3 The Third-Person View of the Mind

Introduction

The third-person view of the mind is from the outside, the objective world of science and medicine. It is how we are observed by those around us. The disturbing part is that our colleagues tell us, *"Sorry old chap, but your mind is nothing but electrochemical activity in three pounds of meat."* This is how science sees consciousness, nothing but the operation of the human brain. To make this even worse, the method of reduction tells us that brain activity is pure *Information*, something so abstract that it can be transmitted over a communications channel or stored in a computer memory. The goal of this chapter is to present the evidence for these stark conclusions.

A Brief Tour of the Brain

Medicine has a good understanding of the functions carried out by the body's various organs. For instance, the heart pumps blood, the lungs deliver oxygen, and the kidneys extract waste. But what about the brain, what does medical science view as its function? The answer is that the brain is needed for *movement*. This is one of the fundamental differences between plants and animals. Since plants do not move, they do not need brains. Animals are different; their very survival depends on body movement to capture food, escape enemies, and find mates. This requires animals to have three specialized systems. First, they need muscles to actually move their bodies. Second, they need sensory organs, such as the eyes and ears, to examine their environment. Third, they need a way of tying the sensory organs and the muscles together. This is where the brain comes in. Its function is to receive information about the environment from the senses, decide how to move the body to achieve survival and reproduction, and control the muscles to carry out the planned action. Figure 3-1 illustrates this role of the brain as the link between the senses and muscles.

Incredible as it may seem, all of these functions are carried out by a single type of building block, the **nerve cell** or **neuron**. Neurons come in a variety of shapes and sizes depending on where in the nervous system they are located. However, all neurons have the same general structure and operate in the same basic way. As shown in Fig. 3-2, each neuron has a cell body containing a nucleus and other components needed to keep the cell alive. Two kinds of projections extend from the cell body, the **dendrites**, where the signals enter the neuron, and the **axon**, where the signals exit. To allow the signals to jump from one neuron to the next, the end of each axon is positioned next to the dendrites of its neighbor, forming a connection called a **synapse**.

The neuron has a unique property that allows it to transport and process information. In the jargon of biology, neurons can **fire**. It works like this. The membrane around the neuron is capable of moving charged particles (ions) into and out of the cell. This pumping action results in the cell becoming a tiny battery, with the inside of the cell negative and the outside of the cell positive. The neuron remains in this condition until something stimulates one of the dendrites. For example, neurons in the eye are sensitive to light, and neurons in the ear are sensitive to sound. Neurons in the brain and spinal cord are only sensitive to the firing of neighboring nerve cells. When the dendrites receive sufficient stimulation, the cell membrane briefly *flips* its electrical polarity. For about one-thousandth of a second, the inside of the cell becomes positive and the outside negative, and then the cell returns to its normal condition. This brief polarity flip is called an **action potential**. Once the action

