Have culture and technology replaced natural selection?

by Scott_LaFee

Once upon an epoch, the forces of natural selection were pretty easy to spot: the lurking lion, the poisonous fruit, the deadly chill or prolonged drought.

Early humans who recognized these dangers - who survived by being smarter, faster, stronger or simply luckier - lived long enough to reproduce. Over millions of years, they perpetuated a species that became, in many ways, even smarter, faster and stronger.

To be sure, it's not so easy to see human evolution at work these days. That it's still happening is not in dispute (at least among the vast majority of scientists), but the factors that influence our evolutionary path have clearly changed.

There aren't so many lions now. Poisonous fruit gets labeled; antidotes invented. No chill or drought seems likely to be big enough or severe enough to threaten a human population that exceeds 6.5 billion people worldwide.

DARWIN TODAY - Have culture and technology replaced Charles Darwin's theory of natural selection? CNS Illustration.

"We've learned how to shortchange natural selection," said Peter Ward, a professor of biology and earth and space sciences at the University of Washington. "People don't die anymore from things that should kill them, that once killed them."

In just 10,000 years or so, humans have changed the world. In doing so, we have also changed the way we will change.

SWITCHING GENES

It's a fundamental principle of evolutionary theory that successful species never stop evolving. The process may not be continuous, but it is ongoing and inevitable. Stagnation equals extinction, the thinking goes, even in humans.

"This is perhaps not surprising," said Bruce Lahn, a geneticist at the University of Chicago. "Why should we stop evolving if evolution is such a universal theme of life, especially given that we are a species that has already evolved rather dramatically in the millions of years prior to our emergence?"

Future evolutionary changes in humans, however, are likely to be less dramatic and not easily observed.

Some scientists point, for example, to our wisdom teeth, which appear to be evolving into oblivion. Two reasons are commonly cited: First, as our brains got bigger, there was less room in the jaw for a third set of molars. Second, wisdom teeth are no longer needed. Early humans required big, heavy teeth to bite and chew through uncooked food. The modern diet is considerably less demanding. The result: A progressively shrinking jaw and more cases of people whose wisdom teeth simply don't come in.

But there's hard evidence of genetic change in humans, too.

In 2004, Lahn and colleagues published data indicating that at least two genes related to human brain size and function have significantly mutated over the past 60,000 years.

More recently, Sarah Tishkoff, a geneticist at the University of Maryland, looked at lactose tolerance among 43 ethnic groups in East Africa. Throughout most of human history, adults have been unable to fully digest lactose - the principal sugar of milk - because the gene that produces the enzyme needed to break down lactose

switches off after weaning.

Tishkoff found, however, that among a few ethnic groups in Kenya and Tanzania, the gene mutated 2,700 to 6,800 years ago. It didn't turn off, so these groups were able to continue digesting milk in adulthood. That gave them a distinct evolutionary advantage.

With continued access to milk nutrients and a buffer in times of drought, lactose-tolerant individuals prospered in comparison to those who lacked the gene mutation. Tishkoff estimates they produced perhaps 10 times more descendants, thus spreading the genetic adaptation.

CULTURAL IMPERATIVE

Boiled down, evolution happens when genetic change - random mutations in DNA - significantly interacts with natural selective forces. The famous finches of the Galapagos Islands, an archipelago of 13 main islands 600 miles west of Ecuador, are the classic example.

Though the finch species were closely related, Charles Darwin ultimately noted that each had adapted its beak to meet the particular environmental demands of the island where it lived. Some birds developed thick beaks to crack indigenous nuts and seeds. On other islands, finches had long, narrow beaks to feed upon cactus pulp or stubby beaks to eat insects.

These examples of "radiative adaptation" required isolation. For an organism to evolve into a new species, it must exist apart from the whole in a sustaining but small enough population that any newly evolved trait can be quickly embraced by the group. That condition no longer applies to people.

"The human population is now so very large and varied that it is hard to imagine that any one new trait that is successful in one group can spread genetically to the entire population in any reasonable period of time," said Dr. Ajit Varki, a professor of cellular and molecular medicine at UCSD.

Significant human evolution probably stopped 50,000 to 100,000 years ago, before the races diverged, said Steven Pinker, a professor of psychology at Harvard University.

Added Varki: "Natural selection in the classic sense of the word is no longer operative in humans."

But the process, say both scientists, continues nonetheless. The difference is what's driving it.

"Technology and culture are responsible for most of the changes in human lifestyle in the past 10,000 years," said Pinker.

Think about it this way, suggests Jared Diamond, a noted UCLA biogeographer. Imagine all human history compressed into a single day - 24 hours. From midnight, when human beings first appear on Earth, through dawn, noon and deep into the night, they are hunter-gatherers, living in small groups, barely eking out an existence.

