Topic:Evolution

INQUIRY: AN OCCASIONAL COLUMN

Are We Still Evolving?

The Answer Depends—And Doesn't—On Which Humans You Ask

By Peter Tyson | Posted 12.14.09 | NOVA

There has been no biological change in humans in 40,000 or 50,000 years. Everything we call culture and civilization we've built with the same body and brain.

—Stephen Jay Gould

I was surprised when I read these words from one of the 20th century's leading thinkers on evolutionary theory. We hominids have been evolving for millions of years. Why would that have suddenly stopped? Isn't our kind, *Homo sapiens*, subject to the same forces of Darwinian natural selection as all other species?

I've got blue eyes and light skin, traits thought to have first arisen many thousands of years after we humans left our ancestral homeland of Africa around 50,000 years ago. Don't such physical characteristics signal that our species has been evolving, even if such traits are only skin deep?

In short, could we really be exactly the same as we were when the ancestors of all of us first spread out from the African continent with their simple stone tools and hunter-gatherer lifestyles?

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Simple question, complicated answer, as I found out. Depending on whom I asked, the answer came back no, yes, yes-and-no, or maybe. Paradoxically, though, I discovered that those who differ ostensibly, and often adamantly, about how to reply to this notoriously sensitive question appear to more or less agree on the answer.

REIGNING PARADIGM

About 40,000 years ago, as we *Homo sapiens* were busy replacing Neanderthals in Europe, the archeological record reveals that a great leap forward took place in our species. We began making cave paintings, jewelry, sculpture, markedly better tools and weapons. And, according to Gould and leading thinkers across many disciplines, from biology to anthropology, our evolution became purely cultural. This paradigm held sway for decades. "There was a really pervasive ideology, especially in social science, that humans are all the same and biology doesn't count," says the anthropologist Henry Harpending.

With increasingly rare exceptions, survival in the West no longer depends on a person's genes.

The most obvious reason for thinking our natural evolution has ceased is that we're just a single species. In the 200,000 years since we modern humans first appeared, we have not split into other species. Any person on Earth today can, theoretically, interbreed with any other of the opposite sex. This is true despite obvious differences in physical traits between individual people as well as between—dare I say it?—races. With my blue eyes and pale skin—I'm of northern European descent—no one would confuse me with an Australian Aborigine, a Han Chinese, or a Bantu African, or any of them with me.

Racial sensitivities certainly played a part in the paradigm holding fast for so long, and I've found that they make writing about this subject difficult even now. The notion that races could differ biologically in substantial ways harks back to eugenics and Nazi atrocities. Particularly when it comes to whether some ethnic groups or races may be "smarter" than others, the unspoken agreement among researchers has traditionally been, and perhaps sensibly so, "don't go there."

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SIMPLE, YES, BUT COMPLEX?

Even if someone had wanted to go there—and some have, at their social and professional peril—no one really could scientifically. Before the Human Genome Project and related studies, the tools and data did not exist to reliably check for signs of recent human evolution. This was particularly true of complex adaptations, those that result from more than a single mutation and involve the coordinated actions of many genes. While anyone can see, for example, that obvious *physical* differences exist between races, even more so between individual people, as the biologist Ernst Mayr wrote in 1997, "when it comes to the *psychological* characteristics that really count, the role of genes is largely undetermined" [my italics].

Evolutionary psychologists, who attempt to explain psychological traits such as language or memory as the products of natural or artificial selection, concur. And they agree with the notion that that great leap forward 40,000 years ago largely freed us from the pressures of natural selection. We made clothes rather than grew more hair; we crafted better weapons rather than became stronger; we handed down learned behaviors through language rather than discovered them anew. Genetically, they held, our evolution had all but stopped.

"It's a simplifying assumption based on sheer numbers, that the amount of time we have spent in a modern environment is a fraction of the amount of time we spent evolving," says Harvard evolutionary psychologist Steven Pinker. Simple traits such as blue eyes, which arise from a single mutation in a single gene, continued to be selected for. But complex traits, such as a new emotion or cognitive ability, simply could not have been installed in such a brief period of time, Pinker believes.

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"GENUINELY OVER"

Even some geneticists contend we've stopped evolving. Steven Jones of University College London is one. While Jones acknowledges that natural selection still operates in parts of the developing world, particularly Africa, where selective pressures favor mutations that benefit people in their constant struggle with lethal diseases, in the developed world human evolution is, he maintains, "genuinely over."

