

Neural Darwinism

GERALD EDELMAN WAS AWARDED THE NOBEL PRIZE FOR PHYSIOLOGY AND MEDICINE IN 1972. ONE OF THE WORLD'S FOREMOST EXPERTS ON THE BRAIN AND CONSCIOUSNESS, HE IS FOUNDER AND DIRECTOR OF THE NEUROSCIENCES INSTITUTE IN LA JOLLA, CALIF., A "SCIENTIFIC MONASTERY," WHERE HE SPOKE WITH *NPQ* EDITOR NATHAN GARDELS. EDELMAN'S MOST RECENT BOOK IS *Wider Than the Sky: The Phenomenal Gift of Consciousness* (YALE UNIVERSITY PRESS, 2004).

NPQ | What accounts for consciousness in human beings—that is, to be aware and able to go beyond “the information given” in a particular situation? When did it emerge?

GERALD EDELMAN | The most important thing to understand is that the brain is “context bound.” It is not a logical system like a computer that processes only programmed information; it does not produce preordained outcomes like a clock. Rather it is a selectional system that, through pattern recognition, puts things together in always novel ways. It is this selectional repertoire in the brain that makes each individual unique, that accounts for the ability to create poetry and music, that accounts for all the differences that arise from the same biological apparatus—the body and the brain. There is no singular mapping to create the mind; there is, rather, an unforetold plurality of possibilities. In a logical system, novelty and unforeseen variation are often considered to be noise. In a selectional system such diversity actually provides the opportunity for favorable selection.

Here, Darwin and his effort to explain variance within biological populations through natural selection provided the key idea. In considering the brain, we are talking about a population of hundreds of billions of cells that far exceeds the number of stars in the sky. The number of possible connections these cells can make exceeds the number of particles in the universe.

To give a sense of this, consider that the cortex of your brain has 30 billion neurons. It has a million billion connections, at least. If you counted one connection per second, you would not finish counting until 32 million years later.

About 300 million years ago, during the transition from reptiles to birds and mammals, the thalamocortical system began to develop from a few collections of neurons, which then grew vastly in number. The thalamus is located in the center of the brain and is about the size of your thumb. It relays signals from all senses but

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smell to the cortex of the brain which, through manifold loops and pathways, “speaks back” to the thalamus.

Competition for advantage in the environment enhances the spread and strength of certain synapses, or neural connections, according to the “value” previously decided by evolutionary survival. The amount of variance in this neural circuitry is very large. Certain circuits get selected over others because they fit better with whatever is being presented by the environment. In response to an enormously complex constellation of signals, the system is self-organizing according to Darwin’s population principle. It is the activity of this vast web of networks that entails consciousness by means of what we call “reentrant interactions” that help to organize “reality” into patterns. The thalamocortical networks were selected during evolution because they provided humans with the ability to make higher order discriminations and adapt in a superior way to their environment. Such higher order discriminations confer the ability to imagine the future, to explicitly recall the past and to be conscious of being conscious. Because each loop reaches closure by completing its circuit through the varying paths from the thalamus to the cortex and back, the brain can “fill in” and provide knowledge beyond that which you immediately hear, see or smell. The resulting discriminations are known in philosophy as qualia. These discriminations account for the intangible awareness of mood, and they define the greenness of green and the warmth of warmth. Together, qualia make up what we call consciousness.

NPQ | To say that consciousness is self-organizing according to evolutionary principles with no ultimate Programmer is to say there is no division between soul and matter, that the spirit isn’t in some spooky domain but rather is a biological phenomenon. Indeed, you say the main purpose of your recent book, *Wider Than the Sky*, is “to disenthral those who believe consciousness is metaphysical.”

EDELMAN | It is silly reductionism, of course, to claim that you and I are just bags of molecules. But I do not believe consciousness arises from spooky forces. I don’t believe in some Cartesian dualistic domain that is inaccessible to science. The brain is embodied and the body is embedded in its environment. That trio must operate in an integrated way. You can’t separate the activity and development of the brain from the environment or the body. There is a constant interplay between what is remembered and envisioned — an image — and what is actually happening in the senses. We now know that this interplay is enabled by reentrant interactions between the thalamus and cortex. First, signals enter my brain through this so-called dynamic

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core. Later, I can “see” images with my eyes closed. But I’m using the same circuits, only in a broader, more general and unique way — perhaps stimulated by a pleasurable memory or an ambitious idea. The brain can speak to itself and the conscious brain can use its discriminations to plan the future, narrate the past and develop a social self. Is consciousness the same as spirit? If you want to call the uniqueness of each individual consciousness a soul, that is all right with me. But there is a problem none of us likes to face. When the body goes, we go.

NPQ | The values that shape our consciousness, you say, are biological — based on survival in the sense of “get food, don’t be food.” Absent metaphysics, how then do we derive human rights from these values?

EDELMAN | The universe is not meaningless when considered in terms of biological systems. Survival through natural selection strongly influences the value systems of the brain. Survival during evolution means that value systems are biased toward life.

The universe may not seem to make any more sense to you if your cosmogony is scientific rather than religious in nature, but in the end there is no escape from the fact that in the evolution of living systems the bias is built in. Is that moral value? No. Moral values come later with social interactions through language, when human groups with common understandings formulate “rights” for the members of their society as they develop a sense of the “other.”

I don’t believe in the existence of genes for altruism in humans and reject any such genetic determinism. That doesn’t make sense to me. However, if you try to build rights in the absence of already evolved biological values, I don’t see how you could do it. To paraphrase Hume, the philosopher, “ought” does not come from “is.” But, whatever the case, we build our “oughts” on the basis of our brain’s activity.

NPQ | In the future, might humans impart consciousness to technology through artificial intelligence?

EDELMAN | Logic can be “imparted” and robots can be programmed. But that is not consciousness, which cannot arise from pre-defined information, but rather from the ability to self-organize, recognize patterns, learn and evolve on its own. Even if we one day had conscious artifacts, they wouldn’t be like us. They wouldn’t have our body and our evolved neural circuitry and the body that make us what we are. Machines might become intelligent one day, perhaps even conscious, but they will not be human. All the more reason to consider what we have to be precious.



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