1
Introduction

1 The Emergence of Mind

"Space, the final frontier." This opening line in a popular television series irritates many cognitive scientists, who protest that the final scientific frontier is not space but mind. Many people would agree; with the science of mind we attempt to study and understand ourselves, as we distinguish ourselves foremost by our mental abilities. Some, however, would ask the scientists: Are you really confronting the final frontier? Is it *mind* that you are studying? You have produced remarkable results on neural excitations and brain anatomy, computer and robot designs. But what is the relevance of these results to our everyday experiences? Can they tell us who we are, how we understand and feel, why we care for others, what are the meanings of life? How many of your claims on knowledge about mind have scientific basis, how many are hype?

The frontier of mind shares a similar predicament with the frontier of space. Scientific explorers of both have made tremendous progress. Most of what we know about the universe was discovered in the last few decades, and so was most of what we know about the processes underlying mental phenomena. However, both frontiers face immense unknown territories, and the headwinds are strong.

Based on the law of gravity and the observed dynamics of galaxies, physicists infer that as much as 90 percent of the universe is dark and hence escapes detection of our telescopes and antennae. Almost all dark matter resides in immense interstellar and intergalactic space, which precludes practical contemplation of on-site investigation. Earth-bound experiments also face a dim prospect, as high costs discourage public funding for them. Physicists have produced many speculations about the identities and properties of the dark matter. However, the only consensus seems to

be that it is nothing like any ordinary matter familiar in the luminous part of the universe. This means that dark matter is mostly beyond the ken of the current standard model of elementary particle physics.[1]

Mind is no less perplexing than space. We know that we have rich and multifarious mental processes because we consciously engage in those processes all our waking hours. Yet to cognitive science, most of our conscious experiences are like dark matter to the standard model in particle physics. Many mental phenomena are marginalized not because they are too remote and strange but because they are too close and familiar, so that they are easily taken for granted and stepped over in the initial scientific advancement. Our ethical restraint from all-out experimentation on humans and other animals rightly regards knowledge as one value among many. For research, however, it poses an obstacle not unlike the vast distance of space. Philosophical doctrines that are concerned exclusively with marketable information and esoteric techniques steer the research agenda from our conscious mentality, similar to political decisions that ground costly physical experiments.

Take vision for instance. To see is not merely to detect light, which a simple camera can do. Seeing implies recognition and finding the environment meaningful, which no supercomputer can yet achieve. We open our eyes in the morning and automatically see a coherent and intelligible world. Young children effortlessly see mountains that protrude partly from behind clouds and flowers from behind leaves. What are the nature and structure of our visual experiences? How do we get the experiences? As our most important sense whose underlying processes engage almost half of our cerebral cortex to provide roughly 40 percent of our sensual input, vision is intensively researched. With advanced brain imaging technologies and experiments on cats and monkeys, whose visual systems are similar to ours, neuroscientists traced optical pathways from photoreceptors in the retina deep into the cortex. Microscopically, they found individual neurons sensitive to special features such as contrast or motion and discovered their operating mechanisms. Macroscopically, they identified many distinct but interconnected areas in the cortex, each concentrating on certain special functions such as differentiating faces or words. The amount of knowledge we have on the neural mechanisms and brain anatomy for optical signal processing is staggering. Scientific ignorance on visual experiences, alas, is equally great. In a book detailing the advances in vision research, cognitive scientist and molecular biologist Francis Crick (1994:24) wrote:

"We do not yet know, even in outline, how our brains produce the vivid visual awareness that we take so much for granted. We can glimpse fragments of the processes involved, but we lack both the detailed information and the ideas to answer the most simple questions: How do I see color? What is happening when I recall the image of a familiar face?"

Cognitive scientists in other areas face the same predicament. Surveying the science of memory, Endel Tulving (1995) remarked: "Research in cognitive psychology and neuropsychology of memory has produced a wealth of data. . . . However, our success has been somewhat less remarkable in interpreting and making sense of this abundance of data. There is less agreement among practitioners as to what the findings and facts tell us about the larger picture of memory." The problem Tulving identified, "the imbalance between what the facts about memory are and what they mean," is not confined to memory or vision research. The disparity between scientific facts and their interpretations is far worse for cognitive science as a whole, where controversies rage as to what the torrent of results tell us about big pictures of mind.

What goes on in vision, in which I am simultaneously conscious of my own experiences and making sense of events in the world? How do I recall the past and anticipate the future, one of which is no more and the other not yet? Who am I, what is my sense of self? What are the meanings of my existence, autonomy, and freedom of action? How is it possible that a chunk of physical matter like me raises such questions at all? Why is it that among all matters in the universe, only a few chunks are capable of experiencing, thinking, feeling, sympathizing, knowing, doubting, hoping, choosing, speaking, and understanding each other? What are the peculiar characteristics of these capacities? These are some of the big questions about mind. I think science will eventually give some answers, but it will take a long time. In the present cognitive science, not only the answers but the questions themselves are like the dark matter of the universe. Unlike the dark matter, which has little influence on us except gravity, experiences, meanings, and deliberate actions concern us most intimately and are regarded by many as the essence of mind. By putting them aside, cognitive science has incurred the criticism of having lost sight of mind.

This book is concerned with big pictures of mind, especially the human mind, and their relationship to the results of cognitive science. What are the arching structures of human experiences and understanding?

How are they illuminated by scientific findings? How does our intuition about them help scientific research? To answer these questions, I propose a model—*the open mind emerging from intricate infrastructures*. I believe that it accounts for both scientific results and our everyday experiences better than the model that dominates current interpretations of cognitive science, which I call *the closed mind controlled by mind designers*. A comparison of the two models brings out the general structures of everyday experiences and serves as a critique of the interpretations of cognitive science.

