The Crucible of Consciousness

An Integrated Theory of Mind and Brain

Zoltan Torey

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To my wife
Margaret Dawn

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Foreword

Daniel C. Dennett

There are lots of books on consciousness being published these days, and I end up skimming most of them and reading a few of them. Reading somebody else's take on the whole set of issues is often frustrating and depressing: *they just don't get it.* Other times it is tantalizing; they start on the right foot, in other words, where I start! and they get lots of it, and clear up some of the fog and even shine some light on part of the terra incognita, but then wander off into some unlikely and unconvincing blind alleys. Rarely, something much better happens: I encounter somebody who starts in quite a different place, with a different agenda and different presuppositions, but who eventually arrives in my own neighborhood having blazed some new trails. Zoltan Torey is such a pathfinder. And surprisingly, the disagreements I still have with some of his ways of putting things, and even with some of his main verdicts, don't disturb me at all. On the contrary, I find it powerfully reassuring that two such different perspectives can home in on so much common ground. Like everybody else who works on the perplexing problems of the mind and consciousness, I have always had a sense that my own vision, while fundamentally correct, of course could be improved upon, and Torey's book contains quite a few suggestions worth further reflection and research.

Torey firmly roots his theory of consciousness in evolution by natural selection, as do I, but he comes at the issues with some strikingly different emphases. He sees that human consciousness is profoundly unlike the consciousness of all other species, and that language is the key to understanding this difference—another point of deep agreement between us—but he has a usefully different account of what kind of difference language makes and how. Much of this I will happily adopt from now on. He and I agree on the utter misguidedness of those who worry about the possibility of zombies and "the Hard Problem" but he has some novel ways of showing what is so bizarrely wrong about it. The greatest point of disagreement between

us is on the power of the computational perspective. By my lights, he has been misled by a few other would be pathfinders—the usual suspects: Edelman, Penrose, Searle, Fodor—into a pinched and unrealistic caricature of artificial intelligence. If AI were what they say it is, I too would turn my back on it. But unlike these, and other, anti-computational ideologues, Torey surefootedly picks his way to a suitably astringent and non-miraculous, non-romantic vision of how the brain works its "magic." He is, I insist, computationalist *malgré lui*. As such, his ways of putting things often shed new light on just what is going on in the "computational" brain, since he has to find alternative metaphors to stand in for the now somewhat overworked comparison with computers. Just as poets often find that the constraints of rhyme and meter force them to discover strikingly apt expressions of their thoughts, it turns out that couching a computational theory of the mind in resolutely noncomputational terms pays dividends.

There is much to repay readers in this book: to the uninitiated, it is a graceful and wise introduction to many of the central problems and arguments; to the veterans, it is a quite bountiful source of arrestingly different slants on familiar topics. Does some of this originality stem from the fact that the author has been blind for a half century, and has developed his skills of visual imagination to an uncanny degree? Perhaps this too has been a constraint turned into a blessing. Food for thought, well served.

Preface

I stand at the seashore alone and start to think. There are rushing waves, mountains of molecules, each stupidly minding its own business, trillions apart yet forming white surf in unison. Ages on ages before any eyes could see, year after year thunderously pounding the shore as now. For whom for what on a dead planet with no life to entertain. Never at rest, tortured by energy, wasted prodigiously by the Sun, poured into space, its might makes the sea roar. Deep in the sea all molecules repeat the patterns of one another till complex new ones are formed. They make others like themselves and a new dance starts. Growing in size and complexity, living things, masses of atoms, DNA, proteins dancing a pattern ever more intricate. Out of the cradle onto dry land, here it is standing, atoms with consciousness, matter with curiosity, stands at the sea, wonders at wondering, I, a universe of atoms an atom in the universe.

—Richard Feynman

This book is about the mind. It is about the evolutionary breakthrough that rendered the brain accessible to itself. It shows how the mind-boosted brain works. It also shows why the neural technicalities of reflective awareness can be neither algorithmic (digitally programmed) nor spiritual (ghostly in essence).

H. L. Mencken noted that "To every human problem there is a solution that is simple, neat and wrong." I took this to mean that a solution did exist that was complex, involved but right. Regrettably, I have found that, complex or simple, involved or otherwise, the mind problem has yet to reach a satisfactory solution. This is significant. The conscious brain is at the crossroad of all investigations. Its decoding is necessary for the understanding of the world and our place in it.

Stressing the mind's importance, Penrose (1989) in *The Emperor's New Mind* expresses the hope that "at some time in the future a successful theory of consciousness might be developed. Successful in the sense that it is a coherent and appropriate physical theory. Consistent in a beautiful way

with the rest of physical understanding, and such that its predictions correlate precisely with human beings' claims as to when, whether, and to what degree they themselves seem to be conscious. . ." Although this goal may sound ambitious, anything less comprehensive is not worth striving for. A theory, like the arch of a stone bridge, can only function when all its pieces are in place.

The human mind is unique. It is not only the epicenter of our knowing but also the outer limit of our intellectual reach. It is the key to what we are all about and to our insightful participation in shaping the course of our destiny. Not to solve the riddle of the self-aware mind goes against the evolutionary thrust that created it. To model it incorrectly is to assign inappropriate values to it (such as computational or spiritual ones), and to generate beliefs, mythologies and rationalizations.

To use evolution's highest achievement—the power of self-directed thought—for the purpose of misconstruing itself is to subvert evolution. The ability to create fiction, and then to believe in it and act on this belief, is a potentially dangerous evolutionary precedent. It allows for individual and collective action that is unconstrained by negative feedback. The brain's license to think what it will is reminiscent of the sorcerer's apprentice wielding the broom. It signifies power without responsibility.

My thesis is consistent with evolutionary monism. This is the view that the world is a closed system and that all forms, including reflective awareness, evolved from within. It has no room for panpsychism or animistic assumptions, even if "simple and neat." These are based on fiction rather than fact. The book attempts to model this entity. It shows that the mind is an essential ingredient and determinant of biological and physical processes. No longer ghostly or incomprehensible, it is an active constituent of the universe and the foremost expression of matter's self-organizing propensity.

The writing of this book posed a special problem. In the preface to his essay *What Is Life?* Schrödinger (1944) expresses it this way:

> We have inherited from our forefathers a keen longing for unified all-embracing knowledge. The very name given to the highest institutions of learning reminds us that from antiquity and throughout many centuries the universal aspect has been the only one to be given full credit. Yet the spreading in both width and depth of the multifarious branches of knowledge during the last hundred odd years has confronted us with a dilemma. We feel clearly that we are only now beginning to acquire reliable material for welding together the sum total of all that is known into a whole. On the other hand, it has become next to impossible for a single mind fully to command more than a specialised portion of it. I can see no other escape from

this dilemma, lest their true aim be lost forever, than that some of us should venture to embark on a synthesis of facts and theories, albeit with secondhand and incomplete knowledge of some of them and at the risk of making fools of ourselves.

Yet unless this task is undertaken, Blakemore's (1979) warning that "man may go out neither with a 'bang' nor a 'whimper' but simply sink in an ocean of undigested information" will come to pass.

As a clinical psychologist I had to piece together many a complex human problem. The decoding of the genesis of the reflective brain and its place in evolution was for me an extension of this challenge. I felt I was in a position to undertake it after Roger W. Sperry had started the "consciousness revolution." This set in train the research work that gave concrete anchorage to the idea that the human mind is the central organ of insight and understanding. Until then, this was shrouded in mystery and was open to fanciful speculation. It was now possible to articulate the insights of key disciplines through the uniting focus of neuro-science. I could attempt to crossrelate linguistics with sociobiology, evolutionary theory, philosophy, and cosmology. The integration of individual aspects of the human enterprise began to emerge and increasingly to highlight a coherent and meaningful role for a reflectively aware humanity.

The nature of such an undertaking is necessarily selective. It cannot do full justice to any of its constituents. There are generalizations and unavoidable omissions. I hope, nevertheless, that the text will present a meaningful overview to the intelligent non-specialist reader. Although it is an outline that concentrates on showing how it all fits together, it may even provide useful insights for specialists. I have attempted to make it accessible and lucid. If here and there the material appears somewhat demanding, I ask for readers' forbearance and persistence. I hope that they will find the end product, the picture of the united human perspective, well worth the effort.

The manner in which I wrote this book may be of interest. I had no blueprint for it, except the constraints of having to achieve internal consistency and external anchorage in scientific facts. I had some fuzzy right-hemispheric notions, and it was the gradual left-hemispheric logical clarification of these that had to be worked out. This was analogous with the evolutionary process itself, in that variations were generated and everything that did not fit the emerging congruence was eliminated. The model grew organically. I merely kept the process going by applying the criteria of consistency and factuality, cutting away what did not belong.

My interest in tackling the riddle of the self-aware mind reaches back into my early life. I felt that to search for the "Grand Design" is the highest

form of reverence. It was therefore disconcerting to find that the mind, this critical focus of our understanding, is left to mythological and animistic projections. It appeared that science and organized thought preferred neither to deal with it nor seek the interdisciplinary insights needed for its systematic clarification. Only in the last ten to fifteen years has this negative climate begun to change, stimulating interest in the phenomenon of consciousness and the physical basis of the self-aware mind.

Much remains to be done to integrate into the new paradigm all the neuro-physiological and neuro-psychological data to hand. *The Crucible of Consciousness* is offered in the expectation that it might promote this process and help with the exploration of this "epistemological niche." In other words, I trust that it will throw some light on the nature of the self-aware mind, as well as on the human enterprise and its place in the scheme of things. I hope that, rather than inventing yet another "solution" that is *simple, neat, and wrong*, I have found a formula that is *simple enough, neat enough, and right*.

Perspective

Michelangelo, . . . when asked how in the world he is able to fashion a sculpture out of a shapeless rock: "It is quite simple. You take a block of marble and chip away what does not belong."

—Anecdotal source

A The Problem

The mysteries of the mind have been around for so long and we have made so little progress on them that the likelihood is high that something we all agree to be obvious, is just not so.

—D. C. Dennett (1991), *Consciousness Explained*

At a time when nuclear physics, aided by mathematical models, takes us back to instants after the Big Bang, when the DNA formula of living structures is known and the substrate of matter is almost understood, the source of all this knowing, the conscious mind, is still a mystery. This is the Achilles heel of our rational understanding of the world. Our ignorance allows for speculations that range from the algorithmic to the occult. Philosophers of mind, trying to penetrate the problem with introspection, are stopped by the impenetrability of introspection itself. The question looms large: if it is the conscious mind that experiences, then who or what experiences the conscious mind?

Reflecting on these difficulties, the sociobiologist E. O. Wilson (1978) has this to say:

An uneasy stalemate exists, leaving the towering psychological enigma of self-consciousness hanging perilously between the murky swamps of metaphysics and the lush but uninhabitable pastures of introspective analysis. Trapped like some lost soul in this awful limbo, it admits of no scientific explanation. Indeed, Huxley's proud claim, echoing clearly through to the present day, was of its untouchability.

This book represents a new approach to the mind, a paradigm shift. In it I take up the challenge, demonstrating the physicality of the conscious mind and the reasons why introspection must invariably fail. I specify the brain–mind functions that are responsible for the failure, highlighting the reasons for the impasse and the false conclusions it necessitates. The book cracks the mind code, identifying the "obvious" to which Dennett is alluding and the way around it.

I show that the mind is a recently acquired subsystem of the hominid brain, designed to render the organism's awareness conscious, knowing that it knows. The means of the upgrading is language, the neural technique that accesses and handles our brain experience, superimposing self-generated thought and the sensation of this internal handling. To clarify the technicalities of why introspection has to fail tidies up the brain–mind domain and discloses the working formula that generates and maintains our self-accessible human consciousness. The text is a neuroscience-based interdisciplinary integration of all the relevant data within an evolutionary perspective. It is a natural articulation of facts, fitting the jigsaw pieces into a unique pattern of congruence.

Loren Eiseley (1961), in his *Darwin's Century*, makes the point that Darwin's great achievement was the discovery of the interconnecting pattern in the ocean of data, which was already there in the Reading Room of the British Museum. It was the overarching synthesis, the identification of the mechanism driving evolution, rather than the generation of primary research data, that was his real contribution. In a similar fashion, this book draws on the work of others. This I gratefully acknowledge, hoping that my novel insights and reassortment of facts supporting them will be seen as a worthwhile contribution.

The book is the implementation of the Schrödinger program (see page xiv of the preface), with special reference to the identification of the crucible, the conscious mind, that makes it all possible. It aims to draw together our compartmentalized knowledge into a meaningful single perspective and to dispel the mystery that surrounds the source and the way of our knowing.

Although this book is a paradigm shift, I do not claim that it is more than a first step in a new direction that I hope is correct. What I do claim is that this sort of integration is quite essential if we want to grasp who we are, how we work and how facts fit together in our complex world. Without such an understanding we are at sea and forced to fall back on arbitrary belief systems—a less than satisfactory option. At a time when "the minds of many people are afflicted with various irrational conceptions, ranging from

relatively harmless superstitions like astrology, to ideologies of the most vicious sort" (Weinberg 1992), and sanity is under siege, our insight into the conscious mind, the source of it all, is "light at the end of the tunnel."

In this Perspective I undertake to clear the conceptual deck, defining key terms and acquainting the reader with relevant issues and technical details. Here and there the going may be a little harder than in the body of the text, which has a narrative flow. Nevertheless, the reader should find the coming pages interesting and thought-provoking.

1 Entering the Labyrinth

> The philosophers, as we all know, just take in each other's laundry, warning about confusion they themselves have created in an arena bereft of both data and empirically testable theories.
> —D. C. Dennett (1991), *Consciousness Explained*

Recent advances in brain science have given us insights of great value, allowing a new approach to the problem of consciousness. This new approach represents a shift of focus from the neuron code to the brain code and centers around the question of how the brain works as an integrated system. Unlike the neuron code (now essentially solved), which shows how individual neurons receive and transmit impulses, the brain code (now in experimental focus) is concerned with the mechanisms by which large groups of neurons transmit "the images, thoughts and feelings which—we suspect—are the fundamental units of our psychological lives" (Cook 1986).

The shift of focus to the brain code is an important step toward the clarification of the riddle of the self-aware brain. Unfortunately it does not go far enough, and fails to provide a satisfactory answer. The problem of reflective (human) consciousness is not tackled, although it is clear that without reflective capability the brain's investigation of the brain code, or of anything else for that matter, would be impossible. It seems that, though by default, brain science is satisfied to leave the problem of reflective awareness and the mind to religion and philosophy. This allows the unqualified to deal with the puzzle of life, to fit the pieces arbitrarily and form distorted pictures.

Illustrating one aspect of what is in fact a double distortion, Searle (1992) observes that:

> A dominant strain in the philosophy of mind and in cognitive science has been to suppose that computation is an intrinsic feature[1] of the world and that consciousness and intentionality[2] are somehow eliminable.

The distortion is double because, over and above the supposition that consciousness can be eliminated, it also assumes that introspection—the ability to settle ontological questions about the world—is just as qualified to settle ontological questions about the conscious mind, its operational source. It is as if introspection, though without access to the brain processes that generate it, were able to define the system that defines it. Indeed, when philosophy looks at consciousness and the mind, it ignores that it is subsumed in the functions that consciousness and mind entail.

It is here that I take a diametrically opposite approach. I contend that the conscious mind's identity is to be found in the processes that enable the human brain to model its modeling and to generate the material with which and about which it thinks.

Since brain science and cognitive science have no viable model that accounts for reflective awareness, a further shift of focus is needed. This shift is to a code that deals with the problem of how reflection, the key to self-accessibility, works. The formulation of a mind code is therefore the primary task I undertake in this book. The mind code relates to the brain code as the brain code relates to the neuron code. I want to show that the brain code not only implies the mind code but that on the human plane it makes no sense without it. Once the mind code is established, it can be expected to throw light on ontological and epistemological problems that philosophy and cognitive science fail to solve. Using the mind code to articulate subjective phenomena on the conscious plane puts an end to the confusion. Terms like awareness, consciousness, reflection, and mind are now anchored and safe from misconstruction.

2 The Trouble with Consciousness

> Consciousness is a fascinating but elusive phenomenon. It is impossible to specify what it is, what it does or why it evolved. Nothing worth reading has been written about it.
> —Sutherland (1989), *The Macmillan Dictionary of Psychology*

While the above quotation is a little hard on consciousness, it highlights the need to clarify our terms. Although the connotations of awareness, consciousness, reflection, and mind differ, they are often used interchangeably, and this leads to confusion. So when possible and unless I am forced to deviate by quoting someone else, I shall use the term *reflective awareness* rather than *conscious awareness* or *consciousness* when referring to human functioning. The term "consciousness," the state "with-knowledge" ("con-

science"), when applied to infrahuman brains is, as we shall see, an unwarranted overstatement that has to be qualified to avoid anthropomorphic implications. This is because although the animal is aware of its surroundings, it cannot be assumed to know that it knows.

When applied to human brains, the term "consciousness" is no less problematic. We seem to know to what it refers, but cannot get a purchase on it. Undaunted, philosophers of mind try again and again to find an identifiable internal referent for it. These efforts always fail, as they are based on the tacit assumption that the solution lies embedded in the verbal matrix of the discourse and that a clever redistribution of words could uncover it. In actual fact an altogether new approach is needed to sort out the mess. This has to entail the modeling of the technicalities that generate the phenomenon we want to identify.

To give the reader a glimpse of what we are up against, I shall digress. Generally speaking there are two ways of dealing with consciousness: *reductionism* and *mysterionism*.

The former tries to account for it with physical laws; the latter sees it as radically insoluble. Then there are some such as David Chalmers who, despairing of both, revert to a computer-inspired version of old-fashioned dualism. In his book *The Conscious Mind in Search of a Fundamental Theory* (1996) he takes consciousness to be a "fundamental component of the universe, like space, time, mass and the electric charge." Unaware that he shifts consciousness out of reach altogether, he notes that:

> I resisted mind–body dualism for a long time, but I have now come to the view where I accept it. Not just as the only tenable view, but as a satisfying view in its own right.

To paraphrase Chalmers: consciousness is awareness (a biological entity) plus an additional "psychic factor" that turns "experience" into "conscious experience." This raises the expectation that consciousness might yet be recognized as a composite effect rather than a natural integer, and that this may lead to a rational revision of the brain–mind domain, giving us facts instead of mystery. But no, Chalmers goes on to define consciousness (already defined as a "cosmic component") as an "organizational invariant, a property that remains constant over all functional isomorphs of a given system"—adding that whether it is neurons or silicon chips that constitute the system "it is causal patterns among circuits that are responsible for the conscious experience that arises." This new twist to the old mind–body dualism makes it only more ambiguous and question-begging. If we take

consciousness to be the "fundamental cosmic component" as Chalmers would have it, it can't be at the same time an "organizational invariant, a property in systems"—to say nothing of the problem of where consciousness was before the systems had evolved in whose circuits (neural or otherwise) causal patterns could have given rise to it. Chalmers goes off the rails where he assumes that a "psychic factor" is adjoined to "biological awareness" and that this turns "experience" into "conscious experience." This is a costly move, a "major misdirector of attention, an illusion generator" (Dennett 1996) that could have been avoided by looking for a "neural technique" instead of a "psychic factor" responsible for making biological awareness self-accessible, that is to say: "conscious."

This is in fact the line I take, keeping awareness and its system-shifted human variant well within the constraints of biology.

On balance we have to conclude that the hybridization of old-fashioned dualism with the conceptual bric-à-brac of artificial intelligence gives us no insight into what consciousness is or how it works. It demonstrates instead that verbal "musical chairs" are of no use and that the term "consciousness" might not be the appropriate reference point for a science based revision of the brain–mind domain. Indeed, there is reason to believe that consciousness is not the integral entity, the reified unitary phenomenon naive introspection takes it to be. This is not surprising, as a closer look at the term tells us this much. Consciousness, the state "with-knowledge," the knowing that we know, suggests something complex, a production routine perhaps, but not something basic, unitary, and biologically homogenous. When looking for the natural starting point of an inquiry into the mind, we have to turn elsewhere.

3 Awareness, the Real McCoy

My guess is that we are looking in the wrong woodpile for the answer to the problem of consciousness.
—M. S. Gazzaniga (1992), *Nature's Mind*

If consciousness is an undetected composite, awareness is not. Awareness (the state of being "wary") is distinct and biological. It is the appropriate designation of the alert state in all organisms that have evolved beyond the level of purely reflexive behavior. Past this watershed, interneurons appear between sensory and motor neurons, and the internalization of data processing begins. A brain is interposed between the stimulus and the response, totalizing the sensory input of the organism into an internal representation of what goes on in and about it.

This representation is what we call "awareness"—a universal feature of all organisms whose decision making is centralized. It furnishes the motor system with the information that enables it to respond adaptively. Importantly, as the interneurons forming the brain are specialized motor neurons, awareness (their product) should be seen as an internal brain-response. This response is in fact a "situation report" for the motor system to read and act upon. Its ever-changing contents reflect the world around it, while the constancy of the awareness format itself underlines its unchanging role: that of the informational focus without which the living organism could not sustain and guide itself. To assume that awareness or its human variant "consciousness" is more or other than this transitional presentation from input to output is a costly fantasy. It is the source of the impasse and the mystery.

To resolve the impasse we must look at our primary data: "human consciousness." As I shall show in the text, this experiential "given" has no antecedent, and looking for lesser versions of it in animals is bound to fail. Human consciousness as we know it is an emergent composite, of whose twin roots only one, that of baseline awareness, is continuous up and down the evolutionary scale. This, as we have seen above, is the sensory totalization of what goes on in and about the organism: a rich tapestry of images and feelings that form the inner "canvas." This we share with all creatures that are brain equipped. What we do not share and what makes us unique is the additional neural facility that accesses and internally handles the "canvas." This neural facility I shall identify, showing how it accesses the "canvas," enabling us to reflect upon it internally. The text will show how we know that we know and why we cannot know how this comes about or what to make of it. It will show that our reflective consciousness is an augmented version of what preceded it, but that our retrovision is blocked from seeing the link. It is like asking what a lamp had illuminated before it was turned on.

As this clarification is very important, this is how Bickerton (1994) formulates the thesis, albeit in somewhat different terms:

> All creatures, ourselves included, enjoy "consciousness 1," awareness of ourselves and our surrounds to a widely varying degree of richness, poorly in simple organisms, quite thoroughly in more complex ones. However, "consciousness 1" is an "on-line" operation, unceasingly involved in the moment to moment exigencies of existence. "Consciousness 2," consciousness of one's own consciousness, can come only in a species, some of whose brain-areas are exempt from this immediate environmental traffic and can scan the behaviour of areas of primary consciousness as objectively as the latter scans the environment.

Awareness has no special locus in the brain. To look for it is like trying to trace the full orchestral sound to a single instrument or spot on the stage. Certain brain areas and structures are of course more important for its production than others, but as long as "neural adequacy"[3] is reached the motor system has enough to maintain a viable adjustment.

As for the biological roots of awareness, it is not always realized that the awareness of the brain-equipped higher organism is the internalized phylogenetic derivative of what were individual local "cell alertnesses" in primitive precursors. The photo, chemo, and pressure sensitivities of the simple life forms that were relocated and integrated are now collectively expressed in multisensory awareness. The point to emphasize is that while the primitive cell's alertness and reflexive reactivity is readily accepted as a biological fact, its back-relayed and upgraded central nervous variant "awareness" is not. As a result of this, the awareness of the brain-equipped organism is seen by many as a new "quality" or "property" that was added to organismic functioning as an optional extra at some point in evolution. This has the absurd implication that before that point organisms were able to function without awareness, that is, internal representation to act upon, and that it was the accretion of this thing called "consciousness" that turned alertness into awareness and eventually self-awareness in humans. This—as can be imagined—is an inexhaustible source of creative fantasy. It turns awareness, this neurobiological product, into a philosophical riddle, a source of myth and misconstruction.

If awareness is confusing, its system-shifted variant, human consciousness, is outright mysterious. This is not surprising, as the neural technique that turns awareness self-accessible is not recognized for what it is, so the end product appears to be uncaused. Perhaps it is this that makes Dennett (1991) observe that:

> The very mysteriousness of consciousness is one of its central features. Possibly even a vital feature without which it cannot survive.

In spite of such statements the facts are clear. The introspecting human brain, ignorant of its inner workings and feeling itself to be a unitary entity, is entirely at sea. The telescoping of the ground state of awareness with the reflecting process is so complete and seamless that the underlying components are not even suspected. The result is that the two-tiered structure of human awareness (consciousness) stays hidden and the pointless search for the illusory "unitary entity" goes on.

4 Why Models Fail

Worse than having no language with which to ask relevant questions of the brain about the brain-mind-consciousness domain, is to have one that asks the wrong questions and confounds the issues on hand.
—C. Blakemore (1977), *The Mechanics of the Mind*

Of the many models that ask wrong questions and give wrong answers, Minsky's (1985) "formula for creating a self-conscious organism" is of interest. The formula reads:

Divide the brain into two parts, A and B. Connect the A-brain's inputs and outputs to the real world so that it can sense what happens there, but don't connect the B-brain to the outer world at all. Instead, connect it so that the A-brain is the B-brain's world.

Minsky's design of a two-tiered arrangement for the conscious mind is a step in the right direction. It points to a second (internal) circuit as responsible for the reflective mind, but there is no follow-up or exploration of how such a dual system might work. The problem is only relocated and shelved. Instead of accounting for how the brain works in terms of the A-brain (i.e., awareness), or in terms of an interaction between the A-brain and the B-brain, he transfers the whole problem to the B-brain (the putative mind) and we hear no more about it—out of sight, out of mind. In spite of his propitious introduction of a second (specialized) brain component to show how self-awareness could be internally generated and managed, Minsky offers no explanation, and there the matter rests.

Another model that asks the wrong questions and confounds the issues is that of the computer paradigm. In spite of its successful application in other areas, here it is flawed, primarily because it ignores the organism's immense thermodynamic depth.[4] This represents no less than 3.5 billion years' worth of accumulated information locked up in the DNA, the key to the living system's repeated explication.

However, if the enormous organizational and ontological difference between the organism and the artifact is overlooked, it becomes possible to draw a superficial parallel between the computer and the brain, and the computer's performance and consciousness. The comparison is of course absurd, for in evolutionary and thermodynamic terms the computer is only a lump, even if cleverly crafted. Yet undaunted by theoretical and practical objections, proponents of the "strong artificial intelligence" paradigm persist with the claim that: "every system with the right functional organization will have the same sort of conscious experience, no matter what it is

made of" (Chalmers 1996). This is nothing if not a new form of animism, "computer-assisted Pygmalionism" (Bickerton 1994), betraying a deep ignorance of the biological system and of what awareness entails. It is indicative of the depth of confusion in this domain that views like those of AI are often espoused and held cheek by jowl with equally absurd mystical ideas representing quite the opposite end of the spectrum. (For a detailed treatment of the "computer fallacy," see section A of chapter 8.)

The two-tiered model of human consciousness I am proposing is a new departure. It is based on biological facts and on the logic of the system's interacting components. I shall identify the lower tier (the ground state of biological awareness) and the reflective upper tier (maintained by the neurofunctional innovation of speech-thought). I show that awareness (Minsky's A-brain) is the sole seat of experience in all organisms, even if they become reflective. I further show that the term "conscious mind" has no concrete referent, but we can identify a new brain module, the "mind-system," whose function it is to turn our awareness reflective, that is, conscious. I demonstrate how this "mind-system" works through reimpacting the brain's self-generated output (spoken or thought) into the ongoing totalization, which becomes self-aware as a result. The neural facility for the reimpacting is language. It creates self-accessibility by experiencing the output as well as the proprioception the output generates. The seat of experience does not change by becoming reflective, but awareness becomes system shifted, and this gives the now self-accessible variant the false impression that it has become a different entity. It is then by courtesy of the mind (the new subsystem) that the brain is reflective, knowing that it knows, though not knowing how this has come about or what to make of it.

5 Experimental Facts and Theoretical Fiction

Guesswork has a useful place of course, but let's distinguish between blind guesswork and educated guesswork and between guesswork and confirmed fact.
—Patricia Smith Churchland (1997), "The Hornswoggle Problem"

Let us now look at the way the brain's processing modules come together to generate the internal representation we call "awareness." Sophisticated imaging techniques, such as PET (positron emission tomography) and MRI (magnetic resonance imaging), reveal "an astonishing degree of region specific activity" (Posner 1993) for functions and subfunctions in the brain. This confirms the step-by-step integration of the afferent totalization that is awareness in all brains, human and animal. The data also

indicate that, unlike the infrahuman brain, that of humans is able to bring on the image of an object, movement, or color internally, and that these internally induced brain functions engage the same modules or processing regions as the direct visual sensation of the same object, movement, or color.

Although the data also reveal that this speech-thought-induced experience engages a kind of speech module that involves the prefrontal areas, the anterior cingulate gyrus, the left-brain's speech areas and the parieto-temporal junction, it is not fully appreciated what this signifies. This is the mechanism with which the human brain accesses its experience, handles it, and experiences the handling.[5]

In the body of the book I outline the evolutionary breakthrough that made this internal percept-handling possible, showing that reflective awareness that results from it can be modeled and that our knowing that we know is due to a novel processing routine and not to the acquisition of an additional "cosmic component," as some would have it.

The MRI and PET techniques may also be useful in giving us a purchase on the seemingly intractable qualia[6] problem. According to the traditional view, it is the agency of "consciousness" that turns neural events (in the brain) into subjective qualia experience (in the mind).

If it is correct that to have qualia experience the agency of a "conscious mind" is necessary, the animal's experience can consist only of raw data, that is, neural correlates, or else it too must be taken to have a "conscious mind." However, this turns out to be problematic. First, we do not know what a mind (conscious or unconscious) actually is, or how to look for evidence of it, whether in humans or in animals. Second, we cannot even guess, let alone know, what the experience of neural correlates could be.

Although the introduction of a "conscious mind" to serve as an explanation only thickens the plot, it is deeply entrenched in the tradition that views *experience* and *conscious experience* as different entities. Chalmers (1996) speaks, for example, of a hypothetical "twin" of his, who has the identical experience and the identical response to this experience, but unlike Chalmers, is not conscious of it. The difference is that the "cosmic component of consciousness" has appended itself to his experience but not to that of his "twin." This has the absurd implication that to be conscious of an ongoing event makes no difference to the response to it, but also that "consciousness" is a passive and inconsequential epiphenomenon, a ghost rider without causal connectedness to the world and to the organism on whom it piggybacks. In view of Chalmer's AI-inspired statement that "every system with the right functional organization will have

the same sort of conscious experience," the claim cannot be made that only one of the twins is conscious of what is in fact identical experience.

While one can understand that in times past and without knowledge of how the brain works such ideas could be entertained, it is hard to see why insights of neuroscience now available are not drawn on to recast and perhaps solve the problem.

For example, MRI and PET data show us that:

A. Upon exposure to stimuli of color, motion, or an object, human as well as animal brains engage the same brain regions in comparable ways to bring the experience to awareness.
B. The human brain (and only the human brain) has the additional facility for the self-initiated internal reactivation of images in the absence of external stimuli.

This points to the conclusion that the way inputs are processed and experienced by the human brain and by the animal brain is very similar, and that the critical difference between the two is the availability of a mechanism in the human brain for the reevocation of an experience from within, a mechanism that is absent from the animal brain. While this is a dramatic breakthrough to self-initiated internal functioning, it is only a technical one that does not call for the postulation of additional "mind" or "mind stuff." In other words, the breakthrough is a physical system shift, a circuitry modification and not the intervention of a "cosmic quality" to upgrade the ape's experience into its human variant.

On the strength of the above, it is the inability to account for self-accessible human experience that points to a "conscious mind" (albeit by default) and to our qualia experience as being "mental" rather than biophysical. While this may be a good way to study how mystical, religious, and philosophical ideas are generated in the absence of concrete data, our aim is to cut the Gordian knot and to replace fiction with fact. There are of course many who are adamant that the agency of a "mind" is obvious. They should heed Dennett's (1991) cautionary note, which is the motto to this section:

> The mysteries of the mind have been around for so long and we have made so little progress on them, that the likelihood is high that something we all agree to be obvious, is just not so.

In view of the close similarity between primate and human sensory discrimination and brain processing, what can we say about the qualia problem in real terms? Taking up Dennett's advice, we may suggest, for example,

that the qualia character of experience should be regarded as constituting a universal biophysical idiom, that is, a neural language that has evolved for the transposition of the raw data into a user-friendly form. Far from being "mental" and exclusive to humans, the qualia idiom is an excellent qualitative shorthand for the simplification of the enormous complexity of the informational substrate of the brain. Indeed, if the brain (human or animal) would have to cope with the ocean of light waves, pressure waves and assorted raw data in which it is immersed, it would be overwhelmed and unable to make sense of it.

The practical and biophysical nature of the qualia-code is further underlined by the extensive use of it by fauna as well as flora. The wide range of adaptations to subserve brains in special niches is equally indicative of its concrete and nonmental character. Take, for example, the absence of the color factor in the visual perception of nocturnal animals or the vast accentuation of the auditory acuity of bats for echolocation and mapping. At each point and in every respect it is somatic needs that are catered to by the qualia, so that the relevant aspects of the substrate could be transposed into a convenient molar, neuronal idiom. It can be concluded, therefore, that the qualia character of awareness, the experience of color, sound, pain, pleasure, and the like, in all brains (human and animal) is not subjective and mind dependent, but brain based and concrete as the substrate itself and the conversion process that generates it.

If the animal's awareness too is a patchwork of qualia, it differs from that of humans only in that it cannot be accessed and internally manipulated. It is not data that is displayed in the ongoing sensory totalization. For that to be the case a breakthrough is needed. The breakthrough is of course language, the motor facility that empowers the brain to handle its neural representations internally. The handling boosts the ground-state of awareness with the knowledge and the feeling of this ongoing contribution. The result is that the brain knows that it knows.

In accordance with this two-tiered structure of awareness in humans, I shall use the term "awareness" to denote only the universal ground state of the internal representation in all brains, and the added term "reflective" to designate its self-accessible, self-handling human variant.

6 From Ape to Human: Continuum or Divide?

I would give absolutely nothing for the theory of Natural Selection if it required miraculous additions at any one stage of descent.
—Charles Darwin, in a letter to geologist Sir Charles Lyell (1860)

Splitting the biological fact of internal (neural) representation into a universal ground state and a self-accessible variant throws useful light on the question of continuity across the ape-to-human divide. The ground state (animal awareness) is clearly continuous; the brain's ability to access it is not. The former is shared; the latter is exclusive to humans.

In subjective experiential quality the two are probably very similar, but there is an "all-or-nothing" difference in being able to internally manage it and in having knowledge of this. The text will show how this breakthrough was achieved and how the upgraded neural representation is able to display itself in itself. The clarification of this process is the linch pin of insight into the nature of human-versus-animal consciousness. It makes biological sense of subjective (mental) phenomena.

The term "mind," like that of "consciousness," should be avoided, whether it is animal or human brains we are talking about. To use it loosely as a synonym for "neural representation" is wasteful and suggestive of nonphysicality. The term *mind*, as I have noted in subsection 4 above and shall detail in chapter 7, has quite specific and important meaning, and should be reserved for this purpose. Rather than a vague generalization it will be identified as an emergent new subsystem of the brain, underpinning the reflective mode of functioning. Its linkup with language (the motor facility for self-handling) suggests that understanding how language evolved might also be the key to an understanding of the brain-subsystem we want to call *mind*. This ties up with the conclusion of the passage quoted from Wilson at the beginning of this section. It suggests that: "The psychic apotheosis"—the achievement of self-consciousness—"is tied tightly to the symbolic skills" and that "it is from this quarter that we might expect a glimmering of light."

I want to reiterate that the *mind* I am talking about is a biophysical entity, a subsystem of the brain that is exclusive to humans. It is anchored in its technicalities to the brain code and the neuron code beyond it. It is not the spiritual construct of conventional thought or the seat of consciousness, but the functional component that boosts the ground state of awareness onto the reflective human plane. I show how this entity evolved, how it relates to its driving component "language," and why its physical character is counterintuitive and inaccessible to introspection. The reader may recognize in this inaccessibility the hidden source of inferred spirituality and of the mind–body dualism that still dominates conventional thinking.

B The Path to the Solution

Follow the yellow brick road.
—L. Frank Baum, *The Wonderful Wizard of Oz*

In this section I outline the contents of the ten chapters that detail my theory of the mind and indicate its central role in evolution. The nature of human consciousness is elusive and in the absence of clearcut and hard evidence the brain is free to distort and invent. Reflecting on this predicament, Konrad Lorenz (1977) wrote:

At an early age I realised that in the interest of objectivity a scientist must understand the physiological and psychological mechanisms by which experiences are conveyed to man. He must understand them and for the same reason why a biologist must know his microscope and understand its optical functions. Namely, in order to avoid taking for one of the characteristics of the object he is observing, something that in fact results from the limitation of his instrument.

This is sound advice when scientists look at the world, but not when they look at themselves. When the mind's focus is the focusing mind, new problems arise. The object and the instrument of the inquiry become one and logic is compromised. The mind is unable to decode itself or find its identity. Its naive experience is dualistic; it is that of the insubstantial "agent" in its physical frame. This "ghost in the machine" paradigm confounds the investigation.

The problem is complex, common sense is no help, and the suggestion that consciousness is an "organizational invariant" (neural or artificial) is useless. It is to brain science we have to turn, to the "equipment" that is responsible for the mind's opacity and for the chaotic conceptualization to which it gives rise. We must build a model of how the mind-endowed brain works, identifying its functional components and the interactions that bring about our subjective and objective experiences. The model must show how language evolved, how reflective awareness is achieved and how syntax (i.e., grammar, logic, the computer) was generated out of the semantic substrate by way of neural transactions. The model must also explain why the mind-endowed brain deceives itself with entelechy-type impressions. This program, if successful, will further strengthen the authority of brain science, underscoring Edelman's (1992) observation that:

I have taken the position that there can be no complete science and certainly no science of human beings, until consciousness is explained in biological terms.

The model I am proposing is an attempt to bring into a single focus all the elements that make up the puzzle. I lay most stress on isolating the two

constituent aspects of conscious human experience, treating them as separate entities in interaction. I identify the neural ground state (or animal awareness), showing that it is the reflecting technique that is responsible for making awareness aware of itself, or in other words, for accessing the ground state and generating in it recognizable traces of this accessing. This is the issue in focus, the *how* of our knowing that we know, and this is a manageable task.

The first half of the book traces the language-linked emergence of the mind, the subsystem of the brain that enables it to be aware of itself. The second half explores this system, showing how consciousness works, why it is not transparent to introspection, and the sense it makes in the context of evolution.

In chapter 1, "The Emergence of the Human Brain," I outline the evolutionary changes that led to the asymmetry that enables the hemispheres of the brain to meaningfully interact and achieve a higher level of functioning. I show how the rewiring of the brain was able to bring about an autonomous speech capability, with reflective thought in its wake.

In chapter 2, "Adaptive Changes for Speech and Thought," I detail the modifications of the attentional process that were needed for the dual (perceptual plus verbal) representation of referents. I outline an excitatory interplay between the percept (in the right hemisphere) and the word (in the left hemisphere) and the way our attention copes with the asymmetry of the inputs. The second half of chapter 2 acquaints the reader with the functional components that interact and codetermine the language output.

In chapter 3, "The Evolution of Language," I describe the breakthrough that led to the stabilization of percepts, followed by their linkup with words and a second breakthrough to articulated language. I show why at first only nouns and verbs (designating objects and actions) could be word-linked, and how this resulted in verbal pointing, that is, "naming." Once the frontal lobes of the brain were able to scan this protovocabulary, the extraction of secondary linguistic material could begin. This yielded adjectives, adverbs, particles, and link-words, the neural takeover of an internal (speech) loop making the articulated delivery of meaningful messages a routine matter. The chapter concludes by showing how the brain modulates the language delivery through feedback, and that the language instrument is independent of the message it conveys.

In chapter 4, "More about Language," I show how language and grammar are shaped by constraining perceptual processes, that is, by nonlinguistic determinants. The child's acquisition of language is viewed as an

extension of its manipulative skill. I show that animal communication, lacking the left-right hemispheric organization that only humans possess, cannot be regarded as language, even of a rudimentary kind.

In chapter 5, "Self-Accessibility," I evaluate the reflective human brain's vested interests in limiting its understanding of itself. I show how self-detection becomes possible through the continuously reentered proprioception of speech and thought, the experience that we are doing it.

In chapter 6, "Reflection: The Key to Human Awareness," a detailed model of language-upgraded functioning is outlined. I show that speaking or thinking is the source of a double-stranded experience: A. The semantic contents (what we speak about); and B. The proprioception (the sensation of doing it). These strands are two of three alternating targets of attention. The third is the nonlinguistic experience in the right hemisphere that is being conveyed. The output of speech is continually tested against chunks of experience, or templates. The attention alternates its focus between members of this triad of content, proprioception, and template experience. The process is like a juggling act that is fixed in configuration but continuously changes in content. Its reflective character is the result of attending to and responding to every aspect of the triad in turn. In the special case of self-awareness the distinction between the members of the triad is blurred. The self is being thought, felt, and perceived all at once, throwing the attention out of focus. The effect enhances but also confounds the self-experience, imparting to it a sense of perplexity.

In chapter 7, "The Mind-System," I identify an emergent organization that underpins our language capability and reflective awareness. It works with novel as well as specially adapted storage and recall functions, generating new neural tissue for the purpose. The reflective (self-aware) brain can have no access to its unconscious causal antecedents. Unable to know or feel that it has antecedents gives it the impression that it is an uncaused causal agent. The verbal system's mandate to integrate completes this pattern of self-deception. Turning from fiction to fact, I show how the mind system runs up action alternatives, creating a range of options releasing what it feels to be value congruent. This "free-will" function of the mind-endowed brain makes it a codeterminant of outcomes, which is a significant evolutionary breakthrough.

In chapter 8, "The Mind versus the Computer," I examine the genesis of syntax, the formalism that makes speech and thought possible. I trace the mind's role in this genesis, showing why a formal logical system such as the computer cannot have created the human mind. For the computer to become a valid mind analogue, interactions between the formal system

and the semantic contents it processes must be possible—a condition the computer cannot satisfy. I then look at the way the human brain self-complexes, and conclude with an examination of the societal context, the formative cradle of the mind. I draw attention to the latter's increasingly important integrative role in evolution.

In chapter 9, "Evolution: The Model of the Loaded Dice," I enlarge on the mind's significance and on the range of speculations it creates. Contrasting the stance of evolutionary nihilism with that of animism, I show that both positions are ill-supported and that the conscious min can be recognized as a data-processing breakthrough in biospheric evolution.

In chapter 10, "Between the Quantum and the Cosmos," all the earlier insights are drawn together into a meaningful perspective. In this perspective the conscious mind is an indispensable component of cosmic unfolding, an important constituent for the explication of the universe on the micro- and macro-scale. If the physical nature of the mind system is granted and is understood as generating integrated insight and order, an unexpected ethical implication emerges. It relates to the promotion as against the retardation of the evolutionary process in which the conscious mind is embedded and of which it is the highest form of expression.

This concludes the brief outline of the path to be followed. I hope to convince the reader that the model of the mind I am proposing is the logical outcome of the consciousness revolution now taking place. It has become possible to tackle a task as complex as this because learning, insight, and sophistication have reached a degree of subtlety that permits the analysis of the problem and its meaningful resolution.

Indeed, such a resolution is necessary to correct for distortions in our understanding and for curbing the reflective mind's tendency to distort. This is especially important in relation to our human identity and biospheric situation.

C Some Technical Aspects

"What do you know about this business?" said the King to Alice. "Nothing," said Alice.
—Lewis Carroll, *Alice in Wonderland*

The reader may wonder how much knowledge of neuroanatomy and neurophysiology is needed to understand this book. The search for the mind code and its implications does not involve any dealings with phenomena

on the level of the neuron code, its infrastructure twice removed. The mind code is concerned only with the brain code, on whose level psychologically meaningful large-scale interactions make their appearance. The neural technicalities that underlie these, though interesting, are not important for us at this point. It is enough to know that the nerve impulse is a bioelectric disturbance, propagated along nerve fibers. The impulse is passed across synapses between neurons with the aid of neurotransmitter chemicals. We deal with neither these nor the cell assemblies and cortical columns into which neurons are organized. We are concerned only with their orchestrated output on the level of the brain code. It is this that can be analyzed and evaluated psychologically.

As for the brain anatomy needed to understand the mind code, it is enough to know that three main functional components interact to sustain it. These are: the *brainstem*, the *neocortex*, and the *corpus callosum*.

- The upper portion of the **brainstem** activates the arousal system that directs the attention to the interhemispheric transactions that are necessary for human cognition.
- The **neocortex**, composed of layers of gray matter, covers the four lobes of each cerebral hemisphere, the frontal, parietal, temporal, and occipital lobes. About 40 percent of these layers are sensory and motor areas or maps. These maps form the basis of what constitutes our awareness and defines the organism's continuously changing sensory and motor situation.
- The **corpus callosum** is a dense bundle of nerve fibers that connects the hemispheres. Through it, new interhemispheric transactions are created and maintained.

Regarding the architecture of the brain it is interesting, but not essential, for us to know that the ever-increasing complexity of the nervous system did not result in the discarding of earlier, more primitive structures. Rather, it led to the incorporation of these into a system of increasingly complex structural superimpositions. The archaic forms of brain structures were retained for more or less automatic housekeeping tasks, leaving the forebrain (the cerebral hemispheres enveloped by the neocortex) free to evolve higher functions. These functions are of special interest to us. They constitute the domain of the mind, of reflective awareness and of mental phenomena in general.

At this point I want to highlight a number of key issues and concepts, to show how the brain's functional units interact and to indicate the modifications in brain functioning that are of relevance for reflective capability.

1. Language is the motor facility for the brain's self-handling. Its production and reception entail a functional arrangement that is unique in evolution. This is the dual (perceptual plus verbal) representation of referents (i.e., objects and experiences to which we refer). The dual representation is largely, though not exclusively, hemispherically asymmetric and involves a pattern of rapidly oscillating attentional shifts to accommodate and integrate the disparate contributions. The attentional oscillation brings on heightened arousal that underpins language performance and leads to its proprioceptive detectability. For this reason, language is the source of an active self-sensation and of an experience of self-generated output.

2. Language uses a new off-line circuitry arrangement. This internal loop is not part of the brain's "on-line" processing commitment. It is like an independent "think tank" to generate internal (thought) responses for the brain, which can be reentered into the "on-line" performance if required. This new language circuit is an all-or-nothing affair and not the end product of a graduated development. Confirming this, Bickerton (1994) notes that: "Between proto-language and language proper there was nothing."

3. The percept is a stabilized product of a sensory (visual, auditory, or somatic) modality or combination of modalities. It is held invariant by a "constancy mechanism" and so made suitable for word linkage and language delivery. When in the asymmetric human brain a stable percept, say the image of a tiger, is linked to the word "tiger," the two form a word-percept. This is the semantic unit of speech. I want to underline that the term "percept" (as in "word-percept") will be used generically as constituting the semantic leg of the linkage. Thus it will stand also for "concept," defined as: "complex general ideas, combining various characteristics and features." What is important here is the functional equivalence of "percept" and "concept," so that either of them can be word-linked and entered into the attentional oscillation that carries the reflective state. While the semantic unit that is being communicated is the "percept" or the "concept," it is the word (the symbol) that can be uttered and conveyed. Word and percept stand for one another and constitute the building blocks with which the speech-capable brain generates entirely novel combinations.

4. The brain's generativity is made possible by the categorical items (the word-percepts) and by the "off-line" language facility with which these can be organized and conveyed. The brain can now combine, recombine, and invent. Thanks to its "off-line" independence, it has unlimited scope to mold its mental contents in new ways, to ask questions, to formulate answers, and to test these for their goodness of fit. Freed of its "on-line"

infrahuman constraints, the brain is now able to access and process itself. It has the means to upgrade its level of functioning, to oversee and guide behavior, and to register a quasi-volitional authorship and active inner self. Generativity thus empowers the brain, puts it in the driver's seat, and turns its awareness reflective, ensuring a qualitatively higher level of functioning, and all without supernatural assistance. It is indeed the source of our humanity and of the system shift on which our cortical autonomy is based.

5. I shall call the product of the continuously updating cortical maps the *endogram* (from the Greek "*endon*"—within, and "grammar"—a writing). The endogram or internal "*readout*" (Mountcastle 1978) is the animal brain's neural representation. It is the integrated audio-, visuo-, somato-sensory model of what goes on in and about it. The endogram is not watched or handled by the animal because in neural terms it is identical with it. By contrast, humans can access this endogram, handle it with language, and proprioceptively sense that they are modulating it. Humans can reflect on this ground state of awareness and integrate experience of reflection into the endogram on which they are reflecting. In other words: they can see that they see what they are doing as they are doing it. The endogram, the neural representation in humans, is therefore also the record of continuous self-management. The failure to account for the genesis of self-management is the source of ideas such as the "agent within" and mind–body dualism in general.

6. There is an important difference between the infrahuman (nonreflective) and the human (reflective) levels of brain organization. In the former, the brain-stem arousal system turns its dual attentional searchlights always and necessarily on target areas of identical or near-identical twin excitations, one in each hemisphere. The excitations occur homotopically, that is, at anatomically corresponding loci, and reflect bilateral symmetry and synchronous processing.

On the reflective or human level this is changed. Because of an evolutionary shift toward hemispheric asymmetry, the homotopic excitations are split and the former "twins" begin to represent different but complementary subaspects of previously indivisible mirror-image representations. This is an evolutionarily unprecedented arrangement, in that it necessitates interhemispheric cooperation to achieve an integrated response. This response is different from and superior to the response the two hemispheres produced in parallel in the infrahuman brain.

Illustrating this new arrangement is the infrastructure of language performance. It is remarkable not so much on account of the left hemisphere's

unilateral motor control of the organs of speech (preventing cross-hemispheric interference), but on account of the left hemisphere's concern with the delivery's denotative aspect as against the predominantly though not exclusively right-hemispheric concern with its connotative context.

The relationship between denotation and connotation is that of the tight focus of a named object against its background of broad meaning and implication. Thus if the denotation of a word-object is "red shirt," its connotation is "colored clothing." The connotation is the broader category or surround.

The integrated output of word and percept is, however, more than an enriched product. The performance of language forces a shifting of the attentional focus from denotation to connotation and back again, and this within the framework of the delivery itself.

7. The hemispheric splitting of denotation and connotation is an oversimplification that needs to be qualified. Although the right brain is unencumbered with the language function and has more neural space and richer limbic connections to form higher-quality percepts for word linkage, attenuated versions of these are passed across the corpus callosum and are held also in the left brain. When the hemispheres are surgically separated or when because of lesion or injury the right brain is no longer able to supply the speech areas with its richer percept-representations, it is these attenuated left-hemispheric percepts that are mobilized and used for word-percept linkage. Accordingly, it is predicted that although the now isolated left brain retains its reflective capability, the quality and subtlety of its experience will be markedly diminished. So what we get is a reflectively aware but impoverished left side and a nonreflective and isolated right side, whose high-quality perception cannot be accessed. On the strength of what is known to have changed, the right brain is not in the position to be aware that it is nonreflective and isolated. Experimental findings support these predictions (Gazzaniga et al. 1992).

8. There is an important corollary to point 6 above. It is that the oscillations between members of asymmetric pairs of excitation form an arousal pattern. This pattern of arousal sustains itself by attending to the interactions that constitute it. This is the basis of the processing brain's perception of the processing.

9. Speaking and thinking are equivalent functions that are performed by the speech areas of the brain. These motor functions use words to activate percepts (semantic objects), which they sequentially align and then communicate. The mechanism that does this is language, whether vocal or signed. Electrodes attached to respective organs of speech (for example,

"throat" for its vocal and "fingers" for its signed variant) confirm that one and the same neural operation is responsible. In view of this equivalence of speaking and thinking, the combined term of *speech-thought* will be used to designate the underlying function. The suggestion that thinking is inner speech (even if truncated) may raise eyebrows. This is hardly surprising. "Thought" and "thinking" are loose terms, and tend to be taken as synonymous with having mental contents, that is, the colors, images, and feelings that all brains continuously totalize. To call these contents "thinking" or "thought," rather than what they are, which is just "experiencing," is wasteful and inaccurate. Thinking is the active handling of contents rather than just the having of them. When we speak or think we mobilize and actively process percepts, and we use the identical mechanism for the job. Underscoring this functional identity, Bickerton (1994) concludes that: "the same biological mechanisms, developed by and for language, run both distinctively human thought and language."

