MICHAEL S. GAZZANIGA

THE MIND'S PAST

"This book is about how our experience is a construction of our apparatus of the brain. . . . Fascinating, easy to read, witty, and wise."

STEVEN PINKER,
author of How the Mind Works

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To the memory of

Charlotte Ramsey Smylie,

a great Texan, a great lady,

and a great friend

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As long as the brain is a mystery,

the universe will also be a mystery.

SANTIAGO RAMÓN Y CAJAL

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PREFACE

Over a hundred years ago William James lamented, "I wished by treating Psychology like a natural science, to help her to become one." Well, it never occurred. Psychology, which for many was the study of mental life, gave way during the past century to other disciplines. Today the mind sciences are the province of evolutionary biologists, cognitive scientists, neuroscientists, psychophysicists, linguists, computer scientists—you name it. This book is about special truths that these new practitioners of the study of mind have unearthed.

Psychology itself is dead. Or, to put it another way, psychology is in a funny situation. My college, Dartmouth, is constructing a magnificent new building for psychology. Yet its four stories go like this: The basement is all neuroscience. The first floor is devoted to class-

rooms and administration. The second floor houses social psychology, the third floor, cognitive science, and the fourth, cognitive neuroscience. Why is it called the psychology building?

Traditions are long lasting and hard to give up. The odd thing is that everyone but its practitioners knows about the death of psychology. A dean asked the development office why money could not be raised to reimburse the college for the new psychology building. "Oh, the alumni think it's a dead topic, you know, sort of just counseling. If those guys would call themselves the Department of Brain and Cognitive Science, I could raise $25 million in a week."

The grand questions originally asked by those trained in classical psychology have evolved into matters other scientists can address. My dear friend the late Stanley Schachter of Columbia University told me just before his death that his beloved field of social psychology was not, after all, a cumulative science. Yes, scientists keep asking questions and using the scientific method to answer them, but the answers don't point to a body of knowledge where one result leads to another. It was a strong statement—one that he would be the first to qualify. But he was on to something. The field of psychology is not the field of molecular biology, where new discoveries building on old ones are made every day.

This is not to say that psychological processes and psychological states are uninteresting, even boring, subjects. On the contrary, they are fascinating pieces of the mysterious unknown that many curious minds struggle to understand. How the brain enables mind is *the* question to be answered in the twenty-first century—no doubt about it.

The next question is how to think about this question. That is the business of this little book. I think the message here is significant, one important enough to be held up for examination if it is to take hold.

My view of how the brain works is rooted in an evolutionary perspective that moves from the fact that our mental life reflects the actions of many, perhaps dozens to thousands, of neural devices that are built into our brains at the factory. These devices do crucial things for us, from managing our walking and breathing to helping us with syllogisms. There are all kinds and shapes of neural devices, and they are all clever.

At first it is hard to believe that most of these devices do their jobs before we are aware of their actions. We human beings have a centric view of the world. We think our personal selves are directing the show most of the time. I argue that recent research shows this is not true but simply appears to be true because of a special device in our left brain called the *interpreter*. This one device creates the illusion that we are in charge of our actions, and it does so by interpreting our past—the prior actions of our nervous system. If you want to see how I get there, get from factory-built brain to the serene sense of conscious unity we all possess, you will have to read this mercifully short book.

There are many people to thank, not least of whom is the cleaning lady at the Hotel des Grandes Hommes in Paris. Paris is a wonderful place to launch a book. It feeds you and nourishes you and smiles at you while you struggle away in your small room overlooking a small courtyard. The cleaning lady quickly deduced my assignment and carefully plucked her way around the suitcase of science

papers, computers, and espresso cups. Always with a smile, she cheered me on until my wife and children arrived; then, as if handing over a baton in a relay race, she announced to my wife, "Do you know, this is the first time I have seen him smile in days." So many people keep us going.

Of course, scientific guidance has come from many. Steven Pinker once again read and critiqued the whole effort and provided insight upon insight. He is a remarkable scientist and scholar. Michael Posner did the same, and his usual candor and incisive wit straightened me out on several points. To George Wolford, Leo Chalupa, Michael Miller, Ken Britten, Jeffrey Hutsler, Miquel Marin-Padilla, Charlotte Smylie, and many others I offer many thanks. Finally, I benefited from several lectures over the years, not the least of which came from Robert J. Almo, who is not only an orthopedic surgeon, but also an expert on magic.

Alex Meredith, Ph.D., has once again captured the spirit of our work. Many thanks for his brain art in Chapter 5 and chapter openings. They are perfect.

Most important, I thank Howard Boyer at the University of California Press. Now, this is an editor. He not only cleans up the prose, corrects the sentences, clarifies meaning, and encourages one all the way, he is also smart and savvy, sassy and witty. The book would have been much less without him. And, just when you think you are done, along comes the U.C. Press copy editor. She, too, has contributed much to this book; my profound thanks to Sylvia Stein Wright.

