Steven Pinker: Evolution of the Mind

Transcript:

Q: Can you talk about our origins in Africa?

A: The genetic evidence suggests that we evolved in Africa. We know that people reached Australia by forty thousand years ago, maybe earlier, which required travelling across sixty miles of open ocean and it would have required a species with considerable intelligence to put together some kind of canoe or dugout that could have traversed that distance.

Also, probably the longer we look the more we'll find evidence for signs of human creativity and ingenuity in Africa. Europe is where you have a lot of caves, which preserve stuff, and Europe is where you have a lot of archaeologists out looking for human remains, and so I think there's a bit of a bias toward the European landscape. As people get cleverer about finding things in Africa and look longer, I suspect that we will see things beyond the age at which the European artefacts appear.

We also know that a lot of our evolution had to have taken place before the human races diverge because we're pretty much birds of a feather. If you took a bunch of human babies from anywhere around the world -- from Australia, New Guinea, Africa, Europe -- and scrambled the babies at birth and brought them up in any society, they'd all be able to learn the same languages, learn how to count, learn how to use computers, learn how to make and use tools. It suggests that the distinctively human parts of our intelligence were in place before our ancestors split off into the different continents.

So in a sense we're all Africans, and if the first group that budded off from the African population and ended up in Australia did so sixty or seventy thousand years ago, then our evolution had to have been pretty much complete by then, because today's Australians and today's Europeans and today's Asians and Africans are all the same species with pretty much indistinguishable cognitive abilities.

Q: So what happened fifty thousand years ago?

A: Human evolution, at first, seems extraordinary. How could the process that gave rise to slugs and oak trees and fish produce a creature that can fly to the moon and invent the Internet and cross the ocean in boats? Was it some kind of divine spark that made our brains special? Well, I don't think so, because I think that you can understand human evolution in terms of the ordinary process of Darwinian natural selection.

The way to understand how different species evolved is to think about the niches that they fill in an ecosystem -basically, how they make a living. And how do humans make a living? Well, with their brains. You could think of an ecosystem as a bunch of antagonistic arms races, almost: Everything that an animal depends upon for food is the body part of some other animal or plant who would just as soon keep that body part for itself. And so all the things that we depend on for food evolve defences against being eaten. Animals run away, they develop spines or poisons. Plants can't very well defend themselves by their behaviour, so they resort to chemical warfare, and plants are saturated with toxins and irritants to deter creatures like us who want to eat them.

Now, whenever you have some kind of defensive weapon in nature, you get an offensive weapon, and vice versa. So as the hide gets thicker, the fangs get stronger and sharper, which makes the hides get thicker still, and so on. This arms race, though, is played out in evolutionary time, and the animal can't will its skin to get thicker in its own lifetime.

Now, here's the trick, I think, behind humans: We participate in this arms race -- but in our own lifetime, not in evolutionary time -- by using our brains, by developing a model of how the world works, what causes lead to what effects, and figuring out ways of defeating the defences of other plants and animals before they can evolve countermeasures in response. So we invent snares or camouflaged pits, or we coordinate our behaviour to drive large animals and stampede them over a cliff, or ways of detoxifying plants by cooking them or fermenting them or soaking them.

And because we can figure these things out in our mind's eye by learning how the world works, we can figure out how to use more of the ecosystem to our advantage and I think that explains why these big-brained creatures became as successful over the planet as they did.

Q: How did evolution, for humans, happen so quickly? We [already] had a big brain, but how did the big brain suddenly start working?

A: Certainly humans didn't evolve to their present state in one instant, in one fell swoop, because we know that our ancestors, the species like Homo erectus and Homo habilis already had a pretty big brain for a primate of that size. They were already using tools. They were almost certainly cooperating with one another. So it's not as if our species was the first to do it; it was building on some earlier stepping stones.

And it's unlikely that it happened all at once. You have to remember that not every creature that was evolving left behind its skull or its tools for our convenience tens of thousands of years later.

Most bones or most tools rot or get buried and are never found again. So the earliest date at which we find some fossil or artefact is not the point at which the species first appeared; it was probably doing its thing for many tens of thousands of years before we were lucky enough to find something that it left behind that lasted to the present day.

Q: Can you talk about the rewiring of the human brain?