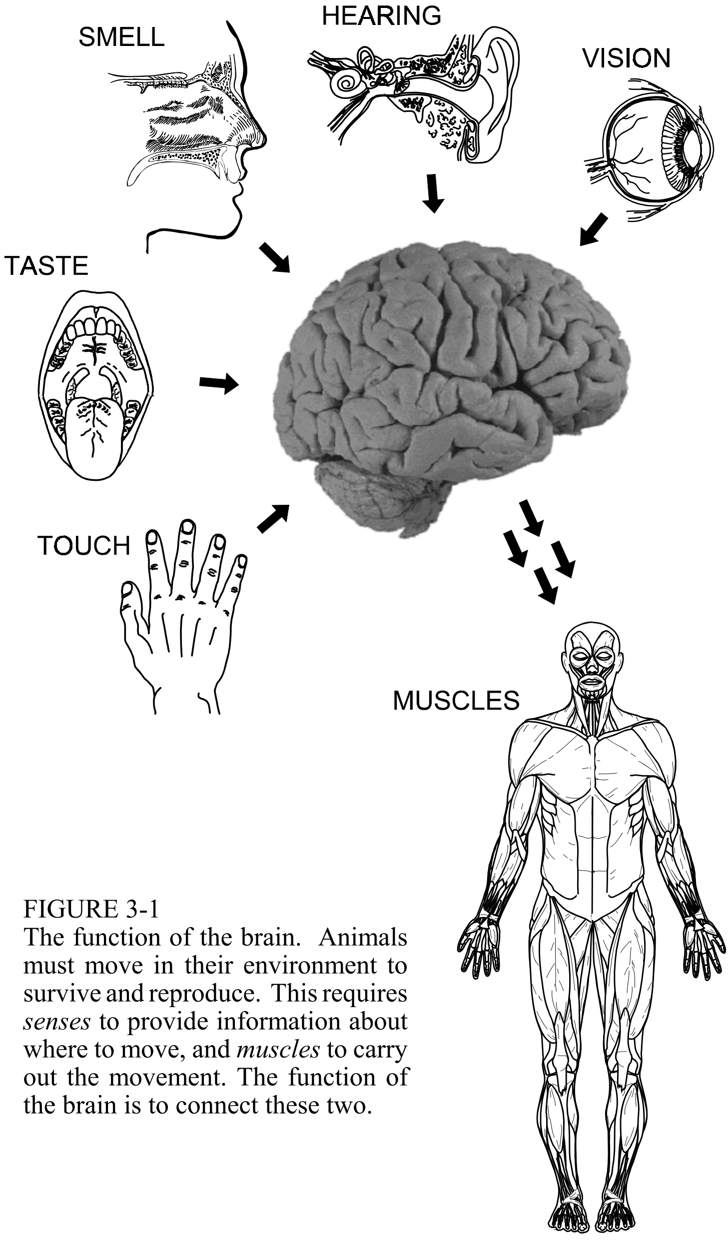

FIGURE 3-1
The function of the brain. Animals must move in their environment to survive and reproduce. This requires *senses* to provide information about where to move, and *muscles* to carry out the movement. The function of the brain is to connect these two.

potential is started at the dendrites it cannot be stopped; it quickly spreads through the cell body and down the axon. In less scientific terms, tickling a dendrite causes the nerve cell to *pop*, sending a short electrical pulse from one end to the other.

Although the action potential only lasts about one-thousandth of a second at any particular location in a cell, it can take much longer to move down a long axon. For instance, some of the axons in the legs and spinal cord are several feet in length, and it would normally take nearly a second for the action potential to move from one end to the other. To overcome this time delay, most neurons have their axons covered with a fatty substance called **myelin**. As shown in Fig. 3-2, the myelin sheath is interrupted at regular intervals by small breaks called the **nodes of Ranvier**. An action potential moves along a myelinated axon very quickly because it jumps from node-to-node, rather than traveling in the normal way. This reduces the transit time by a factor of about one-hundred. For instance, you have probably stubbed your toe and thought to yourself, "*that's going to hurt.*" Several seconds later the pain begins. This is because the neurons in your toe that detect pressure send their signals to the brain by fast myelinated axons. However, sensations of pain are conducted along unmyelinated axons, requiring several seconds to move from your toe to your head. As another example, you may be familiar with a person stricken with Multiple Sclerosis, a disease where the myelin degenerates. The resulting disruption of the neural transmission causes a variety of problems in sensation and movement.

Now let's take a closer look at the synapse, the connection between neurons. This is the most interesting location in the entire nervous system; it's where the important things happen. Except in rare cases, the action potential from one neuron cannot directly cause the next neuron to fire. This is because there is an extremely thin space between the axon and dendrite called the **synaptic gap**. Instead, the end of each axon contains small containers of chemicals called **synaptic vesicles**. When an action potential reaches the end of an axon, it stimulates

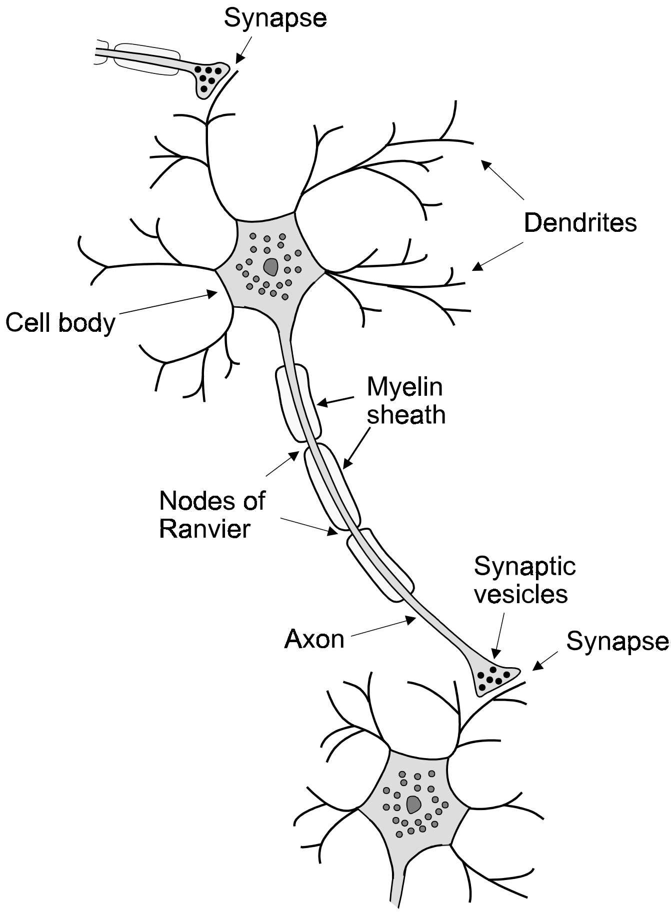

FIGURE 3-2
The neuron. The nerve cell, also called the neuron, is the basic building block of the brain and other nervous pathways. Stimulation of the dendrites cause the neuron to *fire*, sending a brief electrical pulse from the dendrites, through the cell body, and down the axon. This electrical pulse is called *an action potential*, and can be transferred from one neuron to the next through a connection called the *synapse*.

