Charles Pinter

MIND AND THE COSMIC ORDER

How the Mind Creates the Features & Structure of All Things, and Why this Insight Transforms Physics

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To the memory of my late wife Donna Krewedl Pinter, without whom this book would not have been written. And to the archetypal muses who gave shape to my words and thoughts

Contents

1

Introduction

Let's begin with a thought-experiment: Imagine that all life has vanished from the universe, but everything else is undisturbed. Matter is scattered about in space in the same way as it is now, there is sunlight, there are stars, planets and galaxies—but all of it is unseen. There is no human or animal eye to cast a glance at objects, hence nothing is discerned, recognized or even noticed. Objects in the unobserved universe have no shape, color or individual appearance, because shape and appearance are created by minds. Nor do they have features, because features correspond to categories of animal sensation. This is the way the early universe was before the emergence of life—and the way the present universe is outside the view of any observer.

To living beings, the universe has all the color and detail given by the senses. Due to biological imperatives, we are made to imagine that objects "really are" exactly as we experience seeing them. We likewise imagine that when we observe things, it suffices to cast a glance at them and their structure is immediately and directly revealed to us: We are not consciously aware of the elaborate computations that our sensory systems do in the background. Consequently, we believe that what we discern is already out there, just as we see it. We have a naïve idea that our eyes simply harvest the bounty of structure and shapes that exist in the world independently of us, inviting our glance.

Shape and structure are incorrectly believed to be an inherent aspect of solid matter: Actually, they are produced by the synthesizing effort of observers. We are misled even though current knowledge explicitly reveals that our naïve thinking is flawed. In contemporary science we continue to view objects uncritically in the categories constructed by the senses, and investigate them in terms of features attributed to them by our organs of sensation. Even hypothetical entities such as elementary particles and force fields are dressed up to look like things we're familiar with.

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The honeymoon with the senses, however, is coming to an end, and fundamental physics is emerging in a new form. For example, the theory of quanta has been stalled for a hundred years by what appears to be a paradox. It has been known for almost a century that when a fundamental particle such as an electron is not observed, it does not exist in the form of a material particle but as an abstract wave of probabilities. Yet, the instant the same electron is observed, it springs into reality as a material particle having a position, speed and direction of motion. This fact presents a huge dilemma not only for physics, but for our very concept of how the world works—for it suggests that the conscious mind has causal power over material phenomena. (It doesn't). The reason for this apparent anomaly is that we conflate physical events with the way they appear to our senses.

The time is now ripe, in science and in philosophy, to undo this tangle. The advance of science requires us to redraw the boundary between the physical world and the world as it presents itself to our senses. Our innate model of reality was designed by nature to promote the survival of our species, not to probe the cosmos. To understand the universe, the first step is to understand our senses and how they mold our picture of reality.

For example, the logic of animal vision requires that what we see appear to be located in the world outside of us. Thus, objects are displayed to the beholder at varying distances laid out in ambient space—though the visual image is actually formed in the viewer's head. This is a necessary deception built into the brain by nature. In fact, it's a kind of hallucination. This paradoxical fact is in the very nature of sensory perception. Everything we perceive is a "hallucination"—not because what we see is mistaken, but because forms and features aren't aspects of brute matter but creations of perception. (See e.g., Andy Clark, *Surfing Uncertainty*, and Jakob Hohwy, *The Predictive Mind*).

Moreover, the brain has a specialized module to create the sensation of motion, and when we have the experience of moving—or watching something move—the awareness of motion is based on a sensation of *visual flow* induced in conscious awareness by the brain. What living beings perceive as motion is an artifact created by the mind. Physical motion is real but altogether different from the moving window we perceive.

An essential task of the brain is to segment the visual world and present it to subjects as divided into separate objects and parts. This is an indispensable aspect of seeing, for if the perceived world were not segmented and the important objects highlighted and made to stand out, the visual world would not be intelligible. When viewing a visual display, it is spontaneously presented to awareness as a collection of discrete objects—but in fact this division is an artifact of the visual brain. Every species of animal has its own scheme of segmentation into those objects that are important in its lifestyle. Contrary to commonsense realism, the physical world has no pre-existing segmentation.

Far and away the most important and most remarkable attribute of the animal brain is that all creatures perceive in Gestalt wholes. When you open your eyes, what you behold is a comprehensive display of the things before you, and this display is given to you as a single, undivided experience. Vision would be meaningless, and have no biological function if people and animals saw anything less than integral scenes.

Common sense leads us to assume that we see in Gestalts because the world itself is constituted of whole objects and scenes, but this is incorrect. The reason events of the world appear holistic to animals is that animals perceive them in Gestalts. The atoms of a teacup do not collude together to form a teacup: The object is a teacup because it is constituted that way from a perspective outside of itself.

Gestalts do not merely allow you to see whole objects and scenes, but also to experience events that unfold in time. When listening to music, you hear more than just the note currently being played: You hear a whole melody. When someone speaks you hear a whole sentence. Gestalts bring into being an entire aspect of reality that would not exist otherwise—a reality in which many things which are separated in space and time are perceived together as a new combined entity. The new entity did not exist before the parts were perceived as one.

One of the most ancient dichotomies is that between form and substance. Intuitively, it seems indisputable that every material thing has two orthogonal aspects: It has matter and form—and these two things jointly determine what an object is. This belief is another example of naïve realism—for in actual fact form cannot exist except in the view of a Gestalt observer. Form does not inhere in brute matter but emerges in Gestalt observation.

It is not merely the *appearance* of objects that emerges from observation, but also their structure. Indeed, the structure of an object is its precise description in analytic terms: It is an explicit accounting of all the functional parts and the relations by which they are connected. Such a description rests on a specific segmentation of the object into parts. If an object is segmented into parts differently, this of course gives rise to a different description. Thus the structure, as it is perceived by an observer, is relative to a given segmentation of the object into parts and relations between parts. This is an important observation, because it reveals that structure is in the observer, rather than in the object itself. This fact is strongly counterintuitive, for common sense tells us forcefully that every object in the world has a unique structure, and its structure is inherent in the object.

Objects in the unobserved universe have no structure, shape, color or individual appearance, because appearances are created by minds. They do not have features, because almost every feature you can think of corresponds to a category of animal sensation. It has been claimed, for example, that the very notion of solid matter rests on the sensation of hardness. We assign qualities to objects according to the way they affect our senses. In other words, it is our sense organs, and their extensions in the brain, that create features and qualities. Thus, in a universe without sentient beings, all features and appearances are absent. Such a universe is not a figment of our imagination, for it's exactly the situation prior to the evolution of life. Philosophers refer to it as the *mind-independent universe,* or sometimes, the *primal* universe.

The universe as it is outside the scope of any observer is an austere and inhospitable place. In a world in which so much of reality is actually constructed by observers, the laws of physics take on a new form. The new aspect of fundamental physics has been brilliantly captured by a new theory called *quantum Bayesianism.* According to this new way of thinking about material phenomena, what traditional physicists got wrong was the naïve belief that there is a fixed, true external reality that we perceive correctly, as it really is. What the scientist *actually* perceives is the reality depicted in our human model of the world.

By assumption, the universe outside the purview of any living observer is not divided into separate objects. Moreover, rigid bodies have no shape or structure, because those things are created by observers. This universe has no inherent description: It simply *is.* Atom-for-atom it is exactly the universe we know. However, without living observers to give it form and structure, it is radically diminished compared to the reality we perceive. Its physics is not at all like the science we know.

What, then, can we say about it? Surprisingly, we can say a great deal. The remarkable answer comes from the latest research in neuroscience, which aims to elaborate a theory called *predictive processing.* The underlying idea is a very simple one:

In order for animals to survive, they must find optimal ways of using the resources available in their environment. They learn by trying every path open to them: Along some paths they make progress, while along other paths they are turned back because they run into obstacles. Gradually, natural forces oblige them to distinguish what's possible from what's not. It is through the medium of these hurdles—these natural constraints—that organisms gradually learn the structure of their environments. The impediments which the natural world imposes on their efforts progressively shape their understanding of the world.

In fact, that's what the real world *is*: It is the set of all the restraints and obstacles imposed on living beings striving to achieve their goals.

For the scientist, the universe consists of matter and incandescent plasma. These, however, are images invented by the human mind. Behind these images, and evoking them, are the constraints of nature that channel the scientist's thinking and determine the outcomes of experiments.

In fact, what we regard as the *physical world* is "physical" to us precisely in the sense that it acts in opposition to our will and constrains our actions. The aspect of the universe that resists our push and demands muscular effort on our part is what we consider to be "physical". On the other hand, since sensation and thought don't require overcoming any physical resistance, we consider them to be outside of material reality. It is shown in the final chapter that this is an illusory dichotomy, and any complete account of the universe must allow for the existence of a nonmaterial component which accounts for its unity and complexity.

2

The Visual World

What Do You See When You See?

If you lift your eyes from this book, what is revealed to you is a spread-out world of objects of many shapes, colors and kinds. Perhaps what you see are the familiar furnishings of your room, and if you look out a window you may see houses and trees, or a distant panorama of hills and fields. In fact, the word *panorama* is very apt: The root of the word is *orama*, the Greek word for *what is seen with the eyes*, and the prefix is *pan*, as in pantheism, meaning all. What you behold is a comprehensive display of the things before you, and this display is given to you as a single, undivided experience.

Psychologists refer to what you see as a *Gestalt*: It is an organized whole grasped by the mind as a unit. Once the whole is grasped, you can focus on individual parts and discern specific objects in distinct relations. But prior to that you have the experience of the primordial glance which delivers to you the whole panorama as a unified experience. The primacy of the undivided Gestalt in the experience of seeing has been confirmed over and over by experiments in vision science, and will be discussed in the next chapter.

It is in this form that vision exists among all sentient creatures that see. Without integrated perception of visual patterns as undivided wholes, life in its present form could not exist. The appropriate, purposive behavior of almost every creature we observe is evidence that all organisms with developed nervous systems rely on integrated perception of whole scenes. A creature as small as a fruitfly skillfully pursues mates and evades predators—feats which are effectively impossible unless a whole display is grasped in a glance. What an insect perceives may be very simple and lack detail, but the whole of it is seen in one eyeful.

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There is far more to seeing than having eyes. The evolution of animal vision is one of the great epics of evolutionary development: Starting with photosensitive spots on single-celled animals a billion years ago, gradual changes have led to the complex eyes of mammals today. But eyes do not suffice in order for a creature to see. What the eyes capture are patches of light, dark and color in rapid motion: This raw data must be collected and fed to a brain able to assemble and interpret it. Finally, in the most difficult step of all, the brain delivers to a subject's awareness a coded image. The coded image is experienced by the subject as a visual scene. In this final step the scene *looks like something* to the animal subject—it carries meaning—and *this* ultimately is the purpose of vision.

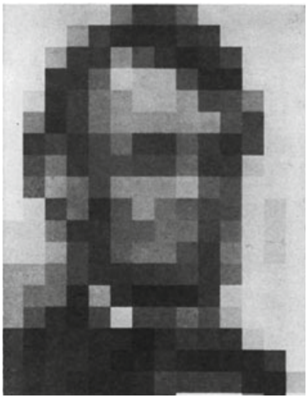
Life on our planet is mostly visual. It could have been otherwise: The earliest animals might have developed senses responsive to other sources of information, such as electromagnetic fields or chemical messages, and any of these senses might have evolved to be the dominant form of sensation. (In fact, many species have secondary perceptual systems of these very kinds.)[1]

What we observe, instead, is that up and down the phylogenetic scale creatures at every level and of every kind evolved with the sense of sight as the primary source of information for navigation and action. Being able to see is so very important to living creatures that in many phyla, more than two-thirds of the brain is dedicated to functions involved in seeing. This is notably true for man.

A Scene on a Very Small Stage

At the other end of the phylogenetic scale from us, there are insects so small they cannot be seen with the naked eye—yet they have complex brains and exhibit sophisticated visual behavior. Among them, the most intriguing are diminutive hymenopterans related to bees and wasps and generally called *fairyflies*.[2] These creatures are at the absolute limit of miniaturization for living animals. The length of a typical fairyfly is between 0.13 and 0.25 mm—smaller than many one-celled organisms such as amoebas. Yet they are fully-formed animals with organs for digestion, circulation, reproduction, and most remarkably, they have a fully developed insect brain. They have compound eyes as most insects do, and though their visual powers are limited, they are fully visual animals.

Let's stop momentarily to consider this: Here we have a real animal as small as a speck of dust, whose eyes and brain can be seen only under a powerful microscope. Yet it thrives in its habitat, which spans the Americas, Australia, New Zealand and the South Pacific. It lives in a simple but sophisticated visual world, though what it sees is very different from the world as it appears to us. The fairyfly's compound eye consists of 20 to 30 independent units called *ommatidia*, each with its own photoreceptor cells and lens. It delivers to the insect a mosaic image, which to us would look like the low-frequency photo of Abraham Lincoln depicted below.



Unlike us, the insect does not perceive this as a low-resolution, boxy image: For one thing, the informativeness of the image is greatly enhanced by exploiting motion and the ever-changing overlap of light and dark regions while in flight. What the insect sees is consistent with its overall experience of the environment, and presents to the insect precisely what it needs to see in order to find nourishment and mates, and to evade predators.

As just noted, how the fairyfly sees the world is vastly different from the way we do. The purpose of vision in any living organism is to enable it to see the world in a form in which it may efficiently (and almost instantaneously) size up the current situation and produce an action program. The visual representation of scenes in an organism is so designed by nature that it closely matches the available response patterns, thereby leading rapidly to appropriate action. Excess information would be confusing and maladaptive. Thus, how a creature pictures the world is very specific to its lifestyle.

The fairyfly has what biologists call an inner *world-model* which represents the world to be a certain way. Every animate being needs such an inner model as a frame of reference in order to make sense of what it perceives, and to make correct decisions about how to act. Undoubtedly the fairyfly's world-model is extremely simple—and since it interprets what it sees in the light of its world-model, the world as the fairyfly sees it is simple. Its visual world must have the same elegant simplicity and economy as its body structure.

It may be pertinent to address the question of whether insects are able to see in the true sense of being aware of a visual image. Not many years ago it was the prevailing opinion that insect behavior is governed exclusively by hard-wired routines, mechanically controlled by ambient stimuli. But currently the opinion of many scientists is veering sharply away from that doctrinaire view. From an important recent article in the journal *Current Biology* we get the following statement: "The last 15 years have generated a wealth of literature from multiple independent laboratories on cognitive function in insects, so that the existence of [higher] abilities is no longer controversial."

To claim that insects see in the true sense does not mean that they have fully developed consciousness or awareness of the kind we believe mammals have. It merely suggests that they possess a biological form of twilight awareness sufficient to support their observed behavior. In science today, such an assessment is no longer anathema. However, we shall not take a stand on the question of insect awareness. Rather, what we wish to retain is that little insects such as fairyflies may lack visual acuity, and surely discern little of what we do, but what they do see is *presented in Gestalts*, which are the hallmark of all animal vision.

The Vision of Robots

In his book *Consciousness Explained*, Daniel Dennett talks about a robot called Shakey which is able to move crates in a warehouse. Shakey is mobile, and sizes up the precise position of a crate with its "eyes" in order to grasp it correctly: It must be able to locate the lower edge and corners of each crate. In order to do this, its eyes are designed to detect just three things: A horizontal edge, a Y shape and an arrow shape. The last two represent what's seen of a corner of a box from an angle.[3]

In order to carry out its assigned task, Shakey therefore needs to distinguish between three fixed shapes. Its "visual brain" contains a template for this purpose, and once it selects which among the three alternatives is in view, an appropriate action program is set in motion. Clearly, Shakey does not need any understanding of geometry, nor any notions of space, shape or lines. Shakey's command center needs to be informed merely which among three discrete options is in place. A suitable template is all that is needed.

At this point, it is very important to note that despite its usefulness, Shakey's visual prowess is nothing at all like animal vision, and should not be called "vision" at all. The reason is that Shakey recognizes things on the basis of a *template*. What Shakey recognizes may look like a shape to us, but outside the human perspective it is perfectly arbitrary. To Shakey, it does not "look like" anything because Shakey is a machine. It is only the mind of a living beholder that perceives the world in shapes. The machine merely checks whether two objects match when compared.

A template is not necessarily a stencil or rigid pattern, but may be a set of instructions for recognizing the form mechanically. In order to identify a pattern mechanically, a computer must decompose the image—break it up into simple components—and analyze how it has been assembled from elementary parts. In contrast, animal vision grasps the image as a Gestalt, an unbroken whole, and recognizes it from its configuration as a single undivided unit, the entire image being taken into account simultaneously.

Let us whimsically pretend that Shakey has some form of awareness of what it is seeing. Unlike our visual awareness, which is richly structured and admits endless variations of form and shape, Shakey's visual "awareness" has exactly three settings. These three discrete options are the whole of its visual world: It is either 1 or 2 or 3, and for Shakey there is nothing more in creation.

Let's now imagine that a thermostat has awareness: The thermostat's function is to turn a furnace on when the ambient temperature falls below 70 degrees, and off when the temperature rises above 72. The thermostat's external world (its world-model) consists of one bit of information—a cipher that can exists in two possible states: For the sentient thermostat, that is the whole of reality.

Multitudes of robots like Shakey—but far more sophisticated—work in factories everywhere. For example, there are robots that pick sundry items out of a bin, detect their shape, then place them in a standard orientation on a conveyor belt. In order to do this, the robot visual system has a template-like shape detector able to correctly select among a small number of fixed shapes.

A robot might, for example, distinguish flat objects of different sizes whose cross-section is either triangular, square or hexagonal: The robot would then adjust a grasping hand to conform to the object. As above, the three shape options are distinguished from one other by means of a template: It is purely in the *template* sense that the machine's vision "recognizes" shapes. But most crucially, there is a built-in association between the shapes of the objects, and the permissible openings of the grasping hand.

In other words, *there is a correspondence which associates each shape with a specific adjustment, or opening, of the mechanical hand.* For the machine, the "meaning" of a given shape is the hand-opening it corresponds to: Clearly, the machine has no geometric conception of what it's doing—and *needs none:* For the machine, to *see* means to correctly associate a few stock shapes with settings of its grasper.

A machine is designed by engineers to carry out a specific function. The evolutionary process of adaptation and selection is likewise a form of design, giving rise to biological structures that play an essential role in the survival of organisms. Hearts develop because they have the indispensable function of pumping blood to supply the body with nutrients and collect waste. Visual systems likewise are very specialized organs, and have gradually developed over great stretches of time to carry out specialized tasks which support the activities of their possessors.

Eyesight in animals—no less than optical recognition in machines—is pragmatic: To understand vision one must take into account the specific tasks, in a creature's daily life, which depend on vision—and in what specific ways vision is utilized to carry them out. Eyesight did not evolve in order for creatures to enjoy *"pure vision"*—that is, to see for the sake of seeing. Rather, what creatures see, and especially *how they see it,* is a complex adaptation to practical needs.

The quality of animal vision surpasses Shakey's by leaps and bounds, yet it is grounded on the same pragmatic basis: Vision brings environmental information home to us in response to explicit needs, and is precisely co-ordinated with those needs. The heart is not an all-purpose pump, legs are not all-purpose walkers, and eyes are not all-purpose peepers.

Do We See the World Realistically?

The cognitive scientist Donald Hoffman of the University of California in San Diego has published an influential theory on visual perception which sheds further light on what is stated above. Hoffman begins with the Darwinian premiss that evolution designs organisms so they are the fittest possible in their environment: The principle of maximizing fitness applies to organs, to behavior, and also to the way creatures *picture the world* in awareness. A particular way of picturing objects in the mind will be selected by evolution if it is the most effective way of allowing the animal to make rapid and correct decisions.[4]

What Hoffman claims is that the way objects appear to us is dictated by considerations of *fitness* and not realism. What an animal experiences seeing may be unlike a high-fidelity reproduction of reality, with all its complexity and inscrutability—yet it may be far more helpful when the animal needs to size up the current situation correctly and act appropriately. The claim is that so long as all the experiences a creature has with objects are consistent with one another—with no discrepancies of any kind—the creature is far better off interacting in mind with usefully simplified and schematized replicas.

It is no different when you set out to solve a technical problem involving a real-world situation: You don't want a photograph of the objective situation, but a diagram showing just the necessary information. An effective diagram is both simple and suggestive: Its labeled nodes are tokens, or place-holders, and don't resemble what they represent. Lines are drawn to indicate the flow of information, or the flow of interaction between parts. A diagram is a pragmatic tool designed to reveal working details and not to be realistic. Visual representation is not a diagram, but the pragmatic intent is similar.

Hoffman and his associates Justin Mark and Brian Marion have carried out experiments, using mathematical modeling, to test this hypothesis. They modeled an environment in which creatures with realistic vision competed against creatures whose vision gave them non-realistic but practical details. They found that faithful representation is driven to extinction by non-veridical strategies based on *utility* rather than objective reality. This suggests that natural selection must do the same: It is not likely to favor rigorously correct representation, but instead, would want organisms to experience visual displays in a form which is most effective for rapidly sizing up events and making instantaneous (and appropriate) decisions.

Hoffman's theory is called the *interface theory* of perception. This word refers to computing devices having a user-friendly interface: Such a device (e.g., your laptop) carries out all its computing in the background and presents you only with the finished result. In the very same way, your brain computes in the background and delivers to you a carefully designed version of your surroundings, representing all the information that you need to know, and withholding details unrelated to your present activity.

In the interface theory, it is important that the forms we experience seeing are completely consistent with measurement and other ways of knowing. What we see as a straight line may be confirmed with a ruler, and what looks round to us has objective curvature in the mathematical sense. The appearance of things is not physically distorted. However, forms should have a quality in experience which is maximally informative to a creature in its moment-to-moment transactions with the world.

In order to *see* a display or scene—that is, to take it in mentally and understand it—it is necessary for the display to be clearly divided into separate objects arrayed in space. The raw scene projected onto the retina of your eyes is a kaleidoscopic montage of colored patches, and the first challenge of the visual brain is to find the meaningful objects deeply embedded in this display. This is an enormously difficult task, beyond the power of present-day computers, yet the brain seems to do it effortlessly. It is the way all creatures see their world—for if the perceived world were not segmented, and the important objects highlighted and made to stand out, it would not be intelligible.

There is no one "correct" way of carving up a scene. What is important for us may be of no interest in the life of a tiger or a fly, so every species has its own scheme for carving up the world according to its interests. In technical language, we say that every animal has its species-specific *segmentation of reality*, linked to its world-model. We are hard-wired to believe that our scheme for dividing the world into objects is the *real* one, because such a belief is necessary for existence.

Though our segmentation of reality is partly bound to physical facts, much of it is arbitrary. However, there is one aspect of any segmentation which is non-negotiable: *It must be self-consistent.* What this means is that regardless of how information is received from the environment—whether visually, by sound or by touch—there can be no conflict: All the items of information must support one another. Also, when the organism undertakes actions, its plan of action must be fully aligned with its scheme of segmentation, so no discrepancy is ever encountered. So long as its segmentation is self-consistent, the animal cannot ever become aware of a difference between its world-model and reality.

The property of self-consistency is the key to understanding animal perception. Even if the experienced visual display is not a geometrically precise replica of the external scene, the totality of what's experienced by an individual, taken as a whole, provides the same information. What this means is that the combined evidence gained from all the senses, including touch, and most importantly from active manipulation of the environment—all are in alignment with one another.

The Shapes of Things

We perceive the world as being a certain way, and it is normal for us to assume it's because the world really *is* that way. We see an object as a cube because it's a cube. What we see is corroborated by what we feel by touch, and for most people that is proof enough that we aren't mistaken in what we see. Nonetheless, it will be argued here that this commonsense belief is only partially correct.

It is known that color is not an objective fact of the world, but rather, it's a reaction of animal visual systems to the light reflected from objects. There is, of course, a connection between color as it appears to us and the wavelength of light. For example, when we have the experience of seeing the color red, the redness we experience is the sensation triggered by light whose wavelength is about 700 nm.

If the wavelength is shortened to 600 nm, our experience changes and we see yellow instead. There is no logical connection between perceived color and the wavelength of light: It is an arbitrary association invented by nature. Moreover, the wavelength of lightwaves varies continuously along a spectrum, and is not cut up into zones corresponding to different colors. The division of the spectrum into discrete colors is a psychological phenomenon, not a physical one. Evolution designed eyes so a distinct subjective experience accompanies different segments of the spectrum.

What is far more difficult to accept, but equally true, is that shape also is psychological. The reason this is hard to accept is that unlike color solid objects occupy a definite portion of space, and their shape is that of the space they occupy. Every chunk of solid matter has boundaries, and in that sense has a shape. But just as an object's color is the way we experience lightwaves of certain frequencies, so its shape represents the specific way the visual system reacts to it and gives it a character that we feel. The shape of an object is the *sensation we experience toward its global configuration in space*.

Shape is a Gestalt quality apprehended by minds and having, for minds, a definite experiential character. Gestalts are recognized by minds, not eyes: It is only a mind that is able to apprehend an undivided Gestalt as a single whole. For the physical world any one shape is as good as any other. If we see an object as a cube, we may measure its sides and angles and find they are exactly as we expect them to be: In the external, physical world, an object is given by measurement and description, but *for us there is more*: There is the distinctive appearance of a shape *as a whole*, and the experience we have when beholding it.

Try to picture a row of triangles touching one another at the ends of their bases. Together they have a serrated appearance, reminiscent of a saw blade, and that's the first impression you get. Or imagine looking at a weeping willow: What you experience is far more than the geometry of its branches and leaves: The image of the tree as a whole gives rise to a unique visual experience which is difficult to put into words.

This is reminiscent of the philosophical riddle that asks, "If a tree falls in a forest and no one hears it, does it make a sound?" Certainly it produces sound waves in the air, but these sound waves do not actually *sound like* anything, for to sound like something is a subjective experience. There is a categorical difference between vibrations of the air and the specific experience of a sound heard by a listener, for example the middle-C note played on a flute. Likewise a cubical stone is an objective cube, and its shape can be verified by measurements.

However, its mathematical description is a fundamentally different thing from the Gestalt image in the mind. It is the Gestalt image that has shape—the list of measurements has neither shape nor an appearance.

Every shape has an *aspect*, that is, a way that it appears for us. Philosophers refer to such things as *qualia*—the way our experience of things feels inwardly. Vision consists of what is made to appear to us by our brain. If an object appears to our eyes as round, or flat, or angular, then its physical structure is such that it *is* round or flat or angular: This is analogous to the vibrations in the air when a tree falls in the forest. The *appearance* of the object as round or flat or angular is like the musical note *as it sounds to you*. Its physical characteristics are like the waves of sound in the airmass.

In a broader perspective, the style of our experience of visual reality is the product of a billion years of evolution of vision. This is true because the way red looks to me, or the way round looks to me, are presumably the same as they look to you, and almost certainly to all creatures. Nature has settled on these sensations as a way of coordinating our mental reality with the parallel reality outside, thereby making it possible for us to interact with the world. These sensations are the ultimate universal language, crossing all species barriers.

There's another thing about sensations as a biological language: The meanings with which sensations are invested are like the meanings of words in our language: There is no reason why in English a stone is called *stone* or why hot is called *hot*: These are conventional sounds chosen for no special reason to convey meanings. The same is true for sensations. They feel different to us, and each sensation conveys a specific meaning. Pain feels a certain way, an object may feel hard, or sharp or hot. But the association between the meaning of a sensation and the way it feels is a biological convention, probably universal among all living creatures

There Is No Innocent Eye

As the sensory information originating at the eyes progresses through the brain—where it undergoes stage after stage of analysis and processing—it progressively loses its topographic organization as well as its physical attributes such as size, angles and geometric relations. The physical attributes of the visual array are re-coded into a brain language of sensation, and integrated with abstract qualities of the scene which have immediate relevance to the observer—qualities such as subjective shape, pattern of motion, meaning and identity.

Bear in mind that light penetrates as far as the retina and no further, and there is no mental periscope to convey the optical image deeper into the brain. Thus, the data the brain operates on is a code which represents abstract general features of a scene. The optical aspects of vision end at the eyes.[5]

The processed visual information emerges into awareness in the form of a cognitive structure which reproduces all the aspects of a scene which are important to the observer. One of the most important insights of contemporary brain science is that *the visual world is a constructed reality*. When we look, what we hold in awareness is not an optical array but a mental construct, built from information in the array, which presents us with all that is of value to us in a scene.

What we see when we look at an object or scene is a reconstruction of the optical array, recast as an experiential schema. It is a picture for us because that is what we imagine a picture to be. For us, a picture is organized in a form revealing shape and object details, not an optically accurate matrix of dark and light patches. What we see is precisely what we imagine that the world looks like. So for us, we are seeing a truer picture of the world: It corresponds faithfully to our world model, whereas the optical array does not.

This is a very important theme in modern philosophy: It is called *indirect perception*, because we are not directly experiencing the optical manifold, but a reconstituted version of it. We know the world through our senses, and have no access to the background reality which brings about, or generates, our sense impressions. Thus, everything we know is one step removed from reality. It is in that sense that vision is indirect.

As noted a moment ago, what we experience when we look at things is a "true" picture of the world, because what our brain has constructed is precisely what a picture is for us. We believe that what we see is exactly what the world looks like. But that's silly, because to *look like* is something in the mind. The bare material world of objects does not "look like" anything.

The picture we see is called a **representation** of the scene, and the claim that what you see are representations (rather than naked reality) is called *representationalism*. To deny representationalism is to assert that it is somehow possible for the mind to perceive reality "as it truly is". This is a debate which has a long pedigree in philosophy, and will be discussed further in a later chapter.

Philosopher Ernst Gombrich speaks about *the myth of the innocent eye*. According to this myth, people such as artists and poets are able to perceive a pristine world in which every object appears as it is, in its primal authenticity, uncontaminated by the demands which animal vision places on the shapes of things. Gombrich correctly asserts that there is no innocent eye, for ultimately it is *we*—the family of all living creatures—who bestow form on objects, bequeath colors to them, and populate the world with the myriad patterns only we discern. If there *were* an innocent eye, what it perceived would be very disappointing.

A Necessary Deception

When you explore your surroundings with your eyes, what appears to you is a detailed and comprehensive picture of specific objects laid out in space. Your visual brain has done such an exhaustive job of analyzing the optic array that the important objects before you have been found, identified and correctly situated in space. The Gestalt picture you see is actually in your mind's eye: You have no access to the raw pattern of dark, light and colored patches projected onto your retina: That display would have no meaning or value to you at all, and for that reason the visual system was designed by evolution to shield you from the clutter, and reveal to you only the fully processed image.

The image, or representation that you see appears to you realistically laid out in space. The correct spatial distribution of objects is obviously of the most extreme importance to all living creatures. A preeminent portion of the visual computation carried out by the brain is devoted to the task of coding the positions of objects relative to one another and to you. Thanks to this coded information, your inner picture of a scene meticulously displays its overall geometry.

This extensive computational work is located in your brain, and in a sense so is the picture you see, since it is experienced in your mind. Yet what you see is presented to you as being in the external world, and the objects you see are clearly displayed to you at varying distances from you, laid out in surrounding space. This is an illusion: It is a necessary deception built into your brain by nature. How would animals cope in their habitat if they felt themselves having pictures in their heads? It is obviously necessary for them to project what they see onto the outside world.

This property of projecting our visual constructions onto the world is ubiquitous, and is called *distal attribution*. It is no different with hearing: Most animals are able to localize the source of a sound, and consider the sound to come from where it's heard. Moreover, it is unusual for us to say "I hear a sound": More commonly we say "I hear the baby crying" or "I hear a dog barking". When the sound reaches our awareness, it is already interpreted, just as the optical array is.

This is true also with somatosensory feeling, such as pain and the sense of touch. If I have a pain in my toe, nerve fibers conduct signals to the brain where it is coded as pain. Nonetheless, I feel the pain in my toe, not my head. And if I have a toothache, the pain is felt in the tooth and not the brain. This too is a necessary deception built into us, for when we're hurt we need to know where the injury is.

Distal attribution goes beyond feelings and sensations. A familiar example is driving a car and having the absolute conviction that "**I** am the driver and controller of the car" which thus becomes a kind of extension of myself. There are situations where a machine operator controls a remote machine, and must assume herself to be the agent in control of it. After a certain amount of practice, the perceived distance between the operator and the machine vanishes, and it is as if the machine were part of the body of the operator, even if it is actually miles away, or deep underground. This type of experience is very common and is another form of distal attribution.

An especially important example of attribution is the recognition of your own body and its parts as belonging to you, and as being an aspect of your Self. This is known as *self-attribution*. The idea that you *are* your body and mind is not as self-evident as it would appear to be. The oneness of your body with your sentient awareness is programmed in the brain. The existence of a Self consisting of a body and a center of feeling is part of the world-model of every creature.

Self-attribution is fragile and can easily break down or be misled. For example, there are psychiatric conditions such as depersonalization syndrome or Cotard's disease, in which patients no longer recognize their bodies as their own and are adrift in a world without a physical anchor. Moreover, there are situations in which normal people are easily fooled into believing that a body part is not theirs. Demonstrations of such situations are routinely carried out in university psychology labs.[6]

In a typical demonstration, a subject's right hand is hidden in a box out of sight, while an identical dummy rubber hand is in plain sight where the real hand ought to be. The experimenter taps on the subject's hidden hand while at the same time tapping on the dummy hand. The taps are in perfect synchrony. Within a minute or two, the subject experiences the tapping to be arising from the visible rubber hand. In an uncanny way, he assigns his own feeling to the rubber hand and assimilates the artificial hand as part of his own body.

Even more remarkably, one can replace the rubber hand by the tabletop. If the subject's concealed hand and the tabletop are tapped in perfect synchrony, then the subject soon starts to personally feel the taps at the table's surface, as if the table were now a body part. The idea is that you can *project* your sensations onto external objects.

The Binding Problem

Nothing, it seems, is more natural, easier and more spontaneous than seeing. It strikes us as self-evident that the instant the optical array is formed on our retina, the image is transferred to our understanding and we see. The feeling of this is so compelling that until relatively recent times there seemed no reason to question it. However, modern research into the neurophysiology of eyesight discloses a reality which is starkly different from what has just been described. In particular, many layers of mental processing are interposed between the eyes and the visual world that we experience, so what we see is indirect at best.

Based largely on research with monkeys, the Nobel laureate David Hubel and his collaborator Margaret Livingstone in 1988 published a surprising and far-reaching discovery: They found that the nerve fibers from the eyes, after entering the brain, divide into many separate and independent streams, or pathways, that analyze different aspects of the same retinal image. It turns out, then, that the retinal image is split apart at its very inception into disembodied aspects each of which is analyzed in a different and specialized part of the brain: One pathway is devoted entirely to motion, another analyzes shape, and so on.[7]

The fact that different brain areas carry out specialized tasks has been known at least since 1860, when the French physician Paul Broca reported on two patients with injuries to an area of the left brain, who had developed incapacitating deficiencies in language comprehension. It rapidly became clear that the brain area in question, known today as *Broca's area*, is the locus of speech production. A nearby area called *Wernicke's area* is the area for speech comprehension. In succeeding years, right up to the present time, clinical studies have revealed that the brain is divided into a large number of modules, or functionally specialized areas, each of which carries out a very specific task.

Many of these facts emerge from clinical studies of patients who have suffered strokes or head injuries. From these studies it is possible to associate particular brain areas with the functions they serve—because the functions they serve are precisely those that fail when the area is damaged. Over the years, and from case studies of a large number of patients, it has been possible to piece together cortical maps linking specific regions of the cortex to specific faculties.

An impairment in vision due to brain injury is known as a *visual agnosia*. Patients whose lesion is in the shape-processing area of the brain are impaired in the recognition of shape: In severe cases they can see a displayed drawing, but are unable to tell whether it's a square or a circle, or are unable to discriminate between an X and an O. In other cases, the patient sees objects clearly but they are stripped of meaning. Some brain lesions are so specific that the patient is impaired in the recognition of just one category, for example fruit and vegetables.

The most dramatic reported cases of visual agnosia are of patients whose lesion is in the motion-detecting area of the cortex. In one well-documented case, the patient was unable to see objects in motion: Her disability was described as follows: "She had difficulty, for example, in pouring tea or coffee into a cup because the fluid appeared to be frozen, like a glacier. In addition, she could not stop pouring at the right time since she was unable to perceive the movement in the cup when the fluid rose."

As visual information travels through the brain, it passes through separate regions for the analysis of color, depth, movement and shape. These regions are different from one another in their anatomy, their physiology and their chemistry. Each process operates on its own timescale and in its own fashion. One expects, then, that there is a terminal end of this progression, where all the streams come together and their contents are integrated to yield a composite image. The most surprising fact of all is that there is no apparent terminus in the physical brain. Quite the opposite: The nerve fibers from these separate processes diverge further and further, and their signaling is distributed over the entire cerebral cortex.

Since animals see a coordinated image in which every object has its proper shape and things move coherently in space, the information parsed by the brain is assembled and comes together *somewhere*. However, no-one knows where or *how* visual information comes together to yield a systematic, unitary image. In brain research, this is called the **binding problem**, and it is not likely to be solved anytime soon. It is plausible that before it is solved there will have to be a paradigm change in brain biology and fundamental physics.

There are several speculative theories to account for binding. According to one, there are *zones of convergence* in the brain where a great many nerve fibers of the visual system converge to a single "Grandmother cell" which combines the information they contain. However, as the British neurobiologist Semir Zeki affirms, this actually explains nothing. Information "coming together" is much more than the confluence of physical streams, or wires, which conduct the coded signals: What must be synthesized and come together is the *information content* of the signals, not the bare physical signals. The signals merely code the content: There is no inherent relationship between the coded signals and the content. Mixing the physical signals isn't even remotely related to reconciling their content.

An alternative theory is based on 40 Hz wave detected in peoples' brains with an EEG. The wave, originating in the thalamus, sweeps the brain from front to back 40 times per second drawing different neuron circuits into synchrony, and hypothetically conjoining visual elements to yield a composite. This explanation, however, has the same flaw as the previous one: Firing in synchrony is just another way of getting all the information together physically as a simple confluence of separate information streams (For example, separate series of 0s and 1s.).

It ought to be clear that joining together, or commingling, physical information streams—for example merging simultaneous telephone lines, or joining wires carrying different TV signals—can result only in a chaotic mess. In the binding problem, we must explain how the content of numerous related (but separate) streams of information is meaningfully fused into a new higher-order synthesis. The synthesis must be hierarchically organized to include the information of the separate streams, and additionally, to present a scaffolding which displays how all this information together forms a single, coherent whole. This happens, but no-one knows how.

Dueling with Dualism

The binding problem is closely linked with a question which has dominated philosophy for the past 400 years. The question was clearly and lucidly laid out by the seventeenth century philosopher René Descartes. We live in a material world which exists in space and is subject to physical law. But also, we have sensations, feelings and awareness. These things are mental and seem to be of an entirely different kind from physical events. The mind seems to be non-material, though tied to the brain which is material. This is the famous dichotomy between matter and mind.

Descartes recognized a problem at this point: Our mind receives information about the world through our sense organs, and conversely, we are able to act on the world by willing ourselves to move muscles. How is it possible for a thought or intention of the immaterial mind to "flip a switch" in the material brain in order to make a muscle contract? The very idea of mind acting on matter by a pure effort of will appears a little spooky.

Descartes proposed that in our pineal gland there is a channel of direct communication between mind and body. Descartes' proposal would easily solve the binding problem, for the computations of the visual brain would pass through the pineal gland and link up with awareness. For modern man in the twenty first century, this proposal sounds extravagant and a little bit comical: A magic portal between body and mind! However, Descartes' idea that there are two realms—the material and the mental—cannot be easily dismissed, and no philosopher since Descartes has failed to tackle the problem. The doctrine that claims there are two separate realms of reality—a material one and a mental one—is know as *dualism.*

Contemporary philosophy is dominated by a materialist way of thinking strongly influenced by physics. The idea that there might be a non-material world with the power to separately influence reality is rejected with an intensity of feeling that is rare in academic circles. Most philosophers are fundamentalists on this issue. People friendly to dualism are mocked as "religious" and "mysterians".

