1 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 capabilities 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.

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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 thermodynamics. 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 experienced 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 and development would probably be generated to explain human language, which is in fact an adaptation. Many models have been proposed, but they have little merit or substance.

The debate about the role of evolution and language has produced some strange bedfellows. Stephen Jay Gould sees language as one of his now-famous spandrels, "the tapering triangular spaces formed by intersection of two rounded arches at right angles." Just as these spaces are architectual by-products of mounting a dome onto arches, language, he argues, is simply a by-product of having a big brain. Language came along free with the obvious evolutionary advantage of having a better decision-making device. Oddly, Chomsky seems comfortable with this idea, even though most evolutionary biologists are not.

I think Gould is correct in arguing that there are many spandrels in the mind, but language is not one of them. There are numerous advantages to having language. As the Premacks have pointed out time and again, pedagogy is what our species does best. We are teachers, and we want to teach while sitting by the campfire rather than by being continually present during our offspring's trial-and-error experiences. With language we can communicate both the dangers and the pleasures of the world. Moreover, the advantages of being able to communicate with our nonkin to cooperate in hunting, securing safety, settling disputes, and negotiating a host of daily occurrences are obvious. The appearance of language, slowly but surely gaining in complexity over evolutionary time, can't help but be a huge species event.

Still, I think that many psychological evaluations are superficial. They explain only the noise, or unattended by-products, of a biological system rather than how the system works and what it is capable of doing. They are indeed spandrels.

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In the past decade we have begun to appreciate that the brain is not a big, freewheeling network. It does not make associations based on simple conditional relations and construct from them complex perceptual and cognitive functions. Research in animal psychology, evolutionary psychology, linguistics, and neuroscience has turned to a more fruitful approach to how the brain is structured and how it functions.

This more promising approach is derived from the notion that brains accrue specialized systems (adaptations) through natural selection. These highly specific systems are best understood in relation to their functions. Errors in analysis of their normal function occur when a device proves capable of handling another everyday task and in that capacity appears to have different properties. These proximate properties may be so tangible in our culture that they are accepted as the mechanism involved in the behavior or cognitive function in question.

Modern day illegal drug use, for example, is viewed by some as a deviant behavior produced solely by contemporary social forces. Some discuss at great length reasons for addictions, therapy for addictions, moral implications for drug use, and all the rest. Others simply wonder why we don't use drugs more frequently—if they make us feel good, why not? None of these proximate reasons reveal the underlying forces at work on drug use.

Randolph Nesse at the University of Michigan nails down the reason why drug use occurs and should be dealt with gently. Several adaptations in our brain modulate our emotional states; fear, anxiety, and sadness all help us in our decision making. They are good devices. To highjack these systems with artificial substances is to impair our ability to use cues from the brain systems that manage these emotions and thus to behave in an adaptive way to new challenges. The seriousness of addiction becomes apparent when viewed from the evolutionary perspective. Our built-in systems for cuing good decisions become broken. We are not hearing our normal brain chemical systems advise us on what is good for us. Debates on the morality of addiction and other factors miss this underlying biological issue.

The ebb and flow of neuronal patterns of firing hold the key to how the brain makes its decisions. The physical substrates allow computations to be carried out; but once they are expressed, it is the pattern of the neuronal code that represents the neural code for a function, like seeing a face or a color. Evolutionary theory has generated the notion that we are a collection of adaptations—brain devices that allow us to do specific things. The brain must deal with new challenges in a complex and probably distributed way. Many systems throughout the brain contribute to a single cognitive function. Here's how it all works.

The neural system of any given animal at any given time is in a specific state, but over time the microarchitecture of the neural system changes. If a randomly mutated change—

one which happens when growth dynamics undergo variations—enhances reproductive success, then future generations are likely to inherit the mutation. For example, a rudimentary eye helps an organism to see a little and therefore helps it to navigate the world. If a mutation improves on the rudimentary eye, the organism will see better, behave more efficiently, and survive longer. The genes for that eye become part of the species' hardware. In fact, as Richard Dawkins of Oxford University has recently pointed out, it would not be surprising if all surviving animals possessed some sort of rudimentary eye. It all may have started with a light-sensitive pigment patch that cued the animal as to whether it was night or day. What is known is that all kinds of eyes have evolved, with many species developing unique ways of seeing.

In no way does an organism construct a solution to a problem de novo. Only by chance is a new network generated and additional characteristics and abilities added. Brain mechanisms evolved by random mutation to meet new challenges and perform tasks that enhance reproductive success. This brilliant idea of Darwin is the only explanation for the apparent engineering or complex organic design in the natural world. Trial and error it is, with the "trial" being the random mutation and the "error" being the evidence that the change in the organism is or is not beneficial. This remarkably simple point is still one of the most misunderstood ideas of our time. No matter how eloquently an evolutionist like Richard Dawkins makes the point, people continue to believe it is wrong. "How," they lament, "can a wonderfully complex entity like a human be the product of chance mutations? We must be the result of divine design. We couldn't have happened by chance mutation."

