



CHAPTER 3

From Soul to Mind

A Brief History

FOR MOST OF human history, we have cherished the idea that there is a separate immaterial part of each of us—a mind or a soul—that must live somewhere within our body. That has gradually changed with the advent of scientific approaches to mind-body relations. We now view the *mind* as a functional property of the brain, not “something located somewhere.” The mind is a firmly embodied process within the *brain*, rather like the program that runs within a computer. However, can the same sort of embodiment be presumed for what we traditionally call the *soul*?

This puzzle over relating mind, brain, and soul has ancient roots. Early theories about where to locate the mind varied greatly. Some argued for the heart, some for the brain, and others for the ventricles, the prominent spaces within the brain. We have had a similarly long history with the idea that our soul is a nonmaterial part residing somewhere within us. Generally in history, we have spoken with great confidence about what we think our minds are doing, but that is not the case with the soul. What possible role could it play in conscious life?

The Hebrew and Christian scriptures are an early treasure trove of material about this relationship. But even this rich source does not offer a simple and unified picture. Surprisingly, the scriptures offer not a single mention of the brain, although they contain many references to the soul—and to the spirit, heart, mind, head, face,

throat, or stomach, for example. This same conundrum shows up in much of the ancient philosophical literature: where to locate the mind/soul, if anywhere at all?

An early debate arose between some who located the mind/soul in the heart and others who believed it lived inside the brain. In the fifth century BC, the Greek philosopher Empedocles reasserted the notion that the soul (the Greek word for the *mind*) was found in the heart and in the blood, a theory labeled “the cardiovascular theory.” But Empedocles’ views did not go unchallenged. Around the same time, Alcmaeon of Croton asserted that mental functions are located in the brain. His view was labeled “the encephalic view.” For two thousand years, these two theories competed with each other. The great physician, Hippocrates, who lived sometime between 460 and 360 BCE, adopted the brain or encephalic theory of mind. His text *On the Sacred Disease* dealt extensively with epilepsy. He argued that epilepsy is not really a sacred event, but rather an understandable disease with natural causes. Hippocrates also decided that the brain was the interpreter of consciousness and the mediator of feelings.

In the fourth century BCE, the encephalic and cardiovascular theories continued their rivalry in the viewpoints of Plato and Aristotle. Plato seems to have wanted it both ways, locating the immortal soul in the marrow of the head (presumably the brain) but locating the passion between the neck and the midriff. He put the appetites at the navel. For his part, Aristotle quite unambiguously localized the soul in the heart. He had good reasons for his views, which still preserved a role for the brain. Being a good biologist, he noticed that the brain was moist to the touch and concluded that it refrigerated the blood. Aristotle’s views were passed on through the Stoic philosophers to one of the early church fathers, Tertullian. The encephalic theory survived through one of Rome’s outstanding physicians, Galen.

With Galen, we see the first significant departure from the simpler heart/brain controversy. An accomplished anatomist, Galen

provided support for his views with anatomical data from his brain dissections. His detailed examination of the brain impressed him with the size and location of the ventricles, the large spaces within each cerebral hemisphere. He concluded that the so-called “vital spirits” or “animal spirits” of a sentient being must move within this network of ventricles.

Shortly after Galen died, the Germanic invasions in Europe nearly obliterated the Greek and Roman research on the mind, although some of it survived. In the fourth century CE, for example, Bishop Nemesius of Syria claimed to be a loyal follower of Galen, producing a new physical theory of the mind. He defined three different mental faculties—sensation and imagination, thought and judgment, and memory—and then localized each in the different ventricles of the brain. A few centuries later, the ideas of Aristotle and Galen were reintroduced into Europe when they were discovered in manuscripts and translations in Spain. So now there were three groups of partisans, each supporting the encephalic, the cardiovascular, and the ventricular theories of the mind-body relationship.