My model of the open mind emerging from infrastructures consists of two theses that are introduced in this and the following sections. First, the locus of cognitive science is not mind but mind's infrastructures or mechanisms underlying mental phenomena. Properly interpreted, results on infrastructural processes enhance our understanding of mind. Mistaking infrastructural processes for mental phenomena, however, leads to confusion and obscurity. Second, we cannot hope to explain how mind emerges from the self-organization of infrastructural processes without clarifying what it is that emerges. Thus we must analyze the structure of our mental abilities, which I call mind's openness to the world. For this we return to common sense and everyday life, for they are the primary and most important arenas of our mental activities. Explorers of space have to boldly go where no one has gone before. Explorers of mind have to deftly delve into where everyone dwells every day and see the familiar anew.

The Closed Mind Controlled by Mind Designers

Cognitive science is a consortium consisting of psychology, neuroscience, linguistics, anthropology, philosophy, artificial intelligence (AI), and more. Coming separately from schools of science, humanities, and engineering, these disciplines have different aims, presuppositions, concepts, and methods. Such diversity increases the difficulty in interpreting results, not only because the results are fragmentary, but also because aims and presuppositions subtly color meanings. For example, as an engineering discipline, AI mainly aims to design and build artifacts that perform certain tasks efficiently in serving certain preconceived purposes. Some philosophers turn it into an ideology that puts manufactured efficiency before natural mentality and artifacts above human beings as the paradigm of the mental. When cognitive science falls under the shadow of such ideologies, the relevance of its results to human understanding becomes ever more obscure.

By mental phenomena, I mean the activities described by commonsense mental and psychological terms such as experience, feel, care, concern, recognize, err, believe, desire, think, know, doubt, choose, remember, anticipate, hope, fear, speak, listen, understand, and intend. Faced with such broad and variegated phenomena, science usually adopts the strategy of divide and conquer. Thus a discipline in cognitive science approximately cuts out a manageable range of phenomena, neglects other factors, and scrutinizes the selected phenomena in detail, effectively putting them under an intellectual microscope. Microscopes are powerful tools that enable us to see many things otherwise invisible to us. Once we look into a microscope, however, we lose the big picture. This poses little problem if microscopists are keenly aware of the limitations of their view. Unfortunately, some people are intoxicated by the power of and the patterns revealed by the microscope and fancy that the instrument has provided all there is to see. They are like the proverbial blind men who claim that an elephant is nothing but a pillar or a hose, or whatever part they happen to have touched.

Technique worship is the bane of interpretations of cognitive science, as it encourages wanton extrapolations of results obtained by a limited technique. Thus some people maintain that because a technique of behavioral conditioning works for pigeons, it not only applies to humans but delimits human psychology. Others maintain that because computers can perform some clever tasks, all mentation is computation. Each new research technique—digital computation, artificial neural network, dynamical theory—becomes an *-ism* claiming that it exhausts all there is to mind. Vaunting the techniques of laboratory psychological experiments, neuroscience, or AI, the most influential interpretations see mind as nothing but behavior, nothing but brain, nothing but computation.

Most disciplines in cognitive science share a characteristic: they pay little attention to conscious experiences but concentrate on unconscious processes. They study not thinking processes but neural and brain processes. You are aware of your thinking but not the neural processes that occur inside your skull; however, neuroscientists can monitor those processes with tools such as imagers and electrodes. One reason for the emphasis on unconscious processes is the constraint of finely controlled techniques of scientific research. These techniques are powerful in investigating unconscious processes, which are relatively rigid and simple. They are less adapted to investigating everyday experiences that, being far broader and more complex, burst the narrow focus of laboratory experiments.

So far, cognitive science has focused on unconscious processes that a person is unaware of and cannot voluntarily command. Limitations of current knowledge are acknowledged by Crick, Tulving, and many other scientists. However, some technique-worshipping interpreters maintain that unconscious processes have exhausted mental phenomena. Consequently, they regard mind as nothing but a closed entity without consciousness, experience, understanding, and freedom of action. The closed mind is the star in prevailing interpretations. It underlies the doctrines that mind is nothing but behavior, brain, or computer. Behaviors are conditioned; computers are programmed; the brain is an organ dissected and monitored. Thus mind is ripped from autonomous persons and given to alien control.

Like a computer program running inside a black box or a brain severed from the animal's body, the closed mind is a solipsist and is mostly disembodied. Models of it draw a chasm between an inner mental realm and the outside world as depicted in figure 1.1a. Imprisoned inside, the closed mind has access only to mental representations, also called symbols, stimuli, sense impressions, and other names. I must emphasize that mental representations are radically different from ordinary representations that we use every day, such as the little black marks on paper that you are looking at now. Ordinary representations such as letters and words are physical entities and they are meaningful to the autonomous person who knows that they represent something else. In contrast, mental representations are mysterious entities inside the head that are meaningless to the closed mind just as 0s and 1s are meaningless to digital computers that operate on them. The closed mind sees only mental representations and has no way of knowing that they represent or are caused by things in the world. When our physical bodies are counted as parts of the physical world, mind becomes not only closed from the world but also disembodied.

