FOCUS ON VOCABULARY AND LANGUAGE

Biology, Behavior, and Mind

A wrongheaded theory Even though *phrenology* was without any scientific merit *(wrong-headed)*, the theory did suggest the idea that different parts of the brain influence a variety of functions and behaviors.

Neural Communication

For scientists, it is *a happy fact of nature* that the information systems of humans and other animals operate similarly . . . The structure and function of neurons are very similar in humans and other animals (for example, squids and sea slugs). This is a good thing *(a happy fact of nature)* for those researching the **nervous system**. Myers makes the important point about this similarity, noting that it would not be possible to tell the difference between a small piece of your brain tissue and that of a monkey.

Neurons

Its *building blocks* are **neurons**, or nerve cells. *Building blocks* are the basic or fundamental parts (for example, the bricks) that make up a structure (for example, a house). The structure of our nervous system, or neural information system, is made up of neurons (they are its *building blocks*).

To *fathom* our thoughts and actions, memories and moods, we must first understand how neurons work and communicate. To *fathom* means to have a deep comprehension. (A *fathom* is also a unit for measuring the depth of water.) To obtain an in-depth understanding of (to *fathom*) our cognitions and behaviors, our memories and emotions, we need to have a thorough appreciation of what neurons are, as well as how they operate and communicate.

. . . a neural impulse travels at speeds ranging from a *sluggish* 2 miles per hour to a *breakneck* 180 miles per hour. The speed of the neural impulse ranges from extremely slow *(sluggish)* to very fast (a *breakneck* speed). Compared to the speed of electricity or sophisticated electronics systems, your neural impulses travel at a relatively slow pace.

. . . The first section of the axon opens its gates, rather *like sewer covers flipping open*, and positively charged sodium ions flood through the cell membrane. The analogy here is to the circular metal tops *(sewer covers)* that conceal entrances to underground sewer lines and water pipes at various points along the length of a tunnel. When a neuron fires, the resting **axon** no longer blocks access to positive sodium ions *(the security parameters change)*. Consequently, the axon begins to open its gates in sequence, much like a series of lids that open in succession *(like sewer covers flipping open)* allowing sodium ions in. The sequential opening of each channel is like a chain reaction with each event affecting the next *(like a line of falling dominoes, each tripping the next)*.

The mind *boggles* . . . *Boggle* means to startle, alarm, or surprise. Our minds are amazed *(boggled)* by the astounding complexity and intricate activity of the brain and nervous system.

Most signals are *excitatory*, *somewhat like pushing a neuron's accelerator*. Some are *inhibitory*, *more like pushing its brake*. Myers is making a comparison between the effect of a neuron firing and the effect of speeding up a car by pushing its accelerator (the *excitatory* effect) or slowing it down by applying its brake (the *inhibitory* effect). He also likens *excitatory* signals to those who love social gatherings *(party animals)* and *inhibitory* signals to those who do not *(party poopers)*; if those who want to have a party outvote those who do not, the party (the ***action potential***) will happen *(the party's on)*.

How do we distinguish a gentle touch from a big hug? This question is concerned with how we become aware of the magnitude of a stimulus, from a soft stroke or pat *(gentle touch)* to a strong embrace *(big hug)*. The answer is that the intensity of the stimulus is a function of the number and frequency of neurons firing. A strong stimulus *(big hug)* does not initiate *(trigger)* a more powerful or faster impulse than a weak stimulus *(gentle touch)*. Rather, it *triggers* more neurons to fire, and to fire more often.

How Neurons Communicate

Spanish anatomist Santiago Ramón y Cajal (1852–1934) marveled at these near-unions of neurons, calling them *"protoplasmic kisses."* Here, the reference is to the fact that the axon terminal of one neuron is separated from the receiving neuron by a tiny space called the *synaptic gap*. *Protoplasm* is the material that constitutes all living cells, and the communication between cells is likened to a kiss between cells *(protoplasmic kisses)*. The transmission between sender and receiver is via chemicals called **neurotransmitters**. The cells do not actually touch but instead send messages across the *synaptic gap*. In this case, Myers makes an analogy to sophisticated females *(elegant ladies)* who will kiss the cheeks of another person without letting their lips make actual physical contact *(air-kissing)* so as to avoid disturbing their facial cosmetics *(so as not to muss their makeup)*.

