Strategic Application of Human Development
Applying Positive Psychology

Cognitive Psychology

9.1 Cognitive Psychology Defined

Cognitive psychology is the study of how people perceive, learn, remember, and think about information. A cognitive psychologist might study how people perceive various shapes, why they remember some facts but forget others, or how they learn language. Consider some examples:

1. Why do objects look farther away on foggy days than they really are? The discrepancy can be dangerous, even deceiving drivers into having car accidents.
2. Why do many people remember a particular experience (e.g., a very happy moment or an embarrassment during childhood), yet they forget the names of people whom they have known for many years?
3. Why are many people more afraid of traveling in planes than in automobiles? After all, the chances of injury or death are much higher in an automobile than in a plane.
4. Why do you often well remember people you met in your childhood but not people you met a week ago?
5. Why do marketing executives in large companies spend so much company money on advertisements?

These are some of the kinds of questions that we can answer through the study of cognitive psychology.

Consider just the last of these questions: Why does Apple, for example, spend so much money on advertisements for its iPhone? After all, how many people remember the functional details of the iPhone, or how those functions are distinguished from the functions of other phones? One reason Apple spends so much is because of the availability heuristic. Using this heuristic, we make judgments on the basis of how easily we can call to mind what we perceive as relevant instances of a phenomenon (Tversky & Kahneman, 1973).

One such judgment is the question of which phone you should buy when you need a new cell phone. We are much more likely to buy a brand and model of a phone that is familiar. Similarly, Microsoft paid huge amounts of money to market its roll-out of Windows 7 in order to make the product cognitively available to potential customers and thus increase the chances that the potential customers would become actual ones. The bottom line is that understanding cognitive psychology can help us understand much of what goes on in our everyday lives.

Why study the history of cognitive psychology? If we know where we came from, we may have a better understanding of where we are heading. In addition, we can learn from past mistakes. For example, there are numerous newspaper stories about how one educational program or another has resulted in particular gains in student achievement. However, it is relatively rare to read that a control group has been used.

A control group would tell us about the achievement of students who did not have that educational program or who maybe were in an alternative program. It may be that these students also would show a gain. We need to compare the students in the experimental group to those in the control group to determine whether the gain of the students in the experimental group was greater than the gain of those in the control group. We can learn from the history of our field that it is important to include control groups, but not everyone learns this fact.

9.2 Dialectic of Human Behavior

In cognitive psychology, the ways of addressing fundamental issues have changed, but many of the fundamental questions remain much the same. Ultimately, cognitive psychologists hope to learn how people think by studying how people have thoughts about thinking. The progression of ideas often involves a dialectic. A dialectic is a developmental process where ideas evolve over time through a pattern of transformation. What is this pattern? In a dialectic:

a) A thesis is proposed. A thesis is a statement of belief. For example, some people believe that human nature governs many aspects of human behavior (e.g., intelligence or personality; Sternberg, 1999). After a while, however, certain individuals notice apparent flaws in the thesis.
b) An antithesis emerges. Eventually, or perhaps even quite soon, an antithesis emerges. An antithesis is a statement that counters a previous statement of belief. For example, an alternative view is that our nurture (the environmental contexts in which we are reared) almost entirely determines many aspects of human behavior.

c) A synthesis integrates the viewpoints. Sooner or later, the debate between the thesis and the antithesis leads to a synthesis. A synthesis integrates the most credible features of each of two (or more) views. For example, in the debate over nature versus nurture, the interaction between our innate (inborn) nature and environmental nurture may govern human nature.

The dialectic is important because we may be tempted to think that if one view is right, another seemingly contrasting view must be wrong. For example, in the field of intelligence, there has been a tendency to believe that intelligence is either all or mostly genetically determined, or else all or mostly environmentally determined.

A similar debate has raged in the field of language acquisition. Often, we are better off posing such issues not as either/or questions, but rather as examinations of how different forces covary and interact with each other. Indeed, the most widely accepted current contention is that the “nature or nurture” view is incomplete. Nature and nurture work together in our development.

Nurture can work in different ways in different cultures. Some cultures, especially Asian cultures, tend to be more dialectical in their thinking, whereas other cultures, such as European and North American ones, tend to be more linear (Nisbett, 2003). In other words, Asians are more likely to be tolerant of holding beliefs that are contradictory, seeking a synthesis over time that resolves the contradiction. Europeans and Americans expect their belief systems to be consistent with each other. Similarly, people from Asian cultures tend to take a different viewpoint than Westerners when approaching a new object (e.g., a movie of fish in an ocean; Nisbett & Masuda, 2003).