To account for meanings and knowledge, most models rely on godlike agents that are external to the closed mind. In view of the vogue of talking about designing mind, I call these external agents *mind designers*. Like computer programmers who endow strings of 0s and 1s with meanings, mind designers control meanings by establishing correspondence between mental representations and physical objects. The bulk of philosophies of mind and cognitive science is a war among various schools of mind designers. Some mind designers project their own thoughts into the minds of their subjects, just as some people attribute their own thinking

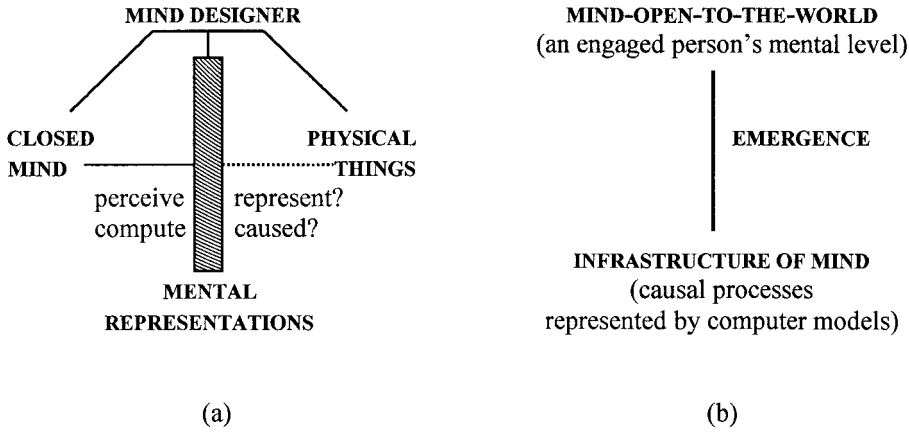

Figure 1.1
(a) Models of the closed mind controlled by mind designers posit mind existing independent of the world and closed off from it. The closed mind perceives or computes with meaningless mental representations. Mind designers match the representations to things in the world, thereby assign meanings that are known only to themselves and not to the closed mind. (b) My model of the open mind emerging from infrastructures posits mind as a high-level emergent property of a person engaged in and open to the natural and social world. As a complex physical entity, a person has at least two organization levels connected by the relation of emergence. The infrastructural level consists of many unconscious processes, which cognitive scientists study and represent by computer models. The infrastructural processes self organize into conscious processes on the mental level, also called the engaged-personal level. On the mental level, mind opens directly to the intelligible world without the intermediary of mental representations.

to their digital computers. Others deny the inner realm altogether and judge subjects by the efficiencies of their overt behaviors and interactions with the environment. To evade the criticism that genuine thinking resides in mind designers and not in the closed mind, many models keep mind designers in the closet or deliberately confuse their functions with the closed mind. In such models consciousness degenerates into an ephiphenomenal inner feeling, intelligence into the efficiency of performing externally assigned tasks, intentionality into an instrument for behavioral control, and autonomous persons into automata.

I reject models of the closed mind controlled by mind designers because they violate our most basic experiences. We need no mind designers. We do depend on other people in our community, but our mental lives have significant autonomy. I do not see mental representations or

other entities inside my head. I see, directly and immediately, trees and buildings, things and people in the great wide world. I understand, without the intervention of Big Brother, your speech. Consequently, my most immediate experiences are meaningful to me. The spontaneous meaningfulness of experiences is an essential characteristic of mind that everyone counts on in their daily life.

The Open Mind Emerging from Infrastructures

The findings of cognitive science about unconscious processes cannot be ignored by anyone interested in mind. But neither can our conscious experiences be ignored. In an attempt to account for both ordinary experiences and scientific data, I offer a model of *an open mind emerging from the self-organization of intricate infrastructural processes* (figure 1.1b). The model is analyzed into three parts: *a mind open to the world*, which is what we are familiar with in our everyday life; *mind's infrastructure*, which consists of the unconscious processes studied by cognitive science; and *emergence*, the relation between the open mind and its infrastructure.

Cognitive science is difficult to interpret because it professes to study mind, but the unconscious processes it focuses on are drastically different from the mental processes that we are aware of. It is partly to account for this difference that prevailing models resort to the dichotomy between the closed mind and mind designers. In lieu of this dichotomy, my model explicitly posits at least two interrelated organizational levels of a person and explains how they are connected. I call them the *mental* and *infrastructural levels*. They exhibit different properties. Properties describable by commonsense mental terms such as experience, think, and see occur only on the mental level and not on the infrastructural level. They constitute the open mind by which we understand ourselves and each other. They are eclipsed in cognitive science, which concentrates not on the mental but on the infrastructural level.

Mental experiences and infrastructural processes all belong to a person, but they operate on two organizational levels of the person. This does not imply that experiences involve some mysterious, nonphysical substance or spiritual force; there is no such thing. A mindful person is a physical entity and a highly complex one. Complex entities typically have internal structures that exhibit features at many scales and levels of organization. Water, for example, is on the macroscopic level a continuous fluid with various flow patterns, and on the microscopic level many discrete

colliding molecules. Similarly, a person harbors many organizational levels with drastically different characteristics. The mental and infrastructural levels are at the top of the hierarchy. There are other levels, for instance, the neural level featuring excitations of single neurons or small groups of neurons.

Levels are familiar fixtures in cognitive science. To understand their full significance, one must both identify the primary level for the phenomena at issue and its relations to other levels. Taking organizational levels seriously enables me to offer an alternative to the prevailing interpretation of the focus of cognitive science. Instead of regarding unconscious processes as belonging to a closed mind operating like a digital computer inside its case, I interpret them as causal processes, which scientists often represent by computer models. These causal processes, which are the underlying "mechanisms" of mental experiences, constitute the infrastructure of mind. Infrastructural processes are mechanical not in the narrow sense of belonging to mechanics but in the broad sense of being automatic and lacking experience, intention, and other mental attributes. Like other causal processes, infrastructural processes are governed by rules in the same sense that planetary motions are governed by Newton's laws, although in their case the rules are tedious and lack the generality of laws of physics. Many causal processes are susceptible to computer modeling; physicists use computers no less than cognitive scientists. When cognitive scientists talk about computation or the computational mind, they usually refer to causal processes in the mental infrastructure. Computer modeling is a powerful tool in cognitive science, but it belongs to the scientists, not to the processes that they study.