A: You have to remember that human intelligence and intelligent behaviour don't just come from having a whole bunch of stuff packed into our skull like meatloaf. The actual organization of behaviour goes on the level of the individual nerve cells and their connections, and we have a hundred billion nerve cells, probably a hundred trillion connections. It's just mind-boggling to think of all the different ways in which they're arranged in a baby's head. And a lot of our evolution consisted not just in getting more of this stuff, but in wiring it in precise ways to support intelligence.

Q: Does Darwinian evolution allow for such internal rewiring as part of its process?

A: There are lots of ways in which Darwinian natural selection could rewire a brain. There are chemicals that are released in the growing brain that attract nerve cells, encouraging them to grow in certain pathways versus others.

There are molecules at the tips of the growing neurons that can engage or not engage some target, like a lock and a key. There are rules for when brain cells die in what part of the brain, so that they might grow in one part, die off in another.

All of these are under the control of genes, and as genes evolve, the way they do throughout evolution, the wiring of the brain can change.

Q: So this rewiring pattern happened progressively?

A: Yes. It's very likely that the changes in the brain didn't happen overnight. There wasn't one magical mutation that miraculously allowed us to speak and to walk upright and to cooperate with

one another and to figure out how the world works; evolution doesn't work that way. It would be staggeringly improbable for one mutation to do all that.

Chances are there were lots and lots of mutations over a span of tens, maybe even hundreds of thousands of years that fine-tuned and sculpted the brain to give it all the magnificent powers that it has today. I don't think there was a thunderclap or a divine spark that suddenly made one species smart.

You can see, in our ancestors, there was a gradual expansion of the brain, there was an expansion of the complexity of tools. Even when our species evolved, it surely was spread out over tens of thousands of years. The fact that we find a whole bunch of artwork or tools in one place just means that that's when they arrived there and left some garbage that survived to the present time. But it's virtually certain that it was extended over many, many generations before that.

Q: What is a "cognitive niche"?

A: Our niche in nature, the "cognitive niche," the ability to understand the world well enough to figure out ways of manipulating it to outsmart other plants and animals. And there's several things that I think evolved at the same time to support this way of life. One of them is cause-and-effect intelligence: How do sticks break, how do rocks roll, how do things fly through the air?

A second is social intelligence: How do I coordinate my behaviour with other people so that we can bring about effects that one person acting alone, like Robinson Crusoe, could never have done?

And I think the third is language: If I learn something, I don't get the benefit of it alone, but I can share it with my friends and relatives, I can exchange it for other kinds of commodities, I can negotiate deals, I can gossip to make sure that I don't get exploited.

So, each one of these abilities -- intelligence about the world, social intelligence, and language -- I think reinforces the other two, and it's very likely that the three of them coevolved like a ratchet, each one setting the stage for the other two to be incremented a bit.

Q: Some scientists think that gossip was the only thing driving language.

A: Gossip is certainly one of the things that language is useful for, because it's always handy to know who needs a favour, who can offer a favour, who's available, who's under the protection of a jealous spouse. And being the first to get a piece of gossip is like engaging in insider trading: You can capitalize on an opportunity before anyone else can.

But language is useful for other things, for exchanging technical know-how -- how do you get poison out of the gland of a toad, what's the best way to make a spear, where are the berries, what's the best time of year to hunt.

It's also good for one-on-one negotiations: "If you give me some of your meat, I'll give you some of my fruit"; "You and I can gang up on the leader: -- even though he's stronger than either of us, he can't beat the two of us acting together"; "If you have sex with me, I'll help bring up the children."

There are all kinds of ways that language can be useful. Gossip, I think, is just one of them.

Q: So languages began just about fifty or sixty thousand years ago.

A: We really don't know when language began. It can't be any later than fifty or sixty thousand years ago because that's when the races diverged, and we know that all the races are interchangeable in

their language abilities. Bring up an Australian Aborigine in New York, they'll speak English with a New York accent, or vice versa.

So it had to be in place before that; it couldn't be later than fifty or sixty thousand years ago. How much earlier? I think considerably earlier, simply because language is complicated. It's like the eyeball or the ear, and complicated organs can't evolve in one fell swoop -they need too many mutations in order to craft this finely engineered organ. So I think language had to have had a fairly long evolutionary history. We don't really know why it took us as long to evolve as we did, but I think there's a strong suggestion that language couldn't have evolved before other things were in place.

