THE INCREDIBLE SHRINKING BRAIN

The human brain has been getting smaller and smaller since the Stone Age—and no one is sure why.

JOHN HAWKS is in the middle of explaining his research on human evolution when he drops a bombshell. Running down a list of changes that have occurred in our skeleton and skull since the Stone Age, the University of Wisconsin anthropologist nonchalantly adds, "And it's also clear the brain has been shrinking." >>>

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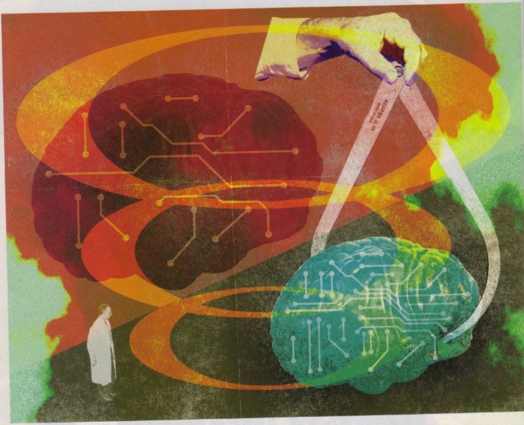

"Shrinking?" I ask. "I thought it was getting larger." The whole ascent-of-man thing.

"That was true for 2 million years of our evolution," Hawks says. "But there has been a reversal."

He rattles off some dismaying numbers: Over the past 20,000 years, the average volume of the human male brain has decreased from 1,500 cubic centimeters to 1,350 cc, losing a chunk the size of a tennis ball. The female brain has shrunk by about the same proportion. "I'd call that major downsizing in an evolutionary eyeblink," he says. "This happened in China, Europe, Africa—everywhere we look." If our brain keeps dwindling at that rate over the next 20,000 years, it will start to approach the size of that found in *Homo erectus,* a relative that lived half a million years ago and had a brain volume of only 1,100 cc. Possibly owing to said shrinkage, it takes me a while to catch on. "Are you saying we're getting dumber?" I ask.

Hawks, a bearish man with rounded features and a jovial disposition, looks at me with an amused expression. "It certainly gives you a different perspective on the advantage of a big brain," he says.

After meeting with Hawks, I call around to other experts to see if they know about our shrinking brain. Geneticists who study the evolution of the human genome seem as surprised as I am (typical response: "No kidding!"), which makes me wonder if I'm the world's most gullible person. But no, Hawks is not pulling my leg. As I soon discover, only a tight-knit circle of paleontologists seem to be in on the secret, and even they seem a bit muddled about the matter. Their theories as to why the human brain is shrinking are all over the map.

Some believe the erosion of our gray matter means that modern humans are indeed getting dumber. (Late-night talk show hosts, take note—there's got to be some good comic material to mine here.) Other authorities argue just the opposite: As the brain shrank, its wiring became more efficient, transforming us into quicker, more agile thinkers. Still others believe that the reduction in brain size is proof that we have tamed ourselves, just as we domesticated sheep, pigs, and cattle, all of which are smaller-brained than their wild ancestors. The more I learn, the more baffled I become that news of our shrinking brain has been so underplayed, not just in the media but among scientists. "It's strange, I agree," says Christopher Stringer, a paleoanthropologist and expert on human origins at the Natural History Museum in London. "Scientists haven't given the matter the attention it deserves. Many ignore it or consider it an insignificant detail."

But the routine dismissal is not as weird as it seems at first blush, Stringer suggests, due to the issue of scaling. "As a general rule," he says, "the more meat on your bones, the more brain you need to control massive muscle blocks." An elephant brain, for instance, can weigh four times as much as a human's. Scaling is also why nobody seems too surprised by the large brains of the Neanderthals, the burly hominids that died out about 30,000 years ago.

The *Homo sapiens* with the biggest brains lived 20,000 to 30,000 years ago in Europe. Called the Cro-Magnons, they had barrel chests and huge, jutting jaws with enormous teeth. Consequently, their large brains have often been attributed to brawniness rather than brilliance. In support of that claim, one widely cited study found that the ratio of brain volume to body mass—commonly referred to as the encephalization quotient, or EQ—was the same for Cro-Magnons as it is for us. On that basis, Stringer says, our ancestors were presumed to have the same raw cognitive horsepower.

Now many anthropologists are rethinking the equation. For one thing, it is no longer clear that EQs flatlined back in the Stone Age. Recent studies of human fossils suggest the brain shrank more quickly than the body in near-modern times. More important, analysis of the genome casts doubt on the notion that modern humans are simply daintier but otherwise identical versions of our ancestors, right down to how we think and feel. Over the very period that the brain shrank, our DNA accumulated numerous adaptive mutations related to brain development and neurotransmitter systems—an indication that even as the organ got smaller, its inner workings changed. The impact of these mutations remains uncertain, but many scientists say it is plausible that our temperament or reasoning abilities shifted as a result.