Take speech comprehension for example. On the mental level, you hear and understand your colleague saying: "Let's go for lunch." Your experience is open and meaningful; it connects you not only to the speaker but to your physical and social world, food and its availability. Your linguistic ability depends on many processes in the infrastructural level: some parsing sounds into words, others assessing word meaning, still others discerning grammatical structure. These infrastructural processes do not understand what they process. They are merely caused by the acoustic stimuli and unfold automatically. They go so fast we are unaware of them. As conscious speakers, we take their operations for granted. Cognitive scientists, however, pour tremendous efforts into identifying them experimentally and characterizing them theoretically. They also show us how

the malfunctions of various infrastructural processes, such as those caused by focal brain injuries, impair speech production or comprehension in various ways.

Infrastructures presuppose what they support; they are integral parts of a larger system where they play certain roles. Thus the mental infrastructure presupposes the mental level. Cognitive scientists delineate infrastructural processes according to their *functions* in mental life, such as their contributions to vision, memory, or speech comprehension. Brain imaging technologies make big impacts on cognitive neuroscience because they reveal the patterns of brain excitation when subjects deliberately engage in certain mental tasks. Thus when scientists zoom in on particular brain regions, they presuppose not only the context of a conscious subject but also the relevance of the brain regions to the mental task that they understand intuitively. The importance of the mental context, dismissed by proponents of the closed mind, is expressed clearly by cognitive psychologist James McCelland in summarizing the themes of a recent scientific conference. Referring to neurologist Alexander Luria, McCelland (1996) remarked: "He used the findings of localizationists to show that each part [of the brain] has its own special role. But he noted the poverty of considering these parts in isolation and insisted that they must be seen as working in concert to achieve system-level functions such as perception, communication, and action."

Perception, communication, and action are activities on the mental level. The contexts they provide imply that the mental infrastructure occupies center stage of cognitive science, but not the whole stage. Even as the scientific spotlight shines on the mental infrastructure in center stage, it leaves the whole stage—an engaged person's mental life—dimly visible as the presupposed context that confers significance on the infrastructure. The dim light illuminates mind from an angle that has hitherto remained in total darkness. The functions of an infrastructure constrain the characteristics of both the infrastructure and what it serves. Because of the symbiosis of infrastructures and superstructures, knowledge about one sheds light on the other. Infrastructural ruins preserve information about ancient civilizations, which archaeologists read eagerly. To those who ask the right questions, infrastructures speak legions about what they serve. The remain of a Roman aqueduct is eloquent about the magnificence of the culture whose sustenance it once carried. Similarly, the complexity of the mental infrastructure leaves its students awe-strick by the sophistication of the

mind that it supports. It dispels forever the picture of a simple and passive mind infinitely susceptible to external control and conditioning.

For instance, many people regard vision as a purely receptive process in which mind is like a photographic film being exposed to light, and memory as a simple retrieval process in which mind is like a computer fetching a file from its hard disk. Thus visual and mnemonic experiences have minimal structures, and mind is like a blank slate. This picture is refuted by scientific findings about the highly elaborate mental infrastructure. So much construction is going on in the visual infrastructure and reconstruction in the mnemonic infrastructure that even our most immediate visual experiences and casual remembrances have complicated structures. Mind is always active. Contrary to models of the closed mind controlled by mind designers, the spontaneous structures in our ordinary experiences ensure our sense of personal identity and mental autonomy.

Although knowledge about the mental infrastructure illuminates the structure of mind, its light is indirect. Infrastructural processes lack understanding and feeling. Therefore they are qualitatively different from mental processes. To explain mind directly, we have to show how the two kinds of process are causally connected, how a process on the mental level *emerges* from the self-organization of many processes on the infrastructural level. Cognitive scientists call this the *binding problem*, which demands an account of how myriad unconscious processes combine into the unity of consciousness. Many regard its solution as the Holy Grail, as it will answer the question of how our mental and physiological properties are related. Unfortunately, the knights are still out and it is unlikely that they will return soon with the Grail.

I am mainly concerned with structures of our experiences on the mental level and how they are illuminated by scientific knowledge of the mental infrastructure. A substantive explanation can be given only by the solution of the binding problem. Since science is only beginning to tackle the problem, we have to be content with a general account of the connection between the mental and infrastructural levels. Fortunately, we need not speculate in the vacuum. Multiple organizational levels are commonplaces in complex systems, therefore to explain the connection between levels and the emergence of high-level properties is a task shared by many sciences. Many scientific theories exist for less complex systems. We can learn from them and borrow some productive ideas in relating mind and its infrastructure. In a previous study (Auyang 1998), I found

examples from various sciences showing that emergent properties are never easy to explain, and the connection between levels is a bridge that requires firm anchors on both levels. Thus philosophers are deluding themselves when they think they can give easy answers for mind by considering only the neural or infrastructural level.

Take a familiar example. Fluids are made up of particles. Their flow and turbulent motions are emergent properties that cannot be understood by summing particle motions, for they pertain to the large-scale structures that span the whole fluid. Physicists had long known the laws governing particle motions; however, they did not directly deduce fluid motions from the particle laws. They could not; such brute force deduction would go nowhere. They first developed fluid dynamics that clearly describe macroscopic flow characteristics. Only then did they develop statistical mechanics to connect fluid dynamics to particle motions. Why did they need fluid dynamics first? Didn't they know what fluids are?