the synaptic vesicles causing them to release their chemicals into the synaptic gap. These chemicals move across the gap and affect the neighboring dendrite in some way, depending on the particular chemical released. Some encourage the next cell to fire, while other act to discourage firing. These chemicals released into the synaptic gap are called **neurotransmitters**. A few of the most common ones are called: acetylcholine, epinephrine, norepinephrine, serotonin, dopamine, and GABA. Figure 3-3 illustrates this process of an action potential traveling down an axon, resulting in the release of the neurotransmitter into the synaptic gap.

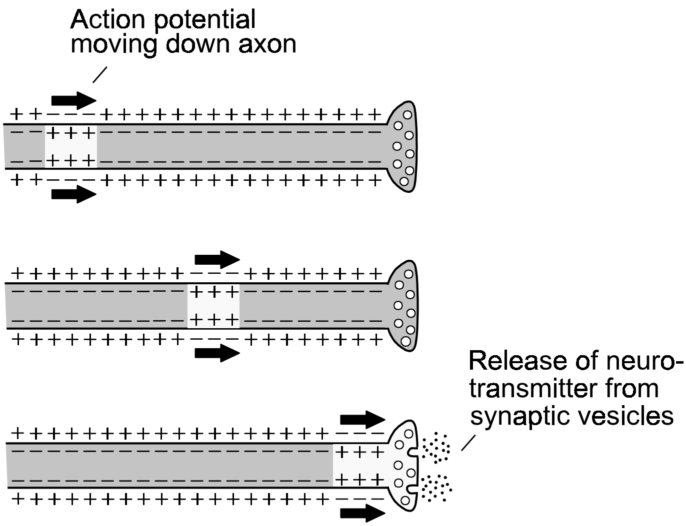

FIGURE 3-3
Neurotransmitter release. Action potentials do not jump directly from one neuron to the next. Instead, when an action potential reaches the end of the axon, chemicals called neurotransmitters are released into the synaptic gap. These chemicals then initiate action potentials in the neighboring neurons.

To understand how these neural connections account for human behavior, consider what happens when we greet a friend. First, light is reflected from our friend's face into our eyes. After entering our pupils, it is focused onto the back surface of each eyeball. This is the location of the retina, a layer of neurons that fire when exposed to light. As an example, a neuron in the retina might fire 200 times each second when exposed to bright light, and only five times each second when in darkness. The axons of about ten-thousand of these neurons leave the back of each eye to form the optic nerve, carrying the signals that represent patterns of lightness, darkness, and color into the brain. The other senses operate in a similar way; neurons in the ears fire when stimulated by sound, those in the skin by pressure and temperature, and those in the nose and mouth by chemical reactions. All of this information is carried into the brain by action potentials traveling down axons.

After a few seconds, we recognize our friend and respond by extending our hand to be shaken. This movement is controlled by neural pathways that start in the brain, lead down the spinal cord, and terminate in the muscles of the chest and arms. The force of the muscle contraction is determined by how fast these nerve cells fire, allowing the brain to control the movement in a smooth and well-coordinated manner. Most of the muscles in the body are controlled this way, except a few that need to operate on their own, such as the heart and digestive tract. The muscles that produce speech are also supervised by the brain. When we utter, *"Hi Bob, it's good to see you,"* the muscles in the diaphragm, vocal cords, tongue and lips, are simply responding to action potentials traveling down neurons from the brain.

Here is the important point: *the only things that go into and out of the brain are firing patterns of neurons.* But this brings us to the difficult part, to say the least. How does the brain determine what output to generate in response to a given input? For instance, how do we recognize the face of our friend, know what muscles to contract to extend our hand, or how to vocalize a greeting? Keep in mind that the brain must accomplish these tasks by using nothing more than cells that fire at different rates. At first glance, this problem of changing the sensory input into the muscle output seems overwhelmingly complicated. And when you look at it longer, it becomes even worse.

How does the brain do it? First, there are an incredible number of neurons in the brain, roughly 100 billion. Second, each neuron is connected to a multitude of other neurons (not just a single one as illustrated in Fig. 3-2). In round numbers, each neuron in the brain influences about 1,000 of its neighbors, resulting in an extraordinary 100 trillion synapses. Scientists call this maze of interconnected nerve cells a **neural network**.

Third, the pathways in the brain do not just go from the input to the output, but bend back on themselves to form *loops* in the neural network. Figure 3-4 illustrates this operation. Information from the senses is conducted to the brain where it joins the already circulating patterns of neural activity. Likewise, portions of this circulating neural activity break off and pass to the muscles for body control. Of course, this diagram is trivial compared to the enormous complexity of the human brain. For instance, imagine that you tried to count all of the brain's connections by looking through a high-power microscope. At a rate of one synapse every second, it would take more than 100,000 lifetimes to tally the entire brain.