Numerous phone calls later, it dawns on me that the world's foremost experts do not really know why our organ of intellect has been vanishing. But after long ignoring the issue, some of them have at least decided the matter is of sufficient importance to warrant a formal inquiry. They have even drawn some bold, albeit preliminary, conclusions.

DUMBING DOWN

In search of a global explanation for our cranial downsizing, some scientists have pointed to a warming trend in the earth's climate that also began 20,000 years ago. Since bulky bodies are better at conserving heat, larger frames may have fared better in the colder climate. As the planet warmed, selection might have favored people of slighter stature. So, the argument goes, skeletons and skulls shrank as the temperature rose—and the brain got smaller in the process. Stringer thinks there is something to that idea, but he doubts it is the whole explanation. As he points out, comparable warming periods occurred many times over the previous 2 million years, yet body and brain size regularly increased.

Another popular theory attributes the decrease to the advent of agriculture, which, paradoxically, had the initial effect of worsening nutrition. Quite simply, the first farmers were not very successful at eking out a living from the land, and their grain-heavy diet was deficient in protein and vitamins—critical for fueling growth of the body and brain. In response to chronic malnutrition, our body and brain might have shrunk. Many anthropologists are skeptical of that explanation, however. The reason: The agricultural revolution did not arrive in Australia or southern Africa until almost contemporary times, yet brain size has declined since the Stone Age in those places, too.

AS COMPLEX SOCIETIES EMERGED, BRAINS SHRANK BECAUSE THOSE PREVIOUSLY UNABLE TO SURVIVE BY WITS ALONE COULD NOW SCRAPE BY WITH THE HELP OF OTHERS.

Which brings us to an unpleasant possibility. "You may not want to hear this," says cognitive scientist David Geary of the University of Missouri, "but I think the best explanation for the decline in our brain size is the idiocracy theory." Geary is referring to the eponymous 2006 film by Mike Judge about an ordinary guy who becomes involved in a hibernation experiment at the dawn of the 21st century. When he wakes up 500 years later, he is easily the smartest person on the dumbed-down planet. "I think something a little bit like that happened to us," Geary says. In other words, idiocracy is where we are now.

A recent study he conducted with a colleague, Drew Bailey, led Geary to this epiphany. The aim of their investigation was to explore how cranial size changed as our species adapted to an increasingly complex social environment between 1.9 million and 10,000 years ago. Since that period predates the first alphabets, the researchers had no written record with which to gauge the social milieu of our predecessors. Consequently, the Missouri team used population density as a proxy for social complexity, reasoning that when more people are concentrated in a geographic region, trade springs up between groups, there is greater division of labor, the gathering of food becomes more efficient, and interactions among individuals become richer and more varied.

Bailey and Geary found population density did indeed track closely with brain size, but in a surprising way. When population numbers were low, as was the case for most of our evolution, the cranium kept getting bigger. But as population went from sparse to dense in a given area, cranial size declined, highlighted by a sudden 3 to 4 percent drop in EQ starting around 15,000 to 10,000 years ago. "We saw that trend in Europe, China, Africa, Malaysia—everywhere we looked," Geary says.

The observation led the researchers to a radical conclusion: As complex societies emerged, the brain became smaller because people did not have to be as smart to stay alive. As Geary explains, individuals who would not have been able to survive by their wits alone could scrape by with the help of others—supported, as it were, by the first social safety nets.

Geary is not implying that our beetle-browed forebears would have towered over us intellectually. But if Cro-Magnons had been raised with techno-toys and the benefits of a modern education, he ventures, "I'm sure we would get good results. Don't forget, these guys were responsible for the 'cultural explosion'"—a revolution in thinking that led to such startling new forms of expression as cave paintings, specialized tools, and bones carved into the first flutes. In terms of raw innate smarts, he believes, they probably were as "bright as today's brightest" and might even have surpassed us.

Still, Geary hesitates to use words like *genius* or *brilliant* in describing them. "Practically speaking," he explains, "our ancestors were not our intellectual or creative equals because they lacked the same kind of cultural support. The rise of agriculture and modern cities based on economic specialization has allowed the very brightest people to focus their efforts in the sciences, the arts, and other fields. Their ancient counterparts didn't have that infrastructure to support them. It took all their efforts just to get through life."

HUNTER-GATHERERS HAVE KILLED BULLIES FOR 100,000 YEARS. WHEN YOU SELECT AGAINST AGGRESSION, YOU GET SOME SURPRISING TRAITS.