For one thing, Jones says, with increasingly rare exceptions, survival in the West no longer depends on a person's genes. Advances in medicine and technology enable 98 percent or more of all babies born in the United States, Europe, or Japan, for example, to survive long enough to reproduce and pass on their DNA. In the past, natural selection would have weeded out the less reproductively fit, but no longer. Furthermore, Jones says, beneficial mutations dispersed through random genetic drift much more rapidly in the past when we lived in small, isolated groups than they do today in our huge, increasingly intermixed global population.

Every population has a strong selective pressure for intelligence.

Jones also notes that the number of offspring that people have in industrialized nations shows little variation. In the past, a single powerful man who procreated with abandon could significantly influence the composition of the human gene pool, at least regionally. In 2003, for instance, researchers at Oxford University identified the Y chromosome of Genghis Khan, whose harems are well-documented, in the DNA of men living today from Mongolia across to Central Asia. (The Y chromosome passes essentially unchanged from father to son so can be traced through the genome.) Today, Jones argues, most families in the West have none, one, two, or several children. There is also a smaller proportion of *older* fathers, who contribute more mutations—the raw material for natural selection—than do younger dads, he says.

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SPEEDING UP

Other experts believe our biological evolution has not only proceeded but has sped up since we developed agriculture about 10,000 years ago, a sea change that led to civilization as we know it. The anthropologist Henry Harpending and physicist-turned-evolutionary biologist Gregory Cochran, both of the University of Utah, make this argument forcibly in their 2009 book, *The 10,000 Year Explosion: How Civilization Accelerated Human Evolution*.

Using one of several techniques now available to search for signs of recent selection in the human genome, Harpending and Cochran and their colleagues determined that fully 7 percent of our genes appear to be under recent evolutionary pressure. Moreover, they contend, we humans are evolving away from each other. "The genes that seem to be the newest and evolving fastest are regional, not pan-human," Harpending says. That is, only some people, but not all of us, have traits such as the upper eyelid fold of northern Asians or the very dark skin of most Dravidians in southern India or the blue eyes of many northern Europeans—all adaptations that presumably arose because they conferred some benefit in specific kinds of environments.

As their foray into the issue of racial differences hints, Harpending and Cochran aren't shy about presenting controversial ideas. They argue, for instance, that we acquired beneficial genes, including genes they believe may have sparked that great cultural leap, from mating with Neanderthals. They cite *FOXP2*, a gene that has been implicated in the development of speech and language. A European team reported in a 2007 paper in *Current Biology* that Neanderthals shared the very same mutated version of *FOXP2* with us. But we apparently acquired that shared version of *FOXP2* later than Neanderthals did, only about 40,000 years ago, Harpending says. "I don't know how else to explain that except to suggest we got it from Neanderthals," he told me.

No one knows why natural selection has favored blue eyes.

The pair also posit that Ashkenazi (European) Jews have a genetic advantage in intelligence, and that it arose from selection pressure for success in financial occupations. They offer striking figures—for example, Jews, while never more than 3 percent of the American population, account for 40 percent of the American Nobel Prize winners in science and economics. The team say the Ashkenazim gained this genetic enhancement because of their way of life in the Middle Ages. Between about 800 and 1600 in Europe, Jews tended to do cognitively challenging jobs rather than menial labor and not to marry outside their community, and more successful Jewish families had more surviving children.

Skeptics point to a lack of evidence. "It could be true," Steve Pinker told me of the Ashkenazim theory, "but we don't have the evidence to know whether it's true." Sarah Tishkoff, a geneticist at the University of Pennsylvania, agrees, adding that, after all, every population has a strong selective pressure for intelligence, the better to succeed in its respective environment. As far as consorting with Neanderthals, Tishkoff dismisses that notion as pure speculation: "I don't know of any evidence for that."

Harpending, perhaps surprisingly, is the first to agree. "A number of people have pointed out that probably half of it will turn out to be wrong," he says of what he and Cochran present in their book. "And that's what we think, too. We're throwing out what we think are interesting and plausible ideas."

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HARD EVIDENCE

Speculation, however provocative, only goes so far in science, of course. What everyone wants, what the system demands, is empirical evidence. And the revolution in genomics has started to provide it, through such landmark projects as the International Haplotype Map. The map provides detailed data on genetic differences in 270 people of Nigerian, Japanese, Han Chinese, and northern European descent. Researchers now have those missing tools and data, and they can begin searching in earnest for signs of recent evolution in humans. This includes ferreting out patterns of genetic inheritance, tying genes to specific diseases, even pinpointing the likely geographic origin of certain mutations.