Lastly, there is a fourth general feature of the brain, it is highly *adaptable*. Each time a person learns something, be it a mathematical equation or the face of a new friend, the brain must change in some way to incorporate this knowledge. In adults, the primary change in the brain is a modification of the so-called **synaptic weights**. As previously described, when a neuron fires it affects its neighbors through the release of a neurotransmitter into the synaptic gap. The more neurotransmitter is released, the greater the effect on the neighboring cells, to either encourage or discourage them from firing. The term *synaptic weight* refers to how much one neuron’s firing affects it neighbors.

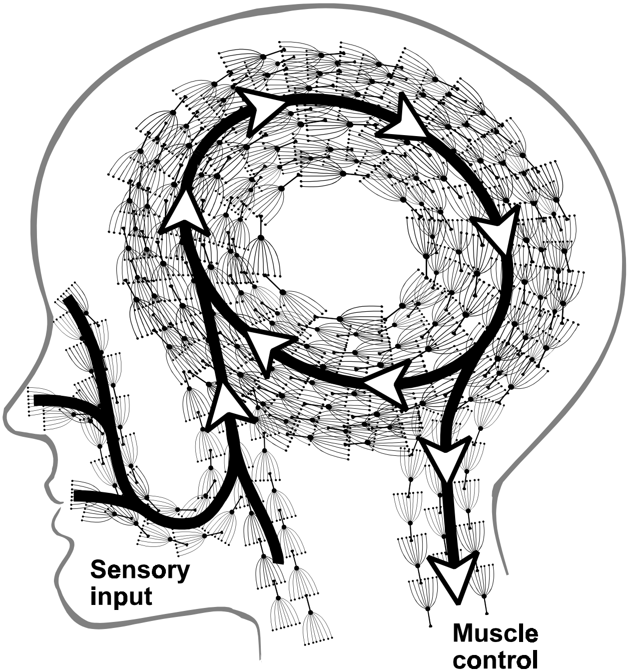

FIGURE 3-4
Circulation of neural activity. Patterns of action potentials are sent from the senses to the brain where they enter the already circulating patterns of neural activity. Portions of this neural activity exit the circulation to control the muscles.

Long term memory is accomplished in the brain by modifying synaptic weights in response to experience. Suppose you meet a person for the first time and your brain tries to remember what their face looks like. The signals pass from the eyes to the brain along the optic nerve, setting up a pattern of neural activity in the brain that corresponds to the person's face. This activity changes the synaptic weights between the affected neurons, such as by increasing or decreasing the level of the neurotransmitter that is released when each nerve cell fires. When you see the person's face at a later time, it causes a similar pattern of neural activity. However, this time the modified neural weights already match the pattern of activity, a condition that the brain interprets as *recognition*. Present day science has a general grasp of how this can occur in neural networks, but a poor understanding of the details. For instance, little is known about how the synaptic weights are modified, and even where in the brain memories are stored. These are the challenges of twenty-first century brain research.

Now let's turn our attention to the actual human brain, as shown in Figs. 3-5 and 3-6. Different areas of the brain are responsible for different tasks; however, the tissue in each of these areas is of the same construction, an intricate maze of interconnected neurons. The outside of the brain is called the **cerebral cortex**, or *gray matter* from its appearance. This is the site of the most sophisticated activity in the brain, the densest part of the neural network interconnections. The complexity of the cerebral cortex is the single most important difference between the brains of humans and lower animals. Inside the cerebral cortex is *white matter*, which is used to transport neural activity from one part of the brain to another. It appears lighter than the gray matter because its axons are covered with the fatty myelin sheath, reducing the time for action potentials to move between locations. An important part of the white matter is the **corpus callosum**, a huge pathway that connects the left and right halves of the brain. More about this later.

Since the brain's function is to connect the senses with the muscles, it is not surprising that each location on the cerebral cortex has one of three general duties: (1) **sensory**, the analysis of signals from the five senses, (2) **motor**, the preparation of signals that go to the muscles, and (3) **association**, the processing needed to connect the first two. For instance, the rearmost portion of the brain, the *occipital lobe* or *visual cortex*, processes sensory information from the eyes. Likewise, touch and pain are processed in the *sensory cortex*, a narrow vertical