Finally, I am reminded of a crack by Pasko Rakic at Yale University. Rakic, one of the world's leading neuroscien-

tists, studies how our cortex develops—a difficult and challenging problem, to say the least. Every sensible scientist stands in nervous awe of the enormity of such task. In reflecting on this, Rakic quipped, "Better not to understand something complex than something simple." My sentiment exactly. Good reading.

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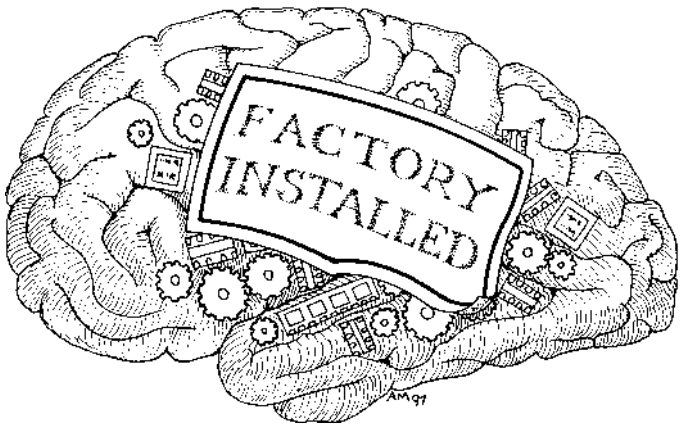
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I THE FICTIONAL SELF

There is no life that can be recaptured wholly, as it was. Which is to say that all biography is ultimately fiction. What does that tell you about the nature of life, and does one really want to know?

BERNARD MALAMUD, *Dubin's Lives*

Well, we do know about the fiction of our lives—and we *should* want to know. That's why I have written this book about how our mind and brain accomplish the amazing feat of constructing our past and, in so doing, create the illusion of self, which in turn motivates us to reach beyond our automatic brain.

Reconstruction of events starts with perception and goes all the way up to human reasoning. The mind is the last to know things. After the brain computes an event, the illusory "we" (that is, the mind) becomes aware of it. The brain, particularly the left hemisphere, is built to interpret data the brain has already processed. Yes, there is a special device in the left brain, which I call the *interpreter*, that carries out one more activity upon completion of zillions of automatic brain processes. The interpreter,

the last device in the information chain in our brain, reconstructs the brain events and in doing so makes telling errors of perception, memory, and judgment. The clue to how we are built is buried not just in our marvelously robust capacity for these functions, but also in the errors that are frequently made during reconstruction. Biography is fiction. Autobiography is hopelessly inventive.

Over the past thirty years the mind sciences have developed a picture not only of how our brains are built, but also of what they were built to do. The emerging picture is wonderfully clear and pointed. Every newborn is armed with circuits that already compute information enabling the baby to function in the physical universe. The baby does not learn trigonometry, but knows it; does not learn how to distinguish figure from ground, but knows it; does not need to learn, but knows, that when one object with mass hits another, it will move the object.

Even the devices in us that help establish our understanding of social relations may have grown out of perceptual laws delivered to our infant brain. Indeed, the capacity to transmit culture, an act that is only part of the human repertoire of capacities, may grow out of our special capacity to imitate. David and Ann Premack, formerly at the University of Pennsylvania, know a lot about human origins. They have spent much of their careers studying the chimpanzee in the laboratory and have found many instances where the chimp's capacities stop and those of a human infant begin. In their view we uniquely possess many automatic perceptual-motor processes that give rise to the complex array of mental capacities, such as belief and culture.

In considering how much complexity is already built into our brains, I ignore the nature-nurture issue in the traditional sense of how much variance in our intellectual lives is due to our genes and how much to our environment. The issue of whether Billy is smarter than Suzy or vice versa is but frosting on a much bigger cake. I am more concerned with why all humans are different from all chimpanzees, and from any other creature for that matter. Why do we have a theory about our dog or cat, but our cat or dog doesn't have a theory about us? Why don't chimps ever imitate actions or develop a history and a culture, but humans do these things reflexively? That difference is huge. The salient task of this book is to understand how human brains carry out these functions and why no other animal comes close. The brain device we humans possess, which I call the interpreter, allows for special human pursuits. It also creates the impression that our brain works according to "our" instructions, not the other way around.

The way our brains get built and the kinds of circuits that get installed have major consequences. Our brains differ from those of animals. Although our brains are founded on the same building block, the neuron, the organization of these billions of units in our brains gives rise to different capacities. The quantitative differences between Billy and Suzy possibly reflect genetic, intrauterine, and environmental factors. Even IQ differences may represent variations in normal birth trauma; new data suggest that cesarean-delivered infants are brighter. But the qualitative difference in the human brain leads to big discrepancies such as in our capacity for reconstructing past events. This

difference deserves our attention. Every normal human, whether a gravedigger or a Nobel laureate, possesses this capacity.

