ORGANS OF COMPUTATION
Interview between John Brockman and Steven Pinker

BROCKMAN: How does one even begin to explain something as complicated as the human mind?

PINKER: I think the key to understanding the mind is to try to "reverse-engineer" it - to figure out what natural selection designed it to accomplish in the environment in which we evolved. In my new book, *How the Mind Works*, I present the mind as a system of "organs of computation" that allowed our ancestors to understand and outsmart objects, animals, plants, and each other.

BROCKMAN: How is that approach different from what intellectuals currently believe?

PINKER: Most of the assumptions about the mind that underlie current discussions are many decades out of date. Take the hydraulic model of Freud, in which psychic pressure builds up in the mind and can burst out unless it's channeled into appropriate pathways. That's just false. The mind doesn't work by fluid under pressure or by flows of energy; it works by information. Or, look at the commentaries on human affairs by pundits and social critics. They say we're "conditioned" to do this, or "brainwashed" to do that, or "socialized" to believe such and such. Where do these ideas come from? From the behaviorism of the 1920's, from bad cold war movies from the 1950's, from folklore about the effects of family upbringing that behavior genetics has shown to be false. The basic understanding that the human mind is a remarkably complex processor of information, an "organ of extreme perfection and complication," to use Darwin's phrase, has not made it into the mainstream of intellectual life.

BROCKMAN: What makes you say that the mind is such a complex system?

PINKER: What should impress us about the mind is not its rare extraordinary feats, like the accomplishments of Mozart or Shakespeare or Einstein, but the everyday feats we take for granted. Seeing in color. Recognizing your mother's face. Lifting a milk carton and gripping it just tight enough that it doesn't drop but not so tight that you crush it, while rocking it back and forth to gauge how much milk is in the bottom just from the tugs on your fingertips. Reasoning about the world - what will and won't happen when you open the refrigerator door. All of these things sound mundane and boring, but they shouldn't be. We can't, for example, program a robot to do any of them! I would pay a lot for a robot that would put away the dishes or run simple errands, but I can't, because all of the little problems that you'd need to solve to build a robot to do that, like recognizing objects, reasoning about the world, and controlling hands and feet, are unsolved engineering problems. They're much harder than putting a man on the moon or sequencing the human genome. But a four-year-old solves them every time she runs across the room to carry out an instruction from her mother.

I see the mind as an exquisitely engineered device - not literally engineered, of course, but designed by the mimic of engineering that we see in nature, natural selection. That's what "engineered" animals' bodies to accomplish improbable feats, like flying and swimming and running, and it is surely what "engineered" the mind to accomplish its improbable feats.

BROCKMAN: What does that approach actually buy you in studying how the mind works?

PINKER: It tells you what research in psychology should be: a kind of reverse engineering. When you rummage through an antique store and come across a contraption built of many finely meshing parts, you assume that it was put together for a purpose, and that if you only understood that purpose, you'd have insight as to why it has the parts arranged the way they are. That's true for the mind as well, though it wasn't designed by a designer but by natural selection. With that insight you can look at the quirks of the mind and ask how they might have made sense as solutions to some problem our ancestors faced in negotiating the world. That can give you an insight into what the different parts of the mind are doing.

Even the seemingly irrational parts of the mind, like strong passions - jealousy, revenge, infatuation, pride - might very well be good solutions to problems our ancestors faced in dealing with one another. For example, why do people do crazy things like chase down an ex-lover and kill the lover? How could you win someone back by killing them? It seems like a bug in our mental software. But several economists have proposed an alternative. If our mind is put together so that under some circumstances we are compelled to carry out a threat regardless of the costs to us, the threat is made credible. When a person threatens a lover, explicitly or implicitly, by communicating "If you ever leave me I'll chase you down," the lover could call his bluff if she didn't have signs that he was crazy enough to carry it out even though it was pointless. And so the problem of building a credible deterrent into creatures that interact with one another leads to irrational behavior as a rational solution. "Rational," that is, with respect to the "goal" of our genes to maximize the number of copies of themselves. It isn't "rational," of course, with respect to the goal of whole humans and societies to maximize happiness and fairness.

Another example is the strange notion of happiness. What is the psychological state called "happiness" for? It can't be that natural selection designed us to feel good all the time out of sheer good will. Presumably our brain circuits for happiness motivate us to accomplish things that enhance biological fitness. With that simple insight one can make some sense of some of the puzzles of happiness that wise men and women have noted for thousands of years. For example, directly pursuing happiness is often a recipe for unhappiness, because our sense of happiness is always calibrated with respect to other people. There is a Yiddish expression: when does a hunchback rejoice? When he sees one with a bigger hump.