From time immemorial people have poured water, fought floods, irrigated crops, and negotiated currents. We all have some intuitive and practical ideas about the properties of fluids but they are too vague and crude to guide scientific analysis. Even as we deal with river rapids and pounding waves, we cannot describe fluid motions clearly. Thus we cannot say exactly what fluid properties we want explained in terms of particle motions. To characterize fluidity systematically requires a theory of its own. Fluid dynamics enables physicists to delineate macroscopic properties clearly and to pinpoint the characteristics most favorable for building the bridge to particle motions. This example shows that the bridge between two organizational levels must be anchored at both ends. It collapses if we lack clear understanding of one level.

Our present knowledge of the mental level is similar to knowledge of fluids before fluid dynamics. Everyone has an intuitive understanding of mental phenomena; we depend on this understanding in our dealing with each other. Our commonsense mental concepts serve us well in daily intercourse. They also work in framing the tacit context for the mental infrastructure in research. However, they are too vague and crude for the scientific bridge between the mental and infrastructural levels. Everyone knows in his gut what it is to see or to believe. To explain more precisely the meaning of having a visual experience or entertaining a belief that may be false, however, has taxed philosophers for millennia. Now scientists inherit the headache. What is it to have a visual experience? As Crick

remarked, we lack not only detailed information and but also the scientific concepts to address such questions. In tackling the binding problem, we come to the problem of spelling out the basic peculiarities of the mental level. What properties emerge from the binding of infrastructural processes? What are the phenomena that we expect the science of mind to explain? To answer these questions we must turn to our everyday experiences. Just as an unexamined life is not worth living, unexamined experiences are not up to scientific explanations.

2 The Openness of Mind

Mind is the frontier of science; it is also the foundation of science. Without mind, science does not exist, although the universe that science studies does. Empirical science is based on experience and observation; scientific theories are products of our intellect; scientific research is a purposive human enterprise, an expression of our capacity to wonder, our aspiration to know, our urge to control. One cannot properly analyze the structure of science without examining the nature of the human mind. Conversely, systematic investigation of mind must include an account for the presuppositions of science. Thus the science of mind is also an inquiry into its own foundations and conditions of possibility.

Self-criticism is crucial for the interpretations of cognitive science. More than in other sciences, here philosophers are prone to confuse science with scientism, the technique worship that reaps it profit by abusing the name of science. To see the significance of cognitive science properly, we must recognize a fact tacitly denied by most models of the closed mind controlled by mind designers: Science is a human enterprise without divine power. Scientists are not gods or godlike mind designers but ordinary men and women. Research is not a miracle but a mundane activity not qualitatively different from any other profession. Scientists and folks in the street think about different things, but they think in the same general ways, and their thinking shares the general characteristics and structures of the human mind. These characteristics, which I summarily call *mind's openness to the world*, are the topics of my analysis, because they provide a big picture of mind.

Science and Common Sense

You see clouds gathering. You believe that it is going to rain. You hope that it will not, but realize that it is not up to you. You decide to take an

umbrella when you leave home. Seeing, believing, hoping, and deciding are some of the most common mental activities that everyone engages in every day. They are equally fundamental to empirical scientific research, where they are generally called observing, hypothesizing, and predicting. All cases share the common characteristic that our observations and beliefs are mostly about events and states of affairs in the world that is physically outside us. It is common sense that reality goes in its own way independent of our thinking, so that hopes can shatter and predictions fail. We are aware of our own fallibility, so that we often doubt our eyes and judge our beliefs false. Scientists, too, make falsifiability an essential criterion of their hypotheses and theories.

People see; cameras do not see but merely register light. See, believe, doubt, hope, and act are parts of the mental vocabulary that expresses what most people mean by mind and embodies commonsense psychology or folk psychology. Commonsense psychology is indispensable to understanding of ourselves and each other; everyone knows and uses it intuitively. It is ordinary and not glamorous.

Once some visitors found Heraclitus warming himself at the hearth. They turned back scornfully, because they deemed the activity too ordinary for a great thinker, who should be doing extraordinary things such as contemplating the heavens. But Heraclitus said, "Come in, there are gods here too." Telling the story in *Parts of Animal* (654), Aristotle exhorted his students to overcome the "childish aversion" of the humble and ordinary. Aristotle poured great effort in examining everyday thinking and practice, and he was far from alone. Immanuel Kant labored to analyze the general structures of ordinary objective experience, value judgment, and aesthetic appreciation. Martin Heidegger went farther in putting everyday life in the center stage and argued that human existence is essentially being-in-the-world. I follow their paths. In doing so I buck the fashion in current philosophy of mind and interpretations of cognitive science.

Obsession with esoteric techniques bolsters aversion to the ordinary. Some philosophers promoting the closed mind controlled by mind designers dismiss commonsense psychology as radically false and deserving elimination in favor of something more glamorous, such as computation or vector activation in the brain. Ordinary experience is like bird's flight, they say; if we are concerned with it, we can never build airplanes. We want something high-tech, something analogous to aerodynamics. Yes, we need aerodynamics to understand flight, but aerodynamics is not obvious. If we

were too arrogant to examine flying birds and other natural phenomena, if we were tempted by technique worship into mistakenly identifying flight with projectile because we have made slingshots that can kill birds, we may never discover the principles of aerodynamics. Similar arrogant disregard of ordinary experiences underlies doctrines of the closed mind; the claim that the brain or the computer exhausts mind is like the claim that the slingshot exhausts flight.