Bear in mind that Descartes was a man of the seventeenth century, and though he was a talented scientist in his own right, the pineal gland hypothesis seemed plausible in his time. Today one would approach dualism very differently: Important scientists such as Roger Penrose and Eugene Wigner have suggested that quantum phenomena seem to bridge the gap between matter and thought. Moreover, modern science is very young, and it is likely that there are properties of matter that have not yet been discovered.

From our current knowledge about visual experience, as noted above, the brain constructs a coded representation of the visual array, and the numerous strands of this representation are widely distributed over the cerebral cortex. Somehow all this information comes together in awareness to yield the experience of a unified and coherent image. There is no known physical mechanism which could achieve this unification.

It may be that a major barrier to finding a solution to the binding problem is the revulsion of scientists to accept the possibility of dualism. With some form of scientific dualism, it might be that the binding problem would vanish. We could begin by modestly admitting that by some unknown mechanism, inaccessible to present-day science, neurophysical activity in the brain gives rise to mental Gestalts. As an analogy, it's a little like the motion of a magnet inducing an electric current in a loop of wire: Seventeenth Century science found electrical induction to be quite inexplicable and spooky, based on the knowledge of the time.

An Evening at the Cartesian Theatre

From time immemorial men and women have speculated about seeing, and how the power of vision reveals the world to us. The great philosopher Plato wrote in the fourth century B.C. that light emanating from the eyes touched objects with its rays. The rays probe objects in much the same way as we would with our fingertips. This idea was plausible for many reasons: First, the ancients believed that seeing is an active pursuit. Also, the ancient Greeks had already noticed the "fire" gleaming in animals' eyes if you surprise them at night, suggesting there is a source of light in the eyes. Moreover, many people believe they can "feel" on their backs when someone is looking at them from behind.

If this scenario strikes you as extravagant, imagine how our modern scientific account of vision would strike our ancestors! In the picture given to us by brain science, the optical image is dismantled by the brain and reconstructed in the form of an abstract Gestalt which is sensory rather than pictorial.

The idea of a picture in the head re-enacting what appears to the eyes has been derisively called the "*Cartesian Theatre*". This expression was famously coined by the American philosopher Daniel Dennett. His criticism is aimed at a theory of animal vision that is still popular among some vision scientists, according to which the brain reconstructs a detailed copy of the visual image. The primary visual areas of the brain map out boundary lines, detect fine differences in shading and reflectance, and use this information—it is believed—to reconstitute a faithful copy of the external image, like a photograph.

The problem with this account is that it brings the visual subject no closer to *seeing* than he was before. Instead of the panorama stretched out in front of him, he must now discern the photograph displayed in his head. Dennett says that this requires us to imagine a *homunculus*, or little man inside the subject's head, peering at the inner photograph. It is this inner spectator who is *really* looking at the picture. But then, the homunculus requires a homunculus of his own, and so on to infinity.

This little allegory makes it clear why it is not the visual brain's task to reconstitute a picture. Rather, the brain assembles a profoundly transformed analysis of what a scene portrays. Instead of producing a pictorial facsimile, the brain creates a coded "report" of all the useful information extracted from the optical array. Finally, by a process which science cannot explain, this information is transformed into the sensory experience of seeing.

The function of the senses is to give animals sensory experience, and evolution has ensured that each of the senses has its own unique, very distinctive way that it feels to us. For example, we experience smells as one thing, sounds as something totally different, and vision as something different again. Vision acts on us in a special way that was discussed earlier, under the heading "A Necessary Deception". We project the scene our brain has constructed back onto the world, and therefore witness it there, where we believe it should be. For that reason, we are unshakably convinced that we aren't merely *seeing an image* of the world, but are right in it and perceive it directly, as it is.

This self-deception is a biological imperative. It tricks us into the belief that we get more from our eyes than merely a *representation* of reality: We believe that what we get is the real thing—reality itself! This belief is the basis of a philosophical ideology called *Direct Realism*. Part of its staying power is that even if you have philosophical doubts about direct realism, you are obliged to go about your daily activity *as if* you believed in it.

In direct realism, the observer is an innocent spectator, and plays no role in shaping reality. Even though this belief is overwhelmingly supported by common sense, it turns out to be false. All of modern science, from fundamental quantum physics up to cognitive psychology, points to a fundamental, constitutive link between the observer and reality. To understand why this is so, it is instructive to try to imagine what the universe is like independently of all observation.

Let's carry out a thought-experiment: Imagine that all life has vanished from the universe, but everything else is undisturbed. Matter is scattered about in space in the same way as it is now, there is sunlight, there are stars, planets and galaxies—but all of it is unseen. There is no human or animal eye to cast a glance at objects, hence nothing is discerned, recognized or even noticed.

Objects in the unobserved universe have no shape, color or individual appearance, because appearances are created by minds. They do not have features, because almost every feature you can think of corresponds to a category of animal sensation. It has been claimed, for example, that the very notion of solid matter rests on the sensation of hardness. We assign qualities to objects according to the way they affect our senses. In other words, it is our sense organs, and their extensions in the brain, that create features and qualities. Thus, in a universe without sentient beings, all features and appearances are absent.

Philosophers refer to a universe of this kind as the mind-independent universe, or as I'll call it here, the *primal universe*. It is not a universe of science fiction, because there was a time in prehistory when life had not yet evolved, and the universe was as we have just imagined it. By definition, then, the primal universe is the residue after all sensable qualities have been taken away. (Sensable qualities are those which can be sensed by living creatures.) It is this universe that the physical sciences strive to understand.

There is less to the primal universe than we are prepared to believe. This is a fact of the first order of importance for anyone who aspires to understand the universe rightly. As a simple example, the structure of objects as they present themselves to us is partly dictated by the anatomy of the mammalian visual system. Imagine that you're looking at a triangular object: The visual brain is provided with a specific mechanism for detecting straight lines and angles, and that's why you spontaneously discern a triangle. More generally, the way the forms of objects appear to us is partly a function of our visual anatomy. Indeed, an animal's visual anatomy dictates its vocabulary of shapes.

In a similar fashion, the notion of *force* in physics is based on the effort needed to move a heavy object—an effort that we feel in our muscles. Even our idea of motion is based on the sensory experience of watching things in motion: We experience what is called *visual flow*, and that distinctive sensation provides the visceral meaning of motion. We humans have a complex intellective understanding of motion, but its meaningful content is rooted in our senses.

Such feelings, which are laden with meaning for every living creature, are the foundations which support scientific concepts. Without these underlying sensations to give them meaning, the concepts would be empty of content. How could you conceptualize force without any reference to a sensation of effort? If it were not linked to the sensation of effort, force would be reduced to a pure abstraction. It could be regarded as an un-interpreted effect in the universe, represented graphically by an arrow, as it is indeed in physics. In actual fact it would be less than that, because a visual system is needed to experience the sight of the arrow, or to imagine it in the mind's eye. If you withdraw all sensation, you may find there's almost nothing left.

The residue would be something so detached from reality as to be totally alien to us. For us, things are real because they have features, properties, characteristics, attributes, qualities and defining traits. If all that is taken away, you have a world in which nothing is actual and concrete. What remains is like the abstractions of pure mathematics. Indeed, features or properties unsupported by sensation are close to pure abstractions.

A Peacock's Tail: The Party Never Ends

When we hear birds singing or the sound of a familiar voice, we don't merely register vibrations of the airmass, but have a unique experience of hearing a complex sound with a well-defined timbre and a distinct quality. When you listen to music, your experience is not just of hearing sounds, but is a unique sensation which exists only inside you, not in the air or the instrument. Almost every quality we experience has a biological origin, and the particular way we feel it is only in loose correspondence with its physical triggers.

It is important to understand why animals and humans transform and rework the environmental information delivered by the senses. Over evolutionary time, it has proved adaptive for animals to become sensitive to important signals from their environment, which the brain then intensifies. If environmental data were represented without any enhancement or embellishment, it would not get the attention that is needed. Moreover, information from the environment is often fine-grained and complex, hence the signals need to be modulated and exaggerated in order for a subject to capture the nuances and fine distinctions. Signals which are easily confused are presented in such a way that the differences between them are amplified.

In order for signals from the outside world to be immediately understood, they must be associated in mind with their meaning. In order to achieve this, signals are transformed by the brain so each one—when it is experienced—has an individual character and style which evoke relevant associations. Also, every important signal gains prominence by having a particular emotional coloring. Everything that is perceived is overlaid with a veneer of emotion, which is essential in order for us to pay the appropriate attention to it and identify it. The emotional energy that comes with everything that we experience adds salience to it and makes it more memorable. It brings events to life.[8]

Animals and even plants have learned to exploit the perceptual sensitivities of organisms for their own purposes. They have adaptations which allow them to respond to, as well as produce strategic signals. As an example of how signals are used in nature, venomous animals such as wasps, poison frogs and rockfish are usually adorned in very vivid colors in order to warn other animals and keep them at a distance. The brighter and more conspicuous the animal, the more toxic it usually is. Likewise, we are all familiar with the vivid colors of tree leaves in the Fall. This is meant as a warning signal from the trees to aphids and other species that migrate to trees at Autumn-time.

In some animal species—birds in particular—conspicuous signaling shapes and defines their social mores. Peacocks and some other birds have evolved extravagant, flamboyant plumage to enhance their attractiveness to potential mates. The tail feathers of peacocks form a train that is twice the length of their bodies, decorated with iridescent eyespots ringed with blue and bronze. In courtship displays, the peacock's tail feathers are arched into a huge fan of fantastical appearance, and made to vibrate, giving the feathers of the train a shimmering appearance. In the peacock world, the party never ends.[9]

This penchant for the vivid and picturesque is most apparent in the style of the perceptual world that we experience. For mysterious reasons, the sensory systems of living creatures have evolved in such a manner that the external world is experienced in ways that are vivid, intense, almost theatrical. The world reaches our consciousness in bright colors, shapely forms, and melodious sounds. The way the world appears to us is painstakingly embellished: Out of a lackluster external reality, the animal senses have created a carnival.

The most clear-cut difference between the reality we see and the objective world "out there" is the way we decorate and enhance the character of objects we perceive. Though we understand logically that there is such a difference, it is hard to convince ourselves that the reality which surrounds us does not have all the froufrou of what we see.

What I shall demonstrate in this book is that much of what we assume to be the material world is actually created by the animal mind. The mind plays no part in the production of matter and energy, but on the other hand, all material objects have form and structure, and these are non-material things which emerge in minds.

One of the most ancient dichotomies is that between form and substance. Intuitively, it seems indisputable that every material thing has two orthogonal aspects: It has matter and form—and these two things jointly determine what an object is. This belief is another example of naïve realism—for in actual fact form cannot exist except in the purview of a Gestalt observer. Form does not inhere in brute matter but emerges in Gestalt observation.

The material universe is dynamic and consists of processes unfolding and evolving. A *process* is like a form: In a process, material bodies move and undergo change. But process, like form, exists only in the purview of a Gestalt perceiver. Process is radically separate from matter, just as form is. Loosely speaking, matter and form are mutually unrelated components of reality, though we naïvely believe that form is an aspect of matter.

In conventional thinking, it is assumed that the animal senses have the function of apprehending the shape of material objects and the patterns in which they move. It is known today that the senses do a great deal more: Because of the Gestalt nature of all perception, it is the senses that *create* the forms of all complex things that we perceive. It could be said, with only a touch of hyperbole, that the cosmic function of the mind and the senses is to bring to light the holistic, Gestalt side of reality, that is, the side where form and structure emerge.

3

Gestalt

Mental Life Gets Organized

Everything you see, hear and think comes to you in structured wholes: When you read, you're seeing a whole page even when you focus on one word or sentence. When someone speaks, you hear whole words and phrases, not individual bursts of sound. When you listen to music, you hear an ongoing melody, not just the note that is currently being played. Ongoing events enter your awareness as Gestalts, for the Gestalt is the natural unit of mental life. If you try to concentrate on a dot on this page, you will notice that you cannot help but see the context at the same time. Vision would be meaningless, and have no biological function, if people and animals saw anything less than integral scenes.[1]

The obvious reason for this is that life plays out in whole events, and the objects with which every animal interacts are complete things. A deer must instantly recognize the form of a cougar (and vice-versa), a squirrel must see the separate branches on a tree, a honeybee must know different kinds of flowers each having a distinctive design. Birds must tell the difference between nourishing and poisonous butterflies by subtle differences in wing design and markings. The habitat of every living thing is multiple and complex, and survival depends on the power to learn and recognize its intricacies. Even single-celled animals respond differentially to complex configurations. The more we learn about animal life, the more clearly we see that all perception and all action are designed for survival in a multiform and dynamic world of whole objects and complete events. In such a world, living organisms must be able to perceive undivided patterns and whole configurations.

C. Pinter, *Mind and the Cosmic Order*,
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When you set your eyes on an object such as a chair, you notice immediately that every part of the object is present in your field of vision at the same time. The back, the arms, the seat, the legs—all exist simultaneously in the field of your awareness. You are also alert to the object's color and surface gloss, as well as to quirks of the object's shape. You experience all these things together, configured in a pattern that you understand. You experience the Gestalt image of the chair.

The animal brain—unlike any manmade computing device—stores and uses knowledge in the form of structured wholes. This kind of knowledge is the very antithesis of the sort of knowledge or information recognized and processed by computers. Computers organize data "from the bottom up:" For a machine, a picture is a matrix of dots, or "pixels". When *you* look at the picture you see an image, because you have Gestalt vision—but the computer sees nothing more than the dots, which it must blindly process according to fixed instructions. A brain, even in the simplest organism, is wholly unlike any computing machine that has ever existed. It is designed to process Gestalts whole, without decomposing them into rudimentary component parts.[2]

The undivided Gestalt whole is not merely the fundamental unit of perception, it is the basic unit of thought as well. This claim hardly requires justification, because solving a problem or producing a rational argument clearly involves having whole ideas or images in mind. There isn't a task, no matter how ordinary, that doesn't require some planning in which a whole context is visualized. Even to sweep my deck I must call to mind where the broom is, decide which side of the deck to begin and which way to sweep. Every waking moment we are seeing, hearing and judging in complete thoughts.

A Gestalt portrays objects laid out in space so that collectively they make sense as one compound unit. A landscape or a portrait are meant to be apprehended whole. They consist of separate elements composed together which convey the different parts individually as well as in relation to one another, and at the same time reveal the whole as an indivisible composite that we behold without analyzing it. Also, perhaps more importantly, Gestalts show events unfolding in time in a form which is coherent and organized. Thus, when we witness an event, for example a book falling off a desk, we experience it as a unitary incident, describable as "book falling-off desk", but the event isn't three things, it is one. That is the very essence of a Gestalt: If you analyze it there are several components, but it is apprehended in mind as an unbroken unit of meaning.

Just as Gestalts permit you to see multiple objects side by side at the same moment, it likewise permits you to perceive objects and events that evolve over a duration of time. When listening to music, you hear more than just the note currently being played: You hear a whole melody. When someone speaks you hear a whole sentence. Gestalts bring into being an entire aspect of reality that would not exist otherwise—a reality in which many things which are separated in space and time are perceived together as a new combined entity. The new entity did not exist before the parts were perceived as one.

When we look at an object in motion we *see it moving*, and this takes a small amount of time, perhaps a quarter of a second, or a little more or less. In the perception of living beings there is no such thing as instantaneous motion: That is an abstraction of physics. What we perceive is the gradual displacement of an object. In a single frame of awareness, we are experiencing gradual change. That is possible only for an organism that perceives in Gestalts.

Not only higher animals, but even the tiniest insects perceive motion. In addition, experiments show that they recognize patterns and are able to distinguish even small variations between them. Ample evidence proves that they perceive Gestalt wholes in space and in time. Insects even have internal Gestalt images of objects. This fact was brought to light in a 2020 experiment reported in the journal Science.[3] From the article, the authors "found that bees could identify objects by shape in the dark if they had seen but not touched them in the light." In order to achieve this, the insect must have retained a visual image of the object, and even recognized the same Gestalt image by touch.

When a story is told, the incidents of the story-line unfold one by one, yet in a listener's mind a coherent narrative comes together in stages until the story is complete. It is then present in mind as a single narrative unit. This fact has been confirmed time and time again in psychological experiments, in which it is found that a short time after listening to a narrative, what a listener recalls is the gist of the story—not the wording and not the details. The gist of a story is an archetypal example of what a Gestalt is. It coheres together in memory as a single unit. It may be unspooled when retelling it, but while doing that you are keeping the gist in sight, for it's the source of what you're reciting.

The value of a gist for retaining things in memory has been known for a long time. In the 1960s cognitive psychologists used the word *chunking* to describe a process of binding together different items to form a meaningful whole which is easily remembered. The reason this is possible is that once a Gestalt is formed, it hangs together tightly as a single unit of thought. It is stored as a single unit, and emerges into consciousness as a single unit. Yet a Gestalt, like a panoramic landscape, may be very rich in content.

Human memory is a remarkable process which is not fully understood. Possibly, what our brain commits to memory is not an exact portrayal of what we wish to recall, but rather the steps through which it was encoded. To retrieve the memory, we go through the encoding process in reverse. This is very likely the case, because in a complex recollection there is too much information to store verbatim. The amazing capacity of human memory would exceed its physical support if it weren't for some feats of encryption which we don't understand.

A series of experiments on Gestalt memory for pictures was conducted beginning in the mid-1970s. Successive experiments were carried out by different laboratories because the first reports to appear in print seemed hard to believe. One of the most definitive studies was carried out in 1973 by the Canadian cognitive scientist Lionel Standing and published under the title "*Learning 10,000 Pictures*". The sizes of the learning sets in these experiments were in the range of 1,000 and up to 10,000 pictures. In the learning phase, subjects were given 5 seconds to view each item, with a half second interval between pictures. In the testing phase, what was evaluated was recognition memory: Given two or three pictures side by side, a subject was asked to indicate which was the one presented during the experiment.[4]

Two days after viewing the pictures, subjects had a recognition test, and it was found that 88 percent of them were recalled correctly. When a test was given on the same day the pictures were viewed, the accuracy was 99.6 percent. In another kind of test, instead of picking out the right picture, subjects provided the gist of what they had seen. The results were no less impressive. Not surprisingly, Standing found that humans recall pictures far better than words. Indeed, pictures are well-structured Gestalts, and that's what we are designed to remember.

In the words of Lionel Standing, "The capacity of recognition memory for pictures is almost limitless." This is an astonishing fact: It is hard for us to remember verbatim sentences—for example poems or the lines of a play. It is even harder to remember sequences of numbers. But when it comes to remembering richly detailed displays, we remember effortlessly. There could be no more convincing evidence that human and animal minds grasp the world in Gestalt wholes.

Seeing the Whole Picture

It is a strange irony that the things which are the most familiar to us—things we live with day and night—often go unnoticed. Perhaps they're too close to be perceived. For example, we are all conscious beings, and nothing is more present to us than the uninterrupted flow of conscious experience. Yet until recently there was no word in our language for consciousness as we understand it today: Rather, the word was conflated with conscience, in the moral sense.

The psychologist Julian Jaynes found that the concept of consciousness is absent from the ancient Greek epics, and suggested that the very realization that living beings are conscious had not yet entered collective awareness.

The same is true today with the idea that we see and think in Gestalts—for example, that when I look at my rosebush I perceive it all together as one thing, and the meaning of "a cat is on the sofa" forms one unit in awareness. (The six words join together to form one meaning.) Those things are just as evident as the fact that you're conscious: Nobody, for example, would deny that they see in Gestalts. But there's a difference between not denying it and being committed to it. One may judge something to be undeniably true, yet ignore it. That appears to be the status of Gestalt in much of contemporary thinking.

There is no word in the English language to refer to Gestalts, and that is the reason we are obliged to adopt a word from the German. A dictionary definition of the word Gestalt is as follows: Something that is made of multiple parts, yet when considered as a whole, it is more than (and different from) the sum of its parts. Since everything we see, hear and think is a Gestalt, it is hard to understand why there is no word in our language to express it. Even in German, the word *Gestalt* does not have the same meaning as the English dictionary gives it. The German word is used worldwide to express something for which there was no word in any language prior to the 20th Century.

It appears that nobody today—not psychologists, not philosophers, not thinking laymen—are fully aware of how "magical" it is to see in Gestalt wholes. It gives us knowledge of many things in the same moment, all bound together in one act of conscious awareness. It presents us with an almost godlike overview of wide, stretched-out vistas. Gestalt vision can bring us a view of a whole vast landscape of rivers, villages and distant mountains, all in a single glance. Actually, it does far more than that: A Gestalt picture does not merely bind separate objects together, but creates an entirely new complex entity which did not exist before. It creates a new world of hierarchically structured new objects—a world which could not exist without Gestalt perception.

A paradigm example of a Gestalt is a simple pattern such as the pattern of seven stars forming the Big Dipper. The stars are merely points of light: the pattern emerges when they are seen together, spread out in a particular configuration. All seven points must be seen simultaneously in order for the pattern to emerge. Each point must be noticed, and all seven must be taken into account at the same time, along with the way they are laid out spatially. Every one of these details, without exception, must be present in awareness together.

The essence of a Gestalt is that it's "different from the sum of its parts." For example, the Big Dipper, when you look at it in the night sky, is something entirely different from the seven stars each viewed in isolation. In the very same way, the letter H is categorically different from the three line segments of which it is composed, viewed separately. The same three line segments can be configured in different ways to produce A, F, N, Z and countless other patterns. What is significant are not the elementary components but the configuration in which they appear. When the components are perceived *together* in one glance, in their correct positions in relation to each other, something entirely new appears—something that did not exist before: The undivided whole reveals itself as a newly-formed entity. The newly risen pattern is something in its own right, *having a distinctive appearance of its own.* The true essence of Gestalt is that it creates something wholly new.

To understand why the visual world is necessarily presented to creatures in Gestalt wholes, just consider the alternative: Suppose some imaginary being existed that is unable to perceive two different objects side by side. Imagine, moreover, that this being lives in the present moment only, and has no sense of the passage of time. In the world of such a creature, there is only one "eternal" moment; there are no patterns or objects, there is no extended space, events cannot be perceived as they unfold, and memory itself is impossible because it involves the comparison of items in different timeframes. Even if perception of this kind existed, it would confer no benefit to its possessor, for it would yield no useful information about the environment. Since it would have no adaptive value, it would never have evolved.

Photosensitive cells on simple creatures emerged long before functional vision did. There is a great deal of controversy as to when vision became established as one of the animal senses. It is likely that vision would not have been useful before nature had developed a means of presenting visual information in coherent, comprehensive scenes. When vision first emerged, there may have been very little information in such scenes, but the information must have been sufficient to give cues for distinguishing important objects. Thus, it is probable that Gestalt perception emerged at the very beginning of the evolution of eyes, and the two evolved in tandem.

It is not only the visual world that comes to us in Gestalt wholes: All thinking, judging, and decision-making—in fact, all mental processing—is done with Gestalts. It is only at the present time that this important fact is beginning to be recognized and is taking root in the social and life sciences. Arguably, psychology in the 21st Century ought to become the science of understanding Gestalt processing in the brains of humans and other animals.

To a large extent, however, the concept of mind in psychology and cognitive science has been advancing in a very different direction. The dominant theory today is called the *Computational Theory of Mind,* and advocates that the human brain is an information processing system. In this theory, mental processes are computations realized by neural circuitry in the brain. Computation is understood as the manipulation of symbols according to rules, hence mental activity is believed to consist of processing symbols in the brain. At no point in this theory is the existence of Gestalts recognized. (It is not denied, simply ignored.)

Computation is an activity that has been extensively studied and is well understood. It is a process that can be carried out in a variety of different ways: by hand, by machine, and indeed by different *kinds* of machines. For that reason, we say that it is machine-independent. Thus, if mental processes are computations, then the same processes can be carried out on mechanical computing devices. However, the mind is able to represent Gestalts, and to draw inferences from data presented in complete wholes. Is it possible that computers have the capability of doing that? In order to answer that question, a few words about computation are in order.

Computer memory is nothing like animal memory. Memory in computers is called "addressable memory" because every stored number has an "address" in memory, and the number can be accessed only by providing its address. Stored information is available to the computer only when a program instruction calls out the contents of a specific memory address and inserts the contents into the "accumulator". The accumulator is where the data is processed, that is, it is read and an operation is executed on it.[5]

In each operation, the computer takes into account only the one number (or item of coded data) in the accumulator, and has no access to any other information. It "sees" only the one number that it has been instructed to withdraw from memory and put into the accumulator. It decides and acts on the basis of that one item of data, while all else lies temporarily in dead storage.

In the scope of one operation, the computer is not able to survey data panoramically, hence at the instant of making a decision it takes account of just one item of data. In contrast, when a decision is made by a person on the basis of a Gestalt, a fully structured whole is taken into account simultaneously. All of it together is needed to make the decision. As a consequence of this, a decision made in a mind is altogether different from a decision made by operations on a computer.

There is an additional and decisive reason why computations cannot deliver Gestalt wholes: Computation, by its very definition, is the manipulation of information. Gestalts, however, are not information: They are cognitive structures in animal minds: They are entities of a biological nature that arise in the minds of living creatures. Information can be coded as data—for instance as sequences of 0s and 1s—but Gestalts cannot be coded. Gestalts are mental realities whose domain is the conscious mind. Only a mind has the power to retain a body of knowledge (for example a scientific concept)—all of it present at the same time in the window of awareness—and draw a conclusion which is based on the whole structure seen as one.

Thinking It and Speaking It

The human mind possesses a most remarkable resource: It is able to unravel a Gestalt thought and transform it into a sequential structure of words. For example, we're able to conceive of a complex event and then relate it as a narrative, using words. This is a singularly difficult and creative process, because the Gestalt must be totally restructured: It must be unpacked and then reassembled in a radically different form.

You're not aware of this labor in everyday conversation because a dedicated module in the human brain (known as Broca's area) does this work in the background. However, you're aware of the effort when you're writing a difficult technical report and feel it's a small miracle if your written account truly matches your initial thought. We're always faced with the need to shoehorn complicated ideas into the tight structure of sentences. We're often forced to compromise and make do with a sentence which is an approximation of what we'd really like to say. It is in this way that language constrains and regiments the range of ideas we're able to exchange.

The power to serialize a Gestalt would be of little value if the human mind weren't able, likewise, to take in a narrative given in words, and transform it into a Gestalt. We do this automatically whenever we hear a story or listen to somebody speaking. The primary function of human language is to evoke, or build up Gestalts in a listener's mind.

Common sense regards language as a straightforward means of communicating facts or ideas from a speaker to a listener. In order to accomplish this, words must refer to objects and events in the world. That is correct, of course, but it is not the real essence of language. Rather, the profound function of language is to decompose holistic images and thoughts of a speaker and transmute their meaning into a linear code of linguistic utterances. These are transmitted in serial fashion and received in serial order by a listener, who is then able to transform them in his own mind back into holistic thoughts and images similar to those of the speaker.

In a way, it is an amazing insight to realize that the only way to communicate a whole thought or image from person to person is to decompose it into small units, each representable in a single shaped sound. What is most wondrous of all, however, is that a spoken sentence contains not merely the individual words, but coded into the sentence is all the structural information needed so the stream of words can be reconstituted by the listener and restored as a Gestalt whole. Understood in this way, language is an invention of staggering genius. Rules of grammar can now be viewed in a new light. They are not primarily intended to clarify our meaning when we speak, but are the hidden rules which a listener must use to rebuild the structured frame of a whole thought from a series of words.

Actually, this invention is not unique to human communication, but is a fundamental principle of the living world. The complete specification of a living individual, with every detail of its organs and how the organs function together, is an indivisible Gestalt plan. When an organism reproduces, the holistic plan of the animal's body is unspooled and expressed linearly in the language of DNA. Then, in the process of gestation, the words of the DNA language are transformed back into a whole organism. The coded DNA sequence is not limited to encrypting an individual's traits, but encodes step-by-step chemical instructions for assembling a whole individual. In that sense, it is like a grammatically correct sentence, whose correct grammar is the key to reconstituting the original whole thought.

One of the great issues being debated in academic circles today is the origin of human language. Some people say that language is a cultural innovation, created purposefully by people in early societies to exchange plans and thoughts. Others maintain that language has biological foundations and is an adaptive trait that evolved with our species. This view has been promoted by the linguistic scientist Noam Chomsky, whose writings and courses at MIT have brought his perspective to a wide audience. There is strong evidence for this position: For one thing, it is known that specific brain areas are specialized in producing and decoding speech.[6]

It is also argued that considering how complex language is, one cannot account for the speed with which children learn their native tongue, except by assuming that certain linguistic functions are innate. In addition, studies have been made of children born deaf and mute who live together in special schools: The most famous case are the deaf children of Nicaragua, who communicate in a sign language which they developed spontaneously, and which has a clear grammatical structure close to that of spoken languages. Linguists believe they could not have invented such a grammar if its roots did not already exist in the human mind.[7]

It is claimed that there are general rules governing the formation of meaningful sentences, and that these rules apply to all languages. There is evidence that the grammars of all the major language groups grew out of them. These general rules—dubbed *universal grammar*—are assumed to be innate, in the same way as weaving a web is innate in spiders, and nest-building is in sparrows.

Chomsky's ideas are widely accepted today—though they have met stiff resistance on account of their obvious link with the nature-nurture debate, where they fall on the side of nature. Chomsky's ideas have merit if you consider language to be the way of channeling Gestalts through a pipeline of communication: For if Gestalt processing is central to living creatures, then a mechanism for converting it to linear form, and recreating Gestalts out of language, must be equally fundamental. Moreover, the function of transforming Gestalt thoughts into a linear form is not restricted to language alone. Every animal conceives of actions it wishes to carry out: The internal image of the action is a Gestalt, and it must be translated into a program of successive arm and leg movements to be carried out sequentially in time.

When a decision to act is converted in mind to a plan of action, this process too has strict rules which conform to a grammar and syntax. After all, you do not move your arms and legs pell-mell in any order, but in a disciplined, regimented way. Studies have been made of how a person reaches to grasp a glass of water, and it is found that the sequence of motions follows a stereotypical pattern. Likewise, observations have been made of spiders weaving webs, and birds building nests: The sequence of individual steps is methodical and follows a conventional order.

Thus, Chomsky's universal grammar is built atop a more general—more universal—grammar which regulates the way of transforming Gestalt images into action sequences. No animal could survive—or more correctly, no animal could take advantage of the huge power of a Gestalt mind—if it were not able to translate whole images of contemplated actions into an ordered series of movements of its limbs. Humans have exploited this function, which exists in all animal brains, and adapted it to the needs of communication.

The value of language is not limited to communication. Perceiving the world in Gestalt wholes confers great power to animals, but also imposes limitations. A Gestalt view brings you knowledge of a broad range of things in one glance, but it lacks precision. When precision is needed, wide-ranging Gestalt information is not suitable: What must be brought into the scope of your awareness are specific items and the exact, explicit relationships between them. In order to achieve that purpose, humans and other animals adapt Gestalt perception so it focuses on small regions of the visual field.

For example, when you're repairing a motor you must know each individual part, where it belongs and how it connects with other parts. This kind of knowledge is encoded in a different kind of memory from pictures or events: It is kept in what psychologists call *explicit memory* and is saved in a form similar to language. Every kind of animal has explicit memory for practical details: It is useful to think of it as "precision memory". When carrying out tasks, all animals (ourselves included) must switch back and forth between a panoramic and a precision way of looking. Non-human animals, of course, don't possess language, but they categorize important objects (for example other animals, flowers, trees) by mental tokens which represent objects.

The combination of Gestalt vision with knowledge in the precision mode—together with a channel for easily passing information between them—accounts largely for what man has been able to achieve. It is in the precision mode that we are able to communicate in sentences, make intricate plans and analyze the way things work. But the precision way of scrutinizing the world is useful only when it is built on a foundation of Gestalt perception which gives us a comprehensive view of the wider context.

Growing the Tree of Knowledge

The average person gathers a prodigious amount of knowledge in the course of a lifetime. According to the philosopher Michael Polányi, most of this vast repository of learning dwells in the mind in the form of tacit knowledge, that is, knowledge that is not expressed in words. It consists of insights, observations, facts and lore all interconnected in a vast and fluid network. For the most part, this knowledge is structured in Gestalt mental images.[8]

Mental images are not necessarily pictorial—in fact, most of them appear to us in the form of schemas that are picture-like but do not depict specific objects. Nonetheless, their Gestalt structure—the way component parts are combined together in intricate ways—is very much like the way a visual scene is organized, hence it feels similar. That is the reason we use so many visual words to express understanding: For instance when something is clearly explained, you respond "*I see!*" This is not merely an expression, for quite literally you behold a mental image in mind. Moreover you sometimes *reflect* about things, and when you speculate you're using the Latin word *specula* which means mirror. An explanation is either *clear* or *murky*; in fact, it may be *lucid*, from the word for "light", or even *brilliant*.

Our repository of tacit knowledge is not stored in words and sentences but in whole images. It could not be otherwise: As explained in Section 1, human memory for pictures is almost limitless, because apparently memory is designed to store Gestalt wholes, and it is poor with words, sentences and numbers. It is therefore natural to hoard the huge amounts of learning we accumulate in Gestalt images. In fact, there are well-known techniques, such as the *Memory Palace*, for memorizing lists by re-imagining them as pictures or narratives.[9]

When you organize your thoughts and put them into words, you are drawing from a pristine source of imagery. For example, when you make the statement, *"the seawater is too cold to swim"*, there is a structured Gestalt idea in back of your mind which is verbalized in those words. The thought represented by those words is a complete mental image: It forms one unbroken unit of meaning, and must be serialized in words to communicate it.

As another example, consider the following sentence: *"This has the potential to be a fearsome new weapon."* Note how the whole sentence works as a single unit of meaning: There is no way of subdividing it into smaller items that assert anything meaningful. It is an indivisible unit of thought. In particular, the thought itself is not made up of words, but is something prior to words. That is exactly what we mean by a mental image.

The thought processes of scientists have long been a subject of fascination. In their self-reports, most scientists say they do their thinking in complex mental images which are almost pictorial. Albert Einstein explained that the creative aspect of his work is carried out in vivid mental pictures sometimes enriched with kinesthetic feelings. In science, conceptual structures can be very extensive, and must be kept in mind in large Gestalt images held together simultaneously.

As a teacher, you gain privileged insights into the learning process. Typically, you lecture in a field that you know thoroughly: In mathematics, you know many hundreds of theorems, and are able to set down the proof of any one of them without consulting your notes. This is possible because you have a coherent Gestalt image of the "germ" of each proof—and it is routine for you to transform the monolithic image into successive steps. But the inner meaning of a mathematical proof is in the image, not the long succession of steps. It is similar from the student's perspective: The moment when a student successfully achieves the complete synthesis of the proof and "sees" the Gestalt, that is the *Aha!* moment. The learner says, "Now I see it!" The word *see* is crucial, because indeed it is as if seen with the eyes of the mind. The *Aha!* moment is the instant that a thought crystallizes in mind as a single unified image.

In this connection there is a wonderful story about Mozart, contained in a famous letter that he sent to a friend. Mozart relates that he had been thinking for a time about a new symphony he wished to write, but had set it aside. One morning he was walking through the countryside when suddenly, he says, the entire symphony appeared to him in mind, experienced simultaneously. I have discussed this episode with my musician friends, and they tell me that when they learn a piece to be performed, it dwells in their mind as a single entirety. Likewise, it is as a single whole unit that a story is remembered, and that a scientific theory has meaning in the mind of a knower.

Creative thinking is a remarkable process of which very little is known. In essence, it is the artful management of Gestalt thoughts, and demands skilled and disciplined practice. A Gestalt thought is a hierarchical structure in mind, and to “know” it requires that the whole thought be present in awareness simultaneously. Clearly, such a thought cannot be too large or detailed if all of it is to be in the window of awareness at one time. Consequently, we have developed ways of subdividing Gestalts into related parts, keeping track of the separate parts, and nimbly skipping back and forth between them.

There are tight limits on the size, or span, that a Gestalt can have in order to be knowable in mind. Skillful knowing is the art of managing our thoughts in such a way that a complicated scheme or idea is divided between multiple individual Gestalts. These separate Gestalts are then linked by something like a mental flowchart which displays how they connect with one another. This allows the thinker to transfer seamlessly from one to another in the process of thinking.

Human thinking is limited by our biology. There are anatomical limits on memory and on the span of human awareness. In order to go beyond those limits, we have developed the skill of identifying the joints along which Gestalts can be naturally split into smaller Gestalt parts. In the course of reasoning, we’re hardly aware of the fact that we are busily cutting and pasting Gestalts, while in the background we keep track of the connections between the subordinate parts. However, Gestalt thoughts cannot be divided and joined together indiscriminately: This process is subject to very stringent psychological laws, whose basics are not understood at this time.

A well-known principle of Gestalt-formation is the memory-expansion technique known as *chunking*[10]. For generations it has been used by so-called “memory champions” who have trained themselves to recollect long lists of numbers or other items. The idea is that out of the roll of items to be recalled, the performer creates a story or a picture in which all the items appear in a fixed sequence. Such a narrative or image becomes a single Gestalt—something that can be “seen” in one mental glance—and by holding the image in the mind’s eye, the master is able to pick out the items of the list.

What this technique proves is that there are specific ways of gathering thoughts together in such a way that they form an all-embracing unified Gestalt which includes them all in one narrative or pictorial framework. Apparently there is something special about a picture or narrative which the brain is adept at holding firmly together in one piece. You might lose the cohesive unity of a complex abstraction, but a picture or story remains firm and steady in mind. Moreover, as discussed in the first section of this chapter, human memory for pictures seems to be almost limitless, and the same is true for stories.

The organization in mind of a narrative follows the same principle: If a story is complex, you recall the gist and are able to access separate episodes at will. It is similar with a picture, such as a landscape. You're aware of the general plan, and by moving your eyes in what are called *saccades*, you have immediate access to any specific region of interest. That is the brain's special way of overseeing and administering Gestalts.

People in certain professions can be trained to recognize and manipulate huge Gestalts in a very narrow domain in which they are specialized. For instance, it is well known that chess grand masters are able to understand and recollect an entire chessboard configuration in a glance. The knowledge they acquire in one look at the board is of an entirely different kind from what you or I would gain. In one play of the game, they are not attending merely to the chess pieces around them, but to the comprehensive situation over the entire board. All of it is in the focus of current awareness, at the same moment.

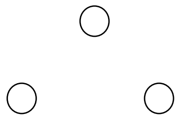
An important practical concern of psychology is the measurement of intelligence. A number of different measures have been devised, but no test has ever been created to measure the ability to do Gestalt problem solving—that is, solving problems in which holding an entire image in mind at one time is crucial. It is quite plausible that this measure constitutes the decisive factor in the ability to solve difficult problems in an innovative and creative fashion, especially in the sciences.

When a person is able to view a scientific problem as a whole, in one comprehensive picture, it is like a forest warden sitting in a high tower, and from his prominent position being able to keep watch over a vast region of parkland. It is a significant fact that people aren't all equal in the size of Gestalts they are able to generate and hold in mind. It would therefore be of considerable interest and importance to develop a psychological instrument for measuring that factor. It is likely that this aspect of mental endowment plays a critical role in overall intellectual capacity.

As our species continues to evolve, it is probable that the capacity to hold and manipulate progressively larger Gestalts will increase. Such a development is inevitable, because the power to think in larger, more comprehensive Gestalts is a very important adaptation for man as we head into an era of steadily more complex science and technology. If the faculty of holding larger Gestalts becomes common, humans of the future will possess concepts that it is impossible for us to think today. With this expanded power of conceptualization, it will be possible to develop science in ways which are now inconceivable.

