Brain Matters

Translating Research into Classroom Practice

2nd Edition

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Opening the Black Box of the Brain

Introduction

We've learned more about the brain and how it functions in the past three decades than in all of recorded history. What is largely responsible for this explosion of information? The answer lies primarily in improved technology. Many years ago, the only way brains could be studied was by the initially illegal method of autopsy. While studying the brain after death provided a fair amount of information—delineating the areas that allow us to produce and interpret speech, for example—it did little to increase our understanding of how information is processed and stored or why certain students have difficulty learning how to read. Today, imaging techniques allow us to look at the specific brain areas a person uses when recalling a noun versus a verb or when listening to music versus composing a song. We literally can look inside a brain and see which areas are most active while the person is engaged in various mental activities.

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The chronology of brain imaging includes many methodologies that, although older and more primitive, remain viable today. As mentioned, the first method was autopsy, which has been in use since the days of Leonardo da Vinci and is still useful. Scientists have learned a great deal about what causes Alzheimer's disease,

for example, by studying the brain tissue of those who died of the disease. Scientists have also learned much about the link between structure and function of the brain by studying people who have had brain injuries, strokes, or other traumas.

Animal studies have long been used to increase our understanding of how the brain works. This is possible because all mammalian brains function in a similar manner. Even though many of the methods used with animals cannot be applied to human subjects, we will see in later chapters that these studies often are useful to increase our understanding of human brain functioning.

Early Brain-Imaging Techniques

Today, the black box of the brain is beginning to share its secrets. With the advent of brain-imaging techniques, scientists no longer have to rely on autopsies or injuries to view the brain. Various new forms of technology have greatly increased scientists' ability to see—and sometimes change—what is happening inside the brain. The first of these technologies was developed in the 1800s, but the past 20 years have seen an amazing advance in the sophistication of ways to image the inner functioning of the human brain.

X-Rays

The journey to the present "electronic age" of imaging techniques began with the development of the X-ray, discovered in 1895. X-rays are high-frequency electromagnetic waves that easily penetrate nonmetallic objects. When they do, the atoms in the test object absorb some of the radiation, leaving the unabsorbed portion to strike and expose a photographic plate. The more dense objects show up lighter on the plate, while the less dense objects look darker. Although this process works well if we want to see whether a bone is broken (or what objects you are carrying in your luggage at the airport), it is of little use in depicting the brain and other parts of

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Long-Term Memory: The Brain's Storage System

You smell a particular antiseptic, and the memory of a hospital stay comes flooding into your consciousness, even though you haven't thought about that event for years. At a high school reunion, the sight of a former classmate who was in your chemistry class brings back a memory that you didn't know was there. At a party, people start singing songs from the 1970s, and you remember most of the words to songs you haven't sung for 30 years. You haven't ridden a bicycle for years, but when your nephew asks if you can ride, you climb on his new bicycle and show him how to perform a "wheelie." How did each of these things happen? You can thank your long-term memory for its ability to hold onto memories for decades in some cases. Without it, you would be unable to learn or profit from experience. Life would be a moment-to-moment occurrence, similar to that experienced by H. M., as described in Chapter 2.

Long-term memory, the last part of our information-processing model, is truly remarkable in what it allows us to recall. When we compare long-term memory to sensory or working memory (both of which are relatively short term), we find that the name is indeed appropriate. Information stored in long-term memory is relatively permanent but not always accurate. The capacity of our long-term memory is unknown, but it is considered to be extremely

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large—some estimates suggest that it contains a million billion connections. In this chapter, we will look at the processes that allow our brain to store and retrieve information over time and the factors that influence the strength of these memories. It is a fascinating journey into the unconscious depths of human memory and one that has powerful implications for teaching and learning.

Types of Memory Storage

Figure 10.1 shows several subheadings in the "long-term memory" box. Although we often think of memory as a single process, memory storage is actually more than one type of process. As early as 1911, the French philosopher Henri Bergson stated that our past survives

Figure 10.1
LONG-TERM MEMORY