10. Since reflective consciousness makes possible the cognitive penetration of the world and of the self that penetrates it, complex questions arise about the system's relationship to itself. This creates epistemological predicaments, which relate to the system's identity, internal logic, and competence. They challenge the conscious mind and create seemingly insurmountable circularities. These may lead to the doubting of the mind-boosted brain's adequacy to decode itself. However, if we think of the computer adage of "garbage in, garbage out," we can recognize that it is the "software" rather than the "hardware" that impedes the human brain's self-clarification. In any case, as the mind-boosted brain is able to supply itself with increasingly valid models of its workings, the odds are that the correct solution will be found in the end.

Although these reflections may seem somewhat abstract, the text will provide them with concrete underpinnings. I leave the precise detailing of the *mind-system* to chapter 7, while in the interim, the terms "consciousness" and "mind" will be avoided. The terms *reflective awareness* for the former and *mind-equipped brain* for the latter will be used instead. These have precise physical referents and will help to eliminate the many ambiguities in the domain.

The book shows how language and reflective awareness evolved, what the "mind-system" is, and how it generates choice for the brain. It shows how it runs up alternative action schemata, which it can abort or implement in line with what it senses to be consistent with the organism's needs and intentions. This "free-will" function is consistent with determinism

and is an expression of the living system's complexity, that is, its thermodynamic depth. It is through this that the human organism is able to co-determine outcomes and achieve optimal adaptation. The model explains why the conscious mind is a mystery to itself and why introspection is unable to penetrate the problem. It details the mechanisms that are responsible for generating our intrapsychic experience and for the illusions about ourselves our functioning engenders. The demonstration of how self-deception is taking place, and what neural mechanisms underpin it, enables us to reassess ourselves and our biospheric situation.

The mind system that does this decoding is a biophysical entity, one that upgrades, indeed system-shifts the brain's functioning, conferring on it unprecedented new capabilities.

Let me restate the plan. It is to design a model that shows how the living brain, the "enchanted loom" (Sherrington 1906) perceives, behaves, and experiences the way it does. The expectation is that finding the formula that directs the machinery will also tell us what to make of ourselves and of the puzzling side effects the conscious brain continuously engenders.

1 The Emergence of the Human Brain

A nice dilemma we have here
That calls for all our wit
And at this stage it don't appear
That we can settle it.
—W. S. Gilbert, *Trial by Jury*

A The Upgrading of the Prehuman Brain

It is impossible to say whether we speak the way we do because of these facilitatory circumstances, or whether these circumstances have developed during evolution in response to natural selection pressures. Does the ass who makes noises with his inspiration and expiration, "ee–aa–," so efficiently because nature has given him the organ with which to do it, or did it happen the other way around? Perhaps we had better not pursue the problem.
—E. H. Lenneberg (1967), *The Biological Foundations of Language*

The self-aware human brain is unique. It generates in us the image of the world and the experience of our having this image. It is not clear how this is done, but we have reason to believe that language lies at the heart of the matter. Let us therefore ignore Lenneberg's advice and get inside "the chicken and egg" circularity, and find out how it all began.

Starting with the brain's developmental background, we must try to identify qualitative changes (changes in design) as distinct from the overall expansion of the hominid brain. In particular, we must look for functional patterns that may have evolutionary significance. We need to go back to the time that preceded the breakthrough to language and look for developments that might be identified as precursive of it. While the reference point is necessarily vague, it can be said that by the late Pliocene or early Pleistocene period hominid evolution had reached a transitional stage. Certain crucial parameters were about to begin their accelerating ascent, in particular, such traits as upright posture, bipedal locomotion, and

increases in brain size. The absolute brain mass increased to 500 grams and cerebral hemispheric specialization and the left-temporal bulge (Broca's area) in the neocortex made their appearance. The figure of 500 grams, if we consider the relatively small body size of the hominids, compares rather favorably with the chimpanzee's and the gorilla's corresponding brain–body ratio.

Let us see now what these data can mean and how the characteristics they represent might have led to a pattern of accelerating functional excellence. The issues and matters relating to them will be examined under three main headings:

1. Shift to Bipedalism
2. Hemispheric Specialization
3. Brain Capacity and Organization

The examination of these characteristics and their continuous upgrading will point to functional breakthroughs and a resultant evolutionary quantum leap.

1 The Shift to Bipedalism

The shift to bipedalism meant the relegation of the task of locomotion to the hindquarters and the freeing of the front limbs for new and specialized operations. It was this development that enabled protohumans to fashion and use implements. This created a selective evolutionary pressure for increased cortical representation of the specializing body parts. For example, the expanded cortical representation of the hands improved the competence for manipulative skills and upgraded the neurosomatic interplay upon which higher grade functioning depends.

Another consequence of bipedalism was a change in lifestyle. In their arboreal habitat protohumans were able to pursue their herbivorous tedium in relative safety. The descent from this habitat meant that protohumans had to cope with a substantially more challenging and competitive milieu. This milieu was populated by a sizeable company of species that was better equipped to face up to the contingencies of the terrain. Consequently, the somewhat undersized hominids must have found themselves outclassed, outfought, and outrun. These circumstances necessitated that they form cooperative teams or packs, whose effectiveness had to depend on coordinated action. However—and this is a crucial point—since the neurosomatic equipment for carrying out such cooperative operations could no longer be furnished by instinctual behavior, coping skills had to be acquired through imitation and learning. The neocortical char-

acter of such skill-acquisitions and of programs for their behavioral implementation was therefore bound to be a selection factor for cortical excellence. This excellence alone was able to guarantee success and to further deepen the organism's reliance on cerebrally weighted behavioral techniques.

Yet another consequence of the competitive and changing milieu was the increased role of neoteny in the gene pool. Neotenous regression, the tendency to start out postuterine life in a less mature form than did earlier members of the species, leads to increasingly vestigialized instinctual equipment. Thus the neoteneously regressed brain of the newborn is less completely wired for predetermined skills. This leaves postnatal learning to play the major part in establishing the organism's survival and coping techniques. Gould (1977) puts it this way:

> Animals become too committed to the peculiarities of their environment by evolving a complex fine-tuned design for a highly specific mode of life. They sacrifice plasticity for future change. Neoteny can now come to the rescue and provide an escape from specialization. Animals can slough off their highly specialized adult forms, return to the lability of youth and prepare themselves for new evolutionary directions.

This implies that there was a genetic component in the lengthening of the period of dependent learning and in the socialization and group-integration of the young. Since, however, there already was a selection premium on cortically based adaptation, a deviation-amplifying pattern of interacting traits is indicated. That is to say, a selective preference for certain traits that deviate from the population norm and whose joint deviation increasingly accentuates their advantageous nature (e.g., manual dexterity and encephalization). This is in line with Maruyama's (1963) evolutionary model, in which certain traits begin to interdepend and form a tightly interlocked front of coadvancement. In this, the mutually enhancing interaction effects combine to form the selection premium that benefits all individuals who function in accord with the pattern. This suggests the way in which the neotenous trend may have become increasingly feasible and decisive in making behavior neocortically determined.

The change from the herbivorous arboreal lifestyle to the rough and tumble of the omnivorous group-based behavior pattern also had to involve a corresponding shift of balance in the sympathicoadrenal hormones that underlie these modes of adjustment. This hormonal shift, together with neoteny and the group technique of survival, forms a pattern of

amplifying deviations. The herbivorous lifestyle, being predominantly defensive in character, had to be largely adrenalin based. By contrast, the group-based hunting context had to be more on the offensive and therefore more in need of noradrenalin hormone support.

The contrasting and behaviorally selective roles of these partially juxtaposed hormones have been receiving increasing attention. To sum up the findings, I quote from an article in the *Encyclopaedia Britannica* (1977):

> It has been shown that people who exhibit fear react by secreting adrenalin. When they manifest anger or hostility they produce noradrenalin. This is supported by findings that the adrenal glands of aggressive predators such as dogs and cats contain noradrenalin while the fearful rabbits contain adrenalin.

It is of relevance that the shift from defense to attack, from adrenalin to noradrenalin as the predominant operational neurohormone is equally characteristic of the endocrine shift that accompanies neotenous regression. This holds good on the genotypic as well as on the phenotypic planes. For example, the young of any species tend to be more noradrenalin-fueled than their more mature confrères. To put this another way, infantilism and immaturity, or the disposition to "act out" rather than control and contain, is characteristically more noradrenalin dependent. Therefore the finding that the human infant, the young child, or indeed the adult psychopath, is noradrenalin disposed is not surprising.

As success and survival in the bipedal hunting context depended on an aggressive, assertive disposition, this gave neoteneously regressed individuals a selective advantage. This was bound to further accentuate the role of the neocortex in shaping and conducting behavior. The product of these selective developments was a creature that was as adaptable and flexible as it was resourceful and aggressive. It was admirably suited to cope with the hardships and challenges of an unstable environment.

While the climatic upheavals of the Pleistocene period, the ice ages and the intermittent spells of aridity and high precipitation, cannot be directly linked with the onset of bipedalism, their effects on survival had to be considerable. It can therefore be suggested that terrain-specific species with a lower adaptive capacity had to suffer more, while more evolved and versatile species might actually have gained ground and preeminence. This applies first and foremost to the hominids with their superior problem-solving ability, resourcefulness, and coping skills. In short they were clearly favored by circumstances that demanded precisely these characteristics for success and survival.

2 Hemispheric Specialization

Hemispheric specialization (sidedness) was an equally vital development in the evolution of the central nervous system and its functional organization. The earlier arrangement of bilateral symmetry in hominid brains worked with a high level of redundancy and the duplications were wasteful. This becomes even more apparent if we consider that either of the two hemispheres alone was just about adequate to serve the body and process the integrative and programmatic work.

The new arrangement, involving the selective lateralization and the asymmetric distribution of the various brain tasks, was a better division of neuronal labor. Even more important, it provided a better ground condition for the qualitative upgrading of the system as a whole. In addition to the shift to bipedalism and neoteny, these organizational changes created a vast new service sector in the brain. This was bound to accentuate the importance of all manipulative skills and precision motor processes based on eye–hand coordination. In the new setup, functional modifications involving cross-hemispheric interactions could, for the first time, become meaningful in character.

The left-temporal or vocal bulge is a feature that only humans (in Broca's area), the songbird, and the chimpanzee possess. However, in the songbird the structure seems to subserve only an audiomotor specialization for sound-pattern recognition and reproduction without further application in higher mental operations. In the chimpanzee the structure is insufficiently wired in with other cortical functions to create the high-grade interactions that form the neural basis of speech in humans.

Starting with *Australopithecus,* however, this structure begins to look promising, not because of improvements in the structure itself but because of the onset of brain lateralization, that is, the rearrangement that is the basis of new functional connections and emergent capabilities. Indeed, the reason why true speech did not evolve in *Australopithecus* is not that crucial components were missing but that there was too little neuroplasticity to wire in new and meaningful functions.

Developmentally *Australopithecus* was intermediate between apes and humans. In absolute terms their brains were slightly larger than those of chimpanzees, but since their bodies were much smaller their relative brain size constituted significant improvement over that of the ape. Most important, however, they enjoyed an advanced stage of lateralization (sidedness), being overwhelmingly right-handed and in just about the same proportions as can be found in human populations today. An examination of Australopithecine sites reveals that the types and patterns of injuries sustained

(probably in the course of intergroup skirmishes) shows a ratio of four to one in favor of the right hand as the leading side in weapon handling. This finding represents a degree of sidedness that is quite beyond any rudimentary preference in modern apes.

In light of all this it is probable that the hominid precursors of protohumans were already evolving the cerebral hemispheric organization needed for the wiring in of cortical processes for speech.

3 Brain Capacity and Organization

Brain complexity over and above that of brain capacity (volume) was also a vital factor in upgrading the brain. Although capacity alone could not account for qualitative changes in the brain's performance, it was an important codeterminant.

Numerical estimates are based on various assumptions and range between 10 and 100 billion cortical neurons in the modern human neocortex, and if we take the lower figure of 10 billion as a convenient figure, then about one tenth or 1.1 billion of these can be taken to be body-committed. These neurons are tied specifically to afferent and efferent processes, leading in and out of the cortex. This leaves something like 8.9 billion interneurons for internal processes and for communicating with other neurons in the system. The number of 1.1 billion body-committed neurons is fairly standard in the primate order. Just about this quantity of neurons is needed for the servicing of peripheral functions. Only what the cortex has at its disposal over and above this figure can be considered for internal elaborations and functional refinements.

From this point of view, the hominid type of more than passing interest to us is *Australopithecus,* whom we may take as the discernible baseline of accelerating hominization. Taking neuronal densities to be comparable, the brain of *Australopithecus*, with an estimated 3.5 billion interneurons over and above the body-committed ones, compares favorably with the 2 billion of the gorilla and the 2.4 billion of the chimpanzee. However, *Australopithecus* compares unfavorably with *Homo habilis* (East African tool-user, tool-maker protohuman) who had some 4.5 billion interneurons, and even more unfavorably with *Homo erectus*, the immediate precursor of *Homo sapiens*. *Homo erectus* had some 7.6 billion interneurons whereas modern humans have 8.9 billion at their disposal.

In terms of volume, *Australopithecus* had a brain of 500 cubic centimeters as against the gorilla's 450, *Homo habilis* had something like 700, *Homo erectus* 950 to 1,050, and *Homo sapiens* 1,350 cubic centimeters. A brain volume of about 750 cc has been estimated by Tobias (1971) and others to be

the minimum for some form of rudimentary speech behavior to commence. The figure of 750 cc corresponds to the brain volume of the one-year-old human infant, but it is also the estimated brain volume of the six-year-old *Homo erectus* child. The comparison permits the making of meaningful conjectures about the two subtypes' respective growth curves and developmental paths (see section B of chapter 2).

We need now to look at two important points that throw some light on the quantum leap of cortical evolution. First, neurons undergo large-scale postnatal branching development. Lenneberg (1967) notes that:

> The major change that evidently occurs during the expansion of the brain is the interconnection of cells. Processes grow out of the cell bodies, axons and dendrites and eventually form a dense network of interconnecting branches. In fact thousands of such offshoots per neuron make their appearance and complete the wiring up of the system.

This development takes place in response to demands for tasks to be performed. The extent of this collateral branching is therefore related to brain usage, offering something like a weighted advantage to the brain user. This can lead to quite sizeable and appreciable differences in practical brain effectiveness even if two brains had been equipotential at the outset.

Second, different cortical areas must be given qualitative weighting. The frontal lobes in particular merit extra attention. This very latest expansion of the neocortex has a quite special relationship with the other cortical areas but also with the brain stem, whose function as an excitatory powerhouse it is able to mobilize. Thus the frontal lobes alone possess neuronal links (by way of descending fibers) through which they can engage the arousal system and fire up the cortex as a whole. Moreover, they are able to do this without the need for body tonicity (as expressed by constant inflow of stimulating nerve impulses from the body).

Because of this special link between the frontal lobes and the arousal system the infrahuman brain's dependence on somatic conditions is circumvented. There is now an auto-excitatory facility, which the human brain is able to use at its own discretion. Besides the "online" processing of its stimulus to response throughput, it can switch to a purely internal "off-line" thinking mode. Thus the frontal lobes can induce the excitation they need for interneuronal (mental) operations and sustain the excitation by keeping the operation going. This is functional autonomy indeed, an evolutionary breakthrough of far-reaching consequences. With it the brain is able to direct its attention and to engage in consciously generated programming of behavior. These changes jointly ensure that the action compulsion of the

motor system can be checked and that newly available options can be considered for implementation. This ability to manage intracortical responses in lieu of just "acting out" is of real value, partly because it guarantees the production of high-quality programs, but more importantly because it is the protective frame in which the speech-thought[1] facility of protohumans was able to evolve, stabilize, and expand.

Therefore, brain weight, brain volume, or the number of neurons cannot by themselves account for the remarkable upgrading of our central nervous performance. Nor does the rather insignificant difference in the brain size of *Homo erectus* and *Homo sapiens* manage to convey the massive operational and organizational refinements that constitute the latter's advantage and superiority. The answer is in the rearrangements that support the brain's functional autonomy. These rearrangements form the new circuitry, the "off-line" language loop that is the basis of internal communication. This is made possible by neoteny. Thus, whereas *Homo erectus* reached the critical brain volume for speech at the age of six, the human infant reaches it at the age of one. This gives the latter optimal brain plasticity and neuronal branching potential for wiring up the left hemisphere's manipulo-spatial area for "verbal" percept handling (speech) before the original function, the physical handling of objects, could lay claim to the area. Supporting this "neural intrusion" hypothesis, Lenneberg (1967) observes that "The use of tools and the use of language demand very similar biologically given capacities" and that "Some earlier function seems to have been transformed to subserve communication."

B Modifications That Underlie Language

The problems that have to do with language and the way humans use language may well be so complicated that only models will tell us a little about what is going on.
—J. D. Cowan (1981), *Modelling or the Black Box Approach in the Understanding of the Nervous System*

Language plays a key role in human functioning. Its intimate links with the conscious mind cannot be doubted. The same neural transaction is responsible for both. The task is to design a model whose neural technicalities are the common source of language and mind. Such a model may be able to accomplish that which neither brain science, working on the micro-level with the neuron code, nor cognitive science, working on the macro-level with behavioral phenomena, manages to achieve. It should clarify how the human mind works, how language and mind are functionally related, and the neural transactions that generate both.

The work on the model must start with the uniquely human *dual* representation of referents, that is, objects of experience. This extraordinary evolutionary innovation demands continuous intracortical transactions between subaspects of internal events. It arose out of a brain that had become functionally asymmetric and in which exchanges between differently specialized subregions and semi-independent hemispheres had become normal routine.

It is an absolute prerequisite of language that every referent be represented by two percepts. The first is a primary or natural percept that is integrated by the brain into some form of modality representation such as vision, audition, or somatosensation. The second is a secondary or learned percept (a word) that stands for the primary. The two percepts are typically at corresponding cortical loci in the two hemispheres, with continuous interaction between them.

Communicational transactions can occur only when word replicas of original percept representations are available for the purpose. This is so because what is shared between communicants is never the original percept whose meaning is to be conveyed, but the mediating word replica of it. This could not be otherwise, for the primary percept in its modality (for example, the vision of a dog) cannot be uttered, whereas its word replica (the sound pattern *dog*) certainly can. This makes word replicas indispensable and their acquisition a necessity. Indeed, they are the only form of exchange coinage with which communications (inner and outer—thought and speech) can be transacted.

To be workable, language needs words (semantic units), and grammar (formal rules) for their delivery. The question of how these were generated is an important aspect of the overall problem and will be examined in chapters 3 and 8. This section merely enlarges on the significance of having words and on being able to reflect on them and on the functioning brain that does the reflecting.

It needs to be stressed that words play both a *semantic* and a *functional* role. The two are not easy to tell apart except when nonsense words are spoken. When that happens, the functional aspect alone carries speech, complies with grammar, and sustains the neural transactions involved. An example is Chomsky's "colorless green ideas sleep furiously."

The word's semantic role is straightforward enough. An initially neutral sound-pattern takes on and then corepresents the meaning of the word's primary (modality) companion. Consider the earlier example of the word *dog* representing the visual experience of a dog. It is clear that the word carrying the modality experience into the communicational transaction,

whether it be speech or thought, acts as a proxy. It allows the brain's modality experiences (its visions, auditions, and somatosensations) to be put into circulation, heard, received, then reconverted once more into modality experience by any receiving organism, be it the self or another. This is an important service to the organism in that through these means it has access to its own modality experience as well as to those of others.

Significant as the word's semantic role may be, its functional role is even more important. The word as neural excitation is one of the two pivotal components of a new interhemispheric transaction. This transaction changes the attentional routine and renders awareness reflective.

The change works as follows. In the infrahuman brain percepts are invariably bilateral twin excitations, that is, carbon copies of a referent. In the asymmetric human brain the original representation of the referent is restricted to the right hemisphere. The left-hemispheric twin is replaced by its symbolic substitute, the word. This is not unlike turning identical twins into fraternal ones. The result is that the dual attentional searchlights of the arousal system, designed to focus onto homotopic spots in the hemispheres, now target onto disparate pairs of primary and secondary percepts, that is, modality experiences and their word representations.

To manage the simultaneous handling of these now specialized sites, an accommodating attentional oscillation between them must take place. Underscoring this, Ornstein (1972) suggests that "There might be a rapid switching between the cerebral hemispheres" and that "this would involve concomitant alternating modes of thought." These "alternating modes of thought" involve the shifting of the attentional focus onto the referent's primary and secondary (denotative and connotative) aspects.

Since speaking and thinking are motor functions, they generate *proprioception*, the sensation of doing the deed just as it is taking place. As a consequence, when we speak or think, we *feel* that we are doing it; and since we are able to speak or think *about* this feeling as well, we manufacture continuous evidence of creating for ourselves our own intrapsychic experience. Without insight into the technicalities of this process and the way it feeds recursively into itself, the naive mind is unable to make sense of it. It thus cannot avoid projective pseudo-explanations.

In summary, the shift from hemispheric symmetry to asymmetry and the splitting of referents into modality experience and word standing for it necessitates attentional oscillations and a new interhemispheric percept-management routine. It also brings about new proprioception, which provides data for the brain about its own functioning. For this reason the functional aspect of the word is a vital component of the breakthrough to

self-accessibility, which is in turn the basis of reflective awareness and the human condition built upon it.

Little else is needed at this stage. It is enough to recognize that the dual (word plus percept) representation of referents (objects, experiences, etc.) is intimately tied up with our functional core and that it is the ins and outs of this intrapsychic "workshop" that the proposed model will try to depict. As we proceed, it will become increasingly apparent how it was possible for protohumans to begin functioning in the new way. Clearly, however, the shift to the higher (mental) mode of functioning, referred to by Monod (1972) as "a second creation," had to be of the order of an autocatalytic surge, a kind of quantum leap of the biological system.

C The Internal Representation of the Outside World

Perhaps some of the problems that worry us about such concepts as mind, body and consciousness, may resolve themselves if we examine how we have come to use them both during individual development and in evolution.
—J. Z. Young (1978), *Programs of the Brain*

Section A briefly alluded to the newly achieved functional autonomy of the cortex, while Section B referred to attentional rearrangements that language-based dual percept processing involves. These changes enable the brain to keep working on the "mental plane" without needing body tonus for the purpose. It is now free to focus and lock its attention onto its own doings and to draw on autonomic support as long as it is necessary. It can internally shift its priorities and manage its workload to concentrate on processing what is relevant to it. This stands in marked contrast with the situation of the prespeech brain. The latter was obliged to go on processing what was fed into it without being able to change the proceedings. The difference is significant.

When coming in contact with the environment the organism first dismantles the data, then reassembles them cortically. However, this reassembled model of the world is not a faithful representation. In Monod's (1972) words: "It is a meager and slanted image. A kind of résumé, where the emphasis of focus is exclusively on what is of special interest to the animal in view of its specific behaviour." This means that what we are responding to, and what we take to be the representation of the outside world, is in fact a weighted and redrawn version of it. Yet it is equally true to say that it is precisely this sort of transformation of the incoming data that enables the brain to draw up and implement appropriate motor programs for coping with it.

This raises two technical points of processing. First, at the locus of its cortical representation a percept is a marked bioelectric disturbance that confers upon the percept considerable "contour clarity." This contour clarity is the product of what is called "surround inhibition." Its function is to dampen potentially disturbing "noise effects" in the immediate vicinity of significant percepts. The mechanism is important because it enables the cortex to highlight relevant aspects of the field. For example, the image of a large predator ready to pounce stands out distinctly, well protected from adjacent blur and interference.

This automatic highlighting propensity for the accentuation of featured percepts will be shown to play an important part in the cross-hemispheric interplay that links the primary percept and its word replica. Which percepts qualify for highlighting? Here again there is a shift away from instinctual determination in favor of acquired criteria of relevance. Thus, humans are free to highlight whatever they want. With their functionally autonomous cortex they can focus and lock onto just about any feature of their ongoing experience.

The second technical point is this: the neuroelectric disturbance (the brain excitation) that the highlighted percept creates automatically locks in the attention of the organism. This remains locked in until motor adjustments change the organism's position vis-à-vis the referent and the latter's percept-representation fades or is replaced. By dealing with highlighted percepts (i.e., speaking or thinking), the brain can secure for the process continuous attentional focus. Speech and thought are therefore free to handle the world of experience because they have the arousal system to back up the activity. This is tantamount to unrestricted license for high-order cognition. It is also a near-complete reversal of roles. Previously the brain's task was to handle the body's problems as they arose. It now creates problems of its own, with which the body has no choice but to live. This picture is an oversimplification, but it illustrates the point that the balance has shifted and that the brain is now actively engaged in self-management and self-comprehension.

In summary, it is not the outside world but its modified and slanted internal representation to which we respond. We do this with a brain that takes an active and guiding hand in the process and in so doing further upgrades its competence and insight into itself. The neocortex, through the neural transaction of speech and thought, has created in us a unique processing facility. The external output of this processing facility is language. Its internal consequence is self-accessibility, the basis of the reflective mind.

The ins and outs of this development will make more and more sense as we decipher the pattern of intrapsychic functioning. In particular it will become increasingly clear that the pieces of the puzzle of language and mind do in fact fit and that the brain is able to crack its own code in spite of self-reference and seeming circularities. For as Bronowski (1977) observes:

> The logic of the mind differs from formal logic in its ability to overcome, indeed to exploit, the ambivalences of self-reference, so that they become the instruments of imagination and a higher plane of resolution.

2 Adaptive Changes for Speech and Thought

If we knew more about the origins of language we might be able to work out how the categories of mind and consciousness developed gradually.
—J. Z. Young (1978), *Programs of the Brain*

A Dual Excitation and the Oscillation of Attention

Language is such an intimate aspect of our thoughts and behaviour that it is difficult for us to obtain an appreciation of its mechanisms.
—E. H. Lenneberg (1967), *The Biological Foundations of Language*

The dual (perceptual plus verbal) representation of referents is unique. It is therefore important to start by outlining the technicalities of the word-percept linkage and to indicate its intrapsychic consequences. These relate to the hemispheric asymmetry that enabled dual representations to evolve. Asymmetric excitations force the arousal system's twin attentional searchlights to cope with a new task: the simultaneous processing of disparate albeit related inputs.

Before the inception of language all excitations were hemispherically symmetrical. Hemispheric asymmetry calls for a new adaptation. This adaptation has to be able to attend to both aspects of the asymmetry and to achieve the integrated totalization of the disparities. In short, word and percept must be as one and the meaning they share must be stable.

The mechanism that can satisfy these requirements is *attentional oscillation* between the inputs. This transaction is led and controlled by the motor areas of speech in the brain. The speech activity creates proprioception: the feeling of doing it. This experience now becomes an integral part of the human endogram, the brain's situational statement of what we are aware of at any given time. Thus, the human brain's new way of coping with hemispherically different inputs creates in its self-representation the added experience of its so doing.

We shall now take a closer look at attentional oscillation to see how it accounts for characteristic phenomena of human cognition. This will bring us nearer to an understanding of the mind, the intrapsychic workshop that renders the endogram aware of itself.

Pioneering "split-brain" experiments by Sperry (1966) and others have shown that in human beings meaningful perceiving of patterns such as faces, objects, and the like is mostly right-hemispheric. The right hemisphere of the brain has by far the closer links with subcortical centers of emotional integration, that is, with the primitive experiential core over which the cerebral hemispheres have built their superstructure of elaborations. Thus it is the right or recessive hemisphere that more resembles the primate brain and is the richer source of integrated modality experiences. In the human brain these visual, auditory, and somatosensory percepts can be word-linked and internally manipulated. The linchpin of the interhemispheric speech transaction is the left or dominant hemisphere's motor facility. While the recessive side furnishes the modality experience (the primary percept of vision, audition, etc.), it is the dominant side that supplies the secondary percept, the word, that represents it and synchronously interacts with it. The two hemispheres come to the party in their specialized ways and are equally able to bring all the referents to the focus of attentional oscillation.

What we have just discussed is the establishment of an associative action bond and a mutually evocative relationship between them. To activate it one only needs to utter the word that means the thing or, conversely, to experience the thing, say, visually, that signifies the word. The two represent each other quite specifically. The dominant hemispheric word-utterance is a reflexive reiteration of the percept, that is, an echo-response to it. The echo-response (the word) occurs almost simultaneously with the percept that triggers it. Word and percept are thus mutually excitatory and equally able to elicit each other. While the technicalities of this echo-responding are simple enough, its consequences are far reaching. The creation of an interplay between percept and word is an important source of the brain's experience of itself.

To illustrate the changes that were generated by the interplay we need to look at the ground conditions from which it evolved. On the infrahuman plane attentional oscillations were neither possible nor needed. There were no hemispherically disparate inputs to integrate and the arousal system's dual attentional searchlights turned onto twin excitations, one in each hemisphere. After a brief moment's fixation the attention was released and a motor response followed. This freed the system to search for and lock onto a new stimulus.

As we turn to the asymmetric human brain we find that the processing format is changed. The arousal system's attentional searchlights lock onto paired inputs that are no longer identical twins but disparate targets, that is, percepts and words. Additionally, one of these, the word, is also motor-wired and responds by triggering its percept-companion anew. This sets the attentional searchlights into a stable oscillation between the inputs, permitting their integration and giving the brain the experience of the accompanying proprioception and of the volitional control that goes with it.

Let us now look at the attentional oscillation itself and the prolonged duration of meaning resulting from it. In the dual-representational layout of the human brain, the attention—first caught, say, by a visual percept—has a secondary or phonemic percept (a word) to switch to. Moreover, it can do this before the experience of the visual primary could have faded. The switching itself is accomplished without losing the shared meaning-content. This is possible because the reflexive word-response to the original visual percept is delayed only by the time needed for its evocation. The time lag allows the word-percept to take over and hold the attention even while the visual excitation begins to fade. Since, however, the two percepts are in a mutually excitatory relationship, the word (now holding the attention) reelicits the visual percept, and does this just before it itself begins to fade. This switches the attention back to the primary, and the cycle of to-and-fro oscillations can proceed without a break. In this manner the two synchronized excitations are able to keep up the alternating reexcitatory sequence. They can rapidly swap the attentional focus between the two alternating—yet in a technical sense novel—events. These events are technically novel in that they are newly focused on at every turn. Therefore they can repeatedly draw on fresh arousal energy.

During the transactions of the interplay the attention is held firmly by the interacting pair participating in it. It is neither the individual percept nor the individual word that commands the attention, but the interlocked pair of a mutually evocative percept and word. The distinction highlights the fact that it is the interplay itself that is attention binding rather than the content featured in it. It is possible to hold the attention with gibberish and to carry the interplay even with nonsense material. This provides evidence that it is the new brain transaction, the interhemispheric juggling of percepts, that is responsible for maintaining the reflectively aware state.

Attentional oscillation as a neural device for integrating hemispherically disparate inputs is not a new idea. Ornstein (1972) observed that "Rapid switchings of attention between alternating modes of thought may be occurring." Guiard (1980)—confirming asymmetry's role—noted that "Although

functionally complementary, denotation and connotation are hemispherically separated aspects of the integrated language process," while Kinsbourne (1978) concluded that "The logic of symmetrically attending to asymmetric disparate excitations all but demands something like an oscillation paradigm."

The oscillation of the attention between percept and word is a familiar experience. It is also clear that prolonging the oscillation will hold the attention onto selected percepts and increase the brain's exposure to their meaning. Needless to say, the naive brain is in no position to realize that its steady experience of continuous awareness is only a stream of overlapping yet discrete occurrences. The brain does not know that:

- it is the continuous shifting of the attention between the hemispheres that prevents the rapid loss of meaning through fading and replacement;
- it is the oscillation of the attention that frees the brain from having to react purely on impulse; and
- it is this mechanism that circumvents the stimulus-bound and response-compulsive condition that delimited even the most advanced of the pre-speech hominids.

We can evaluate these modifications in light of their consequences for human cognition and intrapsychic freedom. To do this, it is necessary to outline the primate's functional baseline and to indicate the qualitative changes the breakthrough to language (the means of self-accessing) has created.

The infrahuman processing scenario may be sketched as follows. A given percept arouses the organism by locking in its attention. This primes it for a near-instantaneous motor response. The performance of this response modifies the organism's situation and this modification is fed back as data; that is, it is flashed onto the endogram as the updated version of the earlier percept. This indicates the effectiveness of the action taken and furnishes clues for the next move. In this fashion the cycle is carried forward continuously. Percepts bring on arousal, attention, and motor response in turn. This uninterrupted circular sequence depicts the infrahuman organism as an elaborate percept-and-response, making "ham" in a tightly packed input-output "sandwich." The essential point is that this sequence cannot be interrupted. On the infrahuman plane there are simply no facilities for bringing about self-induced deliberate interruptions.

On the human plane this is no longer the case. It is possible to build up and elaborate the "ham" phase by means of language. Language is able to manipulate the intrapsychic experience and change the endogram without bringing on a motor action as well.

The human brain's language-based self-accessibility should, however, not be taken to imply that it is free of biological constraints. It would be wrong to infer that conscious (mental) processes have acquired some form of extraterritoriality and are no longer accountable to the organism. Although self-accessibility and mental processing involve an attentional holding mode that inhibits response compulsion, there is no break with the fundamental processing conditions of the organism. To quote Edelman (1992): "Such a view of attention still concedes the major overriding significance to non-conscious mechanisms and to the orienting behaviours mediated by global mappings in response to emergencies." In other words, the motor system is always reengaged, and in spite of impressions to the contrary the "off-line" "ham" phase can be shown to have subserved the organism even if covertly. Although the self-aware state is highly sophisticated, self-guided interference with the endogram is no more than a technical elaboration of the processing equipment, that is, a physical circumstance. The physicality of these qualitative changes leading to the reflective capability must therefore be accounted for in concrete terms. Far from leaving these matters to religion and philosophy, an intrasystemic causal description of the human brain's processing layout should be sought.

It is now necessary to turn to the four pivotal components of the speech operation whose interaction defines and sustains the brain's self-accessibility.

B The Building Blocks of Language

First man invented writing; then he invented reading so that he would be able to read what he wrote.
—Anecdotal source

In its fully developed form language works as a tightly integrated single facility. In this section we shall take it apart and examine the interacting components individually. We identify:

1. The primary percepts (the integrated modality experiences)
2. The secondary percepts (the words that represent them)
3. The cortical interplay (linking the above)
4. The group context (their nurturing medium and formative mold).

The correct characterization of these determinants and the manner in which they interact is a prerequisite for understanding the mind code and the technicalities that sustain it.

1 Primary Percepts

Primary percepts are stabilized modality experiences (visual, auditory, or somatosensory) to which words may be linked, and whose meaning these word companions thereafter share and corepresent.

It is important to emphasize that, in spite of impressions to the contrary, words cannot refer to objects or events directly. They refer only to their perceptually integrated modality representations that are themselves internally assembled. It follows that our experience of the world is mediated and indirect, and that our thinking about both inner and outer reality is constrained by the manner in which our brain works. This seems intuitively implausible. We feel unrestricted by and independent of the processes that render us the world of our experience, very much as if we stood outside the field in which we are in fact embedded. These impressions of extraterritoriality can be accounted for, though only in terms of the technicalities that underlie the language operation and the reflectively aware state that the newly evolved cross-cortical interactions create and maintain.

In section A primary percepts were characterized as modality experiences integrated by the recessive right hemisphere. To this we have to add that they are almost invariably complex. They are comprised of many features, such as texture, color, and shape, as well as cross-modality elements. Nevertheless, they are bound together by the brain and treated by it as single entities. For example: "faces," "motor cars," or "dogs" are percept entities whose features are held together and are held invariant by the brain's *constancy mechanism*. This mechanism automatically computes all transformations (e.g., the turning of a face) so that the transform is still recognized as the same entity. While the constancy mechanism was already well developed much below the human level on the evolutionary scale, its stabilizing effects are further enhanced by cross-hemispheric word linkage. This linkage of percepts and words gives them additional permanence and stable identity.

2 Secondary Percepts

Secondary percepts (words) are initially neutral phonemic patterns. They occupy the left-hemispheric locus of what used to be bilaterally identical primary percept excitations. Because of the shift to asymmetry in the human brain, this mirror-image duplication of primary percepts no longer exists. The recessive right hemisphere alone carries the primary percept while the dominant left pairs it with a word that represents it. However, the speech area of the motor cortex is able to manipulate the word, and this

elicits the percept that is being signified. Therefore an interplay between the two is triggered and the attention begins to oscillate, as already discussed. Since percept and word mutually excite one another, the interplay can be sustained with ease for as long as the brain requires it. Thus, thanks to the motor mechanism that allows the brain to handle words and to marshal and organize them in the sentence form, it is possible to fashion and convey intrapsychic meaning to others through *speech* and to oneself in *thought*. We think or speak *about* primary percepts (visions, somatosensations, etc.), but we think or speak *with* secondary percepts (words). Only words can be uttered, and it is through them that modality experiences can be accessed and circulated in speech and thought.

The key role of the secondary percept (the word) in the brain's handling of its percept repertoire raises the issue of the word's evocative power. If this were not at least closely comparable to the power of the primary percept, their interaction would not be stable and sustainable. Since, however, imaging techniques and other bioelectric data confirm that the evocative potential of words is of the order of 90 percent of primary percepts, we can conclude that they are just about as stable, arousing, and real for the organism as are primary percepts. Thus we can safely assume that there is near equivalence between the evocative powers of sensorily integrated primary percepts and postnatally wired-in words representing them, and that the conditions for effective interplay between them is guaranteed.

3 The Cross-Cortical Interplay

The cross-cortical interplay is the functional frame in which primary and secondary percept-excitations and the induced attentional oscillations combine. During the interplay the speech-thought process guides the flow of meaning and shapes the reflection of this activity in the endogram. On the technical level the interplay is a juggling act of rapidly alternating inhibitions and excitations at homotopic sites. These are linked into functional pairs by the corpus callosum and carry segregated (denotative and connotative) aspects of word-percept pairs. It is the oscillation of the attention that integrates these aspects and achieves their unambiguous meaning. Underscoring the importance of the interplay for human cognition, the structure that carries it, that is, the corpus callosum, has been shown to be the fastest expanding feature of the evolving human brain.

Schematically the interplay can be represented as follows. If we take primary percept X with its meaning M, and secondary percept Y with the same meaning M, and if we take the bond between X and Y to be mutually evocative, then we can see that while the X and Y percepts keep reexciting

each other, their shared meaning M remains firmly locked into the attentional focus. This can be represented as M(X–Y–X–Y–X–Y–X– . . .), bearing in mind that the Xs and the Ys continually reevoke each other but also overlap as they rise and fall in the course of the interplay. The net result is a temporary reprieve from having to perform almost immediate and probably less than optimal motor responses. In short, the interplay circumvents the "online" action-compulsion and allows for the high-quality mental modifications of planning and execution.

The interplay is also the experiential source of syntax/grammar, the formalism that governs language delivery as distinct from the semantic contents the delivery handles. The interchangeability of words, the emergence of word-classes or categories, and the functional (or nonsemantic) role of the word make it possible to differentiate what is being communicated from the means of communication. Thus, the regularities that govern the marshaling of words can be perceived as a set of interlocking rules. These rules (as we shall show in chapter 8) represent the prototype of the formal system whose upgraded abstract derivatives (logic, mathematics, the computer, etc.) prove so useful in analyzing the inorganic world. However, it must be stressed that despite their computing powers they are not analogues of the mind-endowed brain, and that claims to this effect by cognitive science are without justification.

4 The Group Context

The group is the behavioral setting in which the neotenously regressed and neuroplastic brain of the human infant is able to develop its latent speech capability. Without the group and the exposure to language, the child could acquire neither speech nor internal communication (thought) and therefore reflective awareness. It would have no facility with which to access its brain and manage its contents. If the early neuroplastic period passes without exposure to speech, the potential is lost and later attempts to learn the skill prove futile. This shows that the skill is not inborn but has to be wired in. This process involves neural intrusion into and takeover of certain cortical motor-structures for the purpose (see section A of chapter 3).

The critical role of the group for individual language acquisition is clear. It is not clear, however, how the skill of language itself was able to evolve in the prespeech hominid context. Indeed, if an exposure to language is needed to acquire language, how could language itself evolve in the absence of the formative conditions essential for its evolution? Is this perhaps another instance of the "chicken-and-egg" conundrum?

To gain some insight into the problem of language evolution we shall look at protohumanity's puzzling paleolithic stagnation. Why, for example, was there a period of over 500,000 years during which *Homo erectus* with a brain volume of about 1000 cubic centimeters (i.e., much in excess of the critical threshold for speech) seems not to have advanced at all? Why did tool design stagnate and show no improvement when *Homo erectus* had enough neurons to allow for further development? How was this stagnation overcome? Finally, what does all this tell us about *Homo erectus*'s "language," and about the relationship between language and the group that used it?

To understand what was involved it is useful to compare curves of growth rates and cerebral maturation in anthropoid apes, hominids (such as *Homo erectus*), and humans. On the basis of such data Krantz (1961) advanced the hypothesis that the stagnation in tool design and in cognitive competence that could have overcome it was the result of *Homo erectus*'s reaching the critical 750 cc threshold only at around the age of six. This—argued Krantz—left the child with too little time for the language-assisted learning of skills after reaching the required brain capacity for the purpose. In other words, *Homo erectus* missed the cognitive bus; for by the time the young *Homo erectus* was ready to make use of language-assisted learning, little neuroplasticity and growth potential remained. Krantz concluded that subsequent neotenous regressions lowered the age at which the critical 750 cc threshold was reached, and this gradually increased the time available for the acquiring of language-assisted skills. The trend then culminated in *Homo sapiens*, whose children reach the critical threshold at the age of one, that is, at the time of optimal neuroplasticity for language acquisition.

While Krantz's reasoning makes sense, he does not link neotenous spurts with corresponding stages of language evolution. He thus fails to pinpoint the trigger mechanism that overcame the paleolithic stagnation. He emphasizes the brevity of language-assisted enculturation past the critical threshold but ignores the all-important formative effects of the period before it. This is a serious omission, for it makes nothing of the fact that by the time the young *Homo erectus* had reached the level for speech, his or her adaptive orientation, coping skills, and postnatal neural growth were just about fully tied up with non-speech-based motor practices and patterns of behavior. It is known that already established collateral arborizations (i.e., interconnected neural wiring) exert a strongly directive and constraining influence on all further growth, binding the organism to its wired-in ways. Thus it may be said that the six-year-old *Homo erectus* was

not only just about past the point of switching to some form of speech-assisted practice, but that the child was better off with already acquired motor skills. It is almost as if at this developmental level, the child's rudimentary protolinguistic capabilities had little to offer and could not compete with motor skills that had no symbolic overlay. In view of primary language development (see next chapter) and the inability of protolanguage (naming) to articulate and reason, this is hardly surprising.

By contrast, the human infant reaches the critical 750 cc threshold at the age of one, at a stage of very low sensorimotor competence, maturity, and cerebral committedness. The child reaches it at a time of almost complete dependence on the group, and at a time of optimal neuroplasticity and imprint-prone impressionability. These conditions are ideal for the laying in of collateral branchings in cortical areas with direct and indirect bearings on symbolic manipulations of the environment.

Underscoring the relevance of this stage in the child's cognitive adaptation, Ploog (1979) observed that "By crying and early modifications of crying they bring their caretakers close and thereby manipulate the environment through their activity." Through members of the group, language-based manipulation was able to become an effective tool and a superior mode of adjustment. In addition, since actively engaged cortical structures receive increased blood and oxygen supply, collateral arborization (dependent on such increments) was strongly facilitated. This had the result that language-based operations and interactions between the child and its support group grew more and more feasible and adjustmentally favored.

The above observations confirm that the wiring-up for language is a group-activated psychomotor option and not a genetically determined inevitability. It is a latent potentiality that is facilitated by neotenous regressions and needs to be fostered to become effective. Without exposure to language the potential stays dormant and the left hemisphere remains committed to manipulo-spatiality.

Resuming the inquiry, we can say that *Homo erectus*'s protracted paleolithic stagnation was due to neurodevelopmental tardiness and that *Homo sapiens*'s rapid advancement was caused by neotenously attained precocity. It should now be possible to identify the conditions that restarted, then accelerated the neotenous trend in *Homo erectus*, leading to the emergence of *Homo sapiens*. In particular, we should be able to decide whether the upgrading of psychomotor skills was the result of improved cortical wiring or vice versa. This is, of course, Lenneberg's query of whether it was the *ee-aa*-ing of the ass that facilitated the evolution of the organ, or whether it was

the evolution of the organ that facilitated the *ee-aa*-ing of the ass. As it is, the problem is misstated. Not causal alternatives, but mutually enhancing covariations of interacting traits were involved. This covariation was the critical factor in the breakthrough from protolanguage to language proper. In the next chapter I show how the exposure of the frontal lobes to a set of recallable protowords was bound to lead to the extraction of adjectives, adverbs, particles, and link words, and how the neural annexation of motor areas for their manipulation made articulated speech possible. This was the turning point, the acquisition of syntax, the means whereby the brain could handle its own contents, generating and experiencing it reflectively, "off-line." Bickerton (1994) writes: "What this reorganization did was to convert a stumbling, halting protolanguage into the superb and infinitely flexible instrument that all of us control today." Thus the coevolution of brain facilities with language development built an "off-line" circuitry modification that tipped the balance in favor of language-assisted learning. The pattern of reciprocal upgradings was bound to favor the precocious and create for them a selective advantage.

This takes us back to Maruyama's (1963) deviation-amplifying cybernetic model and to the positive feedback relationship between the covarying traits in it. It is not hard to see that, if successful, such a trait combination can lead to a rapid and assortative genetic segregation—a kind of forced drift—in which the pattern that represents the traits is the overriding criterion for selection. Maruyama's model is considered to be particularly relevant in accounting for sudden evolutionary advances, especially where plural skill-integrations are involved. Protohumanity's rapid changeover to a cultural and communicational mode of adjustment is a case in point.

Therefore it can be suggested that the paleolithic stagnation was finally overcome by an increasingly marked breeding advantage for those in the *Homo erectus* range who reached the critical 750 cc threshold first, that is, those whose precocity allowed them to take advantage of secondary language evolution, which was then making its appearance. This evolution involved the articulation of words and the "mental" handling of such problems as the design of tools.

The deviation pattern that provided the breeding advantage was comprised of traits such as eye–hand coordination-based manipulation, verbal (mental) handling of spatial relations, verbal articulation of named objects, attentional perseveration, and active speech-behavior. This winning hand represented a style of adjustment based on the group and the cultural mode of interaction, that is, language. This is the group's instrumentality

for controlling and stabilizing perceptions, attitudes, and behavior. Any deficiency or breakdown of communication between members of the group had to be a threat to the adjustment of both the individual and the group. Clearly, neither could function without a stable basis of communal validation and reinforcing insights.

As for the young, the group context is a veritable psycholinguistic humidicrib—a prescriptive formula for shaping the identity and mentality of the child, who is therefore unwittingly and unconsciously constrained. Nevertheless, the group context confers benefits upon the child. It allows it to partake in the manifold physical and mental advantages that the group's speech-based lifestyle guarantees.

How does language acquisition occur? We may take as an example the action-bound context of the chase, which involves potentially imprint-prone psychodynamics. This becomes particularly relevant at climactic moments when the quarry is cornered and may turn on its pursuers, or when bloodshed and danger are imminent. Under such conditions even simple reflexive vocal ejaculations (especially if uttered by lead individuals in the course of directing the fray) can acquire imprint-like permanence and a stable associative bond with the percept-object in attentional focus. Thus, for instance, an initially random piece of vocalization can assume quite special significance for the group and become a fixed representation of the specified object, intention, or action. In this case the phonemically stable secondary percept (the word) can come to stand for a primary percept (say, in the visual modality). A firm link is formed between the primary percept and its cross-cortical companion, the word. This in turn becomes a reliable and evocative signaling device, which is available for later use even outside the context of acquisition. It can be employed to reevoke, reexcite, and communally reexperience and share the emotional content of the memory. It is easy to see that such a practice of recall in a later, danger-free context could become an absorbing and addictive but also fruitful pastime. It was a pastime that many individuals could increasingly indulge in, a readily available naming game that provided a thrilling communal retroexcitation. It is also obvious that the practice was able to furnish a subtle cognitive tool for the mental reprocessing and upgrading of the rerun. Such a prototypical trial-and-error setting had to constitute a considerable advantage for the organism. It went well beyond the fun and the excitement the practice provided. A percept-replicating (naming) tradition thus begun could then hardly fail to undergo gradual expansion along almost predictable lines, with more than sufficient adaptive gain accruing to ensure its cultivation and continued selective advantage.

These observations indicate the manner in which the group interacted with the individual and provided the formative and practical setting for the thought-language transaction. However, what is demonstrated in subsequent chapters will make it increasingly clear that through its product, that is, language, the group is more than an ex-midwife of the infant speech-process and more than a nutrient for the continuing speech practice. It creates a vaguely sensed experiential riddle in its own right, that of the self-aware mind, in whose functional frame humans know that they know, yet cannot fathom the way of their knowing. The interdependent circularity between humans and their instrument of self-reflection is experiential data of sorts that seeps into the mythological fabric of the group identity and the collective mind.

We have seen that the four pivotal components of the speech paradigm—(1) the primary percept, (2) the secondary percept, (3) the cortical interplay, and (4) the group context—continuously interact and codetermine the thought-language practice at all stages. It is now time to reexamine the technicalities of the breakthrough to language-capability and to shed some light on the consequences and side effects such a drastic modification had to bring about.

It is important to understand what the new functional layout did for and to the organism that acquired it, and how it is bound to distort the framework of reality it is designed to process. It is certainly not hard to sense that some form of deceptive circularity involving the process of self-perception has entered the picture and that humans are caught up in the gearbox of their own comprehension. To remedy this opacity of insight, we shall uncover its source, determine what the mind really is, and free it from mythological overlay. This program—if successful—should allow the formation of new insights and the establishment of more appropriate criteria for perceiving the self and the physical continuum in which it is embedded.

3 The Evolution of Language

Evolution is the one agency in nature that creates new phenomena.
—J. Bronowski (1977), *A Sense of the Future*

A The Breakthrough to Protolanguage

No biological phenomenon is without antecedents. The question is: how obvious are the antecedents of the human capacity for language? It is my opinion that they are not in the least obvious.
—E. H. Lenneberg (1967), *The Biological Foundations of Language*

In this section we look for the antecedents of language. We examine the intracortical conditions that generated the word, stabilized the percept, and made their linkage possible. On the face of it, language has no "fossil records" to tell us about its evolution, but this impression is wrong. It can be shown that it has evolved in two distinct stages and that its structure is layered. This becomes apparent when—because of lesions or disease—the skill deteriorates and the layers are shed in the reverse order of acquisition, leaving the noun, the most primitive component, to be lost last. If its developmental stages are ignored, the manner of language acquisition cannot be explained.

Here we must briefly allude to anatomical changes in the larynx to put paid to the claim that the role of such changes was decisive. They did of course facilitate the process of articulation but were not responsible for language evolution as such. Donald (1991) puts it this way: "It is even more unlikely that the emergence of a high speed vocalization apparatus in the brain and vocal tract of an ape, or even of Erectus, in itself would have led to the invention of symbols or to speech." Quite the contrary—"Vocal skills would not have driven cognitive change. It would have followed or at least parallelled the fundamental change in the modeling intellect that made vocal skill useful."

To achieve a workable basis for language, two developments were essential:

- new motor connections in the *left* brain enabling *verbal pointing*; and
- new levels of *perceptual stability* in the *right* brain to have something invariant to point to.

