CHAPTER 2
LOOKING TO BRAIN RESEARCH FOR INSIGHTS

I consider that a man's brain originally is like a little empty attic, and you have to stock it with such furniture as you choose.

Sir Arthur Conan Doyle (1859-1930)

Introduction

As mentioned in the previous chapter, Eric Lenneberg's watershed 1967 study on the *Biological Foundations of Language* seemed, at first, to give a fatal blow to the hopes that the reformist paradigm had raised up till then, for the simple reason that it appeared to negate the possibility of SLA after the age of puberty. Lenneberg called the period before puberty the *critical* one for language acquisition. He developed this notion after reviewing an extensive corpus of aphasiology data—data on individuals who had suffered language impairments, called *aphasias*, caused by damage to specific language areas in their brains. From his review, Lenneberg noted a pattern. It was statistically more likely for those who incurred left hemisphere brain damage before puberty to have their native language taken over by the right hemisphere. In effect, most aphasics developed language before puberty, despite their early impairments. However, after puberty Lenneberg noted that aphasias tended to become permanent. By extrapolation, he concluded that in normal individuals the ability to acquire a new language after puberty diminished considerably. This had obvious negative implications for SLT. Simply put, if Lenneberg's CPH (Critical Period Hypothesis) were in fact true, then it would be a waste of time to continue tackling the SLT Dilemma through pedagogical means.

Shortly after Lenneberg's book came out, and gained widespread renown, SL teachers reacted swiftly and critically. Some suspected that Lenneberg had interpreted the aphasiology data in a biased manner, so as to lend support to the Chomskyan innatist view of language. They argued that factors other than biological ones were at work in language acquisition at all periods of life. Others decided to ignore the CPH completely, looking at the relevant brain research from an entirely different perspective—to extract insights that would purportedly help them solve the SLT Dilemma once and for all.

The latter reaction has, in my view, been the most productive one for SLT. Since the early 1970s, in fact, interest among SL educators in the brain sciences has increased considerably. The questions that this "neuroscientific trend" has raised generally for the study SLA, and the practical insights it has produced for SLT, will be discussed in this chapter. But before doing so, it is essential to provide a schematic outline of relevant brain physiology, as well as a brief historical survey of neuroscience, in order to establish a background to the discussion to follow in this and subsequent chapters.

The Brain

Knowing about basic brain functions and being able to name the various parts of the brain has no direct implications for SLT. Nevertheless, it is useful to have this kind of knowledge for two practical reasons: (1) the SLA literature has been employing neuroscientific terms and concepts increasingly since the early 1970s, and (2) all neuroscientific models and theories of SLT, such as the ones to be discussed in this book, utilize neuroscientific ideas to varying degrees. In a phrase, knowledge of the brain is fast becoming part of the "shop talk" that researchers and practitioners use to discuss SLA and SLT professionally.

The brain has three main sections: (1) the *cerebrum*, (2) the *cerebellum*, and (3) the *brain stem*. Each one consists chiefly of nerve cells, called *neurons*, and supporting cells, called *glia*. The hard, thick bones of the skull shield the brain from blows that could otherwise seriously injure it. In addition, three protective membranes, called *meninges*, cover the brain. The outermost membrane is the tough *dura mater*, which lines the inner surface of the skull. A thinner membrane, the *arachnoid*, lies just beneath the dura mater. The delicate *pia mater* directly covers the brain. It follows the folds of the brain's surface and contains blood vessels that carry blood to and from the cerebral cortex. A clear liquid, called *cerebrospinal fluid*, separates the pia mater and the arachnoid. This fluid forms a thin cushioning layer between the soft tissues of the brain and the hard bones of the skull.

The blood-brain barrier safeguards brain tissues from any damage that could result from contact with certain large molecules carried in the bloodstream. Substances in the blood reach body tissues by passing through the thin walls of tiny blood vessels called *capillaries*. Much of this flow occurs through the spaces between the cells that make up the capillary walls. The cells in brain capillaries are more tightly packed than they are in other capillaries, allowing them to restrict the passage of substances from the blood to the brain. The brain needs large molecules for nutrition, however. For this reason, the capillary walls have certain enzymes and other properties that enable such molecules to pass through.

Some reflex actions do not involve the brain. If someone touches a hot cup of coffee, for instance, pain impulses flash to that person's spinal cord, which immediately sends back a message to withdraw the hand. But the brain does play various roles in coordinating most other kinds of movements. For example, the *basal ganglia*, which are groups of brain cells that lie at the base of the cerebrum, help control habitualized movement sequences involved in such activities as walking and eating.

Individual brains can differ significantly, depending not only on genetics, but also on life experiences. The fingers activate the same general area of the cortex in everyone's brain. But this area is larger in people who use their fingers particularly often—for example, people who play musical instruments such as the piano or the violin, or people who read Braille (an alphabet of small raised dots developed for the blind). Neuroscientists have also found evidence that the brains of men and women differ. The *corpus callosum*—the thick band of nerve fibers connecting the cerebral hemispheres—is larger in women than it is in men. Careful examinations of brains after death have also shown that women have about 10 percent more neurons in the cortex than men. What such differences entail psychologically is not clear. In my view, culture and life experiences have more to do with psychological differences than does brain physiology.

The Cerebrum and the Cerebellum

The cerebrum makes up about 85 percent of the brain's weight. A large groove called the *longitudinal fissure* divides it into halves called the *left (cerebral) hemisphere* (LH) and the *right (cerebral) hemisphere* (RH). The hemispheres are connected by bundles of nerve fibers, the largest of which is the *corpus callosum.* Four *lobes* (regions) make up each hemisphere—each having the same name as the bone of the skull that lies above it. The lobes are: (1) the *frontal lobe* at the front; (2) the *temporal lobe* at the lower side; (3) the *parietal lobe* in the middle; and (4) the *occipital lobe* at the rear. Fissures in the cerebral cortex form the boundaries between the lobes. The two major fissures are the *central fissure* and the *lateral fissure.* Impulses from the eyes travel to the visual cortex in the occipital lobes. Portions of the temporal lobes receive messages from the ears. The area for taste lies buried in the lateral fissure, and the center of smell is on the underside of the frontal lobes.

A thin layer of nerve cell bodies makes up the *cerebral cortex,* which forms the outermost part of the cerebrum. It is also called the *neocortex,* since in evolutionary terms it is a later development than other brain structures. Most of the cerebrum beneath the cortex consists of nerve cell fibers. Some of these connect parts of the cortex; others link the cortex with the cerebellum, brain stem, and spinal cord. The cortex has many ridges and grooves, greatly increasing its surface area and the number of neurons it contains within the limited space of the skull. There is a *somatosensory* region in the cortex that receives messages from the sense organs as well as touch and temperature messages from the entire body. It lies in the parietal lobe of each hemisphere along the central fissure. Areas in the frontal lobes comprise a *motor* region. This sends out nerve impulses that control the voluntary movements of all the skeletal muscles. The motor cortex of the LH controls movements on the right side of the body, while the motor cortex of the RH directs movements on the left side of the body. More than 90 percent of human beings are right-handed because the left motor cortex, which directs the right hand, is dominant over the right motor cortex, which directs the left hand. The largest portion of the cortex is called the *association cortex.* This is involved in the analysis, processing, and storage of information, thus making possible all our higher mental abilities, such as thinking, speaking, and remembering. Below is a "map" of the cortex:

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