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ARTS & IDEAS/CULTURAL DESK

## The Brain? It's A Jungle in There

By EDWARD ROTHSTEIN (NYT) 1696 words

LA JOLLA, Calif. -- Spend enough time talking with Dr. Gerald M. Edelman, and eventually his theory about how consciousness develops will seem confirmed by experience. Somehow, out of anecdotes about Andy Warhol, Friedrich von Hayek, Jascha Heifetz and Linus Pauling, out of free-floating riffs, vaudevillian jokes, recollections, citations, arguments and patient explanations, out of the excited explosions of example and counterexample, associations develop, mental terrain is reordered, and ever grander patterns emerge.

The immensity of Dr. Edelman's project -- explaining the development of the human mind -- overwhelms. Yet his ideas about how consciousness arises from the firings of neurons begin to seem eminently plausible because something similar seems to be happening in the hum and current of your own brain, in the excited state brought on by Dr. Edelman's voluble mixture of calculation, charisma, enterprise and brilliance.

This is metaphor, of course, but as Dr. Edelman says, "The brain confabulates." It associates diverse sensations, defies contradictions and creates coherence. It even seeks explanations for its own unfathomable behavior.

At 74, Dr. Edelman is one of the most renowned neuroscientists as well as one of the more controversial. Some have hailed his views about neurobiology and consciousness as revolutionary and revelatory; others have dismissed them as unoriginal and unclear. With his maverick stance, immense ambitions and proven accomplishments, the man himself has inspired similarly polarized reactions.

Speaking in his office at the Neurosciences Institute here, Dr. Edelman is reluctant to talk too much about himself, but his effort to understand the brain had to have been inspired by the wide-ranging passions of his own. He grew up in Ozone Park, Queens, and Long Beach, N.Y., and trained to be a concert violinist. (His teacher, Albert Meiff, was Heifetz's classmate.) After getting an M.D. from the University of Pennsylvania in 1954, he worked as a doctor for the United States Army in France. In 1960 he received his Ph.D. from the Rockefeller Institute (now Rockefeller University), where his work on immunology won him the Nobel Prize in 1972 (he was just 43). Dr. Edelman showed how the body produces precisely the right antibodies to fend off cellular assaults. "But I don't get very excited by working out second-order details," he explained, so he soon left immunology, and in 1981 founded the Neurosciences Institute ([www.nsi.edu](http://www.nsi.edu)).

It began as an independently supported part of Rockefeller University, moved here in 1993 and now has its own campus and 36 research fellows. (Dr. Edelman is also chairman of the department of neurobiology at the Scripps Research Institute, just across the street.) The word monastic has been used to describe the Neurosciences Institute's insulation of young scientists from grant-writing and lab hierarchies, a factor Dr. Edelman believes is important for the development of new science.

Though his theories are not accepted by all who work there, the institute seems a physical reflection of his passions: one building is devoted to theory, another to experimentation and the third -- a concert hall -- to music. Some of the most interesting research about music and the brain is now being carried on by one resident scientist, Aniruddh D. Patel. In other important research, a neurobiologist, Ralph J. Greenspan, has been studying the minute brain signals of fruit flies.

The institute's annual budget is low by scientific standards -- about \$6.5 million -- but Dr. Edelman must still be a fund-raiser and a proselytizer. Indeed, in thinking about the future, he imagines the benefits of bigger science, if not big science: \$200 million and 20 engineers, he fantasizes, would enable him to continue his design of intelligent, creaturely machines, who learn, according to his theory, as humans do.

Dr. Edelman's new book, "Wider Than the Sky: The Phenomenal Gift of Consciousness" (Yale University Press), revisits the themes around which that theory developed, a theory first examined in a weighty trilogy from the 1980's, including "The Remembered Present." In his new book, in just 148 pages of exposition, he tries to distill his ideas for a lay reader. This is a quixotic task, given the nature of what he has called "the most complicated material object in the known universe." But Dr. Edelman gives a sense of the problem's scope and some flavor of his proposals.

The theory's first principles and assumptions are relatively simple: There is no overseer in the brain setting rules and making connections. There are also no "spooky" forces, as Dr. Edelman puts it. Neither is the brain a machine or a computer. For Dr. Edelman, there are only the "unlabeled world" and the "embodied brain," a confrontation of unstructured immensities.

This makes the brain all the more mysterious. Its cortex contains at least 30 billion neurons with 1 million billion connections between them; counting one a second, it would take 32 million years to count them all. There are also multiple brain regions, 200 types of neurons, even large-scale neuronal deaths. How does such an object function, let alone give rise to consciousness?