First of all, you have to have something worth saying. What's the use of having long, flowery sentences if you have nothing interesting to communicate? If chickens had language, what would they talk about? Nothing terribly interesting. And also, you've got to be on speaking terms with someone else. If no one else is interested in what you have to say, or if you tell someone something and they will take advantage of you and you can't expect something in return, there'd be no point in having language.

So I think we evolved language when we also evolved something to say and when we also evolved to be on speaking terms with one another. Language evolved over an extended period of time, but it seems to have coevolved with other things that all came to their present configuration about the same time, somewhere before fifty thousand years ago.

Our intelligence, our language, our social interactions, all of them seem to come together at this magic point. I think human evolution couldn't just have been driven by social completion, by people gossiping and plotting against each other, because that's the equivalent of taking in one another's laundry; it doesn't get you anywhere. I think social intelligence coevolved with physical intelligence -- figuring out how the world works. It gives you a reason to hang out together because you can accomplish things that one person couldn't, and it creates an environment in which know-how is that much more worth having because you can share it with your buddies and your kids.

And so the costs of a big brain are repaid if everything you know can be multiplied in terms of sharing it with other people.

Q: We're talking about anatomically modern humans -anatomically modern and behavioural modern are two very different things. Why didn't the others make it and why did this new group make it?

A: It's possible that once the skull had evolved to the present size, there was still more evolving to do. And that might explain the gap between the first anatomically modern human that had the same amount of brain that we had, and the first behaviourally modern human who created art and fine inventions and so on.

The difference is that there could have been a lot of evolution going on inside the skull as the brain got rewired. The actual cause of behaviour is not just brain tissue acting en masse like a muscle but it's the wiring diagram of the hundred billion different brain cells connected by a hundred trillion connections. There are so many ways in which those could be wired and many ways for the genes to bias that in one direction or another that, for a long period of time, there could have been a kind of internal rewiring even if on the outside the skull looked exactly the same.

Q: We always say that we're never going to find the answer to that because the brain doesn't fossilize. Is that true, or do you think we may find the answer?

A: We probably won't find the answer to that in the fossils because the neuron-to-neuron connections certainly don't fossilize. We'll have to be awfully clever about reconstructing it, both from the products that they left behind -- what does a functioning brain do? -- and perhaps also from clever use of genetic evidence, working backwards from the genes that build the brain today to figure out what the genes that built the brain fifty thousand years ago might have looked like. That's science fiction today, but who knows what will happen in ten or twenty or thirty years?

Q: If you look at a Neandertal skull and the skull of the modern human, they're about the same size. One failed and one succeeded. Why?

A: We don't really know why Homo sapiens succeeded and Homo neandertalensis didn't. The brains were the same size, but they may have been wired quite differently and it could have been that there was wiring in the Homo sapien's brain that supported better language, cleverer know-how, better social coordination, that gave them an advantage.

And it didn't have to be a big advantage; even an advantage of a couple of percentage points in survival rate could, over a few thousand years, have driven the less well-adapted species to extinction.

Q: What are memes?

A: Certainly, when we look around us and are amazed at all the things that Homo sapiens has wrought -- rockets that go to the moon and the Internet and modern medicine and so on -- that wasn't because our brain evolved to do those things in particular; no Robinson Crusoe thinking by himself on a desert island could have invented a rocket. It depends on the accumulation of an enormous number of discoveries that were passed on, not through the genes, but from one person to another through language and other forms of communication. This is called cultural evolution.

Some people call the units of cultural evolution memes -- little units of memory or knowledge -- and we've been accumulating them for tens of thousands of years. So we figured out how to make nice sharp tools and our jaws and teeth became smaller. We figured out how to use the hides of other animals to stay warm and we got naked. We are now figuring out how to cure diseases, how to build shelters. And for tens of thousands of years the products of the human brain have accumulated in almost a parallel course in evolution to the changes in our bodies and brains.

These memes can be anything from styles that help you fit into a group, like turning a baseball cap around and wearing the peak in the back, to figuring out the cure for some disease or how to grow crops.

So the products of the brain that have been transmitted not through the brains but through language have, for many thousands of years, been as important or more important than the actual physical stuff that we're made out of.