How Neurotransmitters Influence Us

. . . *"runner's high"* . . . This refers to the feeling of emotional well-being or euphoria *(high)* that follows vigorous exercise (for example, running or jogging). It is the result of the release of opiatelike substances called **endorphins**. Myers notes that these neurotransmitters are part of the brain's natural pain-reducing and mood-elevating chemistry (its *"feel-good" chemistry*).

For suppressing the body's own neurotransmitter production, *nature charges a price*. When flooded with mood-altering drugs such as heroin and morphine, the brain stops producing its own endorphins (that is, the drugs *suppress the body's own neurotransmitter production*). Withdrawal from such drugs initiates changes *(intense discomfort)* that persist for a period of time. For the addict who stops taking the drugs, the cost may be a great deal of pain and agony *(nature charges a price)*.

The Nervous System

The Peripheral Nervous System

Like an *automatic pilot*, this system may be consciously *overridden*, but usually operates on its own *(autonomously)*. The **autonomic nervous system (ANS)** automatically takes care of the operation of our internal organs, much as a plane can be flown by its onboard computerized, mechanical system (*automatic pilot* or autopilot). While the ANS is usually self-directed and independent *(autonomous)*, it *can* be taken over *(overridden)* in the same way a human pilot can take over flying a plane.

The Central Nervous System

Tens of billions of neurons, each communicating with thousands of other neurons, yield *an ever-changing wiring diagram*. The complexity of the **central nervous system** allows or makes possible *(enables)* our thinking, feeling, and behavior. In this way, it is similar to the electronic circuitry *(wiring diagrams)* of the best computer—except that the brain's wiring would seem to be constantly modifying or altering itself *(an ever-changing wiring diagram)*.

The brain's neurons cluster into *work groups* called *neural networks*. Myers is pointing out that the brain works much like a computer making many simultaneous computations. This is accomplished by *neural networks*, which are clusters of interconnected neurons *(work groups)*. Neurons work with other nearby neurons for much the same reason that people live in cities—it is easier to have brief, quick interactions with other people when they are nearby. Learning occurs as feedback builds and strengthens these neural connections *(neurons that fire together wire together)*.

. . . *information highway* . . . The spinal cord is similar to the freeway *(highway)*—but instead of cars moving up and down, sensory and motor messages *(information)* travel between the **peripheral nervous system** and the brain. This information moves either up *(ascending)* to the brain or down *(descending)* from the brain.

The knee-jerk response, for example, involves one such simple pathway. *A headless warm body could do it*. When the patellar tendon of a bent knee is struck, the whole leg reflexively straightens out *(the knee-jerk response)*. This automatic reaction is a function of a simple spinal **reflex** pathway, so it does not require mediation by the brain *(a headless warm* [live] *body could do it)*.

The Endocrine System

The **endocrine system** and nervous system *are therefore close relatives*. These two systems share similarities and are intimately connected; like two members of the same family, they have much in common *(they are close relatives)*. The **hormones** of the endocrine system are chemically equivalent to neurotransmitters but operate at a much slower speed. Messages in the nervous system move very rapidly (they *zip* along as fast as *e-mail*) compared with endocrine system messages, which move relatively slowly (they *trudge along* like regular or *postal mail*).

Conducting and coordinating this whole *electrochemical orchestra* is that *maestro* we call the brain. Myers is comparing the functioning of neurotransmitters and hormones to a large group of musicians (an *electrochemical orchestra*). Their movements and actions are directed by the conductor or master (the *maestro*), the brain.

The Brain

That we can imagine such questions illustrates how convinced we are that *we live "somewhere north of the neck"* (Fodor, 1999). What this means is that we subjectively feel that the essence of our being, the mind, resides in our brain and inside our head, which is above our neck *(we live "somewhere north of the neck")*. The brain in our head allows us to function psychologically as well as physically—*the mind is what the brain does*.