Perhaps we can make sense of this by putting ourselves in the shoes of the fictitious engineer behind natural selection. What should the circuit for happiness be doing? Presumably it would be assessing how well you're doing in your current struggle in life - whether you should change your life and try to achieve something different, or whether you should be content with what you're achieved so far, for example, when you are well-fed, comfortable, with a mate, in a situation likely to result in children and so on. But how could a brain be designed in advance to assess that? There's no absolute standard for well-being. A Paleolithic hunter-gatherer should not have fretted that he had no running shoes or central heating or penicillin. How can a brain know whether there is something worth striving for? Well, it can look around and see how well off other people are. If they can achieve something, maybe so can you. Other people anchor your well-being scale and tell you what you can reasonably hope to achieve.

Unfortunately, it gives rise to a feature of happiness that makes many people unhappy - namely, you're happy when you do a bit better than everyone around you and you're unhappy when you're doing worse. If you look in your paycheck envelope and you discover you've got a five percent raise you'd be thrilled, but if you discover that all your co-workers got a ten percent raise you'd be devastated.

Another paradox of happiness is that losses are felt more keenly than gains. As Jimmy Connors said, "I hate to lose more than I like to win." You are just a little happy if your salary goes up, but you're really miserable if your salary goes down by the same amount. That too might be a feature of the mechanism designed to attain the attainable and no more. When we backslide, we keenly feel it because what we once had is a good estimate of what we can attain. But when we improve we have no grounds for knowing that we are as well off as we can hope to be. The evolutionary psychologist Donald Campbell called it "the happiness treadmill." No matter how much you gain in fame, wealth, and so on, you end up at the same level of happiness you began with - though to go down a level is awful. Perhaps it's because natural selection has programmed our reach to exceed our grasp, but by just a little bit.

BROCKMAN: How do you differ from other people who have written about the mind, like Dan Dennett, John Searle, Noam Chomsky, Gerald Edelman, or Francis Crick?

PINKER: For starters, I place myself among those who think that you can't understand the mind only by looking directly at the brain. Neurons, neurotransmitters, and other hardware features are widely conserved across the animal kingdom, but species have very different cognitive and emotional lives. The difference comes from the ways in which hundreds of millions of neurons are wired together to process information. I see the brain as a kind of computer - not like any commercial computer made of silicon, obviously, but as a device that achieves intelligence for some of the same reasons that a computer achieves intelligence, namely processing of information. That places me with Dennett and Chomsky (though the three of us disagree about much else), and in disagreement with people like Searle, who denies that the brain can be understood as an information-processor and insists it can only be understood in terms of physiology. Edelman and Crick would not state their views in terms as extreme as Searle's but they, too, are not entirely sympathetic to the computational theory of mind.

Like Dennett and Searle, but unlike Chomsky, I believe that natural selection is the key to explaining the structure of the mind - that reverse-engineering in the light of natural selection is the key to answering why our thoughts and feelings are structured as they are.

I also believe that the mind is not made of Spam - it has a complex, heterogeneous structure. It is composed of mental organs that are specialized to do different things, like seeing, controlling hands and feet, reasoning, language, social interaction, and social emotions. Just as the body is divided into physical organs, the mind is divided into mental organs. That puts me in agreement with Chomsky and against many neural network modelers, who hope that a single kind of neural network, if suitably trained, can accomplish every mental feat that we do. For similar reasons I disagree with the dominant position in modern intellectual life - that our thoughts are socially constructed by how we were socialized as children, by media images, by role models, and by conditioning.

BROCKMAN: But haven't there been objections to the computer metaphor of the mind?

PINKER: Some critics think it is an example of our mindless incorporating the latest technology into our theories. The objection goes: when telephone switchboards first came into existence, people thought the mind was a switchboard; before that, when fancy water-powered mechanical toys were the rage, people said the mind was a hydraulic machine, and so on. Of course there's a danger is taking metaphors too literally, but when you're careful, mechanical metaphors really do increase our understanding. The heart and blood vessels really can be better understood by thinking about pumps and pipes, and the switchboard metaphor offers a clearer understanding of the nerves and spinal cord than the models that came before it.

And I think the theory of computation, and in some cases real computers, do offer principles that are essential to understanding how the mind works. The idea is not that the mind is like a commercial computer; it's that minds and computers work by some of the same principles. When engineers first came to understand flight as they designed airplanes, it provided insight as to how birds fly, because principles of aerodynamics, like shape of an airfoil or the interplay of lift and drag, are applicable both to planes and to birds. That doesn't mean that the airplane is a good model of the birds. Birds don't have propellers and headphone jacks and beverage service, for example. But by understanding the laws that allow any device to fly, one can understand how natural devices fly. The human mind is unlike a computer in countless ways, but the trick behind computation is the trick behind thought - representing states of the world, that is, recording information, and manipulating the information according to rules that mimic relations of truth and statistical probability that hold in the world.