Are Gestalts Real?

Are Gestalts real things of the world, or do groups of objects form unitary wholes only in the eye of an observer? Imagine putting three pennies on the table in a triangular pattern, as suggested below:



In perception, the threesome of pennies has its own identity, separate from that of the individual coins: For instance, the threesome has a triangular appearance in our eyes. Does the threesome exist as a separate unit in the mind-independent world? Are there three things in the world (namely the three coins) or are there four things (the individual coins and the threesome-of-coins)?

This is not an easy or trivial question, for it depends on what you understand by *existing*. If existence is limited to the material, then you have only three things, because no new *material* is added when the threesome is formed. However, if reality were limited to what is material, there would be no such things as structure or form, because they neither add to, nor take away from matter. The threesome of coins is a separate reality for *us* because it has a separate quality in perception. What is there in the mind-independent world to make it something separate? What is there in the material world to make any Gestalt group of objects exist on its own merits, over and above the individual objects in it?

There are groups of objects that come together naturally. Think of a table: It has five parts, namely a horizontal top and four legs. However, the table has a proper function which is only achieved by the whole. The same idea applies to living animals, which have numerous organs that work together and jointly make the animal. What distinguishes these examples is that the composite object depends *functionally* on its parts. It exists only as a dynamic combination of its components.

There are many other systems of objects in the world that interact naturally, and by their interaction form cohesive groups. For instance, the planets revolve around the sun and interact gravitationally, thus forming a planetary system. However, material systems which belong together because they function as a unit are few and far between. In contrast with functionally related groups of things, there are innumerable random groups of objects which are nothing more than chance combinations, without purpose.

Hypothetically, *every* collection of objects could be separated out of its background and assigned an identity as a group, in which case everything would be a Gestalt. If that were the case, the very notion of Gestalt would be meaningless. This shows that a Gestalt is more than an arbitrary joining together of objects. There must be a reason, a purpose, for bringing particular things together and taking them to form a coherent whole. But in the mind-independent universe, there are no such things as reasons and purposes.

We are led to conclude that it requires a living *subject* to mentally extract a dynamic group of objects from a background in which it is deeply embedded, and make it stand out as something existing in its own right. In other words, it takes a living subject to isolate a group of things and draw it out of its background so as to perceive it as a separately existing thing. This thing is then a Gestalt in the eyes of the beholder.

Objects don't come together into groups all by themselves, without reason, but are brought together in a purposeful way which must be recognized by someone or something as forming a collective entity: They are then a collective entity for the one who recognizes them as such. A Gestalt requires a subject in order to be perceived as a Gestalt.

Thus, being a Gestalt is not an objective fact of the world, but is a way of being perceived: It is a property of perception, not a property of the external world. A Gestalt is a compound entity when recognized as such by a subject. The subject cannot be eliminated: Indeed, the subject is at the very heart of what a Gestalt is.

The reason objects and events of the world appear holistic is that living observers perceive them in Gestalts, and mentally attribute unity to them. But outside the purview of any observer, there is nothing to join the parts of an object together or designate its boundaries. The atoms of a teacup do not collude together to form a teacup: The object is a teacup because it is constituted that way *from a perspective outside of itself.* It is similar when you look at a photograph. The pixels in a photograph do not conspire among themselves to portray your grandmother: The portrait exists when the whole image is seen from an external perspective by a Gestalt viewer. Ultimately, that is the essence of a Gestalt: It is a whole, unified single entity when viewed in its entirety from an outside perspective.

That is why the essential idea of what *Gestalt* means is hard for most of us to fully grasp. Commonsense leads us to assume that any group of objects that catches our eye is a Gestalt. In a way it is, because once it catches your eye, the group is perceived as a whole and is a Gestalt in mind. But as you may recall, we are all deceived by *distal attribution*: We project everything we see onto the external world and have the experience of seeing it out there, where we believe it belongs. In the same way, the group of objects that catches your eye is seen as a Gestalt ... but it is seen as a Gestalt "out there". Its *unity*, its cohesion as a group, are projected by you onto the environment. That is the reason you are so certain that objects you *see* grouped together *really are* grouped together.

But that's not all: Objects and sundry pieces of matter are scattered all around us. That's because the physical world is a multiplicity and its shards are distributed throughout space. When we try to imagine the universe, what appears in our mind's eye is ourselves looking out upon it. We imagine ourselves perched somewhere in space, seeing planets, meteors, comets and all the rest. We may not explicitly see ourselves in that picture, but we're present, we're the silent observer. It's in our nature to imagine all things as they would appear in our perspective. We therefore believe things are grouped in the universe just as they're grouped in our eyes.

Most importantly, from an impersonal viewpoint, sets of objects are deeply embedded in their background. The human visual system must work very hard to extricate the exact group that's of interest to us. The group of interest then comes into existence as a result of the effort we have devoted to extrude it from a background in which it is buried. The Gestalt group comes into existence because we have created the information necessary to define its boundaries. In all cases, specific information is needed to carve out a given group and individuate it. Gestalts don't come for free.

Immanuel Kant, Philosopher of Gestalt

The Eighteenth Century philosopher Immanuel Kant was the first thoroughly modern European thinker. His ideas about the human mind anticipated much of contemporary psychology: Indeed, most of the founding ideas of cognitive science are prefigured in Kant's writings. It is only his vocabulary that is outdated today and sounds strange to our ears.[11]

The process of mentally uniting many objects together into one global experience, he called *transcendental apperception*. Thus, transcendental apperception refers to the act of forming Gestalts. Kant had the original insight to recognize that a Gestalt is not merely a group of objects, but something entirely new and original. For example, the Big Dipper is not just a group of seven points, but is a pattern, in which the points play a supporting role. We can almost imagine the disembodied pattern without the points. He called a mental unity *synthetic* when it consists of being aware of a number of different things as one.

There is one more element in Kant's conception of Gestalts: In order to tie things together there must be a single common subject, or self, and her or his awareness must be unified. Kant had the insight to recognize that the self, or center, to which we attribute the experience of seeing and knowing, is itself a mental construction—something like distal attribution. (In the present case, proximal attribution.)

Kant believed that sensory experiences form hierarchies, so that out of a multiplicity of distinct experiences we can form a single global experience in which each constituent retains its individual existence. The fundamental nature of a Gestalt, for him, was that it is a hierarchy of perceived things all experienced simultaneously as parts of one act of awareness. It is a most remarkable fact, as Kant observed, that it is possible to be fully aware of a number of items *at the same time*. It is this capacity which singles out the minds of living creatures as something truly distinctive in the world, almost outside the ordinary range of nature as we know it.

Kant's most radical and genuinely modern idea is expressed in what he himself called his *Copernican Revolution*. The empiricists, who preceded Kant historically, asserted that it is not possible to have any knowledge unless it is received through the senses—because the alternative would be that we are born with pre-existing knowledge of the world. Kant's insight was that raw sense data supplied by our sense organs is unorganized and chaotic, and would be meaningless to us if we didn't already possess a synthesizing and organizing faculty in our brains.

We are born with what he calls *categories of the understanding*. For example, the categories of space and time frame all our physical experience and make it intelligible. Out of our sensory experience, interpreted and organized by the categories, we come to understand the world in a certain way. Behind our sensory experience—and causing it—are physical phenomena of the real world. But this world, the *world as it is*, is inaccessible to us and cannot be known directly.

Language too requires the synthetic faculty of the mind to assemble words into coherent sentences and thoughts. Here Kant appears to be making the assertion that—as stated previously—the mind has a way of building Gestalt concepts from sentences. Reading the work of Kant, one is surprised again and again at the number of sophisticated modern ideas he anticipated. The work of great thinkers, such as Kant, Darwin, even Aristotle, are gold mines in which one can profitably dig again and again.

Beyond Kant: Created Worlds of Other Animals

Baron Jakob von Euxkull was a Baltic German biologist of the early Twentieth Century whose foremost interest was to know how living beings perceive their environments. For him, every living creature has an *umwelt*, or subjective world, through which it experiences its surroundings in Gestalts. Through the window of its *umwelt* every animal knows the world in its species-specific way, and feels itself as a living participant in the niche which is its world. Von Uexkull did not write much, but left a beautiful book describing his researches, with the title "*A Stroll Through the Worlds of Animals and Men: A Picture Book of Invisible Worlds*". We'll see shortly why the worlds are invisible.

For von Uexkull, the essential nature of an animal is not so much that it is a biological structure, but that it is a living subject interacting with its environment and deeply integrated in it. The life of every creature is an active engagement with the objects and beings which surround it. Every animal, even the smallest and simplest, is in possession of a world-model which includes all the objects which are significant for it, as well as the ways of engaging with them. For the small marine animals which von Uexkull studied, these objects include stones, shells as well as other creatures which might be predators, prey or neighbors.

In von Uexkull's terms, for every object it engages with, an animal has a Gestalt *perception image*, and with every object it acts on it has an *effect image*. "These images are acts of animals that are projected onto environments, which confer meaning upon perception images only via the effect image." That is, the way an animal represents an object is shaped pragmatically by the way it uses the object. Every object which is significant in an animal's life is mentally projected outward onto its habitat: There, it becomes real for the animal, and acquires exactly the shape and features which it has in the mental representation.

All creatures are sensitive to covariances and constellations of events, as well as recurring patterns. These only become salient if a creature has Gestalt perception. No matter how simple the animal, the configurations which are meaningful to it, and to which it responds, are Gestalts. To perceive useful structure and regularity in nature, recognition of Gestalt wholes is indispensable.

Every creature—as one aspect of its world-model—has its own concept of space, determined by the style of its bodily movements and the kind of environment it moves in. An animal perceives space as a Gestalt which frames its daily round of activities. Moreover, von Uexkull says his research has shown that every species has its own notion of time, which is felt differently by different creatures. All animals live according to a *Circadian rhythm*, which is a 24-h cycle of physical, mental and behavioral fluctuations. Because they possess memory, creatures have a Gestalt representation of different stretches of personal history of varying durations. These representations are necessary to situate and orient them. No living creature exists in the pure present—only machines do.

An animal's perception signs, projected onto the objects around it, become repositories of meaning. An animal's *umwelt* is not filled with inert objects, but is teeming with the most varied carriers of meaning. The animal's world is "magical", because things which don't stand out objectively in an environment—and are invisible to us—each has a meaningful existence in the world experienced by the animal. In this way, we might say that an animal's world is thronged with magical objects and beings, seen by it alone.

Centrally Controlled Organisms

Up to this point we have been discussing the role of Gestalt in the way we *perceive* the world: But Gestalt is just as important in the way we plan and carry out actions. If a living organism is capable of voluntary movement, it must have a sense of its body as a whole, and a comprehensive awareness of the articulation of its body and the effect that its movements have on itself and its surroundings. Just as vision would provide no useful information if it failed to deliver a view of a whole object or background, similarly no action is possible unless an organism has a comprehensive sense of how all its limbs are moving in relation to its whole body and the environment.

Evidence is rapidly accumulating that at every level of animate life, the behavior of organisms is controlled by a detailed mental map of their body and especially its articulations. Such a map is, of course, a Gestalt, for the whole musculature of the body is tightly interconnected, and has to be coordinated and controlled as one unit. This Gestalt informs the organism of the state of its limbs and provides the know-how for controlling every voluntary muscle with its will. The function of this inner map is to tie the whole organism together so it behaves as a single unit.

In traditional biology it is assumed that the behavior of the simplest forms of life such as one-celled animals is rigid and invariant, and consist of autonomic reflex mechanisms. It will be explained later that this belief is in the process of changing. Be that as it may, with the advent of multi-cellular organisms, evolution invented a new form of life: It consists of living creatures whose behavior is controlled by a central decision-making module. This evolutionary innovation is closely connected with the emergence of nervous systems in animals, and is the primary reason that nervous systems evolved.

In complex creatures such as ourselves, both autonomous and central control systems are to be found. We have autonomic functions which include control of respiration, cardiac regulation, and homeostasis. Each control mechanism has a specified function and is dedicated to the care of one bodily organ or system: Its "loyalty" is to the preservation of that one system.

In contrast, a central control system is dedicated to the welfare and preservation of the organism as a whole—as a unified single being. It identifies itself with the physical entity consisting of a whole body with its limbs and articulation. Central control is made possible owing to the existence of a mental model of all the articulated parts of the animal, perceived simultaneously. As a result of this, the limbs can be made to move in a coordinated fashion under the guidance of integrated plans.

Indeed, you may have noticed that the behavior of even the smallest and simplest creature appears to have singleness of purpose. Moreover, the articulation of its entire body—its torso and all its jointed appendages—move in an absolutely coordinated fashion to carry out its purpose. It suffices to look at a spider maneuvering in its web to pull in a fly. The example of the spider is a prototype of what a centrally controlled creature is. Even if a creature does not have what we call a mind, it identifies itself with its body as an articulated whole, and its activity appears to be guided by a global (often unconscious) plan.

The bedrock foundation of every centrally controlled organism is a primordial Gestalt image, or schema, of its entire body, present to it simultaneously. Every motion the animal makes is referred to this Gestalt schema, in which its body is revealed to it as a connected and indivisible whole. The schema, of course, is not visual, but rather, it is visceral: The animal *feels* every jointed part of its body and the motions it can undergo. It feels itself to be *one* and undivided.

If it were not for a whole-body Gestalt, an animate creature could never be operationally a single entity. In the history of life, the internal body image of animals must have evolved in tandem with the nervous system, for the nervous system could not carry out its intended functions if a comprehensive Gestalt of the body weren't available to it.

In a book entitled *Motor Cognition*, the physiologist Marc Jeannerod describes the formation of action plans in the brain. He has found that complex creatures have motor imagery and motor representations which are the foundation of all action. Before an action is executed, a precise delineation of the whole sequence of body movements is present in one mental picture, so the entire motion is prefigured in mind. In fact, when animals observe others in an activity, the same motor Gestalt is activated as if they were carrying out the actions themselves. Scientists attribute this to a process called the *mirror neuron system.*

According to Jeannerod, in order to achieve central control, animals must have an inner sense of self. What he calls the *primordial self* is precisely a creature's Gestalt inner model of the body and its articulation present simultaneously, as if in one glance. In order to function as an undivided single entity, an animal must be fully identified with its body Gestalt, that is, with the multiplicity of its articulated parts drawn into one unified inner representation.

The identification with the body is attributed by the animal to a single locus in the mind. The single locus, which we regard as the center of our self, is a benign hoax designed to fuse the whole of our self-Gestalt into a single imaginary focal point. When we use the first-person pronoun "I", it is this imaginary focal point we are referring to.

Possession of a self-Gestalt is plausibly the earliest form of awareness, out of which consciousness emerged. In its three billion year history, the evolution of life exploited every physical mechanism that could contribute to the construction of organisms. One of those mechanisms made Gestalt perception possible. Evolution did not have to wait for scientists to discover the relevant phenomena, else it would still be waiting.

4

The Animal Sensorium

Feeling-Matter

If we're alive, awake and aware, then something is going on in our brain which produces in us the sensation of being present and engaged with the world. Our sensations are usually fairly specific, and seem to bring us information about conditions in our immediate environment or in our bodies. The information they bring us is not couched in any language, but is made known to us directly. Spontaneously and without instruction, an infant or small animal knows that a certain feeling is a pain in its toe, another is a feeling of heat or cold, another is a sensation of the color red in a red object.

That is the first mystery of sensation: What we sense and feel is a form of communication in which our sense organs dispatch messages that are meant to be understood. These messages are very precise and specific, and express facts such as that there's damage to my right little toe, or the object I'm looking at is red. The messages do not need to be decoded or interpreted, for the information they bring is understood directly, without mediation. Understood by whom or what? Communication of any kind consists of information from a sender to a receiver. So who, or what, is the intended receiver of these messages?

Thinking persons from earliest times have pondered this question, and recognized that there is a kind of divide between the body and something we call the mind, which is the intended recipient of sensory messages. This fact was discussed and written about long before Descartes made it into the centerpiece of his philosophy. The central idea is that the mind and body are in constant communication, and seem to be two parties involved in a dialogue. The simplified story is that sense data are transmitted from the body to the mind, and action plans, decided in the mind, are sent to the body.

C. Pinter, *Mind and the Cosmic Order*,
https://doi.org/10.1007/978-3-030-50083-2_4

Actually, of course, the situation is far more complex. Every organ of the body is designed to carry out a specific function: A heart is a pump, lungs are designed for gas exchange, kidneys are made to filter impurities. Every organ has its autonomy in the sense that centrally it must carry out its intended task according to its own design principle—while peripherally it communicates and coordinates with other organs. The core task of the brain is to integrate the activity of all the organs so that out of the myriad interweaving processes there emerges a unitary organism with a unified single purpose. The perceived separation between body and mind is a natural and inevitable concomitant of any system's division into functional parts with a central coordinating hub.

When the process of evolution gave rise to sentient creatures, it became necessary for such organisms to have a way of internally registering information. Like so many astonishing and unaccountable solutions found by nature, the resolution in this case was to endow organisms with an internal sensibility and reactivity that we refer to as sensation. You and I believe we know what sensation is, because it is the most salient fact of our existence. As Descartes asserted, even if we know nothing else, we know our sensations.

However, from an external perspective it is categorically impossible to explain what sensation is or how it acts. Sensory feelings can be known only "from the inside". Nothing in the material world can give us any clue to what they are. Ask yourself: What kind of entity—in the context of the universe—is a *feeling?*

Sensations, beliefs, imaginings and feelings are often referred to as *figments*, that is, creations of the mind. A mental image is taken to be something less than real: For one thing, it has no material substance and is impossible to detect except in the mind of the perceiver. It is true that sensations are caused by electrochemical events in a brain, but when experienced by a living mind, sensations are decisively different in kind from electrons in motion. They are indeed "figments" because they exist nowhere except in awareness. As a matter of fact, they exist only as *claims* made by sentient beings, with no material evidence to back up those claims. Indeed, brain scans reveal electrical activity, but do not display sensations or inner experience.

An animal's *Sensorium* is the repository of all its sensations and sensory experience. The Sensorium does not correspond to a specific area of the brain, but is a widely distributed collection of innate sensibilities and capacities. One of the central tasks of the brain is to code all sensory input so it gives rise in the organism to specific impressions and sensations. Everything that comes into the field of our awareness, every shading and nuance of feeling, is coded so as to have its unique, highly specific effect on consciousness. The quest to understand the neural code is one of the most intense areas of research in both experimental and theoretical neuroscience.[1]

A question of great interest in neuroscience is whether there is a fundamental neural grammar, perhaps universal across all species. One might ask whether nature would have written the code twice, and created different versions of the experienced quality of feelings for different kinds of animals. Given the prodigious complexity of the animal Sensorium, it is very unlikely that evolution would have produced different currencies of sensation. We are led to conclude that almost certainly, animals feel pain, joy and sadness just as we do, and experience sounds and shapes as we do. For example, an angry fruit fly (they are easily driven to anger) is probably angry in the same way you are.

The human Sensorium is like the surface of a pond, with no limit to how intricately varied this surface may become when moved by a transient breeze. Gentle thrusts from our sense organs are continually shaping and molding the surface, which trembles and shimmers in myriad contours and shapes. When our eyes fall on an orchid, for example, the surface of our Sensorium ripples with the sensation of the triply curving petals and the cunning distribution of pinks, reds and yellows. When a bird song reaches your ear, it sends little surges curling and cresting on the surface, and those surges and ripples on your Sensorium constitute the experience of hearing the various notes.

Many people maintain that an experience is something physical in the brain. Obviously, at a superficial level that is true, because our brain produces the modulations of the nervous signals which are the code that produces our experiences. But by no means can you claim that those modulations *are* your experiences, because if the same modulations were applied to the power cord for your kitchen stove, your stove would not thereby experience feelings. There is a clear physical component of what we feel: Nerve fibers send modulated signals to different parts of the brain, and those signals are *coded* so they give rise to the different feelings.

As an important example, there are cells in the body called nociceptors which, when activated, send specialized signals to the brain which are *coded as pain.* The signals travel along nerve fibers called C-fibers and "notify" the brain that the body area from which they originate has been damaged. It is the specific way these signals are coded that cause us to feel pain. If the same signals were coded differently, we would have a different sensation. This simple fact makes it amply clear that the physical brain is something quite other than the feeling and experiencing mind.

The brain sends coded information, and somehow (nobody knows how) it reaches the mind (nobody knows what mind is) and instills a certain subjective feeling (nobody knows what feeling is though we're all familiar with it.) The nerve signal is chemical and electrical energy present on a physical conductor. In any college laboratory we can measure such a signal and reproduce it artificially. The feeling the signal gives rise to in a mind—*qua* feeling—is something nonmaterial which no laboratory on earth can measure, approximate, reproduce, or explain. Feelings are not physical—period!—and the often-heard claim that sentience = electrical activity in brains is not plausible.

What is true for pain is true for all sense-data. When you look at a ripe tomato you see its color as bright red: What that means is that complex nerve signals are generated when the tomato image is processed by the brain, and these signals are coded in such a way that they give rise in your mind to the subjective experience of red. At the same time, you are given the experience of the tomato's smooth surface and roundness. All this is given by your brain in visual code, which consists of fluctuations of electro-chemical energy in nerve fibers.

Between the electrical activity on the brain's cortex and the vivid experience of a ripe tomato, there is a huge divide. The enterprise of explaining it is often referred to (perhaps facetiously) as the "hard problem" of consciousness. I say "facetiously" because this problem is not merely hard—we are so very far from knowing anything at all about consciousness and how it arises from nervous activity, that our understanding of conscious awareness is at the same stage as physics was in the stone ages.

The Sensorium holds the key not only to the kind of feeling we register from our body and sense of touch, but brings to us all the experience we get through our senses. It delivers to us the specific quality of every sound we hear, and makes it possible for us to see our surroundings as composed of definite shapes, each of which has a specific aspect or character with which we relate experientially.

Structure of the Sensorium

Our sensations are messages from our body: Every sensation tells us something, and it is usually something explicit. A feeling of pain is not merely distressing, it is also specific—for example it tells me I stubbed my left little toe. A stain I notice is red, the very color of the strawberries I have been eating. Our sensations are a way that information is presented to us, but unlike information given to us in words, messages from our senses do not need to be decoded, for they impact us directly: Nothing intervenes between a sensation and what it means to us.

The meaning of a sensation is something primary and biologically given. There is no need to interpret the feelings of hunger and thirst, for example. The meaning of a sensation is embedded in the sensation itself. It may be said that a sensation *is* its meaning. Primary feelings are genetically given, and constructed in the course of gestation just as organs are. They are "standard equipment" in every animal body.

Thus, an organism comes into the world with a cluster of sensations and feelings that it recognizes because each sensation is bound up with a meaning. For an infant of any species, the first meanings are those associated with its primary feelings. Hunger and thirst, the sense of hot and cold, touch, proprioception (feeling-knowledge of the parts of one's own body)—all directly carry meaning. The senses of hearing and vision develop gradually, because they require calibration during the first days or weeks of life. As they mature, the information they carry is especially rich in meaning, and brings critical knowledge about the external world.

The innermost core of the Sensorium reports the state of our own body. We are born *knowing our bodies*: That is, we know by feeling what body parts we have and how to command the motion of every individual joint and articulation. Human infants may require several weeks or months to calibrate the feeling of their body parts and how to control them—but many animals are able to control aspects of body motion from the moment of birth. Using their proprioceptive sense, organisms are likewise aware at all times of the way their body parts and limbs are configured in space. Such body-feeling is a critical—in fact indispensable—aspect of the feeling of being a *self.* Indeed, the core self consists of the permanent background awareness of all our body parts and the possible ways we can move them.

Most animals are alert to ambient sounds, and much of their knowledge of events around them comes from their sense of hearing. As humans, we are extremely sensitive to varied aspects of the sounds we hear: Their pitch, tone color, timbre and so on. A three-month-old infant is capable of distinguishing, for example, the sound of a doorbell, a particular musical toy, a tune played on a piano, a familiar voice. An adult has the power to differentiate between tens of thousands of different sounds and to recall and identify a great many of them.

There is very little correlation between the quality of sounds as we hear them and their physical properties as acoustic waves. Arthur Koestler, in his book *Ghost in the Machine* explains at length how a great deal of what we hear is simply absent in the physical sounds. The vast panorama of different sounds as we hear them is a creation of biology, and does not coordinate with their well-defined physical characteristics. Our power to discriminate all the sounds we hear, and the subjective way they *sound to us*, are biological constructs. The broad sweep of different sounds that we discern, each with its own sensed quality, is a basic component of our Sensorium.

Humans and other primates are, above all, visual creatures. The sense of sight is primary for us, and it is largely through vision that we conceive the world. When you think of objects such as a tree, a carrot, a house, a chair, or even an atom, it is in terms of its visual appearance that you conceive it. Meanings are especially vivid when presented to us visually. When we understand something, we often say "*I see*". The very word *idea* comes from a Greek root for seeing. (So does our word *theorem*, because a theorem is something you must see in your mind in order to understand.)

As discussed in Chapter 1, what we have the experience of seeing is not the optical array projected on our retina. (It's a good thing, too, because the projected image on the retina is distorted and constantly jiggling and moving.) The optical image (such as it is) goes no further than the eye. After that, it is taken apart, and different abstract features of the image (form, color, movement, depth) are analyzed in different brain areas. Aspects of the image go through a great many way stations in the brain, and at the end of this process a visual representation is induced in consciousness. This representation is *presented to the mind* in the visual idiom which evolution has fashioned for living creatures.

The visual image would be incomprehensible to us if it weren't especially coded in a way that we are innately prepared to understand. Most importantly, the visual array is presented to the mind in terms of *shapes*. As already noted, the external universe does not come pre-segmented into detached individual objects: Rather, the mind divides the world into objects to make it intelligible. Likewise, shapes are the mind's way of grasping individual material things and giving each an identity. Shapes, just like colors, "look like something" to us: They have an appearance, a quality with which they appear, or present themselves unto the soul, just as a note of a musical instrument does.

In order to understand that shapes are what objects *look like to us*—and are not something that exists independently in the physical world—is extremely difficult: The reason is that half-consciously, and by lifelong habit, we are fully committed realists, and it is almost impossible to pry away from us the conviction that if we see something, it's because exactly that thing—with its appearance and coloring just as we see it—is what is there. We are compelled by nature to believe that the way objects look to us is *what they actually look like*. However, outside of us objects don't look like anything because *to look like* is mental, not physical.

We do *not* recognize shapes on the basis of carefully articulated descriptions, but spontaneously as unified Gestalts. It would be possible, hypothetically, for beings of another planet to get to know the 3-dimensional forms of objects by making quick, line-of-sight measurements. But animals on this planet don't do that: The scheme of possible shapes is a set of biologically-based categories distinguished from each other in biologically simple ways. For living creatures on earth, shapes are not measured but *felt*.

Just as the Sensorium contains our underlying sensations, it also contains the feeling of our volitional strivings. We *feel* the wish to move an arm, and this feeling is associated with the know-how to command our motor centers to make it happen. Just as a sensation is associated with a meaning in the brain, a volitional decision is associated in the brain with the power to make it happen. Under normal circumstances, one does not consciously plan an action: One wills it, and the motor cortex programs and launches a train of muscular contractions. We experience our volitions wordlessly, just as we experience sensations.

Volition and sensation are closely intertwined. For example, when you have the sensation of hunger, you simultaneously want to eat. When sensing an itch you feel the wish to scratch, and the two feelings are almost the same. To initiate an action, we first experience a feel of the action in our limbs, and it is out of this feeling that the action is shaped. Every action we perform (such as raising an arm) is preceded by the anticipated feeling of what it will be like. The feeling shadows the action and sculpts it.[2]

From neuroscience we know that some primal images and action programs in animals are not present at birth—but rather, there are innate dispositions to *discover* those things. Such dispositions facilitate the rapid acquisition of this knowledge from experience by guiding and channelling learning in the right direction. Among the most primitive contents of the Sensorium are inceptive images waiting to be elaborated, as well as the sensory aspect of simple movement programs, ready to be fleshed out under the guidance of early experience.

The Sensory Basis of Knowledge

When nervous systems evolved and gave rise to sentient creatures, it became necessary to convey information to the sentient brain. If there were no way of getting information to the sentient faculty, the brain would be locked into itself and become a vestigial organ. Thus, the mechanism of evolutionary development had to solve Descarte's conundrum: There had to be an information channel between the world and the brain, going in both directions. This channel had to evolve in tandem with the senses, for the senses would serve no purpose if the information they captured had no way of being received and "understood" by the brain.

The evolution of internal communication systems within living organisms is perhaps the most fascinating chapter of evolutionary biology. The physiological mechanisms of communication in the nervous system are electrochemical, but these physiological processes are doubled by sensory processes in the mind. Modern science is unable to explain how electrical activity in a brain gives rise to sensations. However, incoming sensory information is registered in the mind in the language of feeling. Information in the mind—as opposed to the brain—is in the medium of sensation.

A living creature is not aware of neural events in the brain, but is aware only of the sensory events which they cause. Sensation is the medium in which all conscious activity unfolds. Sensation is nonmaterial, though produced by material means. Although it is nonmaterial, sensation is like a soft clay that can be sculpted in the myriad forms of feelings, wishes, thoughts and ideas. You may think of sensation as *feeling-matter*, because everything mental is fashioned out of it.

The signaling system between the environment and the conscious brain is based on sensation: *No message can find its way into the animal mind unless the message is sensory*, for evolution has devised this one and only medium to carry information into awareness. This fact is hugely important, and when understood clearly, it dispels a great many common misconception about the mind.

The expression "mental contents" refers to all things that may be present in awareness, such as percepts, feelings, ideas, thoughts, beliefs and so on. Until recently, it was generally accepted that mental contents are of two different kinds: Some are sensory, while others are analytic, or as they're usually called, *propositional*. A sensory content is something you experience by feeling—for example a pain, the color red, or the shape of a flower vase. In contrast, a propositional content is a factual claim such as "Paris is the capital of France". It can be precisely expressed in words, and that is the reason it is called propositional. It is stored in mind as a gestalt, but is so structured that it is easily transformed into a series of words.

In our time, linguists and philosophers no longer believe there is a hard-and-fast dichotomy between sensory and propositional contents of mind. In fact, everything that can be "known" by a mind has to be sensory. The only way an event can register in your awareness is if it is a sensation and is felt in your mind. It must be "visible" to the mind, and must make it into awareness. Sensation is the medium in which all information reaches awareness.

All mental content, not just sensory feelings, but ideas and thoughts as well, are grounded in sensation. A specific thought is more complex than a simple sensation such as a sound or a pain, but nonetheless it has sensory content. *Otherwise you would never be aware of it,* nor ever register it in consciousness. This is the rationale for the claim that structured thoughts and ideas, no less than sensory feelings, are constructed out of sensation—that is, made of sensory "stuff". Everything you're conscious of is constituted of sensation, because sensation was invented by nature for the specific purpose of conveying information to the mind. If we're aware of something, that something is a sensation.

The Sensory Basis of Meaning

Cognitive psychologists are increasingly advocating the position that meaning is rooted in visceral feeling. The central idea behind this thinking is that elementary sensations are combinable together to form structured sensory feelings. For example, we experience not only colors and shapes, but also things like a ripe tomato, or a flag with vertical red, white, blue stripes. Such a sensation is not merely a structured experience cobbled together out of separate component parts: It is a new Gestalt in which each part plays a subtle contributing role. Just as words can be strung together creatively to yield a new meaning, the brain joins elementary sensations together inventively to create subtle forms of intelligible experience.

Many cognitive scientists argue that sensations underlie all our thoughts and form the ground on which thoughts are built. What they mean is that for any thought, there is a particular structured sensation corresponding to it, and when we experience that sensation we are having the thought. To have a thought is to *experience its meaning*, and the claim is that the meaning is embodied in the corresponding sensation.[3]

This is currently a very active area of research in neuropsychology, with many groups and laboratories contributing to it. It has received different names from different circles of investigators: In recent years it has been called *sensuous cognition*, or sometimes *cognitive phenomenology*, and is descended from a slightly older trend of thought known as *cognitive linguistics*. The essence of what this research has uncovered is the following:

Every thought corresponds to a particular way of feeling the thought, and the way you retrieve a thought instantly, is by *feeling* it. The brain does not have a filing system in which thoughts are indexed by subject, and you do not recover a thought by a systematic search through mental files. Rather, every thought has the form of a precisely articulated feeling, and searching for a thought consists of seeking contact with the feeling. So long as that sensation persists in awareness, you continue to be aware of the thought. When you're searching for a particular idea in memory, you *feel* what it is you're searching for, and with the feeling to guide your inner process, the brain leads you straight to it.

This belief is not as radical as it may appear to be: All it claims is that sensation comes in many varieties. We have the sense of touch, we experience sounds—for instance when we listen to music—in a particular way; vision too is one of the senses, for what we see comes to us through a sensory channel. Like these, thoughts too are sculpted out of the matter of sensation.

Ultimately, then, all meaning is rooted in the Sensorium—for it is the Sensorium that holds the sensitive matter felt by every living body. Every thought and mental content has a way that it feels to us. The meaning of the thought—that is, the way we understand the thought—is a mental structure constructed out of feeling-matter. A conscious thought is the thought that it is, in virtue of the distinctive way it feels to us. This is no longer a speculative idea but is upheld by supporting evidence from experimental research in psycholinguistics, cognitive psychology, and developmental studies of children.[4]

The movement toward recognizing that mental life is built on a foundation of bodily feeling has been recognized for over three decades. Building on the observations discussed in the previous paragraphs, the discipline known as cognitive linguistics aims to show exactly how meaning is built out of elementary sensations. It appears that a great deal of what we think and say draws its meaningfulness from structured feeling-images which develop early in life.

The psychologist Jean Mandler has shown that infants learn very fast in their first weeks. Mandler's experiments and observations have shown that childrens' early cognitive abilities are far more sophisticated than formerly believed. Right at the beginning, she has found, human infants generalize about what they have observed, and "theorize" about it. According to Mandler, a mechanism of *perceptual meaning analysis* operates in infants: This mechanism extracts the essential aspects of events and organizes them as structured experiences. These structured experiences are called *image-schemas*, or sometimes *feeling-images*.

When a baby begins carrying out volitional actions—for example playing with toys—the action sequences it carries out are associated with the goals they aim to achieve. These associations coalesce into formal schemas which record the structure of simple events in the child's experience. Such schemas, once formed, serve to give meaning to similar events in the future.

Children are not born with specific knowledge, but with propensities to interpret early experience in certain ways rather than others. It is known, based on empirical research, that infants form feeling-images which organize the understanding drawn from their experience. Feeling-images are built out of primary material from the infant's Sensorium, for the purpose of giving structured meaning to the child's experience.

For example, while handling objects, children become acquainted with the physical sensation of *force:* In order to move objects, *exertion* is required, and this exertion is not random but tied to the direction in which the object is moved, as well as the *resistance* encountered. Such a feeling-image takes root in the infant's psyche and matures over the years. Feeling-images are not visual, but are structures of feeling formed of muscular sensations recollected from experience and buttressed by schematic visual images. The feeling-image of force and resistance is the scaffolding on which later concepts are formed.

Infants observe their surroundings closely, and pick up on repetitive phenomena. As an example, it is clearly evident that liquids behave very differently from solids, and young children notice that water flows—that is, moves in a very distinctive and eye-catching way. A feeling-image of *flow* is quickly established, and remains in place for life. The philosopher Mark Johnson has said that "the idea of flow, as in water flowing through a pipe, is used to understand electric currents, the conduction of heat in a medium, and the same image has a productive role in vector calculus". Similarly, the feeling-image of force underlies the ideas of effort, coercion and resistance, and is the root of the scientific notion of force vectors, represented in physics by arrows having direction and magnitude.

You may have noticed that what is happening in each of these examples is that the meaning dwelling in a feeling-image is extended metaphorically to new situations which have the same structure. The elementary schema of liquid flow provides a large number of common expressions with their meaning, which is immediately understood on account of its congruity with the elementary image of a flowing liquid. There is no confusion when one speaks of the *flow of traffic*, the *flow of time*, or the *flow of goods* in commerce.

Linguists have shown that metaphor is a very powerful means of extending the meanings which dwell in feeling-images. Meaning arises when sentences activate composite feeling-images in mind. This happens unconsciously, and so rapidly that we're not aware of it. The way this works has been studied in detail over the past couple of decades by cognitive scientists, and a vast literature is devoted to it.

One more example of an image schema, which has been thoroughly studied, is the *container* schema. Infants gain experience of containers—such as bottles, cups and boxes—from their earliest days. Structurally, a container has an inside, an outside and a boundary. It instantiates the ideas of *in* and *out*, which play roles in almost every situation we encounter: We move *in* and *out* of rooms, get ourselves *into* our clothes, place things *in drawers*, draw water *out of* a well. We may get ourselves *into* difficult situations. The container may have physical boundaries which are hard to pass through: A person might be *in* prison, or metaphorically, stuck in a situation from which he cannot escape.

Like elementary sensations such as pain or hunger—which point directly to objective things, and are constituted by their own meaning—feeling-images point to external things which they elucidate and to which they impart meaning. That is their purpose: For example you don't *explain* the 'container' notion—you feel it, and know it as part of your primary consciousness of how the world is. The feeling-image itself is the court of last appeal, and there is no deeper source of meaning. If you need to articulate a thought verbally, you draw on the way you experience it inwardly, and turn that feeling-image into words.

In conclusion, all original meaning comes out of the rich and varied array of sensations that we and all animals are born with. Under the guidance of experience together with an underlying unifying process, sensations are fused together to yield Gestalt image-schemas which have complex meaning. Original meaning comes from the primary Sensorium, but as sensations are joined in multiple combinations, their meanings are brought together into compound units which have derived meaning. Just as plants draw nourishment from the soil through their roots, all thoughts draw their content ultimately from the Sensorium.

The Grand Design

The most fundamental characteristic of the activity of living things is that it is purposeful: It is carried out in pursuit of goals. An animal's every act is shaped by the objective purpose of the act. If creatures did not have goals then no action would be possible: Indeed, without a purpose *there would be no such thing as activity at all*, because activity would then be nothing but aimless random movement.

Thus every living organism has goals which define and determine its behavior. Living creatures on this planet all have similar goals, which are directed toward their survival and procreation. Clearly these goals are built into the very design of their bodies and nervous systems.

The philosopher Daniel Dennett says that any active system—either living or robotic—is designed to have what he calls *intentionality:* By this he means that it has well-defined goals, and moreover, it acts rationally in pursuit of its goals. The intentionality is built into such a system from the start, and is immediately noticeable if you observe its activity. The behavior of a purposefully behaving system is fully comprehensible if you attribute intentionality to it—and when you do that, you are adopting what he calls the *intentional stance* toward it.[5]

Dennett distinguishes between *original* and *derived* intentionality, and presents the following example: The RNA enzyme has the very specific function of proof-reading and correcting amino acid sequences, but the enzyme has absolutely no inkling of what it's doing or why. It is acting in pursuance of a definite goal, but the intentionality is not its own: It is acquired from the intentionality of nature.

The same logic can be extended to animals such as ourselves. We are driven by our genes to hunt or farm, to court and have sex, to clothe ourselves in winter. Is this truly our own intentionality at work? Or is it possible that the evolutionary process is the original source of *our* intentionality. If that is the case, then perhaps we are mere instruments of an impersonal natural process, and everything we do—including having thoughts and creating new ideas—comes from an external source, and we have no authorship over any of it.