Without these developments the cross-hemispheric word–percept interplay (the basis of language) would not have been possible. The task is to outline the neural breakthrough that created the word, stabilized the percept, and made their bond effective. I shall show that:

- language evolved in two distinct stages;
- the second stage was built out of the processing alterations that the first stage had created; and
- the structure of language and the differentiation of the perceptual processes that are reflected in it furnish evidence of this twofold genesis.

To create words (phonemic units) makes no sense without considering the job for which they are intended. Words are useful tools that are motor wired to bring on percepts. They can be uttered singly or serially organized, as in speech or thought. Words trigger the experience of a percept or a train of articulated percepts, as in a sentence, a paragraph, or a narrative sequence. It is the word that empowers the brain to dip into its store of stable images and to generate and communicate its experience. It is also the word whose utterance adds the proprioceptive sensation to the rich mix and makes the brain feel that *it* is its source.

Before the breakthrough that led to words and verbal pointing, the hominid brain was not able to handle itself internally. It had no neural facility for this job, and it could not sense that self-handling was an option. Its ground-state, animal awareness, was trapped in itself and could not know that it did not know. The breakthrough to an intermediate level of awareness—enabling protohumans to bring on single images with single words, but not yet to articulate as in language—was therefore not striven for. Nor was it achieved through improving vocalization. The special link between the stable sound pattern (a word) and a stable percept (the key to verbal pointing) could become established only when neotenous regression in the asymmetric brain of the human infant had reached a critical point and neural reorganization could begin.

To outline these changes it has to be understood that in the unwired brain of the human infant neural takeovers are possible. Precocious, fast-maturing structures can highjack and wire up for their own use brain areas

that are there for quite another purpose. In this manner the speech areas captured the prefrontal motor center that was designed to manage and control physical objects in the environment. The takeover of this facility in the left hemisphere gave Broca's area the motor arm to manage and control words (stable phonemic patterns), much as the displaced function used to manage and control physical objects. In this reassortment the task of physical object handling remained exclusively right-hemispheric, while the annexed left hemispheric structure specialized in the sister function of verbal object handling. Verbal and physical object manipulations are therefore related functions, a connection that is evident in the similarity and cognateness of speech and gesticulation.

As a result of the takeover of left-hemispheric manipulo-spatiality, there is now a motor link between percept and word. By uttering words the brain evokes percepts, maintains them in focus, and elicits *pari passu* the proprioception of the deed. The coordinated flashing on of percept and word in opposite hemispheres induces an attentional oscillation between them and a holding mode for the word-percept pair in focus. In summary, the new skill of verbal pointing (the focusing on percepts in inner space) generated:

- a fixation device for word-linked percepts;
- a recall capability for such percepts;
- an asymmetry of attention and an oscillation to integrate the disparate inputs;
- an altered and enlarged workload for the frontal lobes to scan (see section B); and
- an experienceable internal trace of the brain's own involvement in running itself.

This breakthrough to verbal pointing was, however, not enough to access the whole of the brain and to manage articulated trains of thought. Although the brain was able to evoke and lock onto individual percepts, it could not subject these to further treatment. It had no facility for modulation and organization.

To overcome this limitation a second breakthrough had to occur. I shall discuss this in the next section, showing how the second breakthrough was built on the first and articulated percept management (important for reflective awareness) was achieved. I shall show how the brain was able to generate new word categories by scanning its protopercepts (the nouns and verbs first stabilized) and how, with the adjectives, adverbs, relational words, and particles thus extracted, it was able to articulate and marshal them into meaningful sequences.

We can now leave the problem of how words were motor wired and turn to the question of percept stabilization in the right hemisphere. It will be remembered that if there was to be a workable cross-hemispheric word–percept bond, both sides of the interaction had to be able to come to the party. This means that both the word and the percept had to be configurationally stable, enduring, and ready to interact. On the word side these requirements could be met with ease. Phonemic patterns are simple to learn and hold invariant. In fact, Donald (1991) goes so far as to say that: "Our speech sounds are 'reified,' that is, heard as if they are objects or events. A word or a common phrase stands out from the other sounds of the environment in much the same way as visual objects stand out. In resolving a word the human auditory system achieves object constancy, much like vision or touch."

On the percept side the problem is more complicated. This is because prespeech perception is and was rather transient, insufficiently fragmented, and without fixed unit-like entities suitable for word bonding. The only aspect of perception that was promising for the purpose was the constancy mechanism (introduced in section B of the last chapter). Only the products of this mechanism have protracted stability and duration enough to enable phonemic marking of percepts (word bonding) to take place. Products of constancy were therefore the only kind of percept material that could at first be word-linked. This means that they provided the raw material from which the second stage of language evolution was built.

Perceptual constancy is a remarkable neural device. As was noted in the previous chapter, it computes all manner of transformations that objects in the focus of attention can undergo. It compensates for apparent changes in aspects such as size, shape, angle, twist, tilt, distance, or illumination, while the object is experienced as invariant. Thus moving objects, faces, or targets in motion can be held in focus and responded to as to an unchanging entity. In the human brain this degree of sustained permanence was a precondition for the linkup of percepts and words.

The percept material that was stabilized and word-linked is of interest to us as it constituted the protovocabulary upon which all further developments were based. As constancy was designed to integrate and maintain invariants, we find that the protovocabulary comprises complex whole-percept entities, depicting objects and actions, designated by nouns and verbs respectively. While this seems like a modest beginning, the skeletal material thus word-represented was a vital springboard for secondary neurolinguistic differentiation.

To have a word to cosignify a percept is in fact more than a simple accomplishment. It entails active participation in the crosscortical interplay, and this involves the exposure and the circulation of percepts under favorable attentional conditions. Thanks to verbal pointing (naming) the brain can dwell on percepts as long as it likes and recall them for contemplation. It can keep action compulsion at bay until—through mental trial and error—it comes up with a satisfactory response.

As a consequence of intensive and repeated exposure, word-linked percepts were bound to undergo a process of rapid overstabilization of form and content. The overlearning led to overfamiliarity and the further loss of perceptual transience. The spontaneity that characterizes primitive perception and the child's early, non-language-assisted experience was compromised, and an object-like fixedness of word-linked percepts was the result. Lorenz (1977) describes this process as "objectification," an excellent characterization of percepts that acquire a word companion. The percept is drawn into the processing tumult of the naming game, undergoes objectification, and qualifies for participation in language.

The objectified percept is in a sense a novel phenomenon. It belongs to a new class of hybridized entities that—though percept-like in their modality (visual, somatosensory, etc.)—are also constrained by corrective distortions. It is these distortions that render them fit for their new role as stable components of the cross-cortical interplay. The way these distortions work is well illustrated by the experimental neurosis paradigm. In this paradigm the experimental subject, a dog, learns to associate the figure of a circle with food reward and the figure of an ellipse with electric shock. Next, the circle presentations begin to be increasingly flattened to approximate the ellipse, while the ellipse presentations get gradually rounded out to approximate the circle. Neurotic breakdown occurs when the dog is unable to discriminate and decide whether the perceived figure is a circle or an ellipse. Of special interest to us is the dog's ability to keep seeing the increasingly deviant presentation figures as if they were the original circle and ellipse. It is able to do this by systematically correcting for perceived deviations, that is, by applying accommodating counterdistortions to shore up the deteriorating match. In this way it prolongs and preserves the functional integrity of the learned stimulus-to-response action sequence.

In the same way and for much the same reason of conserving response integrity, humans, too, perceive objects and events so that they fit in with acquired or learned class criteria. Incoming percept impressions are at once subjected to corrective distortions in a normative way. This is the mechanism for preserving word integrity and is the method we use to resist, suppress,

or modify ambiguous percept occurrences. For example, we tend to perceive the four-legged object we sit on either as a "chair" or as a "stool," depending on the presence or absence of the back rest component. A hypothetical hybrid type with very low back rest we lump into one or another of the categories, though not without some hesitation or bemusement, much as if we were obliged to think of the hybrid object either in terms of the class concept "chair" or the class concept "stool" and as if we had no choice but to see and categorize in preset ways. It also appears as if this presetness and object-like fixedness of our perceived world were a precondition of our symbolic (word-assisted) handling of it.

Indeed, these corrective distortions are essential for our functioning, in that they enable us to hold on to words and their denotative perceptual cores. It is these distortions that help us use the neural technique of percept handling and to resist being swamped by the spatiotemporal uniqueness of everything that is around us. To put it another way, our ability to access percepts with words brings about a cognitively stabilized representational field which—though distorted—allows us to speak and think.

The point can also be illustrated by what happens if there is inadequate percept stabilization, as in schizophrenic functioning. If this occurs, the link between word and modality percept is labile and what is being denoted is vague and ill focused. Schizophrenic word-percept units are hazy and unstable and often less than fit to deliver the informational goods and services that make the language transaction the marvelous instrumentality it is.

This section outlined the neural development that led to protolanguage. It indicated the kind of percept material (nouns and verbs) that was suitable for word linkage, and the accommodating distortions that their stable usage demanded. It described the intermediate or protostage of language evolution in terms of the functional changes it entailed and the developmental openings it made possible. It may be conjectured that the level of awareness that was generated by protolinguistic functioning was similar to the awareness of the speech-impaired who can name but cannot interconnect what is named. Thus protohumans may have been able to access the endogram to momentarily highlight a single aspect of it and to sense that they were doing this. However, they were unable to shape and guide their percepts. Finally, at the protolinguistic stage of hominid evolution, the endogram, the brain's representation of the world, was word-seeded but not yet interconnected, so that there were large areas and aspects of the world and of experience that could not be accessed and conveyed.

The effect of the language equipment upon its user is of interest. The perceptual changes so far touched on could not have disrupted the experiential

nexus between the environmental object and its cortical representation. On this simple level of functioning protohumans felt no discrepancy between percept representation and its environmental source. However, this changes as we shift to the secondary, and from the human point of view, more important, set of speech-induced perceptual modifications. On the secondary level we shall find vagueness of nexus and sometimes no nexus at all between the higher-order word percept and its *de facto* source. This vagueness leaves the brain with a sense of unease (see section C of this chapter). It is ironical that the evolution of the highest cognitive functions should be the inadvertent source of an experiential residue that resists accounting and invites projective pseudo-explanations.

B Secondary Language Evolution

Characterising human language by its construction, however, linguists constantly treat the atomic units in our speech, either the words themselves, or the concepts for which they stand, as if they already existed ready made and in advance of speech.
—J. Bronowski (1977), *A Sense of the Future*

In this section we examine the secondary set of developments that changed the naming routine (i.e., "verbal pointing") into articulated language. Rather than "atomic units" already there and well established "in advance of speech," we expect to find percept-induction and percept-genesis and the achievement of syntax to characterize this stage of language evolution.

To begin, it is necessary to understand what the primitive protolinguistic instrument was really like. We also need to assess whether protohumans were under adaptive pressure to keep upgrading it. If they were, we need to know why, just as we need to know what sort of changes were necessary for the upgrading of the protolanguage.

This task is straightforward. In spite of drastic neural rearrangements, the early language instrument could not have been more than a blunt and ambiguity-ridden device. The neural facility of perceptual constancy that was the source of the protovocabulary could not have created more than a limited stock of nouns and verbs. These stabilized representations of objects and actions were the stuff that constancy was able to furnish. They constituted a basic vocabulary of things like: *man, tree, bird, fire, dog*, or, on the action side of it: *eat, run, sleep, kill*. Clearly such a stock allows for no more than a terse, grammarless, and inarticulate "Tarzan talk" of the *man eat, dog, sleep* variety. It is also obvious that high-grade communicational requirements could not be met with this. Nouns and verbs can indicate

only skeletal outlines of messages. Additional aspects, such as qualifications or specifics of event, place, manner, and time, cannot even be considered. Without being able to ask *who, where, why, when, which, what*, or *how*, no fine tuning is possible, and true communication, that is, facsimile percept transshipment from one brain to another, is quite out of the question.

Nevertheless, the protoinstrument was a marked qualitative improvement on the *status quo ante* and an invaluable baseline for further upgrading. To quote Bickerton (1994): "Protolanguage enabled prehuman hominids to function more efficiently as prehuman hominids, but it didn't and couldn't make them human." All the same, the gains were sizeable: they were attentional fixation and internally guided focusing. More important, they assured collateral neural growth in the child's brain. This growth was the result of the brain's exposure to protolanguage and guaranteed the wiring in and the continuation of the practice. With regard to the course that was still to be traversed by this evolving practice, two points need to be underlined:

- If language were to be truly effective, it had to evolve the internal structures that could create high-quality percept transshipment with fine detail and articulation.
- The adaptive pressure to acquire such refinements could have arisen only after the initial laying down of a core vocabulary, in other words, only after the establishment of a protolanguage facility, however crude and ill articulated.

Indeed, without the neural and attentional rearrangements that were brought on by the primitive naming practice, the frontal lobes would not have had the opportunity to filter the accumulated perceptual raw material (see below) and to establish new varieties of internally generated primary percepts.

As the secondary linguistic structures represented a corrective response to the adaptive pressures in the protosetup, we need to ask: what does adaptive pressure on protospeech performance mean in real terms and how does it work in the context of primate perceptual processing? If language (the spoken phase of communication) is perceived as wedged in between the two nonverbal perceptual events, the coding and the decoding of the message, it should be easy to see what language is supposed to accomplish and what validating criteria and guidance conditions it must satisfy. Language undertakes to transship percept material (message) from one brain to another. Its aim is the accurate representation of the speaker's

nonverbal percept content in the listener's perception. Let us leave aside the fascinating problem of coding and decoding visual, auditory, and somatosensory stuff into sequentially ordered and modulated sound signals. Let us concentrate instead on the procedure that gives rise to, and then results from, the language phase proper.

Clearly, the speaker, even more than the listener, is privy to the actual nature of the evoked percept product. This is so because he or she, too, can hear and receive in full the message that is being communicated at that moment. It is the one the speaker is in the process of broadcasting. This creates a unique setup in which the speaker has a privileged side-by-side comparison of the initial message content that he or she wants to transship and the evoked percept image that is the product of this effort. To decide whether the speaker is succeeding nothing more is required than simple percept matching, that is, pattern comparison. Satisfaction results from a good fit; stress arises out of the frustration with a poor performance.

It is this process of pattern matching that is the validating criterion of the percept-copying efficiency of the language performance. The same process also exerted adaptive pressure on the crudely articulated protolinguistic instrument. Furthermore, it could have been only this that furnished the feedback guidance for the shaping of the emerging secondary linguistic structures. These had to be specifically suited for accurate percept reconstruction in the listener. There is no reason to assume that protohumans, saddled as they were with an incompletely articulated language instrument, did not sense and experience a fair deal of frustration with it, not unlike being in a foreign land, not being understood, and feeling the need to learn the tongue. Thus a selective pressure to seek out the means for the systematic improvement of this state of affairs was inevitable.

How exactly could such improvements have occurred? How could secondary linguistic structures evolve out of the developmental tangle? The starting point of the inquiry is the naming technique, that is, protolanguage. We must examine this not only as the instrument of communication for improved societal bonding and coping but also as the ground state for the next leap in intracortical "dexterity." Protolanguage was a useful reservoir of firmly stabilized and "objectificated" word-percept units. These units, as recallable elective input, formed a valuable source of internal differentiation. To explore this and to appreciate the changes involved we have to look at the primate's perceptual process. This may be characterized as a fluid, transient sequence, defined by sensory input and behavior in continuity (von Weizsacker's *Gestaltkreis*). The prespeech primate can be

thought of as having been carried along "mindlessly" embedded in the flow of the transient sequence and without the means to interrupt the flow or deliberately guide the process. Each moment's experiencing had to pass into irretrievable oblivion. The fleeting instance of cortical attention that could be paid to it during the all-too-brief transit was therefore insufficient to make an appreciable difference.

By contrast, the protohuman perceptual scenario presents a markedly different picture from that of the primate. The previously inexorable transience broken, many of its highlighted percept components stabilized, named, and stored, the processing layout became accessible to deliberate and internally activated, though not yet articulated, cortical procedures. For example, many percepts (those named) enjoyed ready recallability, recirculation, and scrutiny under highly favorable attentional conditions.

This setup was bound to bring about rather dramatic increments in frontal lobe involvement and workload. The frontal lobes are free of specific modality commitments. They scan, filter, extract, and store invariant aspects and recurring regularities. These, though embedded in the overall experience, can be detected, then extracted. In this fashion the frontal lobes generalize, summate, order, and organize patterns and programs to further the organism's ongoing adaptation. The change from the transient ephemeral throughput to a largely stable and recallable percept load was therefore a highly significant one. Thanks to it, protohumans found themselves in possession of something like an audiovisuo-somatosensory cassette bank of readily available fixed percept units. This bank was at their disposal to use and peruse at will. This circumstance could not fail to bring about enrichment and the upsurge of frontal-lobe involvement that generated syntax and made secondary language evolution possible. These changes must therefore be regarded as parental to articulated speech and the emergence of a predominantly language-based human evolution and cultural lifestyle.

As to the specifics of this unfolding, three points need to be emphasized:

- In this neurolinguistic upgrading only the stabilized (named) percept repertoire represents a new acquisition. All other features were part of the primate brain.
- The upgrading was possible because the brain was now able to supply percepts for recirculation, replacing oblivion as the immediate fate of percepts that passed through it.
- Frontal functioning did not need to be changed or adapted in any way. The new workload represented merely a quantitative change, in that more but not different material had to be gone through.

On the strength of the above considerations an interesting scenario of secondary language evolution emerges. The recirculation of the protopercepts led to the extraction of feature components that were embedded in them. Protopercepts (products of the constancy mechanism) were complex integrated assemblages, and could be broken up again into their original constituents. Frontal scanning could do this automatically so that the identification and segregation of the feature components were a natural outcome. Indeed, the many hundreds if not thousands of repeated exposures of protopercepts were bound to isolate and identify hidden feature classes such as color, contour, contrast, texture, form, angle, type of relation, relative position, mood, intent, manner of activity, style, and many more. These could now be labeled in their turn, generating and naming further subcategories and enriching the protovocabulary in the process.

It is not surprising that this happened, for just as population invariants can be extracted by scanning a sample of many, so invariant aspects embedded in single events can be isolated by repeatedly scanning a sample of one. The scanning of single events is particularly useful where relative shifts occur, as for example when salient data about a facial expression are detected, yielding informationally loaded superimpositions, such as changes in mood or intention, that can be judged against the basic pattern of a given face.

To give a combined answer to the double-barreled question of what the scannable aspects were and how they got themselves embedded in percepts in the first place, we can point to a set of feature detectors in the sensory cortex. It is their function to register these aspects that—articulating with one another—are synthesized by the brain on the highest level, so that they appear to us as coherent whole-percept entities. Describing the analytic (preliminary) phase of percept integration, Blakemore (1978) observes that:

> One present view of visual analysis is then that it proceeds as a selective extraction of component features, or points of high informational content on the complete retinal image. It is a decomposition of the visual scene. Not into any simple geometric description but into the coordinates of a feature space, whose many axes are inscribed in different and independent regions of the brain.

Percept integration reverses this decomposition. It synthesizes the feature components into percepts, which are object-like entities, ideally suited to link up with words. Human protovocabulary was just such a collection of complex nouns and verbs. By contrast, the secondary vocabulary consists

of labeled feature components and subcomponents, that is, products not of visual synthesis but of visual analysis. It is these labeled feature components that language uses as adjectives, adverbs, and articulating parts of speech.

The layout I have just described represents the two-stage model of language evolution. It is my thesis that secondary words and structures could not have evolved without, prior to, or even at the same time as the protomaterial of nouns and verbs. This is because the detection of features (i.e., their source) could begin only *after* the protomaterial was established and their scanning could commence. The thesis proposes that, just as nouns and verbs designate complex whole-percept entities (top-level products of perception), secondary words depict intermediate products, features that characterize its preliminary or analytic phase. Thus, through the scanning process that brings about feature detection, the brain penetrates the substrate of percept integration and enriches the protovocabulary with a comprehensive range of useful qualifiers. With its motor control of words it is then able to generate language, the articulated sequential delivery of word-linked percepts, feature components, and subcomponents. By arranging and modulating these, it generates syntax for them and achieves the verbal rendition of the modality experience (the message) it wishes to convey or contemplate (speak or think about).

An interesting and revealing consequence of how protowords and secondary words were generated can be seen in their differential level of concreteness and sensed reality. For example, while intuition tells us that there really is such a thing as a "man," a "dog," and a "tree" (whole percepts), it leaves us in doubt about the reality of a "red," a "sharp," a "fast," a "large," an "in," or an "about." These latter, or for that matter the entire secondary vocabulary, always have to belong to, to be contingent upon, attached to, carried by the protostuff of whole percepts, or else have to link, specify, or modulate these, almost, and quite appropriately, as if they existed in, about, or between the primary words. The relationship between the primary and secondary levels of language is not unlike that of the "Cheshire cat" and its "grin." There, too, a "cat" (protopercept) is needed, with further "cat exposures" (scanning) to isolate out those with the "grin" (the component feature) and finally the "grin" itself (the independent qualification). The sensed absurdity and incongruity of the qualification without the thing to be qualified, that is, the grin without the cat, is then no incidental or mere logical objection. It is an accurately intuited recognition of the perceptual infrastructure of language.

It is now possible to summarize the two-stage scenario of language evolution as a meaningful articulation of linguistic features with perceptual processes underpinning them. Specifically, we can say that:

- Naming, and its articulated form, language, uniquely depends upon high-grade word-percept stability. For each semantic unit the brain has to establish two excitations, one for the word and one for the percept, with a strong associative bond between them. The word side of this association is easy to maintain. By contrast, the percept side represents problems of fixity and containment. Contamination and indistinctness tend to jeopardize the workability of the bond and call for compensatory distortions to maintain the integrity of the percept.
- The stabilization and the locking in of percepts into word-linked semantic units parcels up the experiential field. This fragmentation of the world corresponds to its vocabulary coverage.
- Once these fragments (word-percept units) were established and the protophase (the naming skill) was operational, the brain's workload was drastically altered. The massive increase in frontal processing yielded subfeatures that had until then been undetectable in the percepts. The resulting clusters of segregated subfeatures could be perceived as invariant entities to be word-labeled and added to the expanding vocabulary reservoir.
- The genesis of secondary products of language evolution resulted in a second fragmentation. These new subcomponents could be used for fine-focusing the language instrument. They became the qualifiers, that is, the adjectives, the adverbs, the relational words, and the prepositions with which it was possible to modulate the protopercepts, nouns, and verbs and to link them in a narrative flow.
- The linguistic categories into which the secondary words have sorted themselves correspond to the foci of perceptual organization. This means that all the subfeatures that frontal scanning has taken out of complex whole percepts find expression in language and mirror the perceptual subprocesses that are integrated in experience.

The emerging pattern dovetails structure, function, perception, and language. It makes practical as well as theoretical sense. It justifies the impression that it is in the secondary material of language, scanned and fashioned by frontal processes, that humanity came upon its Aladdin's cave of communicational treasures. Humans acquired a language instrument that could generate syntax and maintain an articulated flow of unfolding imagery. Because of this find, the formerly unaskable questions of *why, when, where, who, which, what*, and *how* could be asked, and Tarzan talk was replaced

with articulated speech. Thus our human ability to fashion percepts and to shape an ongoing message delivery solved the problem of percept transshipment, achieved percept reproduction in the recipient, and made message delivery from speaker to hearer a rewarding and highly feasible practice.

An important point about primary and secondary words should now be emphasized. Although their respective geneses differ, once they are firmly bonded to whatever percept they represent, their functional fixedness and effectiveness is equivalent. Accordingly, just as the primary words of "man," "dog," or "tree" stand for the class of all men, dogs, and trees, so the secondary words of "red," "sharp," "fast," "between," "larger," or whatever now stand for the class of all such occurrences of red, sharp, fast, and so on. Both primary and secondary words possess firm denotative cores and draw on the percept-protective distortions noted in section A of this chapter. In short, regardless of origin, type, or manner of acquisition, the stability and the practical usefulness of all words at our disposal are conserved.

Evidence confirming the layered structure of language has already been alluded to at the beginning of this chapter: that the loss of function through degeneration is predictable. The system's undoing is the reverse of its original integration. Therefore, secondary structures and subtle articulations are lost first, while nouns in particular tend to be retained longest. The manner in which the expanded and enriched instrument is used for the fashioning of the ongoing speech delivery will be taken up in the next section.

C Using the Language Instrument

> So it is clear that manipulo-spatiality and language are complexly related. Manipulo-spatial abilities may have provided the basis of primitive language (object naming) and both language and manipulo-spatiality require similar neural mechanisms.
> —M. S. Gazzaniga and J. E. Le-Doux (1978), *The Integrated Mind*

Primitive naming is the technique of fixing and holding in focus some aspects of the environment. In this section it will be shown how secondary developments have boosted this technique to make it into language, that is, articulated guidance for the manipulation of the self and the environment. In evolutionary terms the development of language was rapid. Constituent aspects of it reinforced and enhanced each other, adding further momentum to their convergence. The progression is signposted by an increasing brain capacity, accelerating neotenous regression and a shift from

concrete to symbolic manipulation of the representational field. These led to protolanguage (primitive naming) and increasing frontality, culminating in articulated language. Yet the ever-increasing involvement of the frontal lobes in this development singles them out as being especially significant in the process of humanization. For instance, it may be argued that:

- The rather low-browed Neanderthal (whose brain size slightly exceeded that of *Homo sapiens*) was somewhat less efficient in frontal functioning (generalization, reasoning, etc.). *Sapiens*, whose takeover was probably cerebrally based, gained an ascendancy through frontal expansion relative to the rest of the cortex. This suggests a link between greater frontality, secondary (articulated) language development, and brain effectiveness. It also indicates that frontality became the dominant component among the positively interacting and mutually enhancing deviation traits that constituted humanity's evolutionary thrust.
- The examination of the frontally generated secondary vocabulary indicates that a nexus break between secondary words and their source occurred during the transition to the next stage of language evolution. This is to be expected, as these secondary words are internally induced products and cannot be unequivocally linked with or attributed to concrete and object-like referents in the environment. It is therefore likely that protohumans may have sensed that some of their words had no independent existence, that is, an existence without the agency of some object or action (noun or verb), much as if there could be no "grin" without the "Cheshire cat," no color without some object to display it, no quality of sharpness without something to possess it or be possessed by it, no largeness without a carrier of that trait, no "larger than" without objects related to one another in that manner, and so forth.

It is quite possible that this elusiveness and perplexing detachability was intuitively detected and unease arose about the nature of redness, sharpness, and fastness, that is, about aspects of experience that were not "things" but came and went, were possessed and lost, in an ephemeral and strange manner.

My thesis, that the modern language instrument evolved in two distinct stages with a clear demarcation between them, is, as we have seen, underscored by the predictably reverse order of its decomposition (Springer and Deutsch 1981). It is also supported in an anecdotal way by an interesting experience of Margaret Mead. In her autobiographical *Blackberry Winter* (1971), she says in passing:

But I began to show signs of fatigue from the effort of learning three new languages in so short a space of time. I would dream that I was standing outside a house asking politely whether I might come in, and no one would answer me. Then I would wake up and realize that in my dream speech only the nouns and verbs were in Tchambuli, I put in particles in Samoan.

One is of course tempted to wonder whether Mead's forced pace of multiple language learning had not momentarily unmasked the structural and ontogenetic distinctions between the primary and secondary stages of language. Can a weakened nexus between the secondary words and their twice removed environmental source lead to projective and arbitrary thinking? In light of the reflective awareness that forces humans to confront concepts such as death and danger, their latitude for projection can be seen as an advantage. It enables humans to invent comforting mythologies and to restore the primate's lost "Nirvana." They can feel safe again, surrounded and protected by their self-generated "explanatory" schemata.

Examples of such mind-generated schemata are plentiful. Systems of belief come to mind, but these tend to be left-hemispheric, conscious, and formalized, less deeply felt than schemata that are part of language itself and are felt to be "natural." As an example of such language-based schemata we may consider the Indo-European and the Semitic noun-gender systems. In these, all things real, imaginary, or abstract are perceived as belonging to one of two or three originally gender-linked ontological strands, as if these strands were immutable natural features of objective reality.

Another schema based on nexus break is the pair of the *yang* and *yin* (male and female) principles of Chinese cosmology. These ontological principles interpenetrate, commingle, and codefine all aspects and phenomena in the world, much as if these principles first created and then incarnated the whole of existence. If we enrich this format with the supplementary principles of *li* and *chi* (form and substance), which also partake in all phenomena, it becomes easy to appreciate that the schematizing brain has an inexhaustible projective latitude to "explain" anything and to subserve organismic interests.

However, the best preserved and detailed example to hand is the Bantu schema of the fourteen conceptual categories, based on common features such as "animate objects," "inanimate objects," "round things," "sharp things," "action-intentions," and the like. While the other examples are somewhat watered down with abstractions accumulated over time, the Bantu pattern is a remarkably stable relic. It shows clearly how the loose nexus between the secondary vocabulary and its twice removed source permits the genesis of conceptual structures that are subservient to and

expressions of societal projections. The fourteen categories, representing independent ontological classes and sources of causation, partake of and to varying degrees incarnate all events, objects, and occurrences everywhere and always. This means that the categories share the possession of and influence over the beings and things shared as if the categories were gods, forces, or determining principles. This is a mind-created superstructure that is anchored in language and articulates with the power-structure of the prevailing socioreligious order and magico-ritualistic practice. The latter provides the means for exercising some measure of control over the world and for rendering the individual less helpless.

Interesting and quaint as these pseudo-explanatory schemata are, they are relevant because they demonstrate the consequences of a loosened nexus between words and referents. They draw the attention to a murky region of projective potential, a soft inner core that has a sizeable bearing on human clarity of understanding and willingness to understand. It can then be claimed that the neurofunctional and neuropsychological changes that were responsible for protolanguage and for the secondary linguistic structures were also parental to the confusion that followed and the mythologies that try to explain it.

Let us now turn to the role of the secondary structures and to their integration into the language instrument, that is, to the part the secondary vocabulary plays in the syntax-enriched language operation. The way it was generated has already been discussed, so in this section we shall look at its deployment and practical use.

As mentioned above, the new words we are considering no longer represent complex whole percepts like objects and actions, but aspects, features, and qualities, fragmented bits that are meaningful constituents of whole percepts. In linguistic terms these bits are all the adjectives, adverbs, attributes, prepositions, particles, and relational words expressing conjunctions and disjunctions, comparisons, and all manner of imaginable markers to signify definitions in space and time, quality, and specificity. We have here the repertoire and equipment necessary for the effective reduction, articulation, and handling of the formerly unyielding percept chunks. Without this equipment no transshipment of percepts (communication) by way of the language medium could occur.

It is worth noting that just as the meaningful fragmentation of the percept chunks is a remarkable accomplishment, so is the reverse process of putting together the same percept material at the receiver's end. The key to human communicational efficiency is this high level of accurate complementarity between dismembering and reassembling of percepts, and the

corresponding coding into and decoding of the intervening language phase. Therefore the meaningful fragmentation of complex percepts is the essential precondition for rendering the percept material manageable and suitable for the sequential arrangement of the fragments. The fragmentation also carries the cues that govern the process of reassembling at the receiver's end. To quote Bickerton (1994):

> Syntax provides us with the host of structural clues that always suffices to tell us who did what and with which and to whom, clues that are provided automatically, indeed obligatorily by the abstract structures that the syntactic mechanism produces.

The spoken language is thus a kind of conveyor belt for the transportation from one individual to another of the material, together with the appended or incorporated cryptoform instructions for the decoding operation needed to complete the job.

The simple, nonarticulated protolinguistic manner of percept delivery (Tarzan talk) is then to be contrasted with the complex, highly articulated, and fully evolved speech performance. Thus the former, consisting only of unfragmented whole percepts (nouns and verbs), was unable to go beyond the bare positing of subject and predicate in a grammarless sequence of two words. This is because there was no mechanism with which to perform or contemplate performing such ordering. Thought, like speech, was limited and incapable of formulating the organism's intentions. Protolanguage was characterized by concrete congruence between primitive percepts and the words representing them. Words were mere sound-versions of percepts that could be uttered but could not be used to generate syntax and a flow of articulated meaning.

Before the fragmentation of percepts and secondary language development there could not have been a way around this limitation. However, past the watershed between protolanguage and language proper, a rapid change took place. Fragmentation occurred and started to supply the bits that were needed for articulation. As a result speech was able to evolve into more than a direct copy, or simple sequential sounding of the percept chunks that were experienced. It became a complex intracortical performance of managing percepts in inner space, able to convey meaning and generate programs for implementation. Summing up the transition, Bickerton (1994) observes that:

> The history of the hominid line appears accordingly as a two-stage process. First the stage in which there was a lexicon without syntax and then the stage in which infinitely productive mechanisms emerged to create syntax as we know it. If this

conclusion is correct, it is a waste of time to look for antecedents of syntax in ancestral species. Syntax could not have come into existence until there was a sizeable vocabulary whose units could be organized into complex structures. There seems no viable alternative to concluding that syntax has a specific neural substrate, laid down at some stage prior to the last 50 millennia, most probably at the time when anatomically modern humans emerged as a separate species.

By all indications, Bickerton's "neural substrate" was laid in by left-hemispheric manipulo-spatiality. This gave the brain the motor facility to handle its lexicon and to generate syntax by way of the internal (language) loop.

Let us now look at the modus operandi of the ongoing language performance. We have to understand how this complex delivery system, enriched by the secondary vocabulary, upgraded the scope and efficiency of the original protolanguage. It will be recalled that language is the bridging or transshipment phase between the percept content to be conveyed and the reconstructed replica of it. The purpose of the undertaking is the faithful high-quality reproduction of the speaker's message in the listener's perception. However, as was noted in section B of this chapter, speakers, like listeners, are able to hear the ongoing speech performance. They, too, are privy to the percept content they are trying to get across. They are in the unique position to observe the message side by side with its gradually unfolding reproduction and to do something about it "in flight." The layout is one of classical feedback with simultaneous comparisons and matching of the two percept entities, the original and the replica. Allowing that the tools for the effective modulation of the unfolding speech performance are available—and this is the case thanks to the secondary percept fragmentation—there is nothing to prevent the successful reconstruction of percepts. This is, in fact, taking place when speech or thought are in progress. The brain modulates and guides the unfolding production to meet the speaker's specifications and to re-create his or her percept experience. The ideal frame for this construction work is the sentence, the extended and articulated form of the percept. The sentence provides the space needed for the qualifying insertions that modify the noun and define its quality, activity, and context.

Being able to go beyond the mere ability to name, for example to call out the word "dog" and so to draw attention to it, the brain is now able to specify and identify many things about the dog, even in its absence. Thus the brain can convey whose dog it is, what sort of dog it is, what it is doing, where, why, and how, and with what result. The sentence frame is clearly ideal for achieving a good match between nonverbal (percept) experience

and its linguistic rendition. The procedure of adding a pinch or two of qualifying words to the semantic brew is the conventionalized formal routine of language. Language is the technique of accessing and verbally reproducing intrapsychic contents. If uttered in communication to others it is called speech; if it is rendered internally for one's own contemplation, it is called thought. Thanks to language and the motor control of percepts that it entails, the brain is able to access and manage its own contents and to impact its internally organized mental activity upon the inner canvas, the endogram. Furthermore, due to the proprioception of this activity, it also has the evidence that it itself is responsible for this self-experience.

Since the language performance is a creative improvisation on an ever-novel configuration of shifting conditions, the individual expresses a personal style and competence in verbal percept evocation. Individual differences are therefore inevitable. They testify to the uniquely creative character of the speech act and the novelty it invariably entails. Without the secondary language development this would not be the case. There could be no individual variability and latitude of choice in the mental handling of reality. Nor could reality be analyzed and modeled to reflect its underlying structure and causal connectedness. In short, without the secondary language development the brain could not have conquered its inner space, discovered itself in the process, and begun to think about itself and the world in which it evolved.

Taking the negative view, it is equally obvious that without the secondary development the brain would not be in the position to distort and to misuse reflective capability for the purpose of self-deception and comfort seeking.

D Language and the Limits of Abstraction

It should not be too surprising if the neural mechanisms that evolved for transacting business with the external world are not the mechanisms by which we conduct our mental life.
—M. S. Gazzaniga and J. E. Le-Doux (1978), *The Integrated Mind*

As we have seen, the cross-cortical interplay between percept and word is a new evolutionary acquisition. Moreover, it is one that does not compete with the organism's normal coping but operates side by side with it, using an internal loop. While this ensures functional freedom, it does not provide the organism with built-in facilities for evaluating its mental output. For this the brain has to evolve its own checks and balances. This is a dicey undertaking. It is easy to err, as there are no firm criteria. The problem is

that mere thinkability can be taken to mean that thoughts must have a truth-value of some description. Misrepresentations of this kind are rooted in a naive faith in language. They are of little moment in the concrete transactions of everyday life, but begin to take on significance as the nexus gap widens and complex issues are considered. Hence we need to look at the process of abstraction, this quintessential source of complexity, and to understand how it works and how it might enrich or deceive the organism.

To do this it is necessary to draw our findings into a preliminary perspective. We first saw how it was possible for protolanguage to emerge. We saw how certain contour-highlighted percepts were able to stand out in the primate's perceptual transience, aided as they were by the neural facility of perceptual constancy. We then saw how these percepts could be stabilized (objectificated) and how they were able to acquire cross-cortical representatives or words. We further saw how these now readily recallable fixed word-percept pairs could be subjected to frontal scanning in the normal course of routine functioning. We also noted that the frontal lobes—just by scanning and ordering the stabilized percept material of protolanguage—had to filter out all manner of embedded invariant aspects and thereby establish new, internally generated percepts. We observed that these in turn acquired their own labels and qualified for inclusion in the word-percept repertoire, thus enriching the language instrument in detail and articulating facility.

Just as protolanguage had created an inroad into the preexisting perceptual setup of the primate, so the functionally generated secondary stuff was creating a comparable inroad into the content fabric of the newly established and objectificated protopercepts themselves. The extraction products of this penetration, that is, the constituent bits of the protopercepts, were thereafter available for the articulation and fine-focusing of the language instrument. Furthermore, the nexus between the protowords and their environmental referents was stable and obvious, but this was no longer the case with the secondary words. With these internally laid-down word-percept pairs, the environmental nexus became somewhat tenuous and problematical, though still discernible after a fashion. This theme will become increasingly significant when we examine the functional changes yet to come, especially the genesis of "concepts," that is, attenuated and abstracted percepts with few or no modality characteristics. Indeed, as we take up the general class of abstractions we find that we must take the nexus question seriously.

Let us therefore begin by stressing that in purely technical terms the abstracting process does not call for new forms of neural functioning and

involves no more than a simple extension of the already well-established processes. This refers particularly to the scanning and extracting operations of the frontal lobes, which automatically scan out the embedded invariant features and regularities. As a result of this routine, additional percepts, somewhat attenuated in content and removed from the original items scanned, are extracted again and again from the perused material.

We need to remember that it was precisely in this fashion that the secondary vocabulary was extracted from the primary (the protowords) and that there is no reason why the extraction products themselves should not be subjected to the identical treatment in turn. It needs to be stressed, though, that ever higher-order products of frontal filtering are bound to be increasingly depleted of concrete content. They thus acquire ever greater generality and vagueness. Such a progression of escalating attenuations might at first seem infinitely regressive. That this is not so—and cannot be so—is a result of a very real constraint on the system, which limits the range of possible abstractions. The constraint itself is a function of the abstracting operation's biological relevance. Since overelaborated abstractions seldom serve adaptive ends, they cannot as a rule mobilize unlimited attentional support and energetic sustenance. This is further confirmation that the mind is a physical entity that cannot be indefinitely extended and made to subserve meaningless and unrewarding activities. This echoes Towers's (1978) observation: "The human brain and its thinking functions are basically trustworthy because they are rooted in biological evolution."

The limitation on the range of abstractions is interesting because the cortex, otherwise well placed to exercise a great deal of functional autonomy, cannot do this with impunity. Although the frontal lobes can activate the arousal system and draw support for cognitive processes, the license is clearly not open-ended. In spite of the excellence of the neural arrangements at the frontal lobes' disposal, the internal checks and balances of the system simply prevent the brain's indiscriminate nonadaptive application. Abstractions can have real value, especially in advanced discourse as in science and mathematics, and where they remain firmly anchored to their concrete substrate. As a rule, however, they are treated by the brain as suspect extensions of its processing capability.

The reason for the brain's caution is not far to seek. While the first-order scanning action of the frontal lobes has created an effective speech facility, its ever higher order scanning-sweeps of the already internally manufactured percept material generates stuff that is attenuated and lacks clearcut referents. Since for the mind (whether primitive or modern) the word not only *means* the thing but *is* the thing, the danger is that the abstracting

process can be the source of self-created yet believable nonsense. In other words, the abstracting process may become a mythogenic cauldron for making up pseudo-explanatory schemata that ignore or distort reality. The reason for this is that humans are disposed to seek comfort and to redress a lost intrapsychic equilibrium using speech-thought, the very technique that created self-accessibility and the resulting predicament.

In summary, language, having emerged out of neurofunctional changes, has lifted our cognitive capability onto a higher operational plane. It made the brain self-accessible and reflective. The initial breakthrough to naming was followed by further upgrading and secondary language evolution. This involved the gradual laying in of the parceled-up and word-linked human perception of reality, replacing the formerly fluid and inaccessible perceptual transience of the primate. This human version of reality was much enlarged and enriched, particularly where word-linked percepts were able to create depth and overfamiliarity with subject areas.

While it is easy to see that language has freed the organism from mindless impulse proneness, it is less obvious that the higher level of goal-directed efficiency and reflective insight was a bounty that had to be paid for. In fact humans find themselves in a predicament of having a "cake" of freedom they are now obliged to "eat." They cannot relinquish their mental powers even if this elevated condition is less pleasing than the all-enveloping protective ambience that characterized the primate's nonreflective drift.

Having irreversibly crossed the Rubicon that separates human awareness from its unreflective animal variant, and with all our eggs in the cerebral basket, humanity's position is evolutionarily unique. In the chapters to come this will be explored and the workings of the self-aware mind revealed. This will create the insight to relate back to the underlying and inherent order of reality that not even our projective efforts of mystification can hope to ignore.

4 More about Language

With language behavior it is the same, the present problem being that there is no agreed upon theory of what language is, let alone how it works in the brain.
—D. R. Hofstadter and D. C. Dennett (1982), *The Mind's I*

A The Perceptual Basis of Language

To me it seems that our current research is not hampered significantly by the lack of accurate data, but rather by an inability to explain in a satisfactory way data that are hardly in question.
—N. Chomsky (1968), *Language and Mind*

As we have seen, language is the coded and sequentially arranged transshipment of meaning. It is the internal handling and delivering of percepts to a recipient—a process that is analogous with the physical manipulation of objects. It is performed by left-hemispheric structures that switched from object manipulation to percept manipulation. Both forms of handling are frontally guided and closely monitored.

In this section I will bring evidence showing that language is an internally grown motor skill and not the expression of an externally acquired syntactic algorithm. The grammar of a language is the stabilized end product of repeated attempts at finding the verbal formulations that generate unambiguous meaning. The criterion of correct language performance is based on perceptual clarity, that is, on the unambiguous meaning of the images that are created and not on conformity to rules. In short, grammar is the formalized expression, the *effect* and not the *cause* of clear speech and language performance. To swap this around is putting the cart before the horse.

The view that the clarity of meaning is formative in the shaping of a language is at variance with the claim (held by Chomsky and some other linguists) that "syntax is independent of semantics" and that the "language

faculty is independent of external cognitive capabilities." Though incorrect, this view is easy to trace, Chomsky himself furnishing the key: "our current research is not hampered significantly by the lack of accurate data, but rather by an inability to explain in a satisfactory way data that are hardly in question." The statement is relevant, for without taking into account the neotenous human infant's unwired brain and the switch to verbal percept-handling at a very tender age, language acquisition is a riddle. Indeed, without an understanding of how the new skill was wired up and how trial-and-error runs found the combinations that work, the mystery is complete. Having only the fully formed language instrument to go on and unable to figure out how such a complex edifice can be "internalized," linguists postulate a "language acquisition device" (Chomsky) or a "language of thought" (Fodor) as innate templates to render language learning somehow possible. These are default options that do not work but only thicken the plot, creating elbow room for the later concept of artificial intelligence.

To underline the connectedness of semantic substrate, language and brain, I refer to Posner's (1993) article "Seeing the Mind" as it summarizes functional MRI and PET data. It shows the close similarity between externally induced (seen) and internally induced (word-triggered) images, and that the brain engages the same areas in the same way and to the same extent for their manufacture. Eminent linguists such as Bickerton, Langacker, Lakoff, and Johnson show us that language embodies what is experientially meaningful, which we then handle and communicate. This means that the semantic substrate molds the syntax and finds expression in the grammaticality of language.

To demonstrate that language is not an autonomous formal system we should remember that the language operation evolved out of the handling of word-linked modality representations, that is, out of handling visual, auditory, and somatosensory percepts. Accordingly, what the neuropsychological equipment does with these percepts decides what form language takes, what linguistic universals apply, and what constraints are observed in language production and language reception. The circuitry modifications that underpin language and the physical conditions that are to be linguistically handled are uniform enough to ensure that all languages are similar and differ only in superficial ways.

While a large number of percepts are represented by single words, say, the percept "table" and the word "table," more complex and detailed descriptions of even simple objects and events call for the sentence frame. In this extended version of percept presentation, the thing to be characterized can be treated optimally. It can be qualified, related, and detailed, and

placed in the time, space, and context of occurrence and experience. The sentence frame is an ideal vehicle for conveying a vast variety of percept representations, even if these embody complex relationships and abstract concepts. It is just these complex percepts and their manageability in the sentence format that show us how constraints work and how language is governed by the manipulo-spatial conditions of percept handling.

Consider the load on the brain's short-term memory as an unfolding sentence is processed. Referring to these all-essential accommodations to brain capacity, Chomsky (1968) has this to say:

> We would expect a system designed for the condition of speech communication to be somehow adapted to the load on memory. In fact grammatical transformations characteristically reduce the amount of grammatical structures and phrase markers in a well-defined way. It may be that one consequence of this is to facilitate the problem of speech perception by a short term memory of a rather limited sort.

That there should be such an accommodating adaptation to memory span is hardly surprising. The longer the sentence and the more complex the juxtapositions in which its subunits, or clauses, are arranged, the harder it is to sustain its coherence. The greater the complexity, the greater is the likelihood that the message will be garbled or lost. Contingencies (clauses and their relational arrangements) involve perceptual transactions in the brain that must be performed in real time and in concurrence with the unfolding of the sentence. This can create serious bottlenecks. Managing and decoding take time and call for holding operations to allow for the sequential processing of the percept load into and out of the language phase.

As the short-term memory of the brain is able to hold and handle no more than about seven items at a time, it is easy to create an overload. This proves that the perceptual processes that underpin and accompany speech and thought involve real work, and that they are not inconsequential abstract events that occur in a mental vacuum. Hence, it is of interest to understand what they are able to do and how they are able to do it.

To illustrate the perceptual substrate of language, take the case of "self-embedding," of phrase within phrase as it shows how a processing overload of even a grammatically correct sentence can turn out to be unmanageable on purely perceptual grounds and be just as confusing as an incorrect sentence. The format of "self-embedding," the A/a constraint, states that a noun-phrase that is embedded in another noun-phrase cannot be processed, but that only the outer phrase, the embedding phrase, can. For example, in the noun-phrase; "the book the man left on the desk," the em-

bedded phrase "the man left the book" cannot be treated or qualified, as this would confuse the meaning of the outer phrase about the book on the desk. So if the embedded phrases were qualified by saying that "the man was the one the gardener saw" the sentence would read: "the book, the man, the gardener saw, left on the desk." It is easy to see that treating the embedded phrase would not only distract from the book, the subject in focus, but would also set the extra task of holding on to the book image while the inner phrase is perceptually processed and a modified phrase is created. The digression to another visualizable object is shown here to break the perceptual continuity of the original image, and the latter cannot be resumed without backtracking, restating, and revisualizing from scratch. Such formulations grossly overextend the brain's processing range and retentive scope.

The tight nexus between language and perceptual processes is also revealed by studies that measure the response time needed for the completion of various types of sentences. They show that affirmative, active, declarative sentences are easier to process than negative, passive, interrogative ones. This is because the less processing there is, such as inverting, transposing, and juxtaposing, the faster the brain can complete the task.

We can conclude therefore that:

- There is measurable neural work in transposing deep structure into surface structure, that is, mental imagery into language and vice versa.
- The difficulty of the task varies with the complexity of the perceptual processes involved.

Other things being equal, simple kernel sentences call for fewer neural transformations and are easier to handle. But things may not be equal by way of semantic or emotive significance and this would affect the task involved. For example, by eliciting excessive limbic, primitive emotional involvement, it is possible to complicate the linguistic transformation and so necessitate sizeable reaccommodation. Thus to use the active sentence: "A car hit John" feels less natural and more contrived than its passive version: "John was hit by a car." This is because on the emotive plane it is John we are concerned with and not the car. So to designate the car as the stressed subject in the active sentence is a kind of misrepresentation. It stops us in our tracks and calls for the reevaluation of significance in the sentence. Next, to show the dependence of language on perceptual processes we look at sentence ambiguity and the way it is resolved. Taking one of Chomsky's examples: "Mary saw the man walking toward the

station," we cannot be sure whether it was Mary or the man who was on the way to the station. We lack the verbal clue to decide the issue and to allow for the clear-cut visualization of the statement. Here too there is nothing wrong with the grammar of the sentence. It is the unclarity of its perceptual "print copy" in our brain that is the snag. Donald (1990) puts it this way: "The only solution would be to construct a mental model of the message contained in the utterance. The construction of such a model would provide an efficient mechanism for dealing with inherent ambiguities."

Another illustration of the role of perception in deciding what can be said and what cannot is given by Whorf (1956) using the prefix "un." Thus, while it makes sense to say uncover, uncoil, undress, unfold, unlock, untangle, untie, and unwind, the prefix "un" implying reversal will not combine with verbs that are perceived as intrinsically irreversible, for example, unbreak, undry, unlift, unpress, and unspill, although on purely grammatical grounds the combination of the prefix and the verb is quite legitimate.

When we speak we take a percept (or concept) and continuously modulate its linguistic representation until it corresponds to what we intend to communicate. This monitoring-cum-feedback technique is an underrated and in some instances ignored aspect of language production. Behaviorists, for example, regard speech as no more than mere output, yet without feedback guidance of the performance and its subtle articulations language would not be possible. This highlights the significance of the production routine from percept to language and back, and enables us to make three interrelated observations:

- The brain is able to sense when there is mismatch, distortion, and incompleteness by comparing the sentence with what it is intended to represent.
- In the course of the evolution of language, grammar was arrived at inductively, retaining only unambiguous combinations of word-percept units, and eliminating those that created muddle and ambiguity of perception.
- Speech is always novel, unique, and creative.

To expand on the last point, language is an improvisation even though it has to be performed according to the rules of grammar. It is goal-directed behavior where the goal is the linguistic reproduction of the speaker's modality experience. It involves complex motor skills, subskills, and constant monitoring of the performance. This suggests a comparison, in that the traversing of a terrain from point A to point B is as unique a motor im-

provisation in the external field as the linguistic attainment of a given percept's reconstruction in the internal field.

If, as we have stated above, grammar ensures the formal correctness of an utterance, perception is the arbiter of clarity. Therefore if there is doubt about meaning, it is perception and not grammar that decides the issue. This becomes quite apparent if we take the techniques of deletion and pronominalization into account. Using an example of Chomsky's (1968), if we say that "John's winning surprised him" or "His winning surprised John," our choice of the pronominalization would depend on what the visualization of these statements implies, that is, on whether the pronoun "he" manages to unequivocally identify "John" by intuition and visualization, or leaves the issue in doubt. Significantly Chomsky himself turns to counterdeletion rather than to grammar to eliminate ambiguity. The perceived context of the case is also relevant in deciding whether or not there are feasible alternative candidates for an implied referent.

The insistence on looking for grammatical criteria, even when an issue is clear on perceptual grounds, is best demonstrated by Chomsky's (1968) statement:

> From "John helped Bill write the book," we can conclude that John helped to write the book. But from the apparently analogous sentence of: "John helped the cat have kittens," we cannot deduce that John helped to have kittens—which is deviant—a fact that suggests that somehow there must be a grammatical relationship between "John" and "write."