In the early seventeenth century, Galileo gained fame for his use of empirical evidence to challenge the cosmological beliefs of the Catholic Church. Less well known, his contemporary, Vesalius, was conducting dissections of the human body, including the brain (previously forbidden on theological grounds). He pioneered the empirical approach to the mind-body problem. By dissected the brains of humans, apes, dogs, horses, sheep, and other animals, Vesalius showed that they all possessed ventricles. At the time, Christian anthropology asserted that ventricles were the probable home of the unique human mind and soul, a biological theory that now collapsed. The growing knowledge of anatomy and physiology delivered a similar fate to the cardiovascular theory, discredited finally by William Harvey’s analysis of the circulation of the blood.

TRIUMPH OF THE ENCEPHALIC THEORY

Though not without occasional challenges, a general encephalic view became widely accepted. The search now became one of finding out where the mind operated inside the brain. There were just two options: either the mind functioned in specific spots, or it functioned across the entire territory of the brain. This continues to be the great debate in neuroscience. As we shall see, this debate has created one school of thought that has tried to localize brain function, at one time interpreting the brain by bumps on the head (called phrenology), and, more currently, trying to do the same by finding local functions in the brain, including a so-called “God spot” for religious experience.

This attempt at finding a physical spot began famously with the French philosopher René Descartes. He said the soul made contact with the brain in the pineal gland, because, among other things, it was located in the center of the brain. He stated this mostly plainly in his 1649 work, *The Passions of the Soul*, just before he died. Some time later, in 1664, the distinguished English physiologist Thomas Willis (after whom the “circle of Willis” is named) chose the corpus striatum to locate the soul. Around the same time, French anatomist Raymond Vieussens decided that the centrum semiovale was the right place, and, about fifty years later, the Italian physician Giovanni Lancisi suggested that the mind or the soul should be located in the corpus callosum. As these cases suggest, scientists in the past used whatever tools they had to find local function in the brain. This search has accelerated with the new brain imaging technology. The perennial quest for “localization,” however, has also stirred dissent from those who take a more global view of brain functions.

That global outlook was exemplified early on by the French physiologist Jean Pierre Flourens. He did experiments in which he destroyed parts of the cortex of animals. In most cases, there was a pattern of loss and recovery, leading Flourens to conclude that the

brain functioned as a whole—mental functions were not localized in particular areas of the cortex. In the early part of the twentieth century, similar experiments were done by Harvard psychologist Karl Lashley, who was trying (but failed) to find the location of the memory for a maze in the cerebral cortex of a rat. Lashley essentially came to the same conclusion as Flourens.

In rebuttal to such a global view, the advocates of localized brain functions have produced their own experimental evidence. Even before Flourens did his work, the Italian physiologist Giovanni Aldini showed that stimulation of the exposed brains of oxen “could produce movements of the eyelids, lips and eyes.” In effect, electrical stimulation of different places on the brain would elicit different responses. This research was a follow-up to the work of his uncle, Luigi Galvani, professor of anatomy in Bologna, who, in 1791, had shown that electricity could excite nerves and muscles. This led him to the claim that “animal electricity,” not “animal spirits,” was the substance secreted by the brain. There was no longer a need to invoke “immaterial spirits” to move the material body.

Perhaps surprisingly, some scientists and doctors still insisted that the brain had no effect at all on human abilities, such as speech. In 1783, for example, the famous English lexicographer Dr. Samuel Johnson suffered a stroke (detailed in his diaries), and the doctors excluded brain damage from his diagnosis. They instead prescribed a folk treatment that inflicted blisters on each side of his throat, one on his head, and one on his back. They also gave him regular doses of hartshorn, or ammonium carbonate. Thus, the “treatment” showed their belief that the surfaces of the neck and throat were the physical basis of speech. For them, brain events and the mental events involved in speech were not linked. In the years following Johnson’s quaint, if painful, experience, the views of medicine would rapidly change, and the debate between global and local brain functions dominated the field.

For the localization camp, a kind of turning point came in the work of Jean Baptiste Bouillard, a contemporary of Flourens. From

his observation of patients with brain damage, Bouillard concluded that “if the brain did not consist of separate centres it would be impossible to understand how a lesion in one part of the brain causes paralysis of some muscles of the body without affecting others.”¹ Bouillard believed that localization applied to the understanding of more complex processes like speech.

