Chapter 1
Brain-Body-Mind Problem: A Short Historical and Interdisciplinary Survey

René Descartes (1596–1650) made the daring suggestion that:

> *Everything in the universe could be explained in terms of a few intelligible systems and simple approaches on which the stars, and the earth and all visible world may have been produced.*

1.1 Introduction

1.1.1 What Is the Mind?

According to the encyclopedia, *mind* refers to the collective aspects of intellect and consciousness that are manifest in some combination of *thought, perception, emotion, will*, and *imagination*.

There are many theories concerning the mind and how it works, dating back to the ancient Greeks, Plato and Aristotle. Modern theories, based on a scientific understanding of the brain, see the mind as a phenomenon of psychology and often psychiatry, and the term is frequently used more or less synonymously with consciousness.

Which human attributes make up the mind is a much-debated question. Many scientists argue that only the "higher" intellectual functions constitute mind, particularly reason and memory. In this view the emotions – love, hate, fear, joy – are more "primitive" or subjective, and should be seen as different in nature or origin to the mind. Other scientists argue that the rational and emotional sides of a human being cannot be separated, as they are of the same nature and origin and should all be considered to be part of the individual mind. This book takes the view that *mind* is inseparable from the psychological and physiological functions of the body. Most strongly, it is argued that physiology of the brain-body and psychology are strongly interwoven and inseparable.

In popular usage the word *mind* is frequently synonymous with the word *thought*: It is that private conversation with ourselves that we carry on inside our heads. Thus, we "make up our minds," "change our minds," or are "of two minds"

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about something. One of the key attributes of the mind in this sense is that it is a private sphere to which no one but the owner has access. No one else can know our mind; they can only know what we communicate.

According to Eric Kandel (2006), a new biology of mind has gradually emerged over the last 50 years. In the 1960s the new discipline attempted to find common elements in the complex mental processes of animals, ranging from mice to monkeys to humans. The approach was later extended to simpler invertebrate animals, such as snails, honeybees, and flies. This modern cognitive psychology was at once experimentally rigorous and broad based. It focused on the arrangement of behavior from simple reflexes in invertebrate animals to the highest mental processes in humans, such as attention, consciousness, and free will, which are traditionally the concern of psychoanalysis. Kandel further says that cognitive psychology merged with neuroscience in the 1970s, and the result was cognitive neuroscience. This new discipline introduced biological methods of exploring mental processes into modern cognitive psychology. In the 1980s cognitive neuroscience was enhanced by methods of brain imaging such as fMRI, PET, brain mapping, and not least, oscillatory brain dynamics. In 1980s molecular biology added great value to our understanding of the biological mind.

Chapter 3 globally outlines the methods of this new discipline of cognitive neuroscience (Fig. 3.11). The present chapter brings together several of the mentioned methods. The question, What is mind? cannot be answered with a unique discipline; it should encompass various disciplines, methods, and systems of thought.

Physiology, biochemistry, philosophy, physical concepts, psychology, Darwin's evolution of species, maturation of the brain, and pathology, should provide deeper insight for reasoning related to mind. This view is schematically shown in Fig. 22.1.

1.1.2 What Is Thought?

According to the encyclopedia, *thought* is a mental process that allows human beings to model the world, so as to deal with it effectively according to their goals, plans, ends, and desires. Words referring to similar concepts and processes include cognition, sentience, consciousness, idea, and imagination. Thinking involves the cerebral manipulation of information, as when we form concepts, engage in problem solving, reason, and make decisions. Thinking is a higher cognitive function, and the analysis of the thinking process is part of cognitive psychology.

Memory is an organism's ability to store, retain, and subsequently recall information. Although traditional studies of memory began in the realms of philosophy, in the late nineteenth and early twentieth century memory was placed within the paradigms of cognitive psychology.

Imagination is accepted as the innate ability and process to invent, partial or complete, personal realms within the mind from elements derived from the sense perceptions of the shared world. The term is technically used in psychology for the process of reviving in the mind percepts of objects formerly obtained from perception.

Consciousness is a quality of the mind generally regarded to comprise elements such as subjectivity, self-awareness, sentience, sapience, and the ability to perceive the relationship between oneself and one's environment. It is a subject of much research in philosophy of mind, psychology, neuroscience, and cognitive science.

1.1.3 The Brain-Body-Mind Problem

The *brain-body-mind problem*, i.e., the relationship of the mind to the body, is commonly seen as the central issue in the philosophy of the mind, although there are other issues concerning the nature of the mind that do not involve its relation to the physical body. This book argues that thought processes are strongly anchored to physiological processes and thus also with the mechanisms of transmitter releases, as analyses of Alzheimer's and bipolar patients clearly show.