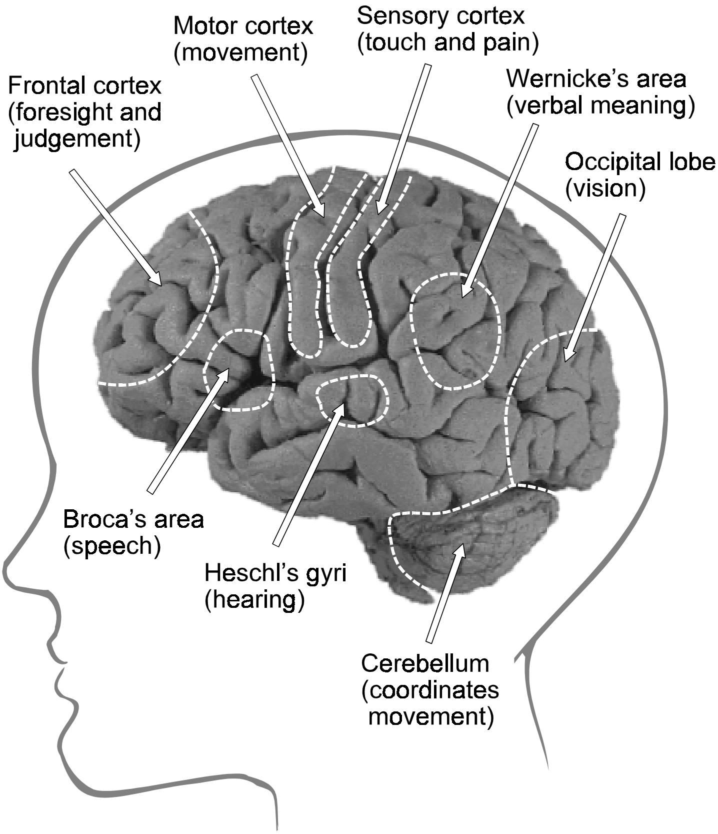

FIGURE 3-5
The human brain. The outer layer of the human brain, *the cerebral cortex*, is where the most complex processing occurs. It is divided into many different regions, each performing a specific task.

strip on the sides of the brain. Interestingly, sensory cortex is arranged as an upside-down body. That is, sensations from the feet are processed at the top of the strip, sensations from the head at the bottom, and the rest of the body at corresponding locations in between. *Motor cortex*, which is the initiator of most body movement, is contained in another narrow vertical strip positioned alongside the sensory cortex. It has the same upside-down organization; feet are controlled at the top and the head at the bottom. Other examples of sensory and motor regions are also labeled in Fig. 3-5. These include: *Heschl's gyri* where hearing is processed, *Broca's area* that controls the muscles of speech, and the *Cerebellum*, a large section at the rear of the brain that makes movement smooth and well coordinated instead of jerky and erratic.

Damage to the Association Areas

Brain damage to the sensory and motor regions results in problems such as blindness and being paralyzed. However, these deficits do not directly alter the mind; the person still thinks, feels, and remembers the same as before the injury. But damage to the association areas is different; it affects the mind at its very core. The essence of what we are is changed. We will briefly describe six examples of this.

Our first example is one of the most famous accidents in medical history. **Phineas Gage** was a railroad construction foreman in 1848 Vermont. One of his duties was to prepare blasting charges by pushing dynamite down a hole drilled into the rock. This was done with the aid of a tamping iron, a heavy metal rod about 3½ feet long and 1¼ inches in diameter. On September 13, Gage was preparing such a blasting hole when the dynamite accidentally exploded, driving the tamping bar completely through his head. It entered under his left cheek bone, passed behind his left eye, exited through the top of his head, and landed about 25 to 30 yards away.

Incredibly, Phineas Gage survived the accident and lived for another 13 years, although much of the front part of his brain had been destroyed. The injury did not affect his sensory or motor abilities; he could see, hear, and move his body normally. It also did not affect his memory or intelligence. What changed was his *personality*, the way he thought about things and how he interacted with the world. Before the accident, Gage was regarded as well-balanced, cooperative and friendly. He was a capable supervisor and shrewd businessman. Afterwards he