Clearly evolution designed animals to have wants and needs, together with *arousal*, which is the zeal to pursue their goals. (Without arousal they might *have* goals but no inclination to pursue them.) Animals are not consciously aware what their ultimate goals are: They are aware only of a strong drive to do certain things (eat, have sex) which—it so happens—lead to the attainment of nature's goals. Nature's way of insuring that organisms actively work to achieve biological imperatives is to build into the animal Sensorium the will to carry out certain activities—activities designed precisely to achieve these goals. But as human animals, we're aware only of the desire to eat and drink, mate, be safe, be free of pain. It might be argued that we are pawns of a vast system that manipulates us to carry out its grand design.

Daniel Dennett is very convinced that original intentionality dwells in the mechanism of evolution and not in individual people or animals. We feel ourselves to be free agents, but in fact we are ingeniously misled to carry out the commands of nature. To achieve this, nature acts through the animal Sensorium, which makes us *want* to do everything necessary for the survival of the species. It uses both a carrot and a stick: We are driven to act by our wants and needs, and if not successful, we are punished with pain and distress. The animal Sensorium is an instrument of Nature for prodding individuals to follow a certain path.

The American naturalist E.O. Wilson, known as the "father of sociobiology", showed that in natural selection there is a spectrum of reproductive strategies, which trade off between quantity and quality of offspring. At one end of the spectrum, a species may follow an *r-selected* strategy, in which each individual produces a very large number of offspring, and does not care for them. At the other end is the *K-selected* strategy in which individuals have few offspring but invest lots of time and energy in their nurture and protection. Humans are at the extreme end of the K-type in our reproductive strategy.[5]

In K-selected species, the male usually commits for life to a female and helps provide for their young. Moreover, the female dedicates a considerable time—often years—to preparing the young for life on their own. How does nature induce animals to make so huge a sacrifice? It is by programming the Sensorium: At the appropriate times of life, male and female individuals are drawn together by the feeling of love. Moreover, the female is induced to care for her offspring by motherly feelings that endure over the years.

Throughout the animal kingdom, males and females are brought to reproduce because sexual desire and the sensation of sexual pleasure are built into the Sensorium. Man and other animals are drawn to build shelters in order to protect themselves—and above all their young—from the vicissitudes of the elements. In social animals, other feelings evolve such as generosity, pity and empathy.

According to the dominant version of Darwinism, evolution is a process that acts on species. It promotes the kind of behavior that is most beneficial to the population at large. In particular, it leads to an optimal balance between competition and cooperation. If competition were too fierce, the species would not survive—and the same is true if individuals were overly altruistic. The animal Sensorium carries out a task which can be likened to homeostasis. It keeps the behavior of individuals within what can be called a normal range.

If the average of the population strayed too far outside that range, our species would crash. But within that range, there is a wide spectrum of individual variation, and it is this variation which yields differences in individual personality, and diversity of cultures. The admissible range is what Aristotle called the *Golden Mean.* To the extent that we have free will, it is possible for every individual to choose their own path and follow a personal destiny. The strictures which we believe society imposes on us—and which the 18th Century philosopher Jean-Jacques Rousseau claimed was a *social contract*—are actually dictated by biological and evolutionary imperatives.

The Role of Emotion

The feelings that force themselves upon us with the greatest tenacity are our emotions. Phylogenetically, they are among the oldest and most conserved of feelings: They are found among the most primitive of organisms and have probably remained unchanged across the ages. Emotions are a powerful way of channeling the behavior of animals into those pathways that promote the designs of nature. They play a decisive role in patterning the way of life of every species.

It has long been assumed that emotions serve as an organism's first line of defense: When a threat is discerned, for example, fear instantly sets in. At the same moment, the heart begins racing, the body tenses, adrenaline courses through the bloodstream and the organism is ready for action. The emotions instantly prepare an organism to defend its body or respond to any kind of threat to its vital interests. According to the neuroscientist Antonio Damasio, emotions are an extension of a animal's homeostatic system, the system that maintains the balance and integrity of the body.[6]

From another perspective, however, it may be argued that the purpose of the emotions is to enforce the commands of nature—to maintain an animal's behavior in those paths that will ensure the survival and maintenance of the herd and the species. In other words, one might argue that the emotions are not there only to protect the individual, but also to keep him in line. For example, if a few individuals are too aggressive, they will prosper, but at the cost of fracturing the group. If a few individuals found it expedient to abandon their young at birth, they would survive but the species would not. That is why specific emotions serve to regiment the behavior of individuals. The original *purpose* of emotions, in this perspective, is to regulate the personal and social life of individuals for the benefit of the population.

Emotions and feelings are part of the design of organisms at the most basic level, just as important to it as its bodily organs are. The individual that is not induced—in fact compelled—to eat and drink will not survive. If individuals were not strongly motivated to carry out the complex patterns of behavior involved in mating, then the population would not endure. It is obvious that these activities do not emerge out of nothing, but must be implanted in individuals.

If we were speaking of machines, there would be no problem. Every movement, every tug or pull of a component, is built into the machine from the start. In a motor, the valves open and close with the motion of the piston, and the connected parts operate in synchrony, each one moving when activated. Living organisms could operate in the same way: They might be so designed that when the level of sugar falls, or the level of impurities rises, the organism automatically initiates certain standard patterns of movement to ingest food or discharge waste.

Mysteriously, nature chooses not to operate that way. Instead, the animal is made to **feel** the need to eat, drink and engage in reproductive behavior, and is given the freedom to chose when and how it will carry out the action. We refer to that as *free will.*

The phenomenon of **feeling** is an uncanny mystery of nature: It is as incomprehensible to us as conscious awareness is. We *feel* the wish to do something, and then freely elect to do it in any one of a large number of equally valid ways. Also, we are free to suppress the feeling, and very often we do. The more important a course of behavior is to survival, the more strongly we are made to experience the urge to do it, and the more difficult it is to resist.

An animal's Sensorium is the repository of its sensations, emotions and volitions. It is a necessary instrument of coercion that pushes individuals into carrying out biologically necessary behavior. For us, it is the driver of the human vehicle, forcing us to *act* rather than remain quiescent, to nourish ourselves, attend to our immediate and long-term needs and care for those with whom we share our gene-pool. It imposes its commandments without specifying the details, and it is this latitude that is called free will.

The question of free will is not a moral one but a biological question which plays a crucial role in animate life. Does a one-celled organism have a Sensorium and is it able to act freely? In a later chapter I will cite relevant research by cell biologists which shows that single-celled animals exhibit a great deal of autonomy in their behavior, and have internal states that it would not be too fanciful to call sensations. These internal events direct them to initiate certain action patterns and suppress others. There is strong evidence for the claim that one-celled animals have a simple kind of Sensorium, and their actions are initiated by a form of feeling.[7]

5

The Mind-Made Firmament

Carving up the World

When we open our eyes and observe the world around us, we don't see a smooth, evenly distributed continuum, but a scene that is sharply and unambiguously divided into separate objects. Each of these objects is familiar to us, we know their identities, and we are able to name them.

To the animal mind, the world is subdivided into separate, discrete things. Without a separation into independent parts, nothing would be comprehensible, there could be no understanding, and thought would not be possible. Common sense has us believe that the world really *does* consist of separate objects exactly as we see it, for we suppose that nature comes to us ready-carved. But in fact, the animal visual system does such a thorough job of partitioning the visual array into familiar objects, that it is impossible for us to look at a scene and not perceive it as composed of separate things.

Every species of living creature has its own mental segmentation of the world, that is, its own way of cutting up the perceived world into varied and separate things. Humans, no less than other animals, carve up the world in a certain way into objects, features, categories, natural forces, all of which constitute their reality. The way we divide our environment into objects and other things circumscribes and determines our way of life as well as the way we see reality. Such a segmentation of reality is formed gradually over evolutionary time and is part of every species' genotype.

A *scheme of segmentation* is a way that the world is carved up into component parts. However, segmenting reality is more than merely cutting it up into pieces. The most significant part of segmenting the world is picking out those objects that are important and relevant to us. Such objects are *individuated*, that is,

C. Pinter, *Mind and the Cosmic Order*,
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made to exist in our world model. The same is true in other species: The objects that have been individuated are then recognized by members of the species, who learn how to act appropriately toward them.

To individuate a chunk of the world is to grant it recognition as an existing thing. It is not only material objects that are individuated, but also *categories* of objects, kinds of events, things people do, and so on. These become parts of our version of reality, and are inserted into our world model. There are countless different ways that reality can be divided up into parts, and the one selected for us is our scheme of individuation, or scheme of segmentation.

Clearly it is not an individual creature that carves up the world: The organization into objects and categories is a product of evolution acting over great spans of time and inherited by every organism. A scheme of segmentation is pragmatic and purposeful: Every detail is there for a reason. A segmentation is shaped by the external forces which impinge on organisms, in combination with the manner in which an organism's anatomy enables it to respond.

If a hypothetical organism had the power to see the world with perfect accuracy and fidelity, what would such a creature see? Surely not the image projected onto its retina, for that picture is a perpetually fluctuating pattern of light, shade and colors. Instead, let's ask: What are creatures *meant* to see? If evolution did its job right, the animal would make out precisely the things in the world that impact its survival. That is exactly what all creatures see—and it's the primary reason for having a segmentation of the world. Out of the surrounding turmoil, the brain detaches the objects that are essential in an animal's activity.

A species' scheme of segmentation is biologically based: It determines how individuals perceive the world visually—how the scene which they behold is composed of separate objects. Psychological experiments have shown that the moment we lay eyes on a scene, we're aware of the specific objects in it. The psychologist Irving Biederman has found that we cannot turn off the process leading spontaneously to object recognition. The British neuroscientist Glynn Humphreys likewise showed that people cannot process the global shape of objects without concurrently accessing their identity. We are biologically constrained to perceive the segmentation of reality in just one way.[1]

The way the mind carves up the world into separate entities is revealed also in human speech. The objects that we perceive, and that claim existence in the world we see, turn up as words in our language. We have words for solid objects, other words for their features and qualities, and yet others for actions and events. Human language brings out the fact that it is not only material objects that are the constituents of the world as we know it: There are many other kinds of constituents, for example things people do, actions they take, natural forces, and all kinds of abstract entities that manage to play a role in human affairs.

The vast assortment of things that we recognize as existing in the world is collectively known as our *ontology.* Most of the objects in our ontology reveal themselves as words in our native language. An ontology is shared by a culture, and it is said that the difference between cultures is basically a difference of ontologies. The American philosopher W. V. Quine has written at length on this topic. For Quine, it is by means of our language that reality is segmented, and therefore our ontology is embedded in our language.[2]

However, historically language emerged long after the human species developed a complex world-model with its taxonomy of objects. Trees and rocks, fire and water, can be known without words. The relationship between language and ontology is probably the reverse of what Quine proposed: A language is created on the basis of an existing ontology. Then, by means of language you make fine-grained distinctions and define things that you don't encounter in nature. Thus, man living in modern society has expanded his ontology far beyond its primitive form. There will never be a stable end-point when our ontology is complete: We will always be moving forward into richer ontological realms.

Our ontology is one aspect of our world-model. Nonhuman animals have complex ontologies suited to their ways of life. Their ontology, no less than their inner model of the world, are innate. Indeed a spider, for example, does not learn web-making from its fellow spiders, nor does it learn about wind and rain and the forces of nature. Its life span is too brief for it to receive such an advanced education. Its education is in its genes, for it starts life with an innate cognitive structure.

The same is generally true for the human species, but for generations we have been enmeshed in the futile debate over nature versus nurture. Unless you believe in a special creation, you know that it is only in a recent geological age that *homo sapiens* has split from its parent species. On the other hand, our basic world-model has its roots in deep time, and its base is certainly shared with our primate ancestors. What we have done is extend it, and future man will extend it further.

How a Scheme of Segmentation Comes to Be

A segmentation of reality is a systematic plan which selects out of the jumble of the real world specific chunks which are then objectified and become existing items of reality. Every species picks out and objectifies those items which matter to it—those strands of reality which are useful in helping individuals get along in their habitat. In the world of the housefly, recognizing a spider's web is of great importance, but in the world of the frog (for example) it has no significance and is not likely to be individuated.

What is it that determines which items a particular species individuates and accepts as real? Clearly they are those objects that have a practical effect on the lives of animals. They are those things that bring useful information, or ones that individuals are required to act upon. The various things that make up a species' ontology are those that it interacts with on a regular basis and that give shape to its *umwelt*. This has been the opinion of philosophers for at least a couple of centuries, and was expressed by William James in the following words:

> We inevitably ignore most of what we are confronted with at every instant, which is indefinitely complex, and single out for attention those elements that are made salient to us in view of our practical and individual interests. Those elements are then elevated to the status of things.

James is saying that in order for something to be an object in our ontology, there must be a reason why it was singled out from what he calls "the primordial chaos of sensation." The object must be of use to us and have a practical purpose. There are infinitely many potential ways that the surrounding "chaos" may be divided up, and the one that a species selects is dictated by practical necessity.

It needs to be emphasized that a scheme of segmentation is a product of biological evolution, and is formed by natural selection. In no manner is there any conscious choice or decision. A creature's segmentation of reality is the end-product of an extensive process of evolutionary development, and is wired into its brain. It is what makes the world comprehensible to an animal and is the foundation for its behavior.

The statement that we are pre-wired for our ontology does not mean that we are born knowing all the items which will affect our later lives. The nature-nurture debate was brought to a delicate conclusion by the discovery that—although all animals do learn—they are born with specific abilities and pre-dispositions to learn particular things. This preparation is crucial in order to drive learning in the right direction and to ensure that only useful things are learned.

Recently it has been verified that human babies are born with a great deal of tacit knowledge of how the world works. For example, every child is born with an "intuitive physics" which predicts the way rigid objects behave. Babies, of course, don't know what they know, for their knowledge is implicit. (Much of our adult knowledge is, too). The knowledge of babies is revealed by an ingenious kind of experiment: In one experiment, the adult is holding a ball and releases it. If the ball drops, the child shows little interest—but if the ball is made to hover in the air when the experimenter lets go of it, the baby shows surprise. A special camera is focused on the baby's eyes and detects the baby's emotional response, whether surprise or boredom.

This lesson applies also to ontologies: We come into the world with an innate inclination to admit just certain objects as things that exist in the world and are worth attending to and remembering. As individuals mature, the higher levels of human ontology are absorbed from the social context.

When people think about the evolution of species, what generally comes to mind is the development of body structures and internal organs. However, the structure of an animal's behavior is at least as important as its anatomy. There is no such thing as an organism without behavior—and by the same token, organisms whose behavior is poorly adapted to their environment do not survive. What an animal is, and how successfully it exploits its habitat, is determined by its behavior. In a sense, what is most important for assuring the success of a species is the set of practical skills it has evolved.

Darwin already observed that some kinds of behavior are more adaptive than others, and species with adaptive behavior eventually replace those whose behavior makes them less fit. The evolution of behavior is grounded on the same principles of variation and selection that underlie the evolution of biological structures. As postulated in the 1940s by Konrad Lorenz, and now confirmed, there is a genetic basis for the behavior of animals, so that particular behavior patterns are closely associated with specific genes or groups of genes.[3]

On the whole, evolution is a process of increasing complexification. The simplest creatures, which existed a half billion years ago, have been largely displaced by animals whose body plan is more complex. Likewise, the behavior of early animals evolved over time and gave way to animals with complex behavior, whose success has been achieved by sophisticated behavioral strategies. It could be argued that the rise in *behavioral* complexity was a more powerful and significant factor than physical evolution in driving the advance of species toward more effective ways of surviving. It is no coincidence that the most successful species today is a puny primate, with little in the way of strength or skill, whose behavioral pattern catapulted it to dominance.

The earliest kinds of inherited behaviors were probably fixed action patterns and reflex mechanisms imposed by the manner in which physical forces and constraints impinge on organisms. These elementary, stereotypical response mechanisms became more flexible when feedback loops became part of the brain's motor regions. We see behavior becoming more flexible yet when learning mechanisms are introduced by evolution, so that each individual can fine-tune its species-specific behavior in innovative ways learned by experience.

However, the most decisive leap forward in the development of animal behavior came with the gradual evolution of world models for representing the environment. A world model is a hierarchy of Gestalt representations of the essential objects and forces in the environment as they affect individuals of a species. Once an animal has a model of reality in mind, every occurrent event is referred to the animal's world model where it finds a context which relates the event to similar past events, and points to options for responding. It likewise enables the animal to perceive the likely consequences of each response option, thereby making decisions possible.

Category Formation. Reification

One of the simplest things that all people do naturally is to discern common features in different objects, and common patterns in different events. Experiments in animal behavior have shown that very simple creatures do this as naturally as we do. The capacity for abstracting particular characteristics out of everyday objects or situations would seem to be a sophisticated ability, but in fact it is widely distributed among living beings and seems to be a built-in feature of all animal brains. Every original or creative solution to a problem—even the very simplest one—is founded on the ability to perceive general, abstract properties that many objects have in common.

If creatures were not able to generalize then every object in the world would be one-of-a-kind: Each would demand its own specific response and way of dealing with it. Every object would only be recognized individually, perhaps by some kind of template identification, for there would be no general features. There would be as many different things in the world as stars on a winter night. No brain would have the capacity to deal with such a huge array of different, unrelated things.

The ability to abstract and generalize is crucial also for the construction of ontologies. What we are doing when we generalize is this: We lift a feature or property out of its natural context and make it into a concrete existing entity. The thing that we have abstracted out in this fashion can now be recognized when it is embedded in other contexts. This process is an incredibly powerful means of simplifying the world and giving it structure.

Many of the words in our vocabulary refer to immaterial forces or abstractions that are *reified* out of common experiences—that is, abstracted out of them and made into independent entities. For instance, having noted that some things are heavy and others are light, we abstract out the notion of *weight*, which thus becomes a new entity in the world. Noises we hear are loud or soft, high-pitched or low-pitched, so we objectify *volume* and *pitch* as abstract entities which apply to sounds, and whose meaning can be extended metaphorically: For instance, we speak of "loud colors". A sharp needle is *piercing* and by analogy we can speak of a "piercing scream". From watching water, we notice that some things are *liquid* and *flow*, and we speak metaphorically of "the flow of traffic".

Almost all the notions of science originate by abstraction from common properties of things: Notions such as temperature, force, velocity, acceleration have been reified out of visceral experience, and are denoted by nouns because they have become concrete things for us. The habit of drawing abstract features out of their context in nature and objectifying them is so commonplace that the human ontology contains as many abstract things as concrete ones.

Our ontology contains not just simple abstractions, but higher-level ones formed by abstracting from existing abstractions. For example, an object is heavier than another if its *weight* is *greater*. A particle *accelerates* if its *speed* is *increasing*. Compound abstractions are like nested boxes, one or more within another, and can be extraordinarily complex. These, like all the items in our ontology, are Gestalts.

The universal aptitude of living creatures to respond to abstractions is not surprising, as it is an indispensable prerequisite for category formation—and recognizing different categories is essential for survival. If there were no categories then the world would be an impenetrable labyrinth. Every chair or table would be a distinct kind of thing and every apple would be one of a kind. The world is comprehensible and action is possible because everything falls into a category, and every item in a category requires the same or similar responses.[4]

The ability to form categories of the objects in an environment is a foundational aspect of mind, and present in all animals. The process of categorization has been studied by psychologists for many years, and has produced important insights into the ways of animal intelligence. Eleanor Rosch, a psychologist at the University of California in Berkeley, has researched the underlying principles of category formation in humans and other animals. She found that common categories are elaborate Gestalts which have a great deal of internal structure.

Rosch has found that a category is not a generic version of the objects in it, but is something newly minted with a character and a structure of its own. For example, the category of dogs is not simply a generic dog, but is a complex of images that we may call the *concept* of dog. Visually, it includes a fluid composite image of what the most commonly seen dogs look like, viewed in various positions and from different angles. It includes general notions of the temperament and character of dogs, and the knowledge that dogs may be both loving and, in some circumstances, dangerous.

If you look around you, you will notice that you are not so much discerning particular objects, but *categories* of objects. You don't inwardly note, "that's the tree I planted last summer", or "that's the chair that usually lies in the corner", but more commonly, "there's a tree" and "there's a chair". You categorize first, and if specifically needed, you individualize next. All animals perceive the world in categories, for nature has designed brains to do just that. If one perceives a category, one also understands the associated concept, for example hard, soft, large, small, moving, still. Philosophers say the category is the *extension* of the concept, that is, the set of things the concept applies to.

There is a great deal of traditional resistance to the idea that non-human animals might have concepts. Often the behavior of animals can easily be explained and correctly predicted if we grant them the capacity to have beliefs, intentions, and concepts. Instead, for ideological reasons, many scientists refuse to grant these capacities to lower animals, and devise complex hypothetical mechanisms to account for the ways they behave. Nonetheless, as research on animal behavior becomes more refined and sophisticated, the resistance to recognizing their mentality is softening. We no longer believe there is a rigid barrier separating our mentality from that of other species.

A concept does not have to be a product of an advanced intellect: At its simplest, the concept of a dog (for example) is simply a general image of dogs or "dogness" and a propensity to behave in a certain way when one is recognized. There may be an emotional component to the concept, resulting from one's memories of previous encounters (pleasant or not) with dogs.

We tend to believe that concepts must be held consciously. This, however, is a mistake, because we can have concepts tacitly. Frequently, an animal's behavior betrays the fact that it is effectively using a certain concept in making choices. Foraging animals, even insects, find the shortest distance between sites, which shows they recognize the concept of distance (and short). In experimental situations, animals can be forced to discriminate in order to get a reward, and even honeybees are found to be responsive to shape categories, line length, and even set size (one, two or three—and even zero). The bees tacitly possess the abstract concept of number, but they don't "know" it.[5]

When humans possess a concept tacitly by using it in some aspect of behavior, there is an additional mental step involved in bringing the concept to conscious awareness. Much has been written about the difference between knowing something "with the body" and knowing it with the intellect. In some cultures, knowing unconsciously, "with the spirit", is taken to be the superior way.

This topic is central in the philosophy of Taoism. In the *Chuang Tse*, the Prince of Wei notes how deftly his cook is cutting up a beef, and praises him. The cook explains that when he started out in his vocation, he saw the whole animal as one great task to be resolved, and perceived it part by part. Now he doesn't need to exercise his volition at all, because he has internalized the entirety in his spirit. His senses no longer play a role, but his spirit acts of itself according to the pattern of what's before him.

Realism

Common sense leads us to assume that if we perceive the world to be divided in a certain way into different objects, it's because the world really is divided into those very things: We believe that objects have fixed boundaries based on their physical properties, and their physical boundaries determine the segmentation of the world into separate things. As a result, there is a fixed number of objects in the universe, and corresponding to those objects, a fixed number of features and possible relationships between them.

This is a natural belief, and is the foundation for a philosophical position known as *direct realism*. There are other, more flexible and finely-shaded forms of realism, to be discussed later. But direct realism is the most natural and deeply rooted way of thinking about nature—and is hard for most people to relinquish. Along with it goes the belief that the external world is exactly as we see it, its features are the very ones we discern—and the categories we recognize in our environment are real things based on properties of the material world.

In a previous chapter we have already cast doubt on this belief. We have discussed distal attribution—an aspect of perception in which animals project onto the external world the visual objects constructed by the brain. We referred to this as a "necessary deception", because it would be very awkward if animals perceived the world as images in their head. Instead, they experience the objects they see as being in the external environment, where they're assumed to belong.

Furthermore, while there is no doubt that solid objects have physical boundaries which separate one from another, every living species selects out of the environment those things which are of interest and importance, and *objectifies* them—that is, chooses them for recognition and special attention. In every scene, awareness and attention are focused on those things, while all else is backgrounded. Moreover, many objects do not have unambiguous boundaries and are not entirely detached. Where does a leaf depart from its stem, where does a foot begin, or a nose or an ear? Such things are separate objects for us, though not separately bounded.

The underlying rationale for justifying direct realism is the fact that the universe came into being long before minds did, hence there exists a *mind-independent* world which is prior to and radically separate from human thought or reason. For realism, the purpose of minds is to understand the world as it actually is, and come into harmony with it. The mind should therefore be the Mirror of Nature. Ideally, it should reflect nature as nature *is*.

As a result—according to direct realism—we are able to think and talk about things truly, as they exist independently of our minds. We are able to do this by virtue of a natural association between the world and the way it is represented in the mind. This idea is usually combined with another, equally venerable notion rooted in the tradition of realism: It is the idea that the words of our language correspond to real things of the world. So when we communicate, our sentences refer to actual objects and events "out there".

This suggestion is not unreasonable, and in fact it's the first idea that comes to mind if you're asked to explain what language is. For example, your sentence "the dog is under my bed" makes reference to the objects *dog* and *bed*, and the position *under*. However, when you give the matter a little more thought, you realize that your sentence is meant to evoke a certain mental picture in your listener, and the components of that picture are the listener's *mental images* of dog, bed and under. So your words actually correspond to mental images which you and your listener have in common. Indeed, the words don't act singly, but together as a sentence they evoke a situation in mind.

The theory which claims that words are directly mapped to worldly objects is called the *correspondence theory of language*. Though perfectly reasonable, it fails because language does not work that way. Such a correspondence is useful if you're learning a foreign language, and your teacher points to a cup and says *une tasse*. But children don't learn language that way—they pick up the sense of whole idioms and sentences as units of meaning. Indeed, as the philosopher W.V. Quine says, a language is what it is *as a whole*, because it embodies an entire culture and a way of life.[6]

Despite recent findings on the relation between language and mind, the philosopher on the street continues to stand by the correspondence theory. It is natural for people to hold such a theory, because it is another example of *necessary deception*. When communicating in speech, it is essential to assume that we're referring to real objects and events, and not to a staged production in the theatre of the mind. We could not function verbally if there remained any doubt at all that what we take to be *true* statements are about things that are really there. When you talk, surely you assume you're referring to real things.

The most important objection to the correspondence theory of language is that it implies there's a mysterious mapping (projection) from thoughts in a mind to objects and events in the world. On a superficial level, this belief seems to be correct: Nouns of our language refer to material objects, verbs to actions we carry out, and so on. But how is such a mapping set up? For instance, we are born with a segmentation of reality: Does the segmentation come with a one-to-one correspondence between thoughts and objects in the world?

Superficially, that too might appear to be the case—but in reality, a segmentation gives us a correspondence between thoughts and our *mental representations* of objects. Thus, we don't get a mapping between thoughts and worldly things, but a mapping between thoughts and thoughts. Indeed, a segmentation has no effect on the material world: It is merely a classification of our representations of things. Once you realize that, you understand why the mapping is not from ideas (or words) to external things, but is purely internal to the mind. This is far more plausible than to claim the existence of a mystical connection between words and objects of the external world. To Hilary Putnam, belief in such a connection is a vestige of magical thinking.

By the *semantics* of language we mean the things that words and sentences *refer to*. Once we understand that semantics is not so much a relation between words and things, as a relation between words and internal representations of things, we are forced to change some of our commonsense ideas. We are then less committed to direct realism, and open to a more flexible kind of realism which accepts the fact that there is more of a gap between the world and the mind than common sense seems to admit. We know the world through our senses, and in principle there's no reason to assume our senses work as a mirror of nature, able to reconstruct nature exactly as it is.[7]

In fact, the very idea that nature *is* a certain way—that things in nature have an appearance or a *way they are* independently of being perceived—is incoherent. Such an idea is the very essence of direct realism: The core thinking in direct realism is not merely that there exists an objective world independent of the mind, but that there exists one way of representing it *correctly*, without distortions. In other words, according to realism, objects in the external world have real features and real properties, and consequently can be described fully and correctly if only you use the right kind of language and concepts. It is *this* belief that most succinctly characterizes direct realism.

Abandoning direct realism is traumatic: It is a little like leaving the safety of the womb. The biologist and philosopher Francisco Varela refers to this sense of loss as the *Cartesian Anxiety*: We set out in life with the belief that we inhabit a real world and can get to know it as it is. Then we find out that all we truly know are our own representations of the world. Even worse, we are "condemned by our constitution to treat these representations as if they *were* the world, for our everyday experience feels as if it were of a given and immediate world." Thus, according to Varela, we are twice deceived: First in believing that the world is the way we see it, and next, in believing that even if we're mistaken in our first belief, at least there is *some* way the world is. Then we realize that isn't true either.[8]

We are now in the last chamber of direct realism: It is assumed in common sense that even in the external, mind-independent world, objects have features and qualities. The features might be different from the way we perceive them, and might be directly linked to physical properties. For example, an object feels hot to us because its molecules are vibrating energetically. Physical features and the features we discern are different, but nonetheless they correspond in a systematic way.

Indeed, how could objects fail to have features? Quite simply because features are something perceived by observers—and without a living subject looking at a thing, it has no specific features, nothing it "looks like". If an object is red, or round, or straight or bent, it has those features in the eyes of a subject that observes it. The world in itself, divorced from observation and observers, does not have any specific form. Without features and characteristics, it cannot have a description. The description we know *is a description of our mental representation of an object.*

The idea that objects and events give rise to representations which depict it faithfully goes back to the earliest days of philosophy. Aristotle said that the things we perceive are reproduced in the mind in the same way as a signet ring leaves an impression in soft wax. This implies that the representation is an exact replica of the thing represented—or as we would say in contemporary terms, is *isomorphic* to the original. Few people today believe that is true: Kant was among the first philosophers to point out that describing the world is not simply copying it. In order to describe something we must first understand it in *our* terms, for otherwise our description will have no meaning to us. Thus, what we put forward in a description says as much about us as about what we're describing.

As a matter of fact, Kant went further than that, for he claimed that what we experience is never the thing in itself, but always the thing as it is represented in our mind. The reason is that minds did not evolve to plumb the depths of reality—but merely to allow living creatures to understand the events pertinent to their daily lives. Sensory perception is assigned the task of redirecting ambient information and transforming it into the categories of what's comprehensible by an animal mind. Features and appearances are what the mind is comfortable with and designed to understand. The external world, on the other hand, is not compelled to present itself by having an outward appearance. *Appearance does not exist materially in the world. It is a category of mind.*

Kant was perhaps the first philosopher to draw a real distinction between properties which things have in themselves, and the experiences they produce in us. Objects have inherent physical properties resulting from electromagnetic energy operating on atoms. On a totally different level, phenomena trigger our sense organs to fire, and after elaborate processing and coding, the sensory signals are registered in consciousness. However, there is no logical reason to assume that there is any similarity between physical properties of the external world, and inner experiences. The animal mind, by its nature, envisions a world of features, aspects and appearances, but those things don't exist outside of mind.

The only conclusion we can draw is that *there is no way of representing or describing the world "correctly"*. The physical world and our vision of the world are different kinds things: The one is matter, the other mind. The brain of every living being has a model of the world sufficient for its needs. In order for language to make claims about the world, what is used is a match-up between words and our representations of objects. When we think about the world, we are manipulating objects drawn from our scheme of segmentation. That's the very reason minds are so useful: You can play with ideas instead of taking risks with real things.

The Picture-Postcard Theory of Reality

When a landscape or view is discerned by a living creature, what the creature sees is a carefully organized display of separate objects. The shape and individual identity of each object is immediately recognized. The visual brain of animals manages this so efficiently that the viewer is not aware of any effort to create this display. What is even more remarkable (though few of us fully appreciate it) is that what we see is a single coherent picture, experienced by the viewer as a unified meaningful whole. It will be explained in this chapter that the task of the living brain is not merely to take casual notice of what lies in front of us, but to organize it in such a way that it is immediately usable by an acting, striving animal. A sentient creature doesn't just passively register sensations, but has the burden of using the data from the senses to manufacture a coherent and useful vision of reality.

As discussed earlier, over evolutionary time every species has evolved an inner model of the external physical world. The model is designed to account, with no contradictions, for all the data received through the senses, as well as all our experience interacting with external things. What we see of the world are the forms and features which our brain has designed. Do the shapes of objects, as they present themselves to us in visual awareness, look like what they "really look like"? Posing this question is wrong-headed, because to "look like" is subjective and mental: In the physical world, unseen objects do not "look like" anything. The appearance of objects is a psychological phenomenon, and "appearance" has no meaning outside the context of a viewer.

This simple fact is almost universally disregarded. People (including scientists) would rather pretend that what they perceive is exactly what there *is*, even though they are fully aware that is not correct. In fact, we all know that it's not correct. For example, when you taste a lump of sugar, you know that your sensation of sweet is purely in your mind, and has no connection with the carbohydrate molecule that triggers a taste bud to fire. It is the same when you experience the fragrance of an orange blossom. When you listen to music, you know that what you experience hearing is categorically different from the vibrations of the airmass, though the vibrations are the physical trigger that brings you the experience of music.

None of the above is surprising, and in fact is common knowledge. However, we have far more difficulty acknowledging the same fact in connection with the things we see. We are aware that vision is one of our senses, and that it plays the same role as all the other senses in bringing us external data. It should therefore be easy for us to admit that what we experience seeing is categorically different from the external triggers that act on our eyes. (It should be like the difference between the sensation of sweet and the carbohydrate molecule). But in fact, we have a tremendous resistance against admitting that fact. Why such a resistance?

The reason is that we are biologically designed to believe that what we see is Reality with a capital R. You might say we are *wired* to have the conviction that the external world has exactly the form that appears to our eyes. The compulsion to do this is so strong that even when we have understood logically that there is no such thing as *appearance* outside of vision, we continue to think of objects in the world each having its own objective shape and appearance. We are almost incapable of shaking this off.

It was already mentioned in Chapter 2 that, although the image of things such as trees and houses is formed in our head, that's not where we have the experience of seeing them. Rather, we perceive them in the space around us, just the "right" distance away from us, each in its own designated place. If you think of it, we are in fact *hallucinating* the objects of vision in surrounding space. This paradoxical fact is in the very nature of sensory perception. Everything we perceive is a "hallucination"—not because what we see is mistaken, but because forms and features aren't aspects of brute matter but creations of perception. That is the core idea of the leading theory of perception today.[9]

It must be understood that nature does not aim to deceive us, but the very opposite: We imagine objects to be in surrounding space because that's where they're supposed to be—that's where we reach out for them. Likewise, we experience visual objects as "holographic" images because that is the most informative and practical way of getting the information about them into our mind. Surely, however, the physical world consists of solid three-dimensional objects, so it seems that we must be seeing them correctly. Again, we are mistaken: The *appearance* of a three-dimensional object such as a teacup is a product of the visual brain. The "cup in itself", the real teacup in the unobserved physical world, consists of atoms and charged particles, and "appearance" is not a force of physics.

By its fundamental definition, the appearance of something is the way it presents itself to a viewer who is located away from it and sees it as a Gestalt whole. The shape and appearance of complete objects arises in the vision of viewers capable of perceiving Gestalt wholes. What is odd is that we understand this, and logically we accept it, yet despite that we continue to mentally "see" objects around us as things whose shape and features are real aspects of the external world.

This is equally true for the layout of the world in everyday scenes, for example a glimpse of your living room or the view out of your window. The arrangement of objects in a visual scene seems marvelously well-organized: We know what each object is, and it seems to be located just where it ought to be, as if the whole scene were a carefully framed picture or a well-designed stage setting. This informative and clear formatting of the world-scene is a creation of perception.

Naïvely, we believe that the world is truly spread out around us in pictures—that is, we believe that the pictorial format that we see is the real principle of the organization of the physical world. The mind conceives an orderly way for objects to be laid out in space, where each object has a position that we understand so we can readily turn our attention back to it. In fact, it is a layout that the visual brain has constructed: It makes all of what lies in front of us perspicuous as a coherent whole. The world is organized by vision into something that looks like a picture postcard, and we are led to believe that layout is the "true" layout of material objects in the world. I call this belief the *Picture-postcard Theory of Reality.*

The truth is that there is nothing in the bare material universe whose function it is to "organize" objects into a coherent array or display. There is no systematic ordering of objects in physical space, nor any kind of physical force or effect that would tend to put objects "in their right place". That kind of organization is a product of mind. Certainly this does not mean that the material world is laid out differently: What it means is that the material world has no inherent principle of ordering or anything like a "layout". The layout of a scene is exclusively a product of a visual system that sees in Gestalt wholes. It has no objective counterpart in the world of matter.

For the Mind, Reality Is Whole

Far and away the most important and most remarkable attribute of the animal brain is that all creatures perceive in Gestalt wholes. When you open your eyes, what you behold is a comprehensive display of the things before you, and this display is given to you as a single, undivided experience. Vision would be meaningless, and have no biological function if people and animals saw anything less than integral scenes.

We are misled by common sense to assume that we see in Gestalts because the world itself is constituted of whole objects. In actual fact, the manner in which physical objects are related to one another and come together rests on an entirely different principle, called the *Addition of Simples*, which is explained in above. The reason events of the world appear holistic to animals is that animals perceive them in Gestalts. The atoms of a teacup do not collude together to form a teacup: The object is a teacup because it is constituted that way *from a perspective outside of itself.*

In a similar way, a photograph consists of a large number of tiny dots of different colors, called pixels. The little dots do not conspire together to give rise to Grandma's portrait. The portrait comes to exist in visual awareness when the whole of it is seen from an external perspective. The existence of an object as an individual whole *is always something external to the object*, not inherent in the object itself.

Gestalts do not merely allow you to see whole objects and scenes, but also to experience events that unfold in time. When listening to music, you hear more than just the note currently being played: You hear a whole melody. When someone speaks you hear a whole sentence. Gestalts bring into being an entire aspect of reality that would not exist otherwise—a reality in which many things which are separated in space and time are perceived together as a new combined entity. The new entity did not exist before the parts were perceived as one.

If a creature did not perceive the external world in Gestalts, it would not be able to discern motion. Indeed, in order to see an object moving it is necessary to observe it at different positions along its path, and see it at different times. This does not mean that objects in the external world, outside the scope of any observer, don't really move. When a material object moves, its physical state of motion is an instantaneous reading just as its position is.

There is a dedicated module in the brains of all animals whose function is to detect motion. We experience the motion of a moving object as a kind of drift, or flow, and it is the sensation of this flow that we recognize as movement. Moreover, we have no experience of instantaneous motion. Rather, what we experience is always the *event* of motion over a brief interval of time, perhaps a half-second or so. With the aid of very short-term memory, we experience the gradual displacement of the moving object as a unique kind of sensation. For a living perceiver, motion is always experienced as something that occurs over a brief interval of time, and is like a moving window. It is nothing at all like actual physical motion, which is defined at each instant.

Despite this fact, we are obliged to conceive of motion in the terms in which we experience it. It is this version of motion that is built into our world-model, and it would be totally impossible for us to perceive motion any differently. Like so many other aspects of the surrounding world, we are constrained to perceive motion in the specific form that the brain has conditioned us to apprehend it.

From the time, long ago, when people first began thinking abstractly, they noticed the division of reality into *matter* and *form.* This dichotomy was pivotal in the philosophies of both Plato and Aristotle, though it led them in different directions. Aristotle viewed form as a natural aspect of all material substance, but Plato considered forms to be real entities unto themselves, dwelling in a separate realm of existence.

Intuitively, it seems indisputable to us that every material thing has two orthogonal aspects: It has matter and form—and these two things jointly determine what an object is. This belief, however, is another example of naïve realism—for in actual fact form cannot exist except in the view of a Gestalt observer. *Form does not inhere in brute matter but emerges in Gestalt observation.* Form is another aspect of the observed universe that comes into existence with Gestalt perception.

This is quite an amazing insight, and it demonstrates how far our native intuition can diverge from reality. We are convinced beyond a shadow of a doubt that every material object has substance and form: That is, an object's form inheres in the object itself, and is an aspect of the matter of which the object is made. Once again, we are misled by common sense. Actually, an object's form is an aspect of the object as an undivided whole, *viewed from outside the object*: It is a facet of the Gestalt image given to an external observer.

The reason this is an important and penetrating revelation is that it shows us that an object's form is not indwelling in the object, and is not located in the object at all. It is located away from the object, in the external perceiver. In particular, the material universe outside the purview of any observer has no such thing as form. We find that very difficult to believe. But the reason for this is that—unwittingly and carelessly—we imagine the universe as if we were there looking at it, and find it very hard to picture a reality in which we are totally absent.