Furthermore, this may be the first time that the necessity is introduced of analyzing the mind problem during the evolution of species by means of electrophysiological evolution. The maturation of the mind from child to adult and to elder brains is also a crucial step that is addressed in Chaps. 10 and 11.

At the beginning of scientific development, philosophers had no knowledge of certain given mechanisms. First, fundamental questions were raised. These fundamental philosophical questions opened the way to essential measurements within the limits of the instrumental progress of the time. Accordingly, philosophy as an integration of the multi-disciplines of basic science merits important attention. This was the starting point toward the establishment of positive sciences. Accordingly, it is necessary to start with fundamental philosophical questions and related concepts.

This chapter gives a brief and concise survey of the work and concepts of selected scientists, starting from the early days of the Renaissance. Each scientist made immense contributions by asking questions, and added to the grand avenue of science and philosophy.

It is useful to review the trends of earlier centuries by trying to find common principles. From time to time science makes great jumps, although at other times there is stagnation for decades or even centuries in a particular branch of science. Sometimes a branch of science or a theory is considered to be "dead;" then, after several years a renaissance of this "dead" branch is observed. In fact, the author of this book began by considering the "dead" branch of the electroencephalogram, which had been declared a "smoke" by several neuroscientists, especially Sir John Eccles. However, the validity of this instrument was revived. Therefore, it is necessary to re-examine the past, and those theories that have been seriously criticized. For example, some authors (Damasio 1994) declared that Descartes' theory related to the mind was unsuccessful, labeling it "Descartes' error." However, Descartes was not in error. Some of his approaches are illuminating, although others are limited. Every scientist achieves a limited path. The conglomerations or "the Holon" of essays of several scientists can partly illuminate future problems. There are fewer than 15 scientists and philosophers who made considerable contributions to the evolution of science. The author has read approximately 70% of the cited works in the original books and articles. As Ramon y Cajal (1911) stated, this is important to avoid disagreeable surprises.

In this chapter some descriptions are long and some very short, as this is not a book on the history of the sciences. Only the essential features from the work of scientists that are the prerequisite to understanding complex phenomena in diverse chapters of the book are given. For example, the causality principle described by David Hume is presented, but not his work on morality.

1.2 Earlier and New Thoughts on the Mind

1.2.1 Introductory Remarks

This section analyzes and evaluates the conceptual frames of René Descartes, Blaise Pascal, John Locke, and Henri Bergson – four philosophers who were geometricians who attempted to develop fundamental ideas for the evolution of the sciences. Descartes' ideas dominated thought from the seventeenth century. Most important discoveries were made between the seventeenth and the beginning of the twentieth century. As new discoveries in physics and biology were established, the importance of using new techniques became clear. In this way, new discoveries opened the way to the development of new machines; and these in turn opened the way to new types of observations and accordingly to new discoveries. A description of Renaissance philosophers should also embrace the work of Galileo Galilee and Isaac Newton.

At the beginning of the twentieth century the development of statistical thermodynamics and, later, quantum theory led to a coordinate system that included uncertain probabilities. Physicists, therefore, were able to make progress following the development of quantum dynamics and the theory of relativity. The creation of the branch of psychology starting with James Stuart and Hermann Helmholtz opened the way to the inclusion of cognitive processes. Although Pascal and Descartes had already mentioned the relevance of cognitive phenomena, measurements of this area were not feasible during the twentieth century. Norbert Wiener (1948) in his book, *Cybernetics*, made predictions about the use of computers and the relevance of their use in the twentieth-century world. Now in the twenty-first century it is possible to measure brain-body processes and make predictions. The following sections describe the few philosophers' work so as to clarify the gap between the time of Descartes-Pascal and Henri Bergson.

1.3 Rene Descartes' Essential Work

Descartes believed that science should be grounded in absolute certainty rather that observation and prediction. Three of the important principles that describe his philosophy follow.

1. To employ the procedure of complete doubt to eliminate every belief that does not pass the test of undeniability (skepticism).
2. To accept no idea as certain that is not clear, distinct, and free of contradiction (mathematicism).
3. To found all knowledge on the bedrock of the certainty of self-consciousness, so that "*I think, therefore I am*" becomes the only innate idea unshakable by doubt (subjectivism).