As the Premacks put it, brilliant people like E. O. Wilson at Harvard and Jane Goodall of Tanzania and New Mexico are off-base when it comes to trying to understand the human condition. Wilson claims, "Culture aside from its involvement with language, which is truly unique, differs from animal tradition only in degree." Goodall maintains that, since a chimp cannot talk, it cannot sit down with its peers as humans do and decide what to do tomorrow. The Premacks say, "Animals have neither culture nor history. Furthermore, language is not the only difference between, say, chimpanzees and humans: a human is not a chimpanzee to which language has been added."

My tale weaves its way through what we know about brain development and the simple facts of evolutionary theory as they affect our understanding of the human mind and brain. Even though I constantly call on the insights of biology, I also consider devices in the brain that create a different story for our species. That big, beautiful theory of Charles Darwin, one of the most important scientific theories in the history of the world (and not one word of it was generated with a computer's or calculator's help) leads us to inevitable truths. In attempting to understand what the brain is for, any evolutionary biologist begins with the essential question of why any organ or process does what it does. This approach puts us on a new course in considering how the brain enables mind. Instead of looking for unique physical substrates that support specific functions, we might discover how the brain generates ca-

pabilities in informational terms. This is the goal of a serious brain science attempting to understand our psychological selves. Scientists schooled in evolutionary theory keep reminding us of this point. Brain scientists who view the brain as a decision-making device are now gearing their experiments to find answers to the question "What is the brain for?"

The smart-aleck answer to the question is sex. Put more completely, the brain exists to make better decisions about how to enhance reproductive success. Thus, the brain is for helping reproduction and sex. Of course, the body containing it has to survive long enough to have sex. There is little question or disagreement about this. The fun begins with trying to understand how the brain manages this task and where we should look for the answer to the question of the brain's purpose. Most of the scientific observations I report were carried out at the psychological level; this work strongly contributes to the mind sciences, especially when derived from a biological perspective.

. . .

All kinds of things immediately get in our way when we try to think about what the brain does. The human brain, with zillions of capacities and devices for helping us make better decisions about how to enhance our reproductive success, can do many other things along the way. While a computer can be used to compute, which is why it was built, it also makes one hell of a paperweight. The finely tuned human brain can engage primal issues of sexual selection, or it can develop the second law of thermo-

dynamics. Understanding how it does the latter may not inform us of what it normally does and how it does it.

The question "What is the brain for?" is quite different from the question "What can the brain do?" Is this distinction important? So what if brains were built to do X but now serve mostly Y functions, one might argue. It is the Y functions in which scientists are interested. Take reading. Brains were not built to read. Reading is a recent invention of human culture. That is why many people have trouble with the process and why modern brain-imaging studies show that the brain areas involved with reading move around a bit. Our brains have no place dedicated to this new invention, but there is a place that manages breathing. Still, many would say, if the brain accomplishes such a function incidentally to what it was constructed for, so be it.

Most scientists, though, concentrate on the incidental mechanisms, which is a pity. If the evolutionary perspective is simply set aside, the data collected by psychologists and neuroscientists are likely to be grossly misinterpreted. The far-reaching implication of the evolutionary view is that models built to explain psychological and behavioral processes examine only the "noise" of the honed neural system devoted to making decisions about survival. Many psychological models of syntax, for example, assume that a child's ability to master this complex skill simply reflects the manner by which all children come to master the problem of communicating with others. B. F. Skinner, America's and Harvard's most outspoken behaviorist, spent his life promoting his view that such human capacities come about through simple reward contingencies experi-

enced by children. While a proponent of this view would never claim a rat could be taught to talk (since it does not have the innate capacity for that skill), a Skinnerian would maintain that simple reinforcement principles teach an animal or a human everything it is capable of doing.

Nowhere has this Skinnerian view been more prevalent than in explorations of human language. For instance, those who suffered the fifties and sixties heyday of behaviorism and rank empiricism remember being instructed that language is acquired through stimulus and response. Not until Noam Chomsky's pioneering work in linguistics did we realize that language reflects a biological event unique to our species. Many topics that wind up being viewed in evolutionary terms were not illuminated by scientists motivated with that agenda. The irony is that Chomksy, who is anything but a student of evolution, cracked the problem from a totally different perspective—that of the formal analysis of language.

Nonetheless, Chomsky's new view of language as a biologically based universal feature of our brain has taken hold. Steven Pinker, a colleague of Chomsky at MIT, has extended it by successfully arguing that language is an instinct—just like any other adaptation. Syntax is not learned by Skinnerian associative systems; rather, we can communicate through language because all members of our species have an innate capacity to manipulate symbols in a temporal code that maps sounds onto meaning. Although we "learn" different sounds for those meanings, the laws of communication are universal. If an evolutionary perspective were not invoked to interpret the work of linguists, more convoluted psychological theories of learning