Three recent studies, for example, have shown that a single mutation in the *HERC2* gene may be responsible for the blue eyes of all the estimated 300 million people who have them. That mutation, the researchers suggest, arose in a single individual who lived near the Black Sea 6,000 to 10,000 years ago, and it spread from there. No one knows why natural selection has favored blue eyes. They may be merely a by-product of selection for paler skin, which enables better absorption of vitamin D (essential for healthy bones and teeth) in cloudier northern climates than darker skin does.

For other mutations, the reason why they "swept," or increased in frequency, is clearer. Take the gene that confers lactose tolerance. For most of our history, our ability to digest lactose, the chief sugar in milk, turned off after weaning; we only drank our mother's milk. But after cattle were domesticated, cow's milk became a nutritious addition to the diet. Natural selection would have favored individuals born with a mutation that kept the so-called lactase gene switched on throughout life, enabling them to digest milk.

Genetic evidence shows that such a mutation first occurred in northern Europe perhaps 8,000 years ago. Recently, a team led by Sarah Tishkoff identified three new mutations, each conferring lactose tolerance, that arose in three different populations in East Africa. All were independent of one another and of the original European mutation. Nature seems be solving the same problem in different ways.

Few would say we're evolving enough to differentiate into one or more new species of human.

Some of the strongest signs of recent selection concern genes that correlate with certain infectious diseases. As early as the 1950s researchers noted that the sickle-cell mutation in the beta hemoglobin gene provided carriers of the trait with protection against malaria. Since then, scientists have identified a number of genetic variants that confer some defense against other diseases, including HIV and lassa, a hemorrhagic fever endemic to parts of central and west Africa.

Techniques to find such variants are improving all the time. Pardis Sabeti, an evolutionary biologist at Harvard who linked two genes to lassa fever, has recently developed a powerful new technique with her team. Dubbed the "composite of multiple signals," it integrates data from three widely used tests for selection. "It's very exciting, because it means that we can get to biological candidates that we can really understand, as opposed to making stories from large regions [of the genome]," Sabeti says. That is, researchers can be much surer which genes an apparent selection pressure is actually acting upon, with consequently greater chance of determining the function of specific traits.

And determining function is the first step to translating findings into better ways to combat diseases and into improved public-health efforts. One such selection study, for example, that was published in *Nature* in 2007 with Sabeti as lead author, led to new diagnostic testing facilities for lassa fever in Nigeria.

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AN EVOLVING BRAIN?

And what about the brain? Any signs of recent selection there? Apparently so. In 2005, for instance, Bruce Lahn, an evolutionary geneticist at the University of Chicago, reported in *Science* that variants of two genes known to play a role in brain development —*microcephalin* and *ASPM*—appear to have undergone strong recent natural selection. Lahn inadvertently got himself into hot water by noting that these presumably beneficial mutations are common in Eurasian populations but rare in African. This even though he emphasized that neither he nor anyone else has any idea whether these genes or this recent selection pressure has anything to do with intelligence per se.

The truth is that, with studies such as Sabeti's and Lahn's increasing in frequency, "don't go there" may no longer be sustainable. As Pinker wrote in a *New Republic* article on the Ashkenazim theory, "Reality is what refuses to go away when you do not believe in it, and progress in neuroscience and genomics has made these politically comforting shibboleths (such as the non-existence of intelligence and the non-existence of race) untenable."

A GENERAL CONSENSUS

In the end, the answer to the question of whether we're still evolving seems to come down to a matter of degree. And when you look at it that way, most scientists seem to be in basic agreement. That is, few would claim we're not evolving at all. The genetic evidence for natural selection—at least for mutations of single or at most a few genes that confer some benefit and thereby spread through a population over time—is just too strong, and it's getting stronger all the time.

By the same token, few would say we're evolving enough to become, say, the bulbous-headed superhumans of sci-fi anytime soon. Or, for that matter, enough to differentiate into one or more new species of human. Even saying unequivocally whether any or all of us are getting smarter is impossible say. As Pinker put it to me, "We're looking at a snapshot of ourselves, and we'd really have to run the movie for another few thousand years."

Few, it seems to me, could argue with that.

Peter Tyson is editor in chief of NOVA Online.

Sources