Albert Einstein knew better than those philosophers who, having learned some technical jargon, use "ideal science" as a bludgeon to beat up everyday thinking. He explained (1954:290, 324): "The scientific way of forming concepts differs from that which we use in our daily life, not basically, but merely in the more precise definition of concepts and conclusions; more painstaking and systematic choice of experimental material; and greater logical economy." Reflecting on the foundations of physics, he remarked: "The whole of science is nothing more than a refinement of everyday thinking. It is for this reason that the critical thinking of the physicist cannot possibly be restricted to the examination of the concept of his own specific field. He cannot proceed without considering critically a much more difficult problem, the problem of analyzing the nature of everyday thinking." If analysis of everyday thinking helps physical research, how much more can it contribute to research on mind.

Theoretical thinking is important in this book, because for big pictures of mind we must introduce theoretical concepts. Some people confuse theoretical thinking with either the view from God's position or idle speculation in contrast to practice. As I will explain, it is neither. Theoretical thinking is not the exclusive property of professional nerds but a common mode of human mental ability that everyone exercises as they cope with the world. Not all of our activities are theoretical; most are not. For instance, you are not thinking theoretically when you enjoy a drive and your car's perfect handling. Suppose, however, that suddenly you hear a clanking noise under the hood. At once your car ceases to be a handy equipment and becomes an object that grabs your attention and tears you from myriad other factors in the rich context of your living experience. You slow down and accelerate, listen to the frequency of the clanks, speculate about their cause. You forget the scenery and look for a place to pull over, preferably a service station. You disengage your attention from many experiences and focus it on a single piece of equipment; disconnect the equipment from its context of use, regard it as a mere thing, try to figure

out how it works and what is wrong with it. Your thoughts become explicit and perhaps even verbal. You have adopted a *theoretical attitude* by which you try to cope with a specific problem.[2]

Life is full of glitches that call for the theoretical attitude, which is a mode of our usual thinking. In systematically refining the theoretical attitude, science has developed many powerful techniques. Do not be fooled by scientism into believing that these techniques have divine power. As Einstein reminded us, they are based on the common human mental ability that underlies ordinary thinking. At a time when scientism trashes common sense and provokes a backlash against science and reason, perhaps the best approach to mind is Kant's motto of the Enlightenment: Dare to use your own mind.

The Intelligibility of the World as the Basic Structure of Mind

What are the major characteristics of our usual thinking that are so difficult to analyze? "The eternal mystery of the world is its comprehensibility," wrote Einstein (1954:292). "It is one of the great realizations of Immanuel Kant that the postulation of a real external world would be senseless without this comprehensibility." Comprehensibility, Einstein hastened to explain, modestly means producing some order and making some sense of ordinary experiences by appropriate general concepts; in other words, intelligibility. Its mystery is expressed by another physicist, Erwin Schrödinger (1961:10): "It is precisely the *common* features of all experiences, such as characterize everything we encounter, which are the primary and most profound occasion for astonishment; indeed, one might almost say that it is the *fact that anything is experienced and encountered at all*."

The founders of relativistic and quantum physics marveled not at their esoteric theories but at the most ordinary mental ability, for that is what separates us from other things. It is our mind that makes things encounterable and the world intelligible. How it achieves that is still a mystery. Scientists of mind may reply to Einstein: "Sorry, we do not believe that the mystery is eternal." Nevertheless, they would do well to heed his insight: The basic structures of our mind lie not in qualia or intelligence hiding inside the head. It lies in the intelligibility of the world and the encounterability of objects.

Consider the visual experience of seeing a tree. What are its peculiarities? It is not the vivid colors and the detail of leaves; cameras, both conventional and digital, can achieve comparable resolution. Unlike the

camera's registration, my visual experience is meaningful. I can make some sense of it, if the sense is no more than awareness that the tree is an external object that persists independent of my seeing it. In this primitive sense, I separate the *object* from my experience of it, and hence am aware of myself as a *subject*. This subjective apprehension of objects marks the consciousness that distinguishes visual experiences from light detection. When I see the tree, I have a visual experience of it and it is intelligible to me; its intelligibility is an essential aspect of my experience. Experiences belong to mental subjects, but they are *of* objects in the world. Intelligibility is descriptive of the objective world, but only in relation to knowing subjects. Einstein wondered at comprehensibility, Schrödinger at experience. Their remarks respectively emphasize the objective and subjective sides of mentality, but simultaneously stress that the two sides are inalienable. This double-sided structure encompassing experiences and intelligibility, subjectivity and objectivity, I call mind-open-to-the-world. It is what the closed mind lacks.

Openness is the mental capacity by which we experience things, care for other people, and turn the blind and indifferent environment into an intelligible and meaningful world. Mind can be open to the world only because it belongs to persons who are physically part of the world. People with open mind are neither pure thinkers nor mere brains; they are fully bodied, manipulating things purposively and communicating with other people through various physical media. Therefore I maintain that the open mind belongs not to the brain, not even to a person in isolation, but to a person radically engaged in the natural and social world. The mental level where mental phenomena occur is the *engaged-personal level*.

The open mind of people engaged in the world accentuates meaning and understanding. Therefore it is much more than the "situated cognition" in AI, which, like other AI projects, stresses only behavioral performances as evaluated by mind designers. So far, robots with situated cognition are like insects. They are situated in the environment in the sense of being interactive parts of it, behaving intelligently in the eyes of external observers, and processing information informative not to themselves but to mind designers. Their situation does not imply openness because they do not understand. People are not only parts of the world but are also open to it in the sense of finding its objects intelligible and events informative for themselves. The difference between people and insects or robots is the essence of the open mind. To sketch a theory for it is an aim of this book.