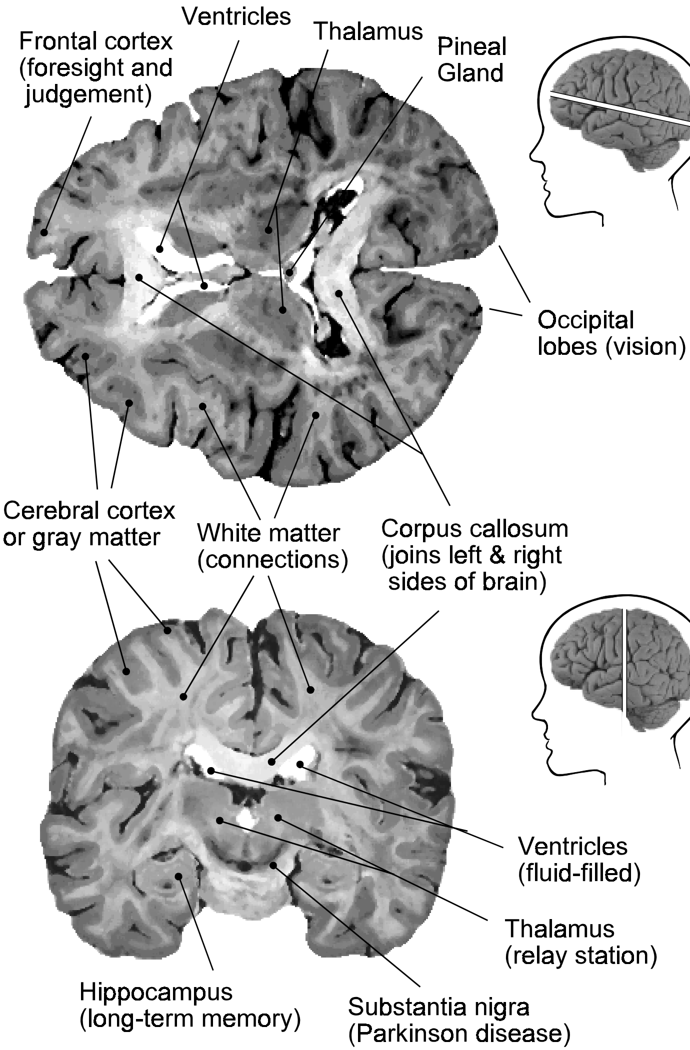

FIGURE 3-6
Cross-section of the human brain. Interesting regions include: *ventricles*, fluid filled holes in the brain; *pineal gland*, incorrectly believed to be the seat of consciousness by Descartes (Chapter 7); *thalamus*, a relay station for passing signals between areas; and *substantia nigra*, which is destroyed in Parkinson's disease.

was impatient and obstinate. He seemed to care little about those around him and was grossly profane. He was indecisive, seemingly unable to settle on any of the plans he devised for the future. According to his friends, *he was no longer Gage*. Modern patients with frontal brain damage exhibit similar problems.

The second example is also from an unfortunate affliction, a patient identified in the medical literature only as **H.M.** In 1953, at the age of 27, H.M. underwent a brain operation in an attempt to control severe epileptic seizures. This procedure removed a region called the *hippocampus,* located deep within the brain (see Fig. 3-6). Although the operation was successful for his problem with epilepsy, it left H.M. with a bizarre mental condition. If you met and spoke with H.M., you would probably not notice anything out of the ordinary. However, if you then left the room and returned five minutes later, H.M. would have absolutely no recollection of having met you. His brain is totally incapable of transferring current thoughts into long-term memory. He can remember events before the operation, but virtually nothing since. H.M. is alive today, nearly 50 years after the procedure, but his mind is trapped forever in 1953.

Example three is also a result of surgery to manage epilepsy, resulting in what are called **split-brain patients**. The left and right halves of the brain are virtually identical in structure, but are different in their function. For instance, the left half of the brain controls the right side of the body, and vice versa. Also, the left half of the brain only sees the right half of the image from each eye, while the right half of the brain only sees what is left of center. There are also other specializations, such as language being a left brain function, while spatial thinking and music perception are handled on the right side. Usually this segmentation of brain function isn't apparent in our behavior because the left and right sides of the brain are in constant communication with each other. This occurs over the large tract of nerve fibers that runs between the left and right halves of the brain, the *corpus callosum* (see Fig. 3-6).

Starting in the 1950's, brain surgeons began cutting the corpus callosum in epileptic patients. This was done in an attempt to keep the storm-like neural activity of the seizure from spreading from one side of the brain to the other. Surprisingly, these patients seem relatively normal after the procedure, just as long as you don't look too closely. Clever experiments allow the researcher to communicate with only one-half of the brain at a time. For instance, if you display an object to the left of where the subject is looking, or have the subject press a button with his left hand, you are in communication with the right half of the brain. Likewise, when the subject writes a message with his right hand, or when he speaks, the left half of the brain is in charge. These tricks can be used to see what each half of the brain is thinking, feeling, remembering, desiring, and so on.

These experiments provide strong evidence that *split brain patients have two separate minds*. For instance, the two halves of the brain can have different knowledge. If a familiar object is placed in the left hand, the right brain will recognize it, but the left brain won't. They can also have different opinions. When asked about their own self worth, the right side might respond "good," while the left side "inadequate." The two sides can also have different goals. For example, the two halves of the brain can be given opposing tasks, resulting in the hands fighting each other. The compelling conclusion is that splitting the brain also splits the mind.

Our fourth example is **aphasia**, the difficulty in understanding and producing speech due to brain damage, such as from strokes. Two regions of the brain are involved, **Broca's area** and **Wernicke's area**, named after researchers in the mid 1800s who studied them. Both these areas are shown in Fig. 3-5, and are only on the left side of the brain in most people. Broca's area controls the muscles used in speaking. Patients with damage in this region speak slowly and with poor flow; however, they know what they want to say and can comprehend the speech of others. In short, their mind is intact; they just have difficulty in getting out the sounds and syntax.