In general, people from Western cultures tend to process objects independently of the context, whereas people from many Eastern cultures process objects in conjunction with the surrounding context (Nisbett & Miyamoto, 2005). Asians may emphasize the context more than the objects embedded in those contexts. So if people see a movie of fish swimming around in the ocean, Europeans or Americans will tend to pay more attention to the fish, and Asians may attend to the surround of the ocean in which the fish are swimming.

The evidence suggests that culture influences many cognitive processes, including intelligence (Lehman, Chiu, & Schaller, 2004). If a synthesis seems to advance our understanding of a subject, it then serves as a new thesis. A new antithesis then follows it, then a new synthesis, and so on. Georg Hegel (1770–1831) observed this dialectical progression of ideas. He was a German philosopher who came to his ideas by his own dialectic. He synthesized some of the views of his intellectual predecessors and contemporaries. Psychologists had ideas about how the mind works and pursued their line of research; then other psychologists pointed out weaknesses and developed alternatives as a reaction to the earlier ideas. Eventually, characteristics of the different approaches are often integrated into a newer and more encompassing approach.

9.3 Cognitive Neuroscience

Our brains are a central processing unit for everything we do. But how do our brains relate to our bodies? Are they connected or separate? Do our brains define who we are? An ancient legend from India (Rosenzweig & Leiman, 1989) tells of Sita. She marries one man but is attracted to another. These two frustrated men behead themselves. Sita, bereft of them both, desperately prays to the goddess Kali to bring the men back to life.

Sita is granted her wish. She is allowed to reattach the heads to the bodies. In her rush to bring the two men back to life, Sita mistakenly switches their heads. She attaches them to the wrong bodies. Now, to whom is she married? Who is who? The mind–body issue has long interested philosophers and scientists. Where is the mind located in the body, if at all? How do the mind and body interact? How are we able to think, speak, plan, reason, learn, and remember? What are the physical bases for our cognitive abilities?

These questions all probe the relationship between cognitive psychology and neurobiology. Some cognitive psychologists seek to answer such questions by studying the biological bases of cognition. Cognitive psychologists are especially concerned with how the anatomy (physical structures of the body) and the physiology (functions and processes of the body) of the nervous system affect and are affected by human cognition.

Cognitive neuroscience is the field of study linking the brain and other aspects of the nervous system to cognitive processing and, ultimately, to behavior. The brain is the organ in our bodies that most directly controls our thoughts, emotions, and motivations (Gloor, 1997; Rockland, 2000; Shepherd, 1998). We usually think of the brain as being at the top of the body's hierarchy—as the boss, with various other organs responding to it. Like any good boss, however, it listens to and is influenced by its subordinates, the other organs of the body. Thus, the brain is reactive as well as directive.

A major goal of present research on the brain is to study localization of function. Localization of function refers to the specific areas of the brain that control specific skills or behaviors. Facts about particular brain areas and their function are interspersed throughout this chapter and also throughout the whole book. Our exploration of the brain starts with the anatomy of the brain. We will look at the gross anatomy of the brain as well as at neurons and the ways in which information is transmitted in the brain. Then we will explore the methods scientists use to examine the brain, its structures, and functions. And finally, we will learn about brain disorders and how they inform cognitive psychology.

9.4 Cognition in the Brain: The Anatomy and Mechanisms of the Brain

The nervous system is the basis for our ability to perceive, adapt to, and interact with the world around us (Gazzaniga, 1995, 2000; Gazzaniga, Ivry, & Mangun, 1998). Through this system we receive, process, and then respond to information from the environment (Pinker, 1997a; Rugg, 1997). In the following section, we will focus on the supreme organ of the nervous system—the brain—paying special attention to the cerebral cortex, which controls many of our thought processes. In a later section, we consider the basic building block of the nervous system—the neuron.

We will examine in detail how information moves through the nervous system at the cellular level. Then we will consider the various levels of organization within the nervous system and how drugs interact with the nervous system. For now, let’s look at the structure of the brain.