Descartes' first principle says, in a nutshell, that everything is untrue until proved true. He attempts to install a great wall of doubt between truth and unproved statements. Unlike the American philosophy "innocent until proved guilty," Descartes pushes for the view "guilty until proved innocent." It is these rigorous standards of proof that can filter many of the half-truths that the scientific community chooses to believe.

Descartes' second principle is related to the first, but only in the rigorous standard that truth needs to be infallible in all aspects of fact. This follows modern philosophy, comparing it again with an aspect of law. It is similar to the philosophy "guilty beyond a reasonable doubt." If there is even the slightest doubt that proof is not totally true, it cannot be true.

Descartes' third principle is the strongest in its implications. In my interpretation, Descartes states that the one thing that cannot be questioned is consciousness. His famous "*Cogito ergo sum*" (I think; therefore, I am) is the only unquestionable truth. A person exists because he thinks. If you think, "Do I exist?" the simple act of thinking is enough to prove existence. *Cogito ergo sum* is the base, the bedrock, of all truth and knowledge. It stands as the foundation of the building of knowledge, the strong taproot of the tree of knowledge, the keystone in the arch of knowledge.

The essentials of the Cartesian system are described in the following. Part IV of this volume contains the proposal, a new Cartesian system, tailored to the needs of a twenty-first century approach to brain-mind.

The word *Cartesian* means relating to the French mathematician and philosopher Descartes, who, among other things, worked to merge algebra and Euclidean geometry. This work was influential in the development of analytic geometry, calculus, and cartography

The idea of this system was developed in 1637 in two writings by Descartes. In Part Two of his *Discourse on Method*, he introduces the new idea of specifying the position of a point or object on a surface, using two intersecting axes as measuring guides. In *La Géométrie*, he further explores these concepts.

1.3.1 Two-Dimensional Coordinate System

The modern Cartesian coordinate system in two dimensions (also called a rectangular coordinate system) is commonly defined by two axes, at right angles to each other, forming a plane (xy-plane). The horizontal axis is labeled x, and the vertical axis is labeled y. In a three-dimensional coordinate system, another axis, normally labeled z, is added, providing a sense of a third dimension of space measurement.

1.3.2 Three-Dimensional Cartesian System

The coordinates in a three-dimensional system are of the form (*x,y,z*). An example of two points plotted in this system are shown in Fig. 1.1, points *P*(5, 0, 2) and *Q*(-5, -5, 10). Notice that the axes are depicted in a world-coordinates orientation with the *z*-axis pointing up.

The *x*, *y*, and *z* coordinates of a point (say *P*) can also be taken as the distances from the *yz*-plane, *xz*-plane, and *xy*-plane, respectively. Figure 1.1 shows the distances of point *P* from the planes.

The *xy*-, *yz*-, and *xz*-planes divide the three-dimensional space into eight subdivisions known as octants, similar to the quadrants of two-dimensional space. Although conventions have been established for the labeling of the four quadrants of the *x′*-y *plane, only the first octant of three-dimensional space is labeled. It contains all of the points whose* x, y*, and* z *coordinates are positive. That is, no point in the first octant has a negative coordinate.* The three-dimensional coordinate system provides the physical dimensions of space – height, width, and length – often referred to as the three dimensions. It is important to note that a dimension is simply a measure of something, and that another dimension can be added for each class of features to be measured. Attachment to visualizing the dimensions precludes understanding the many different dimensions that can be measured (time, mass, color, cost, etc.). It is the powerful insight of Descartes that allows us to manipulate multi-dimensional objects algebraically, avoiding compass and protractor for analyzing in more than three dimensions (Fig. 1.2).

Although Descartes' method had its advocates, it was also criticized by his contemporaries, such as the mathematician Pierre de Fermat, and ultimately dismissed. Leibniz states that Descartes' rules amount to saying "take what you need, and do what you should, and you will get what you want."

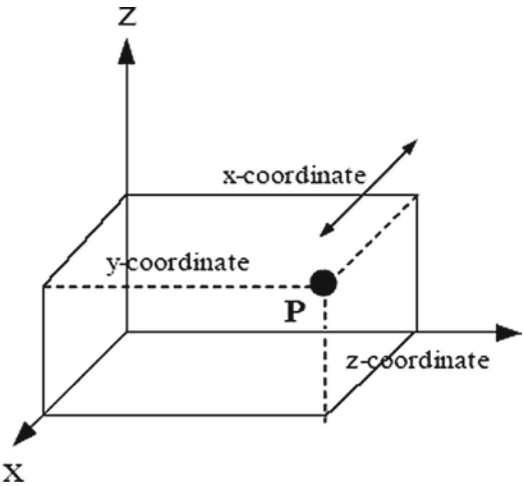

Fig. 1.1 Three-dimensional coordinate system

Fig. 1.2 René Descartes (March 31, 1596–February 11, 1650)

1.4 Cardinal Questions of René Descartes and Alfred Fessard Constitute the Core Philosophical Framework of This Book

René Descartes posed the fundamental suggestion related to general systems in the universe: "Everything in the universe can be explained in terms of a few intelligible systems and simple approaches."