This looking for grammatical clues is absurd in view of the perceptual clarity of both sentences. The meaning depends on the reconstructed sense or nonsense of the statements and not upon some hidden grammatical link between John and one of the verbs but not the other. What Chomsky seems to imply is that there should be grammatical rather than perceptual grounds for deciding between two formally correct linkages connecting a given noun and a given verb; an expectation that would be justified only if language were an autonomous formal system, which it is not. More will be said about abstract formalism in chapter 8. As for formalism's perceptually generated prototype, that is, the grammar of language, it is an inductively arrived at set of instructions from which all ambiguous formulations have been eliminated. It is the formula of how to use word classes and categories, and how to handle percepts to reflect the relationships of objects and events.

The evolution of grammar had to be much like organic growth. It unfolded from within and was kept on track by feedback mechanisms and

environmental confirmations. Commenting on this, Edelman (1992) noted that: "Syntax is built epigenetically under genetic constraints." Language, our instrument of self-accessing, adds a new dimension to the brain's functioning. Due to this intimate link between language and brain, neither can be understood without the other. Studies ignoring this connection fail to characterize either and explain how and why the "off-line" speech-loop emerged.

A few words must now be said about linguistic universals. These signify constraints on the brain's handling of the world by way of language. They tell us what can be done with language, what cannot be done, or what can be done only with considerable difficulty, for example, by overloading the short-term memory. The embedding constraint of "A/a" (noun-phrase within noun-phrase) has already been discussed. It is based on the percept's integrity, which cannot be split and compromised. The constraint is universal because it affirms that the fundamental building blocks of language cannot be disrupted. Then there is "structure dependence." Structure is an indispensable feature of all languages. It improves clarity, simplifies processing, and represents load reduction for the brain. Thus devices such as *fixed usage* or *word order* help in coding and decoding, while *intonation*, *stress,* and *marker words* cue in specific transformations and simplify semantic representations and accurate percept reconstructions.

Constraints facilitate the management of meaning, which is what language is all about, that is, the accurate transformation of percepts into language and back into percepts. This does not mean that grammar (i.e., formalism) is irrelevant, only that it does not tell the full story and can be misleading if taken out of context. Grammar makes good sense only in conjunction with perceptual processes whose product it is and whose representational contents it is designed to regulate.

As language is a formalized routine and percept manipulation is a universal operation, there is much common ground between languages. Thus all languages must have:

- distinct and readily recognizable phonological characteristics (phonemes), such as feature markers, to facilitate discrimination;
- natural word categories, such as nouns, verbs, adjectives, and so on, that depict aspects of the perceived world and are relevant in and for the organism's handling of it; and
- environmental regularities, generalized into classes of phenomena that act as guidelines for parceling up the world in a significant and practical way.

However, it is possible to go beyond these parameters by taking what is perceptually given and to project superimpositions upon the data. While these superimpositions may reflect broad characteristics of the language model with or without reference to reality, they act as societally sanctioned schemata. They tend to evolve into "explanatory" quasi-mythological formulae (such as religious beliefs, superstition, astrology, *yang* and *yin*, etc) enabling the group to relate to and symbolically control the world (see sections C of chapters 3 and 8). On this level language is more than a tool for the brain's management of percepts. It is a source of distortion and limitation that needs to be recognized and corrected for.

B The Acquisition of Language by the Child

By crying and early modifications of crying they bring their caretakers close and thereby manipulate the environment through their activity.
—D. Ploog (1979), "Phonation, Emotion, Cognition with Reference to the Brain Mechanisms Involved"

Let us see whether the model I am proposing can help to clarify the riddle of how the child acquires language. The inquiry is made more difficult by the inappropriate conceptual frames some researchers bring to it. Chomsky's (1968) allusion to the child's internalization of the knowledge of language is a case in point. In fact the child's language competence grows epigenetically from within. There is no internalization of the knowledge of language. The child learns the internal handling of percepts in the way it learns the physical handling of objects.

The key to the riddle of language acquisition is the neotenous, unwired state of the brain of the human infant. It ensures that for a critical period during the first few years of life the child's skill of object handling is eclipsed in relevance by its internal analogue, the verbal handling of percepts. As was stated in section A of the previous chapter, neural projections from the speech areas invade the nearby motor-centers of left-hemispheric manipulo-spatiality and begin to use sound in interaction with others. So while for a substantial period the human infant's motor competence is insufficient to ensure its unassisted survival, its concurrent sound manipulations begin to work as a useful device for controlling the environment. Reinforced by success, the verbal handling of percepts (i.e., sound manipulation) becomes the infant's primary lifeline. Yet this switch of emphasis from object handling to word-percept handling during the child's early neuroplastic period is not appreciated, just as its elaboration—the neural wiring for the sequential delivery of percepts—tends not to be comprehended.

What is curious is that while neurologists would never think of the child's improving motor competence as the "internalization of the rules of walking," some linguists, facing an analogous situation with language, agonize about the process of its alleged "internalization."

Of course, if the neotenous window of opportunity for the neural rewiring for percept management is not recognized and if language is taken instead to be an "autonomous formal system," a deep mystery results. One way to avoid having to deal with this is to put the problem of language acquisition down to an "innate language faculty" and have done with it. Another way is to have a "language of thought" and turn primary language acquisition into something akin to the learning of a second language, a process that is easier to understand. These tactics are somewhat reminiscent of Bergson's *élan vital*, the vital principle that was invoked at the turn of the last century to "explain" the difference between living and nonliving systems—a weighty expression of little substance.

The learning process begins by imitation. Children associate certain sound patterns (words) with the representation of objects (percepts) and elicit them repeatedly. They master the sound trick and manage to evoke it in themselves as they evoke it in others. This allows them to experience not only the remote control of others but to witness (hear as well as proprioceptively sense) their doing the deed. The coexperience of hearing the word and feeling its utterance leads to the laying in of a complex double-stranded memory trace. As the technique evolves and children grow increasingly capable of using the skill, the technique coalesces and becomes an independent action schema in its own right. This is the beginning of the child's perception of the language instrument as distinct from the meaning it conveys.

Once the tentative imitations are over and the laryngeal kinetics of the required sound productions are mastered, little stands in the way of the expanding skill and the child's awareness of it. The process is facilitated because the skill's expansion brings about improvements that act as incentives encouraging the child to persist with the task. In this manner the child learns how to speak, though the acquisition would be more appropriately labeled as "environment and self-management by way of language."

Once the practice is joined, the improving levels of discrimination ensure that only relevant phonemic and syntactic features are selected, retained, and built upon. Confirming this, Mateer and Kimura (1982) observed that: "The infant language learner develops articulatory manoeuvres that mirror both the inherent perceptual discontinuities and the distinctions utilised in the linguistic environment." The acquisition of a language is not unlike

the solving of a jigsaw puzzle. It can be managed and completed only with the pieces that fit and whose combination with other pieces yields unambiguous results. This entails selective reinforcements that guide the acquisition process toward conformity with the specification of the given language. The result is that children, even if they are exposed to limited and degenerate samples of speech, can't help but learn the pattern. There is probably far less actual learning involved in mastering the language skill than is commonly supposed. The child's brain is highly neuroplastic and sensitive to patterns of language transactions, inherent syntactic and phonological regularities, specific markers, and melodic characteristics (intonations, stress patterns, etc.).

Since all these aspects are wired together with ease and are integrated without difficulty, it is not surprising that language acquisition is just about automatic and universal. Of course, the whole business must seem inexplicable if the intermediate steps are ignored and only the initial condition (the prespeech brain) and the end result (the fully fledged language capability) are considered. In the allusion to Chomsky's internalization of a "knowledge of language" just such an omission occurs. Without bridging transitions, language acquisition seems mysterious.

To sum up, language is the skill of percept evocation and percept management. It enables us to convey our intentions and modality experiences by inducing their language-mediated reconstruction. Using this technique we are able to access and influence people around us. Equally importantly, we are able to access and handle our own intrapsychic contents. Language is, in fact, the key to our humanity, insight, and ability to control the environment. Rather than internalizing the skill, as perceived in its completed form, children start out with tentative imitations that are hardly more than reflexive. However, these are supported and selectively reinforced, and a learning sequence is set in train. This is helped by selective reinforcements, and results in the rapid wiring in of the paradigm. Accordingly, language is neither innate nor learned. It is neurofunctionally grown in every normal individual exposed to it. The skill is a natural intrapsychic adaptation of manipulo-spatiality, a remote-control verbal handling of all manner of representations stored by the brain.

This view of language cuts across the conventional battle lines of the debate of empiricism versus rationalism. Empiricism and the idea that behavioristic habit acquisition is the basis of language learning is at variance with what is known about the way the brain functions. Regarding the rationalist position, there is at least some point in talking about innateness of language, though only if innateness is taken to apply to the skill's neural

infrastructure and the potentiality to activate it. This much is permissible, for these infrastructures are known to exist and only need appropriate stimulation to wire up for the take-off. This view is one step short of Chomsky's, in that it rejects full-fledged innateness. It sees all aspects of the skill as equipment based and requiring neural integration and activation. It is supported by the finding that once past the critical age for neural wiring, the skill cannot be activated and speech capability attained. This would not be the case if an innate faculty of language existed.

Since the proposed pattern ties language tightly to the brain equipment responsible for its production, what individual languages do, how they do it, and the set of subfeatures they do it with cannot vary in essence but only in detail. From this it follows that, as the same set of neural components are involved and these work with similar environmental specifications, even hypothetically new languages must be variations on the same theme and therefore must be indistinguishable in essence from already existing members of the class.

A final point of interest is that we know that our language is just an instrument. We know that it is a vehicle, or delivery system, which—though always cooccurrent with the material it handles—is nevertheless not an aspect or an extension of that material. In short, we have the insight that language is not part of the schema it helps to express. This distinction between the instrument of processing and the stuff that is being processed will be of critical significance in the evaluation of the human-versus-ape comparison.

C Ape Talk: A Tip without an Iceberg

STRANGER TO THE DUKE OF WELLINGTON: "Mr. Smith, I believe."
DUKE: "Sir, if you can believe that, you can believe anything."
—Anecdotal source

In view of the special role of language in boosting the brain to a higher level of functioning, the "ape talk" controversy and the insights it might furnish should not be ignored. Although speech and reflective awareness seem to be absent in the ape, a suspicion of some protolinguistic (naming) ability persists, and this requires examination.

Let us recall that the language function is either "on" or "off," and that in its "on" phase it automatically generates reflective awareness. This means that reflective awareness is either present or absent but never "half there" or just "dimly operative." Animal awareness is always present in living organisms in the wakeful state. It is of course graduated in

complexity contingent on the brain that generates it, but it never involves the extra technique that would make it reflective. It is then this extra technique that is responsible for reflective capability and not some ephemeral quality that grew powerful enough to modify the brain's functioning.

However, our ability to reflect does not mean that there is no experiential and functional overlap between apes and humans, or that we are necessarily superior in every way. For example, it is quite likely that the chimpanzee's intuitive schematizing propensity is more subtle than that of a human. The chimpanzee's brain works very much like our own right hemisphere would work if it could act on its own without interference from the speech-endowed left side. It is also conceivable that—undisturbed by eons of speech interference—the ape's functioning has managed to evolve additional subtleties and schematizing refinements of its own. It is therefore not surprising that the ape is able to organize and integrate cross-modality data. It is well able to generalize, group, and sort diverse aspects of experience and so form concepts and categories such as "edible fruit," "dangerous situation," and the like, as well as signs of various kinds, without needing abstract verbal symbolism for the purpose. Therefore, to argue that these generalizing operations indicate some form of higher consciousness is not justified. The ape's functioning is indicative of subtlety but not of reflective conceptual thinking. Its performance is language independent and well established already on the level of much lower vertebrates.

This brings us to the controversy about the ape's signing ability and use of symbols, and the claim that these are tantamount to language. In its natural habitat the ape functions with the aid of *behavioral language*. This consists of body postures, facial gestures, and a fair deal of vocalization. The hoots and grunts carry limbic (emotive) connotations and—in some instances—more specific information indicating danger, intention, and other matters of relevance. These limbic signals may be complex, but are in essence only elaborated versions of group interactions that operate already on lower levels of animal life.

Over and above these forms of natural communication, higher primates in captivity can be taught a moderate number of symbols and signs (hand signals used by the deaf), up to and even in excess of 100 in some instances. They can be taught to use these in tightly defined transactions with their trainers. However, as we shall see, this signaling capability is no more than an extension of "online" motor schemata and does not constitute language proper. True language is an independent "off-line" motor facility with which motor schemata can be expressed, but which itself is not

part of what is being conveyed. With reference to the claim that the ape's signing constitutes speech, Seidenberg and Petitto (1979) say:

> The apes appeared to have learnt not the meanings and linguistic functions of their signs, but rather the consequences of particular acts of signing. They know that forming certain signs will have immediate benefits. For example, someone will give them food or a toy.

Thus Seidenberg and Petitto acknowledge the subtlety of the ape's performance but deny its alleged linguistic status. Clearly, apes are able to learn complicated tricks and to integrate these into motor schemata. Nevertheless, this achievement cannot be regarded as a means for accessing and manipulating percepts and reflecting on what they are doing. They cannot experience data about themselves as signaling entities—which is what true language would enable them to do. The difference between human (true) language and the ape's signing performance is not one of degree but of kind. Human speech is neocortical in locus and is formed and articulated in the left hemisphere's parieto-temporal association areas. Human speech is not limbic in origin even if it uses some limbic innervations in the emotive coloring of the speech performance. As it is the product of a specialized region of the lateralised brain, damage to this region disrupts the delivery of language. The delivery cannot be taken over by the right hemisphere, so the function tends to be completely lost. This also involves the loss or compromise of all other functions that are speech related and speech led. This is not the case with brain-damaged or "split-brain" chimpanzees whose signing behavior is bilateral and nonspecialized; it remains unaffected by unilateral damage.

Another indication that ape signing or signaling is not true language is that the ape cannot use it against itself. It cannot dwell on items of experience and bring about a self-generated neurosis. It cannot transform a fear response into chronic anxiety and cannot generate schemata of purely internal origin, such as neurotic compulsions. The ape can, of course, be trapped into irresolvable conflict. This can occur in captivity or when the behavior of other group members causes frustration. By contrast, in humans language can be used freely to interfere with mental processes, which can result in neuroses.

If the model I am proposing is valid and speech-thought is a tightly defined motor procedure for internal percept handling, the ape cannot be regarded as having it. It simply does not possess the facility with which to generate syntax. This fixed formalism of syntax is the essence of the language instrument and makes it distinct from the semantic content it conveys.

Now, if we contrast the digital computer with the brain of the prelanguage primate, we can see that they are mutually exclusive, yet functionally complementary. The primate brain has no language, that is, digital facility, for processing its semantic experience, while the digital computer has the processing facility, but not the semantic contents and the sensitivity to interact with it. We can also see that our conscious human brain is the successful marriage of the two. It uses its syntactic machinery to manage its semantic substrate. The human brain generates both syntax and semantic contents and functions in a self-accessible, reflective way.

A few words are now needed about the ape's "recognition" of its reflection in the mirror. The latter is used by Gallup (1977) and others to "prove" that the ape is self-aware, that is, that it "knows" that the image in the mirror is its own. In the experimental setting designed to prove this claim the ape notices a patch of red dye on the forehead of its mirror image, the dye having been applied to its forehead without its knowledge. However, it proceeds to remove the offending patch not from the image where it sees it but from its own forehead. This insight is then taken as demonstrating that the ape knows the difference between the image and itself, and that this proves that it is self-aware.

To refute the claim we have to stress that only those chimpanzees who are familiar with their image in the mirror are able to pass the test. Such apes were able to form an extended body-related schema in which they learned to back-refer signals from the new source. They were able to acquire this schema by repeatedly examining the mirror, going behind it, testing it, and generalizing to themselves all body-related signals from that source. The process is a language-independent adjustment. Chimpanzees without previous exposure to their own mirror image predictably fail the test. They pass it only after they have had the opportunity to make the required perceptual accommodations and learn to correlate the image with their own body. This is excellent schematization to be sure, but it is not reflective behavior. No thought operations are involved or needed and the assumption that the ape's behavior signifies reflective awareness of a "self" is not justified.

The ape's behavior in front of the mirror is quite comparable to that of humans learning to cope with an inverted visual field. In this experiment human subjects are fitted with inverting goggles. They take two to three days to begin to cope and to effect the required sensorimotor adjustments. Thought plays no part in this process, and the possession of a reflective capability and awareness of a self is more hindrance than help. The required novel accommodation is purely perceptual, as is the chimpanzee's task to

integrate signals issuing from the mirror but already belonging to the extended schema.

To be aware as we humans are, the ape would need to possess true language, the skill to handle percepts and reflect upon them. This the ape cannot do. Its quite remarkable performance before the mirror is a result of its excellent schematizing propensity, to which I have referred above. The ape's brain probably acquired this subtlety during its evolutionary development in the absence of a language-dominated adjustment.

The case of Kanzi, the Pigmy chimpanzee, is widely known and deserves a mention. He knows more than twice the number of signs than the brightest of the other apes. He learned these in a natural setting, often using them spontaneously and sometimes with augmenting gestures. Still, Kanzi's two- and occasionally three-sign messages are only extended motor schemata, need-directed manipulations (97 percent are requests). Nothing new is involved and the performance does not constitute "true" language or "elementary grammar," as his carers claim. Donald (1991) sums it up as follows: "I would judge human language to be light years removed from Kanzi's accomplishments. Kanzi was given a structured communicative device which he could use very effectively, but to call his simple ordering rules 'grammar' is stretching the definition of the word. Kanzi's sign-use remained at the pre-sentence level and certainly at the pre-propositional level. Kanzi remains several crucial steps removed from human linguistic ability."

Summarizing the main points bearing on the ape's alleged speech capability and self-awareness it may be observed that:

- The available brain mass of even the most advanced modern ape is significantly less than *Australopithecus* had at its disposal. The ratio is in the order of 5 to 4 in the latter's favor. More importantly, by way of brain specialization (sidedness), *Australopithecus* was well ahead of all primates living today. This implies that the ape's cerebral equipment is quantitatively insufficient, qualitatively less differentiated, and wrongly oriented to evolve language. Signaling behavior, even if complex, constitutes quite another sort of brain activity.
- All the experimental apes, Washoe, Koko, Lucy, Lana, Sara, Nym, and the Bonobo Kanzi (though Kanzi less than the others) had to be taught, and drilled, to accept the set of signs that was introduced into their daily transactions. Constant prompting was needed for them to be used, but their usage never became the ape's first option. In other words, it first tried to go about its needs its own way, and only when it failed to get results did

it use the signs it was taught. This has compelling implications, for if signing had created a rewarding or altered state (as protolanguage did in early humans) the ape would have adopted it. This would have established the self-accessibility format, that is, the practice that captivated protohumans and created in them frontal involvement and an acceleration of the new technique.

- As Chomsky and other linguists point out, there is no hint of syntax in ape talk. Hence there is no question of an independent instrumentality for handling the ape's experience, including its experience of itself. The true language instrument's neurofunctional format is different from and independent of what is being handled by it. In view of this, the ape's talking is mere surface simulation, but not language. The ape may use signs to manipulate the environment (as taught) but without bringing about an intracortical shift in the relationship between the creature and its signaling, or between the signaling and the thing that is signified.

It may be further observed that much of the experimental or recorded material relating to the ape talk paradigm is shot through with distortions. There is biased reporting, anthropomorphism, poor experimental design and control, hidden "clever Hans" (the counting horse) effects and an underestimation of the ape's schematizing subtlety and perceptual acuity. The result is a picture of doubtful value and conceptual untidiness.

Let us now turn to the factual and positive side of this issue. It is of particular interest that Khroustov (1968) of the Moscow Brain Institute has tested the high primate's reasoning power. He concluded that its ceiling is at the point where the holding mode of the true linguistic operation would come into play and provide the next step. This point is at the juncture at which the "if this, then that" mental self-instruction comes in, and shows the way to the successful conclusion of the sequence. Such interjections are possible in humans because they involve mental transformations. These take place in the off-line speech loop and do not constitute interference with the "online" peripheral motor task on hand. As the mental operation is not a competing motor alternative, it permits independent digressions for choice and for extending causal ramifications. These ramifications are perceived by the brain as optional programs to be weighed up and implemented if judged suitable.

The resulting format is much superior to the process of muddling through in an ad hoc and one-shot manner. This latter is characteristic of peripheral motor improvisations that involve irreversible physical commitments and not just mental options. In light of the internal shunting

arrangements of mental functioning (invariably involved in language) the "Washoe-talk" type of signaling performance could never extend the creature's reasoning power or provide leverage for self-manipulation.

This takes us back to Khroustov. He found that the ape can fashion a tool of sorts to do a job for which the tool is an appropriate enough implement. However, he also found that the ape cannot create a tool with which to fashion another tool to do a job. In other words the ape cannot take two steps because it is incapable of the second (mental) step essential for advancing the action sequence. The mental step enables the manipulation of the program in accordance with its perceived stage of completion. This is clearly a complex business, with multiple holding operations to guide it and with thought triggers to activate the orderly unfolding of the pattern as a whole. The role of verbal self-instructions in articulating, timing, and phasing such mentally held action patterns is obvious. The nonmotor character of the operation in the brain allows the motor system to do its work unhindered, once it is given the specifications for the job. These are interesting findings because they show why ape talk is not true language, and because they indicate what language allows us to do. Furthermore, they show how and why the motor compulsion needs to be held back until alternative action sequences can be considered, selected, and implemented.

The holding mode is a tremendous breakthrough for humans. It empowers the brain to organize its output and to release it sequentially to satisfy mental or physical specifications. Thanks to language, the brain is now an extraordinary tool of processing subtlety and cognitive penetration, even if its rather limited short-term memory sets an upper limit to what it can readily accomplish. This is demonstrated by our difficulties in coping without material aids such as written records, and our difficulties with tasks involving problems with several contingencies. Working things out in the head often exceeds our capabilities, language-assisted cognition notwithstanding. Another consequence of this is that more marked and systematic advancements in insight, knowledge, and application could begin only after the invention of writing. Only then could data begin to accumulate and the transmission of a corpus of knowledge be institutionalized. A vast pool of stored information could now be created and drawn upon, and it became possible for us to deepen our understanding.

In the next chapter we shall explore various aspects of the brain's self-detection. I shall cover the technicalities of coming upon ourselves and of understanding the philosophical and existential difficulties that result from the brain's breakthrough to self-accessibility.

5 Self-Accessibility

Without consciousness the mind-body problem would be much less interesting. With consciousness it seems hopeless.

—D. R. Hofstadter and D. C. Dennett (1982), *The Mind's I*

A Problems of Self-Detection

"If you think we are wax-works," said Tweedledum to Alice, "You ought to pay."
—Lewis Carroll, *Alice in Wonderland*

This chapter prepares the ground for the linkup of language and reflective awareness. I use the term "reflective awareness" as synonymous with "consciousness," the knowing that we know. The conscious brain's difficulties in thinking about itself are quite exceptional. It is "thinker" and "thought," "experiencer" and "experience" at the same time, and this duality is opaque to introspection. This is not surprising, for the brain is trying to identify no ordinary phenomenon, but one that is always part of what is being experienced. Its generality makes the problem even more intractable, for while there is concern, curiosity, and wonder, there is really very little to work on. Predictably, even sophisticated speculations lead to no more than vacuous or absurd "explanations."

It is easier to define consciousness operationally, that is, in terms of what it does rather than what it is. For example, Sperry (1976) writes:

Consciousness is an emergent property of cerebral activity and is an integral component of the brain process that functions as an essential constituent action and exerts a directive holistic form of control over the flow pattern of cerebral excitation.

Reflecting on this definition, Gazzaniga and Le-Doux (1978) note that:

In no way should such overviews be misconstrued as insights into the mechanism of consciousness *per se*. These types of analyses deal with consciousness as a single impenetrable entity.

While Sperry's definition tells us what consciousness does, Nagel's (1982) reference to it tells us nothing and leaves us wondering what we are up against:

> Conscious experience is a widespread phenomenon. It occurs at many levels of animal life though we cannot be sure of its presence in the simpler organisms as it is very difficult to say in general what provides evidence of it. Some extremists have been prepared to deny it even of mammals other than man. No doubt it occurs in countless forms, totally unimaginable to us, on other planets, in other Solar systems throughout the universe.

Nagel's statement, though not uncharacteristic in this domain, is useless as a definition. For what can we make of a "widespread phenomenon that occurs on many levels of animal life," though "it is very difficult to say in general what provides evidence of it," even if "there can be no doubt" that "it occurs in countless forms" that are "totally unimaginable to us," to say nothing of "other planets" and "other Solar systems" as its presumed venue? The question is of course rhetorical but the answer is not. Reviewing the metaphysics, the mystery, and the generalizations that mask the issue do not lead to insight. Reflective awareness must be positively identified and its elusiveness shown to be lawful. We must understand the machinery and why introspection leads us nowhere.

Let us start by acknowledging two difficulties in the brain's self-investigation. First, as thinking equipment the brain cannot get past regressive circularities about itself. Second, as an organ of integration and survival it cannot permit inquiry into itself if this undermines its sense of security.

The regressive circularity that the brain's self-investigation invariably entails is *self-reference*: a relationship that characterizes the observer's observation of himself or herself. The difficulty has to do with the identity of whatever is the recipient of reception, as there is nothing but reception to receive itself. Not only has the brain's logic no answer to this paradox, but it is its source. The thinking process—given the raw data of experience to think about—simply cannot get past this point. There is in fact nothing wrong with the thinking process, only with the raw data to which it is restricted and which—unless upgraded—must lead it back to the circularity.

The impasse of this circularity can only be overcome by generating a new model of the self-aware brain. The model has to show how reflection works and how the experience of reception can be accounted for neurofunctionally. It is a frameup to leave the solution to logic yet not to supply the brain with components with which it can design a working formula of

awareness. It is like starving it of information and insisting on results. Chomsky (1968), despairing of this chronic simplism in handling the self-aware brain, points to a "faith in the shallowness of explanations," noting that:

> The real problem for tomorrow is that of discovering an assumption regarding innate structures that is sufficiently rich, not that of finding one that is simple or elementary enough to be plausible.

Although neuroscience has not yet shown how self-awareness works, it is able to furnish the physical and conceptual frame for a model that makes sense. Libet's (1990) "time-on" theory, for example, draws the data on brain-processing into a useful perspective. Using this data, a three-tiered model of the conscious brain can be erected in which the tiers represent increasing levels of integration. Neural events are time dependent, and it takes longer to achieve higher levels of integration. Events and subcomponents on the bottom tier are too brief to reach the level of awareness. Awareness requires 400 to 500 milliseconds of processing and is first attained on the second tier. On this level, events and event components are integrated into the simple animal endogram. In all infrahuman organisms this second tier is the top tier, as no facilities for higher integrations exist even if more time were available for the purpose. The third tier is that of reflective awareness. It is exclusive to humans and it involves more than just additional time for integration. It entails extra structures, functions, and neural adaptations for tackling the endogram from within, and for managing and reentering the reflective process as experience. Human awareness normally uses the top two tiers. It shifts in and out of the highest (reflective) gear as required, idling in the middle "gear," and falling to the lowest level during sleep and reduced blood and oxygen supply.

The three tiers, "subawareness," "awareness" (the level of the animal endogram), and "reflective awareness" (the level of the self-accessible human endogram), roughly correspond to events on the level of the "neuron code," the "brain code," and the "mind code," respectively. The point to stress is that the reflectively aware state is the result of a time-dependent process, involving reentrance and self-management; it is not a structureless abstraction.

Turning to the second difficulty, the brain's mandate to provide an optimal and stress-free adjustment, it is necessary to look at the consequences of having acquired reflective awareness. Reflective capability (the facility to modify the character of the endogram from within) can be the source of stress and neuroendocrine imbalance. This must be taken into account

when considering what the brain is able to discover and disclose about itself. To lead into this it must be emphasized that the organism cannot have evolved by maintaining stressful incongruities between constituent subsystems. The attainment of reflective capability had to be a net gain. For this to be possible, defensive mechanisms had to be available to manage the stress. For the unreflective ape this is not a contingency. It cannot stop the experiential "tape," to rewind and replay it, or to perpetuate the memory trace for repeated recall and reexperience. It is not exposed to self-induced stress because its brain does not have the facility to meddle with or reset its data-processing arrangements.

By contrast, humans' speech-thought skill enables them to interfere in all the cortical operations and to wreck the previous symmetry between cortical problem load and endocrine support capability. The availability of objectificated percepts (words) enables humans to enlarge, dwell, and perseverate on selected experiential material from life encounters. Humans can generate in themselves a climate of disproportionate concerns. This means increased vulnerability to perpetuated stress and trauma. What could not have meant more to the ape than a fleeting instance of fright, humans can expand into chronic anxiety, fretting, and anticipation of danger. Humans now need neurotic defenses to deflect, sublimate, or suppress the offending material to maintain some form of intrapsychic equilibrium. Lorenz (1976), reflecting on this mind-generated anomaly, has this to say:

> It is a curious paradox that the greatest gifts of man, the unique facilities of conceptual thought and verbal speech, which have raised him to a level high above all creatures and have given him mastery over the globe, are not altogether blessings. Or at least are blessings that have to be paid for very dearly indeed.

The dislocation that results from language-based self-accessibility calls for somatic adjustments, such as increased or modified endocrine output. While this reduces or counterbalances the stress load, the lion's share of the compensatory accommodations are cortical in character. Language is ideal for the restoration of the primate's ambience and for the control of the elevated stress that the organism's reflection continuously creates. It is worth noting that humanity's psychoreligious constructions, that is, their tendency to fashion belief systems to sustain them in a self-created predicament, is adaptive in character. Chomsky (1968) puts it this way:

> Our systems of belief are those that the mind, as a biological structure, is designed to construct.

Far from representing objectivity, one of the language instrument's tasks is to maintain the organism's inner peace and sense of security. It follows that:

- the brain is not a disembodied research organ with free access to unbiased information;
- its functioning as a data-processing instrument is strongly compromised by tacit and compelling commitments to deep-seated organismic needs; and
- the brain's job of investigating these matters has no clear mandate to succeed, since mind and awareness play a pivotal role in humans' reequilibrating efforts.

It is then possible to conclude that the chronic conceptual confusion in this area is not just the result of lagging insight into a complex frontier domain of understanding. Rather it results from humanity's disposition to palliate, which makes their concern with and commitment to the rational understanding of reality and their place in it no more than nominal.

In view of these limitations the introspecting brain's ideas about itself are only of academic interest. Its views are compromised. It has no direct insight into the nature of consciousness. Furthermore, if this were otherwise it would interfere with it. Leaving aside the mystic and the religious, who see the problem of the mind through the tunnel vision of revealed truth, scientists tend to conceptualize the phenomenon in one of two ways. They regard consciousness as an expression of brain functioning, or brain functioning as an expression of consciousness. The first view seeks material anchorage for it; the second view looks for manifestations of what it regards as a cosmic principle.

Whatever the view, the raw datum of consciousness is the same. It is that of "self-embedding," the knowing that one knows, the feeling that one feels: in short, the reflection of whatever is happening in that moment as part of the ongoing experience. It is a puzzling and enthralling intrapsychic circumstance. It is without clues as to how it is happening and as to whether it is possible to separate it into meaningful constituents.

The view that sees consciousness (reflective awareness) as the outcome of brain processes concentrates on looking for the critical structure and for the localization of the function in it. Historically "master neurons" and "pontifical regions" were sought as representing the seat of consciousness, while others (Lashley, for example) concluded that consciousness is a mass effect of the entire brain, with or without an "epiphenomenal glow." None of these generalizations makes sense, for even if it were possible to localize

the function, this would not clarify its nature, genesis, and manner of operation. Worse still, the vexing question of its reception would remain unanswered and the system's self-reference (the question of who or what experiences the experience) would rehabilitate the "agent" or render the enquiry hopelessly inconclusive.

The lack of clarity in this domain invites projection. A case in point is that of Eccles (1978) who regards consciousness as the "zone of interaction between the brain and the mind": the "physical" brain and the "spiritual" mind, as he would have it, though without ever clarifying what *mind* or *conscious awareness* (both taken to be spiritual) might be, or how an interaction between *matter* and *spirit* is able to take place. Ignoring physical and conceptual difficulties alike, Eccles (1990) simply states that: "Sensations and perceptions are possible because activities in the brain are recorded by the mind" (see section C of chapter 7).

If the first approach of looking for material anchorage fails to isolate and define consciousness, the second approach of viewing consciousness as a cosmic principle renders the inquiry quite pointless. As an uncharacterizable general term, consciousness may be all right for *panpsychism* or *psychophysical parallelism* but of no use to science. As it cannot be measured or modeled, it hinders rather than helps the clarification of the phenomenon. To illustrate the point, Rose (1973) regards consciousness as something "man, dog, mouse, and earthworm partake in or partake of," though the lesser forms to a lesser extent. Teilhard de Chardin (1959), expressing much the same view, observes that:

> Refracted backward along the course of evolution, consciousness displays itself qualitatively as a spectrum of shifting hints whose earliest terms are lost in the night.

Definitions of this sort make no sense. They beg the question of how a quality that cannot be characterized or measured can be said to vary quantitatively. Although Rose tries to give this position a semblance of respectability by stating that "Consciousness is the function of neuronal numbers and the density of synaptic connections between them," the entity remains shrouded in vagueness and there is no way of knowing what it is all about.

These views reflect the generalization that, just as there are gradients of structural complexity and behavioral sophistication that start with simple organisms and culminate in humans, so consciousness, too, can be represented by such a gradient. It, too, can be thought of as coming on gradually like an initially dim light that intensifies. The trouble is that such a linear progression of biological upgrading has no room for emergence

or for a phase transition from simple awareness to its reflective human variant.

To show that the generalization is inapplicable it should be noted that while all biological parameters can be measured, compared, and quantitatively evaluated, reflective awareness cannot. It is either present or absent. Consciousness is not just simple animal awareness done better or faster, but a system-shifted way of being aware. Furthermore, it is uniquely dependent on a distinct technique, that is, language, that turns animal awareness self-accessible and self-managing. Human awareness is an intrapsychic breakthrough that is generated and maintained by the motor function of speech, so there is no trace of it where language is not in evidence. It is built upon a circuitry modification, that is, the speech loop, and is either "on," as in humans, or "off," as in the ape. The idea of a gradual onset of reflective capability is therefore incorrect, as is the retrospective generalization of speech to infrahuman signaling behavior (see section C of chapter 4). Here, too, the critical neurofunctional differences are ignored, speech and signaling are taken to be of the same kind, and a continuity from ape to humans is "perceived" by default.

As consciousness (reflective awareness) is a language-linked emergent phenomenon, it is necessary to decide whether evolutionary mechanisms in themselves are able to account for such a manifestation. The answer is that the onset of a novel function can be quite sudden and phenomenologically unheralded, although the set of modifications that led up to its emergence may be gradual and may have been in the making for some time. The process resembles the joining up of two wires of a new circuit, which thereupon becomes live and performs accordingly. Speech-thought and reflective awareness are of this emergent order. They are the backbone of humanity's upgraded functioning, which contrasts with that of the ape. There is a qualitative gap here that no amount of touchingly egalitarian ape promotion can hope to eradicate. The ape's performance is not a dimmer version of the human's but something that is different in kind. The neural underpinnings of language and mind are unique, and the intrapsychic phenomena that are generated by the process are evolutionarily unprecedented.

It is regrettable that—because of chronic conceptual difficulties—consciousness (reflective awareness) should have received little more than anecdotal attention until the advent of the so-called consciousness revolution. It is true that the modeling of the self-aware mind may in the short run be unrewarding, but this is not reason enough to neglect an issue that deserves serious attention. In the present climate, but even more so in

years and decades past, consciousness was treated with overcautious generalizations and/or loose fancies, making too little or too much of this central puzzle.

In the next section I show that the conceptual difficulties of the traditional approach can be overcome and that it is possible to trace and identify the way in which the reflectively aware brain detects, monitors, and guides itself.

B Elements of Self-Detection

The ability of a higher level to loop back and affect lower levels (its own underpinnings) is a kind of magic trick which we feel is very close to the core of consciousness.
—D. R. Hofstadter and D. C. Dennett (1982), *The Mind's I*

To show how higher levels affect lower levels and how the brain accesses itself, we have to understand the real nature of the endogram. This understanding supplants the traditional view of the mind in which the endogram is only a "temporal singularity," an unextended instance of transition from past to future. The traditional endogram is like a picture in a fixed frame, or more accurately like a set of sequentially flashed-on frames, resembling those of a movie strip. No aspect within these individual frames can influence other aspects in the same frame. However, if the frames are cortical screens for the display of completed events, where and how is our awareness of what we are aware displayed?

It is here that the traditional model fails the test. The reason is that reflection is really a response and should therefore come only *after* the material on which it reflects, that is, in the next frame, but not side by side with it in the same frame. Yet this simultaneity of awareness and what we are aware of is precisely what we experience, and this makes us wonder about the validity of the model. It can be shown that the traditional view of the instant endogram is a misrepresentation of intrapsychic reality.

The endogram I propose is not like a set of fixed frames, but an "event region," a "chunk of time" (to use Edelman's 1992 phrase) that continuously advances *en bloc*. In the durational span of this event region elements of ongoing brain processes crisscross, rise, peak, and fade gradually, doubling back upon themselves and upon other elements directly as well as in reentrant loops to make up the ongoing totalization. It will be recalled from the previous section that both simple awareness and reflective awareness are time-dependent phenomena. In brain processing event components commingle, enhancing or blocking one another, before reaching totaliza-

tion and presentational completeness in the endogram. Later aspects of the gradually and unconsciously evolving endogram are able to affect earlier ones and deflect or modify them for higher integration and presentation in awareness. Similarly, on the even higher level of reflective awareness the speech-thought technique is able to reach down and interfere, this time with awareness itself (Sperry's "downward causation"). It does this by taking out selected aspects of the endogram and feeding them back in, thereby modifying its slant and displaying in it the act of the modifying reflection itself. This language-driven reentrance enables the endogram to survey and near instantly evaluate alternative outcomes, and enables the brain to selectively abort incongruous or threatening action programs. This reentrant procedure of the endogram is an effective device for self-influence and self-guidance. It provides means for overriding subliminal action-components already in train and for permitting the passage of the one that is in accord with the purpose of the organism at large. These reentrant control functions of self-interference—well documented by brain research—will be shown (see sections B and D of chapter 7) to have decisive consequences on the evaluation of what we feel as *free will* and *voluntary action*.

The crucial point about this time-extended new model of the endogram is that it can be contributed to, modified, and handled "in flight." In short, the brain is able to come face to face with what it is in the process of doing, and so to experience itself in this functioning. It is now able to monitor itself, to "read" what it is "writing." The particulars of this monitoring may be clarified in the frame of the answers to four interrelated questions:

1. How does the brain's "writing" take place and what facilities are implicated in the process?
2. How can the brain "read" what it is in the process of "writing," or what it has just "written"?
3. What can be said about the experiential span necessary for the self-monitoring procedure?
4. How can the brain be sure that it itself is the source of what it is experiencing?

We turn now to the first three questions. The fourth deals with the problem of reflective awareness and will be discussed in sections B and C of the next chapter.

To be able to "write," to create a conspicuous trace on its own endogram, the brain needs a secondary and independent response system for the job. This "off-line" response system is furnished by speech, whose effects are

restricted to the bringing about of modifications in the ongoing endogram. Thus the modifications that occur in the endogram are, in this instance, the result not of changes in the organism's field situation, but of what the brain is doing to the endogram from within. Speaking and thinking generate images in the brain (Posner 1993) and these are figurally featured in the endogram while the activity is in progress. This is a self-generated superimposition over what the endogram would otherwise display.

The brain's "writing" is then this conspicuous figural effect as it contrasts with the background of its experiential flow. The "writing" would, of course, be impossible if the peripheral motor-system had to do it. The motor-system's task is to serve the organism's ongoing adjustment, and this depends upon continuous readiness for improvisation. The peripheral system's operational latitude is tied to the task of coping with situations and contingencies that arise in the environment. By contrast, no such constraints apply to the intracortical speech loop's functioning, whose "off-line" system is free to impact word-induced images on the endogram at will and without binding consequences. While speech-thought deals only with percept evocation in the brain, program options that are generated in this way can be acted upon by the motor-system if desired. There is no action–compulsion about it. It is a device with which it is possible to shape and influence the brain's totalization and to provide it with mental options that may or may not be chosen for implementation. In short, speech-thought is an ingenious mechanism for handling and managing the self without automatically committing it to irreversible consequences.

It is relevant that the reflective human brain also experiences its own contribution in addition to its sensory online experience. This plays an important role in the breakthrough to self-detection. Certain aspects of the endogram are speech created while others are not. The difference itself is meaningful data that can be felt, sorted, and interpreted. From such beginnings it is only a short step to noticing intracortical doings and to the generalization to an internal "doer." The evolution of this impression will be traced and drawn together in the next chapter.

To answer the second question: the brain's task of "reading" what it is "writing" is equally straightforward. If reading means the receiving of a message (instruction or implication), all pertinent brain responses that meet the "written-over" (modified) endogram must be taken to mean that the alterations have been read, that is, recognized and reacted to. Having responded, the brain is free once more to alter the message, repeat it, or hand the situation over to the motor-system for behavioral implementation. This self-directed interference is an excellent way to upgrade the

organism's processing and response efficiency. It permits the full utilization of the readily available and behaviorally inexpensive response diversion that speech provides.

Through the speech loop the brain has access to the endogram, and it is able to turn this to the organism's best advantage. For example, it can set up for perseveration and highlighting what it feels to be relevant, and so can change the balance, mood, and significance of the throughput. This enables the brain to form qualitatively superior schemata and mental options for consideration. Furthermore, it is able to gather relevant data about its own role in shaping its experience.

Turning to the third question about the nature of the experiential span in whose compass self-monitoring takes place, there are two points to emphasize:

- Percepts are not "on-off" occurrences, but take time to reach developmental completeness in the brain. For example, in the visual modality the process takes something like 500 milliseconds (half a second), which is a considerable duration. The maturation process begins with low-grade primitive components that are indistinct, emotive, peripheral, and poorly integrated. It then upgrades gradually in detail, accuracy, and integration. The resultant endogram is then a continuously updating presentation of integrated material. Low-grade components do not reach it and are not entered into awareness, whether human or animal.
- To ensure good percept integration and high response quality the brain uses selective inhibition to suppress undesirable components before they can reach the endogram, that is, the level of awareness.

To appreciate the meaning of this form of control, not only for behavior but for the validation of the time-extended model of the endogram, we turn briefly to an interesting aspect of the perceptual-defense paradigm. This aspect is the phenomenon of "suppression," the mechanism that interferes with the cortical integration of ego-threatening stimuli. In the experimental setting, ultrashort exposures of offending words or images have their entry into awareness blocked. The existence of this interference response is strong confirmation that the endogram is an event-region in fact and not an unextended instance of experience, as the traditional model has it. The event-region represents space and time in which the brain can get at the incoming material, processing and sorting it "in flight." It enables the brain to survey, pass, reject, or modify the throughput, to deflect what is offending material and manage the organism's successful adjustment. The manner in which this is done gives us clues about

the intrapsychic workshop and about how the extended model of the endogram functions.

To sum up, the brain has the temporal and technical latitude to affect the endogram and to use its information content, consciously or unconsciously, to shape its configuration. Therefore, the brain can be said to "read" what it is "writing" and to conduct this "writing" to maximize and satisfy the organism's intentionality. It can also be said that the brain's processing capability is subtle enough to be accepted as the sole source of its self-detection, functional upgrading, and self-accessibility.

Drawing these lines together, the endogram is a continuously updating situation report. In it, all input to the perceptual side of the system is integrated. The resultant presentation is the basis of the motor response that carries forward the organism's adjustment. This supplies feedback data that alter the endogram and invite further motor responses in their wake.

In the animal model, in which simple nonreflective awareness is the topmost level of integration, there is a continuous circular flow of processes that cannot be deliberately and internally accessed and modified. By contrast, in the human model this is possible because there is a secondary response system (speech-thought) to do the job. The task of this internal response system is to manage the endogram itself. It alters its balance and generates in it highlighted "figure" features that are essential for thinking and reflection. But this is not all. The speech loop's interference with the endogram is itself proprioceptively sensed experience and therefore data in its own right to be thought and reflected on. By way of this reentrance there is also a continuous flow of data to the brain about its own contribution to its experience. The only thing missing to make this a workable format of reflective awareness is the insight that a double-stranded pattern of parallel events is involved. The primary strand of this pattern represents semantic contents as process. Its secondary strand represents the processing function as semantic content. The most important aspect of this pattern is the novel attentional arrangement that the double-stranded experiencing necessitates. As will be shown in the next chapter, the strands are independent products of a peripheral and an intracortical response system. They constitute independently recognizable experience and demand attentional focusing appropriate to them. This demand can be satisfied only by continuous attentional shifts from one to the other. This activity is additional data about internal self-management and about the operational freedom of the brain. This unfolding pattern of transactions may seem complex. However, it will be shown that no more is involved than a forward-feeding juggling act of totalizations. This permits the brain to

account for its naive experience, and so the problem of the receiving agent does not arise.

Finally, as there is constant emphasis on the "figure" component of the endogram, it needs to be stressed that this "figure" feature is not unique to human processing operations, only that humans alone can make use of it with deliberation and self-directed intent. This is possible for humans because with the help of language they can project any percept entity into the focal position of the endogram and keep it there for the duration of thinking or speaking. The "figure" position is the speech loop's target area in the flow of the ever-changing background of perception. It is the point of entry through which mentally handled (i.e., thought) material is able to join the mainstream of perception to perform its modulating and guiding work. However, it also means that since this point of application is invariably focal (i.e., figural) in the endogram, the impacted speech-thought material always has high attentional priority. Conversely, whatever the intracortical response loop picks out of the background for speech-thought must at once become figural, highlighted, and important.

In the next chapter we shall take a closer look at the modifications that language has brought about in brain processing. This leads to the formulation of the reflective-awareness paradigm and the demonstration of how reflection and self-awareness work, the mechanisms they depend upon, and the consequences they entail.

6 Reflection: The Key to Human Awareness

If awareness in some rudimentary form is an inherent property of living matter, then conscious awareness was always a possibility as an effect of increasing specialization and complexity in the organisation of the nervous system in which the central exchange component evolved.

—B. Towers (1979), *Consciousness and the Brain: Evolutionary Aspects*

A Double-Stranded Reentrance

These issues will only be settled when we have a plausible theory of the brain, which incorporates a role for consciousness. My suspicion is that in the face of such a demonstration the logical objections to the identification of consciousness with some aspect of brain functioning will rapidly evaporate.

—J. O'Keefe (1985), "Is Consciousness the Gateway to the Hippocampal Cognitive Map?"

In this chapter I want to show that our reflective awareness is not a homogeneous single entity but a functionally composite phenomenon that has two neurologically distinct components. If, as it almost always happens, these are telescoped, clarification becomes impossible.

The basic component of human consciousness is animal awareness. This is the integrated neural representation of the world as assembled and experienced by the infrahuman brain. It is what the animal orients by and to what it behaviorally adjusts. The second component is the reflecting technique that only humans possess. Its operational arm is language, the manipulation of percepts with words. This generates trains of thought but also the proprioception of the deed, that is, the feeling that we are doing it. As a result of this double-stranded operation the brain has to attend to two inputs at the same time: the handled content and the handling of the content. As we speak or think both inputs are figurally (focally) featured in the endogram and sharply contrasted with the non-language-managed background on which it is superimposed. Our awareness is reflective because

the brain continuously shifts its representations, keeping the attentional beam darting to and fro between experience, its proprioception and the rapidly alternating regression of representations that do not terminate but feed on, and respond to, one another.

The traditional view ignores these interacting components of the brain and sees the conscious mind as a structureless entity. Hence it cannot account for human experience. Without insight into the technicalities that make it self-accessible, the brain cannot explain its reflective functioning. It reverts to dualism, the "mind–body" dichotomy of old, or accepts the model of the computer analogue by default. Either way, the impasse is here to stay.

Turning to the naive brain's commonsensical misconstruction of its self-generated double-stranded experience, we can observe that rather than recognizing that speaking or thinking is the true source of its intrapsychic experience, the brain takes the latter to be the former's cause. Without realizing it, it attributes speech-thought and even awareness to an inner agent. The switch of roles enables it to raise to the status of an entity the wrongly intuited cause of the experience and to forget that the true source of intrapsychic experience is not an entity of any kind but a continuous sensation of inner doings.

Unaware of this misattribution, the brain accepts the "agent," the "ghost in the machine," as the one who speaks, thinks, and experiences and feels no need to look for technically more sophisticated explanations. On the contrary, it goes along with what seems plausible to it, and the agent becomes "fact."

Although the brain is capable of solving the puzzle of its reflective propensity, the task is complex and seldom attempted. Traditional ideas constantly intrude, generating simplistic "solutions." The agent's position is further strengthened by the baffling reversal of the stimulus-to-response linkage where speech or thought are involved. Thus, although language is an internal motor-response, it is also a guiding influence and a causal antecedent of the next moment's experience and behavior (downward causation). This "off-line" speech-thought function changes the organism's course of action; this "pacing," guiding role of the language-wielding brain is hard to deny or explain.

To enlarge on the "pacing" role of the speech-thought-capable brain we have to look at the attentional changes necessitated by our double-stranded processing (i.e., our managing our mental contents and noticing this activity at the same time). While on the animal level the attention is captive to significant stimuli, on the human plane the attentional beam can be

deliberately and internally directed. We can concentrate on a given subject, look at this, think about that, focus here or focus there at will. We can come and go and run our own show with considerable freedom and operational latitude. It is language that allows us to do this. It provides us with the motor facility that lets us rummage about in our percept reservoir. This has far-reaching implications for the brain's relationship to itself and for its manner of coping with problems. Two points in particular need to be clarified:

1. The attention, captive to percepts of binding intensity at the animal level, is now at the beck and call of the speech-thought transaction itself.
2. This new situation has the result that any percept is now able to draw on attention as long as it is part of the ongoing speech performance; in other words, as long as it is included in the privileged frame of this intracortical technique.

In light of point 2, it becomes clear why even nonsense words or gibberish can command attention and be the subject of conscious awareness, that is, can receive reflective and focal treatment in the endogram. No longer is it necessary for an individual percept to be attention binding by virtue of its own intensity. All the attention it needs is at its disposal by courtesy of the attention-binding facility of the speech event in which it participates.

It is proposed that the neural transactions that carry the speech process create and maintain a protective umbrella under which individual percepts can come and go with ease, be chopped or changed or taken up again as the communicational requirements then in progress demand. This is a remarkable evolutionary breakthrough. It liberates the organism's word-percept repertoire for instant usage "on the cheap," well below the intensity threshold for independent attention binding to occur and motor response to take place. In this privileged format percepts can move in and out of the speech frame, enabling the purely mental manipulation of the material. Conclusions arrived at need not be implemented at once but can be stored, modified, or canceled. The format is ideal for tentative trial-and-error runs because it is the speech frame that is holding the attention and the percept reservoir is free to be used for the purpose of drawing up motor alternatives and action schemata. Confirming this license Edelman (1992) observes that: "Verbal schemas in conceptual areas can, through the activity of the frontal cortex and limbic system, dominate the apportionment of disinhibition by the basal ganglia which have strong connections to such regions." It is not surprising that we feel

marked ideational freedom to fashion, if not outright create, our intrapsychic experience.

Let us now examine what happens to the attentional process once it is locked in with the speech event. Recall that speech-thought brings about two experiential strands that run in parallel. These strands of content and proprioceptive (self-) sensation constitute a dual input that has to be simultaneously attended to. To be able to do this and attend to the speech frame that carries them, the attention has to be divided. But how can this be done? The attention cannot be split, yet attentional sharing is achieved and the mechanism for this must be identified.