9.5 Gross Anatomy of the Brain: Forebrain, Midbrain, Hindbrain

What have scientists discovered about the human brain? The brain has three major regions: forebrain, midbrain, and hindbrain. These labels do not correspond exactly to locations of regions in an adult or even a child’s head. Rather, the terms come from the front-to-back physical arrangement of these parts in the nervous system of a developing embryo. Initially, the forebrain is generally the farthest forward, toward what becomes the face. The midbrain is next in line. And the hindbrain is generally farthest from the forebrain, near the back of the neck.

In development, the relative orientations change so that the forebrain is almost a cap on top of the midbrain and hindbrain. Nonetheless, the terms still are used to designate areas of the fully developed brain.

9.6 The Forebrain

The forebrain is the region of the brain located toward the top and front of the brain. It comprises the cerebral cortex, the basal ganglia, the limbic system, the thalamus, and the hypothalamus. The cerebral cortex is the outer layer of the cerebral hemispheres. It plays a vital role in our thinking and other mental processes. It therefore merits a special section in this chapter, which follows the present discussion of the major structures and functions of the brain.

The basal ganglia (singular: ganglion) are collections of neurons crucial to motor function. Dysfunction of the basal ganglia can result in motor deficits. These deficits include tremors, involuntary movements, changes in posture and muscle tone, and slowness of movement. Deficits are observed in Parkinson’s disease and Huntington’s disease. Both these diseases entail severe motor symptoms (Rockland, 2000; Lerner & Riley, 2008; Lewis & Barker, 2009).

The limbic system is important to emotion, motivation, memory, and learning. Animals such as fish and reptiles, which have relatively undeveloped limbic systems, respond to the environment almost exclusively by instinct. Mammals and especially humans have relatively more developed limbic systems. Our limbic system allows us to suppress instinctive responses (e.g., the impulse to strike someone who accidentally causes us pain). Our limbic systems help us to adapt our behaviors flexibly in response to our changing environment. The limbic system comprises three central interconnected cerebral structures:

1) The Septum
2) The Amygdala
3) Hippocampus

The septum is involved in anger and fear. The amygdala plays an important role in emotion as well, especially in anger and aggression (Adolphs, 2003; Derntl et al., 2009). Stimulation of the amygdala commonly results in fear. It can be evidenced in various ways, such as through palpitations, fearful hallucinations, or frightening flashbacks in memory (Engin & Treit, 2008; Gloor, 1997; Rockland, 2000).

Damage to (lesions in) or removal of the amygdala can result in maladaptive lack of fear. In the case of lesions to the animal brain, the animal approaches potentially dangerous objects without hesitation or fear (Adolphs et al., 1994). The amygdala also has an enhancing effect for the perception of emotional stimuli. In humans, lesions to the amygdala prevent this enhancement. Additionally, persons with autism display limited activation in the amygdala. A well-known theory of autism suggests that the disorder involves dysfunction of the amygdala, which leads to the social impairment that is typical of persons with autism, for example, difficulties in evaluating people's trustworthiness or recognizing emotions in faces two other effects of lesions to the amygdala can be visual agnosia (inability to recognize objects) and hypersexuality (Steffanaci, 1999).

The hippocampus plays an essential role in memory formation. It gets its name from the Greek word for "seahorse," its approximate shape. The hippocampus is essential for flexible learning and for seeing the relations among items learned as well as for spatial memory (Eichenbaum, 1997; Squire, 1992). The hippocampus also appears to keep track of where things are and how these things are spatially related to each other.

People who have suffered damage to or removal of the hippocampus still can recall existing memories—for example, they can recognize old friends and places—but they are unable to form new memories (relative to the time of the brain damage). New information—new situations, people, and places—remain forever new. A disease that produces loss of memory function is Korsakoff's syndrome. Other symptoms include apathy, paralysis of muscles controlling the eye, and tremor.

This loss is believed to be associated with deterioration of the hippocampus and is caused by a lack of thiamine (Vitamin B-1) in the brain. The syndrome can result from excessive alcohol use, dietary deficiencies, or eating disorders. There is a renowned case of a patient known as H.M., who after brain surgery retained his memory for events that transpired before the surgery but had no memory for events after the surgery. This case is another illustration of the resulting problems with memory formation due to hippocampus damage.

9.7 The Midbrain

The midbrain helps to control eye movement and coordination. The midbrain is more important in non-mammals where it is the main source of control for visual and auditory information. In mammals these functions are dominated by the forebrain.