A lot of the creations of our brain can make up for physical deficiencies, and could actually change the course of evolution. Thousands of years ago, someone who was severely nearsighted probably wouldn't have had many descendants; he would have been eaten or fallen off a cliff a long time ago. But we invented eyeglasses and now being nearsighted has no disadvantage at all. There are some people who might say, "Well, isn't this interfering with evolution? Wouldn't we be better off letting the diabetics and the nearsighted die an early death to improve the physical vigour of the species?"

That really goes against the way that human evolution works, which is that for tens of thousands of years we've depended for our survival on our own inventions, on our own creation, and this is simply extending this process.

Q: How important, in your estimation, is Darwin's theory of evolution by natural selection to the field of biology?

A: Biologists often say that nothing in biology makes sense except in the light of evolution and, most importantly, Darwin's theory of natural selection explains the appearance of design in living things.

You look at living things and it looks as if they've been engineered. We've got a heart that pumps blood. We've got eyes that have a transparent lens, irises that open and close in response to the light level, and muscles that move them in and out. We've got ears that record vibrations of sound, and lubricated joints in our knees and elbows. Who put them all together? Until Darwin, it would have been completely reasonable to say, "There has to have been a cosmic engineer." For the same reason that if we see a watch we know that there has to have been a watchmaker, when we see an eyeball or a heart or an elbow, there has to have been something that designed that.

Darwin showed why that is not right, that you can get the appearance of engineering in the natural world without invoking a real engineer. Darwin's theory of natural selection explains how we find signs of engineering or design in the living world; why, whenever we look at a plant or animal, we see fantastically complicated machinery.

Q: If Darwin could see the modern world, what would he be most surprised or gratified to understand that we understand?

A: If Darwin were alive today, the discovery of biology that would have pleased him the most would have been modern genetics and DNA, because to the day that he died he was haunted by the worry that his theory wouldn't work because traits of organisms blended when they mated, that anything that was advantageous in an organism would be diluted when it mated with some other organism that didn't also have that trait, and there was no way to get evolution off the ground.

We know now that genes survive intact when organisms mate, that they are particles that don't get blended but survive in their identical form. We know that they have a physical basis, the sequence of bases in the DNA molecule.

Those were the missing pieces in the theory of evolution, and that's really what convinced scientists that Darwin's theory was the correct explanation for the evolution of life on earth.

Q: Do you think he would be surprised to know how much dissension there still is around his theory?

A: I think Darwin would be surprised to learn that more than a hundred years after he proposed his theory there are still people who think it's just a theory, who have sincere doubts about it, because the evidence was quite convincing in Darwin's time. And now that the last holes of his theory have been plugged by the discoveries of genetics, by the discovery of the age of the earth, by the discovery of the chemical basis of life, no reasonable person can deny that this is overwhelmingly the best explanation we have for the evolution of life on earth.

Chimpanzees are clearly our close cousins. You cut us both open, you see the same organs. You look at our DNA and we share 98.5 percent of our DNA with chimps. But obviously, we're very different.

Chimps are precariously clinging to a few patches of forest in Africa; humans have taken over the planet. What could have produced the difference?

Well, there was six million years in which our brains expanded and got rewired in ways that allow us to do completely different things. We can exchange information by making noise as we exhale -- the gift that we call language. We figure out how the world works, we make many different kinds of tools, we coordinate our behaviour and exchange information. And all of these changes in cognitive evolution, in the evolution of the powers of the brain, account for why humans are making a film in which they can talk about chimpanzees rather than vice versa.

A friend of mine lived and worked with a chimpanzee for several years and tells the story of how the chimp loved to imitate things that she did. For example, after she washed the dishes the chimp would wash the dishes but the chimp's idea of washing the dishes was very different from ours.

It went through the same muscle movements; it would pick up the sponge, let the warm water roll over his hands, would rub the sponge on the plate, but didn't get the idea that the point of washing the dishes was to get the dishes clean. It just liked the feel of rubbing a sponge over the plate. It could wash the same dish over and over again, it could rub some of the dirt off and not get all of it off, because what it was imitating was the particular physical sequence.

What it didn't think about was; what was the goal of the human performing the action?

And the ability to guess what other people's goals are is a key part of human intelligence, and it makes us very different from our primate cousins.