It is not merely the *appearance* of objects that emerges from observation, but also their structure. Indeed, the structure of an object is its precise description in analytic terms: It is an explicit accounting of *all the functional parts and the relations by which they are connected*. Such a description rests on a specific segmentation of the object into parts. If an object is segmented into parts differently, this of course gives rise to a different description. This is an important observation, because it reveals that structure is in the observer, rather than in the object itself. This fact is strongly counterintuitive, for commonsense tells us forcefully that every object in the world has a unique structure, and its structure is inherent in the object.

There are, of course, complex things in the world—and they are what they are even when not being observed. They are complex—but their *explicit structure*, as it is given in a structural description, is not fully determined by the object, but rather, it flows from the way the object is divided into parts. In the 1960s a new branch of mathematics was created, called Kolmogorov Complexity Theory, which addressed the problem of quantifying the degree of complexity of structures. The general idea is that if an object is segmented into parts, and you describe it by disclosing how each part is related to every other part, then its complexity is defined to be the length of the shortest computer program able to describe it. If it is possible to segment the object into parts in an alternative, more efficient way, its complexity is the one corresponding to the most parsimonious segmentation.[10]

There are objects in the world which are complex in an absolute sense, not simply because we know a complex description. There may be several alternative ways of segmenting such an object into parts. The structure of the object is the explicit way of describing it within one given scheme of segmentation, hence the structure depends on how you have segmented it. However, its complexity is something objective, because it takes into account all the alternative descriptions of the same object and selects the simplest. There is an austere lesson in this fact: If structure, like shape, arises out of the mind of observers, then what is actually real in the world? That is the key question that we must now attempt to answer.

As we have seen, the shapes of objects, as well as their structure, are not material aspects of the objects, but are located elsewhere—in observers that survey the objects from an external perspective. Most importantly, if an object is complex, its organization is not an aspect of the object itself but dwells in the observer who perceives it as a Gestalt whole. This fact is vehemently at odds with our most basic intuitions. The living observer projects what he sees onto the external world, and attributes his vision of reality to the things around him. If he perceives complexity in the objects he discerns, it is quite natural to assume that it is the objects themselves, as material bodies, that have the complex structure he observes. But this assumption is wrong.

Other aspects of the physical world, too, are rooted in perception. The notion of force in physics is based on the effort needed to move a heavy object. Such feelings are the foundations which support scientific concepts. Without these underlying sensations to give them meaning, the concepts of science would be empty of content. If it were not linked to a sensation of effort, force would be reduced to a pure abstraction. Our notion of the hardness of a solid object is based on the sensation we experience when we touch it. Indeed, all the features of objects are based on the sensations we experience when we manipulate them.

The external universe, outside the scope of observation by any living being, is the residue after all sensable qualities have been taken away. What remain are only formal entities which have no concrete interpretation. Thus, the universe uncoupled from observation is an abstract system in search of an interpretation. Living beings provide the semantics—the interpretation—of physical reality. Most crucially, it is the living observer that has the unique singularity of being able to perceive in Gestalts, and thereby enriches the universe by bringing to light all composite, multi-part things. Contrary to common sense, structure and complexity are not indwelling aspects of matter but arise in perception.

The material universe, of course, has an independent existence quite apart from observers. But the important lesson for us is that this external universe is very different from the way we imagine it to be. The mind of living beings projects all manner of sensable features onto material objects, hence we perceive the world with all the properties we have projected onto it—but objectively the unobserved universe is formless and featureless.

The universe outside the purview of any observer cannot be described in any way, for in order to describe something it must have particularities and characteristics. If we cannot describe it, we cannot imagine it or picture it. At this point, all we can say is that it has causal power to act on living beings, and the beings themselves have the power to make some changes in the physical world. However, there is very much more that can be said about the external world, and Chapter 7 is devoted to that topic.

Every living being harbors an internal model of its world. The function of the model isn't to produce a faithful replica of the physical environment: Rather, it is meant to model the domain of interactions between an organism and its external milieu. It must represent those features of the environment that impact the organism, in conjunction with the organism's patterns of action and how they alter the environment. The content of the model is presented to awareness in sensory categories experienced as shape, patterns of motion, structure.

Definite objects and features exist only in a world that has been segmented according to a fixed scheme. A world outside the purview of any observer can be subdivided into parts in a great many alternative ways. Thus, the world outside the range of observation is *pluripotent.* Using a word dear to physicists, such a world is a *superposition* of many possible schemes of organization. Thus, analyzing the physical world as we have done here brings us inevitably to the reality discovered by quantum theory, which was a principal motivator of this book.

In the vocabulary of quantum physics, when observed, the manifold possibilities "collapse" into the notional world of the observer. Whereas in the most popular account of quantum theory the multiple possibilities correspond to different universes, in the present interpretation they correspond merely to different observers. This has the effect of naturalizing quantum theory and removing the mysterious aspects that many books describe as "quantum weirdness".

The universe known by an observer consists of definite, determinate things. In contrast, the universe *outside the purview of any observer* is indefinite and virtual. As the physicist Werner Heisenberg said, before observation objects are virtual, but once observed they become actual. The act of observation does not change anything physically in the universe. It affects only the immaterial realm of knowledge in observers. However, in the ontology presented here, knowledge in living observers is a fundamental element of reality, certainly not a "figment".

A major theme of this book is that "reality" is not confined to matter and its physical properties. There is a whole firmament of appearances, sensations, perceptions, insights and wide-ranging Gestalt vision. These things exist in the minds of sentient creatures, and are often won by hard and persistent effort. It is true that they exist only in animal minds, but they are nonetheless real and indispensable aspects of the universe. What is shown above is that the very existence of hierarchically complex objects is confined to the minds of living observers. Only living minds apprehend complexity and multiplicity. Complexity exists in the universe solely because it is discerned—in fact created—in minds. It exists only in minds.

It is conjectured in the closing chapter that the emergence of life is not an accidental property of certain large molecules but is a natural phase of cosmic evolution. The function of living organisms is to assume the task of observation, and in this manner to introduce determinate, individual objects provided with features and a specifiable structure. Also, it is living observers that bring complex, hierarchically organized things into being. There's more to reality than matter and its properties.

6

In Search of Reality

Facts

The Twentieth Century philosopher Ludwig Wittgenstein famously made the following statement:

> *The world is the totality of facts, not of things.*

He is not denying that there are things, but the world is dynamic, and all its objects are involved in relationships with each other at every instant, thereby giving rise to facts.[1] Prior to Wittgenstein, his mentor Bertrand Russell had made a similar claim. Not only is all of reality a collection of facts, said Russell, but these facts consist of propositions which may be expressed in language. Russell made the additional assertion that *facts are what exist*: In other words, if you asked the question "what kinds of things exist in the universe?", Russell's answer would be that it is *facts* which exist.

How reasonable is it to contend that reality consists of facts? For instance: At this moment I am sitting at my kitchen table, my tea kettle is whistling, my cat is stretching, and outside it is snowing. Each of these is a simple fact, and together they partially constitute my local reality. I say "partially", because other facts (or events) are taking place at the same time: For example, my heart is beating, my computer is charging, my eyes are blinking, and so on. Moreover, I am listing the facts at a particular *level of description*. Alternatively, I might have tried to account for the motion of every molecule in my surroundings, describing the displacement of each one in space-time. That would have been a different description of the same facts.

C. Pinter, *Mind and the Cosmic Order*,
https://doi.org/10.1007/978-3-030-50083-2_6

It is important to note that in order for a particular thing to exist, it must be possible to separate it out of the surrounding jumble, and perceive it as a single, well-defined entity. Consider the following fact: *At precisely 10:19 a.m. on Wednesday July 24, 2019 my wristwatch slipped through my fingers, dropped onto the stone floor and stopped running.* With these words I have successfully carved the event out of the general background.

If facts are things that *exist*, then it must be possible to individuate and uniquely designate each one. A fact may be identified by using words, as I have just done: Could there be, however, some alternative way of singling out a specific fact from the stream of ongoing reality? This is a very important question, because it determines whether facts are inevitably bound up with words. Could the mishap with my wristwatch be individuated in any other way than by the use of language? Clearly, the word "language" is not restricted to a natural language such as English, but may be *any communicative medium*, for example a symbolic code or the formal language of mathematics.

Language appears to be so intimately involved with reality that Wittgenstein considered reality to be nothing more than the set of all the propositions which describe it. *Instead of a proposition being a linguistic representation of an objective fact, he claims that the opposite is true: An objective fact holds in the universe* **because** *the corresponding proposition is a true statement in a language.* Is it reasonable to believe that the essence of a fact is that it's a claim expressed in words?

To commonsense wisdom, a fact is primarily something that takes place in the external world. It is then the observer's task to size it up and put it into words. That is why we consider Wittgenstein's claim to be implausible. But think of it this way: Suppose I claim that a certain fact X holds true in the physical world. You would then ask me, "what fact is that?" Until I answer, there is no specific fact on the table. It requires my statement of the fact to identify what fact I claim to be true. As explained above, if it is asserted that a fact exists, it must be possible to separate it out of the surrounding jumble and identify exactly what fact it is. Perhaps a fact *does* begin with its verbal statement, after all.

It is universally assumed that linguistic claims of fact correspond to situations in the physical world, for otherwise language would be futile. We seem to believe that regardless of whether we see it or not, the fact is there, and it is our burden to discern it and try and capture it in words. But as already mentioned, the immediate question is "what fact are you referring to?" and this requires words. Words are essential because every fact must be fully determinate if we are to decide whether or not it is true.

Russell and Wittgenstein believed that the structure of language mirrors the structure of the external universe independently of mind. This would not be true, of course, for a natural language such as English, but it is possible to design formal languages, constructed so they refer with absolute precision to objects in a limited domain.

Bertrand Russell refers to a stringently rigorous language of this kind as a *logically perfect language*. W. O. Quine, the great American philosopher of language, has the very same idea in mind when he speaks of a *regimented language*. Quine asserted that the way in which such a language is organized is *identical to* "the ultimate structure of reality". Russell says, "In a logically perfect language the words in a proposition would correspond one by one with the components of the corresponding fact... A language of that sort...will show at a glance the logical structure of the fact."

For example, a motorcycle repair manual could be written in a regimented language. Each individual gear and separate component will have a specific name. There will also be words to specify exactly how two components fit together. The rules of sentence-formation will then be analogs of the way mechanical parts are assembled.

The idea underlying a regimented language is that by assigning a noun to each separate material unit, and a specific word for every possible way in which material units are physically linked, we achieve a perfect correspondence between sentences and material structures. In this way, since uncertainty is eliminated by the absolute explicitness of the language, and therefore interpretation is unnecessary, a regimented language is able to describe things in a completely objective way that is not necessarily linked to a human intelligence.

Regimented languages are useful not merely to describe physical systems, but may be applied in any domain. Designers of formal languages begin by taking inventory of all the individual objects that are relevant in a particular context. As explained above, the rules of sentence-formation must then mimic the way complex entities are constructed out of simpler ones in the field of application. The use of a regimented language makes the world perspicuous because objects and events can be fully described in propositional form. Most importantly, perhaps, meaning is not a function of context, and does not depend on background information or knowledge. It appears that sentences of a regimented language are able to convey the full content of every fact with no residue. They seem to be something objective and independent of any human perspective.

However, this is not really true: The reason is that every language—whether formal or not—is built on a specific segmentation of reality into separate objects and relationships between objects. Thus, every language exposes a particular version of reality which is built into it from the start. Every language is anchored in a specific perspective, or world-model. A fact expressed as a sentence in a language shares the scheme of segmentation which is built into the language.

Commonsense wisdom tells us that our language is a way of referring to things in the external world. For example, "bird" refers to real birds, "chair" refers to real chairs, and so on. But this intuition is flawed. The reason is, that it is the mind that divides the external world into separate objects and relations. The world outside the purview of any mind is not pre-segmented. Therefore our words cannot refer to things in the world, because those things don't really exist in the world. They only exist when they have been individuated, separated out, and noted in mind. Thus, in reality, our words refer to things in our world-model and not in the external universe.[2]

This is a very important comment, for it undercuts the commonsense belief that there is a natural projection which assigns to every word and sentence some configuration of things in the objective world. (Such a projection is called a *word-to-world mapping*.) Instead, everything we say describes a situation in our inner model of reality. This insight has been discussed at length by the American philosopher Hilary Putnam. It suggests that it is impossible for us to describe the external world "as it is", but limits us to knowing the universe according to our world-model. This philosophy has been called *Internal Realism*.

A fact exists only when a mind extrudes it from the undivided flow of ongoing physical process. Indeed, the external world is a seething cauldron of activity where every molecule is in continual random motion. What we take to be a fact is deeply embedded in this maelstrom, and must be painstakingly and precisely cut out by a living mind. This feat is accomplished by an almost uncanny process which requires huge amounts of unconscious mental computation.

The mind-independent world is not naturally divided into individual parts: At the most fundamental level, we can say that external reality is a continuous flow of ongoing cosmic process. Consequently, facts or events in the sense of individual happenings do not exist in the universe at large. When you speak of a fact or event, you mean something bounded that has been lifted out of the flow of continuous activity. Since a fact must be very precisely extruded from the background, this requires that the observer who lifts it out have a *purpose*—a motive for undertaking to extract this one particular thing. In a universe without an observer having a purpose, you cannot have facts.

As you may judge from this, a fact is something far more complex than it appears to be at first sight. In order for a fact to exist, it must be preceded by a segmentation of the world into separate things, and requires a brain that is able to extract it from the background in which it is immersed. Moreover, this brain must have the power to conceive in Gestalts, because in order to perceive its outlines and extract it, a fact must be seen whole, together with some of its context.

A fact does not exist if it has not been articulated, that is, if it does not exist explicitly as a verbal entity sufficiently detailed that it can be made to correspond (approximately) to something in the external world. Facts don't exist in the absence of their statement (because a statement cuts the fact out of the background), and the statement cannot exist apart from an agent with a purpose. When an intentional agent sets out to carve a specific object from the background world, he has a Gestalt concept of the object—and from the latter, he acts to carve the object out. Thus, a fact cannot exist in a universe without living observers.

A fact does not hold in the universe if it has not been explicitly formulated. That should be obvious, because a fact is specific. In other words, statements-of-fact are produced by living observers, and thereby come into existence as a result of being constructed. It is only *after they have been constructed* (in words or symbols) that facts come to exist. Commonsense wisdom holds the opposite view: It holds that facts exist in the universe regardless of whether anyone notices them, and irrespective of whether they have been articulated in words. You may now judge for yourself if that is true.

The Map and the Territory

Alfred Korzybski was a Polish nobleman of the last century. An engineer by profession and a philosopher by preference, he is remembered largely for his clever aphorisms which open the door to deep and difficult questions. One of his best-known sayings is *the map is not the territory*. Like the pronouncements of the ancient sibyls, his aphorisms are ambiguous, and each of their interpretations is a topic worth pursuing. In the present context, the territory is a metaphor for the physical world, and the map is the way that we represent it in our minds.[3]

The territory is the flow of ongoing process in the physical universe—what we described as a seething cauldron of cosmic activity. The physical basis for every fact is deeply embedded in this maelstrom, and must be painstakingly and precisely cut out by a living mind. The map is the set of all the statements-of-fact which interpret the map in terms that have meaning for us. Korzybski's maxim warns us not to confuse a fact that is clearly expressed in words with the underlying physical reality which has no structure until we organize it.

It was seen in the last chapter that the form of a material object is not indwelling in its matter, because the form appears only to a Gestalt perceiver. Thus, form and matter are separated, with matter located in the object but form located in the observer. It is the same with a fact: The material basis for the fact—which consists of molecules in motion—is located in the material world. In contrast, the *form* of the fact, that is, its narration, is located in the observer. There is a connection between the two, because when we state a fact in words, it is assumed that there is a situation in the material world that corresponds to it.

Another Perspective on Facts

There is a way of thinking of facts and events in a mind-independent fashion, as things of the external world. Scientists like to think of events as pieces cut out of space-time. In order to picture this appropriately, imagine first a particle moving through space: In your mind's eye you should be seeing a moving point gradually tracing out a path. As you watch it, the particle's position is changing and time is passing. If you imagine this in a coordinate system in space-time (that is, with a fourth axis for time), then the particle's trajectory is a curve in space-time.

If you have not one, but several moving points, they trace out separate paths on the same space-time coordinate system. The separate paths are intertwined curves, like a bundle of spaghetti. Thus, their joint motion is represented as a twisted chunk of space-time that looks like a bundle of freshly-cooked spaghetti.

One reason that space-time coordinates are used in science is that they permit the representation of dynamic events in a static picture. Space-time coordinates are coordinates in 4-dimensional space. For a moving point, its first 3 coordinates specify its location in space at a given instant, and the fourth coordinate designates the instant in time.

Any one event consists of a "solid" shape in four-dimensional space. It is *solid* in the sense that it occupies volume in four dimensions. A volume in 3 dimensions is a chunk of matter, whereas a volume in 4 dimensions is an event. An event is like a sculpture carved out of a four-dimensional block. It makes one think of a famous quotation attributed to Michelangelo: "I saw the angel in the marble and carved until I set him free." You may think of an event, similarly, as an "angel" in four dimensions carved out of a four-dimensional block.[4]

Our natural habitat is filled with myriad chunks of solid matter, some of which have recognizable shape whereas others are shapeless. It is the same in four dimensions: Most chunks of four-dimensional "matter" are shapeless, but a few have what humans recognize as a shape. Those few are *facts* that we would recognize. They have shape for us in the sense that they can be narrated intelligibly.

Returning for a moment to Michelangelo's angel, note that its form—what we see and take to be its *shape*—is its outer surface. It is like a veneer with no thickness at all. The inner bulk *supports* the shape, but is not part of it. It is similar if you draw a silhouette on paper: It is the outline that determines the silhouette but the interior is fill. Just like the immaterial, veneer-like surface which covers the statue and *is its shape*, the "shape" of a fact (that is, its narrative content) is *the outer surface of a solid in 4 dimensions.* It is a "veneer" with no thickness in space-time.

Thus, like a marble sculpture whose shape is its visible surface, the "shape" of a fact is its boundary surface in four dimensions. The surface itself presents an appearance to us, but *has no volume.* Since it has zero volume (because its thickness is zero), the shape of a sculpture *does not exist* as something in space, and likewise, the shape of a fact does not exist in space-time. The *shape* of a sculpture is something immaterial (because it has zero volume), as is the shape, or narrative content of a fact. They exist in a physical sense (because the surfaces of objects *do* exist physically) but since they have zero volume they are not part of the material world, nor do they even exist in space and time.

This may appear, at first blush, to be quite an astonishing claim—but in fact it is an idea that has been kicking around for millennia. The sheer surface of an object such as the marble angel has no thickness, and therefore does not exist in space. In the same way, the surface of a fact (that is, its shape or content) has no thickness in space-time, and therefore is not something that exists in the physical universe. In the previous Section we made the same observation from a different perspective. It was shown that a fact is not something of the material world, but exclusively a description or claim made by a living being having a purpose or reason for being interested in that one specific fact.

This is quite an amazing observation. We live in an era when the dominant philosophy is materialism—the idea that everything that exists is material and part of the material world. But we have just found that all that exist are facts, and furthermore, that facts are not parts of the physical world at all, but ideas in Gestalt minds. It would appear, then, that what exists in our universe is not part of material reality, but part of the world of thought and mind. Neither Bertrand Russell nor anyone else denies that there is a material world—but what has just been shown is that matter is not all there is. I will come back to this question later in this chapter and argue that necessarily there are two components of reality: There is a material component described by physics, and another side which, though not material, is real and whose function is to give shape and structure to the material universe. Without this second aspect, the physical universe would be shapeless and without sense or structure—a kind of wasteland.

Facts and Information

It is hard to speak of anything in our day without bringing up the idea of *information*. The concept of information in its contemporary form is a scientific idea that first emerged in a technical paper by Claude Shannon in 1948. The most important aspect of Shannon's idea was that information is a quantity that can be precisely measured. He was specifically interested in how much information can be transmitted per second by a channel of communication such as a telephone line. But it was immediately evident that one could use Shannon's concept to quantify the amount of information in a strand of DNA, to determine how much information is needed to decipher a code, or how much information it takes to learn a new concept. The notion of quantifiable information is now ubiquitous in every branch of learning and is a staple of everyday conversation.[5]

The key idea is that information can be coded as a sequence of symbols of any kind. Since it is possible to translate mechanically from one set of symbols to another, it has become conventional to transcribe information in series of 0s and 1s. In essence, however, wherever there is some variation or modulation of a physical medium, there is potential information: It measures the amount of modulation or differentiation. Though information requires a material base to support the variation, information proper is not material but the pattern of the variation. For example, the airmass is the support for sound, but it is the *pattern* of vibration that is the actual sound. In fact, the very same sound can ride on any material support, for example on the groove of an old phonograph record, as the great inventor Edison realized.

This notion of information is of great value in science, but it falls far short of our intuitive idea of what should be meant by *information*. For us, information should be *informative*: It ought to bring us knowledge of things outside of us. It is in this sense that we wish to think of information in this book. We shall regard information as a non-material "something" which brings us new knowledge.

We have already noted that "the Map is not the Territory". In this metaphor, the territory stands for the external world separate from any observer. In contrast, the map is the description of the world, in images or words, acquired by a living observer. The first is matter, the second is information. Common sense lulls us into the belief that a solid object's form and structure are an inherent, indwelling aspect of the material object itself. However, as argued in Chapter 5, this is incorrect: Form and structure are Gestalt, wholistic aspects of an object and are accessible only to observers able to see in Gestalts.

A related error of common sense is the belief that it suffices to cast a glance at an object in order to spontaneously notice and take in the details of its shape. This is incorrect, because although the object we look at has a shape, the actual details and description of the shape are not *explicit* on the material surface, but must be scanned and assembled by the viewer. In other words, the shape information is not disclosed gratis by the material object: The information is produced by the observer as a result of a task of mental computation. In brief, the information as to an object's form and structure is not located in the physical object, but elsewhere: It is located in the observer. Every object, then, has two separate aspects: A material aspect, and the information which details its formal structure. The latter is manufactured by the observer.

What has been said for a material object is no less true for a fact, which is the description of an episode of matter-in-motion. The physical matter in motion is the "territory": It is part of the cosmic flow of matter in the universe. The fact proper is its description as an encapsulated whole event. It is information, and is located in the observer. The important conclusion here is that every fact consists of two separate pieces of reality: A purely material process that plays out in the physical universe, and information which captures its form and structure. The latter is not attached to the matter-in-motion, but separately located in the observer. Every event has a material aspect located in the material universe, and quite separately from it, information about its structure in the form of a Gestalt description.

As stated above, "information" is something that must be informative. For example, if you look at a message written in an alien script, it is not information to you because you derive nothing out of it. It is only *information* for a person able to read it. Thus, the structure latent in a solid object is information only for an observer able to take it in. Would it be information to a machine able to scan it and read out a certain kind of description? Clearly it would not: The reason is that the readings of the machine have exactly the same status as the structure of the object. The readings might be the positions of pointers on an instrument: They are again something material that has to be perceived by an observer to be real.

I have argued that nothing definite and specific can exist in the universe without the participation of a Gestalt subject. This does not mean that nothing exists, but things that are present in the universe outside the view of any sentient observer are latent and unrealized. They become actualized when living observers individuate them by assigning features and structure to them and perceiving them as wholes.

What does it take for an object to be *specific?* First, it must be precisely cut out of its background. That is, the information that reveals its position and boundaries must exist just as surely as its atoms do. If this information is absent from the universe, then the object does not exist. Indeed, for an object to exist it must be lifted out of the background in which it is deeply immersed. Michelangelo's angel does not exist so long as it is still embedded in the block of marble.

The information needed to separate the object from its background must disclose its features and, above all, its precise outlines. Only a living being having a purpose is able to do that. This shows that a particular, definite object exists if, first, it has a material base, and secondly, its shape, form, structure and individual identity are assigned to it by a sentient observer. As mentioned above, if it has not been separated out of its background, and no attributes have been ascribed to it by an observer, then it does not exist as an object. Its material content—consisting of atoms and energy—may exist in the physical universe, but it does not exist as an *individual object.* Objects do not exist outside the purview of minds.

Assume that an object with the shape of an isosceles triangle existed somewhere in the universe before there was life, and the shape has not changed. Today we can discern the shape of the object and state truly that it is a triangle and not a square. But was the same statement true in the early universe, when there were no observers? The universe obeys a principle of non-contradiction across space and time. Thus, if a statement about a past event (for example the statement"the object is a triangle") is true today, the very same statement could not have been false in the past. Thus, it must have been true in the past, even though unobserved and even though the fact could not be formulated.

By this reasoning, it appears that claims of fact made by living observers today are projected backward in time and are true retroactively. But there is a catch: These claims are expressed in a language known to the present-day observer, so the facts they stand for did not exist in the early world. To put it another way, the information which brings an object or fact out of the background in which it is immersed—this information exists today but did not exist in earlier times. Thus, the ancient object was an equilateral triangle from our present perspective, but was not an equilateral triangle in the ancient universe. Its atoms were there, but the information which assigns its form to it was absent.

This is an important insight: It shows that facts do not hold in the universe in an absolute sense, because the *fact itself* is an existing thing in the universe. If the solid matter is present but a fact (which is information about it) is absent, then the fact does not exist. We are blinded to that insight because of our false belief that what we perceive to be a fact is a fact in some absolute material sense, even if it was never articulated or described. In other words, we entertain the myth that the universe is full of unperceived and never-articulated facts.

Information exists only for living observers, because it must be registered in awareness. Again, the shape (or content) of a fact is not located in the physical unfolding of an event, but in the observer who sees it. This suggests that in the early universe, before the emergence of life, things happened but they did not give rise to information nor did they have any description or organization. What we regard as *real* are things given by information and therefore registered in consciousness. Prior to the existence of conscious awareness, there were physical processes, but they were virtual and not actual because they were not impressed on any aware observer.

In this view, something "magical" happens when a sentient observer registers a fact. What was, perhaps a moment ago, no more than atoms in haphazard motion, suddenly becomes an organized and meaningful fact. The event of being observed does not bring about any change in the matter or its pattern of motion. The change is confined to the observer. It is the observer that creates organization and gives rise to a new wholistic constituent of reality. This aspect of reality is restricted to the observer.

This is a powerful and far-reaching proposal. What it claims is that all of reality is divided into two very different branches. There is the purely material aspect of reality which encompasses matter and energy playing by the rules of physics. In addition, there is information—or rather knowledge—which is immaterial and which presents a far wider picture of what there is in the universe, since it includes form, structure and Gestalt complexity.

This claim is a huge challenge to the materialistic philosophy of our times. According to the prevailing world-view of the 21st Century, all that exists in the universe is matter (which is equivalent to energy) in the forms prescribed by modern physics. In the materialist view, everything else, including feelings, sensations, desires and thoughts consist of physical processes that take place in the brain. In the place of materialism, what is proposed here is that ours is a two-tiered universe. Two different kinds of things co-exist in the universe, one material and the other immaterial but nonetheless real and effective. Apparently it is only in living matter that the two interact. One may speculate that is the underlying cosmic function of life.

Facts and the Scientific World Picture

Contrary to everyday belief, the use of a scientific vocabulary doesn't brings us any closer to describing things "as they really are". It merely gives us a degree of analytic precision that doesn't exist in informal conversation. But it still rests on a human segmentation of reality: Science has a specialized vocabulary based upon its own way of analyzing physical phenomena. In the conceptual scheme used in physics, reality consists of forces, energy, mass, particles and so on. These are formal notions that the scientific mind has abstracted out of the bewildering flurry of ongoing activity all around us, in order to help make sense of it. These notions correspond to images in the scientist's mind, and it is in terms of such images that a scientist understands and creates new ideas.

If you claim that a particle is in motion, you must be able to speak of its position, direction, and relative speed. However, those features arise in the mind of a human observer who perceives the world in Gestalts. Speed, direction and trajectory could not exist if a mind had not carefully and purposefully extracted those features out of the dynamic activity of the world and made abstractions of them. Most importantly, such things exist only for an observer able to perceive in Gestalt wholes. Behind the abstractions, of course, is the bustling activity of the universe. The cosmic process which underlies our scientific abstractions is called the *primordium.*

There is a module of the brain—playing a hugely important role in the activity of all animals—which constructs the layout of space around us. The 2014 Nobel prize in neuroscience was awarded to May-Britt Moser and Edvard Moser for their research on spatial cognition. They showed that the organization of space is carried out in an organ of the brain called the *hippocampus*, which mentally divides space in a grid, which is like an inner coordinate system overlaid on surrounding space. Without a conscious sense of surrounding space, it would be impossible for animals to orient themselves, understand where essential objects are located, or construct action plans. What we know as "space" is the model constructed by the hippocampus, rather than something existing externally in the universe.[6]

The world *as we know it* is built out of sensations—it is made out of internally felt experience. It is second nature for us to assume unquestioningly that the physical world *really is* the way we picture it and experience it to be. How else could we possibly think of it? What alternative picture of reality could we possibly have? Moreover, it is perfectly natural for creatures who possess a coherent model of the world to assume it's reality.

We know by learning that the moon revolves around the earth in a roughly circular orbit once every 28 days. This fact surely seems to be perfectly independent of the human mind. However, when speaking of the motion of the moon in its orbit, the word "motion" refers to the *particular sensation* of visual flow produced in the mind by a dedicated module of the brain, because that sensation is what physical motion **is**.

"Not at all!", one may object, "the sensation is the brain's way of *representing* an external process, and that external process is what motion *really is.*" Well, there is indeed an external process which acts on us and causes our visual system to detect motion. However, that external process cannot be called *motion*, because when we speak of motion we are referring to a specific sensation that is perceived as a flow or drift over a brief interval of time. It is entirely dependent on the faculty of perceiving the world in Gestalt wholes—whole regions of space and (in this case) whole intervals of time. That progressive flow does not correspond to physical motion, which has a fixed value at each instantaneous point in time. The word "motion" refers to a *feeling* induced in us when our senses are affected in a certain way by an external physical process.

No doubt important things are going on in our solar system: But from a general, or universal perspective it cannot be said that those things consist of planets circling a sun and moons circling planets. Indeed, talk of suns, moons and orbits pertains to a specific *description* of the solar system based on man's scheme of segmentation. It is not unreasonable to suppose that there may be other kinds of articulate beings, in the vast immensity of the universe, for whom reality is carved differently, and whose concepts have no translation into ours. They might conceive of a solar system in categories quite different from ours, yet their account may be no less faithful to reality than ours.

The philosopher Nelson Goodman presents a similar perspective in his lively little book entitled *Ways of Worldmaking*. He refers to different schemes of individuation as different *versions* of reality. He agrees that terms such as "motion", "orbit", "circular" and so on flow out of a particular way of segmenting reality, and therefore express a perspective restricted to *one particular version*. He claims these terms do not stand for real things in mind-independent reality.

Goodman suggests there may be an underlying Ground Reality out of which all *versions* of reality are derived. If so, this original Reality would have no planets, no motion, no spacetime, no relations, no points—no structure at all. He describes such a reality in terms of a "cookie-cutter" metaphor: Reality independent of the mind is the dough, and our conceptual scheme is the shape of the cookie-cutter. Goodman concludes with the pessimistic view that a reality without objects or structure serves no purpose. In other words, for Goodman, the mind-independent, or pre-animate world has no value. Everything of value in the world comes from what's added by minds.

Mental activity is deeply involved in physical reality and plays a constitutive role in the very existence of material things. As already noted, it is the collective mind that divides up the physical primordium into individual objects. Every object and every event—prior to being extracted from the background in which it is immersed—is fully integrated in its physical context. Only a mind is capable of separating it out of the primordial mix in which it is deeply embedded, and establishing it as a separately existing thing.

In his book *The Analysis of Matter*, Bertrand Russell presents a comprehensive theory of what can be known of external reality, and how it is possible to know it. His account continues to be very influential in contemporary debates on the philosophy of science and the foundations of physics. These ideas have led to a school of thought known today as *structural realism*.[7]

The thinking of Bertrand Russell is deeply rooted in the philosophy of empiricism which blossomed in England in the Seventeenth and Eighteenth Centuries. The central ideas of empiricism are not new, but in their modern form they were first clearly articulated by the 17th Century Scottish philosopher John Locke. Every person, according to Locke, is born as a blank slate, or *tabula rasa*, and everything we know comes to us from our experiences. In particular, he claims, there is no such thing as innate knowledge. We are born with no preformed concepts or insights: Every item of our knowledge can be traced back to individual experience.

In a very modern way, Locke understood that the outer world impinges on our sense organs and produces impressions, or sensations. According to Locke, knowledge of the world accumulates as we compare sensations with one another, generalize from them, and unite them into larger, more elaborate thoughts. He imagined knowledge to be hierarchical, as well as atomic in the sense that every thought is built out of certain "elementary" thoughts.

Bertrand Russell accepts the core of Locke's thinking, and enunciates what he calls a *causal theory of perception*: Physical processes that take place in the external world activate our sense organs and cause us to have percepts, and from these percepts we are able to infer facts about the external world. The only way to have knowledge of the external world is to draw conclusions based on our perceptions. Consequently, our knowledge of the external world is indirect and inferential: Only knowledge of our own percepts is immediate. We have direct access to information about the nature of percepts, but not of objects, because these can be known only by inference. Russell's reasoning continues as follows:

Drawing on our common experience of cause and effect, we are entitled to assume that different causes lead to different effects, and different effects are the results of different causes. Thus, although the nature of the external world is unknown to us, we have good reason to suppose that the *structure* of our percepts repeats the structure of the external events which cause them.

Russell's conclusion is that the mind-independent universe is not inaccessible to us after all—but what we are able to know of it is limited to its structure. We are able to achieve perfect knowledge of the *structure* of the universe we inhabit, but the substance of objects will forever remain hidden from us. This way of thinking harmonizes perfectly with the practice in science, whose objective is to describe accurately the structure of observed phenomena, preferably in a mathematical form.

Note also that it is not essential that our sense impressions or perceptual experiences *resemble* the external events which cause them. The physical forces that act on our senses may be quite unlike anything that we perceive: Our mental pictures of events are consistent among themselves, and fully consistent with the feedback we get when we interact with objects. Thus, the world presented to our senses preserves the *structure* of its causal antecedents, but tells us nothing about the underlying substance.

If scientific explanation is based exclusively on the *structure* of phenomena, and nothing is knowable of reality except its structure, then maybe the idea that there is anything more than structure is superfluous. A number of scientists and philosophers have proposed as a possibility that structure is all there is—because that's all that can be known. Intuition tells us that this is unlikely, because structure refers to the arrangement or organization of concrete objects. But it has been suggested also that intuition cannot always be relied on, and there are things in the universe that outstrip the resources of intuition.

The ideal of achieving an understanding of phenomena by uncovering their structural properties is not new. Plato referred to this enterprise as *saving the appearances*. In the late Middle Ages, astronomers such as Copernicus who proposed a heliocentric model of the universe were very careful not to offer their theory as fact, but merely a way of *saving the appearances*, that is, describing the structure of the observed phenomena. The unfortunate Giordano Bruno asserted as a fact that the sun is at the center of the universe and the planets revolve about it. For this, he was burned at the stake. Bruno did not stop there, but suggested that all the stars are myriad faraway suns, and there might be planets circling them, some perhaps inhabited by ensouled beings.

Many scientists today identify the mission of modern physics as that of saving the appearances. The arguments of structuralism have decisively persuaded many that what is knowable about reality are the *relations* between entities and nothing more. Attempts to penetrate deeper and search for essences and ultimate qualities are speculation, and are in the province not of science but of metaphysics.

The agenda for modern science was lucidly and articulately laid out by the Dutch-born philosopher of science, Bas van Fraassen, most clearly in his book *The Scientific Image*. Toward the beginning of his book, van Fraassen proclaims the principle that the mission of science is not to give us a "true" story of what the world is like, but rather, to give us theories which are *empirically adequate*. He goes on to explain that a theory is empirically adequate if what it has to say about things and events in the world saves the appearances. In other words, the theories we construct on the basis of scientific measurements and observations must be fully coherent among themselves, and fully consistent with all our experience, especially the results of scientific experiments.

This mission statement for science is based on the recognition that only the *structure* of objects and events is knowable and can be articulated. If scientific laws are to be free of metaphysics they must confine themselves to assertions which are relational and structural. In order to accomplish this, the aim of a scientific research program must be to construct coherent *models* of natural phenomena and show that they are supported by observation and experiment.

A model of a phenomenon is intended to be an analog of the original. That is, whatever the features and behavior of the original, the model should have corresponding behavior and features. If you have a 'good' model, it can be used to predict features that have not yet been observed in the original. If experiments subsequently show that the real object has those features then the model is 'correct', or *saves the appearances*.

The prevailing opinion today in scientific philosophy is that the mission of science is to create accurate models of reality which correctly predict phenomena. We no longer believe that science can reveal the ultimate truths of the universe, nor are we sure that such a thing even exists. The grand adventure of scientific discovery kicked off with the belief that there is a limited number of things to know in the universe, and that one day we will go through them all and understand how the cosmos works. Today we understand that the universe has endless vistas, and as we learn more the mystery only deepens. It is we ourselves—as our understanding advances—who raise and create further questions that need to be answered.

7

Materialism: The Brain As Computer

Mind and Matter

The single most hotly debated issue in philosophy today is whether mental states, such as our sensations and perceptions, are of a physical nature or exist outside of physical law—governed instead by principles of some other, non-physical kind. This question is argued not only among philosophers, but among psychologists, linguists, biologists and physicists, because many other profound questions hang on this one. The most widely shared opinion today is that mental phenomena are subject to physical law, and can be fully explained by the principles of physics. However, this view is far from unanimous, and is vigorously contested.

Common sense points to what ought to be an easy solution: Physical mechanisms in the brain *induce* sensations, but the sensations themselves—as they are experienced subjectively—are not physical. However, if sensations are not physical, then in what sense can we say they exist at all? That's the crux of the problem introduced by Descartes. His solution is that thoughts and sensations truly exist, but they're a different kind of existing thing. Physical objects and forces exist and, separately from them, so do ideas and feelings in minds. So according to Descartes, we live in a two-tiered universe, with two entirely different categories of existing things.

That might not be a problem if the two orders of things remained separate. But they don't: Through our sensory systems, facts of the world impact our thoughts. And conversely, because our brains connect to our motor systems, our minds affect the world. It is therefore undeniable that the physical world and the realm of sensation are connected. Logically, we are left with three alternatives to choose from:

C. Pinter, *Mind and the Cosmic Order*,
https://doi.org/10.1007/978-3-030-50083-2_7

First, it may be that sensory experience can be explained by physical law. Alternatively, it may be the other way around—the nature of the physical world might rest on principles rooted in a mental reality. It is plausible that nothing exists unless it has been noticed, or grasped, by something like a mind. That was the position of the 17th Century Irish philosopher George Berkeley, who famously wrote:

> All the choir of heaven and furniture of the earth – in a word all those bodies which compose the mighty frame of the world – have not any subsistence without a mind.

Logically, there is a third alternative: It may turn out that there is a higher science which is inclusive of both physical reality and cognitive phenomena. No serious scientific work has yet been done on this third proposal. There is no clear best choice among these alternatives, and all three can be defended. However, for historical reasons the materialist, or physicalist approach has prevailed. To understand how that happened, we must go back to the changes that took place in European thinking after the close of the Middle Ages.

From the perspective of modern man, it is hard to fully take in how sweeping—how all-encompassing—was the transformation of the European spirit in the transition from medieval times to the Enlightenment. In the Middle Ages the church was the authority that controlled what people were allowed to believe, and the temper of the age was one of obedience and piety. The church taught (and most people believed) that there was a world of matter, which was the inferior realm, and a world of spirit ruled by divine edict, which was the superior realm.