SMALLER BUT SMARTER

When I follow up with Hawks, the anthropologist who first tipped me off about our missing gray matter, I assume that his interpretation of the trend will be like Geary's. But even though Hawks does not doubt the findings of the Missouri team, he puts a completely different (and, in his view, more uplifting) spin on the data.

Hawks spent last summer measuring skulls of Europeans dating from the Bronze Age, 4,000 years ago, to medieval times. Over that period the land became even more densely packed with people and, just as the Missouri team's model predicts, the brain shrank more quickly than did overall body size, causing EQ values to fall. In short, Hawks documented the same trend as Geary and Bailey did in their older sample of fossils; in fact, the pattern he detected is even more pronounced. "Since the Bronze Age, the brain shrank a lot more than you would expect based on the decrease in body size," Hawks reports. "For a brain as small as that found in the average European male today, the body would have to shrink to the size of a pygmy" to maintain proportional scaling.

Hawks chose to focus on Europe in the relatively recent past, he explains, because there is an exceptionally large number of complete remains from that era. That allowed him to reconstruct a detailed picture of what was happening during our downsizing. The process, he discovered, occurred in fits and starts. There were times when the brain stayed the same size and the body shrank—most notably, he says, from the Roman era until medieval times. But more frequently, the brain got smaller while the body remained the same. Indeed, Hawks says, that is the overarching trend for the thousands of years he studied.

The image of a brain dwarfed by its body conjures up dinosaurs, a group not exactly known for their intellectual prowess. But Hawks sees nothing alarming in the trend. Quite the contrary, he believes the startling decrease in our brain volume —both in absolute terms and relative to our stature—may be a sign that we are actually getting smarter.

This upbeat perspective is shaped by Hawks's focus on the energy demands of the brain. The organ is such a glutton for fuel, he says, that it gobbles up 20 percent of all the calories we consume. "So although a bigger brain can presumably carry out more functions, it takes longer to develop and it uses more energy." Brain size probably depends on how those opposing forces play out.

The optimal solution to the problem, he suggests, "is a brain that yields the most intelligence for the least energy." For evolution to deliver up such a product, Hawks admits, would probably require several rare beneficial mutations—a seeming long shot. But a boom in the human population between 20,000 and 10,000 years ago greatly improved the odds of such a fortuitous development. He cites a central tenet of population genetics: The more individuals, the bigger the gene pool, and the greater the chance for an unusual advantageous mutation to happen. "Even Darwin knew this," he says. "That's why he recommended that animal breeders maintain large herds. You don't have to wait so long for desirable traits to arise."

Hawks notes that such changes would be consistent with the many brain-related DNA mutations seen over the past 20 millennia. He speculates that the organ's wiring pattern became more streamlined, the neurochemistry shifted, or perhaps both happened in tandem to boost our cognitive ability.

A TAMER BREED

Other researchers think many of their colleagues are barking up the wrong tree with their focus on intelligence as the key to the riddle of our disappearing gray matter. What may have caused the trend instead, they argue, is selection against aggression. In essence, we domesticated ourselves, according to Richard Wrangham, a primatologist at Harvard University and a leading proponent of this view.

Some 30 animals have been domesticated, he notes, and in the process every one of them has lost brain volume—typically a 10 to 15 percent reduction compared with their wild progenitors. Domesticated animals also have more gracile builds, smaller teeth, flatter faces, a more striking range of coloration and hair types—and, in many breeds, floppy ears and curly tails. Except for those last two traits, the domesticated breeds sound a lot like us.

"When you select against aggression,

you get some surprising traits that come along with it," Wrangham says. "My suspicion is that the easiest way for natural selection to reduce aggressiveness is to favor those individuals whose brains develop relatively slowly in relation to their bodies." When fully grown, such an animal does not display as much aggression because it has a more juvenile brain, which tends to be less aggressive than that of an adult. "This is a very easy target for natural selection," Wrangham argues, because it probably does not depend on numerous mutations but rather on the tweaking of one or two regulatory genes that determine the timing of a whole cascade of developmental events. For that reason, he says, "it happens consistently." The result, he believes, is an adult possessing a suite of juvenile characteristics, including a very different temperament.

To illustrate how this could happen, Wrangham refers to an experiment that began half a century ago in Siberia. In 1958 the Russian geneticist Dmitri Belyaev started raising silver foxes in captivity, initially selecting to breed only the animals that were the slowest to snarl when a human approached their cage. After about 12 generations, the animals evidenced the first appearance of physical traits associated with domestication, notably a white patch on the forehead. Their tameness increased over time, and a few generations later they were much more like domesticated dogs. They had developed smaller skeletons, white spots on their fur, floppy ears, and curlier tails; their craniums had also changed shape, resulting in less sexual dimorphism, and they had lower levels of aggression overall.