Attentional oscillation (first mentioned in chapter 2) is of course the answer, the technique of to-and-fro shifts between content strand and self strand. If it is through such oscillations that the attentional process manages the parallel strands, our experience would have to be one of continuous fluctuations between the superimposed sensations of what we are saying and the feeling that *we* are saying it. This superimpositional duality, with alternating emphasis on the two components of content and self, is precisely what we experience. Furthermore, this experience is remarkably uniform inter- as well as intraindividually.

While the encephalographic tracing of these synchronous strands should be possible and data about them may well be embedded in recordings already on hand, their subjective confirmation is commonplace experience. For example, we may take an object and just by focusing on it we notice almost at once that *it* (the content component) begins to recede and become overlaid by the nonthematic sensation that the whole experience is our own doing. However, this sense of self-contribution, too, begins at once to fade, allowing the attention to swing back once more to the object in focus, from there to fade in turn, accentuating the self-sensation once more before the attentional pendulum swings back to the object again. This continues with alternating emphasis, accentuating the first, then the second component, with unending regularity. Confirming this, MacLennan (1996) observes that, say, an object "is part of my awareness and partly constitutes my experience of the world. Then at the next moment it is an object of my awareness, an object of something that constitutes my experience of myself." The experience is as familiar to us as it is mystifying, because no sensible model has ever been proposed that could have thrown light on how the intracortical arrangements created the effect.

As to whether the attentional process can be credited with managing such a pattern of to-and-fro fluctuations between content theme and self theme, it has been noted that brain excitations do rise and fall in a graduated

manner. They do not turn "on" and "off" like an electric switch. There is plenty of micro-developmental time for the attentional focus to turn away from a percept and return to it well before it could fade. Both strands of the dual experiential layout (the content and the self) can be comfortably carried and held inside the oscillating attentional play, with neither strand in any danger of becoming lost, at least not under normal conditions. This confirms that the pattern is feasible and workable.

One or another of the input strands can, of course, be lost temporarily. This is an irregular occurrence, but it is of some interest as it furnishes indirect evidence that supports the model. For example: the loss of the self theme is a standard feature of the hypnotic situation. In this situation the content strand of the experience goes on unaccompanied by the proprioceptive sensation that ordinarily supplies the self theme. No conscious trace is laid down or can subsequently be recalled: nothing in, nothing out, as it were. The hypnotic event itself is based on the substitution of the hypnotist's voice for the subject's own verbal self-direction. This pairing enables the attentional oscillation to occur, though not between the two internal strands, as it normally does. It occurs between the content strand and the substituted external source of verbal input, that is, the hypnotist's voice. However, since the subject's own executive motor contribution has not taken place and no proprioception with conscious awareness dependent upon it has been generated and laid in, the incomplete event cannot be accessed or recalled. As it is, this could only be done by the executive motor center, the very thing that suffered the exclusion. The point is important because it shows that the blocking of the proprioceptive doing sensation cuts reflection as well. This demonstrates that human awareness is something that has to be manufactured, that is, actively done. It is not just there as an inalienable property or built-in characteristic of the brain. The individual's behavior in the absence of the self component can, of course, be no more than automatistic (i.e., mechanical) and therefore can lack a sense of personal presence and inner directedness.

The loss of the self strand can occur also by means other than hypnotic induction. There is, for example, the common enough experience of paragraphs or even pages being read without conscious participation and no subsequent recollection of either content or event. The individual "comes to," as it were, reengages the self component and resumes the normal functioning mode of attentional oscillation, but never recovers the memory blank.

The obverse condition, the loss or excessive blurring of the content strand, may also occur. Certain drug states, psychotic conditions, and

metabolic disturbances can affect the intracortical balance and accentuate the self strand at the expense of the content strand, or it can weaken the latter. This prevents adequate percept integration and can bring about so-called *oceanic conditions*, the overwhelming sensation of a contentless and omnipresent self.

To sum up and to bring these aspects into proper focus, let me reiterate that there is the primary or content strand, interacting with the secondary or self strand, and finally the attention process in constant oscillation between the two. It is significant that the attention is no longer captive to the content strand, as it used to be before the evolution of language and the need to divide its focusing. In the new processing format the totalization of experience also includes the brain's active contribution as experience. This totalization never stops but keeps being reconstituted. So does the reflection that makes the endogram self-accessible, that is, turns it into data for itself. It is like a process-dependent, forward-feeding juggling act that cannot be resolved. The reflectively conscious mind, as indeed its nonreflective infrahuman variant, never reaches completion because it is neither a receiving entity nor a function that can be concluded. As soon as the secondary strand (the source of its reflective dimension) disengages, it simply ceases to be, and nothing remains to register its disappearance.

In the coming chapters I shall have more to say about what humans can and do make of these extraordinary intracortical acrobatics. Right here it suffices to say that the brain's acquisition of self-knowledge and self-management constitutes a far-reaching evolutionary breakthrough. It enables humans to have an active role in the shaping of their experience, though only at the cost of losing the protective mindlessness of prespeech innocence. We might say that for a pottage of upgraded processing excellence humans gave up a "birthright" of naive but secure anonymity. Having become data for ourselves we must now shoulder the stress of insight and see how best we can cope with the exponentially expanding complexity of the brain's evolutionary achievement.

If it is mindless self-inaccessibility that characterizes the primate's brain functioning, it is clearly with its speech specialization that the human brain is able to double back on its own doings. It is this that allows it to respond differentially to the total endogram on the one hand, and to its own special contribution on the other. Without speech-thought there could be no inward penetration and self-perception of any kind. The brain could neither construct the "self" nor think about it. The organism—however complex—could not be data for itself. Having speech-thought, the brain is

able to reflect upon itself and function as the cocreative source of its own experience.

These observations take us directly into the processing labyrinth of the brain that renders the endogram accessible to itself. We can now draw together the pieces of the puzzle and the subplots of the breakthrough into a meaningful pattern. This pattern is the solution of what, without bridging insights, would seem incomprehensible, or of another order entirely.

B The Mechanism of Reflective Awareness

> These symbolic self-representations lead to a continued alteration of the subject's transcending reflection. This brings about new sequences of activities and these in turn bring about new symbolic representations. The nature of such a system is that it is never the same, never closed or at rest. It asks questions about its world and about itself which it cannot answer because it changes continually.
> —O. D. Creutzfeldt (1979), "Neuropsychological Mechanism and Consciousness"

The conscious system's experience is continuously changing. The formula responsible for it, and for our awareness of it, is invariant. It is this invariance that is the key to reflective awareness and to the riddle of the human mind.

In this domain of imprecise concepts, characterized by Oakley (1985) as one in which "there are as many definitions of awareness or consciousness as there are writers and readers," it is helpful to simplify and to eliminate unnecessary terms. I propose therefore a clear dichotomy based on functional criteria. The first is the ground-level or *simple (animal) awareness*; the second is *reflective (human) awareness*, the endogram's accessibility to itself characterizing the latter. The difference between the two operational levels is an "all or nothing" watershed, with humanity by itself on one side, and all other creatures on the other. However complex a given organism's brain might be, if there is no special facility such as language with which it can internally handle itself, its awareness can only be simple. Such an organism is alive and reactive, but not aware that it is aware. Its endogram is not self-accessible, that is, it is not data for itself. By contrast, if an organism is reflectively aware, its brain knows that it knows.

Unaware that there is a watershed, Oakley (1985) and others seem satisfied to conclude that "The mental experience of animals is similar to our own" and that "There is certainly no reason to assume that human self-awareness is the unique property of our own version of the vertebrate brain." This denial of the difference gives comfort to the mystic and the ape-talk enthusiast. The telescoping of awareness and self-awareness shows

what we are up against: the nonrecognition of our uniquely human "off-line" internal response loop, the source of our knowing that we know.

The model I am proposing is built on awareness, the biological entity that is the basis of the motor response. Our already compromised position leads to the difficulty of seeing it for what it is. We can't subtract self-accessibility from what we experience and reach the baseline. Nor can we access the conditions of the breakthrough that raised us to our present vantage point. We can model the changes in technical terms but can't hope to trace the transitions that landed us on the reflective upper tier with all other creatures remaining on the unreflective lower tier. It is then the inaccessibility of our evolutionary emergence that gives us license to believe what is pleasing or naively plausible.

To clarify the model I am proposing, we must go back to Minsky's (1985) formula for "creating a self-conscious organism." It reads:

> Divide the brain into two parts, A and B. Connect the A-brain's inputs and outputs to the real world so that it can sense what happens out there, but don't connect the B-brain to the outer world at all. Instead, connect it so that the A-brain is the B-brain's world.

Minsky's formula is a useful lead, except for a vital flaw in the last sentence. This flaw could be eliminated if the terms A and B were exchanged so that the sentence would read: "Instead, connect it so that the B-brain too is part of the A-brain's world." This is because the A-brain is the sole seat of awareness, the only possible locus of experience. This is axiomatic. No organism, simple or complex, can shift its sensory totalization elsewhere. It can, as in the case of humans, turn it reflective, upgrading it and feeding it back into itself, but this is not the relocating of the experience to a new site. Yet this is what Minsky's formula would come to. His B-brain is clearly a new locus of experience, and this entails the inadvertent reconstitution of the very problem he set out to solve. If to account for consciousness we need a new seat of experience, we would need yet another seat to experience our experience, and we would have a regression not a solution of how consciousness works. In short, we are back to square one. If, on the other hand the B-brain is taken to be the new subsystem for running the "off-line" language loop that generates thought and the proprioceptive evidence of this internal activity, we have the answer we want. We have the basic creature boosted by ingenious neural techniques so that its awareness displays these internal activities superimposed upon the baseline. Note that the locus of experience does not shift but is augmented to self-accessibility. In the next chapter I shall give a detailed account of this

B-brain, this new "mind system" and the way it changes the ground state out of which it evolved. In the end there is no magic, no miracle, no infinite regression, but only a system-shifted circuitry that is fed back into itself.

So let us summarize. What we colloquially refer to as our "conscious mind" is really only the old primate brain revealed to itself and empowered by new techniques to take an active part in guiding itself and generating the awareness of being aware. The breakthrough is nevertheless an epic, a passport to a new internal sphere of operation.

I want to say a word or two about David Chalmers's (1996) "hard problem," of why we have "subjective conscious experience" over and above the "neural information-processing" that is its substrate. I want to show that the "problem" is not hard but a modeling error: "the separation of thinking and cognition from the qualitative and phenomenal feeling that goes with consciousness." Believing that the brain's information processing is sufficient unto itself, Chalmers is at a loss to know what to make of consciousness, the subjective experience that appears to him to have no function. As a result, consciousness becomes a mystery, an intractable problem by default. Confirming this, Clarke (1997) observes that: "If experience is taken to be something over and above the neurally instantiated functions, something extra which accompanies them, the central mystery of consciousness becomes the explanatory gap between function and experience." The implication is clear. Chalmers has generated a conceptual maze of misconstructions. As he will not change the premises responsible for this outcome, he is stuck. To get out of the bind he opts for mystery and an additional "cosmic principle" of consciousness. He falls back on dualism, a poor solution. Unimpressed, Patricia Smith Churchland (1997) comments that: "The only thing we can conclude from the fact that consciousness is mysterious is that we do not understand the mechanism. Moreover, the mysteriousness of a problem is not a fact about the problem, it is an epistemological fact about us." Reflecting on the recurrence of misconstructions of this kind, Searle (1992) observes that: "If we were to think of the philosophy of mind as a single individual, we would say of that person that he is a compulsive neurotic and that his neurosis takes the form of repeating the same pattern of behavior over and over."

On balance, Chalmers's "hard problem" is a readily traceable misconstruction. It arises out of the inappropriate modeling of consciousness and mind. His conclusion, that the consciousness phenomenon is neuroscientifically intractable and that we must have a "cosmic principle" to account for it, is therefore wrong. Patricia Smith Churchland commenting on this

notes: "The argument is obviously a fallacy. None of the tended conclusions follow, not even a little bit. Surrounded with rhetorical flourish, much brow-furrowing and hand-wringing however, versions of this argument can hornswoggle the unwary." She adds: "From the fact that we do not know something, nothing very interesting follows. We just don't know." Regrettably problems like that of Chalmers tend to have a long half-life, generating ripples, calling for rebuttal and taking up brain power that could be better employed in tackling real issues.

The locus of awareness and its higher variant "consciousness" is an interesting problem. Taking Libet's (1990) "time-on" theory, awareness and consciousness are achieved at the highest levels of afferent (perceptual) integration. This suggests an event region where high-quality sensory information becomes available to the motor system. So we are looking for a narrow band of spatial and temporal concentration, the "crucible" where the organism's optimal behavioral course can be sensed and set in train. This narrow region is a fair characterization, for as Zeki (1990) observes: "There is no master-area to which all areas project" and "Whatever integration is taking place has to take place by reciprocal connections which occur in all stages." So without a fixed spatial locus the endogram is achieved and maintained through the temporal integration of its spatially separated elements. These elements are on different levels and in different modalities. They are brought together in a temporal sense in a manner similar to that of an orchestra achieving musical integration. Corroborating this, Francis Crick and Christof Koch (1995) have isolated a 40-hertz synchronous oscillation linking brain areas jointly engaged in conscious processing. This may well turn out to be a traceable effect of the temporal integration of the coacting areas involved. The musical metaphor for the achievement of consciousness is also feasible because music, like the production of awareness, is dynamic and time-dependent as well as formative of the character of the unfolding performance.

The endogram is a distinct biological entity that acts upon and is in turn acted upon in the course of behavior. Its reflective human version upgrades the system but does not change the terms of reference. Its self-accessibility empowers it to assess potential outcomes and to guide the organism with insight, foresight, and an understanding of context and relevance. Reflective awareness is therefore a breakthrough to self-responsibility. It implies some form of biological morality in the broader evolutionary context. I shall have more to say about this in chapter 10.

Leading into the discussion of how the endogram became reflective, the animal model's transformation into the "tripartite" arrangement of the

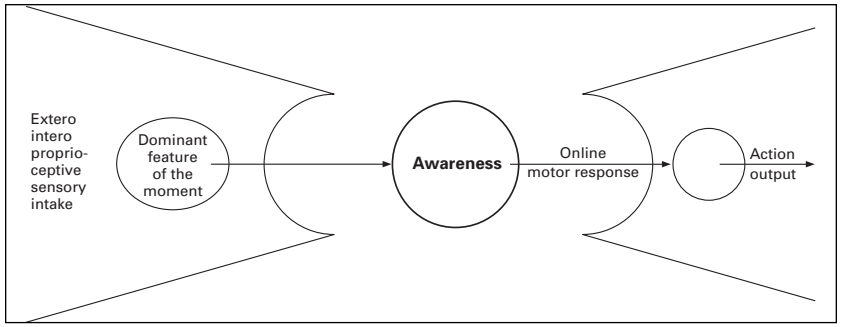

Figure 6.1
Models of animal awareness. The stimulus to response throughput is uninterrupted. The incoming sense-datum is totalized in the endogram. The attention is locked onto the dominant feature of awareness and an "online" motor response completes the sequence.

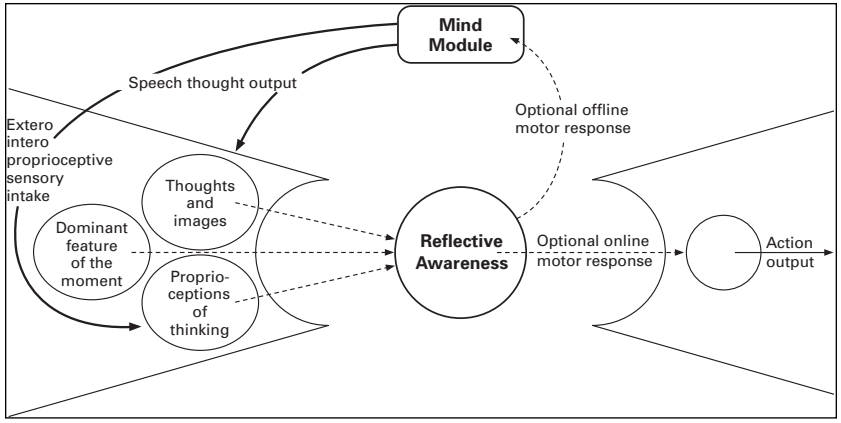

Figure 6.2
Model of human reflective awareness. The stimulus to response throughput is internally manipulated. The incoming sense-datum is totalized in the endogram, which features two additional sites for the attention to focus on. They are the target areas of the reentrant products of the language mechanism, that is, the thoughts and images it generates and the proprioception that goes with it. As the motor-arm of language is under voluntary muscle control, it switches the attention from site to site in rapid succession as it handles the experience and experiences the handling that turns the awareness self-accessible, that is, reflectively conscious. The key to this breakthrough is the mind-module that orchestrates the use of the "online" and the "off-line" alternative response options.

human brain needs to be outlined. The task is to show how a new structure, "the mind-module," was wired-in and the new function of speech-thought turned the endogram layered. See figures 6.1 and 6.2. That is to say, it was boosted to have not just one but three types of salient features for the attention to focus on and switch between. It will be shown how the motor-arm of language with its voluntary muscle control manages the intracortical transactions and registers the production as experience as it is taking place.

To wind up these preliminaries I must mention the "matching" function that complements our speech-thought performance. To align and articulate word-percepts on the conveyor belt of language makes no sense without checking its relevance and keeping the delivery on the right track. To manage this the brain has to monitor the output almost continuously. However, this monitoring is not the same operation as the ongoing speech production which it controls and complements.

We shall now turn to the discussion of the interactions that render the endogram reflectively conscious, that is, accessible to itself. We shall look at the material under seven descriptive points:

1. Speech-thought is the left hemisphere's sequential alignment of word-percepts. The matching function that accompanies it is the right hemisphere's chunkwise comparison of the verbal output with the template of the intended message.
2. Speech and the matching function are complementary operations. They form an action system whose integrity cannot be compromised. Neither speech nor the matching function makes sense without the other.
3. The variability or style of speech (its tightness, looseness, richness, accuracy, etc) confirms that it is the product of an interplay between left-hemispheric motor centers of control and right-hemispheric perceptions.
4. The speech process involves attention sharing, which is achieved by oscillations between the content of the delivery and its sensed doing. The matching function that accompanies it calls for an additional shift of attention to focus on the message that is being conveyed. This involves a further ramification of the attentional oscillations. This consists in targeting not only the content and the proprioception of the delivery but also the closeness of the correspondence between the delivery and the percept material delivered.
5. This complex action format of synchronously attending to content, production, and relevance is on continuous display in the endogram. From here it is picked up element by element, then bounced back to keep the pattern going—focusing in turn on this, on that, and on the third aspect—retreating from each by responding to one of the others. The pattern is

never terminated but is carried forward by the process whose proprioception makes it distinguishable from the endogram on which it is displayed.
6. While the content throughput during these transactions is always new, the technique that drives it is always the same. It creates a sense of inner space for mental transactions and for the manufacture of mind-generated experience. In it subprocesses interact and ensure that awareness keeps doubling back on itself, creating reflection on ongoing contents and occupying the focal position of the endogram for the purpose.
7. As this reflective mode of awareness is process dependent, interruption of the processes terminates the reflective state as well. This leaves the brain in the ground condition of nonreflective or animal awareness, though on this level humans are no longer functional. The human brain's integrative centers are wired in with the verbal facility that creates reflective awareness, and will not restart on the animal level. Humans' language-based consciousness is clearly more than mere "icing on the ape," and its contribution to the individual's growth is profound and irreversible. Humans are nevertheless capable of experiencing simple (nonreflective) awareness, albeit fleetingly, during moments of reverie and perhaps meditation. However, this cannot last, for some new thought diversion always restarts the intracortical juggling and reestablishes the active mode of self-processing and the reflection it entails.

To sum up, reflective awareness is generated by the application of language-driven and language-related techniques to the endogram. These techniques create their own trace and maintain a continuously self-reconstitutive mirror image of what is just then taking place. Since, however, this too is being continuously reflected on, as are all further members of this series, the content side of conscious experience is inconclusive and open-ended.

But if the content side of experience is ever changing, its technical basis is not. The process that generates conscious experience can be represented as an invariant formula that is an excellent framework for a comprehensive mind theory. That this has not been taken up before by others may well be because of the chronic misapplication of our proprioceptive experience as "proof" that there is something in us, something intangible, that is conscious and runs the show. Through misconception of the true situation we "perceive" our self-reflective endogram as a receiving "mind," an intrapsychic agent that lives in the body, acts on the body, and uses the body to act on the world. This is not only a recipe for dualistic self-perception but also for animism, religious beliefs, metaphysics, and mystery.

I shall now look at some relevant aspects of the reflective mode of functioning. These aspects contribute to, or are consequences of, the paradigm. In particular, I want to examine:

- How we manage our thinking
- The transformations and distortions we unwittingly generate
- The way distortions influence and constrain our perception of what goes on in our intrapsychic workshop

Since speaking or thinking is an intracortical operation whose functional units are word-percepts, anything we ever think of (rather than just vaguely visualize) must be in the word-percept form. Only in this form can modality-percepts (visual, auditory, or somatosensory) be handled in the neural transaction of speech or thought. However, to change sensorily coded material into the word-percept form is itself a transformation, and this transformation has qualitative and temporal consequences.

With respect to the former, it is significant that it is only after the word-response is given to the modality-percept that it takes on firmness and lucidity. It is what the word-response does to the prespeech modality-percept that changes it into the object-like stable entity of which we are aware. There is, of course, a close semantic relationship between the percept before and after the transformation. However, the reimpacted higher variant, "*X*," is not identical in experiential quality with the relatively transient percept, "*x*," to which the word-response first accrued. Whereas the *X*-percept is the content-enriched stabilized product of the word-response, the *x*-percept is only the product of the integration of sense data. It may be suggested therefore that the *X*-percept belongs to a new class of serially reimpacted (exclusively human) percepts with which speech and thought are transacted and which keeps the level of human experience well above the primate's experiential baseline. It is significant that these upgrading transformations do not just happen, but are *done*, and that the organism whose doings they are is in an excellent position to be aware of this. Word-responses and verbal behavior are therefore an important source of qualitative change to perception and a significant step in the humanization of functioning. The crucial point is that it is the response phase that plays the decisive part in what the organism will next experience, both in quality and in choice of subject. This is very different from the *status quo ante* where the response was only a *post hoc* accommodation to what the endogram signified. This is a fundamental change of roles from a passive to an active mode of brain participation in the shaping of experience. For this reason it was the acquisition of the language skill that humanized the

primate and not the other way around. It was language that brought insight and thought and upgraded the primate's behavior. To suggest that insight and thought as we know it evolved independently in the primate, and that language came along to give it expression, puts the cart before the horse. It overlooks the functional nexus between language and reflective capability and sees the "mind" as independent of language.

Consider now the second consequence of the speech-thought transformation. Changing the prespeech percept *x* to the *X* variant, that is, turning the modality experience into the thinkable form, though easy and automatic, takes some milliseconds to accomplish. This has the result that what we speak or think is not quite the same as the prespeech experience we set out to communicate. The object "table" when thought or spoken is no longer what it was when it was sensorily experienced. Let us recall that speech and thought always generate the proprioceptive feeling that the performance is done by us. Let us also remember that this sensation is the secondary or "self" theme that speech-thought creates. The primary theme is the actual content material that is being thought or spoken at the time. Our attention oscillates between these parallel strands, and "prints out" for us overlapping dual impressions such as "the table is over there" plus the feeling that "we are having the experience." There is an active self-component in our experience of the "table," so that it is not just the "table" that we experience but also that the experience is "ours."

But now if we think of the self (if we use it as content) we create an unexpected complication. We momentarily lose the contrast between primary and secondary strands because both of them signify the self, albeit as percept and as proprioception, respectively. The experience is blurred. Something like "semantic congruence" or "thematic fusion" takes place. We feel bewildered because *knower* and *known* merge, and the experiencer seems identical with what is being experienced. This prints out as "I am thinking me," where "me" and "I" are interchangeable and stand for experience, experiencer, and experiencing. The muddle defies decoding because the self is unable to isolate the proprioceptive component of the merged self-experience. By the time it manages to render even this proprioceptive aspect of the experience thinkable by changing it into the percept form, its doing so will have generated further proprioception that is not yet transformed, and therefore is not yet thinkable. We are forced to conclude that the thinking process, involved in this shadow game of chasing its own tail, cannot solve the mystery of the self. It always remains with a sizeable self-sensation that is experientially real yet outside the range of thinkability. The brain's failure to come to grips with the problem fuels the suspicion

that there is more to the "conscious mind" than meets the eye and there is no solution to the riddle. The "agent within" comes once more to the rescue, even if disguised in some pseudo-scientific way (see what was said about Eccles and dualism in section A of chapter 5).

By contrast, the new model of simultaneously attending to and experiencing the two parallel strands of content and proprioception solves the mystery. It predicts that if the experiencing self *itself* is being thought about, then the brain loses its power of discrimination and its ability to distinguish between what it thinks and what it thinks with. This intrapsychic telescoping is reminiscent of the "delayed-feedback" paradigm of experimental psychology. In this, the subject's own speech is fed back to him or her with a small delay. What the subject hears is not what he or she is just then saying but what he or she has already said, albeit an instant earlier. The disruption this creates results from an attentional hesitation about what to focus on and how to reconstitute the desynchronized routine.

Next we need to look at the perceptual raw material that speech-thought has to work with and which the brain must be able to furnish. There is, of course, a large reservoir of stabilised word-percept units ready for use. The brain is able to augment this with additional percepts as it goes along. It can shape and articulate percepts during the speech delivery and can achieve a good match between modality experience and its verbally rendered variant. The brain is, in fact, able to meet just about any degree of complexity of percept, concept, or schema. Varying lengths of linguistic articulations are needed, however, depending on levels of difficulty. The ability to make up new percepts or percept configurations means that the brain is able to generate the stuff it wants to handle and of which it wants to be reflectively aware. This is true operational freedom, demonstrating that we can shift about in our inner field of stored as well as ongoing experiences. It shows how we switch from *this* to *that* aspect, first focusing our attentional beam on selected features, and then shifting it to close in on some further aspect of relevance. This facility to fashion percepts and to play around with them in language-created reflection is an ideal means of mentally manipulating the experiential flow of thought and for penetrating the very process that is responsible for it. Since reflective mental operations wholly depend on the off-line response system of speech-thought, it must be concluded that the creature's awareness cannot be reflective where special motor techniques for this purpose are not in evidence. Thus, however bright the dolphin or the chimpanzee, unless an intracortical facility for self-accessing is demonstrated, it cannot be assumed that they know that they know, and therefore have minds like ours. Also, since the nexus

between language and the reflective mind is absolute, the latter cannot have existed without the evolution of the former.

Finally, it is necessary to stress that—in spite of the brain's greatly enriched percept reservoir and the conscious lucidity with which it is able to handle it—there is no certainty about the truth-value and the factuality of its output. The thinkability of a percept involves no more than the application of a neural technique to it, and this can have quite distorted and unreal results. It can be concluded, therefore, that while our cognitive skills are indispensable for handling the world and for building representational schemata to depict it, only high-grade correspondence between these representations and what they refer to can lead to the understanding of reality and the way the self-accessible human brain works.

C Self-Awareness

Upon first reflection self-consciousness is likely to seem implacably mysterious and utterly unique. This is part of what makes it so fascinating . . . Self-consciousness, it seems, is a kind of continuous apprehension of an inner reality. A reality of one's mental states and activities.
—P. Churchland (1984), *Matter and Consciousness*

In the last section we have looked at some of the consequences of rendering experiential material suitable for speech or thought. We have noted the distortions and the time lag that the transpositions into the thinkable form create and the sense of mystery that shadows the percept entity of which we are conscious. The technicality of this phenomenon is hard to trace, though once it is understood, the mystery is dispelled.

There are some special problems with self-awareness. Churchland (1984) is right in suggesting that it is "utterly unique" but wrong in characterizing it as a "kind of continuous apprehension of an inner reality," for this is only the sensation it creates, not what the process is. Although incorrect, the characterization is interesting because it affords a clue to what is wrong with this sort of unanchored conceptualization. In this case it revolves around the by now familiar telescoping of content and function. Self-awareness ceases to be mysterious if we realize that we are dealing with two entities rather than one. These are the entity of the "self-percept" (constituting content) and the entity of the "self-sensation" (representing proprioceptive function). Now since function does not vary with content, and awareness is awareness regardless of what we are aware of, our being aware of the "self," that is, our being self-aware, is not a technically irregular occurrence that involves something new. The sense of undeniable specialness

that accompanies the self-conscious state must therefore be attributed to the noted thematic fusion, the running together of content and function when we are dealing with the "self." The phenomenon is, of course, baffling. This is further aggravated by the fact that only the self's thinking about itself brings it on, and because our introspection about it renders the problem intractable. Underscoring the point, O'Keefe (1985) observes that:

> The strangest source of the mind-ness of my consciousness is the phenomenon of self-awareness, the awareness of being aware. This quasi mystical notion with its constant threat of tumbling the introspector into the chasm of infinitely nested awarenesses (I am aware, that I am aware, that I am aware), has seemed the least likely of all attributes of consciousness to admit a scientific explanation.

Yet, as we have seen in the last section, there is no mystery at all. The self, when thinking about itself, enters itself into the experience of the moment along both strands, that is to say, both as percept and as proprioception. This brings about semantic congruence, the loss of contrast between what is thought and who thinks it. The experience momentarily blurs, and it is this confused global self-sense that we are next thinking about. Our thinking—far from clarifying the issue—makes matters worse by topping it up with the proprioceptive self-sensation of the introspection. The exercise is clearly regressive and insoluble, although entirely predictable in terms of its technicalities. Without an explanatory model that is able to shed light on what is going on, the brain has, of course, no choice but to give up trying. Its introspection can lead it only deeper into mystery and into the trap of the mind–body dualism that shifts the technical problem onto the transcendental plane where common sense no longer reigns. This links back to Creutzfeldt's (1979) observation that:

> The symbolic self-representation is the basis of the dualistic experience of the self. In this sense, dualism is in fact the nature of our experience of consciousness.

The "explanatory" distortions in response to the mystery of reflective awareness extend from the trivial to the profound. They manage to put a dualistic construction on our monistic world. They take a world of consistent and interlocked functions and turn it into an untidy schema that relies on fiction and faith. It is ironical that the riddle of an unsolved technicality should suffice to frustrate the brain in demonstrating that its nature is physical and biological. The trouble is that (rather than leaving the riddle temporarily unsolved) the human mind prefers to generate fanciful theories about itself, and to come up with self-serving explanations.

To sum up, the self-percept is not a special entity in an irregular relationship with the brain, but a normal percept that is perfectly adequate for the

thinking process. The specialness that seems to accrue to it is caused by a semantic overlap that blurs the demarcation between the two input strands that represent the *self as content* and the *self as proprioception*. If the technicalities of the working brain were understood, the "mystery" could be seen as a predictable consequence of its production routine. The confusion remains, however, because while humans are ignorant about their brain's inner workings, they want to be soothed by comforting projections. Language, too, constrains understanding and has to be corrected for—specially where abstractions are involved and projections are hard to check. An example of this is the perennial *subject-object*, *knower-vs-known* dichotomy. This time-honored construct is the linguistic source of the nominalized psychic agent, that is, the "self," or the "mind," that manages the intrapsychic stage. This is a misrepresentation that raises more problems than it can ever hope to solve. Yet we are stuck with it, and shall have to account for it in terms of the technicalities that define the physical mind. The battle is bound to be uphill, as the brain is ill motivated to penetrate and solve the riddle of its own functioning. It risks having to abandon long-standing and comforting projections. Still, if the brain's misconstructions are ever to be dispelled, this will be accomplished with the very instrument that shields it from exposure. In other words, only the reflectively aware brain can redress the accumulated conceptual consequences of its past misapplication.

In the coming chapter we look at the mind-system as distinct from the brain. We shall try to decide whether there is enough reason to make this distinction and whether we are justified in identifying a "mind." If the answer is *yes* then we need to clarify:

- Why does the mind's self-conceptualization invariably lead to circularities that border on the nonsensical?
- Why do the mind's effects upon itself deepen the mystery?
- Why does the mind accept self-generated impressions of itself as objective data rather than as predictable side effects of the brain's functioning?

7 The Mind-System

The entity we call the mind is perhaps that part of the brain's functional organization of which we are conscious.

—N. Chomsky (1968), *Language and Mind*

A The New Identity: Brain to Mind

The assumption that consciousness is an epiphenomenon and of no interest to the study of behaviour, has to be discarded. New strategies must be found to define the conceptual properties of the mind, combining behaviour, phenomenal experience and neuro-biological data.

—A. Rougeul-Buser, J. Bouyer, and P. Buser (1978), "Transitional States of Awareness"

The end of the last chapter raised the question of whether there was justification in speaking of a mind or mind-system as distinct from the brain. This section argues that there *is* a novel physical system in the brain and that this system satisfactorily accounts for the subjective manifestations of what used to be thought of as the *nonmaterial mind*. It also shows that this new entity is not a mere continuation of animal awareness (its substrate), but is a superprocess that is built out of known and identifiable subcomponents of the brain's processing repertoire, with new interconnections and neural tissue to support it. The physical mind is the product of language-assisted integrations and involves a system shift. It represents not just more and better animal awareness, but an altogether new dimension of cortical management. However, this emergent character of the physical mind is not fully appreciated even by brain science. This allows for the indiscriminate attribution of the term "mind" up and down the evolutionary scale from the lowest organisms to the primates and humans, wherever neural (internal) representations are involved. Oakley (1985) observes, for example, that: "the emergence of neural modeling . . . corresponds to the emergence of mind." I argue that this overgeneralization is wasteful

and misleading. If all neural representation, from the simple awareness of the paramecium to that of reflective humanity, is designated as "mind," the term is as good as useless. This is unfortunate, because the mind can be shown to be a functionally distinct entity on the human plane. It can be identified as a complex system or module that is maintained by stable processing routines involving a variety of neural adaptations, supplementary growths, and functional rearrangements, all emergent and unique to humans.

To delineate this mind-system is not difficult, yet it is necessary to proceed with caution, as its many constituents are widely distributed and aspects of it are also shared by non-mind-related functions. The best way to approach the mind is through the content material that is within the range of what we can be aware. This makes sense because the content is also the implement with which we create awareness and because the two aspects cocreate the illuminated segment of the mind. This segment illuminated by the twin attentional beams represents only a tiny portion of a large reservoir of stored representations that can be drawn into the narrow focus of awareness. Hassler (1978) puts it this way:

> We must therefore conclude that our actual conscious experience embraces only a small area of all that can be potentially brought to awareness. The field of awareness is restricted and excludes a number of engrams. This leads us to postulate the existence of neuronal systems that are independent of most other neuronal systems and that have the ability to activate at a given moment only a small fraction of the huge mass of potentially retrievable material stored in the integrative cortical areas that are not primary sensory fields.

The neuronal system that is critically important for the mind's functioning is that of language. This verbal system includes all the subfunctions that are needed for the recalling, marshaling, and delivering of semantic contents by speech or thought. It implies a reservoir of stabilized percepts that are word-linked and can be used for creating awareness. Such reservoirs (and *ipso facto* minds) do differ in range, richness, and character, not to mention even larger cross-cultural disparities where the differences involve marked variations in patterning and representations. While these larger variations are the result of differences between languages representing differing cultural molds, they do not mean that neurofunctionally different processes are involved. Indeed, it is axiomatic that mind states, mind experiences, and mind functions do not vary in kind and neuropsychological significance.

To equate the mind with the reservoir of semantic units with which reflection is generated means that we can only be aware of the segment

that is just then illuminated, and that the rest of the mind is outside the immediate range of awareness. However, the unilluminated rest is also available for recall and inclusion in the focus of awareness and for generating the reflective state.

If we draw a sharp demarcation between the conscious and the unconscious segments of the mind (unconscious implying the material outside the illumination), we can use the conditions of entry into the focus of awareness for gaining insight into the mind's relationship with other subsystems of the brain. The blocking of the entry of a given input (its suppression or repression) can be accounted for in terms of inhibitory innervations. These innervations are triggered by subliminal exposures to threatening contents. However, for the brain to be able to decide what is threatening content and what is not, an initial entry into the system on the unconscious plane is necessary. As the endogram is an ongoing experiential wave in whose span percepts evolve gradually (see section B of chapter 5), inhibitory innervations can come into play and prevent integration and so entry into the reflective phase of awareness. Tachistoscopic (high-speed visual) presentations of emotionally threatening percepts confirm that such an initial and unconscious entry always takes place and that it is a subliminal response to the rising early phase of the percept that leads to its facilitation or suppression.

The possibility of permitting or blocking the passage of an input draws the attention to a censoring mechanism that operates in conjunction with the mind-system. It is important to understand how this censoring function works and to decide whether it is an aspect of the mind, on any level, conscious or unconscious. This helps in demarcating the mind's sphere of jurisdiction and assists our recognition of it in the processing tumult in which it is embedded. If the censoring function is not an aspect of the mind-system, then what is its status, manner of operation, and relationship to the mind it is designed to protect?

To clarify the matter it needs to be pointed out that a variety of inhibitory mechanisms exist between higher and lower centers of integration in the central nervous system. These keep an advantageous balance between interacting subsystems in the intuitively sensed interest of the organism. Higher centers can override or inhibit lower ones. Lower centers, too, can veto the higher ones, particularly where survival issues are involved. To quote Edelman (1992): "Such a view of attention still concedes the major overiding significance to non-conscious mechanisms and to the orienting behaviour mediated by global mappings in response to emergencies." It can therefore be suggested that the function of

suppressing subliminally sensed percept contents is not a function of the mind.

In his *The Logic of the Living Brain*, Sommerhoff (1974) traces the circuitry pathways of a given input. His findings are particularly relevant for the clarification of the mechanisms of suppression. Paraphrasing his results: an ultrarapid stream of excitations sweeps from the representational cortices to the frontal evaluation cortex. From here it descends to the limbic area and the reticular formation, where it is given or denied further facilitation by the arousal mechanism. The decision for or against facilitation depends upon the emotional implications of the input. If accepted by this subcortical censoring gate, the stream is sent once more to the representational and evaluative centers of the cortex, but this time with the attention/arousal component added to lead to awareness and/or motor response. If the input is not passed by the censor, all further arousal is denied by way of inhibitory innervations and the sequence is terminated without reentry into higher areas of consciousness.

Sommerhoff's analysis makes it clear that the mind operates (or more precisely, is permitted to operate) only in conjunction with the other subsystems of the brain. The mind, unaware of the protective conditions that surround it, is in no position to discover that it is being monitored and guided. The clues needed for this insight are not experientially available and are hard to come by, even through analytic inference. The mind's objective information about itself is in fact so limited that it is able to entertain fanciful ideas without fear of contradiction. As will be demonstrated in the next section, the mind's self-validation is solipsistic: it uses its impressions of itself to *prove* its self-impression. This allows it to accept simplistic notions such as an entelechy type of "free will," "indeterminacy," and even the "ghost in the machine."

Let us now delineate the mind in a systematic way. It is the brain's multifaceted subsystem for generating and maintaining the reflective self-accessible state. All structures and functions that are involved in this production are parts of the system. The mind's functional core is language, the facility that does the accessing. It generates superimpositions that are coexperienced with the rest of the endogram.

To manage this routine the mind-system must have:

1. Working parts, that is, word-percepts as units of transaction.
2. Working routines, that is, grammar and semantic transformations that code into and out of the semantic substrate.

3. A memory bank, including a retrieval mechanism and a short-term memory hold for organizing and managing the delivery.
4. A percept- or concept-generating capacity to match requirements and to furnish the brain with models for comprehension and coping.

To meet these specifications, to integrate disparate functions and manage the reflective state, the mind depends on structures such as:

A. The speech areas.
B. The frontal lobes to oversee and focus the output.
C. The cross-hemispheric link, via the corpus callosum, that integrates denotative and connotative aspects of the output.
D. The supramodal association areas to generate and supply percepts, concepts, and schemata to be used by the process.
E. The brainstem arousal system, which gives high-energy priority to speech-thought production.
F. The extensive collateral branching that rewires the human brain and boosts the new technical routines with massive neuronal growth. This arborization is entirely mind dependent and confirms that the mind system also involves self-generated tissue over and above modifications to, adaptations of, and recombinations of preexisting structures.

Without this complex multifaceted physical system the brain could not be aware of itself in a reflective way. It could not know that it knows, could not contemplate this or anything else and know that it is doing it. Humans would be like their cousins the big apes, subtle and intuitive, but not transparent to themselves. We could not upgrade and enrich our range of choice, insight, and behavioral options.

On the neural plane, the mind cuts in where animal awareness (its ground state) reaches developmental completion. The mind system is a time-dependent elaboration, built on event components brought forward from the animal level. The critical switchover is at the 400-to-500 millisecond level of integration, which is where—if no mind system existed—a motor response would occur. In this sense the mind is a higher form of internal responding. It arises out of and is built on more primitive and in part subliminal brain events. The mind-boosted brain's reflective performance and operational freedom is like walking on water while being fully supported by invisible neural stepping stones, that is, the substrate.

The mind system's physicality and the brain's dependence on it is shown by its vulnerability. Biochemically it is easy to disrupt it, distorting its perception and rendering it ineffective. The mind system's complex

topography, its manifold roots and structurally distributed character, is well reflected by the specifications listed above. In varying degrees it is an offshoot, a modification or rewired arrangement of preexisting structures, with copious neural growth to ensure the steady delivery of the transactions that are necessary for reflective functioning. Higher areas of the cortex are especially implicated in the complex orchestration the system entails.

It is possible to estimate the mind system's stratification by the pattern of its disintegration. Lesions and a variety of degenerative conditions give us an indication of the system's structural organization. The many types of aphasias, apraxias, and agnosias afford insight into the mind's wiring design and into the likely consequences of its malfunctioning. It is also possible to get some idea of the system's physicality if its essential growth conditions are denied and the pattern of stunting and incomplete development resulting from it are evaluated.

To sum up, the mind is a concrete and distinct physical system, involving identifiable structural components, functions, and products. It is neither a ghostly entity nor a mere incremental version of the animal's central nervous functioning. It is an emergent system whose unique contribution is the rendering of the animal's neural representations as perceivable and manageable internal experience. The mind's knowing that it knows is an evolutionary breakthrough and not a quantitative upgrading, as many would have it. Humans are more than complicated apes. Their formula of cortical processing makes them a new phenomenon altogether. This does not mean that there is not a great deal of common ground between human and infrahuman awareness on the level of their shared ground state. It implies that humans have managed to build another layer of processing and experiencing on top of the infrahuman baseline.

As we have seen, the mind operation is based on the language-guided manipulation of its percept repertoire. This involves double-stranded processing and experiencing, which in turn necessitates an attentional oscillation that is experienced in its own right. As the mind-equipped brain is clueless about the physical processes that sustain it, it is left with the impression of an inner self which it cannot account for. Since the human brain's self-experience is more baffling and elusive than any other experience it knows, its concern with it is as intense as it is unanchored in facts. In the section that follows we shall examine the mind's self-generated impressions. I shall pinpoint their functional source and demonstrate that the conclusions reached by the naive mind are inevitable.

B The Alchemy of Self-Deception

If physicalism is to be defended then the phenomenological features of experience must themselves be given a physical account.
—T. Nagel (1965), "Physicalism"

One thing that would greatly strengthen the materialist case here would be the production of an independently plausible explanation of why materialism is introspectively implausible.
—D. M. Armstrong (1968), *The Headless Woman Illusion and the Defence of Materialism*

In this section I shall examine the conditions that fashion the self-aware brain's conclusions about itself. While it is illogical for the mind to doubt its own competence, it is possible to show that the technicalities of its functioning generate for it plausible if incorrect impressions. These impressions form the basis of the mind's misperception of itself and must be traced and corrected. The task is to figure out why the reflectively aware brain deceives itself into concluding that the mind is spiritual in character when it is in fact wholly concrete and biological. I am not suggesting that the mind's self-deception is deliberate, but that the exigencies of reflective awareness and the verbal system's functioning block insight and generate mystification. Accordingly, I propose that the normal functioning of the reflective brain is the inadvertent cause of the delusional slant of self-experience. Furthermore, I propose that this is the source of our entelechy[1] type of "free will" experience and of the epistemological riddle of how the knower knows and how awareness becomes reflective.

We start the analysis by drawing attention to four types of seemingly indisputable internal evidence. In terms of the reflective model of human awareness I am proposing, it is predicted that they have to arise out of the self-aware brain's routine functioning and generate misleading impressions about the human mind's nature and identity.

The First Source of Evidence

The first evidence is the mind's experience that it *knows* itself to be free because it cannot know itself as unfree, that is, caused or determined. The conscious mode (the unique condition in which we think and reflect) is switched on at a definite point along a neurofunctional event sequence, whose earlier components (those occurring before the onset of the conscious mode) are always inaccessible and therefore unknowable. This is in accordance with Libet's "time-on" theory with respect to event components too short in duration to reach the integration threshold for awareness

at 400 to 500 milliseconds. Since self-accessibility is thought dependent, and thinking is a process that gets switched on, there can be no memory of what was there before it had occurred. It is as if we were to inquire into what a lamp had been illuminating before it was turned on. The question of what went before is therefore technically as well as experientially meaningless. The reflectively aware brain can have no memory of what brought it on because, when that event was about to take place, it did not exist. It is restricted to the experience that is just then occurring. Even remembered material is input in the present.

In view of its self-generated impression, the mind is in no position to deny the given, that is, its naive self-experience. Hence it is driven to believe that:

- it has no materially determined causal source;
- it got where it is in some mysterious, nonbiological way; and
- it is an entelechy-like entity in the physical frame.

The Second Source of Evidence

The second source of evidence is the mind's *feeling* that it is the causal source of its own self-experience. This impression arises out of the proprioceptive sensation that always accompanies speech-thought and the resulting conscious condition. The effect is inevitable. Just as the mind cannot know itself to be unfree (having no data to the contrary), it cannot feel itself as other than causal of the reflective state in which it operates. Once more the effect can be traced back to the undetectability of what leads up to the speech-thought transaction. What the conscious mind is able to notice first is the "on" phase of the transaction. During its "off" phase there is nothing there to do the noticing. However, everything of which the mind is conscious is accompanied by the feeling that it is all part of its own production. As the mind is able to experience itself as well, it is also forced to accept that it is the causal source of itself, in other words, that it is self-created. The impression is inescapable and suggests that the entelechy-type of self-characterization is valid.

The Third Source of Evidence

The third source of evidence is the seeming *volitionality* of the reflectively aware mind, the impression that it can act outside the frame of causal determination. This is a compelling impression, strengthening the sense of an entelechy-like free will and of great importance in human beings' thinking about themselves. Yet this, too, is a mere by-product of the reflective brain's manner of functioning. To demonstrate the validity of this

assertion it is necessary to look at *intentionality*. This is the capacity of the mind to refer to or feel disposed toward specific objects or ends. I do not mean the mentalistic term of philosophical discourse, but the neurofunctional condition that makes perception work hand in glove with the motor phase of central nervous processing. Underscoring this, Monod (1972) observes that "Perception is a critical analyser" and as part of the teleonomic equipment of the organism, it "prepares a prejudicially loaded representation for the motor-system to act on."

The central nervous system builds a slanted and *prestructured* version of the world, and it is in terms of this "evaluated resumé" that responses are fashioned in stress-reductive ways. Intentionality is a goal-directed *structured* disposition. It always relates to some need-state that aims to link up with the motor sequence most appropriate to its implications. In the infrahuman context the appropriateness of the action sequences is a question of "valencies" (sensed biobehavioral gradients). There is no case for "deliberate choice" based on volitionality. The intentional state "slots in" automatically with what is intuited as the most appropriate action sequence.

It is at this point that humanity's new reflective capability modifies the scenario. It does this specifically at the point where the afferent perceptual preparation and evaluative summation of the intentional state are taken over by the efferent (motor) system for the action sequence to be implemented. By all indications this switchover point from afferent to efferent is either located in or has to do with the two supplementary motor areas attached to the superior surfaces of the two cerebral hemispheres. In these structures, marked preaction potentials invariably occur, regardless of whether the cortices are human or infrahuman. However, the infrahuman subject and its preaction potential is fully locked in with the constraints of the concrete situation (experimental or otherwise). By contrast, humans can generate preaction potentials just by thinking about possible actions, that is, by inducing the intracortical loop of the brain to run up hypothetical mental alternatives. These can then be assessed and used by the brain for the selection of the motor response that is to complete the sequence.

This implies the existence of thought-created options that can be introduced into the brain's processing at the very point where the organism's future course is being continuously decided. The mind-equipped brain can generate a wide range of possible action schemata. These allow it to far transcend the concrete constraints of the mentally unelaborated situation of the ape. Unlike their infrahuman cousins humans *can* say to themselves: we *could* do this or that because we have speech to say it *with* and mental

alternatives to say it *about*. Furthermore, we *can* think about how we *could* implement other options, and this gives us the sensation and the compelling data that we *have* latitude for self-guidance and free choice of alternatives. We are also convinced that we *will* our actions and that what we choose is the free outcome of a process that is different in kind from what happens on the infrahuman plane.

The problem is that although these impressions are right in assuming that a dramatic change has occurred, they are wrong about the nature of the change. The new processing format does not bypass deterministic causality in absolute terms; it only modifies the standard frame of the stimulus-to-response transition. It interpolates mental alternatives into the "ham" phase of the input/output "sandwich." While this is a significant breakthrough and the key technique of "causal bootstrapping" (which *is* a kind of freedom), entelechy-type of volitionality it is not. Nevertheless this is often insisted on by those who agree that whatever we choose we could have chosen differently. The argument is compelling but mistaken. It hinges on the unverifiable assumption that we could have opted for what we had not. This leads to the circularity that, if we had after all opted for what we had not, what was until then hypothetical proof would in its turn need to be similarly proven. However, this "proof" would once more be in need of some imagined alternative that would remain unactualized. The upshot is that the mind is never able to prove that it can choose. It can only be sure that action alternatives exist and that *it* (the mind) runs them up for perusal and potential linkage with intentionality.

The mind's role is vitally important for creating choice and for maintaining the reflective frame for its contemplation, but this is not the same as the choosing of an action sequence for implementation. Yet, for reasons that will be detailed in section D of this chapter, the verbal system misrepresents the mind. It insinuates it into the process of decision making and rationalizes its role, much as if the mind had executive authorship when it has not. Decision making is done by the animal brain as before, on the basis of valencies (brain stem—limbic value categories) that are intuitively sensed. It is on this nonreflective tier that actions are selected in response to intentional states at a particular moment.

I want to emphasize that in this section I am not dealing with the question of free will but only with the ways the mind-equipped brain distorts its true character and ends up again and again with an entelechy-type of self-characterization. I want to show how the brain generates the impression of a causal agent in us, working the machinery as the proverbial "ghost."

The Fourth Source of Evidence

The fourth source of evidence is the mind's *sensing* that there is something intangible and mysterious about it that defies concrete analysis and cannot be captured by language and thought. To clarify this point it is necessary to return to sections B and C of the last chapter where the special effects that accompany the self-aware state were first examined. Of particular relevance is the finding that the self as percept (the entity in the mind that is thinkable) can only be *post hoc* to the self-feeling that the occurrence proprioceptively engenders. The self, when thought or spoken of, is not quite the same as the feeling of it. The discrepancy implies that thinking (our sole instrumentality for analysis and evaluation) is not able to fully capture the self. By the time the self-feeling becomes thinkable, it has undergone its transformation into the percept form. It is no longer what it was when it was experienced, but only its representation. In short, what we are able to think about is the entity into which the self-feeling is translated but not the self-feeling itself. The very process that creates thinking is responsible for generating the proprioception that is the basis of the self-feeling that cannot be thought of at the time of its occurrence. This has the result that the self must always seem in some way elusive to itself and that thinking about it can only deepen the impression.

Oriental thought comes up with a rather similar, probably intuitively arrived-at, conclusion. Thus Alan Watts (1971) describes the Buddhist-Taoist conception of the self as arising out of mistaken inferences and beliefs:

> The notion of the ego arises because of the apparent phenomenon of self-consciousness, of knowing that one knows, or feeling that one feels. But it is pointed out that we are never actually self-conscious. While thought A exists, we are not aware that we are aware of thought A. "I am aware that I am aware of thought A" is no longer thought A but thought B. Every attempt to be aware of being aware is an infinite regress, for thought B is not thought A; it is the memory of having had thought A, so that one is never aware of an ego that actually has an experience.