Alfred Fessard (1961) emphasized that the brain must not be considered simply as a juxtaposition of private lines leading to a mosaic of independent cortical territories, one for each sense modality, with internal subdivisions corresponding to topical differentiations. The fundamental question of Fessard is the following: *What are the principles dominating the operations of hetero-sensory communications in the brain?* Further, Fessard (1961) indicated the necessity of discovering the principles that govern *the most general, or transfer functions*, of multi-unit homogeneous messages through neuronal networks.

The questions of R. Descartes and A. Fessard are cardinal inquiries that govern the leitmotivs and core conceptual framework that led to a unifying trend in the understanding of brain-body-mind (see Chaps. 22–26).

1.5 Galileo Galilee

In this book, oscillations, rhythms, neurotransmitters, and resonance phenomena have a fundamental role, which is true of all processes in nature. The physics of the *harmonic oscillator;* that is, *Galileo's pendulum*, made it possible to measure the flow of time and leads far beyond a device for making accurate clocks. These oscillators have been found to be the basis not only of what we hear as music and see as the color of light but, via quantum theory, of what we understand as the fabric of the universe. An interesting book by Roger G. Newton (2004) describes events from the rhythm of time to the making of matter. *Without oscillators there would be no particles: any air to breath, no fluids to sustain life, and no solid matter to form the earth.* Although biological mechanisms do not work with the accuracy or stability of modern clocks, a sense of time and its rhythms is built into the functioning of the human body. The autonomy of biological clocks is now a well-established fact. In addition to the heartbeat, some internal time keepers have shorter periods, called ultraslow oscillations. The electrical activity of the brain is one of the most important rhythms in the human body.

Galileo's first important scientific discovery was the property of the simple pendulum of a heavy bob suspended by a cord long enough not to swing so widely that its period is independent of the amplitude of its oscillation. In Appendix C the basic principles of the harmonic oscillator as well as the resonance phenomena in physical systems and nature are described. The observation of *synchrony* and *asynchrony* in clocks as described by Albert Einstein was important in the development of the relativity theory (see Chap. 2). The atom as a harmonic oscillator, neurons as basic oscillators in the brain, heartbeat, and rhythms of smooth muscles in the vasculature and peristaltic organs all obey the general principle of oscillators (see Appendix C).

Galileo's physics is accordingly the basic element in several physical and biological systems. However, the principles of oscillations or oscillatory phenomena are a basis on which to build a conceptual framework binding several sciences.

1.6 Isaac Newton

Although Galileo discovered the isosychronism of the pendulum as a fact of nature, he did not offer an underlying reason for his seminal observation. Newton – regarded by many as the greatest figure in the history of science – was the scientist who found the explanation. His treatise, *Philosophiae Naturalis Principia Mathematica*, described universal gravitation and three laws of motion, laying the groundwork for classical mechanics. The unifying and predictive power of his laws was central to the scientific revolution. Newton carried out fundamental work on gravitation theory, optics, and decomposition of white light. However, possibly his most important contribution was the use of analytical geometry created by Descartes. The union of the concepts of Galileo, Descartes, and Newton opened the way for the huge development of science from the sixteenth century to the present day.

In Newtonian mechanics, all physical phenomena are reduced to the motion of material particles, caused by their mutual attraction; that is, the force of gravity. The effect of this force on a particle or any other material object is described mathematically by Newton's equations of motion, which form the basis of classical mechanics. They were considered fixed laws according to which material objects moved, and were thought to account for all changes observed in the physical world. In the eighteenth and nineteenth centuries Newtonian mechanics were used with tremendous success. Newtonian theory explained the motion of planets,

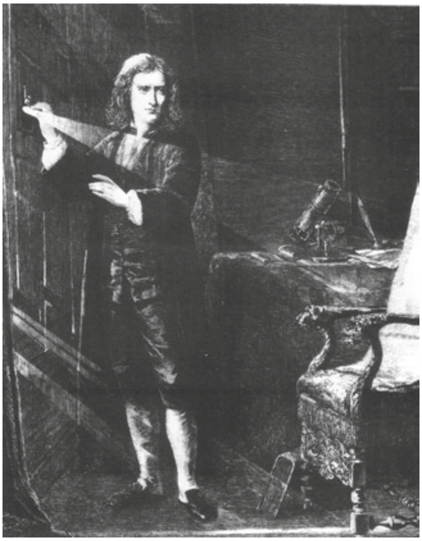

Fig. 1.3 Isaac Newton (January 4, 1643–March 31, 1727)

moons, and comets down to the smallest details, as well as the flow of the tides and various other phenomena related to gravity. Newton's mathematical system established itself quickly as the correct theory of reality and generated enormous enthusiasm among scientists and laypersons alike.