The Tools of Discovery: Having Our Head Examined

Now, within a lifetime, a new generation of neural cartographers is probing and mapping the known universe's most amazing organ. A *cartographer* is someone who prepares or makes maps. Myers is suggesting that the brain *(the known universe's most amazing organ)* is being graphically depicted *(mapped)* by a new younger group of neuroscientists *(a new generation of neural cartographers)*.

Scientists can even *snoop on* the messages of *individual neurons* . . . Researchers can also *eavesdrop on* the *chatter* of billions of neurons . . . With today's technological tools it is possible to unobtrusively view or spy on *(snoop on)* single nerve cells *(individual neurons)*. Scientists can also covertly listen to *(eavesdrop on)* the back-and-forth communication *(chatter)* of millions and millions of cells.

Unlike **EEGs**, *newer neuroimaging techniques* give us that *Supermanlike ability* to see inside the living brain. Modern technological means of viewing the brain *(newer neuroimaging techniques)*, such as the **PET scan**, **MRI**, and **fMRI**, provide us with a greater-than-normal ability (a *Supermanlike ability*) to look inside the cortex without destroying tissue. (Note that *Superman* is a comic-book, TV, and movie character with X-ray vision, which allows him to see through solid matter.) As Myers points out, we are living in a period of great achievement and rapid progress (a *golden age in brain science*).

. . . *glucose hogs* . . . When neurons are active, they consume more of the brains chemical fuel, the sugar glucose (they are *glucose hogs*). Cognitive activity, such as doing math calculations, uses greater amounts of glucose, which can be tracked by the PET scan *(PET scan "hot spots")*. Myers jokes that the glucose consumed during cognitive activity is like *"food for thought."*

Such *snapshots* of the brain's changing activity are providing new insights . . . into *how the brain divides its labor*. The fMRI technique allows pictures *(snapshots)* to be taken of different brain areas at work *(how the brain divides its labor)* while a person is carrying out various mental tasks.

Older Brain Structures

. . . *vegetative state* . . . A person who is in a *vegetative state* is alive but, due to brain damage, often not conscious or aware. If the brainstem is intact, it can automatically control basic functions (it can *orchestrate our heart's pumping and lungs' breathing*)—we do not need a conscious mind to operate.

This peculiar cross-wiring is but one of the brain's many surprises. In the **brainstem**, most nerves from the left side of the body connect to the right side of the brain, and those from the right connect to the left side of the brain. This strange *(peculiar)* traverse of nerves from one side to the other *(cross-wiring)*, which occurs in the brainstem, is one of the many marvels or astonishing findings about the brain *(one of the brain's many surprises)*.

Think of the thalamus as being to sensory information what *London is to England's trains*: a hub through which traffic passes en route to various destinations. *London* is the relay center for trains going to all parts of the country, just as Chicago is the hub or relay center for many airlines flying to different parts of the United States. Myers uses this as an analogy for the **thalamus**, which receives messages from sensory neurons and sends them on, or relays them, to higher brain areas. (It also receives some of the higher brain's responses and directs them to the **medulla** and the **cerebellum**.)

. . . they made *a magnificent mistake* . . . Olds and Milner accidentally discovered *(stumbled upon)* a brain area that provides a pleasurable reward and then went on to find other similar areas, which they called *"pleasure centers."* Myers calls this a splendid and spectacular error *(a magnificent mistake)*. When rats are allowed to stimulate these areas by pressing a bar or lever *(pedal),* they seem to prefer this to any other activity and will continue at a very rapid rate *(feverish pace)* until they are too tired to go on *(until they drop from exhaustion)*. Myers notes that, rather than attribute human feelings to rats, today's scientists refer to *reward centers*, not "pleasure centers."

The Cerebral Cortex

If you opened a human skull, exposing the brain, you would see a *wrinkled* organ, shaped somewhat like *the meat of an oversized walnut*. The human brain has a convoluted *(wrinkled)* surface, and the **cerebral cortex** is divided into two halves or hemispheres just like the two lobes of the edible portion *(the meat)* in the shell of a very large *(oversized)* walnut.