Damage to Wernicke's area is far more interesting for the study of consciousness. These patients can no longer associate words with their meaning. Even though they may hear normally, they cannot understand spoken language. They have lost their dictionary; the language they have used since childhood is suddenly foreign and incomprehensible. Their speech is even stranger. While it is grammatically correct and formed into complete sentences, it is gibberish and has no meaning. This is exactly the opposite of Broca's aphasia. Wernicke's aphasia patients have no difficulty producing the sounds and syntax, but their minds can no longer produce verbal meaning.

The fifth example is the effect of **psychoactive drugs**. These are drugs that affect mental activity in some way, such as our moods, perceptions of events, and patterns of thinking. Most psychoactive drugs act by altering the neurotransmitters in the synaptic gaps, usually because the two molecules resemble each other. This allows the drug to change the patterns of neural activity by encouraging or discouraging the firing of individual neurons. For instance, alcohol produces relaxation, reduces inhibitions, and impairs judgement. Barbiturates and diazepam (Valium) calm people and reduce anxiety. Amphetamines and cocaine produce alertness and euphoria. Hallucinogens, such as LSD, mescaline and PCP, alter perception and thinking patterns. Nitrous oxide, and other drugs, change the way we perceive pain; it still hurts, but we don't care. Still other drugs are successful at treating such psychological disorders as schizophrenia, depression, and manic-depression.

Our sixth and last example is a strange condition called **synesthesia**,[1] from the Greek words for "combined sensation." About one person in every several thousand has their senses cross-linked in some unusual way. In the most common case,

1. "Do you see what they see?", Brad Lemley, Discover, 20, Dec. 1999, pp 80-87. Also, search the web for many on-line references.

the person perceives a color whenever shown a letter or number. For example, the letter "g" might always be seen as red, the letter "h" as blue, the digit "7" as yellow, and so on. These colors can be extremely vivid, and are often seen as a transparent glow around the figure. Slightly less common, colors can be evoked by sounds, odors, tastes, and pain. Much less frequently there are cross-links between the other senses, such as sound causing odor, or vision causing taste. It most cases, people with synesthesia are normal in all other ways.

What causes synesthesia? The exact details are not known, but it is clearly related to neural activity in one area of the brain leaking into another area where it doesn't belong. Imagine that we open a person's skull and graft a nerve tract from one location in the brain to another. Since each location handles a different function, we would expect to see two types of brain activity, that are normally separate, becoming joined. One theory is that we are all born with synesthesia, a result of undeveloped neural pathways crisscrossing the newly formed brain. Most of these pathways die during the first few years of life, leaving the highly segmented brain we find in adults. Synesthesia might be caused by some of these pathways refusing to die, leaving a "neural leak" from one area to another.

Synesthesia may seem strange at first encounter, but it is easily explained in terms of brain structure. In fact, all six of the previous examples provide this same lesson: *The structure and function of the mind are totally dependent on the structure and function of the brain*. All of these examples seem bizarre and unexplainable if the mind is taken to be an entity in itself. But when the mind is viewed as the operation of the brain, everything falls naturally into place, and the explanations become straightforward and simple.

The Evidence

By definition, the third-person view of the mind is from the outside, what is seen by an external observer. And what this external observer sees is *brain activity*, incredibly complex patterns of action potentials moving through a neural network. The following are undisputed scientific facts, and any theory of the mind must be able to account for each:

> First, there is an unbroken path of nerve cells running from the senses, through the neural network of the brain, and to the muscles. For instance, suppose a person sees an object and proclaims: "*This is an apple*." Brain scanners and scientific instruments can monitor the resulting neural activity from its beginning to its end. Action potentials are generated by the eyes, pass through the sensory, association, and motor areas of the brain, and end up at the muscles that control speech. There is no "hidden area" in the middle; it is an unbroken chain of events.

> Second, neural networks do have the capability of changing various patterns of input into various patterns of output. This includes all the general things that science observes the brain to be doing, such as muscle control pattern recognition, short and long term memory, forming relationships between abstract concepts, and so on. This knowledge comes primarily from the study of *artificial* neural networks, computer programs that mimic the activity of the squishy things inside the brain. While this work has partly been motivated by brain research, it is largely directed at the development of better computer systems. We know that neural networks can carry out these general types of tasks because engineers use them on a daily basis. Present day artificial neural networks cannot match the performance of the human brain, but they clearly can perform the same kinds of functions.

> Third, altering the *brain* results in fundamental changes to the *mind*. Psychoactive drugs affect our emotions, patterns of thinking, how we interpret pain, and so on. Aberrant connections in the brain can cause us to "see sounds" and "smell colors" (synesthesia).

> Brain damage is even more dramatic, being able to literally rip the mind apart. For instance, it can obliterate judgement and foresight (Phineas Gage), prevent storage of new long term memories (H.M.), create two minds from one (split-brain patients), and prevent the association of words with meaning (Wernicke's aphasia).