By a bizarre logic which is hard to understand, the world of matter was equated with pleasure, greed and self-indulgence, hence people were admonished to resist its pull. Instead, one should aspire to exist in the realm of spirit, in which man reaches a higher level of existence by denying the yearnings of the flesh. Matter and material things were seen as base: For that reason, thinking people directed their interests to questions of the soul and neglected the study of the physical world.

By the opening of the 17th Century all that had changed. Men and women were exulting in a newfound freedom gained by a decisive rejection of the church's dominion over thought. After a thousand-year hiatus, interest was turning once again to the material world and to the sciences. The work of Galileo and of Isaac Newton showed that by applying reason and systematic thought, it was possible to fully account for the motions of the stars and planets—and moreover that material objects on earth obeyed the same laws as the heavenly bodies in their orbits. The Age of Enlightenment saw a sweeping, all-embracing transformation of the European ethos from mystical contemplation to a rekindled fascination with the material world in all its manifestations.

This was not merely a shift in the way problems were seen and the kind of solutions that were put forward, but was a re-commitment to a whole new order of reality. The universe was no longer viewed as a great stage on which the divine drama was enacted, but was now seen as a space extended in three dimensions in which material bodies travel in well-defined orbits governed by deterministic laws. From the dynamics of moving bodies it was possible to discover the nature of other forms of energy such as heat, and to understand how substances interact chemically. As time passed, it became clear that the scientific method of reasoning and experimentation was uniquely suited to achieve a deep understanding of all aspects of the material world.

Newton referred to his grand synthesis as the *System of the World*, and that was an appropriate title for the aspirations of science in the centuries following the Seventeenth. From a basic understanding of the dynamics of moving bodies it was possible to derive, one by one, all the principles of classical physics, so each new discovery found a natural place within the grand design. Modern science comprises our knowledge of the material world, and it is generally accepted in our day that all firm, reliable and correct knowledge is based in physical reality.

The Mary Chronicles

The contemporary debate on mental phenomena is over the question of whether or not mental processes—especially consciousness—can be explained by the laws of physical science. The theory which upholds this position is called *materialism*, or sometimes *physicalism*. The most explicit form of physicalism is called the "identity theory" and maintains that feelings and thoughts are *nothing but* electrochemical events in the brain. The theory cannot explain what feelings are, nor does it enlighten us on how electric activity in nerve fibers could be literally *the same* as an experienced sensation.[1]

Nonetheless, the identity theory is probably the working hypothesis of most research scientists who study the brain, for it is consistent with a large body of experimental evidence. Every form of mental activity—thinking, seeing, feeling, dreaming—shows up on MRI scans as activity in particular areas of the brain. Such probes are replicable, in the sense that the same sensation or thought always produces the same pattern of activation in the same regions of the cortex. From a perfectly rational point of view, the case is closed: The evidence reveals nothing more than neurons firing in the brain. All else is figment.

An alternative to the identity theory is an approach known as *functionalism*. The idea is that any complex system, of any kind, consists of many parts, each of which carries out a specific task. In the animal body, for instance, the heart pumps blood, the liver produces enzymes for breaking down complex molecules, the kidneys filter impurities, and so on. Systems such as the animal body can be represented by flowcharts which exhibit all the components, along with the task each component is mandated to carry out. Hypothetically, every organ might be replaced by a machine which does the same job. If the exact organization of the flowchart is retained then the resulting system would function like a body.

The brain too consists of a great many modules, each dedicated to an assigned task, such as memory, attentional focus, arousal and others. According to functionalism, mental activity consists of a great many isolable functions. We remember, weigh choices, make decisions, and so on. The way these activities interact may be represented in a flowchart. Moreover, it is plausible that each of these fundamental activities could be carried out separately on a silicon wafer—and so long as we retain the same flowchart, the same processes will unfold. It is irrelevant how the individual tasks are done: The essence of functionalism is that all that matters is the way the tasks interact globally as a system. Once appropriately organized, a system is what it is.

Functionalism, as well as the identity theory, are physicalist approaches to the mind. What they have in common is that both argue that physical mechanisms perform mental functions such as thinking and feeling. Both have a feature called *multiple realizability*: It claims that elementary mental processes do not need to be carried out on living organisms, but could be executed on artificial systems so long as the same functional organization is retained.

There are other arguments, too, constructed in order to support the claim that mind is merely the electro-chemical activity of the brain. Each one of those arguments, however, leaves out the matter of sensation and felt experience. They would be rock-solid scientific explanations if humans and animals felt no pain, joy, sadness, and were not aware of what's happening around them. In fact, some of the best minds in cognitive science have found arguments which purport to prove that sensation and awareness don't *really* exist at all—and have managed to convince themselves of this. In this way of thinking, sensations and feelings are *epiphenomena*, that is, they are illusions, and don't exist in the world.

There are volumes devoted to arguments supporting as well as demolishing the ideas of physicalism, but most of them are too technical to be discussed in detail in the present book. However, there is an animated exchange of views among philosophers and scientists—on both sides of the controversy—which has come to be known as the *Mary Chronicles*. Though most of the debate is contained in papers found in scholarly journals, a few representative ones are collected in a recent book which makes entertaining reading and sets out the principal viewpoints.[2] The question debated in these papers is whether the sensations that a person experiences—in this case the sensation of colors—can be reduced to electrical activity in the brain, or whether it is something that is not physical.

The underlying premise of the Mary Chronicles is that a scientist named Mary has been imprisoned all her life in a dungeon in which everything is a uniform grey. She has a computer with a black-and-white screen, and has learned absolutely every material fact about color vision. One day she is rescued by a philosopher-prince[3], and as she goes into the garden she sees color for the first time. Frank Jackson, the author of this tale, asks whether at the moment she steps into the garden, Mary learns something she did not know before: If she does, it cannot be a material fact, for she already knew all the material facts about color vision. So her experience of color is not something material.

Jackson proposes this mind-experiment as proof that not all mental things are physical. The subjective experience of color, for example, is not. Thus, although Mary knew all the *facts* of the color experience, she did not know the feel of it. The feel is something new which Mary could not have known before, because *it is not something physical*.

Materialist philosophers don't agree with that reasoning: Famously, David Lewis asserts that what Mary has discovered in the garden is a *new ability*: She now has the skill needed to recognize colored things when useful, for example in daily tasks. In Lewis's view, such abilities are mundane pragmatic skills necessary for survival, and nothing more. It's something we are able to *do*, not something we *know*.

Others argue that since Mary already knew all the facts of the color experience, she couldn't have learned anything *new*. Rather, in the garden she encountered something she already had knowledge of, but it was now presented to her in a different form. The point of this objection, like the previous one, is to argue that if Mary already knows all the material facts about the color experience, then she learns nothing new because there *is* nothing more to subjective experience than physical fact.

On the other side of the fence are the philosophers who aim to discredit the physicalist viewpoint. One of their stratagems is the Zombie argument. In philosophy, Zombies are imaginary quasi-humans that resemble humans in every anatomical and physiological particular – even their brain structure is the same—but they are not conscious. We even allow them to have beliefs, thoughts and decision-making processes such as ours, but in Zombies these processes are directly connected to behavior and don't lead to awareness. For example, when Normal Jack and Zombie Zack each take a bite of chocolate cake, they both have the same reaction: They both comment on how delicious it is and ask for a second helping. But only Jack has the sensation of its taste and is *aware* of the pleasure.

The upshot of this story is that Jack's awareness—his feelings and sensations—are something over and above the physical facts. From this, one is expected to conclude that consciousness must be nonphysical. Although this story argues against physicalism, it has the unfortunate consequence of suggesting that sentient awareness serves no purpose and that people and animals could very well get along without it. This viewpoint is called *eliminativism*, and is staunchly defended by many neuroscientists. You might say that it is an extreme form of physicalism.

... But not the most extreme: A number of very clever people would like to convince us that subjective feels don't exist at all. Daniel Dennett, for example, would like to reverse our 'mistaken' intuitions about consciousness and prove that the special qualities we seem to experience when we taste sweet or see the color red are not real, and their existence cannot be defended except by appealing to something mysterious outside the bounds of nature. To illustrate his viewpoint, he too proposes a modern myth, or as he calls it, an "intuition-pump".

Mr. Chase and Mr. Sanborn are coffee tasters. One day Chase says, "You know, today the coffee isn't the same to me—the taste has changed." Sanborn replies that he too notices a difference, but the difference is in his taste buds, and the coffee's taste is exactly as before. Who's right—Chase or Sanborn? Chemical analysis would be able to detect any possible change in the chemistry of the coffee, but would not reveal a change in its *taste*. Since taste is what this is about, there is no *fact of the matter* of who's right.[4]

Dennett takes this as a typical illustration of the fact that subjective qualities such as taste have no relevance to the real world. They may be very real in the mind, but they have no objective validity. In particular, they lack any power whatever to affect things in external reality.

The reluctance to accept the existence of anything non-physical is not entirely new in science. In the Seventeenth Century, the idea of electromagnetic waves traveling through space, in the absence of material support, was considered implausible. Electromagnetism and gravitation do not conform to the laws of classical physics in which force is relayed by physical contact. Instead, they appear to be some kind of spooky action at a distance. Magnetism was well known—just as consciousness is to us—but no explanation for it was available in terms of the accepted paradigms. Newton himself searched for an explanation consistent with accepted physical principles—even once proposing invisible skyhooks holding planets in orbit. It is worth quoting Newton on the matter of force relayed without physical contact:

> [T]hat one body may act upon another at a distance thru' a Vacuum, without the Mediation of anything else by and through which their Action and Force may be conveyed from one to another, is to me so great an Absurdity that I believe no Man who has in philosophical Matters a competent Faculty of thinking can ever fall into it. [Isaac Newton, Letters to Bentley, 1692]

The matter was not clarified until the Nineteenth Century when James Maxwell introduced the notion of fields of force, which are able to unite the phenomena of gravitation, electricity and magnetism into one system. This new paradigm was so powerful that it was immediately accepted by scientists, who learned to incorporate its ideas into their framework of common sense. This historical episode is very much comparable with the present-day refusal to admit sentience as something consistent with physical law. Almost echoing Newton, there are people today who say that having sensations and feelings without the mediation of a physical mechanism is an Absurdity.

Meanwhile, look at how far physics has come in the last hundred years: It is universally accepted that space and time interpenetrate, they can be bent and deformed, and are not continuous but granular. Particles are not bits of matter, but abstractions that achieve physical existence only at the instants when they interact with other particles.

The mystery is that in an age when physics has carried us into such a fantastic and unimaginable reality, we still balk at the idea that there are mental phenomena which do not follow the rules of classical physics. Why is it so hard to accept that in a universe in which space-time bends and curves, where particles of matter weave in and out of existence, and space itself is particulate—why would it be strange to accept that the mind of living animals is something complex whose laws are not the same ones that have been familiar to us for centuries?

The Heart of Physicalism

The physicalist way of thinking has a tight grip on Western science and philosophy, and possesses the distinctive spirit which sets European civilization apart from the high cultures which have flourished in Asia. The basic intuitions, the manner in which fundamental problems are formulated and the kind of solutions that we seek—all possess the essential hallmarks of pragmatism and materialism. Moreover, the materialist point of view has been prolific in giving rise to an abundance of new ideas, which harmonized with one another to form a coherent Western ideology.

The physicalist way of thought appears already in a mature form in the writings of the Ionian Greek thinkers in the First Millennium B.C. What they aspired to know were the fundamental principles of nature, which they called *physis*. They conceived the idea that, underlying all natural phenomena, there are systematic laws and principles. Most importantly, these laws are accessible to the mind and therefore knowable by human reason. The idea that nature is ruled by systematic laws—and moreover that these laws are knowable by the mind—was revolutionary. It empowered man and promised control over nature.

Perhaps the most central contribution of the Ionian philosophers was their assertion that nature is formed of *matter*. They theorized that all matter is made up of certain underlying elements. In early accounts, these elements are earth, water, fire and air—but in a later, more sophisticated version, all matter is made of indivisible particles called atoms. The atoms are in motion and interact by colliding with one another or hooking together to form larger units. One can only marvel at how closely they anticipated modern science.

Plato took the next step by making it clear that in order to attain correct knowledge, it was not enough to observe and make conjectures. Rather, you had to *abstract* from what you observe in order to discover underlying patterns that unite many observations under a very few basic laws—because the most important aspects of knowledge are the broad principles you are able to derive by generalizing from particular cases. Aristotle added that the source of all knowledge is in the world, and does not arise in the mind as speculative thought. He also brought to light the importance of two cornerstones of physical thought: *causality* and *determinism*.

It is a great irony that whereas physics was the inspiration for Western materialism, contemporary physics has turned in a direction where it nonchalantly disregards violations of causality and determinism, which are the very bases of original physicalism. Research in physics is indifferent to ideology, and goes wherever the results of research take it. Its basic concepts are becoming increasingly abstract, and increasingly detached from the natural intuitions which originally defined it.

One classical definition of materialism claims it's the viewpoint that all natural phenomena can be explained by physical theory. The philosopher Carl Hempel pointed out that such a characterization of materialism is flawed, because physical theory is a work in progress, and undergoes profound changes every generation. What once violated a law of physics may be core physics today. As discussed earlier, that is exactly what happened with the phenomena of "action at a distance" in magnetism and gravitation.

In this regard, it is worth noting that the introduction of field theory did not retroactively explain magnetism and gravitation in the familiar terms of classical physics. Quite the opposite: It introduced an entirely new conceptual framework, alien to the old physics, which demanded a whole new way of thinking about the motion of charged particles in space. There was no intuitive crutch to prop up the notion of fields existing in a vacuum. Instead, since this was plainly the only feasible path for moving forward in physics, scientists made the adjustment and incorporated the new imagery of fields into their intuitive judgment of what is physically plausible. Intuitions are more pliable than we believe.

Thus, while physicists were open to new ways of imagining reality and were able to change their commitment from an old paradigm to a new one when the facts called for it, thinkers who studied the mind were bogged down in viewpoints which have been held since the time of Plato. The study of mind today has been shaped by two events of the Twentieth Century: The first was the rise of behaviorism, which was motivated by the very legitimate desire to remake psychology into a more empirical, experimental science. However, due to its limited technical resources at the time, the new psychology confined itself to the study of stimuli and responses, and conceived of minds as systems of reflex arcs.

The second, and far more important event of the century was the invention of electronic computers. Early computers were known as "electronic brains", and it was assumed that any problem that can be solved by people can be solved more rapidly and accurately by computers. In public opinion this was the sequel to the industrial revolution: Just as machines had replaced human muscle, it was assumed that computers were about to relieve man of the drudgery of routine thinking tasks.

Work in the anatomy and physiology of brains had already demonstrated that animal brains consist of millions of nerve fibers which transmit messages, and many billions of neurons which are essentially electrochemical relays. You are inescapably struck by the resemblance between computers and brains. From the 1960s on, the digital computer became a standard metaphor for the brain—and the metaphor was taken very literally.

What also seemed inescapable was the conclusion that if the brain is a computer, then conscious processes are software running on the hardware of a brain. This idea captured the imagination of psychologists and philosophers alike, and gave rise to the discipline of cognitive science, which is the culmination of physicalism. According to cognitive science, thinking and problem-solving are computations, and all mental activity consists of manipulating symbols in the brain.

There is no hard evidence to support that idea, and it is plainly false: Indeed, brains operate almost exclusively with Gestalt thoughts and images, whereas computers are forever constrained to operate serially. The hallmark of mental processes is that they are global and unifying, whereas any process that moves forward step by step, in linear fashion, is quintessentially mechanical.

It is an interesting fact that everything computers do can be done just as well (but more slowly) on the calculating machine invented by Charles Babbage in the 1820s, which works with cogs and pinions. If you believe in the computational theory of mind, you must likewise believe that a gadget of cogs and gears can do everything a brain does.

The computational theory of mind has a clever and controversial way of explaining how computers are able to carry out intelligent tasks which (when *we* perform them) require the understanding of meaning in language. All language, either natural or artificial, has two aspects: First is its *syntax*, which consists of the rules of grammar and word order which make it possible to communicate with language at all. Second is its *semantics*, which is the way words and sentences correspond to things in the world, and therefore have meaning. Computers operate mechanically on symbols, and are therefore able to handle the syntax of language, but computers have no access to meaning.

It has been suggested that this difficulty can be overcome by tying the syntax of computer languages to their semantics. In other words, word meanings can be *coded into the syntax*—so semantics runs parallel to the syntax, although there is no contact between the two. A computer pays attention only to the shapes of the symbols (that is, the syntax), but it is claimed that it may operate in a manner which respects semantic constraints. In a nutshell, the shapes of symbols and the ways they connect with each other can be made to mimic the way the objects which the symbols represent combine with each other. So according to this claim, the way computers process symbols can be made to mirror the way objects relate to the world. Thus, though they have no semantic power, computers can be made to operate *as if* they understood meaning.

Cognitive scientists claim that it is due to this parallelism that intelligence and meaning are mechanically possible. They also claim that this very mechanism explains *how meaning is understood by people.* According to this view, meanings (and perhaps sensations too) don't exist as such: They exist only virtually—hitching a free ride on the computations carried out by the brain. The claim is that brains operate *as if* sentience and meaning existed; when we observe others, we mistakenly impute sensation to them, and by extension to ourselves.

According to this viewpoint, "as-if" meaning is not merely the way of computers, but *all* meaning is "as-if". This is entirely consistent with materialist philosophy, because it presumes that brains are physical devices with analogies to computers, and carry out their functions linearly, in the form of sequential computations.

The Berkeley philosopher John Searle vigorously opposes this viewpoint, and has written an influential critique called the *Chinese Room* which has generated as much commentary as the Mary Chronicles. This thought-experiment begins, just as Mary's story does, with a scientist locked in a room. His task is to receive questions written in Chinese through a slit in the door: He has a great pile of Chinese characters on the floor, and among them he must find a match for the question that has just come in. Then he slides the answer out through another slit. He must do this although he doesn't know any Chinese at all. In order to help him, he is given a rule book—and by comparing the shapes of Chinese characters to similar shapes in the rule book, he picks out the correct answer. What he does is based on the shapes of symbols, and nothing else.[5]

After awhile, the scientist becomes so proficient at following the rules that, from the point of view of a Chinese speaker outside the room, his answers are indistinguishable from those of a Chinese native. This is true even though he actually knows no Chinese.

Now forget the scientist locked in his room, and imagine the same situation with a computer having the rules in its program. Such a computer would give polished answers to questions posed in Chinese. Could one argue that the computer knows Chinese?

Of course not: The computer acts mechanically, just like the scientist in his room when he compares the shapes of written characters. The computer—and the scientist—pay attention only to the syntax and have no access to meaning. The computer is merely simulating intelligence, and hasn't solved the problem using authentic understanding. What Searle is telling us with this story is that computers are not truly intelligent, and in addition, syntax cannot give us semantics.

Physicalists respond that if the computer accomplishes the very same task as a person who *has* understanding, it is meaningless to claim that the computer lacks understanding. It is merely our human bias to assume that if it doesn't *feel* intelligent to us, then it isn't. We associate understanding with a particular sensation—but understanding may come in many different forms. The physicalist would tell us that if only we opened our mind to a wider perspective, we would see that understanding can occur outside the human context, in a form such as that of our Chinese room program. To coin a phrase, understanding *is* what understanding *does*. This would be mechanical understanding—and that's what many cognitive scientists say we have.

Beyond Physicalism

Even the true believers acknowledge that much of the physicalist theory of mind has only limited plausibility and is hard to accept. The critics, who batter and pummel the physicalist point of view, are many and articulate. It almost seems unfair because physicalism is so easy to criticize. But the physicalists remain dominant, because at the end of the day, there is no viable alternative.

In the interests of fairness, it must be acknowledged that physicalists, too, disparage and flog their critics: That too is easy to do, because the critics cannot present the physicalists with a solid alternative. The critics of physicalism are often accused of being mysterians, or even worse, Cartesians. They're in a difficult position, because what they're claiming is that there are phenomena in the real world that are non-material but nonetheless able to affect the material world. (Material includes force and energy.) When you defend such a position you find yourself in the same party as proponents of psychokinesis and extrasensory perception: You're skating on thin ice.

There is an intermediate position that some people have taken, called *emergentism*. Emergent properties are important in science, and also quite common.[6] As an example, when water freezes, remarkably complex ice crystals are formed, whose geometry is neither present nor latent in liquid water. The formation of such crystals is an *emergent property* of water. Very frequently, a complex structure has properties which are absent in the component parts, and could not have been predicted: They're emergent properties of the newly-formed structure. It has been claimed that sensations and awareness are emergent properties of complex nervous systems.

A related but far more egregious idea is called *Integrated Information Theory*. It is a proposal which has wide currency today, and is accepted by a number of very clever people who ought to know better. The theory concerns any system, such as a brain or computer, in which a network of interconnected wires brings channels of information together. According to the theory, when the network of wires is sufficiently large—so the connectivity of the system exceeds a certain unknown threshold—then the network undergoes something like a phase change. Just as the phase change in water gives rise to crystals of astonishing complexity, the phase change in data processors gives rise (somehow, but nobody can explain how) to the phenomenon of consciousness. So the theory claims. However, there is not a scintilla of evidence to support it.

A scientific account of conscious awareness is something that lies in the distant future. A lot of new facts remain to be uncovered, as well as new ways of studying mental phenomena. There is a huge gap between what is known today and what remains to be known in order to explain what mind is. Scientists refer to it as the *explanatory gap*, but few really appreciate how wide the gap is.

What do we really mean when we say we're seeking an account of mind to replace the physicalist point of view? Certainly we don't expect to find an explanation which is at odds with scientific theory, or even independent of it. A reasonable attitude to have is that present-day physics is incomplete, and that continued empirical research, probably based on a fresh paradigm, will bring to light new aspects of the physical world.

An important point to consider is that the way we represent the world—the picture of the world in our heads—is a biological adaptation, designed to give us a depiction of reality made to serve our activities and goals. Moreover, we project this custom-built perception onto the outside world, and assume that what we perceive is ultimate reality. This habit may blind us to important aspects of the world which are right in front of us, but go unnoticed. Further progress will depend on an open-minded approach, unfettered by dogmatic commitments to a rigid and outdated idea of physicalism, and also unencumbered by Quixotic speculations.

Materialism and Objectivity

Science is based on a notion of *objectivity* which is intimately tied to materialism. The idea of objectivity concerns the kind of claims that science is entitled to make, and how those claims correspond to actual facts of the world. *Objective* statements are required to be radically divorced from all personal and subjective judgments, interpretations and perceptions. When a scientist observes phenomena, it should be as if no person is watching. Instead, measurements are made with instruments, and the results of measurements are recorded on a material support such as paper. In fact, the measurements could very well be carried out by a machine with no human intervention: The results of measurements are given, say, by a pointer on a gauge, and may be printed automatically. All personal judgment is suspended. It should appear as if this process is taking place in a zombie universe.[7]

The "zombie universe" of objective science is exactly the mind-independent universe discussed in Chapter 2: It is the residue after all sensable qualities of objects have been taken away, leaving objects with no color, appearance, feel, weight or any other discernible features. In fact, every feature which might impact the senses—hence produce an impression of some kind—is absent because in this hypothetical universe there is no life and there are no senses. Everything material may be there, but not the senses. As Kant said about the noumenal world (which is the same as the mind-independent world), nothing can be said about its objects except that they exist.

In the absence of features of any kind, it is impossible to describe individual objects and characterize them. What can be done instead is to compare things with one another and define them in terms of each other. For example, a straight line looks a certain way to the human eye—a way that makes us recognize it as 'straight'—and a heavy object makes itself known to our senses by being hard to lift. But the ideal of objectivity requires that we reject these interpretations of physical phenomena, because they rest on the idiosyncrasies of sensory impressions.

Instead, we must treat the objects of study in a neutral fashion, based on the way they relate to one another. For instance, we perceive a straight line as the shape of a dangling plumb line. The path of an object in free fall is also a straight line, and so is a taut string. In order to be "neutral", you take the notion of straight line to be an *undefined concept*, and record the fact that taut strings, plumb lines and the paths of objects in free fall are straight lines.[8]

If you aim for objectivity, you must then go one step further: When you speak of a straight line in science, you must suppress the image of the taut string in mind. You must force yourself to forgo any mental picture of what a straight line looks like, and instead, think of it as nothing but an empty word. When you use that word, you may hold the image of the taut string in mind, but that's for your own benefit: It may guide your intuition but should not participate in your reasoning.

In order to carry out such a program, it is essential that the basic notions (distance, mass, and so on) be treated as undefined concepts related to one another by formal relations. Within the confines of scientific reasoning, these entities must have no meaning. If you yield to the temptation to imagine them in mind with a concrete meaning (for example, to imagine a line as the shape of a taut string), you must be careful not to allow the meaning to slip into your reasoning and play a role in your conclusions. For suppose you slip, and continue to identify a straight line with a taut string. Suppose furthermore that you *make use of your mental image* in scientific reasoning, so the validity of your conclusion rests on the intuitive image.

If that were permitted, then the laws of science would depend on the meanings we attach to concepts—on the mental images we hold in mind. The laws would be true for all the objects having the same meaning or mental image—but might be false for objects with the same formal definitions but different meanings in mind. They would depend on subjective mental contents. That is the very situation that the objective method is designed to avoid.

Imagine now that we try to use the objective method to study the mind. The elementary constituents of mental phenomena are things such as feelings, sensations, awareness and so on. If we applied the objective stance to these concepts, they would be treated as undefined notions, without meaning, just as points and lines are treated in geometry. We would not be allowed to attach any intuitive interpretation to them, but instead, they would be treated as tokens with no intrinsic meaning.

If this were done with mental entities, we would no longer be speaking of mind. Subjective categories such as sensations and impressions are *nothing but* the way they feel to us. If they were abstracted out of psychology, the resulting science would be vacuous, a meaningless board game.

Claims about mental phenomena depend ineliminably on the meanings of terms such as feelings and sensations, and cannot be treated as the objects of physics are treated. One can study the material universe while pretending there is no mind, but one cannot study mind while pretending there is no mind.

The question that arises in that case is the following: Can the science of mind be regarded as the study of a material system, or not? Is it possible for a material system not to yield to objective analysis? This is not a textbook of philosophy, so I will not go further into this question. But I surmise, and propose, that phenomena which don't allow themselves to be studied objectively are not material phenomena. This suggests that we may define material phenomena to be exactly those phenomena that are amenable to be studied objectively, as formal systems. Phenomena which are not amenable to being treated objectively are not material. They are phenomena of a different kind, located in a different order of reality.

8

The Universe Observed and Unobserved

Addition of Simples

Science is not without heart. Throughout history, the scientific explanations that have endured are the ones that are simple and easy to understand. In addition to simplicity, they have a certain quality that is called “elegance”. For instance it was Archimedes who discovered the law of buoyancy. It is said that he was taking a bath when it suddenly came to him that the buoyant force lifting him upward was equal to the weight of water his body displaced. He was so struck by the naturalness and elegance of this discovery that he jumped out of the bath and into the street shouting “Eureka!”

Many scientists have stories of their Eureka moments, whether in bathtubs, during walks in the countryside, or in their labs. What incites them to shout out Eureka is not so much the fact that the explanation they have discovered is correct, but that it is simple, graceful and fits together naturally. Many scientific discoveries start out in a form which is needlessly complex, but eventually it is pared down to its bare essentials, and then gets the recognition it deserves.

One of the most important virtues of a good scientific theory is that it is *parsimonious*: It depends on few variables, invokes few extraneous assumptions, and provides a unified explanation of the data. One of the earliest statements of this principle was made by the 14th Century Franciscan friar William of Ockham, and is widely known today as *Ockham's razor*. What it says is that, other things being equal, the simplest theory consistent with the data is the best one.

The ideal of elegance and simplicity has been a guiding principle of science from its very beginnings. That is not surprising. What *is* surprising, however, is that nature itself is simple, and lends itself readily to simple explanations. *That*

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is an astonishing fact, and it begs for an explanation. Why aren't the phenomena of nature far more tangled and complex than they are? Trying to explain why nature is simple is the aim of this section.

The dynamics of moving bodies, for example planetary systems, was rigorously explained by Isaac Newton in the 1600s. The basic idea is that any two bodies in space are attracted to one another by a force which is proportional to the product of their masses, divided by the distance between them squared. This particular detail doesn't concern us here: What is important, instead, is that the pattern of motion of the myriad bodies coursing through the universe is completely determined by a law which applies *to just two bodies at a time*. Thus, to explain the dynamics of moving bodies in space, it is sufficient to know the dynamics between two bodies. The law governing each pair of bodies is repeated innumerable times—on every pair of objects in the universe.

Every body in space influences every other body by Newton's law, and the combined motion of this numberless swarm of heavenly objects is completely accounted for by the dynamics of two bodies, repeated over and over on every pair of them. A law involving just two—or a small number—of separate objects is said to be *simple*. And when a simple law acts on every pair of objects in a swarm, resulting in a complex global pattern of the whole throng, the overall pattern is caused by what is called an *addition of simples*.

It is similar when objects are stationary: If you have a structure with many forces acting on each component, for example a Gothic cathedral, you consider every force vector individually, then add the forces by vector addition to get the resultant force. In fact, vector addition is the archetypal example of addition of simples. In a situation in which there seem to be infinitely many forces—such as the pressure of water at every point of a ship's hull—we integrate the force vectors, which is a fancy way of adding infinitely many of them.

A force field such as that of gravitation is spread out in space. The field gives rise to a force vector at every point at which a mass is present. In order to find the total gravitational force on a solid object, the separate vectors at all the points of the object are added together, or integrated. Physics would not exist if it were not possible to analyze phenomena of the world by decomposing them in this manner into elementary interactions. We are able to do this because nature itself is constituted that way. It appears that all of the physical world is an addition of simples.

It may not be outrageous to argue that the rise of science in the 16th Century was less due to the discovery of rigorous reasoning than to the revelation that nature is simple, and that this simplicity can be exploited to find elementary laws which account for phenomena.

Simple rules, acting over and over on each of a large number of objects, are able to give rise to astonishingly complex collective behavior. In fact, they often generate repetitive patterns having great regularity and symmetry. This fact is at the origin of the new science of Complexity, which is striving to work out the details of how simple laws lead to complex global phenomena. The perplexing intricacy that we see in the world is actually the cumulative result of simple laws that have been operating for billions of years, creating patterns upon patterns.

A computer program known as the *Game of Life* was devised in 1970 by the British mathematician John Conway: It is a provocative example of the way simple elements, manipulated according to simple rules, can give rise to complex global behavior that looks like the product of careful design. The game unfolds in successive steps, one step at a time. It consists of a two-dimensional grid like a chessboard: Each square may be either dark or lit, and there are three rules whereby each square interacts with its neighbors. (1) Every lit square with fewer than two—or more than three—lit neighbors goes dark. (2) All the other lit squares remain lit. (3) Any unlit square with three lit neighbors lights up. Each step of the game leads to the next step by applying one of these rules.

The game begins with an arbitrary configuration of lit squares, and in one cycle, the rules are applied to every square. The same is done on every cycle, over and over. Depending on the initial configuration, all kinds of regular patterns evolve and dance in unison across the screen as the basic cycle is repeated. Patterns build on patterns and appear to be purposefully designed, though in fact the patterns evolve blindly.[1]

The fact that the physical world evolves by addition of simples is enormously significant: *It reveals that Gestalt, or wholistic processes, do not play a constitutive role in the physical world. When global patterns emerge, they are the result of elementary laws. Physical laws are not irreducibly wholistic.* In fact, global processes are alien to the strictly physical side of reality, for they arise in perception only.

For complex objects, their Gestalt unity is a creation of the mind and is not an aspect of the underlying matter: Their global character is the way they appear to observers. Their wholeness rests on a material substrate but is not material—it exists only in perception. The unity seen in complex objects does not dwell in the physical world but in perceivers.

For instance, Newton's equations, which apply to pairs of bodies in space, determine the trajectories of planets around the sun. However, these trajectories are meaningful only to beings who see and conceive in Gestalts. The shape of an orbit, though it exists only in the eyes of a Gestalt observer, is a direct consequence of Newton's laws, and no further principle is needed to account for it.

Although the shapes of orbits are fully determined by the underlying physics (that is, by addition of simples), orbits *exist* only in the scheme of reality of Gestalt observers. The reality which a Gestalt observer perceives is quite different from that of the underlying physical world. In the Gestalt whole, the observer sees patterns—and these patterns do not exist in the ground reality because patterns emerge only in spread-out wholes and exist only in Gestalt perception.

This idea may be clarified with a parable. You often see displays in store windows in which little lights turn on and off, synchronized to produce a message in lights which is seen as a series of words moving across the display. As a Gestalt observer what you see is the written message, for instance "Best Price Guarantee", drifting slowly from right to left. However, what is actually happening materially is that light bulbs are turning on and off separately from one another. Two very different things are going on at two levels of reality. On one level, single lights are turning on and off. At a different level, a written message is being displayed.

What *physically* reaches your eyes are the separate lights. However, because you view them not as individual lights but as a composite whole, what you *see* is a message, hence a different reality altogether. The separately flashing lights are the ground reality rooted in the physical world, but you're a Gestalt observer and your experience is of a unified display—a reality which is entirely different.

When a subject sees a whole, spread-out scene in one glance, what lies before her or him is nothing over and above the elementary components which are physically present—the many individual pixels. The subject is not seeing anything that is not physically there. Yet what's brought to awareness are not the elementary components but the entirety of the display as a unified, single Gestalt. Seen all together as a single entity, a display evokes meaning that was absent in the components separately. There is nothing physically new in the unified glance, but by seeing it as one, *what is perceived is something new.*

As another example, think of a machine, such as a steam engine used to power a locomotive. A human observer is capable of holding all the different parts together in mind and visualizing how each part interacts with others to make the engine work. The human *understands* why the engine does what it does, and knows that its purpose is to supply power to the wheels of the locomotive. In the physical world, however, all that is happening is that each part separately pushes or pulls the parts that it's attached to.

There is a physical side of reality which unfolds heedlessly, dumbly, mechanically—and there is a separate aspect of reality which has unity, wholeness and exists only in the purview of a perceiver of Gestalts. Perhaps Descartes was on the right track, after all. There *is* a fundamental schism in reality, but Descartes failed to identify correctly where the fissure lies. It may be argued that the divide actually lies between the strictly material side of reality, and the side which has the power to present itself in Gestalt wholes.

If Gestalt processes are not indispensable in the physical universe, why do they exist at all? The global patterns and large-scale properties of the universe come into being only as Gestalt representations in observers. One might contend that they are *potential* in pre-animate reality, but they don't exist until perceived by a Gestalt subject. They come to exist when they are—with great computational effort—purposefully separated out of the background in which they're enmeshed.

Compound objects, such as machines, exist in a compound form by being perceived that way—but when they function mechanically, they operate by addition of simples, with each component acting mechanically on every other.

It may be concluded that there are two forms of existence: One is the purely material: Its properties are fully accounted for by the addition of simples. The other form of existence is the one given to observers. They perceive in Gestalt wholes, and see an entirely different world, rich and complex. The realm of compound wholes is just as real as the realm of simples, but it is not physical. It *has the same material content* as the physical world, but presents itself differently.

Life Stages of the Universe

One of the mysteries that has puzzled physicists for several generations is the discovery that the laws which apply to objects at the subatomic scale are radically different from the laws which apply to objects at our scale of magnitudes. The two levels are often referred to as the microscopic and the macroscopic. The macroscopic level of reality is also called the *midlevel*, for it is between the subatomic and the cosmic. Objects at the midlevel are the kind that we see and deal with in everyday life. They obey the laws of classical physics—laws which agree with our daily experience. In contrast to this, *microscopic* objects, such as atoms and subatomic particles, behave in ways which are totally unfamiliar to us and strike us as weird and unnatural.

According to the best models of cosmic evolution, the universe started out as a hot, uniform plasma and evolved through different phases, the earliest ones lasting a small fraction of a second. As the universe cooled, atoms were formed, and matter gradually began to bunch together and gather into clumps. The clumps became organized due to the action of gravity and of electrical forces operating within and between atoms. Gradually these large-scale properties overshadowed those regulating the behavior of elementary particles, and a new kind of physical order emerged at the macroscopic scale.[2]

I shall not go into the physics of this metamorphosis, because that is not the topic of the book. Rather, I will discuss how the characteristic properties of matter in the macroscopic world influence what Gestalt observers are able to perceive. In this context, the most important property of material objects at the middle level of physical reality is that objects are *rigid*, that is, they retain their form and structure over time. In addition, bodies can be moved and rotated in space, which means that potentially, comparison between different objects is physically possible.

Does such a thing as a triangle exist in primal reality, that is, outside the purview of any observer? It is quite possible that there might be a rigid piece of matter of triangular shape, but how could it be a triangle in the absence of any standard for an angle, for a straight line, or for the cardinal number 3? This is where the properties of rigid objects comes into play, because rigid objects may be compared with one another. Hypothetically, we might have a template for triangular shapes which would serve as a standard to define triangles. Since objects are physically comparable, it would be useful (and possible) to have templates for different angles and for straight lines.

The most significant fact about the universe at the midlevel scale is that rigid objects are comparable to one another in their shape and structure. It is hypothetically possible to select given objects as standards, and classify other objects by their accord with the standard items. This fact turns out to be so important in the pre-physical behavior of rigid bodies that we shall name this phase of cosmic evolution the *Template Age.*

In the universe of the template age, you might characterize a straight line as the shape of a taut string. Or perhaps it is the path of an object in free fall. To us it is both, because we have a visual picture of what a straight line is, and we confirm by sight that both a taut string and the path of a falling stone have that shape. But we cannot rely for scientific evidence on our subjective perception: Instead, we *define* a line to be the shape of a taut string, then confirm by experiment that a plumb line, or the trajectory of a freely falling object, are the same.

It is similar with our notion of force: Force is what is needed to extend a flexible spring. Also, force is required to lift a heavy object, or to accelerate a body in motion. Thus, you may define force in terms of the spring, and then show by experiment that the same effect is needed to accelerate a body in motion or lift a weight.

In each of these examples, a physical procedure is used to define a magnitude: For instance the taut string defines what a straight line is, and the power to extend a spring is what force is. Any object may be lined up next to a taut string to determine if its edge is a straight line. If the edge matches the shape of the string, then it's a straight line. Likewise, it may be shown by experiment that a compressed spring, when released, is able to project a body forward, that is, to accelerate it. This shows that the power to accelerate an object is the same as the power in a compressed spring.

Objects at midlevel reality are subject to the laws of classical physics. Moreover, it is at this level that rigid objects first appear. Since bodies can be moved and rotated in space, their shapes and dimensions now become comparable. It is for that reason that in midlevel reality a square is different from a triangle. Since an object's mass is the amount of force needed to accelerate it by a fixed amount, objects are also comparable with respect to their mass. Objects are comparable because the midlevel universe possesses the physical "resources" (for example rigidity and mobility in space) needed to make comparisons.

If the resources exist in the universe to make comparisons between two objects and show that one is longer than the other (or has more mass than the other), then that relationship between them is actual, and really holds. It is not necessary for the comparison to be literally carried out: It is sufficient that the comparison be *possible* in terms of the resources available in the universe. (Of course, you won't know *which* body is larger or heavier until the comparisons have been actually made.) This claim might appear a little bit surprising, but is true for the following reason:

Imagine two straight rods in space: Call them A and B. Let us assume that *if* A were moved next to B and the two compared, it would turn out that A is longer than B. In symbols, $A > B$. Actually we have not really moved A so we don't know as a fact that A is longer. As a guess, we might claim that B is longer, that is, $B > A$. Since we have not physically made the comparison, our guess is just as good as the contrary guess.

