible to liberate the upper limbs from support functions. According to anthropological data, bipedalism appeared prior to 6 million years ago. Although the *Ardipithecus* species and also the *Orrorin* were already bipedal, like the later-appearing *Australopithecus* species they still retained upper-limb adaptations for living in trees. Although many paleoanthropologists maintain that these forms already moved very well on two legs (e.g. with legs straightened, rather than bent at the knee), the method of locomotion used by these ancestors of ours continues to be a subject of debate. The bipedal means of locomotion used today by modern man, with its biomechanical efficiency of walking and running, is known for certain to have been present around 2 million years ago in *Homo ergaster*.

However, this evolutionary change (bipedal locomotion) that gave rise to the *Homininae* subfamily around 6 million years ago certainly did not come “for free” in the biological sense, a fact that still makes itself felt even nowadays for many of us. It is for this reason that we relatively frequently experience knee injuries. It is also responsible for back pain – which experts say affects 80% of Americans in their lifetimes, and on average 30% of all people each given year. The problem is that adopting the two-legged stance placed a heavy burden particularly on the lumbar section of the spine. Pain and problems with the spine and lower limbs, however, are just part of the price we pay for the original causes of our evolutionary line’s subsequent success.

Costly brain

The next evolutionary change, significantly more important from the standpoint of hominization than bipedalism, is increased cranial capacity. However, man is not the species with the largest brain size to body mass ratio. A measure that seems to better capture the cognitive capacity of *Homo sapiens*, our exceptionality in this regard and evidently the reason for the evolutionary success of our genus, is known as the encephalization quotient, or EQ (see

box). The EQ of humans exceeds 6 (compared to the chimpanzee's EQ of just 2). It was this encephalization of *Homo* that paved the way for an explosion of technology and culture, and as a result allowed many factors of selective pressure which had effectively limited the rapid population growth of our ancestors to be overcome. In consequence, as far as a simple, purely evolutionary measure is concerned, encephalization can be seen as the source of the processes that led to our species' current quantitative success. But we should not delude ourselves: this quantitative success, like all successes, will most likely be only temporary.

The price-tag that came attached to high encephalization is a serious one, which is why so few species has such a trait. Firstly, the brain, especially the cerebral cortex, is a very energy-intensive organ. In an adult human, the brain accounts for 2% of body mass on average, yet consumes more than 20% of the energy (in infants, even more than 60%). Few species can afford the high cost of such a "luxury limousine" style brain. Secondly, the large surface (in relation to body mass) of the very poorly insulated cranium leads to constant heat loss. Of course this cost is greatest in the first year of life, when the head is relatively large compared to

cently even facing the serious risk of death during birth or soon afterwards. Although women live longer than men nowadays, we should bear in mind that because of birth-related fatalities their average life span was shorter than that of men as recently as in the 19th century. Around 100 years ago, problems related to giving birth were the number-one cause of death among women of reproductive age.

Growth in brain size and the attendant refined behavior and culture also bring with them the appearance of such new types of selection as suicides, accidents caused by very risky behavior, and difficult toxic addictions. The dark side of having a large brain, it seems, makes itself felt in the phenomenon of cruelty - which is a true manifestation of humanization, rather than animalization, as many people might think.

The big brains that characterize our genus *Homo* are from today's standpoint still an evolutionary success, albeit one attained at significant cost. I only hope that this "success," which has made possible not only such explosive demographic growth but also the dramatically rapid pollution of the planet and consumption of its resources, will not soon prove to be but a short-lived episode, an ephemeral "flash in the pan." A large brain could turn out to be an evolutionary dead-end, in fact not because of its physiological cost but because of its owner's dictatorial attitude with respect to the whole biosphere. If this evolutionary line should die out, it will be very dramatic and will end in another great wave of extinctions (as are in fact already taking place), after which it will take a long time for our planet's biosphere to recover - only this time in a much altered form.

Communication vs. choking

The next undoubtedly extraordinary success of our evolutionary line is the development of language and the ability to precisely convey information by verbal means. The production of speech is relatively cheap in terms of energy, yet yields many gains related to the exchange of information, for instance about past events or interpersonal relations. It is thought that language was the factor that facilitated lavish cultural development, complex forms of cooperation and trade. This success, too, inevitably came with a price-tag - and not just all the lies, slander, rumors, and intrigues that language made possible, the refined manifestation of

The encephalization quotient (EQ) is a relative measure of brainpower proposed by Harry Jerison. It is calculated by dividing the mean cerebral mass for a given species by the expected cerebral mass for animals of the same body mass within a given group of animals (e.g. mammals). For example, the average brain size for mammals with a body mass similar to that of humans (around 50-60 kg) is 200 g, whereas the human brain actually weighs in at about 1.3 kg, so the resulting EQ = 1300/200 = 6.5. However, the latest studies argue that for primates, at least, absolute brain size may offer a better measure of cognitive abilities than EQ.

the rest of the body. Thirdly, a big brain means that fetuses have big heads, and since the size of the female birth canal is limited by the biomechanical demands of bipedalism, that in turn means that giving birth is frequently a long and painful process. This cost of human intelligence is of course paid by women, affected by various birth-related complications and until quite re-



The evolutionary changes that enabled humans to adapt to nearly any conditions have nevertheless come at a price. For example, it is because of our adoption of a bipedal means of locomotion that we are plagued by knee injuries and back pain

human intelligence that is Machiavellian cunning, whose price for so many human individuals and societies is impossible to estimate. Rather, because of the lowering of the larynx to allow for the creation of articulated speech, we are unable to speak or breathe at the same time as swallowing (something that infants can do). That is why we so often experience choking. It is estimated that several thousand people die for this reason every year. In the United Kingdom alone, in 1999 hospitals noted 16,000 cases of choking, including 218 fatal cases of choking on food. Apart from that, 55 people choked to death on inedible objects.

The pros and cons of culture

Another success of course lies in our various technological and cultural achievements, which have proved to be very important cultural factors contributing to the our species' demographic explosion and evolutionary prosperity. Of course they would not be possible without our cognitive abilities, in other words without our large brain size. But we still do not know the answer to the fundamental question of why, of all the closely related species that co-occurred with *Homo sapiens* until not that long ago (a few tens of thousands of years), our species alone has survived to the present day. It seems unlikely that this evolutionary "victory" was the result of morphological or physiological adaptations, especially since there are many suggestions that the Neanderthals, too, used language and engaged in complex forms of communication. It is more likely that it was some kind of cultural developments that gave our ancestors the necessary competitive edge – for example, perhaps the domestication of the dog. Until recently it was thought to have happened some 11,000-16,000 years ago, meaning at a time when there were no longer any Neanderthals,

but there are new studies indicating that it may have occurred earlier (some 33,000 years ago). Such canine "backup" may have given representatives of our species a great adaptive advantage over others, and might have been crucial from the evolutionary standpoint.

Another milestone for humanity came with the shift from a hunter-gatherer economy to an agriculture-based one. That happened around 10,000 years ago, when *Homo sapiens* already stood alone on the evolutionary battlefield, as the sole remaining *Homo*. We should remember that this economic change was ecologically necessitated, caused by humans being ousted from the "paradise" where they had harnessed naturally created environmental resources. We know that the first farmers had things significantly harder than the first hunter-gatherers. But as hindsight shows, this change also turned into an evolutionary success. The same thing can be said for urbanization – the first city-dwellers had a significantly harder time than farmers. So as we can see, evolutionary successes in our phylogeny most often came at the expense of suffering. But as they say, *per aspera ad astra* (note how in this modern era of space exploration, the old Latin phrase has become more than just metaphorical!) ■

Further reading:

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