What is relevant here is that there may be some lingering intuition in us that is not quite taken in by the delusionality of the mind-generated self-data. This is interesting, even if it is not of practical value for unmasking the deception. In any case it should not be surprising that there always is some vague sensation of unreality and elusiveness about the self. This mind-created sensation stays with us and keeps being regenerated by the mind's way of functioning. The elusive unreality is particularly noticeable when the self-concept itself is being dealt with, that is, is felt or thought about. This creates an experience for the mind-equipped

brain that it can neither trace nor question but must treat as relevant primary data.

On the basis of these four types of mind-generated evidence, we must conclude that the reflectively aware brain itself is responsible for the deceptions. Furthermore, without insight into how these self-deceptive distortions are generated, the mind has no choice but to regard itself as nonbiological and as ontologically unique in character. As shown earlier, it must experience itself as: (a) free, (b) causal, (c) volitional, and (d) elusive—in other words as: (a) undetermined, (b) autocausal, (c) free-willing, and (d) essentially indefinable and insubstantial. It is not hard to recognize that these specifications and characterizations are consistently entelechy-like and that they make the mind resemble an autonomous and uncaused causal agent, an agent that impacts itself upon an otherwise deterministic world quite freely and of its own accord. It is also remarkable that a rather tightly typecast image of the mind keeps emerging with almost unfailing consistency, regardless of culture context, societal sophistication, primitivity, modernity, or anything else. This is how Humphrey (1984) puts it:

> Thus when allowance is made for certain eccentricities, there is a remarkable convergence in the accounts which people of all races and all cultures give of what reflexive consciousness reveals to them. The gist of it—and I am attempting here to summarise, not to caricature, is this: "In association with my body, there exists a spirit, conscious of its existence and continuity in time. This is the spirit, mind, soul, which I call 'I.' Among the chief attributes which I possess are these: I can act, I can perceive, I can feel. Thus it is I, who, by exertion of my will, bring about almost all my significant bodily actions, etc."

The predictable nigh universality of this experience strongly suggests that almost uniform conditions surround its genesis. It is quite plausible that experience pertaining to the self or mind gets wired in with the young child's rapidly expanding representational schemata at an early age. This is likely because the mind operation supplies itself quite automatically with the confirmatory evidence that the entelechy-like self-characterization requires. It does this unwittingly but, for all that, with a sense of irrefutable factuality that makes for faithlike certitude, so that no reasonable doubt as to the truth of the matter can arise. In short, the young child grows up with, as well as grows into, the fabric of its core perceptions about itself and the "entity" within. Furthermore, nothing during its subsequent functioning can convince it that its intuitions could be operational side effects without ontological factuality of any kind. Thus it is predisposed to think in terms of "soul," "spirit," and "agent-like" internal self-representations,

and is programmed to resist technically more sophisticated physical models of its inner workings. The conclusion is unavoidable that the mind-equipped brain is the unwitting author of an unsolicited self-characterization that is not only binding and intuitively persuasive but also loaded with ontological implications of disturbing complexity. These implications cannot be ignored but must be taken seriously because the mind's self-decoding is at stake. This calls for the accurate perception of the structure, function, and context in which the self operates and in whose terms it makes sense.

It is clear that a technically feasible schema such as the model I am proposing is needed to explain and resolve the contradictions and incongruities of experience and introspection. Without such a schema, the mind cannot decode the riddle of its functioning and has to leave the controversy of free will and determinism unresolved and unresolvable.

C Problems with Self-Conceptualization

I think a book about how to think clearly might be very useful but I do not think I could write it because I haven't the vaguest idea either how I think, or how one ought to think.
—Bertrand Russell, in a letter to Gilbert Murray

Having looked at the mind's structure and function and examined the mind's self-generated delusionality, it is now time to turn to its self-conceptualization. The self-data is shrouded in semantic murk and there are instances of soul-mongering and simplistic generalizations to contend with. Before going any further let us therefore consider Hume's dictum that "No testimony is sufficient to establish a miracle, unless its falsehood be more miraculous than the fact which it endeavours to establish."

This quote is particularly relevant in this context because attempted explanations of the brain—mind—consciousness interaction turn out to be more obscure and problematic than the interactions they wish to clarify. This is not surprising. As long as the "mind" is a mere verbal allusion to an unspecified generalization, its functional linkage with the brain remains meaningless. Similarly, the term "consciousness" (or awareness), variously designated as quality, internality, principle, or effect, is too vague to be useful for functional linkage. Indeed, none of the traditional constructs in this domain is sufficiently well defined even for mutual compatibility. There is no knowing whether terms like "mind" and "consciousness" signify special states in the brain or mere verbal allusions to experience. Some may

even envisage a nebulous receiving entity through whose agency brain experience is thought to undergo some form of transubstantiation.

In this obscurity common sense simply drowns. It is weighed down by ponderous questions that cannot be answered or understood. These may not be questions at all, but meaningless misconstructions of an instrument out of its depth. For example: what is one to make of queries such as "Who or what experiences the mind?" or "Is the conscious mind the experience of the self, or vice versa?" or again, if either of these alternatives be the case: "Is consciousness an experience, or just some special mind state in which experience devolves upon itself?" All of this is clearly beyond grasp or even coherent formulation. Nor is it hard to see that it is not possible to solve interpenetrating and semantically circular questions about intangible entities that have no referents. It is also futile to search the brain's vocabulary store, hoping that some juxtaposition of words will make sudden and incontrovertible sense. Indeed, such a flash of insight cannot arise out of this game of semantic "musical chairs," just as the addition of further epicycles to the Ptolemaic scheme of planetary orbits could not have led to the Copernican insight.

The answer to this confusion is the correct identification of the referent. This calls for an integrated model of the mind, one that is based on neurobiological facts and insights. Yet no such model can be found across the spectrum from speculative thought to neuropsychology. As Hampden-Turner's (1981) *Maps of the Mind* so clearly shows, there is no scheme (ancient or modern) that has all the elements needed for a coherent and consistent account of how the mind works.

As I see it, this consistent failure is the result of the equally consistent practice of fragmenting the field into quasi-independent entities, such as speech, thought, consciousness, reflection, and mind, when in fact they jointly constitute an inseparable and unitary action-system. No schema can emerge and no sense be achieved if this fact is ignored and the system's subaspects are treated as if they were independent and not in need of at least a skeletal pattern to articulate them.

The fragmentation and conceptual unconnectedness is well illustrated by Konrad Lorenz's (1977) reference to "abstract thought," "verbal language," "the ego," and "reflection" as if these were independent entities and had developmental backgrounds and functional infrastructures of their own. If Lorenz, with his intuitive insight and broader frame of reference, could not get past this traditional perception of the domain, what can be expected of the philosopher's introspection, which uses verbal analysis for the inquiry?

In section A of the next chapter we shall examine what analytic philosophy and cognitive science managed to make of the mind. Here we shall look at the five conceptual frames that are used (overtly or covertly) to avoid the need to come to grips with the conscious mind—the ultimate challenge of brain science. We shall touch on radical materialism, promissory materialism, panpsychism, epiphenomenalism, and dualistic interactionism in turn, emphasizing that neuroscience no longer has to adhere to the Cartesian apartheid of body and mind. It is free to investigate the brain and the reentrant loops whose functioning generates and maintains the conscious state. The connecting link of the five conceptual frames is dualism, whose longevity, according to Edelman (1992), relates to the fact that "While in modern science matter has been reconceived in terms of processes, mind has not been reconceived as a special form of matter." Bearing Hume's dictum in mind, the five frames may be characterized as follows.

1 Radical Materialism

Radical materialism is in essence the behaviorist position to cover the brain-mind area. Predictably, it ignores the possibility of any interaction between brain and mind because it denies the existence of anything conscious. This includes the mind, even in an operational sense. Radical materialism insists on staying on the level of the neuron code, as if in fear of coming upon the brain code with its psychologically meaningful interactions and the mind beyond it. The position is therefore a prejudicial opting out of the search to discover the transactions that characterize the brain's highest level of integrated functioning.

2 Promissory Materialism

Promissory materialism is an open-ended stance of hopeful expectations that at the end of the "research rainbow" a fully material (i.e., mechanical) account of all transactions will be achieved. It is just about inconceivable that piecemeal increments of knowledge without the aid of conceptual leaps could ever achieve the representational complexity that the mind's organization and functioning most certainly require. Promissory materialism arbitrarily restricts the terms of reference and hamstrings the investigation. This is becoming increasingly counterproductive as there is a shift toward the exploration of large-scale and behaviorally meaningful phenomena on the level of the brain code. As Cowan (1981) puts it: "Ultimately the brain works because it is a network and not because it is an assembly of individual cells."

3 Panpsychism

Panpsychism holds the view that consciousness or mind is coextensive with matter and constitutes its inner aspect at all levels of development throughout evolution. It is easy to see that this "inner aspect" designation of consciousness, as if inherently given, automatically absolves brain science from having to define, map, and substantiate the referent in question. In short, panpsychism, with its subvarieties such as psychophysical parallelism, is prejudicial to the attainment of knowledge and to the penetration of the "black box" of our integrated cortical functioning.

4 Epiphenomenalism

In the epiphenomenalist schema, mental events, though not wholly denied, are perceived as having no effects on neural events. The latter are regarded as taking place quite independently of the former so that consciousness is a mere afterglow effect of the physical brain and therefore outside causality and functional relevance. This arbitrary discounting of the conscious mind is not only preemptive but also generates the unanswerable question of why evolution should have created such a complex and extraordinary form of pure redundancy.

5 Dualistic Interactionism

Dualistic interactionism regards the conscious mind as being in some form of bilaterally causal relationship with the brain, to which it brings a sense of identity and unity. Up to this point the schema is neither absurd nor useless for the purpose of further elaboration, especially if the conscious mind is taken to represent the verbal system, an operationally definable entity. However, dualistic interactionism offers no further data relating to the conscious mind, except holding that it is not a structural or functional subsystem of the central nervous processing apparatus but essentially a nonmaterial entity. It claims that this entity is spiritual, yet in active interaction with the material brain. Inexplicable as this "spirit-to-matter" interaction seems, nothing is said to indicate how it might work, except to suggest that the supplementary motor areas are the sites of brain–mind exchange. Trying to fill this explanatory gap, Eccles (1990) advanced his "microsite" hypothesis. According to it "psychons" (alleged units of mind) interact with "dendrons" (units of neural integration). To avoid violating the conservation laws of physics, Eccles takes the energy level of this brain–mind interaction to be of an order of magnitude "well within the limits of the Heisenberg uncertainty principle." He describes the exchange as a "process, analogous to a probability field in quantum

mechanics." Though Eccles admits that there is no evidence of "psychons" or of an exchange at the "interface," he goes on to conclude that: "In this way a mental event of intention could bring about appropriate neural events, for instituting the intended movement." The microsite hypothesis is in fact only a facelift. There is no intimation of how sense can be made of such a matter–spirit paradigm or how such an untidy rationalization could assist science in clarifying the intrapsychic action scene.

Taken together, these five conceptual frames do not add up to a single working hypothesis of how the brain uses the mind system, or how the mind interacts with and deploys the brain. Nor do they shed light on how consciousness is generated, what it entails, and how it is experienced. What they do accomplish, albeit by default, is the filling out of an epistemological vacuum with heat rather than light. This seems harmless enough at first sight, yet on deeper reflection it begins to look otherwise. The often comforting constructions lull the mind into believing that it is onto something when in fact it is not.

To illustrate what the mind is up against and how fact, fiction, hope, and logic are combined to mystify, we shall look at MacKay's (1978) so-called elegant argument in support of a "logical indeterminacy." This would have the conscious mind free and "morally responsible" even if its neural correlates in the brain are fully determined: "The 'I-story' and the 'brain-story' are logical complementaries, different aspects, as it were, of the irreducible duality of human nature, with access to essential facts that the other may systematically ignore."

What MacKay is intent upon proving is that the "I-story" (the conscious mind) has freedom and ontological otherness. He wants to do this by demonstrating that it is impossible to give the mind a prediction of its future or, in other words, to tell it what it will do next. To demonstrate that this is indeed the case he uses a "test by assent" as the criterion. This gives him the expected result that the mind is in fact unable to assent to any form of prediction of its behavior. MacKay explains this finding by pointing out that if the mind assented (i.e., believed the prediction) this would materially alter it and this would falsify the prediction. On the other hand, if the mind were given a prediction that seemed to it to be incorrect—though unknown to it, the prediction were to be true at the appointed time (self-verification)—it could still not assent, but this time on grounds of nonrecognition of what are to be facts in the future.

On the face of it this appears to be freedom of some description, but all is not well with the underlying argument. The conscious mind's "freedom," in

this context, is only a projective inference. It arises out of the inapplicability of the "test by assent" to decide the issue. The test is useful only to decide a system's nondeterminability but not its freedom. There is a clever (if unwitting) sleight of hand here, an "operator shift" that makes the failure of the "test by assent" seem like positive proof of something that the test is not qualified to decide. This is like the "headless woman" stage illusion, where—unable to see the woman's head—the mind opts to believe that what it sees is in fact a headless woman. MacKay's operator shift, as indeed that of the "headless woman" illusion, is based on taking an unproven negative to be a proven positive, and shows what can happen if a referent is not identified but generalizations about it go unchecked.

The inapplicability of MacKay's test to decide the question of freedom becomes apparent if its logical implications are examined, in particular, if it is recognized that any prediction fed into an information-seeking processing system (such as the conscious brain) is in fact input. This is a crucial point, because every piece of information causes some form of dislocation and modifies the system if it is assented to, that is, if it is acknowledged and absorbed by the system. This is not in doubt, for it is the nature of such a system to update and totalize. It is unable to remain unmodified and unaltered by input that is fed into it. It also follows that artifacts would fail the "test by assent" (just like minds) and that they would fail for the same reason. The prediction would change them and there would be no way to circumvent this.

The result is clear: MacKay's "test by assent" cannot discriminate between minds and artifacts (say, computers of a certain design). This would still be all right if the argument were not pressed past the modest assertion that: "self-updating systems (machines or minds) are non-determinable because they continuously change." Regrettably, however, MacKay does press the argument and turns simple nondeterminability into ontological freedom of the system with "moral responsibility." This illicit shift is neither sanctioned nor suggested by the test. It is introduced by MacKay quite arbitrarily in order to underline what is for him an item of faith: "the irreducible duality of human nature."

If anything, MacKay's "elegant" argument deepens the confusion about the mind's functioning. He talks freely about what the mind can or cannot do but never attempts to identify it. To claim that "I-stories" and "brain-stories" (read: "conscious mind" and "neural substrate"), though correlated, can be "free and determined" at the same time implies epiphenomenalism. This leads to a dualistic outlook with irresolvable metaphysical consequences, or as Dennett (1982) points out: "to a counsel of despair where

all truly interesting questions of how the mind works remain not only unanswered but unanswerable."

In this section we have discussed self-conceptualization, that is, what the mind thinks about itself. Next we shall examine the snags posed by the delusional tendencies of the mind, and shall contrast them with its true contributions to the upgrading of the brain.

D The "Freedom" of the System: Fact and Fiction about the Mind

> The uniqueness of man is his ability to verbalise and in so doing create a personal sense of conscious reality. It is as if the brain demands integration.
> —M. S. Gazzaniga and J. E. Le Doux (1978), *The Integrated Mind*

> There is free will, and we have no choice about it.
> —I. B. Singer (1991), *In My Father's Court*

Section B of this chapter examined the conditions that generate the entelechy-like self-characterization of the brain. Here we will evaluate the brain's mandate to integrate and the verbal system's commitment to this task. I shall show that, although the mind's executive role is fictitious, there are factual grounds for attributing to it a significant free-will function of sorts. I shall also show how the mind system modifies and upgrades the brain's processing capability.

In going from fiction to fact (from what the mind is not, to what it is), I propose that while there is no evidence that the causal order of reality can be upset from without, it is possible to modify its course from within. Ironically the brain ignores this genuine form of autonomy, preferring the spurious claim that the mind is an entelechy executive. As Searle (1984) puts it:

> For reasons I don't really understand, evolution has given us the form of experience of voluntary action, where the experience of freedom, that is to say the experience of the sense of alternative possibilities, is built into the very structure of conscious, voluntary, intentional human behaviour.

Let us, however, ask whether this is correct, or correctly put, and what if it were possible to demonstrate that it is not the entelechy type of causal freedom, but only its impression that is built in? Indeed, in section B of this chapter it was shown that such impressions of freedom must occur and that this is because the reflectively aware brain remembers that it actively participated in the formation of preaction alternative motor schemata. Having had alternatives leads it to believe that *it* did the choosing. The shift is subtle, but the resulting error is serious. To be consciously aware that choice has taken place does not mean that the operation that

generated the conscious state did the deciding. So let us emphasize that, while the mind's preaction work on alternatives is causal contribution of a very real kind, it is not decision-making authorship. The mind is an essential component of the preparatory action stage, but this is not ground enough to assume that *it* is the instrumentality of the decision-making process. This assumption is nevertheless insisted upon, because the brain's integrative mandate (as expressed through the verbal system) is programmed to achieve optimal representational unity and causal coherence. This is none other than the role of the "inner executive."

The representation is false, or at least badly distorted, and there are epistemological consequences to face and a price to pay. For example, the deception must be continuously carried, and for this to be possible the mind-boosted brain is forced to rationalize, confabulate, and pretend that *it* and *it alone* is in charge of whatever is taking place on the intrapsychic plane. It can best achieve this undertaking by doctoring the ongoing totalization of experience. Gazzaniga and Le Doux (1978) put it this way:

> The conscious verbal self is not always privy to the origin of our actions. When it observes the person behaving for unknown reasons, it attributes cause to the action as if it knows, but in fact it does not.

Split-brain studies confirm this effect, and the hypnosis paradigm can also be cited to demonstrate that:

- The mind-boosted brain rationalizes and lays false claim to action sequences with which it has nothing to do. This happens, for example, when it insists that the posthypnotic suggestion it has just carried out was really its *own* intention all along. This is an absurdity it alone believes and is prepared to defend.
- The mind is in fact unable to force decisions upon the nonreflective brain if these run counter to the latter's intuitively sensed values or valencies. Not even the hypnotist's voice, using the verbal system as a vehicle of entry into the decision-making process, is able to break down this barrier.

In going from fiction to fact, from that of "inner executive" to that of brain-upgrading superprocess, it is possible to show what the mind does for the brain and how it fits into its overall processing routine. Simply put, it provides language-based neocortical interference with the stimulus-to-response transition. It supplies the brain and the intentional state at the time with a set of options, that is, alternative motor schemata for solving the situation on hand. The causal chain is temporarily rerouted through the intracortical loop. The action alternatives can be mentally experienced

and evaluated free of charge. Meanwhile the motor system is on hold until the preferred alternative is selected and set in motion. The selection takes place in terms of intuitive valencies, although the executive mind rationalizes the choice to make it seem its own.

The mechanism of the mind's interference with the brain is explained by Libet's (1990) "time-on" model of cortical processing (see section A of chapter 5). This is the way it works. About 400 milliseconds must always elapse before a would-be motor event in the brain reaches the threshold of awareness. This means that actions are never consciously initiated (willed into existence) but are "discovered" as they reach the critical level for consciousness in the course of their preparatory phase. However, at this point (designated by Libet as "w" and defined by him as the point at which the wish or urge to act appears) there still remain some 150 to 200 milliseconds before the motor command is issued and the action commences. In this short space of time the brain, enabled by the mind to sense outcomes and consequences, can interfere with an action sequence. It can abort it or switch to another preliminary action sequence already waiting in the wings. Or as Libet puts it: "A conscious veto of the process, resulting in no motor action at all can be exerted after 'w.' " Libet also notes that: "The potentiality for a form of free choice in the classical sense is not excluded by the theory . . . though apparently in the form of control rather than initiation of an act."

The picture is clear. Although the mind is not the mechanism that decides and aborts, it is the agency that supplies the decision-making process with information about possible outcomes and alternatives. It is the mind system that gives the brain the substance and the leverage with which to reflect and decide upon a course of action. This is a significant evolutionary breakthrough. The brain's organizational complexity allows it to draw on stored insight and to redirect the causal chain to achieve acceptable outcomes. This is "downward causation," the mind-boosted brain's ingenious way of exerting causal leverage without breaking the laws of nature. Merely by drawing on what is neurally given, it takes the would-be action in its preparatory phase, plots it against its likely consequences, and selects one of the mentally held alternatives, or opts for inaction. The mechanism of selection is brain-stem-limbic disinhibition of what is selected. In Edelman's (1992) words: "In accord with a given plan the basal ganglia selectively disinhibit thalamic nuclei projecting to the cortex. This leads to an anticipatory and selective arousal of cortical areas corresponding to the motor program." All action schemata are withheld except the one seen or felt to be congruent with the dominant value system of the organism. This

quasi free-will function of selecting a path through a self-generated maze is not unlike the game of twenty questions. By blocking unacceptable choices the sequence of ever closer approximations charts the course to what is acceptable.

It is conceivable that this mind-induced selection process, generating a free-will effect and a system-shifted access to self-management, is yet another application of the Darwinian selection principle in the biological world. Edelman, who worked on the clonal selection in the immune system and who extended the selection principle to the evolving embryonic brain's neural groups, holds the view that selection, rather than instruction (copying a blueprint), characterizes biological upgrading. This works as follows. A population of variants is generated in one domain, from which another (independent) domain selects specimens that are fit in terms of the constraints of the second domain. If, as Edelman suggests, Darwinian natural selection has selected for two quite different somatic selection systems (that of clonal immunology and that of neural group selection), can it be that the mind-endowed brain too belongs to this set? What we have here is the mind system generating a population of action alternatives (variation) and another domain (the brain-stem-limbic value categories) doing the selection by disinhibiting value-congruent variants. While this is not free will in the absolute sense, it is an ingenious way to achieve functional autonomy, the nearest thing to it in a deterministic world. Thanks to it, the organism's values and characteristics are now significant codeterminants of outcomes. As in natural selection, immunological selection, and neural group selection, greater fitness and survival is the result.

The breakthrough to this quasi free-will function was itself selected for and the system shift it constitutes is remarkable. The mind-endowed brain represents an immense increase in negative entropy (order and organization), complexity, and efficacy. The brain is now transparent to itself and can draw on sophisticated information from intrasystemic and extrasystemic sources (i.e., from memory and from stores of knowledge). With all this at its disposal and with leverage to implement it, the mind-endowed brain is a causal codeterminant of outcomes within and without. It is a challenging thought that this breakthrough to inner transparency and the option to further enrich knowledge and insight may lead to an increasingly relevant understanding of the organic and inorganic world out of which we evolved and whose future course we may now be able to affect.

Let us look at the mind's contribution in more detail. Provided that emergencies or powerful drive states do not take priority, these new mind-induced

alternatives can be linked with intentionality in terms of sensed biological priorities, as in the animal. This potential range of alternative responses is the brain's *primary gain* from possessing a mind. Contingent upon it is its *secondary gain*, the reflectively aware state that directs and sustains the concentrated attention on the range of responses with the help of speech-thought-based percept management. This ensures access to the relevant segment of the memory store and enables the brain to elaborate and build on the ongoing response process. Finally, the overprocessing that occurs during these transactions creates enriched memory traces that become information-laden experiential schemata for future use. This is the brain's *tertiary gain*. It gives it practice-based competence that further enlarges its functional autonomy. Simplistic predictions of behavior thus become quite impossible, though on account of the system's complexity rather than on account of its ontological otherness.

This reopens the question of who or what is really benefiting from the mind's contributions to the brain. Here the reader may recall that I have consistently characterized the mind, the mind system or the mind operation, as only an instrumental extension, an operational arm of central nervous processing. Reflective awareness has been shown to be a technical consequence of the reentrant self-representation. Nowhere has it been claimed that this spectacular brain technique is in any sense *us*, that is, the living creature. The point is relevant, for it is easy and tempting to believe that the reflectively aware mind *is* us and to conclude that our sphere of awareness is synonymous with the self, the agent, or the soul. Let me therefore emphasize that it is the un-self-aware biological entity, the intuitively operating organism, that experiences. Furthermore, that its manner of decision making (though not the sophistication of what leads up to it) is very similar to that of other creatures and of higher apes in particular.

I hasten to add that this presentation cannot seem right to the mind-endowed brain because the "inner executive" (its favorite guise) is not given top billing. The verbal system, the custodian of the guise, is in fact unable to accept data that deny this image. Nor is this surprising in view of the mind's necessarily solipsistic basis of self-validation, which requires the belief to constitute the "proof" of the belief itself.

The mind's contribution, though highly significant, is not that of decision making but of furnishing the high-grade preparatory work on which options are built for intuitions to sense. The executive function is exercised by the intuitive animal brain that senses the relative values of the available action alternatives. It is therefore values and valencies that are the guidelines for behavioral decisions. They represent deeply entrenched early

imprints, dispositions, and preferences that exercise compelling sway over the organism's conduct. The conscious brain is therefore not part of decision making, or in Gazzaniga and Le Doux's (1978) words: "It attributes cause to the action as if it knows, but in fact it does not." In short, we can conclude that it is the biological system that owns and uses the mind and not the other way around.

In summary, the mind operation uses an interpolating response diversion through which a range of choice is continuously generated. This puts the brain into the position to opt for action alternatives that are congruent with its sensed value categories, or to abort unacceptable ones that are already in train. Thanks to its reflective awareness, the mind-endowed brain is able to perceive that it has operational latitude, though not that this freedom is also the source of inventions and distortions. The mind-endowed brain, ignorant of the technicalities of its functioning, rationalizes its identity and ends up (more often than not) with ontologically absurd conclusions. These conclusions notwithstanding, the mind is a self-illuminating subsystem of the brain that continuously processes and upgrades the brain's storage capacity and the accuracy of its representations.

Inasmuch as its internal order keeps upgrading and changing, it is not possible to predict the organism's behavior. The more the mind-endowed brain approximates a self-enhancing and internally elaborating system of highly ordered information, the greater is its own contribution to the determination of the organism's behavior. As we have seen, this does not imply self-causation or freedom in an absolute sense, but a system that draws on and works with stored, enriched, and then optimally released causal contributions. The result is the codetermination of all events of which it is a part and in which its own contribution is increasingly important. This autonomy from within is more than an immense achievement. It is the only form of freedom that a self-enclosed monistic universe can lawfully generate. Thus, the prediction of human behavior, as that of the position or the momentum of the elementary particle, is masked by insurmountable uncertainty. However, while on the subatomic plane the effect has to do with the observer's unavoidable interference with the entity observed, on the human plane it is the system's complexity that creates the snag. The snag is the discrepancy between what is to be considered and the observer's limitations in time and ability to catch up with the updating totalization of the ever-changing system. This is a critical constraint on the prediction, which cannot be overcome either theoretically or practically. The nonpredictability, or indeterminacy, of the human action scene is an information-processing limitation, an ab-

solute and final barrier, but not a sign of entelechy-like otherness. While there is no way around this, it stands to reason that all aspects of the transactions in and about the system have lawful antecedents. Thus indeterminacy is a function of the organism's order (negative entropy). It is an expression of the internal order that has stolen a march on the system's knowability by all, except—in a limited sense—its own highly focused insightful perception.

Let us see, however, what the mind's corrected perception can tell us, now that it is divested of its executive garb and of its traditional image of free will or entelechy. First it is important to remember that all enrichment and functional upgrading are results of purely internal differentiations. They were generated out of the organism's own functional resources, that is, out of the organizational and informational order already existing in the system. Indeed, the mind operation is only a further extension of its negative entropy. The process itself is clearly self-enhancing and is another instance of "deviation amplification," which—as we have seen—leads to the attainment of higher levels of functional equilibria.

Inasmuch as evolutionary progression is signposted by ever-upgrading processing excellence, the mind operation represents a dramatic evolutionary breakthrough that confers unprecedented insight and processing latitude on the brain that uses it. Mind-equipped brains are qualitatively superior to non-mind-equipped ones in problem solving and self-management. They are data for themselves, and work on a higher level of internal functioning. In view of this, human beings' insistence on finding themselves to be ontologically other, entelechy-like, or free, is misguided; first, because it overlooks the self-aware mind's true contribution to the functional capacity of the individual and to the evolutionary process; and second, because it is our evolutionary mandate to upgrade and refine our understanding of what this understanding entails rather than believing ourselves to be causal agents, planted by some cosmic quirk. Indeed, only in this manner can we begin to perceive ourselves in informationally correct creative ways, thereby adding to order (negative entropy) and shedding delusional fancies about ourselves and about the evolutionary scenario of which we are a part.

In this chapter I have tried to show what the mind system is in physical terms, where it is located, and what structures are involved in its functioning. I showed how it renders the world to us and how it renders itself to itself. Other particulars of the scenario, such as the technicalities of speech, thought, reflection, self-awareness, and the orchestration of the infrastructures that make them work, were also accounted for in this and in earlier

chapters. I have also indicated what the mind or mind system is not, and why its operational characteristics nevertheless make it prefer fiction about itself rather than fact. In this connection I traced and analyzed the mind-endowed brain's inherent confusion about itself and came up with the mind's self-generated self-data as the obvious source. This led to the problem of self-conceptualization and to its contribution to projective fancies. Last but not least, it led to the functional peculiarities that shield it from insight, guard it from logic, and uphold its need-motivated ignorance.

The system would certainly be better served by accurate models of itself and of its functioning. This would enhance its negentropic state and do greater justice to itself as the organ that generates improved self-understanding.

In later chapters I shall detail the implications of the mind-equipped brain's relationship to itself, its modeling of itself, and its societal source. This societal source validates it but also imparts to it the burden of mythology. It will become clear that by remaining the lifelong support facility of an upgraded primate's ongoing adjustment, the brain falls short of its optimal role as the organ of insight into the structure of life and of evolution.

8 The Mind versus the Computer

Worse than having no language with which to ask relevant questions of the brain about the brain-mind-consciousness domain, is to have one that asks the wrong questions and confounds the issues on hand.
—C. Blakemore (1977), *The Mechanics of the Mind*

A Formalism and the Logic of Misconstruction

The analysis by language of the logic of its subjective functioning has made possible the formulation of laws of objective logic and the creation of new symbolic instruments such as mathematics.
—N. Chomsky (1968), *Language and Mind*

No mind inquiry is complete without examining the position of analytic philosophy and computer science. The symbolic operations with which they are concerned are marginally cognate with one particular aspect of thinking, and the overlap has been taken to imply that the mind resembles these operations or that these operations are analogues of the mind. This section demonstrates that there is no similarity and that no formal system, be it logic, mathematics, or analytic philosophy, is mind-like or a source of insight into the nature and structure of the mind. The task is to show that it was the brain that generated formalism, such as grammar and logic, and that no formal system is able to generate anything even remotely mind-like. The asymmetry between the brain and the computer is complete, all comparisons are flawed and the idea of computer-generated consciousness is nonsense.

To prove these points is bound to be difficult, not least because of formalism's spectacularly successful application in computing. It is this success that led some protagonists of artificial intelligence to insist that the computer program, when implemented, generates consciousness itself. The basis of this claim is the computer's alleged display of active, problem-solving intelligence.

Reflecting critically on these ever increasing claims, Bickerton (1994) notes that:

> Consciousness is seen by many as an emergent property that appears whenever brains achieve the right degree of complexity. But the brain is, according to the same school of thought, just a machine that carries out computational processes. It follows that there can be no principled distinction between brains and computers. Computers, just like brains, could achieve consciousness and we would have to regard the "conscious self," in the words of Dennett, as merely "the program that runs on your brain's computer."

Rounding out this position, Chalmers (1996) views consciousness as "an organisational invariant, a property that remains constant over all functional isomorphs of a given system," adding that "whether it is neurons or silicon chips that constitutes the system, it is the causal patterns among the circuits that are responsible for the conscious experience that arises."

These claims are way out, as is Dennett's (1995) explicit statement that nothing but algorithms exist. Accordingly he finds it "curiously inconsistent" that "an algorithmic process (working on natural selection)" could be seen as "having created a non-algorithmic subroutine," thereby "turning the whole process of evolution" into something that is "non-algorithmic." Indeed, for him there are only algorithms, computational routines working on other computational routines, reminiscent of "the world that rests on a turtle, that rests on a turtle, with turtles all the way." In for a penny, in for a pound, he asserts that: "It is finally time to dispose once and for all of the hunch that original intentionality could not emerge in any artifactual mind without the intervention of a human artificer." Ignoring Searle's and Fodor's objection that "a robot's intentionality cannot be the real thing," Dennett concludes that: "The meaning such a robot would discover in its world and exploit in its communication with others, would be exactly the same as the meaning you enjoy." To make sure that the message is clear, Dennett tells us in plain words that the repeatedly rerun computer program (the algorithms constituting the robot) is not only the source of consciousness but will, in due course, interact with and modify the inorganic frame that houses the circuitry.

This is not only absurd but self-contradictory, for on technical grounds alone an artificial circuit's workability depends on its isolation from its physical frame. What is absurd is that while this ensures the circuit's integrity, it also prevents the potential interactions that are needed for internal change. Dennett's claim, that a well-designed robot's intentionality will, in due course, be as real as ours, is therefore nonsensical. Intentionality, a system's

ability to refer and to act, is of course a distinguishing feature of living organisms. But since Dennett sees life as "algorithms on algorithms," he regards us already as machines, so the objection cuts no ice.

How then might such claims be evaluated? First, by demonstrating that rule-governed formalisms, that is, mathematics, grammar, the algorithm, and the computer, do not constitute working systems of any kind; second, by illustrating just how limited and un-mind-like they are; and third, by revealing their true epistemological status and manner of genesis.

Taking up the first point, formalisms are invariably unconnected with the contents they are designed to handle. The procedures they represent are insensitive to semantic validity and significance. Underscoring this, Penrose (1989) observes that:

> Algorithms themselves never ascertain truths. It would be as easy to make an algorithm produce nothing but falsehoods as it would be to make it produce truths. One needs external insights to decide the validity or otherwise of an algorithm.

Penrose's reference to "external insights" confirms that rule-governed formalisms are incomplete. They are not systems that are self-sufficient, but implements that systems (minds) may use. An interesting inquiry by French mathematician Jacques Hadamard (1945) into how scientists think confirms this. They mold ideas in visual semantic space, and only when their desired configuration is achieved do they involve mathematical formulations to give it expression. In other words it is minds that generate input and validate output (both terminals involving contents), while the intervening phase of formalism fulfills an un-mind-like, nonsemantic, instrumental role.

It is against this finding that the view that takes formalism (the computer) to be a mind analogue has to be evaluated. The task is not easy because protagonists of the formal position, analytic philosophers, computer scientists with "strong AI" views, though not averse to extrapolating and generalizing about intelligence and consciousness, as engendered by the computer program, never tell us what consciousness is or what is actually conscious. Is the frame that houses the circuit conscious, or the circuit itself, or the program that is running? It is all unclear, unsubstantiated, and unspecified.

The position is nevertheless hard to challenge and expose precisely because it is vague and inaccessible. To refute it or even just to talk about it we must first formulate formalism's version of the mind, as its logic would have it. As it happens, Gunderson's (1984) description of the mind is just what we need. It is: "The scanner that can scan all objects except itself in

the scanning mode." This is clearly the definition of an implement such as the computer. It has no access to itself and can make no sense without the additional "external insight" to which Penrose refers. In short, formalism's version of the "mind" does not work. It can say nothing about the identity of the experiencer, or about the dicey question of who or what experiences the experiencer or processes the processor. In point of fact it can be said that analytic philosophy and artificial intelligence have no model of the mind, conscious or unconscious, and afford no insight into our "intrapsychic workshop." Chomsky (1968), despairing of this sort of simplism about the mind, points to the "faith in the shallowness of explanations" as its underlying cause. This he characterizes as "The belief that the mind must be simpler in its structure than any known physical organ and that the most primitive of assumptions must be adequate to explain whatever phenomena can be observed."

Indeed, as was shown in chapters 6 and 7, the mind system is complex and the way it upgrades baseline awareness to human consciousness entails internal "off-line" operations, whose output is continuously reentered into the endogram that is being totalized. It is clear that the mind is anything but simple, structureless, and unitary. Nor is the mind a single function such as "thinking" or some receiving terminal where the experiential buck stops. Least of all can the mind be viewed as a single function that is its own reception at the same time.

This brings us to the second point, the illustration of formalism's failure to deliver. This is a serious objection, concerning which Carello, Turvey, Kugler, and Shaw (1984), in a paper entitled "The Inadequacies of the Computer Metaphor," make these observations:

> A system executing solely in the discrete mode cannot increase its expressive power. It cannot develop a capacity to represent more states of affair at a later date than it can in the present. What it can do is to distinguish, within limits, states of affairs that occur from those that do not. The order of complexity achievable by a system executing solely in the discrete mode is frozen. It is determined by the order of complexity with which it began.

This means that the computer cannot generate anything beyond what is written into the program it is instantiating. It cannot discover or even mimic the ways of the mind system, let alone make sense of itself and its experience. The computer, or if you like the computer program, cannot step outside itself or model the formative interactions between contents and function, which is the essence of the living open system. Nor can it access and rewrite its own defining axioms, its so-called Gödel sentences,

achieving thereby levels of complexity beyond its own. The computer, standing here for the general class of rule-governed formalisms, is clearly not competent to judge questions of content validity, semantic sense, and congruence. Accordingly, it is totally indifferent to absurdities of meaning, such as that of Chomsky's "colorless green ideas sleep furiously," as long as the grammar is correct, that is, the rules are obeyed.

The celebrated case of Russell's paradox is an excellent illustration of formalism's inability to judge or even just to look in on problems that are lifelike and not merely formal in character. In its classical form Russell's paradox is about a set "R," which is defined as the set of all sets that are not members of themselves. "R" is then a collection of sets to which a given set can belong only if it is not found among its members. This has the paradoxical result that if a set is taken not to belong to set "R," it qualifies as belonging, while if it is taken to belong, its qualification is void. Reflecting on this, Russell (1960) noted that:

> It turned out on logical analysis that there was an affinity with the ancient Greek contradiction about Epimenides the Cretan, who said that "all Cretans are liars." A contradiction essentially similar to that of Epimenides can be created by giving a person a piece of paper on which is written: "The statement on the other side of the paper is false." The person turns the paper over and finds on the other side: "The statement on the other side of the paper is true."
>
> At first I supposed that I should be able to overcome the contradiction quite easily, as probably there is some trivial error in the reasoning. Gradually however, it became clear that this was not the case.

The contradiction resisted all attempts at resolution because Russell kept looking for formal flaws, errors of logic, where none existed. Having no model of the mind to give him a lead for the correct identification of the problem (see below), he had to insist that logical formulations would eventually do the trick. In the end the paradox was never solved, at least in formal terms, thereby furnishing another example of formalism's unrelatedness to contents, the circumstance that tolerates the handling of semantic nonsense.

The claim that formal systems are mind-like, or may be viewed as analogues of the mind, was finally settled by Gödel. In his 1931 theorem he furnished conclusive proof that mathematico-logical formalisms are unable to validate themselves. They are dependent on an external entity, such as the mind, for definition and validation. Indeed, formalisms are only operational specifications, neural transactions in human brains and instantiations of procedural steps in machines. They are no more than working frames in which contents can be reassorted and recombined in

rule-governed ways. Formalisms have nothing to do with contents per se, justifying the computer adage of "Garbage in, garbage out."

The mind-boosted brain is clearly more than rule-governed procedure. To ignore this leads to misrepresentations and outlandish claims. While the mind does use formal techniques, that is, language (its own invention), to manage its percept-contents, this is no reason to regard the formal system as the equal of the mind it subserves.

This brings us to the third point, the genesis and the identification of formal systems as a class. As we have seen, formal systems based on rule-governed (computational) procedures are unable to transcend themselves, evolve and interact with what they process, and so become mind-like. In short, the computational procedure cannot have created the conscious mind or been its evolutionary blueprint. By contrast, it can be shown that the conscious mind is in fact parental to the computational paradigm, the genesis having taken place by the brain's schematizing of the invariant relationships that were emerging out of the evolving language routine. In particular, the frontal lobes of the brain (see section B of chapter 3) were able to perceive that the semantic units (the words) were interchangeable within the language frame and, quite importantly, that the language frame was a stable formula for the handling of contents. Having evolved an internal "off-line" loop for reflection and empowered to see what it was doing, it could easily manipulate classes of words and the function of words. This led to the perception of the instrument as distinct from the contents it handled, and to the realization of the rules that were governing it. Once the prototype of the rule-governed operation (the grammar) was perceived and formulated, units other than words could also be handled. Counting could begin, the treatment of numbers growing more and more sophisticated, leading to mathematics with applications in technology and culminating in the apotheosis of the digital computer.

Before we take a closer look at the computer, let us underline an important difference between it and the language-formalism that was its source. While in the case of language there remains a formative nexus between the instrument and the semantic material (the words) it handles (contents being able to influence the frame), in abstract formalisms, such as mathematics, the computer, and the algorithm, the nexus is lost. This is because the contents themselves are abstract generalizations rather than real entities. Constructs and operations, such as the "unit," the "integer," or "equivalence" and "multiplicity," are not real things in an absolute sense. They are given idealized status by definition. This is because abstract formal systems, predicated to function with idealized "yes—no" concepts, have zero tolerance for semantic

approximations, for example, for "almost units" or "near-enough equivalences." By contrast, entities in the real world, people, objects, and events, are unique, complex, nonadditive, and noninterchangeable. They could never be and could have never been the outcome of computational routines, however complex and subtle.

Let us now turn to the identification of the computer, this spectacularly successful product of human achievement, science, and technology. If, as we have seen, it is not even remotely a mind analogue, or mind-like in essence, is it at least cognate with some aspect of the brain and of the thinking process in particular? The answer is a qualified "yes," but only if we restrict the analogy to the functional or procedural side of it. In this limited sense we can draw a valid comparison between computing and the brain's motor performance as it drives its word-percept units across its focus of awareness—an activity in which the neural equipment provides the hardware, while the language formalism provides the software. The computer's performance can be seen as an extension of the brain's motor capability. It is complementary to and epistemologically on a par with extensions on the sensory side of the brain, such as the telescope and the microscope. Just as these vastly enhance our sensory penetration of the world, enabling us to see inside the cell or detect invisible radio sources in distant galaxies, our digital computers empower us to process much of what used to be wholly unmanageable or unthinkably complex. Similarly, just as our new sensing devices (imaging techniques, etc.) open up for us unsuspected aspects of the world (both macro and micro), our computing machines lead us to unimagined combinations and resolutions of immensely complex processing tasks. What is rather puzzling here is that, while no one of sound mind would suggest that the electron microscope or the gamma-ray detector can actually and literally see, some scientists and computer experts hold the view that the computer does think, display intelligence, and its configuration of programming patterns does generate consciousness. This is a disturbing fallacy, as is the glib attribution of life qualities, such as intentionality and volitionality, to mere implements. When viewed against what is in fact given, that is, the brain's extended motor capability for the handling of digitalized contents, it all seems absurd. The absence of a meaningful mind-model, which this text sets out to correct, is at least in part to blame. In what is a conceptual vacuum, free-floating terms like "consciousness" and "mind" are bound to be used in an attempt to make sense of our cognitively fragmented world.

Let us however return to Gunderson's (1984) definition of the mind—"The scanner that can scan all objects except itself in the scanning

mode"—but only to stress that it applies to machines, not minds. Minds are structured systems, able to process but also to experience. Gunderson's metaphor depicts only the machine, the incomplete system that needs an additional receiving entity, a mind, to make sense of what is being scanned. To make it fit the real mind, Gunderson's definition would have to read: "The scanner that can scan all objects, *including* itself in the scanning mode." The model of the mind that aspires to meet this specification must provide a biological baseline where all input is totalized (an endogram) and an additional account of how this is accessed, processed, and reentered. Models of the mind, aiming for less, mislead, confuse, and in the end contribute only to fiction. In short, the difficulties with the mind are attributable to the philosopher's and the AI advocate's featureless generalization, that is, "simpler in its structure than any known physical organ" (Chomsky 1968).

To conclude this mind-versus-formalism debate, we have to show why the real mind succeeds where formalisms fail. For example, how can the mind detect and resolve the formal conundrum of Russell's paradox, perceiving semantic flaws that are undetectable on formal grounds? The answer lies in the mind's content-relatedness, the very quality that formalisms lack.

As we have seen, the mind has an experiential base (the endogram) and a motor facility (speech-thought) with which it can project back onto it percepts and combinations of percepts. These it validates and tests against concrete experience to decide whether they are valid or otherwise. The mind, able to tell fiction from fact on experiential grounds, recognizes with ease that the idea of a "truthful liar" is nonsensical. It understands that its language facility can distort and confound.

To show how distortions are generated we go back to Lenneberg's (1967) observation that:

> The cognitive function underlying language consists of an adaptation of a ubiquitous process among vertebrates of categorisation and the extraction of similarities.

On the strength of this it is easy to see that if words designate classes and invariant characteristics and if these can be lawfully juxtaposed within the sentence frame, we can hybridize percepts quite simply and without being aware of it. For example, we can run together incompatible aspects like "this black is white," "this liar is truthful," and "these colorless ideas are green." The nominalization of these contradictions into single concepts like "black whiteness," "truthful liar," and "colorless green ideas" follows automatically. It also follows that the subsequent handling of these in-

congruities within the frame of the proposition, that is, predicating this or that of them, leads to perpetuated and increasingly confusing logical anomalies.

As the genesis of these hybrids is uniquely language-linked, we can conclude that no such semantic incongruities could come into being without a language instrument to do the hybridization. In short, the incongruities are generated and laid in by courtesy of the language formalism—a reminder of what this "off-line" processing facility of ours can generate for good or for ill. Indeed, the purely formal aspect of language is powerless to exercise effective control over the output. This is especially true once it is released in circulation and terms are given accreditation, even if on spurious grounds (leprechauns, ghosts, computer-generated consciousness, etc.). They take on a life of their own because on purely technical grounds they are indistinguishable from percepts that were generated in the course of normal percept integration.

The resolution of Russell's paradox of Epimenides the Cretan's "truthful liar" and problems of semantic validity in general is therefore not a question of formalism and should not involve a search for logical flaws. Instead, it should entail the retracing of the linguistic transformations that change the initially straight semantic material into a nonsensical riddle. This is further proof that formalisms are not at all mind-like but only facilities the mind-boosted brain can use or misuse with impunity. Formalism's role is the overseeing of the functional frame, in which percepts, real as well as imaginary, can be effectively and properly handled.

To sum up, a mind-model based purely on formalism is unworkable. It implies an entity that is self-referent, regressively circular, asymmetric, and incapable of decoding itself. To make matters worse, as formalism's failure is seldom recognized to be a failure in modeling, further inquiry into the mind may be discouraged and nonrational "solutions" given credence.

The case of the real mind is another story. Its processing symmetry of what is "inner" and what is "outer" tells us that we think with percepts and that all percepts are thinkable. From this it follows that since everything that exists is either already in the percept form or can be rendered so by the mind, it is possible to scan (think about) absolutely everything, including the mind itself, as even this is just a percept in and for the thinking process.

This constitutes unlimited adaptability and an ever-expanding reach for the thinking mind. It implies the creation of new percepts and the repudiation of the idea of preconceived limitations for the thought-capable brain. In the light of this, Wittgenstein's dicta, "The limits of my language mean

the limits of my world" and "What we cannot talk about we must pass over in silence," are wide of the mark; first, because they imply that the mind is trapped in its linguistic mold, when it is not; second, because they claim that the mind cannot upgrade its percept repertoire from within, when it can; and third, because they assume that the mind can recognize what it cannot speak about, then manage to pass over it in silence—in other words, that it can reflect and decide upon what is outside its reach and mental jurisdiction.

Wittgenstein's dicta (speaking for formalism and philosophical introspection) are furthermore mistaken on more than logical grounds. *Homo sapiens'* immense mental expansion, the paradigm shifts achieved, the upgrading of science, and increasing penetration, insights, and methodological sophistication bear witness to an internal process of revision that reworks the content material of the brain and renders accessible what was previously outside thinkability. This suggests that the mind is like a semantic cauldron that creates percepts, models, and schemata for handling the world and for penetrating what is unclear and unknown. Wittgenstein's and formalism's implied model of how the mind works is therefore irrelevant and useful only because it exposes an essentially false lead. This in turn helps to clear the deck for a better understanding of the mind and the way it builds its self-representation.

B Model Formation and the Role of Semantics

Our cognitive apparatus is itself an objective reality which has acquired its present form through contact with and adaptation to equally real things in the outer world.
—K. Lorenz (1976), *Behind the Mirror*

In this section we look at the problem of how the mind-boosted brain is able to build a representation of itself out of the semantic porridge of ongoing experience. It will be shown that the mind does this from within and that it has remarkable generative powers, in spite of Wittgenstein's belief in language-based limitations. If thinking is the mind system's operational arm that can only be done with percepts, then the model of the mind, too, must be of the order of a percept. Yet how can such a representation be manufactured and validated?

The answer lies with language, the brain's motor facility. It enables the brain to marshal its existing percepts and, through hybridization and grafting, create new ones. Language permits the handling of intrapsychic contents, allowing the brain to run up tentative representations that can be tested against intuitively sensed events and experiences.

The mind-boosted brain's modeling is a kind of hypothesis formation. It is a process of building mental constructs by stirring the semantic cauldron. It is a creative activity that uses language as its molding implement and the brain's content experience as the substance to be molded. The product of this semantic cooking, for example, the new model of the mind, is therefore a working hypothesis. Concerning this interpretation, Carello, Turvey, Kugler, and Shaw (1984) note that:

> A hypothesis is a logical formula, as is the evidence for its evaluation, and both formulas must be expressed in the discrete symbols of the system's internal language. If the evidence is sufficient to confirm the projected hypothesis, then the fact to which the hypothesis corresponds can be registered in the representational medium.

In this manner the self-complexing mind, using its digital facility (language) on its experiential substrate, is able to generate new and upgraded representations. For example, it can integrate into a unitary percept its body experience and the thought-induced proprioception of it, then match this representation through reflection with the modality experience of the integrated entity. By using its self-generated formalism the brain is able to build up increasingly detailed and well-focused representations of itself and its ways of functioning.

This creative process is not without accompanying complications. On the technical plane the task is to find neural mechanisms that are complex enough, yet distinct enough, to be credited with the processing of the double reentrance into the endogram and with being the source of the subjective experience that seems to be nonmaterial. This is a tall order that cannot be filled without taking apart the seeming unitariness of reflective awareness.

On the psychological plane resistance is generated by the paradigm shift that the mind's new (physical) identity requires. The new representation has to draw heavily on the system's production routine and draw less heavily on fixed structures that are features of traditional thinking. The new model of the mind has to be about what the mind does and how it does it, rather than what it is. It has to represent the experience of continuous totalization and self-embedding *and* the manner in which this is rendered accessible. The model also has to account for the proprioception of the rendering and the way this is integrated into the evidence on the basis of which the mind-model is delineated.

Besides technical and psychological difficulties, the modeling of the mind is up against the fact that much of the data that is needed for building it is locked in with earlier and mostly simplistic representations. These

are hard to shift, as they are often part of deeply felt systems of belief. The search for the correct identification of the physical mind may well seem sacrilegious and misguided. In short, the building of a watertight model of the physical mind is likely to be resisted. Animistic schemata tend to be preferred and retained, even in the face of well-founded evidence to the contrary. Yet, in spite of these complications, the mind has a better chance now than ever before to arrive at a model of itself that does justice to its true identity. There is much new and valuable material to draw on. Naive common sense is no longer the sole arbiter of what passes for an acceptable representation.

O'Keefe (1985) designates five areas that the modeling of the mind has to take into account. These are:

1. a neural substrate capable of sustaining it;
2. introspective evidence leading to subjective experience;
3. technicalities of transactions responsible for the entity;
4. social context and anchorage; and
5. the mind's place in the evolutionary schema.