Subjective Perspectives and Objective Invariance

Of course we see things in the world—need it be said at all? Openness is so fundamental to our mental activities and so prevalent in our experience it is usually taken for granted. Only in rare cases where it fails do we take notice, so that by "you must be seeing things" we mean not normal vision but illusion. Our ordinary experience of seeing real things is so obvious and intuitive many people cannot see any problem with it. To Einstein, Schrödinger, and others who seriously ponder the relation between mind and world, between beliefs and reality, however, this ability is precisely what is most wonderful. The closed mind, for instance, is unable to see or form beliefs about things and events in the real world. A computer has no inkling about the weather when it runs a program that its human designers interpret as a model for weather prediction; it simply operates on meaningless symbols. Similarly, the closed mind playing with mental representations has no inkling about the real world and hence cannot believe in anything about it. That is why models of the closed mind are so counterintuitive and why their promoters are so eager to trounce common sense.

A major aim of the science of mind is to analyze human understanding, to explain how we manage to find events in the world intelligible. Therefore it cannot tacitly appeal to our intuitive notions of mind but must articulate the intuition explicitly. This turns out to be more difficult than many people think. In seeing or knowing the world, our mind is not like a mirror that simply reflects external happenings. It spontaneously injects certain structures so that even our most immediate sensual experiences are meaningful. But then how can we say that reality is independent of our observation and thinking? What does reality mean? How can we ever know anything about it? How is it possible that we simultaneously claim objective knowledge and are aware of our own fallibility? These are big questions that demand explanations from the science of mind. Their answers have many ramifications because mind and reality touch all our concerns. Inadequate answers fuel current controversies in science studies where, to the dismay of scientists, it is fashionable to deny the objectivity of scientific knowledge (Koertge 1998).

Most cognitive scientists need not tackle these questions because they are mainly concerned with details of particular mental phenomena, for instance, how to perform a particular mental task or how to diagnose a

particular mental disorder. Those satisfied with tinkering with small aspects of mind can tacitly rely on our commonsense understanding of mind and its objective knowledge. Those striving for a clear big picture of mind and a comprehensive interpretation of the great variety of scientific results and everyday experiences, however, find themselves facing the difficulty of accounting for mind's relation to the world.

Models of the closed mind do contain an insight. Our experience and knowledge of the world are partial and not isomorphic to the world itself. To account for the fallibility of experience, a theoretical model of mind needs at least two variables, one of which accounts for objects in the world. What is the second variable? Models of the closed mind take it to be mertal representation; we make mistakes when our mental representations mismatch with objects. Unfortunately, mental representations are so overpowering they become a screen that completely shuts mind from the world, thus creating the necessity of appealing to mysterious mind designers.

My model of mind-open-to-the-world jettisons mental representations and mind designers. Instead of the variable of mental representation, I posit the variable of *subjective perspective*, which covers both physical and intellectual viewpoints. Mental representations are something inside the head private to the mental subject. Perspectives or viewpoints put the subject squarely in the world; I see an object from my perspective, which is a position in the world relative to the object.

An open mind coping with the world's vicissitudes is much more sophisticated than a cooped-up mind playing with meaningless mental representations. Consequently models of the open mind are conceptually more complicated than models of the closed mind. They must account for the relation between subjective experiences and the objects of the experiences. This relation is the fruitful problem for the science of mind. It is also a hard problem; models of the closed mind can only relegate it to the godlike mind designers, whose ability they never explain. My model accounts for the relationship by stressing that the subjective perspective is not a constant but a *variable* with many possible values. A person adopts a particular perspective in a particular experience, but he is simultaneously aware of the possibility of many other related perspectives, some of which he may adopt in other experiences. Thus his open mind must have enough structures to accommodate many possible perspectives; to synthesize experiences from these perspectives, transform among them, compare

them, and extract certain invariant features that he attributes to the objects of his experiences.

The synthetic structures of the open mind are presuppositions and preconditions of all our encounters with of objects, everyday and scientific. Because of them we can acknowledge many perspectives without degenerating into relativism or social constructionism where reality evaporates and caprice reigns. Our acknowledgment of subjective perspectives is accompanied by our ability to transform among the perspectives, which explains the *objectivity of our knowledge*. This objectivity issues not from God's position but from the human position, hence it contains awareness of its own vulnerability. It holds equally in our everyday lives and in empirical science. Science is a human endeavor. It does not, cannot, claim to put us in God's position. However, neither does it concede the objectivity of its results. This is possible because the human mind is intrinsically open to the world.

An Outline of the Book

This book not only presents a conceptual framework covering the open mind and its infrastructure but substantiates it with examples from everyday life and cognitive science. Because of the bulk and diversity of ordinary activities and scientific results, the conceptual analysis is spread out. To bring out the thread of my argument, I list the major points and their locations in the book.

Chapter 2 surveys major theories of mind and explains how most fall under the rubric of the closed mind controlled by mind designers (figures 1.1a and 2.1). These models sharply distinguish an inner realm for the closed mind and an outer realm accessible only to mind designers. Most theories emphasize either the inside or the outside, sometimes to the extent of rejecting the other side. Computationalism and connectionism are examples of inside theories; behaviorism and dynamicalism outside theories. In discussing them, I introduce and explain many traditional and technical concepts that will become useful later in the book. The final section of the chapter presents several theories that abolish inner-outer dichotomy. Chief among them is existential phenomenology, from which I borrow major ideas but not terminologies, because I think they are obscure to most of my intended readers.

The conceptual structures for my model of the open mind emerging from infrastructures (figures 1.1b and 3.1) are mainly presented in

chapters 3 and 8, the former addresses mainly with emergence, the latter openness. These two theoretical chapters are separated by case studies that substantiate the model with factual results from cognitive science and explanations of how the results are relevant to ordinary experience.