BROCKMAN: Haven't there also been political objections to the biological approach you are taking?

PINKER: Many people lump together the idea that the mind has a complex innate structure with the idea that differences between people have to be innate. But the ideas are completely different. Every normal person on the planet could be innately equipped with an enormous catalog of mental machinery, and all the differences between people - what makes John different from Bill - could come from differences in experience, of upbringing, or of random things that happened to them when they were growing up. To believe that there's a rich innate structure common to every member of the species is different from saying the differences between people, or differences between groups, come from differences in innate structure. Here's an example. Look at number of legs - it's an innate property of the human species that we have two legs as opposed to six like insects, or eight like spiders, or four like cats - so having two legs is innate. But if you now look at why some people have one leg, and some people have no legs, it's completely due to the environment - they lost a leg in an accident, or from a disease. So the two questions have to be distinguished. And what's true of legs is also true of the mind.

BROCKMAN: As you know, I have been increasingly interested in the growing presence of the internet and its effects on intellectual life. Do you think that what we know about the mind has any implications for how quickly computer technology will change our world?

PINKER: Computer technology will never change the world as long as it ignores how the mind works. Why did people instantly start to use fax machines, and continue to use them even though electronic mail makes much more sense? There are millions of people who print out text from their computer onto a piece of paper, feed the paper into a fax machine, forcing the guy at the other end to take the paper out, read it, and crumples it up - or worse, scan it into his computer so that it becomes a file of bytes all over again. This is utterly ridiculous from a technological point of view, but people do it. They do it because the mind evolved to deal with physical objects, and it still likes to conceptualize entities that are owned and transferred among people as physical objects that you can lift and store in a box. Until computer systems, email, video cameras, VCR's and so on are designed to take advantage of the way the mind conceptualizes reality, namely as physical objects existing at a location and impinged upon by forces, people are going to be baffled by their machines, and the promise of the computer revolution will not be fulfilled.

Part of the problem may be that our best technology comes from Japan and the manuals were written in Japanese and then translated, but I have a hunch that in Japan they have as much trouble programming the VCR as we do here. It's not just the instructions, but the design of the machines themselves, that's the problem. The machines were designed by engineers that aren't used to thinking about how the human mind works. They're used to designing machinery that is elegant by their own standards, and they don't think about how the user is going to conceptualize the machine as another object in the world and deal with it as we've been dealing with objects for hundreds of thousands of years.

BROCKMAN: Let me turn the question around. What is the significance of the Internet and today's communications revolution for the evolution of the mind?

PINKER: Probably not much. You've got to distinguish two senses of the word "evolution." The sense used by me, Dawkins, Gould, and other evolutionary biologists refers to the changes in our biological makeup that led us to be the kind of organism we are today. The sense used by most other people refers to continuous improvement or progress. A popular idea is that our biological evolution took us to a certain stage, and our cultural evolution is going to take over - where evolution in both cases is defined as "progress." I would like us to move away from that idea, because the processes that selected the genes that built our brains are different from the processes that propelled the rise and fall of empires and the march of technology.

In terms of strict biological evolution, it's impossible to know where, if anywhere, our species is going. Natural selection generally takes hundreds of thousands of years to do anything interesting, and we don't know what our situation will be like in ten thousand or even one thousand years. Also, selection adapts organism to a niche, usually a local environment, and the human species moves all over the place and lurches from life style to life style with dizzying speed on the evolutionary timetable. Revolutions in human life like the agricultural, industrial, and information revolutions occur so quickly that no one can predict whether the change they will have on our makeup, or even whether there will be a change.

The Internet does create a kind of supra-human intelligence, in which everyone on the planet can exchange information rapidly, a bit like the way different parts of a single brain can exchange information. This is not a new process; it's been happening since we evolved language. Even non-industrial hunter-gatherer tribes pool information by the use of language. That has given them remarkable local technologies - ways of trapping animals, using poisons, chemically treating plant foods to remove the bitter toxins, and so on. That is also a collective intelligence that comes from accumulating discoveries over generations, and pooling them amongst a group of people living at one time. Everything that's happened since, such as writing, the printing press, and now the Internet, are ways of magnifying something that our species already knew how to do, which is to pool expertise by communication. Language was the real innovation in our biological evolution; everything since has just made our words travel farther or last longer.