At this point it is important to refer again to the fundamental evolution in physical and engineering sciences that had been reached by the union of Descartes' concept and Newton's work. At the beginning of the twentieth century the rigid Cartesian system was no longer efficient. A great jump or a type of bifurcation happened after the discovery of the new physics by Einstein and later by the Copenhagen school pioneered by Niels Bohr. At the same time Sigmund Freud and Bergson also opened a new area, which was not deterministic. Bergson introduced the concept of duration, and Freud's explanation of dreams explicitly changed the notion of time. These concepts ushered in a completely new understanding of the brain by introducing the non-deterministic view. The deterministic time of Newton had become the good old days (Fig. 1.3).

1.7 Thoughts on the Mathematical and Intuitive Mind By Blaise Pascal

The difference between the mathematical and the intuitive mind are explained by Pascal (Fig. 1.4) as follows:

> "In the '*mathematical mind*,' the principles are palpable, but removed from ordinary use; so that for want of habit it is difficult to turn one's mind in that direction: but if one turns

Fig. 1.4 Blaise Pascal (June 19, 1623–August 19, 1662)

> it thither ever so little, one sees the principles fully, and one must have a quite inaccurate mind who reasons wrongly from principles so plain that it is almost impossible they should escape notice. But in the '*intuitive mind*' the principles are found in common use and are before the eyes of everybody. One has only to look, and no effort is necessary; it is only a question of good eyesight, but it must be good, for the principles are so subtle and so numerous that it is almost impossible but that some escape notice. Now the omission of one principle leads to error; thus one must have very clear sight to see all the principles and, in the next place, an accurate mind not to draw false deductions from known principles."[1,2]

Therefore, the reason that some intuitive minds are not mathematical is that they cannot at all turn their attention to the principles of mathematics. But the reason that mathematicians are not intuitive is that they do not see what is before them, and that, accustomed to the exact and plain principles of mathematics, and not reasoning till they have well inspected and arranged their principles, they are lost in matters of intuition where the principles do not allow for such arrangement (Pascal, *Pensées*, 1660).

According to Pascal, mathematicians are only exact provided all things are explained to them by means of definitions and axioms. Otherwise they are inaccurate and insufferable, for they are only right when the principles are quite clear. Further, people of intuition, who are only intuitive, do not have the patience to first reach the principles of things that are speculative and conceptual.

For explanations the reader is referred to Chaps. 17–20, which relate to unconsciousness and intuition.

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[1]Pensées by Blaise Pascal translated by W.F. Trotter.

[2]In mathematics there are also intuitive solutions. See the story of H. Poincarre in Chap. 20.

1.8 David Hume

Hume's positive, naturalistic approach has much in common with contemporary cognitive science, and his concept was a revolutionary one in physical sciences at the turn of the twenty-first century. Hume outlined a strategy that concerns human understanding. The first view looks at humans as active creatures that are driven by desire and feelings, painting a flattering picture of human nature. Philosophers make us feel that what they say about feelings is useful and agreeable. In this way simple people confronted with these views are readily inclined to accept them.

According to Hume, causation is the only principle that takes us "beyond the evidence of our memory and senses." It establishes a link or connection between past and present experiences with events that we predict or explain so that all reasoning concerning a matter of fact seems to be founded on the relation of cause and effect. Certainly, Hume's philosophy is not limited to description or comprehension of the causation. Here it is only necessary to take his original view on the cause and effect; in later chapters related to memory and those on common principles, the cause-and-effect concept is one of the dominating leitmotivs so as to understand brain-body-mind integration. As Hume postulated, there are simple and complex ideas. This view can be extended by saying that there are simple and complex causes, or *multiple causalities*, in brain-body-mind integration (analyzed in Chaps. 15 and 16).