Following on the work of Bouillard, Marc Dax argued in 1835 that speech disorders were linked to lesions of the left hemisphere. This view was further reinforced in 1861, when French neurologist Paul Broca reported the case of a patient who stopped speaking when pressure was applied to the left anterior lobes of his brain. Thus, the notion of cerebral dominance of language in the left hemisphere was enunciated. German neurologist Karl Wernicke (1874) provided further evidence that even different aspects of language and speech were localized in different parts of the brain.

During the 1870s, Gustav Fritsch, an anatomist, and Eduard Hitzig, a psychiatrist, carried out experiments in which they stimulated the cerebral cortex of a dog with electric current to show for the first time that, by stimulating certain cortical areas, there were contractions of specific muscles. They claimed that these experiments demonstrated that the cerebral cortex contains “motor centers.” Further research on vision in animals, by lesioning the visual cortex of a dog, showed that, while the dog could still see, it could no longer recognize objects. From this time onward, careful research on animals, together with astute clinical observations by neurologists, were to build up a picture confirming localization of function within the brain.

In England, physiologist David Ferrier explored the cerebral cortex both by stimulation and by judiciously placed lesions. He showed, for example, that the sense of smell depends on a region at the tip of the temporal lobe. This substantiated English neurologist John Hughlings-Jackson’s observations that hallucinations of smell often accompanied epileptic fits that arose from tumors in the same temporal lobe. Nevertheless, Ferrier argued for a medical

distinction between a symptom that arises from a lesion (such as hallucinatory smell) and a local function such as language. He believed that a symptom and a function operated on different cerebral organizations.

Debates between the localists and globalists have continued well into the twenty-first century. Some neuroscientists today explore examples of tightly constrained local functions in the brain. Others probe the concept of neural networks and parallel distributed processing. They emphasize the unbelievably complex interconnections and interactions between adjacent and distant parts of the brain. In either case, the older belief that mind is separate from the brain has been completely overturned. Today, we recognize the links between brain events and mind events. What is more, data are rapidly accumulating that support a link between brain and personality, including social and ethical behavior.

PHRENOLOGY: MAPPING THE BRAIN

One of the most colorful episodes in this long search for the mind in the brain was the rise of phrenology. It was the first great leap forward in the attempt to localize mental characteristics. After it emerged in the early nineteenth century, phrenology survived for a remarkably long period before it was discredited. It originated in the work of German physicians Franz Joseph Gall and Johann Casper Spurzheim. They identified twenty-seven different mental faculties with areas on the surface of the skull and, therefore, by inference, to underlying brain areas. In this sense, phrenology was both an encephalic and a localizationist model. Persons were thought to have greater or lesser endowment of a particular faculty if there seemed to be a bump or enlargement of that area of the skull.

Between 1820 and 1850, some of the proponents of phrenology, together with those of another fashionable topic, Mesmerism, founded journals to prove and popularize their claims. Their views

very soon entered the marketplace. At local fairs and markets, you could have the bumps on your scalp analyzed to discover your special skills and defects. The chief popularizer of phrenology in Britain was the Scottish lawyer George Combe. He learned about phrenology when he attended one of Spurzheim's early lectures in Edinburgh. He was particularly interested in applying phrenology to the reform of society and morals.

Before Franz Gall's empirical work on the brain and head shape, psychology was largely a branch of philosophy and epistemology. No attempt had yet been made to divide the brain into functional regions and to relate these to behavior. Gall pioneered the attempt to use objective measurement to link brain function to behavior. He argued that we should look to external nature rather than personal introspection to classify mental and behavioral phenomena. The goal of his research was "to found a doctrine of the functions of the brain," hoping that "the result of this doctrine ought to be the development of a perfect knowledge of human nature."²

The phrenology of Gall and Spurzheim shows that, while empirical evidence is necessary in science, it can also be used to make erroneous claims. To his credit, Gall had collected a massive amount of evidence. His collection of skulls and casts of skulls contained more than six hundred pieces and may still be seen in the Musée de l'Homme in Paris. But a mass of evidence will not guarantee that valid scientific inductions will be made. Gall's naturalism led him into error, and the experimental approach that he rejected would finally win the day. He had adopted a naive inductionist view of science, the so-called Baconian method of gathering facts and then drawing conclusions. In reality, though, Gall had only collected facts that supported his preconceived hypothesis. As historian of science Robert M. Young has written,

He drew data from each method insofar as it was found to support his initial hypothesis. In short he sought only confirmations. It is not his naturalism that was at fault; it

is his anecdotal method and the standards of evidence. . . . Beginning with Gall, phrenologists have had two characteristic reactions toward evidence. If it can be construed to support phrenology, it is proclaimed as confirmatory. If not, it is explained away.³

This, in fact, is not an unheard-of procedure (or problem) in research even today.