As mentioned in the preceding section, my model consists of three parts: the mental level, the infrastructural level, and the relation of emergence connecting the two. The mental level is the arena of common sense and our everyday life. I leave the analysis of it with its structure of mind-open-to-the-world to chapter 8. The other two parts of the model are addressed in chapter 3. They provide the conceptual framework for interpreting the experimental results from diverse areas in cognitive science.

Section 7 of chapter 3 introduces a self-consistency criterion for theories of mind and explains why it is violated by models of the closed mind. Then it introduces my model of the open mind emerging from infrastructures and its underlying hypothesis: *mind is an emergent property of certain complex physical entities*. This hypothesis is different from crass materialism that reduces mental phenomena to neural and other phenomena. A nonreductive conception of physical mind obtains because many organizational and descriptive levels are necessary for the understanding of complex entities in general and mental beings in particular. Disparate levels and their interconnections must be taken seriously, and that is always a difficult task. Lip service merely covers up their importance. Sections 8 and 9 introduce the infrastructural level for mindful persons, describe the characteristics of infrastructural processes, place them between the neural level below and the engaged-personal level above, distinguish computation from causality, and reveal that most talks about the computational mind actually refer to causal infrastructural processes. Sections 10 and 11 survey various attitudes toward the relation between two descriptive levels and explain why the usual scientific approach is not dualism or reductionism but synthetic analysis. Synthetic analysis introduces a theoretical framework that encompasses both levels, analyzes the whole to find productive parts, and explains how the parts self-organize into salient structures of the whole. *Emergent* properties of the whole produced by self-organization are defined in contradistinction to *resultant* properties produced by aggregation. Many general ideas of synthetic analysis and emergence are illustrated with examples from fluid dynamics and chaotic dynamics. Using these ideas, section 12 explains why mental processes are emergent and not resultant and why mental causation is nothing mysterious. It refutes

doctrines of the disunity of consciousness by revealing hidden assumptions that rule out emergent properties beforehand. Synthetic analysis allows different scopes of generalization for different levels and gives precedence to the level for the phenomena at issue. Therefore, although infrastructural processes are contained within a person's skin, mental concepts can account for factors outside the skin to describe the person's mental states. *Situated properties* of individual entities that include external factors are common in the sciences, as illustrated by examples from physics. Section 13 explains how mind is a situated property of an individual person, thus paving the way for the analysis of mind-open-to-the-word in chapter 8.

The open mind is so intuitive I am comfortable relying on our everyday mental vocabulary to describe it in chapters 4 to 7. Everyone understands "Tom sees a tree" or "Tom loves Mary" and knows that Tom is concerned about a thing or a person in the world, not a mental representation in his head. To articulate the understanding explicitly and frame an adequate theory for it, however, is not simple. Chapter 8 is my attempt.

Section 22 of chapter 8 presents the central feature of mind-open-to-the-world: the mental subject does not exist independent of the intelligible world. I come to know myself as a subject only by differentiating my experiences from the objects of the experiences. Thus subjectivity, objectivity, and intersubjectivity rise and fall together. Section 23 surveys various meanings of intelligence, consciousness, and intentionality. I explain why some concepts are not fruitful in scientific investigations of mind and how my analysis of the open mind differs from them. In section 24 I note the logical affinity among intentionality, time, and possibility, and take these concepts to be the keys to mind. I contend that the most basic mental ability is to break free from the actual and immediate present and to imagine possibilities. As the presupposition of generalization, possibilities underlie all concepts, including temporal and objective concepts. In section 25 I model the structure of the open mind by a framework with two interrelated general concepts: *mental perspective* and *object*. The gist of the model is that mind depends on many perspectives and the possibility of transforming among them, thus holding the object as that which is invariant under the transformations. Contrary to relativism, the multiplicity of perspectives engenders *objectivity* of mind, the precondition of science. Analysis of mental perspectives in section 26 reveals that a full sense of

the *subject* depends on one's ability to conceive oneself from both the first-person and third-person views. Generalizing perspectives leads to the notion of *intersubjectivity* as a three-way relation among two persons and the objective world that they share. Thus subjectivity and intersubjectivity are both open to the world; neither implies an inner self accessible only by introspection. Section 27 analyzes the intelligibility of the objective world, both in everyday routines and as described by the sciences. It teases out characteristics of knowing-how and knowing-that, or skills and theories, and holds that both are practiced in mundane activities, as both are essential to the intelligibility of the world. Finally, section 28 explains how language constitutes much of our mental activity, not only by making explicit our tacit understanding but by being an essential medium of thinking. Only with language can we explicitly think about past and future, narrate our autobiographies, and exercise freedom of action.

Chapters 3 and 8 emphasize the theoretical framework. They contain many scattered examples that mainly illustrate the particular concepts at issue. To substantiate the conceptual framework further, chapters 4 to 7 examine four major areas in cognitive science and explain how various mental faculties are subserved by their respective infrastructures: the language organ, perceptual pathways in the brain, memory systems, and emotive circuits. These chapters emphasize factual discoveries but do not neglect their conceptual interpretations. Each chapter contains two sections. One explores phenomena and theories for the mental faculty at issue; the other brings discoveries on the mental infrastructure to bear.

Each mental faculty is complex. Therefore I do not attempt to provide a comprehensive picture. Instead, I try to focus on one important conceptual issue: the modularity of mind in the context of language; the concept of objects in perception; causality in memory; reason in emotion. In many places the issue is framed as a three-way debate among defenders of the open mind, the closed mind, and mind designers. I argue that the complexity of the mental infrastructures upholds the emergence of the open mind. For instance, the heavy two-way traffic in the visual infrastructure discredits the theory of a closed mind passively registering optical stimuli. The spontaneous constructive nature of memory militates against the dictate of mind designers. Many conclusions drawn from these case studies are used in chapter 8 for the general model of the open mind.