

# 1 ORGANS OF COMPUTATION

## Interview between John Brockman and Steven Pinker

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

10 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.

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

20 PINKER: Most of the assumptions about the mind that underlie current discussions are many decades out of date.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.

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

30 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.

45 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.

1 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.

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1 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  
5 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,  
10 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  
15 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.

20 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  
25 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  
30 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  
35 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  
40 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  
45 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  
50 conditioning.

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

5 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.

15 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.

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

30 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.

45 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?

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1 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  
5 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  
10 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.

15 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  
20 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.

25 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  
30 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  
35 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  
40 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  
45 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  
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1 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  
5 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.

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### THE HAPPINESS TREADMILL

35 The pursuit of happiness is an inalienable right, says the Declaration of  
Independence in its list of self-evident truths. The greatest happiness of  
the greatest number, wrote Jeremy Bentham, is the foundation of moral-  
ity. To say that everyone wants to be happy sounds trite, almost circular,  
40 but it raises a profound question about our makeup. What is this thing  
that people strive for?

45 At first happiness might seem like just desserts for biological fitness  
(more accurately, the states that would have led to fitness in the environ-  
ment in which we evolved). We are happier when we are healthy,  
well-fed, comfortable, safe, prosperous, knowledgeable, respected, non-  
celibate, and loved. Compared to their opposites, these objects of striv-  
ing are conducive to reproduction. The function of happiness would be  
50 to mobilize the mind to seek the keys to Darwinian fitness. When we are

1 unhappy, we work for the things that make us happy; when we are happy,  
we keep the status quo.

5 The problem is, how much fitness is worth striving for? Ice Age peo-  
ple would have been wasting their time if they had fretted about their  
lack of camping stoves, penicillin, and hunting rifles or if they had  
striven for them instead of better caves and spears. Even among modern  
10 foragers, very different standards of living are attainable in different  
times and places. Lest the perfect be the enemy of the good, the pursuit  
of happiness ought to be calibrated by what can be attained through rea-  
sonable effort in the current environment.

15 How do we know what can reasonably be attained? A good source of  
information is what other people have attained. If they can get it, per-  
haps so can you. Through the ages, observers of the human condition  
have pointed out the tragedy: people are happy when they feel better off  
20 than their neighbors, unhappy when they feel worse off.

But, O! how bitter a thing it is to look into happiness through another  
man's eyes!

—William Shakespeare (*As You Like It*, V, ii).

25 **Happiness**, n. An agreeable sensation arising from contemplating the  
misery of others.

—Ambrose Bierce

30 It is not enough to succeed. Others must fail.

—Gore Vidal

35 Ven frait zich a hoiker? Ven er zet a gresseren hoiker far zich. (When does  
a hunchback rejoice? When he sees one with a larger hump.)

—Yiddish saying

40 Research on the psychology of happiness has borne out the curmud-  
geons. Kahneman and Tversky give an everyday example. You open your  
paycheck and are delighted to find you have been given a five percent  
raise—until you learn that your co-workers have been given a ten per-  
45 cent raise. According to legend, the diva Maria Callas stipulated that any  
opera house she sang in had to pay her one dollar more than the next  
highest paid singer in the company.

50 People today are safer, healthier, better fed, and longer-lived than at any  
time in history. Yet we don't spend our lives walking on air, and presumably

1 our ancestors were not chronically glum. It is not reactionary to point out  
that many of the poor in today's Western nations live in conditions that yes-  
2 today's aristocrats could not have dreamed of. People in different classes  
5 and countries are often content with their lot until they compare them-  
selves to the more affluent. The amount of violence in a society is more  
closely related to its inequality than to its poverty. In the second half of the  
twentieth century, the discontent of the Third World, and later the Second,  
10 have been attributed to their glimpses through the mass media of the First.

The other major clue to the attainable is how well off you are now.  
What you have now is attainable, by definition, and chances are you can  
do at least a little bit better. Evolutionary theory predicts that a man's  
15 reach should exceed his grasp, but not by much. Here we have the second  
tragedy of happiness: people adapt to their circumstances, good or bad,  
the way their eyes adapt to sun or darkness. From that neutral point,  
improvement is happiness, loss is misery. Again, the sages said it first. The  
20 narrator of E. A. Robinson's poem (and later Simon and Garfunkel's song)  
envies the factory owner, Richard Cory, who "glittered when he walked."