Well, the chance factor is embedded in the idea of natural selection, but at the level of the genome. Chance variations in our genes create potentially better mutations, some of which survive. Over millions of years natural selection works on those chance mutations. Chance mutations and natural selection, working together, produced human beings. But it is completely wrongheaded to say that chance variations in our genome produced us suddenly. It was nibble, nibble, nibble for millions of years.

This ad hoc fashion of building the human, and in particular our brain, unfortunately makes it difficult for neuroscientists to tease out which tasks a system has evolved to accomplish. This is surely why finding localized circuits *wholly* responsible for a perceptual or cognitive capacity is so difficult. A neuropsychologist, the type of scientist who studies the effects of brain lesions on behavior, observes patients with focal lesions—which can result from strokes, tumors, or bullet wounds, or even railroad spikes driven into the skull by explosives. Such a patient may exhibit a specific disorder, such as the inability to detect upright human faces. A neuropsychologist may also study a patient with a large brain lesion that results in an amazingly specific disorder, such as not being able to speak nouns.

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In the profoundly fascinating but young study of how the brain represents adaptive changes, not only within but between species, contemporary knowledge is found wanting.

The human brain is generally regarded as a complex web of adaptations built into the nervous system, even though no one knows how. The neural specificity underlying adaptations probably constitutes a network widely distributed throughout the brain. Since evolutionary changes work in ad hoc ways, often by chance commandeering systems to assist in a chore, the prospects for finding a circuit linked to a task may be very poor.

The powerful theory of natural selection determines how we view the evolved brain and its functions; in accepting this approach we reject traditional behaviorist views of psychology, which posit that our minds are built from simple conditioning and associations. Although the behaviorist view is now out of favor among psychologists, the concept of association networks is currently popular among connectionist theorists. The bastion for these ideas is in La Jolla, California. The intellectual leader of this view is the engaging, clever, and always enthusiastic Terry Sejnowski, a professor sponsored by the Howard Hughes Medical Institute at the Salk Institute by the sea.

Sejnowski and his colleagues believe that genetic specification plays little or no role in the development of our mental devices, and they maintain that neurobiology supports this view. Sejnowski refers to his idea as "neural constructivism," which means that "the representational features of cortex are built progressively from the dynamic interaction between neural growth mechanisms and environmentally derived neural activity. This contrasts markedly with popular selectionist models." While some would argue that constructivism need not necessarily conflict with selectionist views, I think he is right to draw the line at that point. Selectionist models usually refer to how an enviromental stimulus selects out a preexisting capacity that an organism possesses from birth.

Even more boldly, Sejnowski announces that we now know learning guides development; then he quotes a barrage of controversial work. He marries the questionable neurobiology he reviews to the work of Jean Piaget, then suggests children learn domains of knowledge by interacting with the environment. It is not that built-in devices are expressing their capacities.

The La Jolla group draws upon what it calls the "nonstationarity" of the learning device in the brain. Learning transforms the learning device itself, so what has been learned can influence future learning. Sejnowski and his colleagues came to this idea in part because of the difficulties large networks have making guesses about how to organize themselves to solve a problem. They say tiny networks solve small problems and then gradually build up through trial and error.

As David Premack pointed out in his inimitable fashion, the La Jolla group's view of the work amounts to an evolutionist perspective. They want trial and error working ontogenetically, which is to say developmentally; evolutionists have it occurring phylogenetically. The difference is one of time scale, in addition to possible mechanism disparities. But there are deeper problems with connectionist theory. At the level of brain science, the cellular organization of cortical regions can be detected before birth. It is hard to explain to a person who holds a constructivist view that the basic structure of the language cortex is in place before a baby is born. The baby isn't exactly chatting away about Michael Jackson in utero.

Premack points out another problem with the way the La Jolla group thinks about domain-specific knowledge: the fancy way people have come to talk about the fact that what one needs to know about learning language is different from what one needs to know about learning causality. Each has its own domain. The constructivist view of the brain is that it has a common mechanism that solves the structure of all problems. This is aptly dubbed the *problem space*. When the common mechanism confronts language issues, it winds up building the brain one way; when it confronts the problem of detecting faces, it builds it another way—and so on. This sort of assertion leaves us breathless because if we know anything, it is that any old part of the brain can't learn any old thing. Yet Sejnowski and his colleagues strongly believe that the environment plays a major role in structuring the brain and that our experience directly reflects reality. As they say, "This interaction . . . is sufficient to determine the mature representational properties of cortex with no need for domain-specific predispositions somehow embedded *a priori* in the recipient cortex. As a consequence, this makes the relations between environmental changes—whether natural or cultural—and brain structure a direct one." But as Premack says, "When we consider the problems humans are designed to solve, we are struck not by their similarities but by their differences. . . . In the case of language, structure includes phonemes on the one hand, and forms classes, noun vs. verb, on the other. . . . Structure concerns