One of the primary aims of this book is to develop a new Cartesian system, which emerges from the existence of multiple causalities in brain-body functioning. In theoretical physics Newton is a philosopher working with simple causes. Accordingly, the causality principle developed by Hume opened the way to modern science and Heisenberg's indeterminism injected the probabilistic behavior in the physics of atoms. C.F. von Weizsäcker defined causation as *nebulous wave packets* that are not precisely located in the atomar space (micro-space). It is seen in brain research that the chaotic nature of brain oscillations implies the probabilistic nature of the causality principle. Another very important aspect is Bergsonian intuition and duration, which completely destroys the importance of causality in human reactions. In our sentiments and emotions we also present a model of multiple causalities related to our emotions (see Chaps. 12, 15, 17, and 18).

1.9 John Locke: Sensations and Ideas

Locke's greatest philosophical contribution was his book, *Essay*, and he recorded his own account of the origin of that work. Locke's work is dominated by the concept of *sensations*. Understanding, like the eye, although it makes us see and perceive all other things, takes no notice of itself; and it requires art and pains to set it at a distance and make it its own object. Locke does not "meddle with the physical consideration of the mind"; he has no theory about its essence or relation to the body. At the same time, he has no doubt that, if due pains are taken, understanding can be studied like anything else. We can observe its object and the ways in which it operates on them.

Furthermore, *ideas* in general plays a major role in Locke's philosophy. All the objects of the understanding are described as ideas, and ideas are spoken of as being in the "mind." Locke's first problem was to trace the origin and history of ideas and ways in which the understanding operates on them. This wide use of the term *idea* is inherited from Descartes. Locke pointed to the variety of human experience, and the difficulty of forming general and abstract ideas.

Locke thought that "everyone is conscious of them in himself, and men's words and actions will satisfy him that they are in others." His first inquiry was "how they come into the mind." The next task was to show that they constitute the whole material of our knowledge. All our ideas, he said, come from experience.

There is another perception of the mind concerning *the particular existence of finite beings without us*, which, although it goes beyond bare probability, does not yet reach either of the foregoing degrees of certainty. This is called *knowledge*. This view has some similarity to the intuition of Bergson, which is elicited on accumulation of knowledge. There can be nothing more certain than that the idea we receive from an external object is in our minds: This is intuitive knowledge. The closing Chapters of Book IV of the *Essay* are devoted to a consideration of that kind of apprehension of reality that Locke calls "judgment," as distinguished from "knowledge." Reason must be our last judge and guide in everything.

1.10 Gottfried Leibniz

Leibniz's best known contribution to metaphysics is his theory of monads, as exposited in *Monadologie*. Monads are to the metaphysical realm what atoms are to the physical/phenomenal. Monads are the ultimate elements of the universe; they are "substantial forms of being" and are eternal, indecomposable, individual, subject to their own laws, uninteracting. Monads are centers of force. Substance is force, whereas space, matter, and motion are merely phenomenal. In Leibniz's philosophy, the essential features are similar to Descartes' view. Unlike atoms, monads possess no material or spatial character. They also differ from atoms by their complete mutual independence, so that interactions among monads are only apparent. Each monad follows a preprogrammed set of "instructions" peculiar to itself, so that a monad "knows" what to do at each moment. By virtue of these intrinsic instructions, each monad is like a little mirror of the universe. Monads need not be small; for example, each human being can be considered to be a monad. In this case free will is problematic.

Monads present the continuation of ideas of important philosophical approaches:

- Interaction between mind and matter arising in the system of Descartes.
- Lack of individuation inherent to the system of Spinoza, which represents individual creatures as merely accidental.

1.11 Immanuel Kant

The German philosopher Immanuel Kant wrote the core of his philosophy in his work, *Critic of Pure Reason* (1787). In this book Kant attempted to set up a contrast between things that exist in the outside world and actions of the human mind. For Kant, pure reason without reference to the outside world was impossible. He has borrowed this idea from the empiricist David Hume. What one knows, according to the empiricists is the result of what has gathered up with one's senses. The essential part of Kant's philosophy is that human beings only have access to the phenomenal world. They can have no knowledge of the true nature of *things-in-themselves*.

1.12 Henri Bergson

Henri Bergson was one of the leading philosophers of the twentieth century. *Duration, memory*, and *Élan Vital* mark the major stages of Bergson's philosophy. *Intuition* is the method of Bergson. Intuition is not a feeling, an inspiration, nor a disorderly sympathy, but one of the most fully developed methods in philosophy. It has strict rules constituting that which Bergson calls *precision* in philosophy. Bergson emphasized that intuition, in his understanding, methodologically, already presupposes *duration.* "These conclusions on the subject of duration were decisive. Step by step they led me to raise intuition to the level of philosophical method" (Deleuze 1966).