At this stage, there is no fact of the matter at all, and we are therefore free to assert that our guess is the truth. However, at a later time it may happen that A is moved alongside B, hence it is confirmed that $A > B$. Then our guess that $B > A$ is proved to be wrong. Because *it is possible* to move A alongside B, we must allow that A was the longer rod all along. For otherwise, the cosmos would allow that a given fact, $A > B$, is true at one time and false at a later time. This would be an imperfection of cosmic proportions.

It is therefore reasonable to propose that there must be in the universe a principle of non-contradiction that holds over space and time. In other words, it is not possible to witness a particular fact in one place and time and witness the opposite of the same fact at a different place or time.

It is a reasonable claim that what holds the universe together as a single unified entity is the principle of non-contradiction. The same principle may be what holds all of time together as a single unbroken thread where any one event either precedes or follows any other event. The principle of non-contradiction is at the heart of the template age.

Because objects in the midlevel universe may be compared with one another, it is hypothetically possible to have templates for any rigid shapes that are of interest to us. This does not mean that the unobserved universe has such things as triangles and pentagons: It simply has templates for Xs and Ys which have neither appearance nor a description. Appearance and description will emerge later, when living observers view things as meaningful Gestalts.

Note that template recognition is not at all like visual recognition, because a template shape differs from another template shape merely by the fact that it matches one template rather than an alternative one. It has a form only in the sense that it can be mechanically checked against a template. In contrast, for a living observer a shape is a Gestalt unity, experienced whole in a single frame of awareness. It is something definite and specific, and requires no template to be recognized. The shape of an equilateral triangle is something unique which can be known only by contemplating the whole of it at once.

What is especially important about comparisons in midlevel reality is that in order for two objects to be comparable for some feature, it is not necessary that a comparison be carried out physically. The mere fact that comparisons are *possible* suffices to establish the existence of real, specific distinctions between material objects. You may think of these distinctions as *features* of the objects, but with one crucial difference: To a living observer, a feature is a quality which has a distinct *feel* to the viewer, whereas in the universe outside the range of any observer, the distinction is purely formal and has no appearance or quality.

In a universe in which objects are comparable for length, it is physically possible to lay down a unit of length and measure objects by comparing them with the unit of length. In a universe in which mass also is measurable, the law of the pendulum holds and therefore intervals of time are comparable. In a pragmatic sense, therefore, space-time exists in the midlevel universe.

In the reasoning that leads to the Special Theory of Relativity, a yardstick at rest is compared to an identical yardstick in motion with respect to the first. The lengths of these identical yardsticks, within their respective frames of reference, depend crucially on their state of motion in relation to one another. What is important is that these yardsticks are not merely mental props: They are assumed to be rigid and have mass. Special relativity holds in a material universe and not in a vacuum: It holds in the midlevel universe, but may fail to hold in a reality without large-scale solids that hold their shape.[3]

The laws that operate on objects at the subatomic scale are different from what has just been described. Motion is a different phenomenon altogether: A moving particle does not have a fixed trajectory in space, its velocity is not fixed, even its location at an instant is not a fixed point in space, but rather, its location is "spread out". It is reasonable to assume that space and time are not what they are to us, but something more elementary, more "primitive". What experiments in fundamental physics show is that when entities are observed by using instruments which are real in the midlevel universe, the quantum entities are immediately incorporated into the reality of the instrument (which is midlevel reality): Then they have a specific position and momentum, and behave as rigid particles.

The physical antecedents, or supports, for the sensable qualities that we discern in objects are things that exist at midlevel reality. For instance, the molecules of solid objects are tightly bound to each other by electrostatic forces, and for that reason we experience such objects to be rigid, or hard. If the molecules of a solid are vibrating energetically, we feel it to be hot. If light in a particular frequency range is reflected from an object's surface in a certain way, we experience the object's color to be red, or perhaps blue or green. In each case, the underlying physical attributes are those of midlevel reality.

Our interaction with the physical world is limited to midlevel reality. It is the forces and processes occurring at the midlevel that impose constraints on the things we strive to do, and in that way shape our world model. The phenomena at the middle level of physical reality are the ones that act on our sense organs and give rise to our sensations. When we speak of the pre-animate or mind-independent universe, it is the midlevel that we are talking about.

All of science from earliest times until a century ago has been dedicated to understanding the world at the middle level. It was only recently that the existence of a subatomic world was discovered, and it is still poorly understood. Many physicists today continue to search for an understanding of subatomic phenomena in terms of the facts observed at the macroscopic level. Their thinking is supported by mental images of space and time as they exist in the universe we're familiar with.[4] This is hard to avoid, for that is the way that nature has conditioned us to understand the world. From a philosophical perspective, perhaps physics might benefit from a greater openness to the idea that different forms of reality exist at different scales. The physical reality at each scale depends on what kind of actions and comparisons are physically possible between the entities that exist at that scale.

Phenomena

We refer to regularities in the physical world as natural *phenomena*. It is an interesting fact that the word ‘phenomenon’ is derived from the Greek root *phanein* which means “to show”. In one sense, that isn’t surprising, because phenomena are things that nature shows us—things that are *presented* to us. But the use of this word is in fact remarkably revealing, for it is an overt recognition of the fact that people do not have direct access to the hypothetical “true core” of reality, but rather, they are spectators to things that are presented to them by nature.

We are generally more open to the belief that reality consists of things that are actively *happening*. However, that isn’t inconsistent with taking natural phenomena to be presentations. The advantage of thinking of physical events as phenomena that are *presented* to us is that it reveals clearly that every event comes to us as a Gestalt whole. This is important because to us every physical event is a Gestalt: That’s the way events appear to us, and the only way we understand them.

The Nobel laureate Werner Heisenberg, one of the creators of quantum physics, explains that in physics one cannot ask what *is*, but rather, how things present themselves to an observer. The first question (*what is*) has no answer, only the second one does. He says that existence is an idea dear to humans, but is misconstrued when applied to reality in fundamental physics. For instance, an electron is not something material, nor does it have a definite position, velocity or mass: It is something observed in the context of a particular apparatus when the apparatus is used in a specific way. The experimental setup yields certain measurements, and this set of measurements, suitably interpreted, is a presentation that we take as revealing an electron.

All science works in this fashion: The results of experiments are given by the readings of dials and gauges, and these readings are interpreted in the light of a theory. All we get from the world are presentations, and from them we try to figure out the process taking place in the background. We do this in everyday life too: From every sensory cue, we infer a likely cause and visualize it inwardly.

If that is correct, then in what fashion does nature present its activity to us? The most recent studies of animal perception offer a remarkable new account of how we pick up the events of our environment. Our most essential information is picked up when we are active in our surroundings. Here, reality hits us in the form of physical constraints on the actions we’re trying to carry out. The constraints of reality channel our activity into the narrow pathways which are physically achievable.

All living organisms are engaged in a struggle for existence. To survive, they must find optimal ways of using the resources available in their environment to obtain nourishment and keep themselves safe. They learn by trying every path open to them: Along some paths they make progress, while along other paths they are turned back because they run into obstacles. Gradually, natural forces oblige them to distinguish what's possible from what's not.

Organisms struggle to wrest from their environment the resources they need. At first, all courses of action seem to be worth a try. But in some attempts they find themselves blocked by natural barriers, while in other attempts they succeed. It is through the medium of these hurdles—these natural constraints—that organisms gradually get to learn the structure of their environments. Most of this is not learned by individual animals but by the species in the course of evolution. The impediments which the natural world imposes on their efforts progressively shapes their understanding of the world. The constraints of nature act to mold their model of reality.

This is a fascinating insight, because it reveals that the physical world does not need to have specific features for us to discern, ***or any features at all.*** Instead, what sculpts the way we perceive things and educates us are the forces with which nature opposes us. It is our mind that creates features, and attributes them to objects. The external world does not need to possess features, only restraints. This insight underlies the latest theories of animal perception.

According to current research in neuroscience, the perceptual mechanism of animals functions by using a stick and not a carrot. It has been found that the animal brain is continuously forming hypotheses of what will be encountered in the next glance. The hypothesis, or prediction, is then confronted with an incoming signal from the eyes, which it either matches or not. If not, then a corrected hypothesis is composed on the fly and the cycle is repeated. If the prediction matches the incoming signal, the animal experiences the visual scene it has just predicted. What the animal experiences is, of course, a creation in its world-model. The same is true for the other senses.[5]

The most essential element of this process is that only a *mismatch* needs to be registered, for only a mismatch is relevant for correcting a hypothesis. Again, this reveals that only the restraints of nature are effective in perceiving and learning: The world's negative side is what is useful. The external world does not need to have definite features for us to recognize, because the constraints that it enforces do the same job.

The neuroscientist Andy Clark, who has written a book on the subject, has called attention to a remarkable consequence of this process: Since it is the observer's brain that generates the image which is predicted—while the external information is used only to correct errors in it—it turns out that it's the living, seeing subject who actually produces the visual scene. Clark suggests (perhaps with a grain of salt) that perception is like a controlled hallucination. Moreover, since it is the brain that crafts the image, it has the task of producing a veridical representation without any form of direct contact with the world.

Interestingly, the scientific method works in the same way. Hypotheses are formulated, and subjected to testing by experiment. As the British philosopher Sir Karl Popper made clear, the most useful result of an experiment is if it fails, for then the issue is settled, and the hypothesis is rejected. If an experiment succeeds, we're encouraged to continue with cautious optimism, but with no assurance that our hypothesis is true. Here again, you see that nature guides science by means of its constraints. The only hard-core reality known by direct experience are nature's prohibitions. Out of them, science must create a picture of reality.[6]

A scientist's contact with the external world is at the points where the world *opposes* him or her with its restraints and impediments. Our imagination may wish to fly free, but is restrained by the boundaries of what is physically possible. It is by confronting those boundaries and dealing with them that we are able to form an image or model of the world. Many notions of science have a negative character: Force is what we must produce when objects *resist* our push. The very notion of space emerges from the experience of wanting to move, and facing the limited degrees of freedom open to us. Moreover, science reveals its secrets in *laws* of nature, and laws are restrictions to unlimited freedom.

I'd like to share my favorite metaphor for the scientific quest to discover the structure of the universe: Think of a hollow bust of Julius Caesar. Imagine that our world is inside the bust and we would like to know Caesar's features as they would be seen from the outside. To explore our world, we fly out in every direction until we meet the inside surface of the bust, which impedes our going further, and we map the points where we're made to turn back. From our knowledge of the inner surface we attempt to infer the outside aspect of the bust. That is how science tries to understand the world. We know the side which is exposed to us, but the hidden side is merely inferred.

By means of this insight, we get a much clearer understanding of what the mind-independent world is like. The mind-independent world—or background reality—does not need to have any positive characteristics or features. Its character is determined by the actions it blocks and forbids in the material world. Thus, the search for attributes or properties of the background world is futile: The quest to find the features of the primal universe is a wasted effort because background reality is featureless in its very essence. It acts powerfully on the empirical world by legislating what cannot be done.

It is nature's prohibitions that guide our hand as we segment our world and form a model of it. Although there may be alternative ways of segmenting reality—hence different, non-similar world models may be constructed—few are actually possible: The prohibitions whittle down the possibilities to a very few, or perhaps to just one.

At the beginning of this section, it was argued that physical phenomena could be treated as things *presented* to the observer by nature. We are now able to put this claim into sharper focus: Physical phenomena are presented to observers in the form of restrictions to their freedom of action. The observer is assumed to be an active agent in its environment, and its activity is sculpted by nature's restraints just as a whittler shapes a figure by carving out of a block the material that is not wanted.

In order for nature to act on an observer by enforcing constraints, it must be assumed that the observer is a striving agent which has specific aims and purposes. Indeed, if the observer were not actively pursuing definite goals, then restricting its activity would not achieve anything. The essence of this mechanism is that the observer is actively striving to achieve definite ends, and nature is acting on it by constraining the ways it is able to behave in pursuit of its goals. This insight reveals to us once again that the form of the natural world is not inherent in matter, but emerges out of the interaction between the background reality and the living observer.

In the previous chapter we noticed that a similar process is at work in all animal perception. What we take to be an object or event is deeply embedded in the physical background, and must be painstakingly and precisely extracted by a living observer. It is the observer who extrudes this essentially arbitrary concurrence of happenings from the objective flow. In order to accomplish this, the observer must have a *purpose*, that is, a motive for undertaking to extract this one particular thing—because what it is separating out of the background is not random but something very specific and deliberately chosen.

Once again, we are confronted with the realization that the very existence of individual objects and facts in the universe rests upon the prior existence of observers having goals and purposes, and above all, having Gestalt perception. It appears, then, that all of existence consists of two separate and equal strands, or components: There is the pre-animate universe whose effect is to introduce physical constraints, and there are active observers that strive to accomplish goals in the face of these constraints. It is the observer that divides reality into objects and features and creates structure. The structure is represented within the observer, and does not exist separately from the observer.

Although the pre-animate universe has no separate objects or properties, it harbors a great amount of latent information and order, since it must contain the seeds of its future development. That is precisely what the science of cosmology predicts: The universe began in a state of maximum information, and as it ages the store of information gradually winds down. The universe will die when its stock of information is depleted. The information in the early universe consisted mainly of heat: This kind of information is called thermodynamic information.

However, there is also another kind of information: It is found in the more mature universe as it cools and life-forms appear on planets. This is the information that exists in complex, organized objects, especially in knowledge structures, where it is in the form of Gestalts. Everything complex is a store of information, and arises in the course of learning and knowledge-creation, which use thermodynamic information to fuel the process of creating order. In an optimistic version of cosmology, the thermodynamic information which came out of the Big Bang is gradually being transformed into the information of knowledge structures and organized objects which are created by life processes. While the universe is cooling, it is concurrently becoming more structured and complex.

It is important to note that in this section and the previous one, nothing new has been claimed about the physics of the universe. If we choose to think of natural phenomena as things *presented* to us instead of things *happening* in nature, that is merely an alternative way of looking at the same thing. If we decide to think of natural forces as constraints to our freedom of action, that too is no more than a shift in viewpoint. It's what is often called "looking at things from outside the box". The value of looking from outside the box is that sometimes you observe things that you had never noticed before, and gain insights you would not have acquired otherwise.

Mind and Cosmos

We are created as beings with sense organs, hence we're compelled to know the world in a sensory fashion. We are limited to receive all knowledge of the world in the form of sensory experience. The very meaning of *knowing* our environment is that specific aspects of it are represented in a form that we experience by sensing and feeling. *There is no other possible way of knowing.* The romantic idea of knowing something directly, "as it really is", is unintelligible. Even sensing an object by machine requires that information from the object be received. What is sensed is merely information, not the object proper. The link between the information and the object is just as indirect as the link between our sensations and what they represent.

Our experience shadows a background reality that, according to physics, consists of vibrating force fields. They impact us by activating our sense organs. It is on the basis of this sensory information that we get experience of the world. This experience is given to us in myriad varieties and gradations of feeling. The subtle and exuberant language of feelings must be sufficiently fine-grained that sensations can be molded into all the knowledge of the world that is accessible to us. It's in the idiom of sensation that we articulate every meaningful detail of what we see, hear and think.

The language of feeling is like all languages in one respect: Its "words" are basically arbitrary, and have no necessary connection with their meanings. English words such as "horse" or "farmhouse" have no mandatory connection with animals or buildings—they're just sounds chosen by convention. In the same way, the experienced quality of our sensations have only a formal connection with what they mean to us. There is one difference, however: We *acknowledge* that the sounds of words are arbitrary conventions, but we are tenaciously committed to the idea that what we sense is firmly anchored in reality.

The idiom of sensory feeling has a rich semantics. Every detail of our environment—every subtle distinction which our survival requires us to be aware of—must be represented by a feeling or a combination of feelings. The texture and surface appearance of objects, their essential structure and outward aspect, are represented by distinctive sensations. The way we perceive objects and events around us does not reproduce their precise physical measurements, but every feature has its own distinguishing sensory marker that we cannot fail to understand. Also, everything we experience is covered with a veneer of emotion which serves to highlight its meaning and make it more distinctive.

As explained in previous chapters, all sentient beings project the way objects look to them onto the external world. We referred to this as a "necessary deception". It is therefore inevitable that we experience all the objects around us in the very forms that our mind gives to them. We experience their features as if those features were inherent in the objects themselves—but they're not.

The very idea that objects have *features* is a human idiosyncrasy. The midlevel universe has energy and mass, but does not have "features". The belief in features is the result of having sense organs which produce sensory experience. This illusion leads to the corollary idea that every object has a "true" appearance, and there is one correct way that it *is*. In actual fact, because there are no objective features in the world, there is no such thing as a *description* of an object outside of a mind. In the primal universe, objects have no shape or appearance: The reason they don't is that in the primal universe objects don't need to "present themselves" to anyone or anything.

It goes against the grain to acknowledge the fact that shape and structure emerge from the minds of living observers, and don't exist in the physical universe apart from living beings. Moreover, we are "forbidden" by our biology from tearing apart the illusion of appearance. This does not imply that the way creatures see the world is contrary to the material facts. The very opposite is true: Over eons of biological evolution, the world-models of animals have been fine-tuned and fitted ever more precisely to the material environment.

Yet there is one radically important—in fact, elemental difference between the physical world and the world perceived by creatures: The world known to living beings is made of compound whole objects and complete events that unfold over time. Living creatures perceive their environments in spread-out wholes. They experience whole events which take place over a region of space and over a stretch of time. The fundamental units in awareness are complete objects and events. They are Gestalts.

This should not surprise us, because common sense dictates imperiously that nature—the physical world we inhabit—is the very same way. For us the world consists of whole objects and undivided events unfolding in time. As you know by now, our nature as biological creatures compels us to attribute to our environment everything that we perceive. In particular, *we attribute to the external world the Gestalt unity created by our minds.*

For example, in the physical world there are mechanical interactions occurring in series: One example is a falling row of dominoes (where one event sets off a chain of similar events). As another example, there are the successive notes of a musical tune. A Gestalt subject is able to hold the entire series of events in mind as a single mental snapshot, and perceive it together as one compound event. For instance, we are bound to experience a familiar tune as a single drawn-out entity.

Common sense assumes it is the same in the physical world—that a sequence of simple events is objectively united into one comprehensive event. But the very idea of a "compound event"—meaningful as a combined whole—is a Gestalt concept. The series of events is united into one combined event in the mind of a Gestalt subject. There is no force in the universe at large that would act to combine events into broader, more inclusive events. This is a typical example of our mind projecting our experience outward and attributing it to the external world.

It is no different with the seven stars forming the Big Dipper: Outside the purview of a mind which perceives the Big Dipper as a specific pattern, there is no physical effect or force which holds the seven stars together as an objectively compound entity. They're a combined entity for an observer, but not objectively in the universe at large. The creative activity which consists of joining objects and events together into more inclusive and meaningful unions is an activity of mind. In no way is it done by the physics of the universe.

It is very important to understand this point: In the physical world there are myriad material objects in unceasing motion. An observer such as ourselves may discern patterns and meaningful structure among these objects, but these regularities are something unique unto themselves, which minds have fashioned, because that is what minds are for. Gestalts are a creation of minds to the same extent that bile is the creation of livers. Do Gestalts exist in the universe? They exist as mental constructs, objects of awareness, structures of knowledge.

As a somewhat simplistic example, ask yourself whether a tune (for example "Yankee Doodle") is an independently existing thing in the physical universe. What physical force would act over time to draw the notes together into that particular configuration and hold them there?

The physical world—the material reality that exists prior to mind—is altogether different from the world known in Gestalts. The physical world consists of objects moving in space under the impulsion of physical forces. Every object—or pair of objects with a force acting between them—exists in relative isolation from others. The trajectories of moving objects are determined by the forces between them, yet the shape of a trajectory—the kind of curve traced out as an object moves in space—is a wholistic entity, and only a Gestalt perceiver is able to apprehend it. In order to seize an entire pattern, an observer must have the power to discern a whole region of space, over an interval of time, in a single act of awareness.

Animal perception isn't designed to see elementary physical relationships between subatomic particles, and bring these low-level events to awareness. Rather, animal perception informs living organisms by bringing to awareness whole processes unfolding in time and covering a region of space. Only spread-out, extended events have relevance in the lives of creatures. For that reason, the minds of living beings have the biological function of representing the external environment in a kinetic and wholistic fashion, by means of Gestalt perception.

There is an interesting metaphor that brings home what I am saying. A few decades ago, stereo movies could be seen that used the anaglyph method: The spectator wore a pair of glasses having a green lens over one eye and a red lens over the other. Thus, one eye saw only the red parts of the image while the other eye saw only the green. Hypothetically it is possible to make two completely different silent films overlap on the same screen, one movie projected in red light, the other in green. A spectator with red glasses (over both eyes) would be viewing Movie 1 while a spectator with green glasses would be viewing Movie

2. The two would be looking at the same screen, and each spectator might have no knowledge that a completely different drama was unfolding in the eyes of the other.

This metaphor may help us understand the relationship between the underlying physical reality and the extended reality of Gestalt perception. If there were a way of viewing elementary physical phenomena, they might be seen through "green" glasses which pick up the basic physical interactions and nothing else. But Gestalt perceivers are blind to the basic relations between elementary particles. They wear "red" glasses and what they perceive, while looking at the same 'screen', are extended scenes spread out in space. They see trees and hills, animals and people, mountains and valleys. Their reality is a universe of diversity and Gestalts, and there is no limit, potentially, to the hierarchical breadth and extent of Gestalt wholes in such a universe.

Which is the "true" reality: The one revealed by wearing the green glasses or the one displayed when wearing the red? An easy answer might be that the material world of physics is the foundation which is the platform for all reality: Complex objects are constructed out of the material "stuff" that exists in physical reality. In this perspective, matter and energy provide the foundation: Everything composite, manifold or structured is fashioned out of matter and energy. This is the commonsense solution. It's not wrong, but it's simplistic. Like the philosophy of materialism, it disregards Gestalts, which provide a whole new opening to reality.

There is indeed a basic physical reality of the material universe, governed by laws of physics which act on objects by addition of simples. But there are also living observers, and somehow these creatures are endowed with the uncanny, almost otherworldly power to hold a version of reality in their minds, in what we call conscious awareness, and perceive the world in extended, comprehensive displays which are grasped as single units of knowledge. You might say that the minds of living beings have "re-packaged" ongoing reality so that for a living subject, the units of reality which it grasps and responds to are entire objects and whole events playing out over intervals of time.

As already mentioned several times, we cannot help but project this vision onto our surroundings, and therefore we perceive the external world to consist of entire objects and meaningful events unfolding. But it is the living mind that has re-worked the ongoing activity of nature and created a world model whose basic units are comprehensive Gestalts. It is through that model that all creatures perceive the world. Consequently, the world we know is a constructed reality. It is not the individual mind that has constructed the Gestalt world, but the action of biological evolution, that is, the force of life acting over eons of time.

What this suggests is that complexity—the hierarchical organization of different things existing in the same frame of reality and related in elaborate ways—is an innovation which arose in the universe with the animal mind, or more generally, with the introduction of life into the universe. For us, it is second nature to perceive the universe as complex, diverse and interrelated. It is hard to grasp that hierarchical organization in space and time is a specific invention—a revolutionary cosmic novelty—which came to exist with living creatures.

Why Do Things Exist?

The physicist Werner Heisenberg, one of the founders of the theory of quanta, wrote in his book *Physics and Philosophy* that the concept of existence appears to be quite straightforward, but this appearance is deceptive. In reality, the question of existence is a tangled web that easily leads one astray. Why is that so?

When it is asserted that a certain *definite* object X exists, what does that imply? If it is firmly established that X exists, then the information which specifies the location of X and its outlines must also exist. This information is discerned by an observer. Thus, the fact that a specified entity X exists is not an absolute in the universe at large, but rests on a claim made by an observer. As explained in the previous paragraph, the claim consists of information which the observer must possess in order to identify and point out the object. The idea of singling out a particular object implicates an observer who creates the information required to segregate the object from the background in which it lies.

In the mind-independent universe there are no features, hence if an object is embedded in a background, it is as completely melded with its surroundings as the angel which Michelangelo saw embedded in the marble. There is nothing inherent in the background to help find the desired object. An observer must be in possession of a precise delineation of what he wants to lift out of the context. A *definite* object does not exist in the absence of the information required to locate and extract it. This, in turn, is the work of an observer, and this implies that definite objects can only exist in terms of observers. In the absence of observers, there are no *definite*, specific objects in the universe.

This is a familiar fact in fundamental physics. An electron which is not observed does not exist as a particle, but only as a wave function conceived as a wave of probabilities. The instant the electron is detected by a living observer, the wave function collapses and the electron is a particle with position and velocity. It continues to be a particle as long as it remains "in sight". In Heisenberg's words, the unobserved particle is "potential", and it becomes "actual" when observed.

As explained above, a definite, or specific, object comes to exist when an observer provides its location and outlines, and in this manner the object is made to stand out of the background in which it is embedded. In other words, the observing mind provides the information which sets a particular object or event apart, thereby individuating it. In order for specifics to exist in the universe, they must be delineated and set apart, and this involves the creation of information by an observer. This simple fact reveals that information is an essential aspect of existence.

To generate the information needed to locate a particular object in a busy background requires computational power. For example, to locate a letter T in a field of letters tilted at various angles requires a definite amount of computational search. Computation can be quantified, and it is possible to determine the exact amount of computation needed to extract specific information. An observer is never a passive entity, but uses computational power in order to produce the information it needs, for example by carrying out a search of the visual field.

If an observer does the computational work necessary to precisely carve an object out of the background, the observer must have a *purpose* in undertaking this task. The purpose determines the specific boundaries along which the observer will cut to extract it. The more complex the object is, the more specific the observer's purpose must be, and the more computational power is devoted to the task.

In the philosophy of science, a person or thing that carries out actions is called an *agent*. If an agent acts in order to accomplish specific results—that is, if the agent has specific goals—it is said to have *intentionality*. Objects have intentionality if they're designed to carry out a specific task: For example, a hammer is an intentional object, but it has what is called *derived intentionality*: The intentionality of the hammer is derived from that of the carpenter, and it is he who has *original intentionality*. What has been stated above is that in order for an observer to allocate computational resources to the task of extracting a particular object from a background, the observer must be an intentional agent: The agent must have its own agenda, its own set of specific goals. This shows that every definite object in the universe is the product of a living observer possessing intentionality. This may be summarized as follows:

A *specific* complex object exists only if there also exists information sufficient to determine its location and boundaries. If this information does not exist, then it is impossible to point to, or designate a particular object. The object, in that case, cannot be definite. If an object is definite, the identifying information is provided by an observer able to deploy computational power in order to produce the information. In order to select a particular object, an observer must have an underlying purpose: It must have intentionality. What is true for objects is likewise true of facts. If a certain fact holds true, one may ask, "What fact is that?" A fact exists if it can be uniquely situated and its outlines detailed.

Behind every shape or structure there must be purpose, and likewise, behind every fact there must be purpose. In Chapter 6, I said: "A fact must be expressed in a language, and it shares the scheme of segmentation which is built into the language. The external world is a seething cauldron of activity where every molecule is in continual random motion. What we take to be a fact is deeply embedded in this maelstrom, and must be painstakingly and precisely cut out by a living mind. In order for a fact to exist, it must be preceded by a segmentation of the world into separate things, and requires a brain able to extract it from the background in which it is immersed. Moreover, this brain must have the power to conceive in Gestalts."

In these words, then, it is asserted that actual facts do not exist contingently or randomly in the universe, because a fact must be defined, cut out of the ambient chaos with great precision, and this precise act is carried out by an agent having a specific reason to do so.

The Mind in Physics : Quantum Bayesianism

The theory of quanta is in an existential crisis. It has been known for almost a century that when a fundamental particle such as an electron is not observed, it does not exist in the form of a material particle but as an abstract wave of probabilities. Yet, the instant the same electron is observed, it springs into reality as a material particle having a position, speed and direction of motion. In physics this mystery is known as the *measurement problem*, or the *problem of the observer*. This fact presents a huge dilemma not only for physics, but for our very concept of how the world works—for it suggests that the conscious mind has causal power over material phenomena.

For a hundred years physicist have brooded over this problem, and invented all kinds of implausible solutions that might do away with the influence of mind on subatomic events. But no matter how you cut it, the observer with a mind is always present and cannot be abolished. All of these attempts were built upon one reigning presupposition. It was assumed that there is an independent world with its own rules and ways of behaving—and that this world is totally detached from living observers and minds. Could it be that this is not true?

During the past decade or so, a few physicists lit upon a brilliant idea. When a subatomic phenomenon is witnessed by an observer, it may be that the event that is detected is something that occurs in the observer's mind rather than in the external world. To understand this, it must recalled that we never see reality "as it is": Instead, what we see is the way it appears to us in our world-model. Thus, when the scientist observes the result of an experiment, he interprets it—and indeed *sees* it—in the light of his own world-model. This approach to fundamental physics is called *quantum Bayesianism.*[7]

According to this new insight, what traditional physicists got wrong was the naïve belief that there is a fixed, "true" external reality that we perceive "correctly, as it really is". If that were the case, then it would indeed be magical if the true reality underwent an abrupt change when observed. But that isn't what's happening. The scientific observer sees the readings of his instrument, and correctly interprets the readings from the standpoint of his world-model. There is no abrupt change, or dislocation in what's happening in the outside world. There is merely a shift in perspective in the scientist's world model.

Recall that the external universe, outside the purview of any observer, has no inherent form or structure, because these are contributed by the observer. The external universe is orderly in the sense that it gives rise to an organized, meaningful structure in the living observer. The world that we experience is an organized version of reality, whose shape and structure come from our world-model. It is the only world we can know, and is the world described by physics.

It is a categorical mistake to believe that science describes the external world "as it is": What science describes is the organized model of the world in our minds, for that is the only coherent and comprehensible version of reality. Physics is a description of real events as interpreted in our world model. That observation is the fundamental insight that underlies quantum Bayesianism.

9

Mind, Life, and the Universe

Tools of the Mind

There are two contrasting ways of exploring our world visually: We may look widely at a spread-out perspective, or we may focus narrowly and take in an area of minute detail. These activities are very different from one another and involve distinct parts of the brain. The first involves the acquisition of Gestalt knowledge, whereas what is obtained in the second is detailed information which is precise and explicit.

When we spread attention widely so as to have a panoramic view, we have the subjective impression that we are taking in a great amount of information. In fact, this is an illusion: For example, when we look at a tree, we might glance at a leaf, and since all leaves on a tree look pretty much the same, we feel that we are seeing them all. When viewing Andy Warhol's painting of twenty-five identical Marilyns, we generally focus briefly on one, and then mentally experience seeing the whole canvas in detail. In psychology, this is called the *filling-in phenomenon*.

The French philosopher Maurice Merleau-Ponty has written at length on this phenomenon in his book *Phenomenology of Perception*. For him, in vision the indeterminate is very real, and is a fundamental aspect of seeing. For example, a perceived polygon must have a definite number of sides, but perception admits ambiguity, so we neither count the sides nor do we notice the absence of a definite count. He says that perception is only possible if you admit this kind of ambiguity.[1]

Merleau-Ponty says it is commonsense belief that when we're looking at a scene, we experience every detail of what's there. What leads us to that impression, he says, is that the scene remains before us while we're looking, and the

C. Pinter, *Mind and the Cosmic Order*,
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detail (which continues to be available) is in the scene, not the representation. An example is the visual impression of a tree in winter: You see branches extending in countless directions—but close your eyes for a moment, and you recall neither the number of branches nor their layout. You didn't *really* see it all, but while it was in front of you, you knew you could focus on any one at will, and therefore assumed it was part of the picture you were viewing.

The phenomenon of filling-in is especially evident in the fact that we all walk around with a large hole in our field of vision, but are unaware of it. The hole corresponds to the spot on the retina where the optic nerve leaves the eye: There are no light-detecting cells in that region, so the corresponding part of one's field of vision is not physically seen. Instead, it is filled-in with textural information from the surrounding area. All in all, a wide-angle view provides less visual information than it seems to: Much of what we believe we see, we actually infer.

Just as we are able to focus widely, we are also able to focus in on small details. When circumstances require, we focus our eyes, as well as our attention, onto small areas of fine detail. When doing this, we are no longer seeking a broad Gestalt impression, but rather, we seek precise information about a small object of interest. The information we want in this situation is *analytic*. That is, we seek to know the relevant single parts of the object we're focused on, and the precise relationships between the parts. As examples of this kind of looking, imagine yourself repairing a small instrument, or learning a letter of a new alphabet.

In such an activity, you are carrying out a task of exploration and investigation. You are not engaged in passive contemplation, but active search: It is a constructive pursuit. When beholding a scene, you're open and receptive. By contrast, when occupied with analyzing a visual object, you're building new understanding and your volition is in command. You are constructing a mental description of the object because when you act on the object, such a description is indispensable. You must know without error how it can be manipulated.

When a person inspects an object in the analytic mode of looking, he or she mentally creates an account of it. The account takes note explicitly of every component part, and of the precise way each component is related to every other one. Such an account does not have to be verbal, for there are other ways of recording it in the mind: It is registered in the form of a mental image, comparable to a diagram because only the essential details are present. It is nonetheless a Gestalt, because it unites multiple components into the perceived image of a single complex object. Psychologists refer to this kind of mental record as an *engram.* It is, in a way, a minimal unit of meaning—

minimal in the sense that if you subtracted anything away from it, it would no longer have the same meaning.

In the context of the human mind, a unit of knowledge in this sense is called a *proposition.* Humans are able to put propositions into words, but they can exist in thought without words. The content of a proposition is a Gestalt, and activates that Gestalt in the mind of the listener. If you say, for example, "the dog is asleep under my bed", this proposition gives rise to a Gestalt picture of a canine sleeping under a bed. The mental picture is wordless, and may exist in mind even if not spoken. This should be obvious, because even a pre-linguistic child or an animal may notice that there's a dog under your bed, and they know that fact in precisely the same way that you know it. There is a Gestalt in mind whose content is that fact. I don't wish to belabor the obvious, but if it were otherwise then the minds of animals and infants would be empty of all meaning and understanding.

A proposition does not have to conjure up a picture as in the previous example. A proposition may be a complex idea, and evoke a thought-image in mind. If you say something like "Smith claims the elections were rigged", that too evokes a Gestalt in the appropriate context. Though not pictorial, this is a mental image with a crisp and precise meaning. Just as our brain constructs visual scenes in such a way that we understand what we're seeing, the brain works in the very same way to construct thought-images. As stated above, a proposition is the smallest independent, self-contained unit of meaning.

Note that propositional knowledge of an object—that is, knowledge via a description—is entirely different from knowledge of the object as a Gestalt—the knowledge we get by looking at it. For example, to know the letter A by sight is one way of knowing it: the pattern is discerned as an undivided whole. In contrast, learning that it consists of two oblique line segments leaning against each other, and joined in their middle by a horizontal crossbar, is another way of acquiring the same knowledge. If you are required to draw the letter A, as a school child is, you must have the knowledge in the second way. Indeed, in order to *do* something with your knowledge, for instance to draw an A, you must have the propositional description, because it instructs you on what to do.

In practice, the partition between these two kinds of knowledge is porous. When given a verbal description of the letter A, you simultaneously try to visualize it. And when looking at a letter A, you have an inkling of how it can be built out of three line segments. Earlier, we referred to descriptive knowledge as analytic. Both types of cognition—the analytic and the Gestalt—are indispensable for any animal to function in its environment. They operate in tandem, but are the result of different mechanisms in the brain. Though they work together, they are radically different.

The animal mind perceives everything in Gestalt wholes, for it requires wholes to make reality intelligible. However, the holding capacity of conscious awareness is fairly limited, and the cost of having a wide purview is that you sacrifice detail. As animal behavior became more complex, and species became fine-tuned to their environment, it became necessary to be attentive to rigorously precise and specific details of the surroundings. The information in a Gestalt has excess range and poor resolution.

Thus, further evolution of the animal brain gave rise to a new mental tool for the precise management of information—a mental equivalent of the precision grip. Animals acquired increased attentional control over mental processes. With greater attentional control it becomes possible to focus on small areas of detail, and mentally detach specific items which have a practical role to play in the animal's activity. In order to act effectively on external objects, an animal must form a representation of the structural details of objects. It must be able to zero in on specific pieces which are the functional components of a structure, and take careful note of how those pieces are related to one another in space.

Divide and Conquer

The paramount fact of all animal vision is that what is seen by a subject is experienced as an undivided whole. The visual scene presents itself as a unified whole, so all the parts appear in consciousness together as one simultaneous unit of knowledge. As noted in Chapter 2, that is what is meant by vision in living animals. The very fact that animate life exists in the form it does on our planet, is due to the holistic nature of perception.

However, there is another side of the coin: The purposeful activity of all animals, from insects to man, rests on the ability to understand the world analytically. It seems poignantly ironic that whereas living beings have the almost magical power to behold the world in comprehensive wholes, they must fragment those very wholes in order to exploit their powers of perception. As noted previously, the holding capacity of short-term memory and the span of consciousness are narrow, while at the same time the physical articulation of animals is limited. Thus, animals may perceive problems as wholes, but their brains and bodies do not have the complexity of articulation that would be needed to solve problems in one simultaneous operation.

You may be able to imagine a living being with a hundred arms and two hundred eyes, able to attend to every aspect of a problem in one deft, convoluted movement. Perhaps the evolution of our octopus was headed in that direction, because it has an autonomous brain in each arm, and each one can operate on its own. If it had hundreds of autonomous arms and hands, a mythical creature might be able to live a life where a Gestalt stimulus would be met with a unified, Gestalt response.[2]

Nature has not found it expedient to create such animals, so the problem of exploiting the power of Gestalt knowledge was solved in a different manner. In order to understand the world and generate the right kind of response to every challenge of nature, the animal brain learned to decompose wide-ranging Gestalts into smaller units that the brains and bodies of animals could deal with. The smaller units are propositions—contemplated in mind or expressed in words—as well as motor programs which specify sequences of movements for carrying out tasks.

One of the most important things we do mentally is to divide Gestalt thoughts and problems into smaller parts. Once divided into parts in this fashion, one can work on the parts separately, and this limits the amount of memory needed at one time, as well as the span of the Gestalts needed while working on the problem. All effective thinking is carried out by segmenting holistic impressions and images into separate parts, suitably sized so we can hold each one in the scope of attention without losing it. At the same time, if a whole problem has been divided into parts so each part can be tackled separately, it is necessary also to keep track of the various parts and how they connect with one another.

It is a remarkable thing that this can be done at all, because each separate component of a problem must be autonomous: That is, each component must be a unit in itself—it must be self-contained—so it can be tackled independently of other components. It must be meaningful in itself. Moreover, the various components involved in a problem must be related to one another as a network in memory, so we don't lose sight of how each one is linked to every other—for if you lose sight of that, your search for a solution collapses. The fact that our Gestalts can be decomposed in such an exacting way is an amazing feat. No wonder thinking is hard, and demands effort.

We have already seen that when we wish to communicate a thought, our Gestalt idea is unspooled and transformed into a structured sequence of words. What is most uncanny about this is that our sentence, though stretched out and spoken one word at a time, has the power to resurrect the Gestalt thought in the mind of a listener. We are so accustomed to doing this day in and day out, and find it so effortless, that we fail to recognize how astonishing it is.

Apparently, creative activity is based on a subtle balance of Gestalt and analytic. Gestalt is indispensable because the world is plural and complex.

Also, the mind is a beehive of holistic images. When thinking creatively, the mind is searching through a forest of Gestalt images, and extracting deeply embedded parts which are themselves meaningful images. New Gestalts may be created by combining them, and these must be subdivided again to express them in words.

We do the same when we think deeply about a subject and come up with new ideas, or with new, more solid understanding of a topic. We are beholding a large, perhaps hazy Gestalt: We bring it into sharp focus, and divide it into convenient parts. It is likely that all creative thought is of this kind. From what we know of the thinking of scientists, that is exactly what they do.