This evidence overwhelmingly points to only one explanation: *the mind is the activity of the brain*. There is no reason for an external observer to believe that anything more is going on, because this explanation accounts for everything that can be seen from outside the mind. All of the things that we associate with consciousness, such as thinking, perception, emotion, and short term memory, arise from the neural activity circulating in the neural network loops. From the third-person perspective, this circulating neural activity <u>is</u> the mind; there is nothing more.

Brain Activity and Information

Our next step is to apply the method of reduction to this third-person view of the mind. As with everything in our reality, we find that the brain is composed of only two things, Elements-of-reality and Information. In other words, the brain is formed from ordinary materials assembled in an exquisitely complex way. But the mind is not the brain; the mind is the *activity* of the brain. Does this make the mind an Element-of-reality, or Information, or both? This question can be answered in two different ways, by looking at brain *structure* and brain *function*.

To understand the importance of brain *structure*, consider the difference between a brain and a rock. Using reduction, we find that both objects are composed of the same Elements-of-reality, that is, the electrons, protons, and neutrons that form all ordinary matter. The difference between a brain and a rock is in how this raw material is assembled. The brain has an incredibly intricate biological and chemical structure, while the rock is relatively random and unorganized. It is this difference in structure that allows a brain to support a mind, while the rock is a mindless lump. From the third-person view, the mind arises from the structure of the brain, not the raw materials. Therefore, the mind is Information, and not an Element-of-reality.

This same conclusion is reached by looking at brain *function*. To an external observer, the function of the brain is to generate an appropriate neural output in response to a given neural input. This means that the brain is manipulating Information, not Elements-of-reality. To illustrate this, imagine that your hand is stroking the soft face of a young child. Suddenly, this sensation is replaced by intense pain when the child bits your fingers. This unpleasant event will clearly change the activity of your brain and nervous system. A new pattern of action potentials will pass from your fingers, through your brain, and to your muscles. The final result will be your screaming and attempting to escape the child's hold. However, the raw material that makes up your body will *not* be changed in the slightest. The same electrons, protons, and neutrons will be present after the event as before. In short, the activity of the brain involves only Information, not Elements-of-reality. Again we find that the mind is pure Information.

While both these lines of reasoning reach the same conclusion, there is an important distinction between the two. The analysis using brain structure is based solely on the method of *reduction*. Here we are concerned with the identification of irreducible entities and how they are assembled. This is science in its most pristine form. In comparison, the analysis using brain function is based on *emergence*. This is an attempt to integrate our observations with existing human knowledge. We want to know more than *what* the physical structure is; we want an explanation of *how* and *why* the brain behaves as it does.

The important result is that reduction and emergence, the two primary methods of science, lead to the same conclusion: *the third-person perspective sees the mind as Information*. An interesting consequence of this is that the mind will therefore act as all Information does. For instance, the mind can be transmitted over a communications channel or stored in the electronic memory of a computer. Using reduction, this would be accomplished by recording the exact location and state of each electron, proton, and neuron that forms a person's brain. Duplicate copies of the brain could then be constructed by using other electrons, protons, and neutrons. Since the mind is the activity of the brain, this would also create duplicate minds.

An even more interesting case of "mind duplication" is provided by emergence and the functional view of the brain. To create a duplicate mind, we do not necessarily need to create an exact duplicate of the brain. Rather, we only need to construct a device that duplicates the *function* of the brain. For instance, suppose we start by creating an *artificial neuron*, a manmade device that exactly matches what a real nerve cell does. How this device is constructed is of no importance; it may be a few transistors wired together, a tiny digital computer, or some other technology developed in the future. The important feature is the logical relationship between its input and output. When the artificial neuron is presented with the same input as a real neuron, it must generate exactly the same output as the real neuron. Now suppose that we use this device to treat brain deterioration in an elderly patient. As each neuron in their brain dies, we replace it with an artificial neuron, allowing the person to retain their full mental capabilities.

But where does this process end? Eventually, all of the real nerve cells will have died and only artificial neurons will be left. This means that our patient's mind will have been transferred from their brain to a manmade computer. This line of reasoning is called **functionalism** and is one of the most striking conclusions resulting from the third-person view. In short, brains create minds by carrying out certain computational activities. Likewise, any machine that carries out these same computational activities will also create a mind.

To summarize, science sees the mind as being synonymous with brain activity; they are one and the same. Taking this a step further, reduction and emergence tell us that brain activity is nothing but Information, and not an Element-of-reality. In short, *the third-person viewpoint sees consciousness as pure Information*. These conclusions are based on overwhelming scientific evidence, and there is not the slightest objective reason to suspect that they are not true. But now we need to look at the other side of the coin, a viewpoint that makes science cringe, the subjective view of the mind.