Points 1, 2, and 3 we have already covered in earlier chapters; we have traced the emergence of language and the neural changes that underpin it. We have also examined why the mind's entelechy-like impression of itself is an unavoidable consequence of the system's functioning and why unaided introspection cannot account for it. Point 4 will be taken up in the next section, while point 5 will be assessed in the last chapter.

This section has outlined the way the mind-boosted brain is able to upgrade and enrich its percept reservoir. I have stressed that the brain manages this with the aid of its language formalism, and that without this motor facility it could neither think nor represent itself to itself. In short, it would not be reflectively aware.

It was also underlined that formalisms are not related to the content material they handle, and that this implies a nexus break between content and function. With respect to language, this means that the speech-thought operation is neither subservient to nor constrained by the material it processes. The evolutionary significance of this is that the brain has now an internal response alternative and can redirect into the mental realm what would otherwise find motor expression on the behavioral plane. Through language, experience can be stored, processed, and recalled, and insights and solutions can be generated, evaluated, and, if necessary, implemented. With the help of language it is also possible to perceive the self as a volitional entity, a free agent in the societal context.

The brain's problem-solving genius is now in the position to take an active and purposive role in dealing with personal and environmental predicaments.

However, since the nexus break between intrapsychic contents and the means for handling them frees the brain to chart its behavioral course, feedback mechanisms no longer apply, and a situation of risk is created. Insight and reflective awareness are in themselves no guarantee of evolutionarily responsible behavior. The reader will need no convincing that the mind-boosted brain is free and able to think and implement any nonsense that takes its fancy. Furthermore, it can distort its representation of the world (consciously as well as unconsciously) by inventing belief systems because they give it comfort. The breakthrough to reflective consciousness is therefore a mixed blessing. Like a joint opening of Aladdin's Cave and Pandora's Box, it can lead to treasure and trash, and to the potential upgrading or downgrading of the quality of life for the individual and for the group.

The sense that the mind-boosted brain is able to make of its insight and power of cognitive penetration will be examined in the last chapter and will there be evaluated from an evolutionary point of view. Next its societal source will be traced. Having shown that the brain can transcend Wittgenstein's perception of language as a limitation to what is thinkable, we shall now turn to Whorf's concept of the language mold, arguing that whatever initial constraints it imposes, language is a passport to their transcendence.

C Society and the Shaping of the Mind

Every language is a vast pattern system, different from others, in which are culturally ordained the forms and categories by which the personality not only communicates but also analyses nature, notices or neglects types of relationships and phenomena, channels his reasoning and builds the house of his consciousness.
—B. L. Whorf (1956), *Language, Thought, and Reality*

The breakthrough to self-accessibility added an altogether new dimension to protohuman society. The ability to speak created a symbolic level of interaction and brought about a communal perception of reality. As language was the vehicle of these group transactions it evolved to reflect societal ways and attitudes. It is now necessary to identify the role of the individual's mind in this group interaction and to assess its autonomous significance for evolution. Whorf's description of the language mold highlights its formal significance:

> The categories and types we isolate from the world of phenomena we do not find there because they stare every observer in the face. On the contrary. The world is presented in a kaleidoscopic flux of impressions which has to be organised by our minds. This means largely by the linguistic systems in our minds. We cut nature up, organise it into concepts and ascribe significances as we do, largely because we are parties to an agreement to organise it in this way. An agreement that holds throughout our speech community and is codified in the patterns of our language. The agreement is of course an implicit and unstated one, but its terms are absolutely obligatory. We cannot talk at all except by subscribing to the organisation and classification of data which the agreement decrees.

Whorf's perception of the societal mold, though correct in outline, overlooks an important point. Language not only shapes and channels our thoughts but provides us with the neural machinery that gives us self-accessibility and renders us reflectively aware. It may influence the way we think and perceive but it also confers upon us thought capability with which we can doubt, revise, and transcend all the specifications that constrained us to begin with. Far from being a permanent cognitive trap, language is a passport to ever-increasing insight allowing the penetration of the mind system itself.

However, before we look at the liberation of the mind from its constraints, some of the costs and consequences of its initial acquisition must be assessed. This can be done by referring to the baseline of the non-mind-equipped brain, a level more or less comparable with that of the highest apes. On this level, prehuman functioning relied heavily on complex—if logically unelaborated—schemata, and operated in the closed context of the nonlinguistically interacting familial band, somewhat like Jane Goodall's free-ranging chimpanzees (Gombe Studies 1986). This context is characterized by leitmotifs and parameters such as *behavioral language*, *dominance hierarchy*, *pair bonding*, *food gathering*, *intergroup skirmishes*, and *territoriality*. These motifs are still around, even if muted, as they were with our hominid precursors up to and past the Ice Age hunter-gatherers. The mind-upgraded brain built upon this substrate. What we are looking for is mind-assisted variations on these themes. These probably take the form of reactively exaggerated and formalized compensatory attitudes.

The breakthrough to self-accessibility and self-interference rendered protohumans highly effective but also vulnerable. The mind-induced "great leap forward" in reasoning, communication, and applied insight had a dark side, an Achilles' heel to it. This becomes obvious if we remember that early humans' effectiveness was the result of their ability to access their own brains—to get hold of experience, use it, adapt it, and finally put it to a

practical test. This was clearly auspicious, but it was not all. It was impossible not to dwell on negative aspects, such as death and destruction, danger, threat and pain, fear, darkness and injury, hunger and loss, or malice and defeat. These experiences, whose contemplation was now possible, constituted sympathico-adrenal dynamite and a ready formula for generating anxiety and limbic overinvolvement.

The human version of what used to be the prespeech scenario now begins to unfold. For example, dreams—formerly transient, unrecallable, and therefore lost—begin to enter into the communal pool through retelling and contemplation. Portents, premonitions, and a host of previously incommunicable sensings and impressions start to have an inflated group effect. Interacting with the concrete issues on hand prompted the mind to come up with compensatory schemata aimed at environmental control and intrapsychic equilibrium. Myths were created out of anxiety states, furnishing explanations, meaning, and certitude. This is how Wilson (1978) describes the construct:

> Finally there was myth, the narratives by which the tribe's special place in the world is explained in rational terms, consistent with the listeners' understanding of the physical world. Pre-literate hunter-gatherers tell believable sacred stories about the creation of the world. Human beings and animals with supernatural powers and special relationship to the tribe fight, eat and beget offspring. Their actions explain a little of how nature works and why the tribe has a favoured position on Earth.

It is easy to see that what is at work here is the newly mind-endowed former ape-brain's projective overconcern with the threatening complexities and implications of its now conscious experience. If, as is proposed, the mind system was neurofunctionally generated, it is possible to work out the sort of schemata and compensatory dispositions it would create. This draws attention to the role of the schema, the stabilized bridging construct between what is real and what is self-generated in our perception. Wilson (1978) describes it as follows:

> A schema is a configuration within the brain, inborn or learnt, against which the input of the nerve cells is compared. Matching the real and the expected patterns can have one or other of several effects:
>
> A. The schema can contribute to a person's mental set;
>
> B. It can screen out certain details in favor of others, so that the conscious mind perceives a certain part of the environment more vividly than others;
>
> C. It is likely to favor one kind of decision over another;
>
> D. It can fill in details that are missing from the actual sensory input; and
>
> E. It can create a pattern in the mind that is not entirely present in reality.

This way the impressions objects give of being a square, a face, a tree, or whatever are aided by the taxonomic powers of the schemata.

Since it was anxiety overload that had to be compensated for, it is easy to identify two distinctly mind-created and mind-enhanced danger schemata:

1. Invisible forces, or gods, that is, agencies that lend causal coherence to incomprehensible phenomena.
2. Humans, or more precisely alien groups of humans, with their imagined intentions as constituting the source of danger.

The ensuing response dispositions are predictably paranoid and schematized to cope with the challenge. Simply put: humans defensively deny their own fear-motivated preemptive inclinations and, believing the world to be ill-disposed toward them, set out to put matters "right." With respect to the first danger schema they try to expiate, appease, and, if possible, control the invisible forces and gods by sacrificial rites, offerings, and ritualistic practices. With respect to the second, they attempt to pacify or, if necessary, exterminate human adversaries. Anecdotally speaking, Wilson (1978) illustrates the point by quoting a Navaho chief as saying that "We are very tired of all this fighting and would stop, but the others can't be trusted."

This enables us to identify the twin roots of the chronic human preoccupation with religion and warfare. In this sense, religion, or more precisely its ritualistic variety, is an expression of animism, fear, and ignorance, while warfare, based as it is on supposedly innate aggressiveness, is an example of a societal misconstruction. Both preoccupations are mind-created. The response dispositions they generate are maladaptive.

Insofar as the mind's quest is to decode itself and the world around it, ritualistic religiosity is counterproductive. It interferes with the cognitive freedom that the inquiry demands. The freedom to build better models of reality and of our place in it is especially important. As Wilson (1978) observes: "Species lack an evolutionary goal toward which their molecular architecture automatically steers them."

This leaves the finding of goals up to us. Yet, if we are constrained by mental straitjackets the task is impossible. If the human mind is a "device for survival" and "reason is just one of its techniques," reason should be permitted to tackle the task.

The second problem, the belief that warfare is an expression of innate aggressiveness, is based on a misconstruction. This is the idea that an aggressive instinct exists and leads to mass violence. Actually, it works the other

way around. Most violence is societally organized and triggered, and the individual merely conforms. Human endocrinology, as the ape's, is neutral and there is no evidence to support an instinct or aggressive drive as such. Humans can, of course, respond aggressively when stressed or provoked and can be made to participate in mass violence, but these actions are precipitated effects rather than expressions of uncontrollable forces. The actions are generalized anxiety states, organized to lead to paranoid reversal and counterresponse. They are mental in origin and mind-dependent in organization and therefore at variance with Lorenz's (1966) view that "Human beings share a general instinct for aggressive behaviour with other species."

This folk tradition ignores the large body of cultural evidence running counter to it. It also overlooks the fact that the mind of the individual is subject to manipulation by the group. Just about all varieties and shades of adjustment occur, ranging from the totally peaceful Zuni of North America to the warlike and pathologically bellicose Mundugumor of New Guinea. This could not be the case if instinct were the true determinant. Oakley (1985), summarizing Slobodkin's reflections on this issue, notes that:

> Though the formation of the self-image can be seen as a result of a biological imperative, the contents of the self-image are not biologically predisposed but are determined by the individual's own experience within his or her cultural group. Our behaviour as individuals is determined in significant ways by whether we perceive ourselves for example to be warriors or pacifists, and the conduct of whole societies may reflect the self-image which they foster in their members. Slobodkin offers this perspective as a counter to those who believe that humans are ordained by their biology to act aggressively, to fear their neighbours, and so forth.

The group's hold on the individual's mind is significant. Through the language medium, the group shapes perceptions and controls the individual's will. It does this by locking individuals into collective action schemata (fraternities, loyalties, etc.) and manipulating their language-accessible mind. The point to emphasize is that although reflective awareness comes about through the individual's self-accessibility, the acquisition of this capability is group induced and group assisted (see section B of chapter 2). As a result of this, the mind is, in part, collective in content and character. The instrumentality of reflective awareness and thought is therefore an interaction product, a wired-in variant of the group-mind, which is administered by the language-endowed left hemisphere. The left-hemispheric monopoly of generating and running the reflectively aware state draws attention to the problem of balancing the relationship between the hemispheres. The reader may wish to

refer to the fascinating literature on split-brain studies, which explores the personality and motivational differences between the hemispheres and the psychopathological implications of the failure to integrate (e.g., Gazzaniga 1989). Rather to the point, Zaidel (1977) describes the hemispheres' relationship and notes:

> Foremost for a theory of consciousness is the persistent and active left-hemispheric neglect and denial of right-hemispheric experiences. It is as if overt and unified behavioural control and/or verbal denial of the independence of the right hemisphere are important defences of the integrity of the conscious ego.

The message is clear. The reflectively conscious left-hemispheric ego and the publicly endorsed self-schema it underwrites are threatened by the silent yet restive right-hemispheric presence, that is, by the suppressed ape, whose intuitive perceptions and inclinations are not distorted to conform and serve societal specifications.

The juxtaposition of the spontaneous and impulsive asocial ape in us and the socially prescribed normative perceptions of the reflective human mind calls for a continuous intrapsychic balancing act. This takes place under the left hemisphere's mostly repressive guidance, and largely in terms of ignoring right-hemispheric insights and intuitive perceptions. This arrangement is a source of potential stress. The communal prescriptions that set the tone for these interhemispheric relations can, in fact, be too restrictive. This, as La Barre (1972) suggests, can lead to societies being "psychologically sick," or "strained." The group may, of course, be able to cope with such conditions and control deviations and threats to its internal cohesion. Take the method of the Ndembu society as an example. Quoting Turner (1981):

> Associated with this process of revealing the unknown, invisible or hidden, is the process of making public what is private, or making social what is personal. Anything that cannot be shown to be in conformity with the norms or in terms of the values of Ndembu society is potentially dangerous to its cohesion and continuity. Hence the importance of the public confession of the "Ihembu" ritual. By exposing their ill-feelings in a ritual context to beneficial ritual forces, individuals are purged of rebellious wishes and emotions and willingly conform once more to the public mores.

In this manner it is possible to redirect and make societal use of psychodynamic stress in the community, for example, in outward aggression. The psychological implications of the group mold may therefore be regarded as a flexible and exploitable source of group action, inspiration, and even internal reconstitution.

It needs to be stressed that whatever value the group may put upon itself, it cannot be regarded as more than a substrate in sustaining and support-

ing individual lives. Although societies are indispensable for evolution, they have to be evaluated in light of their organizational and intrinsic suitability for furthering the development of the individual. This is seldom understood, and has the result that incorrect abstractions prevail and societies are perceived as higher-order organisms, superior even to the individual human. This view often appeals to ideologues and social engineers, with disastrous consequences. The view nevertheless persists, though it is more than obvious that it is not society but the individual that lives, evolves, and thinks. It is the individual who upholds even the societal persona, that is, the overrated abstraction itself. Although this could not be otherwise, it should be recognized that the arrangement is not one to which individuals were free to accede. Rather, it is one into which they were contracted through chance of birth, even if membership is now a passport to humanity. As it is, individual humans are irretrievably dependent upon the collective whose product (at least in part) they are, but whose future course each individual is now free to influence.

It becomes clear that even a strong initial commitment in favor of the local version of the truth (as enshrined in language) is worth having. This is because, in spite of the limitations of parochial mythologies, the mind-capability can lead to self-generated options. Once in possession of the equipment for speech and thought, humans can use it to question and revise, to upgrade and distill, and to evaluate their situation. This enables humans to distance themselves from the very conditions that put them onto the intrapsychic stage as actors, for better or worse.

On the strength of its record, the brain—and in particular its reflective human variant—must be judged to be able to work itself out of binds and into organismically and evolutionarily more workable situations. It remains to be seen whether self-decoding and self-demystification will seem to it an advantage or a threat. Yet, inasmuch as the brain is the guiding organ for optimal adjustment, the chances are that it will be motivated to expand its horizons and strive for a deeper understanding of itself and of the world. For this it will need better models with which to represent the inner layout and the reality in which it is embedded.

Humanity's currently available mythological schemata, whether of religious or philosophical hue, are of little intrinsic worth. They are inconsistent and question-begging, and call for faith rather than reason. In fact they are no models at all but anthropological props. They represent inadequate attempts to create some semblance of order and comforting certitude for the only recently emerged mind-upgraded human primate.

9 Evolution: The Model of the Loaded Dice

"I flattered myself"—replied Pangloss, "that we should have the pleasure of arguing with you on causes and effects, the best of all possible worlds, the origin of evil, the nature of the soul and the pre-established harmony." At these words the Dervish shut the door in their faces.

—Voltaire, *Candide*

A The Watershed of Insights

The evolution of consciousness can scarcely be matched as a momentous event in the history of life. . . . There may be nothing new under the sun, but permutations of the old within complex systems can do wonders.

—S. J. Gould (1977), *Ontogeny and Phylogeny*

In this section we look at the implications of the brain's achievement of reflective consciousness. The growth of knowledge and the marginalization of myths encourages the brain's self-analysis and leads to the formulation of previously unaskable questions. The mind-boosted brain, able to understand the context in which it is embedded, can now try to identify its role in evolution and view evolution itself against the backdrop of the material universe. As the mind is now able to conceive of such questions and can no longer retreat behind the shield of ignorance, it has to think its way through the epistemological maze its insights have created. The task is complicated by the brain's mandate to protect the organism and by the possibility that its expanding knowledge will destabilize it. How, for example, may the brain seek objective facts about itself and the world if these can undermine its sense of security? No more acceptable is the alternative of opting for mythologies by rejecting the knowledge that could be the key to its evolutionary role. There is a third possibility, the recognition that objectivity is not at variance with organismic interests, at least on higher levels of understanding. If this were so it would make the mind's quest to find

psychic shelter in myths a pointless exercise. As we shall see, the evidence favors this third possibility. Knowledge and security are positively correlated, and it is myths that are counterproductive. It is belief systems that are suspect, while the mind-boosted brain (the physical entity) appears to be increasingly relevant in the biosphere.

Putting the matter in perspective, the brain's situation can be compared to a twofold watershed. The first watershed was the breakthrough to self-accessibility. The second is the expanding body of knowledge that gives it insight and environmental control. The watersheds cannot be recrossed. The brain can neither become unreflective again nor lose its cognitive grip upon the world. The accuracy of its representations of self and of the world is being continuously upgraded. This makes it increasingly difficult for it to sustain its identity as the "ghost in the machine." The "ghost" violates the laws of physics. A ghost cannot act on or interact with the world in which it is embedded. It is entirely useless for the exploration of the physical mind and for building a model that works and makes sense in the evolutionary context. It is a relic of the dualistic worldview that is itself a failure in trying to make sense of subjective phenomena.

At this stage of expanding insight there is a need for a scientifically valid model of the mind. The lack of such a model is not a reflection of the matter's importance, but of the serious difficulties the undertaking involves. The task can be tackled only in an interdisciplinary way and this does not accord with the predominantly reductive methodology of science. The systems approach of the consciousness revolution is not quite ready for the complex modeling that is called for. Reflecting on this problem as early as 1968, Chomsky accurately observed that:

> The real problem for tomorrow is that of discovering an assumption regarding innate structures that is sufficiently rich, not that of finding one that is simple or elementary enough to be plausible.

As we have seen in earlier chapters, richness of structure for the modeling of the mind is to hand. It consists of the neural representation of the animal brain plus the speech facility that handles it and the proprioceptive trace this generates. The model has nothing to do with the "ghost," or with anything ontologically "other." Paraphrasing Gould, the mind is indeed the wonder that the "permutations of the old within complex systems" have generated. The physical mind is of course far from universally welcome. Many prefer the "ghost in the machine," as its simplism is familiar. It is not recognized that the mind's physicality means expanded and not reduced horizons. Nor is it appreciated that the spiritual mind of old is a

conceptual no-man's land, a hindrance rather than a help in understanding the self and the world.

In the model I am proposing, the physical mind, unlike the ghost, consists of interacting components that combine to create the reflective human state. The physical mind interacts with and acts on the organism and the world of which it is part and out of which it evolved. Though it seems unitary to itself, it is in fact a complex orchestration of:

A. the organism's integrated experience as displayed in the endogram which, without the enhancements described in points B and C below, is nonreflective and similar in all essential aspects to that of the ape;
B. the neural adaptations and supplementary growths that are needed to sustain reflectiveness; and
C. the speech-thought function with which the brain manages its percept repertoire and handles the endogram.

Component A, the endogram, is the sole seat of experience. It is there, not in a fictitious new entity referred to as "the conscious mind," that reception takes place. Components B and C are higher-order time-dependent neural elaborations of A. They are the human "tip" of the infrahuman "iceberg." They humanize the endogram and render it reflective without changing or replacing its experiential monopoly. There is no switch of experiencer, or of location of experiencing, only a change to the reflective mode.

The mistake about the mind's true identity, though understandable, is unfortunate. It allows the reflectively functioning human brain to feel free to characterize itself the way it wants or society decrees. This adds further urgency to the correct decoding of the mind. Only a technically realistic model can lead to insight and knowledge and to the understanding of the mind's role in evolution.

The paradigm shift from the "ghost in the machine" (the traditional view of the mind) to the system of interacting components that renders the brain reflective calls for the jettisoning of familiar but unworkable ideas. The new paradigm also entails creative cooperation between the hemispheres. The right hemisphere's role is to reassort all relevant data into provisional templates (hypothetical schemata; see section B of the last chapter). The left hemisphere tests their goodness of fit and matches their congruence against the body of technical, neurological, and subjective parameters.

The interhemispheric cooperation required for successful model building will not be achieved universally. Effort, involving hard work with a lot of mental experimentation, is seldom seen as an attractive proposition.

Consequently, insights that may be attained by individuals at high cost are not sought by many. This results in an unavoidable cultural lag and a qualitative break between what can be known and what is believed. The correct solution to the riddle of the mind and its place in evolution may for a while remain unwanted and unrecognized.

On the other hand, an information-processing self-enhancing system, whose welfare depends on internal organization and order, cannot in the long run choose to remain ignorant about its identity. Yet there is a problem. It is that while the brain's integrative drive worked well on the level of concrete functioning, open-ended thought capability without feedback mechanisms to curb it entails risks. The group is not an organism and is not able to think or to exercise control commensurate with the forces it can unleash. Therefore its salvation may lie in the perception of an evolutionary purpose that commands universal assent and suggests clear enough guidelines for behavior and decision making alike. Such a perception could balance out the disorientation that the brain's coming upon itself has created. Open-ended thought capability is power, a product of evolution that is not yet integrated with the process that generated it. This is important for, as Wilson (1978) has noted, "Species lack an evolutionary goal toward which their molecular architecture automatically steers them."

On the infrahuman level the series of ever-upgrading neural representations allows us to perceive an evolutionary trend. The continuation of this trend on the human plane is the re-representation of representations: the function of the reflective mind. The characterization of the mind as the developmental consequence of the systemic upgrading of the brain makes excellent sense in organizational as well as evolutionary terms.

In the next section we shall examine some of the contentious aspects in the mind's quest for recognition as the key player in evolution. In particular, we will focus on how vested interests subvert the inquiry either by overzealous negativism or by reverting to animistic palliation. Whichever way we look at the situation, once past the watershed that separates reflective awareness from its nonreflective substrate, the mind-boosted brain has no choice but to give an account of itself. This is a challenge that will not go away, but will grow increasingly urgent with time. It is a challenge the brain did not have to face when innocence and ignorance shielded it from insight.

B Prejudice and Counterprejudice

The present challenge as I see it is in the areas of the two extremes of evolution—the origin of the first living system on the one hand and on the other, the inner workings

of the most intensely teleonomic system ever to have emerged, to wit the central nervous system of man.
—J. Monod (1972), *Chance and Necessity*

To evaluate the mind's task of finding its identity and evolutionary role we have to take into account the human need for an emotionally secure explanatory frame. It is also relevant that on this level of understanding such security cannot be attained without considerable projective distortion. This need is so strong that information seeking and striving for objectivity tend to be subverted or deflected in subtle and persistent ways. Deep-seated animistic tendencies are implicated, pressuring the mind to come up with some comforting scenario. This is a particularly dicey bind because it makes one wonder whether a given pattern, if emotively favorable, is not in fact the result of wishful thinking. Monod's objections to animism (see below) typify this predicament. His essay, *Chance and Necessity*, will therefore be used as a background for examining certain philosophical, conceptual, and attitudinal problems.

In spite of the essay's intrinsic merit and lucid exposition, some of Monod's conclusions represent an unwarranted and unsupported overreaction. This centers around his denunciation of the "old animist covenant": the schema that links humanity and nature into a meaningful if arbitrary arrangement. He categorically rejects any conceivable pattern that might emerge out of the data, lest it be palliative and provide humanity with a "safe harbor."

Monod is right in insisting that objective knowledge is the source of truth. He is also right in stating that seeking it is the only ethic worth having. Furthermore, the quest for establishing the truth can only take place with correctly perceived and interpreted regularities in the sea of phenomena surrounding us. Where Monod is wrong is in vetoing all further attempts of the mind-boosted brain to scan the data for signals and invariants in the "noise." The veto expresses distrust of the brain. This is surely not justified, as it was this very instrument's scanning, sorting, and generalizing that opened up science, with its promise of expanding knowledge. Nor are there valid grounds for doubting that after false leads and projective deviations have been discounted, there might not still remain patterns and themes that make sense and throw further light on the biosphere and the mind's role in it. There are no intrinsic reasons why there should not be some pattern of unfolding that might be a meaningful expression of a universal process. I am not saying that this *is* so. I am only saying that Monod's grounds for insisting that it is *not* so seem *a priori* and perhaps

tendentiously negative. It is almost as if he felt that anything that just might seem good news for humans would have to be contrived, artifactual, or animistic in character; that is to say, illgotten or fraudulently motivated.

In defense of Monod's distrust, it must be said that bad news is never welcome, that humans have got around unpalatable facts before, and that their track record is dismal. Yet on balance, this is still not enough ground to conclude that the brain, the source of our sophisticated understanding, is simply unable to produce any further relevant insights unless these are verdicts of final futility.

What I am saying is not that there is purpose in the universe (implying some preset goal), as this would clearly go beyond the data on hand; but that there are discernible patterns everywhere, which should be evaluated and used for hypotheses about deeper regularities and blueprints. Monod's categorical refusal to give the brain and its scanning capabilities another chance and to suspect instead some animistic conspiracy in anything the mind might produce is all the more surprising as it is *he* who states that:

> Objectivity nevertheless obliges us to recognise the teleonomic character of living organisms. To admit that in their structure and performance they decide on and pursue a purpose. Here therefore, at least in appearance, lies a profound epistemological contradiction. In fact the central problem of biology lies with this very contradiction, which, if it is only apparent, must be resolved or else proved to be radically insoluble.

Yet the contradiction is neither apparent nor insoluble. It is nonexistent. Monod's concern is caused by the misleading implications of our language mold, in particular, by the unconscious semantic shift from what is teleonomic behavior to what is metaphysically purposive causation. The latter implies that an event in the future influences the present, and this is simply unacceptable. To clarify the matter it is necessary to demonstrate that:

- all behavior is determined always and only in the present; and
- language-based conceptualization is the source of the distortion.

The first point to establish is that when living organisms "decide on and pursue a purpose" they do this always in the present. The envisaged goal is not "out there," situated in the future and attracting the organism, but inside the system as an intention or program in the here and now. The self-sustaining living system can never be other than self-directing and self-managing, and these operations always take place in terms of built-in and/or self-created specifications. The creature's behavior is geared to life-

sustaining metabolic and ecological transactions. These involve the intake and processing of information and the revision of plans for coping and survival. Its strivings, its reaching out into the environment, are therefore internally determined, and are dictated by specifications that keep to a tight schedule of feasibility.

To throw more light on the internality of the decision-making process and on the perpetual present tense of the organism's processing and planning, it has to be stressed that the processing phase responsible for the state of the endogram reaches levels of great complexity. The brain draws on larger and larger chunks of stored information that lead to considerable functional autonomy. This enables it to make up mental goals in the here and now, but also to treat these goals as if they were in the future exerting influence from "out there." The latter is, of course, a complete misrepresentation. In light of what is really happening, purposes and goals are exclusively internal events. They call for internal adjustments to change the organism's situation to approximate increasingly the mentally envisaged and striven-for state.

Since the brain keeps up an ever-updating situation report in the form of the endogram and since it is to this and not to the outer world that it responds, the issue of purpose *qua* external or future source of influence does not arise. Purposive behavior (so-called) is therefore a reference only to an internal realignment in terms of a desired program.

More evolved organisms, drawing on stored and highly integrated information, must, of course, seem increasingly goal-directed. This impression reaches new heights in humans, whose self-manipulated endogram is so far removed from recognizable causal linkage that a semblance of indeterminacy is created. This encourages entelechy-like attributions and a loose mentalistic modeling of reality in which causation from the future is construed as an admissible event.

The semantic shift that changes goal-directed behavior in the present to seem like behavior that is guided by a future event (a purpose) is therefore a traceable modeling error of the language mold. It is peculiar to languages that perceive the flow of time as a continuum coming at us, or us as progressing forward in it. Such an error could not be committed by speakers of, for example, the Hopi language (see Whorf 1956). The Hopi language mold has no time concept, no future or past, and is unable to represent "purpose" *qua* future event, that is, *qua* event "out there" to be striven for. The Hopi handle the matter in a purely intraorganismic fashion, in the enduring here and now where everything always happens. They regard what lies for us in the future as dwelling in the imagination at present, and what

is for us in the past as reposited in our memory. In such a conceptual model of reality, purpose can be none other than a mentally held action plan, an intended condition, conceived of, maintained, striven for, and implemented always and exclusively in the organism and always in the ongoing present. Telecausation is in this sense only a misconstruction, a modeling error.

A moment's reflection will tell the reader how valid this interpretation is and how markedly language molds can affect what seem to us immutable aspects of concrete reality. It may be asked, of course, whether without our type of time continuum and analytic approach to matters of duration and quantity, science proper would have ever evolved. Whatever the verdict: the lesson is clear. The brain-mind system is obliged to operate with one language instrument or another if it wishes to operate at all. This privilege is not free of charge. All instruments have distorting side effects, even if these can be detected and compensated for to some extent.

Nevertheless, while language models of reality have few appreciable side effects on the level of concrete transactions, on levels of abstraction built-in characteristics of the equipment create cumulative and ever-larger distortions. Once this stage is reached—and in complex discourse this is the rule and not the exception—the brain-mind system is liable to get badly entangled when trying to maintain or restore clarity. This is another incentive to accurately decode and understand the physical mind and the ins and outs of its *modus operandi*.

Monod's crusading stance against the animists, however, goes beyond the limits of objectivity. Teilhard's "intellectual spinelessness" appears to irk him, and he will not have the facts twisted under the banner of science. In his zeal to prevent any interference with truth, he becomes erratic and overlooks the vital difference between the goal-directed behavior of an organism and a "purpose" that implies causation from the future.

Monod also mishandles the role of chance. Here, too, he overcompensates and, in so doing, compromises the objectivity he wishes to uphold. As could be expected, his own transgressions occur where the animists have a chance of putting a mythological construction on the data. These critical points lie between well-mapped causal sequences of evolution:

A. the origin of the first living system, which deals with the onset of life,

and:

B. in the context of the inner workings of the "most intensely teleonomic system ever to have emerged," which deals with the onset of language and mind.

Monod begins by disallowing the possibility of detecting meaningful patterns in nature. Thus, even if observational data and theoretical insights are attained, they should—according to him—be seen for what they are: pieces of an anthropocentric animist plot. Monod appears to believe that the mind, having come so far, will not yield objective information about the structure and function of itself and reality, information that could modify or transcend his own viewpoint.

Looking at his difficulty with the problem of chance, Monod states that: "Before the actual inception of life, the probability of complex megamolecules becoming self-replicating was zero." He believes this primarily because the transition had to be an enormous leap whose complexities are not well understood even today. "The event," says Monod, "having in all probability been a singular occurrence and therefore unique, fortuitous and the product of blind chance." But also because: "On the strength of the theory, unique events, such as the breakthrough to life, are quite beyond predictive scope."

While this categorical finality adds weight to the cosmic isolation Monod wants to impress on the animists, his viewpoint involves a narrowing of the conceptual focus. He only accepts reductionist considerations, and this results in a biased picture. It seems that Monod's views on critical evolutionary problems are not as well supported by sound reasoning and concrete evidence as he would want us to believe. Even on the practical plane, Monod's views do not do justice to the knowledge and insight that are already available. For example, it is known that molecular aggregation and growth of structure and organization are thermodynamically feasible if a system is driven far out of equilibrium by energy input. In this case the situation arises where complex structures begin to show deviations on an increasingly large scale. In the area of nonequilibrium thermodynamics, Prigogine et al. (1978) explored a wide range of structures that at first appeared to defy the second law of thermodynamics by evolving into greater complexities of nonequilibrium rather than breaking down to a final point of equilibrium. These so-called dissipative structures draw their energy for growth from outside the system, but attain the conditions sufficient and necessary for discontinuous quantum leaps to higher levels of organization from within the fluctuations of the system itself. This means that there is a range of fluctuations about an equilibrium point, which leaves the system more or less unchanged. If, however, the fluctuations become amplified, the range of stability may be exceeded, and the system shifts into a new dynamic regime of functioning. An autocatalytic surge, involving positive feedback, is needed to achieve the higher level of stability.

These findings add weight to Porter's (1971) observation that: "The lottery for the inception of life may well have been played with loaded dice at every stage of a graduated sequence." This implies a scenario in which every step of the negentropic organizational buildup was increasingly feasible and probable.

Here it is relevant to allude to the thermodynamic cost of running the biosphere, our own negentropic system, and to observe that the solar energy transfer is easily misconstrued. The point is that at all times the solar energy input into the biosphere (about 2 billionths of the sun's radiation at any given time) is a free lunch. The estimated annual 150 billion tons of photosynthetically generated living material (forming the bottom of the food chain) captures and uses only waste energy, that is, energy radiated away by the sun and not specially drawn from it for this purpose. The biosphere's energy consumption does not alter the level of solar energy dissipation and will not be debited against some future account. Thus, the existence of a biosphere in our solar system and in similar solar systems in our galaxy and presumably in all the countless billions of galaxies does not increase overall entropy. This may be significant on the cosmic scale in view of what life, that is, matter locked into ordered systems, might be able to accomplish.

The Prigogine studies and various experiments investigating the conditions that preceded the appearance of life do not, of course, prove that such a transition was necessary or inevitable. They do, nevertheless, indicate that the "big leap" may have been simpler (perhaps much simpler) but also different from that implied by Monod. Quite possibly no single gigantic step, no tour de force, was really needed to achieve the breakthrough to life. Matter in the living mode of organization could in fact have been phased in without much fanfare and probably on a broad front wherever physical conditions were suitable for it.

With regard to the second problem, the role of chance in the onset of language and mind, Monod observes that the breakthrough to language may well have been another unique event in the biosphere. To this he adds that: "If it was unique, as the appearance of life itself may have been, it was because before it did appear its chances of doing so were almost nonexistent." This is surprising indeed, for if dice were ever loaded it was surely here. Admittedly, elsewhere in his writing he is more equivocal about the issue of the onset of speech and does not stress the zero probability of this "first and unique" event. However, the inconsistency only deepens the impression that, perhaps for personal reasons, Monod either overstates the case or else is unaware of the inconsistency of his position.

His use of the term "chance" for estimating phenomena that are evolutionarily emergent is suspect, as it is more applicable to cumulatively structured linear continua than to an abrupt and discontinuous occurrence. We have already looked at the lawfulness of phenomenologically discontinuous systemic changes, as when critical values in a system achieve a new regime and equilibriate around it (see Prigogine et al. 1978). This paradigm is no longer frowned upon as in the past, when discontinuous changes in nature were simply not given credence (*vide* the old adage of unknown origin: "*natura non facit saltus*—nature does not proceed in leaps"). Now, however, with Thom's catastrophe theory in mathematics (1975), Prigogine's dissipative structures in chemistry (1978), Rossler's turbulent flow and Plat's plasma dynamics and hierarchical reorganization in physics (1970), the conceptual climate has changed. Nor does Monod himself seem to be averse to dealing with systemic discontinuities, except—as we have seen—where critical issues of potential use to the animists are at stake: the onset of life and the onset of mind. This is what he says:

> Order, structural differentiation, acquisition of function, all these appear out of a random mixture of molecules. Individually devoid of any activity, any intrinsic functional capacity other than that of recognising the partners with which they build a structure, which only comes into actual existence through their assembly.

And:

> The complete structure was never performed, but the architectural plan for it was present in its constituents themselves, so enabling it to come into being spontaneously and autonomously without outside help and without the injection of additional information. So that the necessary information was present but unexpressed in the constituents. The epigenetic building of a structure is therefore not a creation, it is a revelation.

These reflections of Monod's are cognate with Bohm's (1981) perception of the "folded" or "implicate" order of matter, which "unfolds" and "explicates" its potentialities in organization, that is, in negentropic structure.

Returning to the role of chance in the onset of language, it appears that Monod simply ignores the manifold implications of the asymmetrically lateralized brain plan whose rudimentary specializations were already evident in *Australopithecus*. He seems to ignore the setup that was likely to lead to cross-hemispheric communication and collation of inputs. These latter enabled the speech-thought-sustaining neural interactions to begin. This process was bound to take off in a big way. It was a qualitative shift of high instrumental and survival value. If anything, this potentiality, already there in hominid precursors, should be seen as having had a high probability of

becoming actualized, and this once again on a broad front and simultaneously in creatures with similar brain architecture. It may therefore be concluded that the onset of intracortically wired-in human speech-thought functioning (and *ipso facto* that of the reflective mind) was highly likely, if not altogether inevitable.

The emerging picture is very much in line with the "loaded dice" model of epigenetic unfolding and tends correspondingly to reduce the significance of Monod's chance component. On the other hand, the recognition of greater developmental continuity makes it possible that evolution reaches even further back to a time before the inception of the biosphere. This could link us up with prebiotic conditions, and could render the perception of an even broader scenario theoretically possible.

While this is a challenging and interesting perspective, it also entails the loss of our previous sense of biospheric exclusivity and anthropocentric specialness. These matters are far-fetched and problematic at this stage. In dealing with them it is important to remain open-minded but cautious. Nor is the mystery of the inception of life solved, even if some aspects of the transition from prebiotic precursors are fairly well understood. To quote Francis Crick (1982):

> It is impossible for us to decide whether the origin of life here was a very rare event, or one almost certain to have occurred. It seems almost impossible to give any numerical value to the probability of what seems a rather unlikely sequence of events.

However, since a great deal of further scientific effort is bound to be channeled into this research area, the gap of unknowns may well be narrowed and perhaps one day even closed.

The use of Monod's writings as the connecting thread of this discussion illustrates the danger of partisan extremes. It demonstrates that the search for a factual model of reality can be compromised by omission as well as commission, that is, by denying and/or suppressing data, or by inflating and distorting them to tie in with belief systems or mythologies. Both positions (that of Monod and that of the animists) hinder rather than help the search for the correct model of evolution. They entail the risk that the quest, our scanning for patterns in nature, might remain a battleground for wasteful prejudice.

The point is that there *is* a puzzle to solve and that there is nothing wrong with trying to fit the jigsaw pieces this way and that. On the other hand, there is everything wrong with forcing unyielding pieces into false arrangements or with refusing, like Monod, to fit anything anywhere on the incongruous premise that we humans are too dishonest to solve the

puzzle while maintaining that there is no puzzle to solve. It may be concluded therefore that neither Monod's negativism nor the animists' practice of using the mind for covert comfort-seeking does justice to the mind system and to its quest for understanding itself and the world.

Going beyond this common ground of misperception or nonperception of the mind, it can be said that it is confusion that creates the free-for-all. The mind and the reflectively conscious experience it engenders have no obvious material and operational contours that could be traced and easily identified. The naive mind must seem to itself nonmaterial and elusive, an enigma that cannot be connected with the substantive world.

To break this impasse and do away with these chronic difficulties, I have attempted to show that what we sense and think of as "the mind" is materially and technically traceable and is neurologically well anchored. It is a system whose output and performance characteristics faithfully predict reflective awareness and even the manner of its genesis. I have also indicated that the system generates entelechy-like impressions about itself and how these are used for human mythopoeic self-schematizations. Hence there is no enigma and no mystery, only a gap in comprehension as a result of the lack of an adequate model. This is the cause of much of the confusion to which I have alluded several times in this book.

In my view the mind system is an experience-creating self-reentrant staging post that has the means of reflecting (with the aid of speech-thought) on the ongoing experience and in which this very reflection is experienced as self-generated performance. The entire performance pattern is continually advancing into the oncoming moment's totalization. It is in the confines of this neural interplay that mental options are generated. It is in these confines that the two disparate hemispheres optimally interact. This brings together right-hemispheric pattern perception and left-hemispheric critical analysis to create the highest form of insight and cognitive synthesis possible. In short, I perceive the mind system as being a miracle of cognitive organization. This must seem even more miraculous now that purely physical processes can be shown to sustain it. But then: "A miracle explained makes it no less miraculous," and we can rest assured that the physicality of the mind system adds to—rather than subtracts from—this wonderfully intricate achievement.

If the physical mind is at last taken to be what it is, this puts an end to the muddle and double-think of naive introspection. It is also the end of the projective free-for-all that has caused this overworked entity to fit in with magico-metaphysical molds of anyone's fancy. Having passed its "identity crisis," the mind is now in a position to recognize itself as real,

neurofunctionally anchored, and causally related to the organism *and* to the outside world. The beauty of this is that this seeming reduction of the formerly spiritual mind entity to a physically functioning organ system is no reduction at all but an expanding perspective and a widening horizon. This is because the mind in its true role as the biosphere's most negentropic and advanced manifestation can now begin to explore the whole scenario, including itself.

10 Between the Quantum and the Cosmos

It is conceivable however that life may have a larger role to play than we have yet imagined. Life may succeed against all of the odds in moulding the universe to its own purpose, and the design of the inanimate universe may not be as detached from the potentialities of life and intelligence as scientists of the twentieth century have tended to suppose.

—F. Dyson (1988), *Infinite in All Directions*

A A Range of Perspectives

It is an attractive notion that the mysteries of quantum physics and the mysteries of consciousness are somehow one. An epistemological loop that Morowitz describes as "just about the proper amount of hard science, beauty, weirdness and mysticism to sound right."

—D. R. Hofstadter and D. C. Dennett (1982), *The Mind's I*

Let us now look at the implications of the mind's breakthrough to self-comprehension, especially with reference to its possible role in evolution. What follows is tentative and speculative, though not unrelated to the order and organization that is increasingly discernible in the sea of phenomena surrounding us. Whether the mind-endowed brain is trustworthy and competent enough to reach relevant conclusions about itself and its situation must be viewed against its tendency to look for patterns come hell or high water. Such is the strength of this integrative disposition that if it is left alone and closed in upon itself, as in sensory deprivation, it will create order out of "the noise," and should this be impossible, it will invent schemata to make sense of this impossibility.

Its self-accessibility forces the brain to include itself in its comprehensive picture of the world. No longer an outside observer looking in, it finds itself embedded in a monistic world model that demands a new approach to reflective consciousness. The shift to this new view is consistent with

scientific insights, and replaces the dualism that regards mind as spirit in matter.

The mind with which we are concerned in this book, and whose functional characteristics we have been trying to identify, is an integral part of the material world. It is an expression of structure and organization that matter has generated out of itself, and one that may help to link aspects of science in a coherent perspective. This accords well with Wigner's (1973) suggestion that:

> Physical theory should be extended to the phenomena of life and consciousness. There is little doubt that it would be desirable to follow up this proposal. The question is only whether a deeper understanding of the phenomena of life and consciousness would alter our views on the role of quantum mechanics and the meaning of observation. It is my opinion that it is likely to do so.

Wigner's proposition is particularly relevant in light of the conscious observer's apparent indispensability for the transition of quantum effects to the macro-plane. The implication of this for the correct perception of the nature of the mind is far-reaching. The quantum substrate of the world, the level of the atom, the nucleus, the electron, the photon, and so on, though determined in itself, cannot be shown to have a determinable (causally necessary) passage to the macro-plane without a conscious observer. In the quantum world there is never a definite outcome, only the weighted probability of potential occurrences. Quantum events do, of course, assume definite form, but only when absorbed as information (through measurement or observation) by the nonquantum system (the mind) with which they are coupled. The philosophical and cosmological implications of this calls for the revision of the meaning of consciousness. This is how Penrose (1989) formulates the point:

> We know that at the sub-microscopic level of things the quantum laws do hold sway, but at the level of cricket balls, it is classical physics. Somewhere in between, I would maintain, we need to understand the new law, in order to see how the quantum world merges with the classical. I believe, also, that we shall need this new law if we are ever to understand minds!

The irreversibility of the quantum's elevation to the macro-plane, that is, its transition from an observed indefinite to something definite as a result of a measurement, highlights the mind as a critical component of the transaction. It demands the mind's redefinition as an interacting system, the processing focus of material self-organization, the nonquantum entity that resolves the indeterminacy of the quantum world.

The mind is the organism's functional epicenter, the focus of its order creation. The resolution of quantum uncertainty must therefore be taken to mean that the probability wave associated with the quantum has been absorbed (informationally assimilated) by an order-enhancing nonquantum system. In short, the quantum event has become a part of a system of high-level organization whose negative entropy (internal order) the event enhances still further. On the other hand, if the mind believes it has ontological "otherness" (that it is "soul" or "spirit"), it builds a model of the world that only reflects fantasies, not the reality it ought to seek.

The identification of the conscious mind is especially important for the task of penetrating the two farthest frontiers of our world, that of the quantum and that of the cosmos, because the mind may materially modify the interpretation and the order-creating value of observations.

This contingent relationship between our "knowing" and what we know holds true up and down the continuum of phenomena. Niels Bohr, reflecting on our instruments of knowledge and the substrate it tackles, puts it this way: "Physics tells us what we can know about the world, but not how it is."

Reflecting on the mind's "knowing" highlights the exclusive internality of the process. The world in all its aspects, substratal as well as surface, is strange enough. Our process of coming to know the world and its fathomless complexities is quite astonishing. The organism, representing structural and functional order, and having evolved out of lesser precursors, forms an internal image of reality. With its self-generated technique of reflection it then proceeds to analyze and interpret this. So without ever leaving its cortical confines, the mind generates means with which it can confirm, deny, or upgrade the internal representation and its own position in it. It creates order out of lesser variants, and continually refines the process, its insights, and degrees of accuracy. The result increasingly approximates an asymptotic state, never reaching final accuracy, but driven on nevertheless to reflect with greater and greater fidelity the optimally attainable image of what there is to perceive.

If the mind is the biosphere's order-creating focus, then its knowledge represents the integrated totalization of what it currently encompasses. The accuracy of this is especially relevant in the areas of the *microcosm,* the substrate that defines it, and of the *macrocosm,* the context of the biosphere and the universe in which the mind evolved and in whose terms it makes sense.

It may have bearing on the issue that subjective criteria, too, seem to play a part in the evaluation of the cosmic scenarios furnished by scientific modeling. For example, Penrose, Böhm, and many others regard "beauty"

and "elegance" as telling aspects of mathematical models that depict reality. Indeed, it is conceivable that qualities like "beauty" and "elegance" are intuitive reflections on how well basic symmetries and characteristics of the substrate are expressed. Nor is it absurd to assume that some deeply sensed order-seeking disposition in us rejects the incongruous or the surrealistic in representation. For example, cosmological models that imply a weird scenario, such as an infinite number of parallel worlds, have far less appeal than the so-called standard model, with its coherent outline and conceptual economy. It is as if sense and comprehensibility (though not necessarily simplicity) were important criteria by which to judge, as if Einstein's "God"—though complicated—were not chaotic but in the end comprehensible. In a similar vein one senses that the closed or oscillating versions of the universe are more acceptable than the open-ended or infinitely expanding variant.

These intuitive (probably right-hemispheric) preferences seem anthropocentric but they should not be dismissed or deemed unworthy of note. They, too, are expressions of biospheric order that matter has generated out of itself and which may be congruent with what our knowing signifies. To deal with such matters calls for another balancing act. The aim of this would be to avoid the animistic, if unconscious, reconstitution of the old "covenant with nature," but also the tendentious negativism of Monod. On the other hand, it must be stressed that speculations about cosmic scenarios must at this early stage be no more than tentative. Research and theoretical work in this field are progressing. Deeper insights come online continuously. For example: what were formerly regarded as nature's four fundamental forces, that is, the electromagnetic force, the weak nuclear force, the strong nuclear force, and the gravitational force, are now regarded to be part-expressions of a single force at different levels and in different contexts. The first two have already been drawn together into the so-called "electro-weak force," and a grand unified theory for bringing the remaining two into the same conceptual frame is being attempted (Weinberg 1978).

It is of the greatest relevance that all these models, theories, and achievements are products of the mind-boosted brain. Though this may seem self-evident and truistic, it is more than that. What we are witnessing is the biosphere—in and through human beings—opening conceptual windows upon itself and upon the universe. This is an extraordinary development. Here we have matter achieving self-reflection. Through this event the mind (its instrumentality) is able to increase its insight, its relevance, and perhaps even its power to influence the future of the biosphere and the cosmic scenario of which it is part.

This takes us back to the mind. As we have seen, mathematical language and the conceptual frames used for mental achievements are mind derived and mind generated. They arose out of language usage and out of the independent perception of its formal (grammatical) component. The evolution of an instrument with which thinking can be deliberately guided and which is distinct from what is being thought enables the mind-endowed brain to think about itself and the world and perceive universal regularities. Furthermore, the mind is now able to recognize that it is the expression of the process that generated it, and that it is anchored in neural technicalities. This means that it is no longer constrained to regard itself as some sort of spiritual entity and that the dualistic mind-body schema has seen its day. It also means that the mind is free to concern itself with large-scale processes that express themselves through it and promote themselves by its agency. For this reason, the mind-boosted brain emerges as an ever increasingly important product of evolution. It is able to steer its own course and promote or retard the order-creating quest in line with its own perceived level of responsibility.

Let us, however, look at the wider context of which the biosphere itself is part and which may give us additional clues to our own situation. While the biosphere is remarkable in its own right, it may be that it is just one of countless billions of similar islands in what seems to be an almost completely isotropic universe. The isotropy implies that there is near uniformity of conditions throughout the cosmos. It is exceedingly unlikely that this circumstance should have been a mere chance occurrence. Regions were not causally connected, and standardizing effects could not have played a part. If similar conditions exist throughout the cosmos, and if, as it seems, organization and spontaneous structure formation are inherent in matter, then it is likely that biospheres are not a rarity but exist in astronomically large numbers. This means that there could be growing concentrations of negative entropy, that is, information and order.

To be able to function, biospheres need sheltered conditions for protracted periods of time. For this to be possible, matter has to be structurally stable and the supply of energy has to be constant and adequate. If these conditions are met, biospheric viability is guaranteed and evolution can achieve highly advanced stages of organization, culminating perhaps in the reflective state, that is, in the organizational level on which the brain becomes its own source of upgrading. This is, of course, a tremendously important watershed, for the creation of order is a deliberate option no longer dependent on the slow evolutionary accumulation of structural changes.

Of the first of the two main preconditions of life, stability of matter, it can be said that if the ratio of the electromagnetic to the gravitational force (the key to intra-atomic stability) were out one part in 10^{40}, then the long-lasting stellar types of intermediate size, like our sun, could not exist. Instead, the star population would consist of short-lived and (from the biospheric point of view) unsuitable "blue giants" and "red dwarfs." Of the second condition, stellar energy production, it can be said that if the strong nuclear force (which binds protons and neutrons) were out by a fraction of its value either way, steady conversion of hydrogen to helium could not take place and the required stable energy output for billions of years could not be achieved. Specifically, if the strong nuclear force were somewhat stronger, conversion to helium would have taken place very early in the evolution of the universe, leaving insufficient fuel for later. On the other hand, if it were fractionally weaker, it would not be taking place now and in the quantities that represent a satisfactory level of supply.

To outline the evolutionary process as it unfolds in the "standard model": the universe started with a big bang out of a singularity with infinite or near-infinite temperature and density and no space-time extension. Triggered perhaps by a quantum occurrence of this last, the singularity was given something to expand into, so evolution began (see Weinberg 1978: *The First Three Minutes*). As to what was outside, before or beyond the singularity, this is deemed to be meaningless by definition of the term and therefore unaskable. Stephen Hawking (1988) has coined the expression "principle of ignorance" to designate this ultimate barrier to cognitive penetration.