Gall was not a crank. His views were endorsed by such distinguished investigators as British biologist Alfred Russell Wallace, codiscoverer of the theory of evolution by natural selection. Apparently, Wallace had read *The Constitution of Man*, a book written by Combe, the enthusiastic disciple of Gall. The book persuaded Wallace of the truth of phrenology (he also seems to have believed the evidence for Mesmerism).

Wallace conducted his own experiments in phrenology and believed the evidence he obtained was confirmatory. He had his own head looked at by two phrenologists in 1847 "with such accuracy as to render it certain that the positions of all mental organs had been very precisely determined."⁴ Thus convinced, Wallace needed to explain the contrary findings of David Ferrier on the effects of local brain lesions. He did this by saying that "the supposed localization of motor areas by Professor Ferrier and others, which are usually stated to be disproof of the science are really one of its supports, the movements produced being merely those which expressed emotions due to the excitation of the phrenological organ excited."⁵ As Young comments, "the fact that Wallace could hold these views further highlights the dangers when the naturalistic method of study is the only one used."⁶

This was also the case with Wallace's own theory of evolution by natural selection. Wallace, like Darwin, had used a very great number of naturalistic observations, as well as pieces of anecdotal evidence, in support of his theory. For most of the nineteenth century, their evolutionary theory was in much the same position as

phrenology, resting as it did on naturalistic observations and the massive set of anecdotes collected more or less systematically. Evidence clinching the evolutionary theory ultimately was available when it was confirmed by the experimental production of varieties by selection. In the case of phrenology, however, no experimental confirmation was forthcoming.

PHRENOLOGY MEETS CHRISTIAN BELIEF

Gall and Spurzheim soon discovered that they had opened themselves to charges of religious infidelity. Gall left Vienna in 1802 when he was accused of advocating materialism and fatalism. This happened despite his assertions about God and his careful description of his methodology. "I leave unsought the nature of the soul as well as the body. . . . I confine myself to phenomena," he wrote of his method. "The object of my research . . . is the brain." One of Gall's favorite mottos was "God and the Brain: Nothing but God and the Brain." Writing in *On Innate Dispositions* (*Des disposition innées*), he explained his scientific ambitions this way: "If we can demonstrate that a relationship exists between the exercise of the soul properties and the origination of their existence in the brain it would no longer be possible to doubt that it is possible to establish a doctrine which will enable us to know the noblest part of the organism."⁷

The historian Robert Rieber has argued that Gall's statement about God and the brain is an example of a pantheistic worldview (in which God is viewed as present in matter).⁸ This view clashed with the Catholic Church in Austria, which embraced the Thomistic theory that the soul was above matter and the cause of its life. According to Rieber, Gall seemed to argue that "living bodies are the result of the union of the body and soul."⁹ The leaders of the Church in Vienna saw Gall's unified theory of mind-body as a threat to the notion of free will and also to the clergy's responsibility to guide Catholics toward proper moral conduct. Hence, Gall was forced to leave Vienna and flee to Paris. In Rieber's view, "Gall

was struggling, either consciously or unconsciously, with how to reconcile a holistic, monistic, theoretical concept of the organism, with an elementalistic mind/brain faculty type of psychology."¹⁰

If this assessment is correct, then we can see Gall's dilemma as a foreshadowing of current debates about the impact of neuropsychology on some widely held traditional religious views of human nature. Meanwhile, Spurzheim sought to defend himself against similar charges when he wrote *A View of the Philosophical Principles of Phrenology*, in which he invoked Saint Augustine in his defense.¹¹ However, the pressures on him remained and he moved to Britain to continue his advocacy of phrenology.