It's not until 11:54 p.m., Diamond observes in "The Third Chimpanzee: The Evolution and Future of the Human Animal," that agriculture is discovered. And in the last six minutes of humanity's compressed history (10,000 years ago to today), the world has been transformed. Cities have arisen. Writing has been invented, as have cars, refrigeration, antibiotics and the scientific method.

Peter Richerson, a professor of environmental science at University of California Davis and co-author of "Not

by Genes Alone," with UCLA anthropologist Robert Boyd, said culture and technology have long played key roles in human evolution.

"We argue they have played the leading role: Technology and social organizations evolving through cultural means, then genes responding."

The mutation of the lactose gene in Africa is a good example, Richerson said. The societies in which the genetic change took hold were becoming cattle-raising cultures. With milk available, it became evolutionarily advantageous to be able to consume it. Thus, the body adapted.

ARTIFICIAL SELECTION

In this feedback loop of culture, technology and biology, scientists say, selection is still at work.

"Culture in general and technology in particular don't eliminate selection pressures," said Daniel Dennett, a professor of philosophy and co-director of Tufts University's Center for Cognitive Studies. "It simply shifts the balance of their importance - and creates new pressures. Disease resistance, not fleetness of foot, is perhaps the chief variance on which selection operates."

Pinker at Harvard agrees: "In countries with vaccination and antibiotics, for example, there might be less selection for resistance to certain infectious diseases, but perhaps more selection for resistance to atherosclerosis and Type II diabetes."

More profoundly, culture and technology give humans the power to consciously rewrite the rules of evolution. Modern medicine - and rapidly advancing reproductive technologies - mean people can produce

offspring for more of their lives.

Global transportation and communications mean people and influences are broadly spread.

And it's all happening faster than ever. Even if biological evolution is proceeding at its usual pace, said Nick Bostrom, director of the Future of Humanity Institute at Oxford University in England, nature is very slow compared with the rate of change in culture and technology.

"Significant evolution usually takes a large number of generations," he said, "but technology and culture now change substantially within a single generation."

"In the not-so-distant future," said Lahn at the University of Chicago, "humans will likely change the game of evolution altogether by genetically engineering themselves.

"Instead of the traditional Darwinian process that has dominated the evolution of life for the last several billion years since its inception (whereby mutations are introduced randomly and subsequently selected according to fitness), humans will be able to introduce non-random, designated changes to their own genetic makeup."

Which brings up the obvious question: What will we look like?

Over the years, various researchers and futurists have taken stabs at predicting the evolutionary fate of humans. These prognostications run the gamut, from a generally homogenized monoculture not unlike domestic cattle (in which everybody looks and behaves pretty much like everybody else) to a race of uber-humans who have been modified genetically, pharmacologically, mechanically and electronically.

Last year, an English economist published an essay in which he offered some specific predictions. Over the next several centuries, wrote Oliver Curry in a "think piece" commissioned by Bravo Television to celebrate its 21st anniversary, humans would diverge into two basic groups: a genetically improved upper class and a dimwitted underclass.

The former, Curry suggested, would be tall (6 feet to 7 feet), slim, healthy, attractive, intelligent and creative (thanks to embedded computer chips). The average life span would be 120 years.

Conversely, the underclass would be squat, ugly, stupid and short-lived.

Curry's specificity garnered lots of headlines and plenty of ridicule.

"The question to ask is this," said Dennett at Tufts. "What features are shared by most of the people having babies that survive to have babies of their own?

"In different environments, different pressures may well dominate. If pandemics or huge shifts in the environment occur, this may create bottlenecks, through which only a lucky few can pass their genes.

"Perhaps tolerance for mercury in the diet, or an ability to digest kudzu, or a pronounced fondness for living underground in the dark will be strongly favored after some catastrophe."

However, Dennett added, "Since evolution is an amplifier of noise - unpredictable insertions into the prevailing patterns - it is a mistake to extrapolate current trends with much confidence."

In other words, it's best to leave prediction-making to science fiction writers like Stephen Baxter, whose 2003 novel "Evolution" foresaw humans diverging into eyeless mole-men, neo-apes and elephant people herded by giant rodent masters. Entertaining, but not to be taken too seriously.

The divergence of humans on Earth into multiple species is extremely unlikely, say experts. Indeed, if humans are to evolve into something decidedly nonhuman, they would probably need to leave the planet altogether.

"If a group of humans were to go off to a distant planet and be isolated from the main human population for many generations, I suspect that evolutionary selection might become operative again," said Varki at UCSD.

But Ward, the University of Washington biologist and space scientist, thinks vast cosmic distances and deadly radiation will present insurmountable barriers to humans colonizing the universe.

"My guess is, there will be no more human species," he said. "We're all there is for as long as we're on Earth. We are what we are, and we'll go on being what we are, with minor changes."

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