So what breeding effect might have sent humans down the same path? Wrangham offers a blunt response: capital punishment. "Over the last 100,000 years," he theorizes, "language became sufficiently sophisticated that when you had some bully who was a repeat offender, people got together and said, 'We've got to do something about Joe.' And they would make a calm, deliberate decision to kill Joe or expel him from the group—the functional equivalent of executing him." Anthropological records on hunter-gatherers suggest that capital punishment has been a regular feature of our species, according to Wrangham. In two recent and well-documented studies of New Guinea groups following ancient tribal custom, the ultimate punishment appears to be meted out to at least 10 percent of the young men in each generation.

"The story written in our bones is that we look more and more peaceful over the last 50,000 years," Wrangham says. And that is not all. If he is correct, domestication has also transformed our cognitive style. His hunch is based on studies—many done by his former graduate student Brian Hare—comparing domestic animals with their wild relatives. The good news, Wrangham says, is that "you can't speak of one group being more intelligent than the other."

Hare, now an assistant professor of evolutionary anthropology at Duke University, agrees. "All you can say is that wild types and domesticates think differently."

The two scientists point to the results of studies comparing the cognitive abilities of wolves and dogs. Wolves, with their larger brains, are more prone to flashes of insight, allowing them to solve problems on their own; dogs, with smaller brains, excel at using humans to help them. "Wolves seem to be a little bit more persistent than dogs in solving simple problems like how to open a box or navigate a detour," Hare says. "Wolves persevere when dogs readily give up." On the flip side, dogs leave wolves in the dust when it comes to tracking the gaze and gestures of their masters—or as Hare puts it, "They are very good at using humans as tools to solve problems for them." And while dogs may appear lazy and pampered, some can survive for multiple generations in areas far removed from humans—an indication, Hare says, that they have retained an ability to adapt to the wild.

For more insight, Hare is now studying other primates, notably bonobos. He tells me he suspects that these great apes are domesticated chimps. As if on cue, bursts of exotic, birdlike trills suddenly drown out his voice over the phone. "Sorry about that," he shouts over the line. "Those are the bonobos." It turns out that as I am speaking to him, Hare is not at his desk at Duke but in a Congo forest where the bonobos live. "Bonobos look and behave like juvenile chimps," he continues. "They are gracile. They never show lethal aggression and do not kill each other. They also have brains that are 20 percent smaller than those of chimps."

Hare thinks bonobos became domesticated by occupying an ecological niche that favored selection for less aggressive tendencies. That niche, he says, offered more abundant sources of nutrition, so a habit of fighting over meals became less important to survival. From that lineage came the bonobos, highly cooperative primates known for their peaceful ways.

Both Wrangham and Hare see parallels between bonobo development and our own. Our self-domestication, they think, may hold the key to our species's extraordinary motivation to cooperate and communicate —arguably the twin pillars supporting the whole of our civilization.

ABOUT-FACE

Just as I begin to absorb these varying interpretations, I am hit with the next surprise in our human evolutionary narrative: After a long, slow retrenchment, human brain size appears to be rising again. When anthropologist Richard Jantz of the University of Tennessee measured the craniums of Americans of European and African descent from colonial times up to the late 20th century, he found that brain volume was once again moving upward.

Since evolution does not happen overnight, one would assume this sudden shift (much like the increase in height and weight) is unrelated to genetic adaptations. Hawks, for instance, says the explanation is "mostly nutrition." Jantz agrees but still thinks the trend has "an evolutionary component because the forces of natural selection have changed so radically in the last 200 years." His theory: In earlier periods, when famine was more common, people with unusually large brains would have been at greater peril of starving to death because of gray matter's prodigious energy requirements. But with the unprecedented abundance of food in more recent times, those selective forces have relaxed, reducing the evolutionary cost of a large brain.

Whatever the reason for the recent uptick in cranial size, Jantz believes it is having an effect on how we think. Recent MRI studies, according to Jantz and other scientists, show that brain volume really does correlate with intelligence—at least as measured by that oft-celebrated but widely criticized metric, the IQ test. Seen from that perspective, a bigger brain sounds like good news. Then again, if aggressiveness rises with brain size, maybe not.

Perhaps, like so many things in life, our fluctuating brain size is a mixed bag—and in contrast to animal breeding, we cannot determine where evolution is taking us. "Natural selection is different from artificial selection in that it acts on every trait at once," Stringer says. "It's perfectly plausible our modern brain is smarter in some ways, dumber in others, and more docile overall."