25 So on we worked, and waited for the light,  
And went without the meat, and cursed the bread;  
And Richard Cory, one calm summer night,  
Went home and put a bullet through his head.

30 The futility of striving has led many dark souls to deny that happiness  
is possible. For the show-business personality Oscar Levant, "Happiness  
is not something you experience, it's something you remember." Freud  
35 said that the goal of psychotherapy was "to transform hysterical misery  
into common unhappiness." A colleague, consulting with me by email  
about a troubled graduate student, wrote, "sometimes i wish i was young  
then i remember that wasn't so great either."

40 But here the curmudgeons are only partly right. People do come to  
feel the same across an astonishing range of good and bad fortunes. But  
the baseline that people adapt to, on average, is not misery but satisfac-  
tion. (The exact baseline differs from person to person and is largely  
45 inherited.) The psychologists David Myers and Ed Diener have found  
that about eighty percent of people in the industrialized world report  
that they are at least "fairly satisfied with life," and about thirty percent  
say they are "very happy." (As far as we can tell, the reports are sincere.)  
50 The percentages are the same for all ages, for both sexes, for blacks and

1 whites, and over four decades of economic growth. As Myers and Diener  
remark, "Compared with 1957, Americans have twice as many cars per  
5 person—plus microwave ovens, color TVs, VCRs, air conditioners,  
answering machines, and \$12 billion worth of new brand-name athletic  
shoes a year. So, are Americans happier than they were in 1957? They  
are not."

10 Within an industrialized country, money buys only a little happiness:  
the correlation between wealth and satisfaction is positive but small.  
Lottery winners, after their jolt of happiness has subsided, return to their  
former emotional state. On the brighter side, so do people who have suf-  
fered terrible losses, such as paraplegics and survivors of the Holocaust.

15 These findings do not necessarily contradict the singer Sophie Tucker  
when she said, "I have been poor and I have been rich. Rich is better." In  
India and Bangladesh; wealth predicts happiness much better than it  
20 does in the West. Among twenty-four Western European and American  
nations, the higher the gross national product per capita, the happier the  
citizens (though there are many explanations). Myers and Diener point  
out that wealth is like health: not having it makes you miserable, but hav-  
ing it does not guarantee happiness.

25 The tragedy of happiness has a third act. There are twice as many  
negative emotions (fear, grief, anxiety, and so on) as positive ones, and  
losses are more keenly felt than equivalent gains. The tennis star Jimmy  
Connors once summed up the human condition: "I hate to lose more  
30 than I like to win." The asymmetry has been confirmed in the lab by  
showing that people will take a bigger gamble to avoid a sure loss than to  
improve on a sure gain, and by showing that people's mood plummets  
more when imagining a loss in their lives (for example, in course grades,  
35 or in relationships with the opposite sex) than it rises when imagining an  
equivalent gain. The psychologist Timothy Ketelaar notes that happiness  
tracks the effects of resources on biological fitness. As things get better,  
40 increases in fitness show diminishing returns: more food is better, but  
only up to a point. But as things get worse, decreases in fitness can take  
you out of the game: not enough food, and you're dead. There are many  
ways to become infinitely worse off (from an infection, starvation, getting  
45 eaten, a fall, ad infinitum) and not many ways to become vastly better  
off. That makes prospective losses more worthy of attention than gains;  
there are more things that make us unhappy than things that make us  
happy.

50 Donald Campbell, an early evolutionary psychologist who studied the

1 psychology of pleasure, described humans as being on a "hedonic tread-  
mill," where gains in well-being leave us no happier in the long run.  
Indeed, the study of happiness often sounds like a sermon for traditional  
5 values. The numbers show that it is not the rich, privileged, robust, or  
good-looking who are happy; it is those who have spouses, friends, reli-  
gion, and challenging, meaningful work. The findings can be overstated,  
10 because they apply to averages, not individuals, and because cause and  
effect are hard to tease apart: being married might make you happy, but  
being happy might help you get and stay married. But Campbell echoed  
millennia of wise men and women when he summed up the research:  
15 "The direct pursuit of happiness is a recipe for an unhappy life."

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