The project to Christianize phrenology soon became widespread. Between 1820 and 1860, there were Christian advocates of phrenology on both sides of the Atlantic. When Spurzheim lectured in Edinburgh in 1817, George Combe was in the audience. Two years later, he established the Edinburgh Phrenological Society. By 1838, Combe had written his most famous work, *The Constitution of Man*, which drew heavily upon phrenology. Combe, like many Edinburgh intellectuals, was heavily influenced by the Enlightenment. Phrenology, the so-called new "science of man," afforded another critique of Christianity in the Enlightenment tradition of emphasizing the importance of reason in establishing beliefs.

Around the same time (1833), Orson Fowler graduated from Amherst College in Massachusetts with plans to enter Lane Theological Seminary that fall. During the summer, however, he found that he could earn money lecturing on phrenology and giving character readings of his classmates' heads for two cents each. With \$40 in his pocket, he abandoned the idea of ministry and started out on the phrenology circuit. His approach was practical: he used phrenology to give advice on marriage, education, child rearing, and intellectual improvement. For Fowler, British phrenology was too theoretical, "too anxious on a scientific and philosophical basis, to

the neglect of practical examinations." In 1843, he published *The Christian Phrenologist*, with the alternative title *The Natural Theology and Moral Bearings of Phrenology: Its Aspect on, and Harmony with Revelation*.

Combe came from a Scottish Calvinist tradition; Fowler was within the American populist Protestant tradition with evangelical overtones. Keeping in mind these differing traditions, it is interesting to explore how these two men sought to relate their shared enthusiasm for phrenology with their religious beliefs.

Combe used his knowledge of phrenology to answer a question that preoccupied him, "How does God govern the world?" Therefore, he probed how the brain (as described by phrenology) produced natural religion and morality—a view influenced by his Enlightenment thinking and, in particular, by deism. "The world is material, man's nature is material, and the whole relation between them depends on the material conditions," he declared. His so-called "spiritual hypothesis" leaned toward materialism, although Combe still believed that God had revealed himself in Scripture as well as through nature. In his study of Combe's belief, psychologist Wayne Norman concludes, "Combe came to phrenology as a deist and argued for deism from phrenological principles. . . . Thus, Combe's critique of Christianity can be seen as an argument for the replacement of orthodox Christian doctrine with deistic principles."¹²

Norman argues that Fowler was also seeking a scientific basis for religion. There is no indication that Fowler ever rejected Christianity, he says, but Fowler was nevertheless deeply concerned to counter sectarianism. Although Fowler questioned a number of orthodox doctrines and elevated reason over revelation, according to Norman, he also sought to purify Christianity. Norman notes that many phrenologists tried to reconcile their science with a Christian faith. In 1835, for example, the Christian minister Henry Clarke of Dundee, Scotland, published *Christian Phrenology*; or

The Teachings of the New Testament Respecting the Animal, Moral and Intellectual Nature of Man. He saw phrenology as a friend to Christianity.

In a similar vein, the British physician Charles Cowan in 1841 published his *Phrenology Consistent with Science and Revelation*. He championed a harmony between divinely revealed scripture and the science of phrenology. Since the same God rules nature and revelation, he argued, science and religion must ultimately be in harmony. Belief in the immortality of the soul, he added, is based on revelation, not science. Similarly, phrenology cannot interfere with revealed truths. Yet another phrenology reconciler was W. Easton, who wrote a book entitled *The Harmony of Phrenology with Scripture on the Doctrine of the Soul*. Easton believed that “the truths of Nature discovered by science must be respected, and Scripture must accommodate itself to these truths.”¹³

Theologically, the most conservative of the Christian phrenologists was William Scott. He held a high view of Christian revelation, yet at the same time wanted to vindicate phrenology. The title of his book, *The Harmony of Phrenology with Scripture*, reflects his beliefs—some of which sound very modern. For example, the soul (or self) is a “simple and indivisible being of which the brain is the organ during life.” Of the phrenological faculties, he wrote that they are “merely different states of this simple being; that the separate organs of the brain afford the means by which these states of mind are induced and manifested.”¹⁴

By considering the views of this small sample of nineteenth-century Christians who sought to relate the “brain science” of phrenology with their Christian beliefs, we find a wide variety of proffered solutions. Some wanted to “replace” religion with science (Combe), some to “purify” religion (Fowler), some to find in science a “friend and helpmate” (Clarke), and some to “harmonize” science and faith (Cowan and Scott). All of these positions are echoed in modern writings about the relationships between psychology, neuroscience, and religious belief.