Dr. Edelman calls his theory "neural Darwinism." He believes that what organizes the brain is precisely what led to the organization of the eye -- or the evolution of species. It is also the process he found at work in immunology: he showed that the body produces the precise antibody required not by manufacturing it according to a specific set of rules, but by making available an incredible diversity of material from which the appropriate antibody is selected.

The brain develops in a similar way, he suggests: connections among groups of neurons that are most effective in their reactions to certain stimulations become strengthened and succeed in affecting perception and behavior. These connections are modified by what Dr. Edelman calls a "value system," the impinging realities that affect the brain's evolution. The brain cannot be conceived of apart from the body, which provides its first and continuing "values."

But here is where controversies begin. Some critics say that Dr. Edelman is misinterpreting other models of the mind. The philosopher Daniel C. Dennett has suggested, for example, that Dr. Edelman is ignorantly "reinventing the wheel" and has called his theory "neither revolutionary nor original." Others have found the next steps in his theory excessively obscure. In 1988 the biologist Gunther Stent said: "I consider myself not too dumb. I am a professor of molecular biology and chairman of the neurobiology section of the National Academy of Sciences, so I should understand it. But I don't."

But Dr. Edelman sees the Darwinian idea and its biological working out as essential aspects of his theory and necessarily difficult. The brain will always have more going on than seems necessary, more randomness and variation than any humanly designed system. There is enormous redundancy (which Dr. Edelman refers to as "degeneracy") in the brain's functioning, giving it remarkable resilience and evolutionary possibilities. No brain event happens the same way twice. Even memory is always a variant, he says -- a re-creation, never a repetition.

Using such ideas, Dr. Edelman and his colleagues have been creating primitive Darwinian neural universes: robots that "learn" to avoid objects and pick up others, not because of a preset program of rules, but because of how various "neuronal groups and paths" are strengthened by experience -- mirroring, perhaps, the way an infant might gradually learn to grasp objects or distinguish among them.

Of course, it's a long way between this and even simple consciousness, but in Dr. Edelman's view, similar principles are at work. What, for example, does it take to recognize an object? Stimulations spurred by the color red and others by the shape sphere must be coordinated before a red ball is recognized. But such coordination doesn't require a manager. These first stimulations may trigger other stimulations that associate the earlier ones with one another; in turn, these groups of neurons become elements in ever more intricate mappings. Patterns evolve and interact in a dizzying dynamic. The brain is not a logically structured organ; these processes of connection resemble the processes of metaphor more than those of logic. Eventually, consciousness is a consequence of these neural mappings.

In the knotty working out of this theory, Dr. Edelman's supporters see him developing a new view of the body and mind. The neurologist Oliver Sacks has been one of Dr. Edelman's most impassioned advocates, calling his theory in *The New York Review of Books* "the first truly global theory of mind and consciousness, the first biological theory of individuality and autonomy." In the same publication the philosopher John R. Searle referred to Dr. Edelman's neurological theory as "the most impressively worked out and the most profound" he had seen.

Another supporter is the neuroscientist Antonio R. Damasio, who in a recent interview described his own views as "entirely compatible" with Dr. Edelman's. He said many in his profession tended to overlook Dr. Edelman's work: "There is an enormous resistance against theory in neuroscience and biology."

But that theory has also found a surprisingly ardent following in the arts and humanities. Elizabeth Coleman, the president of Bennington College, for example, recently visited the institute with an architect, a dancer, a biologist and a clinical psychologist, exploring ways to apply his theories to the curriculum.

These theories are part of what Dr. Edelman hopes will become "sciences of recognition," studying how biological processes recognize other biological processes. It is an enterprise, he

argues, that spurs amazement, because if it succeeds, it will show that out of accident and diversity, something as miraculous as human consciousness can be born. But this vision can also spur discomfort, because it implies that there is no supervising soul or self -- nobody is standing behind the curtain. This, for Dr. Edelman, is Darwin's final burden.

**CAPTIONS:** Photos: Dr. Gerald M. Edelman in 1972, when he won the Nobel Prize, with a diagram of gamma globulin. (Photo by Don Hogan Charles/The New York Times)(pg. B9); Dr. Gerald M. Edelman, a Nobel laureate and neuroscientist, and Darwin, a robot he's invented that demonstrates his theory of how the brain develops according to natural selection. (Photographs by Misha Erwitt for The New York Times)(pg. B7)

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