In the initial seconds and minutes following the big bang, the rapidly expanding and cooling fireball underwent a series of dramatic transformations. These involved the gradual "freezing out" of extreme high-energy reactions as the temperature of the immensely hot cosmic soup fell step by step below critical thresholds. After about 500 thousand years of this exponentially decelerating cooling process, the temperature of the universe reached 3000 degrees Kelvin. At this point the cosmos resembled an opaque soup of radiant energy in thermal equilibrium, with the continuous creation and annihilation of matter and antimatter particles, occasioned through their collisions and reabsorptions. However, below the critical temperature of 3000 degrees Kelvin even this interaction had to cease. Radiation became uncoupled from matter, and whatever residual matter failed to be canceled in the last instant was frozen out. Through this uncoupling of energy and matter the universe became transparent and the gravitational lumping of the scattered matter particles began. This lumping

led to the eventual formation of large gas clouds. These protogalaxies, consisting mostly of hydrogen and some helium, evolved into galaxies with high gravitational subregions (stars). The subregions began in turn to contract and warm. Under ever-increasing gravitational pressures they then turned into hot spots. They ignited, starting nuclear fusion and energy production. Importantly for the eventual commencement of life, a process of nuclear "cooking" of elements began. This occurred in massive stars where—because of excessive pressures—the original hydrogen was rapidly exhausted and the synthesis of nuclei heavier than those of helium could begin. Under still-increasing gravity they, too, ignited, allowing for the production of even more complex elements. Thus step by step all the chemical ingredients of the next, life-bearing phase of cosmic evolution were created. When all sources of energy for balancing gravity were finally exhausted, these large first-generation stars exploded in supernovae, scattering their accumulated chemical debris and seeding newly forming gas clouds in the process. Thus oxygen, carbon, nitrogen, together with hydrogen, the constituents of life as well as all the elements of our material environment, found their way into the planetary systems of then-evolving second-generation stars. In their turn, these stars also ignited and settled down to steady energy production to await billions of years' worth of development under moderate conditions that were stable enough to favor biospheric evolution.

Meanwhile, since the energy balance of the universe is calculated to be zero, and the rate of its expansion is exactly matched by the gravitational pullback, the cosmic outcome hangs suspended. It teeters on the brink of infinite expansion, with entropy or heat death as one possibility, and the halting of the expansion and the gradual retraction of the universe into a "big crunch" (the reformation of the singularity) as the other.

These alternatives draw attention to a set of large odds that seem to keep the undecided outcome on a razor's edge. Indeed, such is the nature of these odds and their combined probability that serious doubt is cast on the adequacy of mere randomness or chance as a feasible model and determinant of cosmic evolution. I have already alluded to the one part in 10^{40} as the odds that the ideal star types will form the bulk of the stellar population. I have also alluded to the narrow limits that define the strong nuclear force that ensures steady hydrogen burning and constant energy output. As for the ratio between the explosive force that started the expansion of the universe and the gravitational force that determines the strength of the pullback, it has been calculated that the odds of ending up with the teetering balance is of the order of one part in 10^{60}. Davies (1983) illustrates

these odds by comparing them to the firing of a bullet across 15 billion light years at a target one inch in diameter and hitting it. But exceeding even these already phenomenal odds is Penrose's calculation of the probability that the universe would consist largely of galaxies rather than of black holes, turbulence, and vast irregularities. His finding was that the odds to come up with our kind of universe was one part in ten raised to the power of 10^{30}.[1] This means one single chance against a number that would have so many zeros after it that if a typewriter were to print a zero each and every second, day and night, year-in and year-out, for the entire duration of this universe (about 15 billion years) then 2000 billion additional lifetimes of such universes would be needed to print it out in full.

The implication here is that failure to meet these tight specifications would have made the cosmos uncontrollably violent, short-lived, and in every way too destructive to support evolutionary development.

In the light of such extraordinary odds and compounded improbabilities which guarantee evolutionary shelter for biological development, the possible role and significance of life cannot be dismissed. Going to obvious extremes, protagonists of the so-called *strong anthropic principle* argue that it all makes sense only if the end product, the emergence of human life with its conscious mind, is taken to have been the purpose of the universe all along. While it is impossible to prove that this question-begging interpretation is wrong, it is easy to see that anthropocentric solipsism is once more at work. Its aim, as always, is to reerect the "old animist covenant" with nature, even if this involves the tendentious juggling of scientific facts and interpretations to "prove" the point.

Discounting such self-serving interpretations, it is possible to imagine that the singularity and its extended form, the universe, represents a reconstitutive process, and that human reflective consciousness, the end product of biospheric evolution to date, may have an instrumental role in the reconstitutive process. This role might be the shifting of values from energy to mass in the frame of conserved parity and so the gravitational tipping of the teetering balance toward cosmic regression and the singularity's reconstitution. The shift could occur through the artificial creation of black holes and the spontaneous creation of gravitational quantum mass in its immediate vicinity. This is thought to be possible in principle. Thus it is conceivable that life might be instrumental in the reconstitutive process and that the reflective mind in this biosphere, and in other biospheres where the breakthrough to reflective consciousness has been achieved, is or can become an important factor for the outcome of the cosmos. It may even be suggested that life, the unfolding of matter in structure and function, is the

only way the universe can reverse its scatter and achieve wholeness and identity once more in the "big crunch." The scatter may also be holographic in some way. All quanta and all fragments might carry blurred information about the whole and might assist in the reconstitutive process through negentropic organization.

While it is wise to stay clear of science fiction, and while this scenario may seem somewhat strange, it is more plausible, symmetric, and integrative than other "explanatory" models. Myths, whether religious or pseudoscientific, such as "strong anthropism," are necessarily question-begging, none more so than the myth of "cosmic roulette," the belief that order and organization in the universe is the product of blind chance and random occurrences. Naturally, these are only speculations and perhaps of no more than heuristic value, but as there must be a correct scenario it makes good sense to look for a model that brings all that is known together into a uniting focus.

Let us now shift from the macro- to the micro-scale, from the cosmos to the quantum, for further clues about the singularity and the scenario that may be in progress. Here we find that, although conventional intuition tends to let us down, the impasse is not total. For example, since it is known that the quantum wave needs the human mind to collapse it to reality, it is just possible that the reflective mind is the universe's self-generated nonquantum system. This view implies that the mind is the universe's means of enabling the substrate to unfold in matter and organization and perhaps become the instrument of cosmic self-management.

Some insight might also be gained from the strange circumstance that while the probabilistic outcome of large-scale (summated) quantum occurrences is extremely stable, that of the individual occurrences that constitute it is not. This effect is quite inexplicable in causal terms, and makes one wonder why an event should be able to take place only probabilistically but not with absolute certainty and determination. It is as if outcomes, though overwhelmingly granted, could never be regarded as guaranteed. We may also wonder whether this unvarying constraint is not in fact a significant residual characteristic of the singularity, a characteristic that is preserved on the quantum plane (holographically as it were) and finds expression in quantum behavior now that the singularity is dispersed into its expanded form, the cosmos.

Looking at it anthropomorphically, the discrepancy between the stability of the large-scale occurrence and the unpredictability of the individual component implies that the certitude of an outcome rests on plural accord, but that individual components are not compelled to conform. It is as if

free will dominated the quantum world, as enshrined in each quantum, and chose every single outcome to work out as if deterministically.

To reflect on characteristics of the singularity may seem far-fetched, but if we consider that quantum behavior as well as reflective consciousness can be expressions only of the scattered singularity, the exercise begins to make sense. Indeed, if there is to be knowing of any kind in the universe, this can only be internal to it. Knowing would involve juxtaposing different subaspects to build up asymptotically an ever-improving representation. This is how Sachs (1973) reflects on the internality of model-building representations:

> Thus it seems to me that man's investigation of the world is not a matter of his looking in as an impartial outsider, rather a matter of man's reflection, introspection and deduction on the nature of the single abstract underlying reality. The proponents of a fully unified field theory must view the universe with Spinoza as a fully deterministic existant that may exhibit an infinite manifold of intrinsic manifestations, yet where free will (actual individuality) is then only an apparent illusory feature that is not more than a particular approximation of the one-ness of the universe.

This puts the onus on the dualists to prove that the world is not monistic, and that the idea of its internal genesis is invalid, for it may be asked, whose characteristics, if not those of the singularity, might quantum behavior and reflective consciousness represent? The question is rhetorical if it is considered that the present universe can be none other than the expanded singularity, especially as by definition nothing extraneous could have entered it to compromise its integrity. The conscious mind's reflections on the singularity may therefore be relevant. They may disclose for it a role in the scenario which would give it sense and dignity beyond anything it could ever have suspected.

As an anecdotal footnote to this subject area, I want to mention two interesting and thought-provoking examples of prescientific speculations about the universe. They represent a combination of insight, subtlety, and grandeur. The first is Leibniz's theory of the "monads," those remarkably quantum-like basic building blocks of the universe. They are characterized as causally autonomous and aware only of themselves. They are conceived of as individually scripted and as independently and internally responsible for the unfolding of the cosmic scenario or, at any rate, for their contributions to it. Thus what seem like interactions between monads are only conjunctions in the unfolding of independent scripts without causal contact of any kind. This means that the phenomenal world must be regarded as an emergent and conjoint effect of the pluralistic substrate, a kind of aggregate

effect that arises out of individually caused cooccurrences. Whatever its objective truth-value, the scheme's intuitive relevance and conceptual breadth is remarkable. Nor can its cognateness with aspects of the quantum world be overlooked, to say nothing of its similarity with the holographic principle as the informational basis of universal unfolding and potential reconstitution.

The second example is one of Cabalism's mystic scenarios, formulated largely by Isaac Luria in the sixteenth century out of gnostic and rabbinical elements. It is thought-provoking and relevant in quite another way. This scenario suggests that after the transcendental God (beyond human grasp) withdrew from Himself into Himself, the vacuum that was created was filled with his emanations. This divine light filled ten vessels, representing His ten graspable manifestations. However, the light's intensity broke all but three of the vessels, spilling some of the emanations and creating confusion by intermingling darkness and light, spirit and matter, and good and evil. The eventual recovery of the "sacred sparks" (the emanations) is the end to strive for, and human virtue is the instrumentality for the restoration.

The aspect of particular interest in this scenario is that it assigns a definitive role to humanity and that the role represents a measure of symmetry between humans and the universe, in other words, that there *is* something that humans can do for the universe and that this potential contribution is significant. The idea is imaginative and dignified and at variance with the usual run-of-the-mill mythologies. It integrates human conduct with the course and outcome of evolution and of the world. It features humanity as an active participant in the drama which, in our real universe, may well be the noted creation of gravitational quantum mass and the tipping of the cosmic balance toward the regaining of the oneness of the singularity. Should biospheric action turn out to be an important, if not critical, aspect of the cosmic scenario, life would gain tremendous significance and would do so in ways that are as unrelated to animistic schemata as they are to Monod's constrictive nihilism.

At this point it may be of interest to allude to Dirac's (1976) cosmological speculations involving large dimensionless numbers. This is because their relationship reflects discernible regularities that imply a balancing of values on the cosmic scale. In this balancing life might just play a part. Dirac, as indeed others, is puzzled by those regularities that seem to govern cosmic variables and large-scale phenomena. He observes, for example, that the ratio of the electromagnetic force to that of gravity is a constant, and that its value is 10^{40}, as already discussed. He also notes that the age of

the universe is 10^{40} in atomic units of time, and that the product of the two, 10^{80}, is the estimated number of elementary particles in the universe. Now if this relationship is to remain constant, which is the prerequisite for keeping the universe's expansion exactly balanced with gravitational retardation, the gravitational constant must be steadily if fractionally increased to keep step with the time factor, which is itself constantly and steadily increasing. If this were not happening somehow, the value of gravity would in fact be decreasing in relative significance, and this would render infinite expansion with entropy death (heat death) inevitable. In view of this, we may well wonder whether biospherically induced gravitational increments might not after all be significant. As discussed earlier, this would involve black holes, quantum effects, and the conversion of energy to mass on a large scale and in all or most of the participating biospheres.

It is important to take these tentative ideas as deliberate extrapolations of what is thinkable on the basis of the data, whether tangential or straight. Indeed, it is only a matter of time before these questions will have to be faced because of an inner need and as an expression of our order-creating negentropic propensity—that is, as an expression of our inbuilt quest for truth and knowledge.

The onus of proof is not on this argument but on its detractors. For example, it should be asked why life's significant participation in the transactions of the universe ought to be seen as less plausible than the idea that chance is its sole determinant. To insist on this latter is beginning to look more like an act of faith. Order, structure, and organization exist, life in the biosphere is fact, and matter's unfolding in patterns and systems is increasingly apparent. Furthermore, as the old and discredited mind-entity no longer casts entelechy-like shadows on the subject, even the conscious mind can be openly acknowledged as the ultimate expression of matter's self-organizing characteristics. These changes allow for the open investigation of humanity's biospheric role and for the guiding impact humans might have on evolution and the cosmos beyond.

To be able to make a correct assessment of these matters it is necessary that the conscious mind should recognize itself as materially one and continuous with the rest of the biosphere and the universe—not of another order superimposed on matter but a process that has evolved out of it and is now its organizational focus and jumping-off point for further evolutionary developments.

The evolution of life and the emergence of the conscious mind is an epic of magnificence and mystery. In the concluding chapter of his book *On Human Nature*, Wilson (1978) puts it this way:

Every epic needs a hero: the mind will do. Even astronomers, accustomed to thinking about ten billion galaxies and distances just short of infinity, must agree that the human brain is the most complex device that we know and the crossroads of investigation by every major natural science. The social scientists and the humanistic scholars, not omitting theologians, will eventually have to concede that scientific naturalism is destined to alter the foundation of their systematic inquiry by redefining the mental process itself. . . . I hope that as this syncretism proceeds, a true sense of wonder will reinvade the broader culture.

While I agree with Wilson's perception of the "epic," I cannot regard the mind as its rightful hero. The mind is only the processing focus of evolving organization, and this makes its role an instrumental one. In other words, the mind is not the "end" but only the "means" for the promotion of what the universe is all about: the singularity's struggle to achieve self-reconstitution and oneness. Thus, although the mind is not the hero of the epic, its role is crucial. It involves its working on the script, acting in the play, directing it, and being responsible for the production. The challenge is great, as nothing seems to be predetermined, yet whatever is done is bound to affect the final outcome.

B Light at the End of the Tunnel

It is not possible to formulate the laws of quantum mechanics in a fully consistent way without reference to consciousness.
—E. Wigner (1973), "Epistemological Perspective on Quantum Theory"

Looking back, it may be asked what this writing has accomplished. Inasmuch as it has succeeded in physicalizing the mind, it has given this entity functional basis and material anchorage. It has eliminated the old mind concept by demonstrating that the mind is not another kind of state or ontological existant, but a self-generated device, a consequence of evolutionary unfolding. Furthermore, all along it was inherent in matter as a potentiality that could emerge only out of the functional organization of a complex structure. This is a characterization that allows the mind-boosted brain to perceive itself as an integral part of the biospheric process and as a means of finding its place in the cosmos.

To reach this conclusion and to be able to bring the necessary pieces of the puzzle together an act of demystification had to be undertaken. Without this it would have been impossible to establish the mind's true identity and epistemological status. As a result of the demystification, the "black box" of the mind is no longer opaque to insight and we have a plausible model of reflective consciousness. The model also shows that the new way

of looking at the mind cuts across the contradictions that are inherent in introspection (such as self-reference), and that the cognitive trap of the now defunct subject–object dichotomy can be avoided.

I want to conclude with some observations that relate to the theme of this writing. It may be argued that the mind's drive to decode the secrets of reality (including that of itself) is an expression of an inner urge to control the environment and to make sense of what is incomprehensible. Yet this cannot be the full story, for the wish to know is more than just a need for environmental control. We also want to know why we want to know. This metaquest is not tied up with practical advantages. Rather it can be seen as an expression of an integrative drive that wants to reach out beyond itself to maximize the cosmic idiom it appears to represent.

The last section speculated on possible extrapolations. Here I shall be looking at attitudes, consequences, and implications as well. This will be done without guidelines but not without linkage to what went before. In the concluding chapter of *Chance and Necessity*, entitled "The Kingdom and the Darkness," Monod (1972) makes a strong case for objectivity, not just as the means of gaining environmental control through science but as constituting an ethical stance, a value statement of truth-seeking. He reflects that humanity accepts science and knowledge for the practical power they confer, not for their deeper meaning and basic message. For these humans prefer mythologies and look to animism for values, meaning, and purpose. Without having the benefit of the mind's self-decoding, Monod could only deplore but not prove that the animist stance was wrong, just as he could not demonstrate why objective truth-seeking had to be right. This helplessness is now circumvented because the device, the mind, is finally revealed and its evolutionary emergence is traceable.

The device is in fact a self-accessible, problem-solving instrument with a capacity for creating knowledge. It generates, sorts, processes, recalls, and programs information. Through reflection it also renders much of itself accessible as experience. Yet, at least until now, it had not managed to figure out how it was doing this, and with what neural formula it was doing it. This lack of insight was the source of the projective latitude that allowed it to fancy many strange things about itself with impunity. Now that its physical source is revealed, this license is worthless. This does not mean that the mind's function is clear to all and the nonsense about it will stop, only that the usual soul-based characterization of it will have less and less credibility. Nonsense will necessarily remain, but only by default or by ignorance. In short, from now on there should be no arguable middle ground for rationalization, only fact versus fiction, operational reality versus gibberish.

This dichotomy can no longer be validly ignored. The point is that the conscious mind can now know itself to be properly and lawfully connected up with biospheric order and evolutionary progression. It also knows, or can at least choose to know, that it is not an entity (i.e., a thing) but a complex process for creating reflection and reflected experience. It knows, or can choose to know, how it manages the intracortical show and why there is no ontological "otherness" about it.

Mystery and fanciful ideas no longer being tenable, the consequences must be faced and work lies ahead. Even if initially ignored, this prospect will not fade away. The search alone represents ethical standards of intrinsic value. In fact, the only real value now lies in the mind's objective self-recognition and the search for its implications. These are directly related to the acceptance of the noted dichotomy between order and disorder, creation and destruction, and the promotion versus the retardation of the process that we are part of and that brought us to this level of insight. We have to decide whether we will enhance life by recognizing and promoting its directional growth (i.e., its potential quest and our role in it) or whether we will ignore it.

I wish to stress again that the successful decoding of the riddle of the self-aware brain puts an end to anthropocentric narcissism and the brain's thinking of itself in terms of the old "soul—spirit—mind" entity. Far from being abstract, these issues are practical and impinge on our daily lives. They affect attitudes and outlook, meaning and purpose. This is not surprising. What we take the conscious mind to be is central to what we believe in, and what we believe in can easily interfere with the process of truth-seeking. This is particularly applicable where our truth-seeking sets out to investigate the very premises on which belief systems are based. As a result there tend to be societally sanctioned constraints on the mind's freedom to understand reality and its place in it, and on joining up with other minds to create a safe and rational habitat. Humanity is saddled with dangerously distorting belief systems that not only conflict with each other but also with reality. There is little perception of or concern with the human role in evolution, or in the biosphere and human responsibility for it. This is a state of mindlessness that leads to crises through societally condoned individual and communal indulgences, that is, to crises brought on by the exercise of power without wisdom, foresight, or moderation. The biosphere is threatened by excessive population growth, consumption, and pollution. These are consequences of irrationality on the large scale that lead to the degradation of the environment and of cultural values. This is how Konrad Lorenz (1966) sums up the situation:

All the great dangers threatening humanity with extinction are direct consequences of conceptual thought and verbal speech. They drove man out of paradise in which he could follow his instincts with impunity and do or not do whatever he pleased. There is much truth in the parable of the tree of knowledge and its fruit. I want to make an addition to it to make it fit into my picture of Adam: "That apple was thoroughly unripe." Knowledge, springing from conceptual thought robbed man of the security provided by his well adapted instincts long before it was sufficient to provide him with an equally safe adaptation. Man is—as Arnold Gehlan has so truly said—by nature a jeopardised creature.

We may ask how such a predicament could have come about and why the biosphere has generated for itself such a potentially dangerous situation. The answer is that the evolution of reflective consciousness had to be intraorganismic because of the immensely complex neural circuitry needed for it. Evolution was therefore forced to create autonomous and individual processing centers of reflective consciousness. It is to be hoped that these centers will come together to work out a common destiny based on a rational understanding of reality within a safe societal context.

Evolutionary arrangements for preventing chaos and breakdown do, of course, exist. Social insects, for example, have inbuilt mechanisms to protect the hill or the hive. The problem is that these mechanisms are stultifying. They entail the absence of intrapsychic autonomy that goes with self-accessibility and conscious reflection, the conditions on which further evolutionary development must rely.

If it were possible to demonstrate that only the mind-boosted human brain with its knowledge-creating capacity is able to promote the evolutionary quest and that for this the social substrate needs to be carefully managed, perhaps mind-created excesses could be avoided. In particular, population trends might be reversed, the run on resources halted, and a program of preservation and conservation agreed upon and implemented. This would secure for us a high baseline of collective insight, cultural stability, and rational orientation. Furthermore, the recognition of our potential influence on the evolutionary process would have salutary effects. Or as Sachs (1973) reflects:

Should man be able to accept this view, it must lead him to a fully rational approach to science as well as to a higher ethical behaviour with regard to his interaction with his fellow constituents of the world. For it is a philosophy that implies humanism and the one-ness of man with nature.

Such an outlook would allow humans to explore the implications of the evolutionary panorama and their place in it. However, since power is

often with the deluded and mass mentality tends to be confused and anarchic, these thoughts must seem unrealistic. The picture is grim, and we are justified to wonder whether our predicament will lead to the "Darkness" rather than to the "Kingdom," just as we may well ask how many biospheres had to face this sort of transitional crisis and survived or perished in the process.

Let us now look at the two critical breakthroughs that were necessary for the achievement of reflective consciousness. The first, already discussed, was a shift from a radiation-dominated to a matter-dominated universe. It uncoupled matter from energy, and it rendered the formerly opaque universe transparent and permitted the gravitational lumping that coalesced matter into galaxies and within them negentropic hot spots or stars, that is, centers of steady energy production. Stars (as our sun) in turn could form shelters that led to the emergence of life, that is, the organizational frame in which matter unfolded and in which it was able to achieve functional autonomy.

The second breakthrough was a shift from the matter-dominated state to one dominated by mind. It freed knowledge (information and the process of knowing) from its earlier unreflective state and set up means for autonomous knowledge creation through self-generated functioning. In other words, it rendered the universe transparent to insight and information. By refining its processing techniques it managed to model the cosmos as well as itself in this extraordinary unfolding.

The order and knowledge-creating capability of the reflectively conscious mind does qualify it to be regarded as the nonquantum system that collapses the quantum wave, resolves its ambiguity, and assimilates it as knowledge. Furthermore, this is tantamount to acting on, and reacting to, the field that acts upon it. Thus, far from being a nonreactive entity of another order (e.g., an entelechy) the conscious mind can now be recognized as the legitimate focus of biospheric organization. Indeed, the physical mind is not just sitting there as a passive receiver, but is in continuous two-way interaction with the environment and all aspects of it, large and small, cosmic and quantal. Thus Wigner's and von Neumann's all-essential mind factor, the elementary constituent of the quantum event represented by the conscious observer, is now identified. Furthermore, thanks to the mind's decoding and modeling excellence, it is able to account for how it evolved, how and why it performs the way it does, and why its true nature has for so long been shrouded in vagueness and misleading impressions. The mind's self-delineation is the key to epistemology and the nature of reflective awareness. Simply put, the mind is an emergent regime of higher functioning, one that evolved in a

biologically lawful way and is now able to run itself in terms of the intrapsychic order it itself generates.

Beyond guiding the organism's adjustment, it is the mind's task to work out humanity's biospheric role and future orientation. As Wilson (1978) observes: "No species, human beings included, possess a purpose beyond the imperatives created by their genetic history." This puts the onus squarely on the reflective mind, as it is the only possible source of insight and purposive guidance to draw on.

Since it is conceivable that mind-dependent organization and development are codeterminants of the cosmic scenario, anything that endangers or subverts the quality of life must be viewed with concern and censure. In fact, if meaning is ever to be attributed to the terms "good" and "evil," there could be a valid application for it in the promoting or retarding of our biospheric role. This implies the existence of something like biospheric morality, with reverence and support for life as its attitudinal core. Stated in its minimal form, this means not rocking the boat, not creating or contributing to crises, degradation, and destruction.

On the optimal level it implies active and objective truth seeking, the enrichment of knowledge and intuition, and the creation of stable grounds for further expansion. The underlying ethical imperative comes from understanding that the process we represent and are now able to consciously influence is not an inconsequential free lunch, but that it matters a great deal what we do in and for our biosphere.

Let us now reflect on how and why science has come to be concerned with the conscious mind and how its conclusions might help to round out the emerging cosmological picture. Davies (1983) writes:

> Yet it has to be conceded that all our observations and through them all our science is based ultimately on our consciousness of the surrounding world. As usually conceived, consciousness can be acted on by the external world, but cannot itself act on the world, thus violating the otherwise universal principle that every action includes some reaction. Wigner proposes to reinstate the principle in the case of consciousness also, so that it may react by in fact collapsing it from a superposition into reality.

Had consciousness been correctly perceived and the processes generating it traced and understood, Wigner's proposition would have been regarded as obvious and valid. That this was not the case is a result of the traditional mind-entity, the nonmaterial "soul" that has until now usurped the niche and rendered the investigation of consciousness impossible by definition. Let us, however, get back to Davies, who further observes that:

Few physicists are willing to evoke consciousness as an explanation of the transition of the world from a ghostly superposition to a concrete reality. Yet von Neumann's chain has no other obvious end. We can consider larger and larger systems as acting as a sort of observer of the other, recording the state of the smaller system until the whole assembly encompasses the entire universe. But as we know, this collapse to reality requires an external non-quantum system to observe it. When we are dealing with the whole universe, all of creation, there is by definition nothing external that can observe it. The universe is supposed to be everything that there is. If all is quantised, including space-time, what can collapse the cosmos into reality without invoking consciousness?

Although Davies's question is rhetorical, there may be a way to answer it. Von Neumann's chain is being continuously collapsed by the conscious mind, the nonquantum device the universe has generated out of itself and perhaps just for this purpose. This would mean that the conscious mind, this ultimate expression of matter's self-organization, was evolved to witness the cosmos and perhaps to exert some decisive influence upon its outcome.

We have seen that the forces of nature create negentropic, gravitational islands and use space-time and a number of tightly held parameters to maintain structural and functional stability in the universe. We have also seen that the quantum substrate allows for this stability—albeit probabilistically—and permits the unfolding of matter into a staggeringly complex organization. Furthermore, this organization at its pinnacle becomes reflectively conscious and able to bring about information-based changes in itself and the world around it. The question that remains to be answered is whether a closed system, such as the universe, to which nothing can come from without, is able to internally change the nature of its outcome. The answer is that if the interconvertibility of mass and energy is granted, the shifting of the balance in favor of this or that outcome is possible. This should be feasible through techniques such as quantum effects and black-hole engineering, provided that the system is in possession of the internal leverage for doing the job, that is, for the shifting of values from one expression to another (say energy to mass) without the infringement of the physical laws involved.

The large-scale transformations would, of course, have to depend on physical capability on the one hand and information on the other, the latter to decide the nature of the job and how it might be done, the former to do the job itself. Such a project is not beyond the realm of possibility, but it is up to us and to our expanding insight to determine and implement.

Besides witnessing the cosmic drama and collapsing the quantum world to reality, the mind's role seems therefore to involve some form of active participation in the singularity's self-restoration, perhaps by tipping the fine balance to avert its entropy death. Time for this there is plenty, as the universe is in a "hung" state, that is, it is capable of maintaining the undecided issue on the razor's edge for some aeons yet.

As for the why of this titanic Odyssey, there is simply no telling. It could be Atman breathing in and breathing out: it could be that this is the way the singularity is able to experience itself or that no anthropomorphic projections even remotely apply. By contrast, what appears to be clearly indicated is that we, the participants of this drama, should be involved in it. Furthermore, we should grow increasingly aware of the miracle of organization that has generated out of itself a self-conscious vantage point that brings all the other miracles into thinkable and experienceable focus. A lack of concern and awareness will only prolong and deepen our transitional confusion, gradually degrading and destroying the biosphere and us with it. In short, uncaring may lead to catastrophe, even by default. This is an unacceptable outcome.

Although speculative, I hope that these thoughts are compelling and inspiring. They seek sense in objective terms and without animistic intent. This is a significant point. We must be free to glean all potential data, learn to distinguish wheat from chaff, and use intuitive perceptions side by side with analytic critique and the application of logic and knowledge. We are not to accept dogma and compromise: to err Teilhard's way by commission, or Monod's way by omission. It is also important to recognize that traditional theories of the mind are misconstructions and that they do not reflect the inner reality they purport to represent.

In summary, the conscious mind is living matter's processing epicenter in whose focus ambiguities are resolved, quantum waves terminated, and knowledge created, stored, evaluated, programmed, and released for implementation. If we consider that its operations enhance its internal order and biospheric relevance, and that this may lead to its increasing insight and material leverage, we may begin to sense that a dynamic quest might be in progress; furthermore, that we are part of it, and that it in turn might depend on our contribution and perhaps even on contributions from other parts of the universe. This is a perception that may in time become a beacon—a source of dignity, significance, and guidelines for further insight and penetration.

Tennyson's Ulysses puts it this way:

But something ere the end,
Some work of noble note, may yet be done,
Not unbecoming men that strove with Gods.
The lights begin to twinkle from the rocks;
The long day wanes; the slow moon climbs; the deep
Moans round with many voices. Come, my friends
'Tis not too late to seek a newer world.

Notes

Perspective

1. An "intrinsic feature," e.g., the mass of an object, is not observer relative. It is independent of the mind.

2. Intentionality is the autonomous ability of a mind to refer beyond itself.

3. The term "neural adequacy" denotes the level of sensory integration needed by the motor system for successful adaptation.

4. The link between information and entropy has been regarded as an aspect of thermodynamics after Brillouin (1956) and Shannon (1959). Information locked up in structure, order, and organization represents negative entropy; a portable action-potential in the system. The organism functions as an integrated single entity, awareness being its informational and decision-making focus. By contrast, the artifact (the computer) is an inorganic agglomerate, that is, an entity in name only. The procedures it is designed to mimic are without thermodynamic consequence, as the identity of the artifact is purely lexical.

5. For a demonstration of how the brain manages this double experiencing, see section A of chapter 2 and section A of chapter 6, where the attentional oscillation that is used for the purpose is given detailed treatment.

6. Qualia are the colors, sounds, tastes, smells, pain, and pleasure we experience rather than the neural events in the brain to which they relate.

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1. Speech-thought or language is the technique of accessing and verbally reproducing intrapsychic contents. If uttered in communication to others it is called "speech"; if it is rendered internally for one's own contemplation it is called "thought." The term "speech-thought" draws these cognate operations together for convenience.

7 The Mind System

1. An "entelechy" is an uncaused causal agent; an autonomous source of causation.

10 Between the Quantum and the Cosmos

1. It is easy to misread this figure as 10 to the thirtieth power, when in fact it is 10 to the 10 to the thirtieth (contrasting the power of 30 with the power of 10 to the 30), a truly enormous sum.

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Glossary

Accessing computer jargon for contacting information stored elsewhere.

Adrenalin hormone secreted by the adrenal glands, a transmitter substance of the sympathetic nervous system.

Affect a feeling or emotion, particularly a strong one.

Afferent bringing or directing toward a given organ, as for example the passage of nerve impulses toward the brain. (Contrasts with **efferent,** directing away from.)

Algorithm any method or rule-governed procedure of computation, usually involving a series of fixed steps.

Animism the belief that natural objects, phenomena, and the universe itself possess souls.

Anthropic principle the view that the universe must be such as to admit conscious beings in it at some stage. It holds that, far from being unlikely, the universe was designed with a degree of order required for life to appear.

Anthropocentrism the regarding of humanity as the most important and central factor in the universe.

Aphasia (general or global) a disorder of the central nervous system that is characterized by an inability to communicate, to receive, or to express speech or thought.

Arborization a branching tendency. In neurology, the dendritic growth of interconnections among neurons.

Artificial intelligence (AI) the capability of machines or electronic devices to carry out complex computations and solve problems of an analytic character, thought of as requiring the ability to learn and think.

Association areas secondary or tertiary layers of the cerebral cortices overlapping primary maps and integrating inputs from different modalities. Mostly concerned with integrative and abstractive functions.

Assortative arranging or selecting like traits or characteristics into populations.

Asymptotic state approaching a given value or condition as a variable approximates a limit, usually infinity.

Australopithecus Pleistocene ancestral protohuman, characterized by upright posture, human-like dentition, right-handedness as in humans, and cerebral development intermediate between apes and humans. Estimated brain volume: 500 cc.

Autocatalytic surge a complex systemic response arising out of high-level disequilibria and terminating in a new regime of equilibrium on a plane of higher complexity.

Autonomic nervous system a system of nerves running to smooth muscles and glands, controlling self-regulatory activities such as digestion and circulation (divided into sympathetic and parasympathetic systems).

Axon the long process of a neuron that conveys impulses away from the body of the nerve cell.

Behaviorist adherent of the school of psychology known as *behaviorism* that, under rigid methodology, considers only the measurable component of behavior, such as stimulus and response (S-R theory), and treats concepts such as *consciousness* as superfluous.

Bilateral pertaining to, or having, two sides.

Bilaterally symmetrical consisting of two halves, each of which is the mirror image of the other.

Bit *Binary digit*. The smallest unit of information. A bit is either *on* (1) or *off* (0).

Brain code the fundamental rules by which psychologically meaningful information is transmitted within the brain (compare with **Mind code** and **Neuron code**).

Brain lateralization the tendency to specialize and divide brain functions between the hemispheres.

Brain stem all parts of the brain below the cerebral hemispheres and above the spinal cord. Usually divided into the upper brain stem (the thalamus and hypothalamus), the lower brain stem (midbrain, pons, cerebellum, and medulla oblongata), and the ascending reticular activation system.

Broca's area a portion of the neocortex in the left hemisphere, tied up with the motor aspect of speech.

Bytes eight *bits*. A character is generally expressed by a single byte (see also **Bit**).

Central nervous system central aggregation of nerve tissue. It forms the brain and the spinal cord in vertebrates.

Cerebral cortex in humans and higher mammals the large outer layer of cerebral hemispheres. In major part responsible for our characteristic human behavior (see also **Neocortex**).

Cerebral hemisphere the two (left and right) portions of the **Cerebrum** (see **Hemisphere**).

Cerebrum brain region, originating as bilateral swellings of the forebrain and ultimately forming the cerebral hemispheres.

Cognitive science the systematic study of mental acts and processes by which knowledge is acquired. It combines branches of psychology, aspects of neuroscience and computer science, linguistics, and philosophy.

Collateral arborization the postnatal neural branching development, creating complex and interacting nerve nets.

Conscious awareness see **Reflective consciousness.**

Constancy mechanism a neural device to compensate for apparent changes in the appearance of objects, allowing for their continued recognition.

Contour clarity refers to the sharply demarcated neural effects, created with the aid of the collateral inhibition of other neural activity in the immediate vicinity of a highlighted spot.

Contralateral of the opposite side (see also **Bilateral, Ipsilateral,** and **Unilateral**).

Corpus callosum the large bundle of nerve fibers that is the principal cable linking the left and the right hemispheres of the **Cerebral cortex**.

Cortical column a functional and structural unit of the cortex, containing 100 to 10,000 nerve cells, most of which show similar response characteristics.

Critical threshold a definite value of a given variable, designating the point where a qualitative or phase change or shift to a different mode of functioning is to occur.

Cultural lag a characteristic delay of population response or adjustment to a new situation, condition, or idea.

Cybernetics the branch of science concerned with control systems in electronic and mechanical devices, and the extent to which useful comparisons can be made between human-made and biological systems.

Deep structure term denoting the semantic substrate of language that is transformed and expressed in speech as we know it.

Delusionality the tendency to hold beliefs in the face of evidence to the contrary.

Dendrites branch processes of **Neurons** that **Synapse** with **Axons** and receive from them impulses which they convey to the nerve cell.

Deviation amplification accentuation of traits that have deviated from the statistical average by way of positive feedback.

Digital operating by the use of discrete signals to represent and handle data in the form of numbers or other characters.

Dissipative structures complex prebiotic organizations or systems that absorb, use, and dissipate energy input in maintaining themselves.

DNA *deoxyribonucleic acid,* the genetic material of the cell, located in the nucleus.

Dominance usually used to mean the specialization of one hemisphere for the kind of task that presumably either hemisphere could perform. Dominance effects are found for speech, musical chord recognition, etc.

Dominant hemisphere the left hemisphere, normally the seat of speech and of the controlling function of the verbal system (compare with **Recessive hemisphere**).

Echolalic reiteration the tendency to repeat, mechanically or reflexively, words or sounds just heard, usually by another person.

Efferent carrying or conducting outward from a body or body organ, especially from the brain or spinal cord (see also **Afferent**).

Encephalization genetic tendency for increased brain size relative to the rest the body.

Enculturation the modification from infancy of an individual's behavior to absorb, and/or to adapt to, cultural values, techniques, and attitudes.

Endocast the mold of an interior, for example, of a fossil braincase.

Endocranial within the skull.

Endogram the brain's situational statement of what we are aware of at any given time. A construct denoting the brain's ongoing multimodality self-representation. Cognate with awareness, the endogram is the product of integrated experience in the brain.

Engram the physiological memory trace recorded in the brain.

Entelechy something that contains or realizes a final cause. A source of vital force to causally direct the life of an organism.

Entropy a measure of the disorder of a closed system, implying lack of pattern or organization.

Entropy death expression referring to the total dispersion of matter in the scenario of the infinitely expanding universe. It is characterized by the final nonavailability of energy in any form.

Epigenesis the widely accepted theory that an individual develops through the gradual differentiation and elaboration of the fertile egg cell.

Epiphenomenalism the doctrine that consciousness is merely a by-product of the physiological processes and that it has no power to affect them.

Epistemology the theory of knowledge, especially the critical study of its validity, methods, and scope.

Equipotent having equal ability.

Equipotent hypothesis the view that for certain cognitive functions any part of the brain can substitute for any other.

Evolutionary monism the perception of and accounting for all the phenomena of the evolving universe in terms of a single principle. It regards the cosmos as a closed and coherent system.

Feature markers fixed signs or critical indicators in phonology and semantics.

Feedback (negative and positive) the return of part of the output of an electronic circuit, device, or biological system to its input, so maintaining characteristics. In negative feedback a rise in output reduces the input; in positive feedback an increase in output reinforces input.

Figure component a featured or central aspect of a field, for example, the visual field. It contrasts with the nonfocally perceived background.

Forced drift genetic segregation or selection for certain characteristics accelerated, for example, by cultural factors.

Forebrain the most recently evolved part of the nervous system, subdivided into cerebral hemispheres and the thalamus.

Formal system a set of interlocked and stable procedures; a rule-governed way of operation.

Frontal evaluation cortex highest integrative center, collating information received from the sensory cortices for preparation of response.

Frontal lobes the anterior region of the cerebral hemispheres.

Frontal scanning expression signifying the frontal lobes' filtering and generalizing function, resulting in the extraction of invariant features from processed experience.

Functional asymmetry designating the effect of **Brain lateralization.**

Functional autonomy the relative independence of a system or subsystem in maintaining its output and level of activity.

Genotype the genetic constitution of an organism.

Gnostic relating to or possessing knowledge, especially of an esoteric or spiritual kind.

Gnosticism a school or movement of the early Christian period (see **Gnostic**).

Gödel sentences defining determinations or axioms of a formal system, to which the formal system itself has no access, and on account of which it is unable to self-complex and evolve.

Hemisphere either of the two **Cerebral hemispheres**, the *left* or **Dominant**, or the *right* or **Recessive hemisphere**.

Holding mode a neural technique that renders transient experience as if it were intransient, resembling a "still exposure."

Hologram the photographic record of an object (image) in unrecognizable patterns of stripes and whorls which, when illuminated by coherent (laser) light, organizes the light into a three-dimensional representation of the original object. Any portion

of the record can be used to reconstruct the image, though portions of diminishing size decrease its clarity.

Homeostasis general capacity of living organisms to adjust to a chemical or physical stress by reestablishing equilibrium so as to preserve stable activity and composition.

Homo erectus the immediate precursor of *Homo sapiens,* with wide geographical distribution (Java man and Peking man). Brain volume: approximately 950 to 1050 cc.

Homo habilis East African tool-maker, tool-user protohuman, evolutionarily further advanced than *Australopithecus.* Brain volume: approximately 700 cc.

Homo sapiens Modern human race, with brain volume of 1350 cc, marked cerebral changes, neotenous development, much-increased frontal lobe participation, articulated speech, etc. Replaced Neanderthal subvariety that had larger overall brain size but less evolved frontal functioning.

Homotopic sites contralateral areas of the brain that are mirror images of one another.

Hopi a member of a North American people of northeast Arizona.

Hypothalamus a brain region originating from the floor and sides of the forebrain, known to contain the centers that regulate homeostatic mechanisms associated with heat, thirst, satiety, sex, pain and pleasure, and the emotions of rage and fear.

Implicate order the folded or unexpressed form of structures as held, for example, in the potentiality of a seed.

Imprint neurologically acquired and perpetuated fixed perception or disposition.

Indeterminacy refers to the impossibility of accurate knowledge or prediction.

Inhibition surround the silent or suppressed neuronal region adjacent to a region or point of high activity.

Innervation the supplying of sensory and motor nerves to an organ, thereby incorporating it in an integrated larger network or system.

Intentionality the capacity of the mind to refer to, or feel disposed toward, specific objects or ends.

Interhemispheric between the cerebral hemispheres.

Interneurons small communicating neurons connecting major pathways, particularly numerous in the cerebral cortex.

Intracortical loop a new brain circuit for speech and thought. Not involved in the S-R throughput, its output feeds back as input, allowing the brain reflect on itself.

Intrahemispheric within a cerebral hemisphere.

Intrusion hypothesis the idea that left-hemispheric manipulo-spatiality was invaded and taken over by neuronal projections of the speech areas.

Ipsilateral of the same side (see also **Contra-**, **Bi-**, and **Unilateral**).

Isotropy the assumed property of the universe that to a typical observer looks the same in all directions.

Laterality usually used to mean lateral specialization of the cerebral hemispheres. Loosely means an asymmetry of the specialization.

Limbic areas an evolutionarily ancient part of the brain, concerned with emotions and instinctive behavior. It is connected with the hypothalamus and the lower brain stem.

Linguistic universals essential categories and regularities of all languages.

Localization of brain function the finding that certain parts of the brain perform certain specific functions. It is the opposite of the **Equipotent hypothesis.**

Logical indeterminacy the argument that a conscious agent cannot assent to the prediction of his or her behavior.

Manipulo-spatiality the skill of handling objects in the environment. The hemispheric motor areas controlling it are understood to have been taken over by the speech areas in the left hemisphere for the purpose of language.

Maps primary cortical areas (about 40 percent of cortical surfaces) used for the topographical representations of sensory and motor events.

Master neuron referring to the no-longer-current idea of a terminal recipient of experience in the brain.

Midbrain the middle region of the vertebrate brain between the hindbrain and the forebrain.

Mind code The formula for large-scale neural interactions on the level of the brain code that renders awareness reflective, enabling the brain to know that it knows.

Monism see **Evolutionary monism**.

MRI *Magnetic resonance imaging* is a technique of tracing tissue activity in the brain and other organs by the computer-assisted reconstruction of activities in progress. It uses radio-wave-induced destabilization of cells and records their release of stored energy.

Mundugumor a member of a warlike New Guinea people.

Mythopoeic myth-making; of, or relating to, the composition and production of myths.

Natural selection the principal method of biological evolution through the preferential survival and reproduction of organisms that are better adapted to their environment than their competitors.

Ndembu Bantu people of the Lunda group in North-West Zambia.

Neanderthal see ***Homo sapiens***.

Negentropy (or negative entropy) a measure of order, structure, and organization, cognate with information and highly evolved systems.

Neocortex the younger part of the outer surface of the cerebral hemispheres; thought to be involved in the highest cognitive functions.

Neotenous regression the tendency in a species to exhibit increasingly incomplete structures and organization at birth, allowing for postnatal neural growth to wire up the system.

Neoteny persistence of quasi-embryonic (uncommitted) features in the adult form of an animal.

Neuron a nerve cell, the basic unit of the nervous system and the fundamental building block of the brain.

Neuron code the fundamental rules concerning individual neurons, the way they communicate with each other and in concert in the brain (compare with **Brain code** and **Mind code**).

Noradrenalin a transmitter substance of the sympathetic nervous system, associated with aggression.

Objectification the rendering of fluid and continuous variables, for example, in perception, into stable, quasi-object-like fixed form.

Occipital lobes the posterior part of the cerebrum. It contains the areas of the brain that are concerned with vision.

Ontogeny the development of an individual life history as distinct from phylogeny, the evolutionary development of the species.

Operator shift refers to a switch in the thinking brain's processing routine, usually unconscious, that significantly affects the outcome of an argument or belief.

Panpsychism the theory that a psychic or conscious component or principle is part of or is associated with all aspects of reality. Often thought to be the internal aspect of objects, events, and phenomena.

Paradigm any pattern or set of rules accepted as governing a field of knowledge.

Paradigm shift a fundamental change or reorganization of a field of knowledge in terms of a new model or explanatory frame.

Parameter an arbitrary variable or factor.

Parietal lobes approximately the middle portion of each cerebral hemisphere mostly concerned with somatosensations and body schema.

Percept an organized and integrated modality experience, for example, the stable appearance of a perceived object that can be identified and named.

Perceptual constancy the neurofunctional device that maintains the invariant perception of objects, regardless of their apparent size, tilt, illumination, distance, etc.

PET *Positron emission tomography* is a technique to produce images of the brain and other body tissues. PET enables scientists to observe and record chemical changes in specific areas of the brain, while tasks such as listening, thinking, and visualizing are performed.

Phenomenalism the theory that only phenomena are real and can be known; the tendency to think about reality as phenomena in the mind.

Phenotype the physical constitution of an organism as determined by the interaction of its genetic makeup and the environment (compare with **Genotype**).

Phoneme unit of speech sound; one of the set of speech sounds in any given language that serves to distinguish one word from another.

Phonemic pattern relating to or denoting speech sounds that belong to different phonemes or organization of phonemes.

Phonology the study of the sound system of a language or of languages in general.

Phrase marker fixed signs, conventions, or configurations indicating syntactic position in a sentence.

Phylogeny the evolutionary relationships of a particular species.

Plasticity the capability to be shaped or formed (especially neurodevelopmentally) by the external environment.

Pleistocene the first epoch of the Quaternary Period, which lasted for about a million years and was characterized by extensive and periodic glaciation and the evolutionary development of *hominidae*.

Pliocene the last epoch of the Tertiary Period, which lasted about 10 million years and saw the emergence of many modern mammals.

Pontifical region an assumed brain region of an overwhelmingly controlling character.

Prebiotic before the onset of life, preliminary to or leading up to life.

Primates an order. One of the taxonomic classifications of mammals that includes lemurs, monkeys, apes, and humans.

Proprioception one of the three sources of the sensory inputs into the brain conveys information about muscle activity and the state of the dynamics of the active body. The other two sources are exteroception (inputs from sense organs) and interoception (inputs from viscera and other internal structures).

Qualia the subjective properties of color, sound, taste, smell, pain, and pleasure experienced rather than the neural events in the brain to which they refer.

Quantum leap refers to a discontinuous elevation or diminution of functioning on a higher plane or on a higher qualitative or energy level.

Radical materialism the **Behaviorist** position in the area of brain science. It does not go beyond the neuron code, as it disallows integrative concepts already on the level of the brain code.

Recessive hemisphere usually the right non-speech-endowed half of the human brain, contrasting with the dominant left half that has language.

Reductionism a theory of causality that, when applied to cortical functions, maintains that anatomical (usually cellular) differences between the cortical areas play the predominant role in determining differences in their functional properties.

Redundancy of function units that perform similar tasks substitute for each other in case one or more are destroyed, thereby ensuring that the task can still be performed.

Reentrance the leading back of an output as input. It is an important aspect of the neural technique of self-processing.

Referent an object or event that words and percepts designate.

Reflective consciousness same as **Conscious awareness**. It is the human brain's capability to render its simple or animal awareness accessible and knowable to itself.

Reflex arc the nerve pathway that goes from a sensory cell or organ to the spinal cord and back by the motor nerve to the muscle or gland.

Regressive circularity the logically irresolvable relationship of the mind to itself when in the self-analytic mode.

Representational cortices cortices that deal with the perceptual integration of sensory inputs before their frontal evaluation.

Reticular activation system a network of fibers and nuclei in the brainstem whose function is to activate portions of the cortex.

Scanning the process of sifting data to extract invariant aspects and characteristics.

Schema (schemata) a complex internal representation, in part real, in part made up, by the brain. It is a mental construct for evaluating and managing reality, which—though useful—is a source of projective distortion.

Selection pressure environmental conditions strongly favoring individuals displaying a particular trait or set of traits.

Self-complexing a system's ability to expand its structural and functional organization in terms of its own resources.

Self-embedding inclusion of a thing in itself, for example, thinking about thinking.

Self-reference refers to the circular relation of an observing system vis-à-vis its self-observation. It leads to logical anomalies and irresolvable circularity.

Semantics the branch of linguistics concerned with meaning.

Short-term memory memory retained for brief periods of time, for example less than a day.

Simplism affectation of simplicity.

Singularity a physical concept denoting a point or state in which the laws of physics that operate in a normally extended context no longer apply, and distortions or disappearance of parameters such as time and space can occur.

Solipsism the condition where the self uses itself as the source for the purpose of proving itself or its beliefs.

Somaesthetic (Somatosensory) referring to bodily sensation.

Somatic of or relating to the body as distinct from the mind.

Speech-thought an expression linking the two facets of language: if language is used in communication with others it is called speech; if it is rendered internally for one's own contemplation it is called thought.

Split brain a brain divided surgically into right and left halves, so that each half can be trained and tested independently.

Standard model the cosmological scenario of overwhelming consensus, tightly integrated with subatomic physics. It centers on a "big bang" type of inception of cosmic evolution but is without conclusive views on the universe's outcome.

Structure dependence linguistic concept stressing the functional role of formal constraints and nonsemantic indicators for the conveyance of meaning.

Supernova the enormous stellar explosion in which all but the inner core of a star is blown off into interstellar space.

Supplementary motor areas structures on the superior surfaces of each of the cerebral hemispheres, thought to be the seat of the afferent to efferent transition, i.e., the point where the printout links up with the motor system.

Surface structure the overt form of language into which the unformulated deep structure is transformed.

Synapse the point where an electrical impulse is transmitted from one neuron to another.

Syntax the branch of linguistics that deals with the grammatical arrangement of words.

Tachistoscope an instrument used for the rapid presentation of visual stimuli to either the left or the right half of the retina in order to compare recognition thresholds of the cerebral hemispheres, etc.

Taxonomy the science and practice of classification.

Teleonomy the goal-directed organization and execution of behavior.

Temporal lobes part of the cerebrum's lateral and frontal regions. They process the brain's auditory intake and take part in the decoding of language.

Temporal singularity refers to an unextended (dimensionless) instance. The construct is an abstraction, because in a dimensionless moment the laws of physics cannot operate.

Territoriality term denoting possession of and dominance over a specific terrain.

Thematic fusion the running together of otherwise distinct semantic experiences.

Thermodynamics the branch of the physical sciences that is concerned with heat as a form of energy.

Tonicity the state or condition of normal tension of a muscle at rest.

Topographical of or relating to the two-dimensional patterning of cortical activity.

Transcendence falling outside a given set of values or categories; also free from the limitations inherent in matter.

Transmitter substances neurochemicals released at synapses to excite or inhibit the postsynaptic membrane, i.e., the receiving surface of the dendrites of the neighboring neurons.

Unilateral having or pertaining to one side only.

Valency the phenomenon of forming bonds or having an attraction for something.

Verbal system the left hemisphere's highest integrative skill, the motor facility for external and internal communication and control.

Vestigialized having attained a simple structure, and a reduced size and function during the evolution of the species.

Visual cortex the area at the back of the **Cerebrum** responsible for the processing and interpretation of signals from the retinas (see **Occipital lobes**).

Vocal bulge left-hemispheric structure in some higher mammals and songbirds specializing in sound pattern recognition and reproduction. In humans, cognate with Broca's area.

Volitional freedom the assumed condition of being able to act without the constraint of causal determination.

Zuni a member of a North American Indian people in New Mexico, known for an exceptionally peaceful and socially cooperative disposition.

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