FINDING THE “GOD SPOT”: THE NEW PHRENOLOGY?

Today’s dramatic new results in brain research, known to us in eye-catching multicolored pictures from brain scans, are reminiscent of the old phrenology maps showing “spiritual bumps” on the head. Using the latest brain-imaging techniques, the “new phrenologists” are on the same quest to identify the part or parts of our brains most active when we are meditating, praying, or seeking contact with the transcendent. The earliest contemporary studies focused on how epileptic seizures in the temporal lobe seemed linked, in some patients, to experiencing religious awe, a cosmic presence, or visions. Of course, this was eventually popularized as a discovery of the “God spot” in the brain.

One of the earliest volumes relating brain structures to the search for the sacred was the provocatively titled *Where God Lives in the Human Brain* (2001). The authors, Carol Albright and James Ashbrook, believed that they had begun to identify the elusive “God spot” and suggested that it is possible that we are indeed hardwired to seek God. For example, they wrote, “All that may be new here is an analysis that finds in the human brain a mirror of these *imagines dei*—all these images of God—and thus may suggest further ways of comprehending them.”¹⁵ Christian phrenologist Henry Clarke would have approved of this.

A more recent advocate of the temporal lobe as the elusive “God spot” is writer and researcher Willoughby Britton. Reporting on Britton’s work, Julia Keller wrote, “The temporal lobe, Britton said, is considered ‘the God module,’ the part of the brain that connects with the transcendent.”¹⁶ Others look elsewhere in the brain. Osamu Muramoto, a research neurologist, describes his interest in the causes of people being hyper religious. He writes, “Hyperreligiosity may stem from increased activity in the medial prefrontal cortex of the brain. . . . My theory is that the medial prefrontal cortex plays the role of the conductor of an orchestra in religiosity.”¹⁷

All of this neurological study of religious experience has resulted in people talking about a new field of research called *neurotheology*. Indeed, some researchers have even tried to draw conclusions about the truth of religious claims from the study of biological brain events. Others are far more cautious in presuming interpretations. For example, Mario Beauregard, who works in the departments of Radiology and Psychology at the Université de Montreal, offers this: "Obviously, the external reality of God can neither be confirmed nor disconfirmed by delineating neural correlates of religious/spiritual/mystical experiences. In other words, the neuroscientific study of what happens to the brain during these experiences does not tell us anything new about God."¹⁸ Christian phenologist William Scott would have applauded this sentiment.

The distinguished Jewish physician Jerome Groopman expressed his concerns about some of the motivations for neurotheology when he wrote, "Why do we have this strange attempt, clothed in the rubric 'neurotheology,' to objectify faith with the bells and whistles of technology?" He went on, "Man is a proper subject for study in the world of science. God is not." Groopman acknowledges that, while the idea of humans being intrinsically wired for spirituality cannot be summarily dismissed, he cautions that, "as has been the case with all attempts to 'prove' the presence or intent of God, [brain] scans and cerebral anatomy fall far short of doing so." And he concludes, "Indeed to believe that science is a way to decipher the divine, that technology can capture God's photograph, is to deify man's handiwork. And that, both religious mystics and scholars agree, is the essence of idolatry."¹⁹

We saw earlier how Combe sought to use phrenology to influence other domains of knowledge and behavior (in his case, the reform of society and morals). Today, some people seem to be using neurotheology to prove theological truths. Similarly, Fowler attempted to find a scientific basis for religion from phrenology. We have apparently not learned the lesson that it is unwise to try to bolster faith with current science. For those who relied on phrenology to have faith, what happened when phrenology turned out

to be wrong? Phrenology seemed to provide "scientific evidence" for "spiritual bumps" on the brain's surface, proving the reality of the spiritual. If our modern society had remembered the story of phrenology, we might have been spared the current enthusiasm to, as Groopman says, "objectify faith with the bells and whistles of technology."