Many scientists over the centuries have commented on this. The French mathematician Jacques Hadamard wrote a beautiful little book on the subject, in which he records interviews with some of the greatest scientists in his day, and asks them to describe their mindset in their creative moments. The common thread running through all the reports tells of spending a certain amount of time laboring to become very familiar with the problem at hand. Each scientist tells of letting go of the problem at that stage and thinking of other matters. Then, at the most unexpected time, the solution emerges in consciousness.[3]

It is evident that the problem had been slowly incubating in the unconscious mind: Vast, half-formed Gestalt images were being shifted, re-arranged, simplified, tentatively divided into parts and recombined. Gradually, a solution was taking shape. For example, the mathematician Henri Poincaré tells the following story: He had been working in vain for two weeks, searching for the proof of a theorem. At that time he left on a geology excursion and temporarily forgot about his problem. In the middle of the journey, he put his foot on the step of the bus, and at that instant the critical idea came to him. He had no time to check its accuracy, but felt a perfect certainty that it was correct, and later verified it.

Symbols in Nature

If propositions are symbolic constructions which may exist in mind apart from language, this suggests that there must be symbolic systems in the brain, unrelated to human languages and developmentally prior to them. In other words, it's possible that there are symbolic mechanisms of a biological nature which are fundamental to human activity. This idea is very much in vogue today and is the focus of a great deal of research and debate.

In a purely biological context, what is a symbol? It plays the same role as symbols play in any other context: A symbol is a place-holder. The letter *x* in a mathematical equation refers to a number. In the brain, a symbol has reference to some representation in the mind, for example the representation of a dog. There are ideas in the mind which involve dogs, but to express them, it would be redundant to represent a dog explicitly and in detail. For example, the idea that some dogs bite can be represented from the idea of *dog* and the idea of *bite* without fleshing out what a dog looks like (does it have long legs, does it have a fluffy tail?) or what a bite feels like. The idea is easily represented symbolically with *tokens* for dogs and biting.

Tokens are mental devices which allow a lean representation of simple events, with no details. Instead of constructing a complete representation of an event with a great deal of superfluous detail, the same event can be smoothly represented by using tokens in place of the originals. It is obvious that mental tokens play a highly important role in the mental economy. They are indispensable in human thought: For instance, consider the following sentence: "The prince rode an elephant through the gates of the city". If every detail regarding elephants, princes, gates and cities had to be present in mind, the content of the sentence would be lost in the jumble—it would have no focus. Quite literally, it would not have the meaning it does. In order for precise meaning to emerge, concepts must be pared down to elementary signs.

The mental activity of constructing meanings is a sophisticated process that the science of language has largely ignored. As illustrated above, a limited number of objects are named, and attention must focus on them lightly—just enough to activate a token which identifies them without calling up all the associations they evoke. It is a disciplined, controlled exercise that must restrain the natural flow of associations and keep the resulting image within narrow bounds.

Mental tokens also play an important role in planning complex behavior. Almost all animals, even the smallest and simplest, are able to pre-play action sequences mentally before executing them, and preview their likely consequences. This is done by manipulating symbols. The power to pre-enact responses internally confers a huge benefit to animals by making it possible to have rational, well-planned behavior.

The purposeful activity of all animals reveals that mental tokens, or symbols, are being used. For example, a bird observes a hole in a tree-trunk, flies in search of a thin twig, then pokes the twig into the hole. The hole and the twig are mentally present as tokens, and the idea of inserting the twig in the hole is no different from your idea of using a screwdriver to loosen a part of a machine. It is analytic understanding, represented in mind propositionally.

The presence of tokens in the brain as stand-ins or representatives of complex objects is confirmed today by experiments on single neurons. It is known that there are neuron circuits and individual neurons that fire up every time a specific object is seen or occurs in mind. Such object-specific neurons are assumed to be the neurological equivalents of tokens in memory. When they fire, memories associated with the object become accessible. In a strong sense, they behave as symbols.

Symbolic systems are among the oldest inventions of nature. Evolution could never have gotten off the ground without the molecular genetic system, which is a paradigm example of a symbolic scheme. The double helix is a symbolic structure, essentially an extended proposition, which contains the description of an organism's entire body plan.

It is well-known today that strands of DNA are "words" written in an alphabet of four symbols: Like words and sentences in any language, the sequence of symbols is the linearization of a Gestalt: It represents a whole-body description reorganized in serial form, and preserves the blueprint of the whole organism in order that out of it, an organism may be reconstructed.

The control mechanisms in living animals and plants are symbolic systems. They receive input data from sense receptors, and produce output whose function is to regulate the behavior of organs or organisms. The data they receive as well as the information they generate consist of symbols, because this data *represents* external conditions or elements of motor output. Thus, symbolic mechanisms of various kinds make their appearance at the most fundamental level of life.

At this stage, it is possible to understand more clearly what a symbolic system is. When it is necessary to describe an object of the external world, we must decide on the *level of specificity* that is wanted. For example, to give a description of a steam engine, the relevant objects are the cylinder, the piston, the rotary valves, and the boiler. It would be redundant and quite unnecessary to begin the description at the level of quarks and elementary particles, or by describing the molecular properties of metals. In fact, it would be *incorrect*, because those are not the functional components of a steam engine.

Every description is meaningful at a level of specificity whose basic parts are the ones you need for your description. The symbols used in the description refer to basic parts. The basic, or elementary parts at your current level may actually be composite things at a lower level. For example, in a description of the steam engine, the piston is made of an alloy of different metals and has a crystalline structure. So the piston, which is an elementary object in your description of a steam engine, is a compound object from the perspective of a metallurgist.

In this example, you may consider a next-higher level of description: For the industrial engineer who is designing a factory, the basic components of his design are various machines, each with its own specifications and capabilities: The engineer is indifferent to how the individual machines work. What this example suggests is that reality itself is multi-tiered: Each level works according to its own principles, and is not affected by things at the next-lower or next-higher tier. Scientists say that each level has its own *emergent* properties. These properties are fully accounted for by the laws operating at their level.

Returning to our discussion of symbols, a symbol is used as a token to represent an object when that object is indivisible at its level of specification, hence it would be redundant to analyze that object further. When you say "the dog bit John", the proper level of that claim has three objects, namely *dog*, *John* and the act of *biting*. A description of the dog or its teeth, or details of John's life, would add nothing at all to the claim being made. Thus, the words *dog, John* and *bit* are correctly used as symbols in that proposition.

In consequence of all this, if a bird habitually uses twigs to fish for ants in holes, or picks up pebbles to crush tough seeds, it is not wrong to say the bird has mental symbols for twigs and pebbles. It knows what they are, returns to them habitually, and they are objects in its ontology. I believe it is fair to say that all living beings have symbols, or tokens in their mind, for all the different objects in their ontology, for otherwise, how could you say they have an ontology at all?

If an animal, or even an insect, has learned to solve a problem, for example by using a twig, it must be true that the solution found is placed as a record in memory, and can be retrieved for later use. The format of this record is analytic and may be called a proposition. As mentioned earlier, we mainly think of propositions as sentences in language, but the content of a proposition can exist in mind, and does not have to be articulated in words. Long before the introduction of language, ancient man did many intelligent things: He made sophisticated stone tools, cooked food on fires, made clothing and shelters, and discovered soap when animal fat mixed with the ashes of the hearth. The ideas underlying these activities surely existed as propositions in mind.

The Rational Animal

The main purpose of the last three sections has been to discuss the analytic mode of mental processing. In order to successfully act on the world, animals must have a mode of "precision thinking", corresponding to man's precision grip—metaphorically speaking, a way to take the bull by the horns in order to get things done. This requires narrowing visual attention to small functional parts of the environment, picturing how they fit together, and representing these strict, meticulous details in a special form in memory. These rigorously precise reports are encapsulated in units that we call propositions.

Humans have the capability to further separate propositions into words. But mostly, we and other animals apprehend propositions as structured mental images, for it is in that form that they have meaning. Generally, a proposition is a unit of meaning which cannot be decomposed into separately meaningful parts. For example, an isolated word or phrase does not bring any new knowledge.

When an animal is carrying out a task, its attention is narrowed so it is aware only of the specific items it is dealing with, to the exclusion of all else. Its mind is operating in the analytic mode. In that mode, the mind works somewhat like a computer—making comparisons, trying different combinations, exploring possibilities. Emotion plays no role in the decisions it makes, for they depend only on how things of the material world fit together. This way of operating is almost mechanical.

Moreover, when an animal is busy carrying out a task, it is the individual's volition—its will—that is firmly in command. There is a well-defined goal to be achieved, and the individual is acting with a clear purpose to achieve this end. It may be said that the open, receptive aspect of the psyche is in eclipse in those moments, whereas the pragmatic, goal-driven, willful side is in control. While occupied with a practical task, an individual's mind is turned outward, fully engaged with the external, material world.

All animals—including humans—process information analytically when involved in their activities. They are focused on immediate facts and specific details. In order to carry out even the simplest tasks successfully, a creature must operate in a systematic and highly disciplined way. Indeed, it is generally recognized that all living creatures behave in a rational manner in pursuit of their goals.

Throughout history, humans have defined themselves as the *rational animal*. It is still believed that reason and logic are features that belong exclusively to the human mind. We believe this because we are the only species that have language, and traditionally we recognize rigor and disciplined thought most easily in verbal productions. We have a long tradition of argumentation and enjoy finding flaws in the reasoning of others. Thus, we have a keen eye for lapses in logic. What is specifically human is that we have reified logic—made a separate object of it—and recognize it explicitly as a feature of discourse and behavior.

We also mistakenly assume that symbolic thought is a human achievement, and it is widely believed today that the evolution of modern humans can be equated with the emergence of symbolic forms of expression. What we overlook entirely is that the practical use of symbols is almost universal among living animals, and is necessary for their survival, as discussed in this section. We keep searching for the one crucial attribute which sets us apart from all other species. Each time we believe we have found it, we soon learn that other species have the same attribute.

The Emergence of Life

Mind is immanent in every living form, from microbe to man. Indeed, life itself is widely considered to be a cognitive process. The Chilean biologist Humberto Maturana stated this directly: "Living is a process of cognition." (Cognition refers to processes of acquiring and organizing sensory inputs so that they can serve as guides to successful action.) According to Maturana, the essential biological function of every living organism is self-maintenance: The organism, for example a single cell, lies in an environment whose forces are continually acting to disrupt the integrity of the cell. In order for the cell to remain alive, its chemical factory is at work maintaining its inner equilibrium, and constantly replacing the essential ingredients of which it is constituted, which are being broken down by external influences. In order to do this, the cell is continually processing mechanical and chemical information, and issuing orders to all parts of its chemical factory.

The connection of life to sophisticated information processing is a recent insight of biologists. This perspective has been described in several books by Maturana and the biologist Francisco Varela. The same idea is expressed by Daniel Dennett in the following thought: An entity comes into existence with behavior designed to fend off its dissolution. The creature thus comes to have its own interests and goals. Purposeful behavior starts with the first macro-molecules having enough complexity to do things. Thus, for Dennett, purposefulness is born with the first molecules that replicate.[4]

For the eminent philosopher of biology Ruth Millikan, the distinguishing characteristic of living organisms is that they are intentional agents. The activity of every living being is directed toward the achievement of specific goals. It may be that every organism has original intentionality, but it is also possible that original intentionality is rooted in evolution—in the scheme of life itself—and that the activity of living individuals is covertly animated by the original intentionality that exists in the enterprise of life at its very foundation.

Recognizing the fact that mind is present in the very simplest living forms is of huge importance. The eminent American biologist Lynn Margulis goes even further: She writes of "microbial consciousness" and the "conscious cell".[5]

She says, "Not just animals are conscious, but every organic being, every [self-organizing] cell is conscious. In the simplest sense, consciousness is an awareness of the outside world." The philosopher Maxine Sheets-Johnstone explains why this must necessarily be so: She says that bacteria, which are able to sense their environment and move in response to what they sense, must have some form of proprioceptive, or body consciousness. They respond in accordance with what they "feel". This point of view is now in the mainstream of biological thought. It has given rise to a new discipline known as *Cognitive Biology.* This is a seismic shift in traditional belief.[5]

Another scientist who has done cutting edge research on this topic was Barbara McClintock, who received the 1983 Nobel Prize in Physiology and Medicine for this work. It is known today that bacteria have information-processing and cognitive abilities: Though they are small in size, they exhibit enormous complexity and sophistication in their behavior. Most remarkable is their ability to change their own DNA when needed, and to take possession of DNA components of other organisms and transform it to their own uses. "Bacteria are master cell biologists and possess both the know-how and the technology they need to seize control of cell growth, metabolism and structure from the most highly developed multicellular organisms." The mystery is how they hold onto that knowledge, and how they know precisely what to do in order to use the knowledge to accomplish their goals.[6]

It is essential to keep in mind that bacteria do not have nervous systems, and therefore do not carry out logical operations on discrete data. Their knowledge is not given to them as propositions, nor do they communicate (internally and with others) by using anything like a language having syntactic rules. (It requires an advanced nervous system to learn analytic concepts.) Yet, no matter how you cut it, bacteria *know* things—and are able to use that knowledge to *do* things. The regulatory mechanism of bacteria has been called a *nanobrain.*

Nobody knows how that knowledge is stored in the bacterial "mind". As explained, the knowledge is not analytic: It must be Gestalt knowledge, existing in the form of "feeling". How can a bacterium "feel" in the absence of a complex brain? Here we stand at the absolute limit of what is known about living creatures. Since we have absolutely no idea what *feeling* is in any creature, we cannot say if bacteria have it or not. Something like feeling could be carried in the complex chemical milieu of cells, modulated by the continual ebb and flow of electrolytes and other chemicals. No experimental work has been done on that question, so we may try to use logic to tease out a plausible scenario.

Single cells would not have the equivalent of analytic knowledge because it requires complex brain circuits to develop. Early animals likewise are unlikely to have had the benefit of analytic knowledge because it must have developed over great stretches of evolutionary time as brains became more complex. It is likely that cognition in early animals consisted chiefly of Gestalt image-like patterns, for those are products of biology. Thus, it is likely that historically, animal perception and cognition consisted initially of Gestalts, and analytic forms of cognition came much later.

It is a common misconception that only higher animals, such as mammals, have advanced skills such as the ability to plan actions on the basis of fine discriminations and understanding. This is wrong, because the real difference is between modern animals and those that existed, say, 700 million years ago. Advanced mental skills exist today in almost all creatures, because they have had the time to evolve. Researchers in animal cognition are constantly surprising us with revelations of the unexpected cognitive skills of small-brained creatures such as birds, even insects, and most recently, bacteria.

In view of this, a major question in the science of evolution is whether animal species are becoming progressively more complex over time. It is the common belief of most people who are acquainted with Darwin's theory that evolution is progressive, and that over long spans of time species are becoming progressively more "advanced". The evolutionary biologist Stephen Jay Gould forcefully rejected that popular belief, and laid out what is now the orthodox view.

The "official" position in biology today is that natural selection has no intrinsic direction, and that over time some organisms increase in complexity while others decrease. The reasoning is that according to Darwin's theory, species change in response to conditions in their local environment. The purpose of whatever change they undergo is to increase their fitness in the environment, and this should have no bearing on their complexity.

However, there are well known and recognized processes in nature that lead to greater complexity in some species. The most outstanding is the predator-prey relationship, which gives rise to what are called *arms races*. For example, the predator gains increased fitness by acquiring sharper teeth. Then the prey evolve a harder shell. The predator evolves keener vision, and the prey, in response, adopts camouflage as a new strategy.

Ultimately, none of these arguments provide an answer to the question of whether evolution is inherently progressive. The reason is that nobody today knows what life is, why it emerged, how it emerged, and whether it was a chemical accident or an integral phase of cosmic evolution. Again, the current orthodoxy is that in the early days of our planet, certain large molecules fortuitously underwent transformations that gave rise to self-reproducing entities. In this scenario, life is accidental and contingent: It could very well not have emerged at all.

Considering the momentous importance of life in the complexification of physical reality, it is far more plausible to assume that the advent of life is not the result of an accident but is an integral phase of cosmic history. We have no idea why the cosmos exists: Many people have asked, "why is there something rather than nothing at all?" But even if there is something, we don't know what that "something" is. We know there are things that we interpret as matter and energy, but our experience of those things is indirect. Our only direct experience is that of our conscious minds. That's all we are *really* sure of. We have direct experience of sensations, thoughts, ideas and feelings.

Yet, by a strange travesty of logic, our current ideology holds that only the material is real, and everything we experience is a figment that is somehow produced by a material process. Is it not more likely that our sensory experience is something real, but not material? Could the universe not contain two tiers of reality, one material and the other experiential?

If that were the case, then we would have to conclude that the cosmic function of life is to be the vehicle of experiential existence, and to be the repository of Gestalt multiplicity whose purpose is to bring into existence newly minted and highly complex organized structures. While the material aspect of the universe evolves in one way (by cooling down and dissipating information), the experiential aspect evolves in the direction of producing ever more intricate hierarchical productions. Perhaps the cosmos, from its very inception, has been a process leading toward ever increasing complexity, with no journey's end.

A Revolution in Physics

Rigorous science had its beginnings more than two thousand years ago in Greece and the Greek city-states on the shores of Asia Minor. The early scientists proclaimed that in order to arrive at true knowledge of the world, the observer had to radically separate himself from the object he was observing. This dogma became enshrined in the practice of science, and from that time on the removal of the subject from science became a basic principle of our way of learning about the physical world.

This dogma was a cornerstone of scientific practice for two millenia: It was essential in early science in order to separate truth from superstition. Today, however, a stage has been reached in physics where disregarding the subject is no longer feasible. The living observer plays an indispensable role in selecting and interpreting what is available to observation. We recognize today that the scientist is not an idealized observer, who in some mysterious way picks up an explicit, well-formed version of external events. Instead, the observer has the burden of giving a fixed shape to the information he or she receives. As explained earlier, without an observer nothing actual or specific is happening. That is the underlying theme of this book.

In fundamental physics this idea has been present, in a latent form, for over a century. The great physicist Niels Bohr wrote in 1929 that the purpose of science is not to uncover "the real essence of phenomena" but to disclose "relations between the many aspects of our experience". There is no such thing as the "real essence" of physical events, because events can only be described or visualized by living observers. That is, events assume a definite form only in living experience.

An elementary particle such as an electron does not have a given position, mass or speed if it is not observed. Instead it exists in the form of what is called a *wave function* which reveals the probability of obtaining certain values when it is measured. Yet if it is directly observed, the wave function collapses and the particle is in a fixed state, with a specific position and velocity at each instant. This simple fact makes it evident that at the subatomic level, the observer participates in the phenomenon under observation. It is not clear how this can be, and quantum theory has been stumped for a hundred years by this quandary.

It is only in the last decade that a reasonable answer has been proposed: The underlying idea is that the wave function's probabilities do not stand for the likelihood that a certain material fact is true in the physical world. Instead, it represents the experimenter's *degree of belief* that the fact is true. This approach is called *quantum Bayesianism*, which is usually shortened to QBism. In order to explain this position, I must say a few words about the Bayesian concept of probability.

Let the letter H stand for some possible fact in the real world. Then $\mathcal{P}(H)$ stands for the probability that the proposed fact H is true. If D is some other fact, then $\mathcal{P}(H|D)$ is the probability of H being true, *assuming that* D is true. Likewise, $\mathcal{P}(D)$ is the probability that D is true, and $\mathcal{P}(D|H)$ is the probability that D is true assuming H is true. Mathematically, Bayes' Rule is given by the formula

$$\mathcal{P}(H|D) = \mathcal{P}(D|H)\mathcal{P}(H)/\mathcal{P}(D)$$

The formula is irrelevant here: What needs to be retained is that these four quantities are related, so that any one of them can be obtained if we know the other three.

In applications of this formula, H stands for our *hypothesis*: A hypothesis is a fact that we believe to be true at the start. You may also think of a hypothesis as a scientist's expectation of the outcome of his next experiment. As for D, it represents *data*, that is, a fact or facts we get experimentally. Thus, $\mathcal{P}(H|D)$ is the probability that our hypothesis is correct on the strength of the data D.

On the other hand, $\mathcal{P}(D|H)$ is the probability of the observed data arising from the hypothesis. This is known by the experimenter, because it expresses the consequences which follow if the hypothesis is true. Likewise $\mathcal{P}(D)$ is known experimentally, because it depends on the frequency with which the outcome D arises when a certain experiment is performed. But $\mathcal{P}(H)$ is different: It is the scientist's subjective estimate of how likely the hypothesis is to be true.

Every experiment yields some data D. As noted just above, $\mathcal{P}(H)$ is the scientist's personal degree of confidence in the hypothesis. After the experiment has been carried out, $\mathcal{P}(H)$ is replaced by $\mathcal{P}(H|D)$, because the scientist's belief is no longer H but a version of H that has been updated by the data D.

You should notice, then, that in the Bayesian version, probability reflects an experimenter's subjective level of confidence in a hypothesis. A quantum state changes when a measurement is made. However the change is not in the physical world but results from the scientist's updating his degree of belief in a hypothesis after seeing new experimental data. Thus, the knowledge gained from carrying out an experiment does not correspond to an objective reality of the physical world, but to a scientist's beliefs. New knowledge is not about the unseen, unknown objective world, but about the scientist's personal model of reality, fine-tuned by experimental confirmation.

In particular, the collapse of the wave function when an observation is made is simply the observer updating his beliefs after making a measurement. Thus, the wave function is not a material reality of the physical world, but merely the description of an observer's knowledge. It is a remarkable fact that when the wave function is viewed in this light, the famous paradoxes of quantum theory disappear.

Despite the many impressive results of QBism, a weighty question hovers over it: What kind of knowledge of the physical world does QBism give us? It is said by scientists who are fully committed to it that at present there is no good answer to that question, and for that reason, QBism remains an uncompleted project.

The scheme presented in this book provides a foundation for quantum bayesianism. As explained in the previous chapters, there is a radical divide between the physical world removed from observation—that is, the universe outside the range of any observer—and the aspects of reality created by the minds of living observers. It has been argued that it is the mind that divides reality into distinct, separate objects and creates the shapes and structure of solids.

The mind organizes phenomena into complex and comprehensive wholes, and by doing this creates most of the reality that we perceive.

In addition to this, the mind lures every individual into believing that what is perceived is present in the external world with the very features and qualities that our brain has assigned to it. Our biologically-designed model of reality is thus superposed on the physical stuff of the world and structures it. It is with this reality that we interact. As a consequence of this, the universe that science analyzes and describes is the universe according to our inner model of reality. There is absolutely no conflict between our model and the external "stuff", because what we discern is—you might say—an organized version of the same matter.

It might be said that the physical universe of matter and energy is the substrate on which the universe we know is built. This is not quite accurate, however, because even *that* is a human interpretation. Instead, as living beings we have a body made of matter, and we exist in a material environment. Both of these things are unknowns, but we have experience of the *mutual interaction* between them. This (largely unconscious) base of sensory cognition, embedded in the animal Sensorium, is the totality of our knowledge of the background universe.

It would appear, from this, that reality is not limited to the physical. On a par with space and time—with matter and energy—the universe must include an organizing force which acts to create unified hierarchical structures. These are not composed of matter, but subsist on something nonmaterial that we interpret as mind.

In order for physical science to advance to the next level, it is necessary to overcome a biological force that compels us to perceive the external world in the forms which our collective mind has created. Classical physics is an elegant description of the universe as it is laid out in our mental model of reality, and is a huge achievement. It may appear that it is impossible to go further, because that would be seeking what the philosopher Thomas Nagel called *a view from nowhere*. However, that is unwarranted pessimism. One might begin by examining the evidence for the existence in the universe of a nonmaterial mindlike effect that assigns form and structure to matter. The most obvious place to begin this search is in the phenomenon of life.

Chapter Notes

1. The Visual World

1. This topic is covered in depth in the book *Sensory Exotica* by Howard C. Hughes, MIT Press, 2001.
2. This tiny insect is also named *kikiki*. As of 2020, it is the smallest known flying insect. Discovered by John Huber and John Beardsley, its description was published in 2000. More details may be found in "World's Smallest Insect", College of Agriculture and Life Sciences, Northern California State University.
3. I have simplified the description of Shakey given by Dennett. See Daniel Dennett, *Consciousness Explained*, 1991, Little, Brown.
4. Hoffman's work is laid out in several journal articles as well as in a recent book titled *The Case Against Reality: Why Evolution Hid the Truth from Our Eyes,* (see References).
5. This material, as well as almost anything else you may wish to know about human and animal vision, may be found in the volume titled *Vision Science* by Stephen Palmer.
6. This phenomenon, together with many related ones, is described in V. S. Ramachandran, *Phantoms in the Brain*.
7. This important research is contained in David Hubel and Margaret Livingstone's article *Segregation of form, color, movement, and depth: anatomy, physiology, and perception* which appeared in the magazine *Science* in June 1988.
8. The role of emotional energy in perception is one of the topics of Antonio Damasio's book *The Strange Order of Things*.
9. A beautiful film of the peacock display may be viewed at: www.youtube.com/watch?v=pTOblw2NRP8.

C. Pinter, *Mind and the Cosmic Order*,
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2. Gestalt

1. Contemporary psychology had its beginnings in the early Nineteen Hundreds, when the experimental psychologist Max Wertheimer, with his associates Kurt Koffka and Wolfgang Kohler, rebelled against the traditional empiricist foundations of psychology and pioneered a new approach to mental phenomena, especially relating to visual perception. They referred to their work as *Gestalt psychology*, and their idea of Gestalt is the one described in this chapter. Their interest, however, was in the perceptual organization of vision. We shall not go into that specialized subject here. We retain the word Gestalt in its original meaning, which is the living mind's ability to perceive complex, many-part, spread-out displays in a single eyeful—a single act of awareness.
2. The article referenced here is to be found in the journal *Science*, February 21, 2020, page 850.
3. An excellent analysis and criticism of the computational paradigm is contained in the book by the Berkeley philosopher Herbert Dreyfus entitled *What Computers Can't Do: The Limits of Artificial Intelligence*.
4. A number of different laboratories conducted experiments similar to those of Lionel Standing, and obtained comparable results.
5. The same computers are able to conduct memory searches using a system known as *content-addressable memory* (CAM). In this procedure, the computer is made to search for a particular content (for example the sequence 001011001) by going through all the memory locations in a rapid sweep. Even so, CAM is nothing like human associative memory.
6. The linguist and philosopher Noam Chomsky has had a great influence on the course of cognitive science, especially the study of language. For further details on his work, an excellent source is the online entry for Chomsky in the Stanford Encyclopedia of Philosophy.
7. An excellent account of the deaf children of Nicaragua is to be found in Steven Pinker's book, *The Language Instinct*. Also, a brief description of the topic is given in *Scientific American*, September 17, 2004, in the article titled "In Nicaragua a Language is Born".
8. Michael Polanyi was a Hungarian philosopher and polymath who made important contributions to economics, physical chemistry and philosophy. Many of his most influential ideas may be found in his book *Personal Knowledge*.
9. The *Memory Palace* is a well-known memory technique used by "memory wizards". It is described in the article *The Secrets of Sherlock's Mind Palace* By Sarah Zielinski, in Smithsonian Magazine, February 3, 2014.
10. Chunking is a way of taking individual items of information and relating them to one another so that together they form a single, coherent Gestalt idea.

By doing this, information becomes easier to retain because a whole Gestalt is almost as easy to remember as a single item.
11. Immanuel Kant is perhaps the one classical philosopher who most influenced modern thinking. One may find a fairly comprehensive outline of his work in the entry for Kant online in the Stanford Encyclopedia of Philosophy.

3. The Animal Sensorium

1. Sensory neurons signal the brain by firing voltage spikes called *action potentials* whose pattern varies. The message contained in these signals is coded in the "firing rate" of the signals, that is, the number of spikes per second. The message may also be coded by the exact timing of successive spikes. However, the organization of this code is not understood at this time.
2. An important area of study in neuroscience is the way the brain organizes actions. The motor cortex receives information on the brain's intention to act, and responds by planning the action and generating a sensation of what the execution will feel like. This is described in Marc Jeannerod, *The Cognitive Neuroscience of Action*. A simple discussion of this topic may be found in the essay *How the Brain Prepares For Action* in the online journal *Neuroscience News*, February 7, 2019.
3. Essays explaining and supporting this position can be found in the volumes *Phenomenal Intentionalty*, Uriah Kriegel (2013) and *Cognitive Phenomenology*, Bayne and Montague (2011).
4. This is currently an active area of research. Several excellent books have been written on the topic. The earliest and most readable has the colorful title *Women, Fire, and Dangerous Things* by George Lakoff, University of Chicago Press, 1987. Another excellent treatment of the subject is Jean Mandler's *The Foundations of Mind: The Origins of Conceptual Thought*, Oxford University Press, 2004.
5. The concept of r vs. K selection was introduced by the ecologists Robert MacArthur and E. O. Wilson in 1967. Further details may be found in the article *Life history tactics: a review of the ideas* by S. Stearns, 1976, *Quarterly Review of Biology*, volume 51, pp. 3–47.
6. The clearest and most informative studies of emotion are those described by Antonio Damasio in several books. Here, I refer particularly to his volume titled *The Strange Order of Things: Life, Feeling, and the Making of Cultures*, Pantheon Books, 2018.
7. This fascinating topic belongs within a new branch of biology called *cognitive biology*. A splendid overview, not too technical, is the article by J.A. Shapiro entitled *Bacteria are small but not stupid: cognition, natural genetic engineering and socio-bacteriology*, in *Studies in the History & Philosophy of Biological & Biomedical Science*, volume 38, 2007, pp. 807–819.

4. The Mind-Made Firmament

1. Many psychological experiments over the years have shown that when a human subject views a scene, the objects in it are recognized spontaneously, and so are their identities. This research may be found in the article "On the semantics of a glance at a scene" by Irving Biederman. Further details are in the article "Global shape cannot be attended without object identification" by Boucart and Humphreys. (See in References.)
2. Willard Van Orman Quine was an American philosopher who wrote widely on language. Much of his philosophy relating to language may be found in his book *Word and Object*.
3. Konrad Lorenz was one of the first and greatest ethologists—that is, a scientist of animal behavior. Among his several books, the most celebrated, perhaps, is the volume titled *On Aggression*. Since Lorenz was writing in the 1960s, it was his assumption that genes were the only source of inherited information. Today we know that many behavioral traits—even phobias—are transmitted "epigenetically" by certain markers which find their way onto the DNA.
4. The structure of categories, and the question of how they are formed by human and animal minds, is a central question of modern psychology. A classical study of categorization is described in the book *Classification and Cognition* by W. K. Estes. However, the entire discipline was transformed by the doctoral thesis that Eleanor Rosch presented at Harvard in 1969. She found that basic objects have a psychological centrality that transcends cultural differences and applies to all people. She also showed that a basic principle of categorization is the tendency of all people to classify things by their prototypes.
5. The question of insect cognition is of great interest to scientists and is a very active area of research. The intelligence of bees, in particular, has been amply documented. Bees navigate with the help of an internal cognitive map, and use sophisticated deduction to discover new pathways using the map. They have good memories and are surprisingly capable learners. It has even been found that they have a sense of number—including the number zero. This surprising fact is described in the magazine *Science* in a 2018 article titled "Numerical ordering of zero in honey bees".
6. These ideas are explained in Quine's *Word and Object*, especially in Chapter 2 entitled "Translation and Meaning".
7. This insight was made widely known by the American philosopher Hilary Putnam. In the literature of philosophy, it is known as *internal realism*. It is discussed at length in Hilary Putnam's book "Reason, Truth and History".
8. As explained previously, we are biologically "wired" to be totally committed to the belief that what we perceive is precisely what there is in the world. In the

book *The Embodied Mind*, Varela is expressing the thought that it is traumatic to have to face the fact that what we perceive to be an absolute truth, and have always believed, is incorrect.

9. An influential contemporary theory of perception is called *predictive processing:* In this theory, the brain is constantly referring to its world-model in order to generate hypotheses of the external situation. The hypothesis is compared to incoming sensory information, and if errors are detected, the hypothesis is altered. The corrected hypothesis is what we experience in perception. The theory is elaborated in two recent books: Andy Clark's *Surfing Uncertainty*, 2016 and Jakob Hohwy, *The Predictive Mind*, 2013.

10. Kolmogorov complexity is a very important concept in theoretical computer science. It was the outcome of work by several researchers, especially Ray Solomonff, Gregory Chaitin and Andrey Kolmogorov. In addition to its application in the science of computing, it is of great philosophical interest as the rigorous definition of complexity.

5. In Search of Reality

1. Many consider Ludwig Wittgenstein to be the greatest philosopher of the 20th Century. His short book, the *Tractatus Logico-Philosphicus*, was the only book-length work on philosophy published during his lifetime. It is a strange book, which contains no logical arguments but mainly declarations which he considered to be self-evident. The declarations are in the form of numbered propositions. The book begins with the claim that "the world consists of facts, not things", and this is given as Proposition 1.1. Wittgenstein considered his propositions to be "logical pictures". He believed that a picture is something that requires no explanation, because its meaning reaches us directly.

2. This important insight is prominent in the work of the American philosopher Hilary Putnam. He referred to it as *Internal Realism*. It is discussed at length in the article titled "Internal Realism" in the journal *Synthese*. It is also the central topic of Putnam's book *Reason, Truth and History*.

3. Alfred Korzibsky wrote several books on a number of topics that excited his interest. The map and the territory is discussed in his book "Science and Sanity", on page 58.

4. Authors of popular books on physics go into great detail to try and convey the idea of four-dimensional space to the general reader. An interesting book on the subject is Rudy Rucker's "The Fourth Dimension: A Guided Tour of the Higher Universe".

5. Information theory as a scientific discipline was pioneered by Claude Shannon in the 1930s and 40s. The founding text is Shannon's paper entitled "A Mathematical Theory of Communication". It must be noted, however, that the technical concept of information is limited. Our intuitive idea of information

as something which brings us news and knowledge goes far beyond the notion as it is treated in the literature of science and engineering.

6. It has been known since the 1970s that a type of nerve cell in a brain area called the hippocampus is activated when a rat is at a certain place in a room. Other nerve cells are activated when the rat is at other places. It was concluded that these cells are "place cells" in the brain. Taking up this research thirty years later, May-Britt and Edvard Moser discovered another specific cell type in the brain's system for locating objects in space, and called them "grid cells". These cells actually give rise in the brain to a coordinate system which carries out precise positioning and pathfinding.

7. Structural Realism is the leading theory of the relationship between scientific ideas and the real world. Its ideas were pioneered by Bas van Fraassen, a Dutch-born philosopher of science. Today there is a large school of researchers writing on the topic. An exceptionally clear exposition of the ideas is to be found in the article "Everything you always wanted to know about structural realism but were afraid to ask", published in the *European Journal on the Philosophy of Science.*

6. Materialism: The Brain As Computer

1. This subject is covered methodically in the book titled *Physicalism* by Daniel Stoljar. An interesting discussion is given also in Jaegwon Kim's 2007 book, *Physicalism, or Something Near Enough.*

2. *There's Something About Mary* by Peter Ludlow (Editor), Yujin Nagasawa (Editor), Daniel Stoljar (Editor), MIT Press, 2004

3. According to a credible source, his name was prince Chalmers.

4. Dennett discusses "intuition pumps" in his 1984 book *Elbow Room.* He describes them as thought experiments which harness a reader's intuition to help her or him better understand an abstract idea. The concept is further elaborated in Dennett's book *Intuition Pumps and Other Tools for Thinking.*

5. John Searle is a professor of philosophy at the University of California, Berkeley. The Chinese Room argument is introduced in the article "Minds, Brains and Programs" which appeared in the journal *Minds, Brains and Programs* in 1980. He discusses similar ideas in his address *Is the Brain a Digital Computer?*. The same ideas are discussed in his 1992 book *The Rediscovery of the Mind.*

6. The idea of emergence plays a central role in many contemporary debates in science and philosophy. A good source for these ideas is the volume entitled *From Complexity to Life: On Emergence of Life and Meaning* edited by Niels Gregersen.

7. A similar approach to objectivism is discussed by the philosopher Donna Haraway in her monograph *Situated Knowledges.* (See References). Haraway

argues that objectivity in the sciences consists of a kind of disembodied examination of objects from no particular perspective, or in her words, a "gaze from nowhere".

8. You cannot define a straight line to be the "shortest distance between any two of its points" on pain of circularity: Straight lines are necessary in the definition of distance, and distance is needed in the definition of straight line.

7. The Universe Observed and Unobserved

1. For a live demonstration, see Wikipedia, "Conway's Game of Life".

2. A beautifully clear account of the early universe is to be found in the book *The First Three Minutes* by the Nobelist Steven Weinberg.

3. Nobody has ever written more lucidly about the theory of relativity than Albert Einstein himself. Einstein's account is available in his book *Relativity: the Special and General Theory*, first published in 1920.

4. Even Albert Einstein, throughout his career as the most innovative physicist of his time, continued to believe that physics must respect our intuitive notions of causality and determinism. In his work he advocated a position called *local realism*, which now appears to be superseded by a new view of time and space. Local realism has two strands: First, locality, which states that faraway events can't influence each other faster than the speed of light. Next, realism, which asserts that properties of physical entities are the same whether we measure them or not, that is, whether anybody is aware of them or not.

5. A great deal of research is currently devoted to the theory of predictive processing in perception. A very clear exposition of the ideas is given in Jakob Hohwy's *The Predictive Mind*. An entertaining in-depth review is given by Andy Clark in his recent book *Surfing Uncertainty*.

6. Karl Popper is regarded as one of the greatest philosophers of science of the present time. His views on the validity of the experimental method are outlined in two of his books: *The Logic of Scientific Discovery* and *Conjectures and Refutations: The Growth of Scientific Knowledge*.

7. According to quantum Bayesianism, what traditional physicists got wrong was the naïve belief that there is a fixed, "true" external reality that we perceive "correctly". Quantum Bayesianism claims that instead, the scientific observer sees the readings on his instrument and understands that they bring him new information pertaining to his mental model of reality. He has abandoned the belief that he is seeing the real world "as it truly is". A new book which explains the ideas in non-technical terms is *QBism: The Future of Quantum Physics* by Hans Christian von Baeyer.

8. Mind, Life and the Universe

1. Maurice Merleau-Ponty was a French philosopher of the second half of the 20th Century. His most important work is to be found in his book *The*

Phenomenology of Perception. Many of his ideas anticipate results of cognitive science, and present them in a wide perspective.

2. The study of octopus psychology is full of unexpected and surprising facts. An excellent overview is the book *The Soul of an Octopus: A Surprising Exploration into the Wonder of Consciousness* by Sy Montgomery.

3. Jacques Hadamard was a celebrated mathematician of the early 20th Century. His little book on creativity has the forbidding title *The Psychology of Invention in the Mathematical Field*, though it speaks of invention and creativity in a far broader context. For anyone with an interest in the creative mind, it is well worth reading.

4. Francisco Varela and Humberto Maturana are Chilean biologists who worked together to form a fundamental theory of living organisms, which has wide currency today. They argued that all life is cognitive, since at its root it involves receiving information and actively responding to it. Daniel Dennett is an American philosopher who has written many books on a diversity of topics. His books are entertaining, original and always provocative.

5. Cognitive biology is a new discipline at the intersection of biology and cognitive science. Most of the new findings in this field are in specialized books and journal articles. However, a very accessible review of the subject is contained in an article titled "Bacteria are small but not stupid: cognition, natural genetic engineering and socio-bacteriology."

6. The Nobel Prize in Physiology or Medicine 1983 was awarded to Barbara McClintock for her work which helped usher in Cognitive Biology. Earlier work on the same general topic was also rewarded with a Nobel prize: The French biologist François Jacob, together with André Lwoff and Jacques Monod, received the 1965 Nobel Prize for Physiology or Medicine for discoveries concerning regulatory activities in bacteria.

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Index

C. Pinter, *Mind and the Cosmic Order*,
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