Being human takes a lot of nerve. Myers is using humor to make a point here. The expression *"it takes a lot of nerve"* means to be very brave or courageous. (Another expression, "it takes a lot of guts," means the same thing!) Thus, when Myers states that *being human takes a lot of nerve*, the literal meaning in this context is that *humans* are made up of many, many *nerves* (the humor is derived from the double meaning).

Glial cells are worker bees. Here, the analogy is to a beehive where the queen bee has to rely on the *worker bees* to feed her and take care of her needs. ***Glial cells*** perform in a similar way by looking after the needs of neurons that, like queen bees, cannot feed or insulate themselves *(glial cells are worker bees)*. *Glial cells* may also be involved *(play a role)* in learning, memory, and thinking by communicating *("chatting")* with neurons and promoting information transmission.

In a sense, we do *have eyes in the back of our head!* The reference here is to the visual cortex (or **occipital lobes**) that processes visual information and is located at the rear of the brain. So, in a way, seeing is not just done with the eyes but also involves specialized areas at the back of the brain *(In a sense, we* do *have eyes in the back of our head!)*.

Their [the association areas'] silence has led to what Donald McBurney (1996, p. 44) has called *"one of the hardiest weeds in the garden of psychology"*: the claim that we ordinarily use only 10 percent of our brains. McBurney compares this very persistent myth to the way weeds continue to grow in a garden despite efforts to eliminate them. The 10 percent myth, like a weed, is one of the toughest misconceptions to get rid of *(one of the hardiest weeds in the garden of psychology)*. Research into the **association areas** of the brain has shown that they do not have specific functions, but rather are involved in many different operations such as interpreting, integrating, and acting on sensory information and linking it with stored memories. The incorrect notion that we use only 10 percent of our brains may have arisen because early researchers were unsure about the function of the association areas. Remember, we use all of our brain, all the time. Damage to the association areas would result in very serious deficits.

With their frontal lobes ruptured, people's moral compass seems to disconnect from their behavior. When people, such as Phineas Gage, suffer damage to the frontal lobes *(with their frontal lobes ruptured),* they lose many of their normal inhibitions. This loss can cause them to veer away from their previously ethical and honest ways *(their moral compass seems to disconnect from their behavior)*.

. . . *head-scratching findings* . . . When people are in a confused or questioning state of mind they may literally *scratch their heads*, which is a behavioral manifestation of their mental state. Brain stimulation studies of people who were undergoing brain surgery produced contradictory or counter-intuitive results that leave us with many questions (they are *head-scratching findings*).

Our Divided Brain

Waking from surgery, one even *joked* that he had a *"splitting headache"* (Gazzaniga, 1967). People who have had their **corpus callosum** severed or cut to control epileptic seizures are called **split-brain** patients. Despite having had such a major operation, the patient described here managed to make fun of the situation *(joke)* by saying he had a very bad headache (a *"splitting headache"*). Personality and intellectual functioning are not affected by this procedure, and you would not be able to detect anything unusual if you were having a casual conversation with a split-brain patient.

When the "two minds" are at odds, the left hemisphere does *mental gymnastics* to *rationalize* reactions it does not understand. In split-brain patients, if information or commands were delivered to the right hemisphere (which does not have language), the left hemisphere (which can talk) would not be aware of what was requested. So, if the patient carried out the command to do something (for example, "walk" or "clap"), the left hemisphere would go through all kinds of contortions *(mental gymnastics)* to create some plausible story that accounts for the response (it *rationalizes* and constructs theories to explain its behavior).

Right-Left Differences in the Intact Brain

Simply looking at the two hemispheres, so alike to *the naked eye*, who would suppose they contribute uniquely to *the harmony of the whole*? Myers points out that research with people with split-brains and people with intact brains shows that we have unified brains with specialized parts. Thus, if we observe the two hemispheres without optical aids (with *the naked eye*), they may seem to be the same; however, their differential functioning combines to produce an integrated unit *(the harmony of the whole)*.

Yet what is unknown still *dwarfs* what is known. This means that all that has been discovered so far about the brain is very, very small *(dwarfed)* compared with what yet remains to be discovered.