Bergson relied on the intuitive method to establish philosophy as an absolutely "precise" discipline; as precise in its field, as capable of being prolonged and transmitted as science itself. Further, without the methodical thread of intuition, the relationships among *duration, memory*, and *Élan Vital* would remain indeterminate from the point of view of knowledge.

The most general methodological question is this: How is intuition, which primarily denotes an immediate knowledge (connaissance), capable of forming a method, once it is accepted that method essentially involves one or several mediations? Bergson frequently presents intuition as a simple act. But, in this view, simplicity does not exclude a qualitative and virtual multiplicity, the various directions in which it comes to be actualized.

Bergson considered that he had made metaphysics a rigorous discipline, one capable of being continued along new paths that constantly appear in the world. The following is a short commentary on the history of Bergsonian philosophy.

As a mathematic genius and concrete scientist Bergson introduced considerable important concepts to the cutting edges of natural philosophy. His popularity declined for various reasons, one being the criticisms made by the British philosopher Bertrand Russell, who, contrary to Bergson, was an elegant politically oriented social philosopher. The French philosopher Deleuze wrote an important book on Bergsonism and started a Renaissance of Bergson's ideas. Following is a short summary of the important points. Chapter 18 contains further information on the essential development of Bergsonism philosophy and his most relevant contributions to the metaphysics of brain function and Darwin's theory.

1.12.1 Intuition

Bergson saw intuition not as an appeal to the ineffable, a participation in a feeling, or a lived identification, but as a true method. This method sets out, first, to determine the conditions of problems; that is to say, to expose false problems or wrongly posed questions, and discover the variables under which a given problem must be stated as such.

Bergson defined duration as a type of multiplicity. This is strange word, because it makes *multiple* a noun rather than an adjective. Intuition is seen as method, philosophy as rigorous science, and the new logic as a theory of multiplicities. Bergson invokes metaphysics to show how a memory is not constituted after present perception but is strictly contemporaneous with it, since at each instant duration divides into two simultaneous tendencies, one of which goes toward the future as the other falls back into the past.

According to Bergson, new ideas in science always appear strange at first, but these are precisely the ideas that may be the most fruitful; they may well be ideas engendered by philosophical intuition. Accordingly, he stated:

> I take the view that several of the great discoveries, of those, at least, which have transformed the positive sciences or created new ones, have been so many soundings in the depths of pure duration. The more living was the reality touched, the more profound had been the sounding.

Really important intuitions are rare events by nature. The point is that Galileo's, Newton's, and Leibniz's treatments of motion are the absolutely essential turning points in the history of science. Modern science could not be realized without them. Bergson believed the intuitions leading to such discoveries were achieved only haphazardly, although it is now possible to search for them methodically.

In his *Évolution créatrice* (1907) (*Creative Evolution*), Henri Bergson declared that the most lasting and fruitful of all philosophical systems are those that originate in intuition. If one believes these words, it appears immediately with regard to Bergson's system how he has made fruitful the intuitive discovery that opens the gate to the world of his thought.

What we usually call time, which is measured by the movement of a clock or the revolutions of the sun, is something quite different. It is only a form created by and for the mind and action. At the end of a most subtle analysis, Bergson concluded that it is nothing but an application of the form of space. Mathematical precision, certitude, and limitation prevail in its domain; cause is distinguished from effect and hence, raises that edifice, a creation of the mind, whose intelligence has encircled the world, raising a wall around the most intimate aspirations of our minds toward freedom. These aspirations find satisfaction in living time. Here, cause and effect are fused; nothing can be foreseen with certainty, because certainty resides in the act, simple in itself, and can be established only by this act. (See Chaps. 14–16 for the Cartesian system in probabilistic hyperspace.) Living time is the realm of free choice and new creations, the realm in which something is produced only once and is never repeated in quite the same manner.

According to Bergson, imagination and intuition are sometimes capable of flights in which intelligence lags behind. It is not always possible to decide whether the imagination is seduced or the intuition recognizes itself and allows itself to be convinced. In any event, reading Bergson is always highly rewarding. In the account of his doctrine, *Évolution créatrice*, Bergson created a concept of striking grandeur, a cosmogony of great scope and unflagging power, without sacrificing a strictly scientific terminology. It may be difficult at times to profit from its penetrating analysis or the profundity of its thought, but one always derives a strong aesthetic impression from it without any difficulty (Deleuze 1966).