LESSONS FROM HISTORY

The long search to locate the soul/mind "somewhere" in the body is rich with lessons. Many of those lessons are simply being revived by modern attempts to find the brain location of each human experience, especially in the trend we have called *neurotheology*. The work of Joseph Gall, the pioneer phrenologist, offers us four lessons on why today's neurotheology faces pitfalls in its technological attempts to find a biological basis of religious experience.

The first lesson is this: although Gall's work showed great skill at collecting empirical evidence about the human skulls, he failed to undertake experiments to test his conclusions. He used an admirable naturalistic approach but never investigated his hypothesis. The failure to do this adequately was the Achilles heel of Gall's formidable research. Second, Gall's work was always in danger of slipping into an unthinking reductionism, as is some neurotheology. To his credit, however, Gall did try to understand our complex mental functions before attempting to link them to the brain. He foreshadowed the excellent work of Donald Hebb, one of the twentieth century's most distinguished psychologists.

The third lesson we draw from Gall's work is salutary. He was very wise to conclude that the physical findings of brain science are extremely limited when trying to draw theological conclusions. As he wrote,

The investigator of nature can only fathom the laws of the world of the body and takes for granted that no natural truth could be inconsistent with any revealed one.

Beyond this, he knows that . . . he has nothing to decide about mental life. He only sees and teaches that in this life mind is bound to body organisation.²⁰

Robert Rieber has analyzed Gall's writings and presents us with a fourth lesson from phrenology—a lesson relevant to the ambitions of neurotheology. Hidden in Gall's work was an assumption about material constraints on free will, a view that conflicted with long-held dogmas of the Catholic Church. Rieber believes that Gall's unified theory of mind and body was indeed a threat to the classic notion of free will, to which we shall return later in the book.

Overall, we can see that the era of phrenology produced a variety of reactions among Christian leaders, all of them drawing different conclusions for religious beliefs and practice. George Combe, for example, used phrenology as an Enlightenment critique of Christianity and as a support for his deist beliefs. In contrast, Orson Fowler saw phrenology as a helpful tool for practical pastoral matters such as marriage, education, and child rearing. Charles Cowan believed that scripture must accommodate itself to the truths of nature. William Scott, much like Gall, believed that there was a harmony between phrenology and scripture. With phrenology, as with the information being revealed by modern neuroscience, there is a wide variety of possible relationships between science and one's religious faith.

As this survey reveals, the empirical and reductionist approach of phrenology is not as old-fashioned as it seems. The general public is regaled almost daily with dramatic pictures from brain imaging that claim to show separate parts of the brain selectively active for almost every conceivable human activity. Science has indeed begun to show us discreet modules in the brain for each possible mental capacity. Nevertheless, the story is always more complicated, and that leads us to looking at the more complex models of the brain offered to us today by the best science.



CHAPTER 4

Principles of Brain Function

ALTHOUGH THE BRAIN can be thought of in terms of parts, modules, and systems, it also may be understood by its varied principles of operation. These principles can guide our understanding of broader psychological issues. By understanding these principles—and we shall outline eight that we feel are most helpful—we can begin to talk about how neuroscience is finding ever-tighter links between the functioning of our brain systems and our mental lives.

1. ACTION LOOPS

The nervous system is, in its simplest form, an action loop. The basic task for the nervous systems of all organisms is to adjust its ongoing motor activity based on sensory consequences. The nervous system modulates actions in the world by using sensory systems to monitor action outcomes, comparing actual outcomes to intended outcomes, and, on the basis of this feedback, making adjustments to ongoing action. This process results in the constant cycling of an action–feedback–evaluation–action loop (see Figure 1).

This principle reveals that it is the nature of organisms to be involved in constant interaction with their surroundings, always moving toward biologically relevant goals. Thus, even in the case of human beings, it is not so much that we stop-and-calculate and then act, but rather we are constantly acting (in some form) and making adjustments to actions based on feedback. Consequently,