Possibly, one can apply to this intuition, the central point of the Bergsonian doctrine, the brilliant expression that he uses about intelligence and instinct – the perilous way toward vaster possibilities. Within the limits of its knowledge, intelligence possesses logical certainty, but intuition, dynamic like everything that belongs to living time, must without doubt content itself with the intensity of its certainty. This is the drama: Creative evolution is disclosed, and humans find themselves thrust on stage by the *Élan Vital* of universal life that pushes them irresistibly to act, once they have come to the knowledge of their own freedom, capable of divining and glimpsing the endless route that has been traveled with the perspective of a boundless field opening onto other paths. Which of these paths is humanity going to follow? Chapter 18 returns to the Bergsonism concept with its transcendent nature.

Einstein's theories of relativity and quantum dynamics are completely different from the classical physics of Newton. Things are completely changed in the physics of the twentieth century. In the search of brain-mind we are still far from including this transcendent view. However, new steps can be seen on the horizon. The recent work of Kelso and Engstrom (2006) offers an ambitious and much-needed analysis of the "complementarity" concept of Niels Bohr within an extended physical-psychological-philosophical framework. The necessity of new frameworks, including a Cartesian one, is contained within a very interesting book by Fritjof Capra, *The Turning Point* (1982). In Chap. 18 a semi-empirical approach is introduced to search for the biological causation of evolution. Charles Darwin's evolution of species will be studied using electrophysiological tools to reconcile this theory with the creative evolution and *Élan Vital* of Bergson (see also Başar and Güntekin 2008, 2009). Accordingly, it is possible to concretize Bergson's view on Darwin's work with modern methods that were not available in Bergson's lifetime. For this reason a detailed chapter is included in Chap. 17 on the electrophysiology in the evolution of species to provide a prerequisite for Chap. 18, which is related to the creative evolution of *Élan Vital* and intuition. The philosophical views of Freud and Jung are described in Chaps. 19–20. The concept of time in dreams and in the views of Freud, Jung, and Bergson might provide new clues in the search for the boundaries of the metaphysics of the brain.

1.13 A Comparative Treatise of the Conceptual Frameworks of Pascal, Locke and Bergson

According to Locke *sensations* (phyletic memory) and *ideas* are almost equivalent. Sensations are the base of knowledge leading to complex ideas and a type of intuition. Ideas in general play a major role in the philosophy of Locke. All the objects of the understanding are described as ideas, and ideas are spoken of as residing in the mind. Locke's first problem is to trace the origin and history of ideas, and the ways in which the understanding operates on them. This wide use of the term *idea* is inherited from Descartes. Further, judgments are different from sensations. Table 1.1 outlines the evolution of concepts and ideas by four major philosophers.

Reviewing Bergson's concept combined with those of Pascal, Descartes, and Locke leads to the conclusion that the most developed thought function is Bergsonian intuition, which consists of instinct, associations of ideas, judgment, and reasoning. These entities converge in changes of substances, that are, in turn, a consequence of complex ideas. The existence of intuitive developments possibly enhances new connections in Hebb's (1951) sense. The invasion ability of such Hebbian networks can help brain growth during its evolution and maturation.

This chapter has presented the revolutionary ideas of prominent philosophers and scientists, who established fundamentals of philosophy and science. In the beginning science-philosophers created new and substantial theories; some were also able to perform experiments that were based on their essential thinking. Philosophy and science (including empirical science) were inseparable until the beginning of the twentieth century.

This begs the question, What were the most important contributions of the philosophers to science? The answer is that leading philosophers ask leading questions. Finding the right path to answer the questions can, at the very least, lead to

Table 1.1 Summary of the evolution of concepts and ideas by Descartes, Pascal, Locke, and Bergson

René Descartes	Blaise Pascal	John Locke	Henri Bergson
Cogito ergo sum	Mathematical Mind	Cogito ergo sum	Élan Vital
Mathematical Mind	Intuitive Mind	Skepticism	Substance; complex ideas
Skepticism		Sensations; phyletic memory	Instinct phyletic memory
		Substance; complex ideas	Judgments are different from knowledge
		Judgments are different from knowledge	

partial answers, and this is what scientists did from the seventeenth to the end of the twentieth century. By following this process, the approach to the mind gained new concrete territories, as stated in the "Prologue".

This volume presents empirical evidence about new systems to approach brain-body-mind integration; and the "Conclusion" poses new questions, based on this evidence. Some of these questions have metaphysical structures. It is hoped that these metaphysical questions can one day find empirical foundations and become reality. This is why this chapter has presented the first steps performed in the "metaphysics of the brain-mind."