By far the most indispensable of these structures is the ***reticular activating system*** (RAS; also called the "reticular formation"), a network of neurons essential to the regulation of consciousness (sleep; wakefulness; arousal; attention to some extent; and vital functions such as heartbeat and breathing; Sarter, Bruno, & Berntson, 2003).

The RAS also extends into the hindbrain. Both the RAS and the thalamus are essential to our having any conscious awareness of or control over our existence. The brainstem connects the forebrain to the spinal cord. It comprises the hypothalamus, the thalamus, the midbrain, and the hindbrain. A structure called the periaqueductal gray (PAG) is in the brainstem. This region seems to be essential for certain kinds of adaptive behaviors. Injections of small amounts of excitatory amino acids or, alternatively, electrical stimulation of this area results in any of several responses: ***an aggressive, confrontational response; avoidance or flight response; heightened defensive reactivity; or reduced reactivity as is experienced after a defeat,*** when one feels hopeless (Bandler & Shipley, 1994; Rockland, 2000).

Physicians make a determination of brain death based on the function of the brainstem. Specifically, a physician must determine that the brainstem has been damaged so severely that various reflexes of the head (e.g., the pupillary reflex) are absent for more than 12 hours, or the brain must show no electrical activity or cerebral circulation of blood (Berkow, 1992).

9.8 The Hindbrain

The hindbrain comprises the medulla oblongata, the pons, and the cerebellum. The medulla oblongata controls heart activity and largely controls breathing, swallowing, and digestion. The medulla is also the place at which nerves from the right side of the body cross over to the left side of the brain and nerves from the left side of the body cross over to the right side of the brain. The ***medulla oblongata is an elongated interior structure located at the point where the spinal cord enters the skull and joins with the brain. The medulla oblongata, which contains part of the*** RAS, helps to keep us alive.

The pons serves as a kind of relay station because it contains neural fibers that pass signals from one part of the brain to another. Its name derives from the Latin for “bridge,” as it serves a bridging function. The pons also contains a portion of the RAS and nerves serving parts of the head and face. The cerebellum (from Latin, “little brain”) controls bodily coordination, balance, and muscle tone, as well as some aspects of memory involving procedure-related movements. (Middleton & Helms Tillery, 2003).

The prenatal development of the human brain within each individual roughly corresponds to the evolutionary development of the human brain within the species as a whole. Specifically, the hindbrain is evolutionarily the oldest and most rimitive part of the brain. It also is the first part of the brain to develop prenatally.

The midbrain is a relatively newer addition to the brain in evolutionary terms. It is the next part of the brain to develop prenatally. Finally, the forebrain is the most recent evolutionary addition to the brain. It is the last of the three portions of the brain to develop prenatally.

Additionally, across the evolutionary development of our species, humans have shown an increasingly greater proportion of brain weight in relation to body weight. However, across the span of development after birth, the proportion of brain weight to body weight declines. For cognitive psychologists, the most important of these evolutionary trends is the increasing neural complexity of the brain. The evolution of the human brain has offered us the enhanced ability to exercise voluntary control over behavior. It has also strengthened our ability to plan and to contemplate alternative courses of action. These ideas are discussed in the next section with respect to the cerebral cortex.

9.9 Cerebral Cortex and Localization of Function

The cerebral cortex plays an extremely important role in human cognition. It forms a 1- to 3-millimeter layer that wraps the surface of the brain somewhat like the bark of a tree wraps around the trunk. In human beings, the many convolutions, or creases, of the cerebral cortex comprise three elements. Sulci (singular, sulcus) are small grooves. Fissures are large grooves. And gyri (singular, gyrus) are bulges between adjacent sulci or fissures. These folds greatly increase the surface area of the cortex. If the wrinkly human cortex were smoothed out, it would take up about 2 square feet. The cortex comprises 80% of the human brain (Kolb & Whishaw, 1990).

The volume of the human skull has more than doubled over the past 2 million years, allowing for the expansion of the brain, and especially the cortex (Toro et al., 2008). The complexity of brain function increases with the cortical area. The human cerebral cortex enables us to think. Because of it, we can plan, coordinate thoughts and actions, perceive visual and sound patterns, and use language. Without it, we would not be human. The surface of the cerebral cortex is grayish. It is sometimes referred to as gray matter. This is because it primarily comprises the grayish neural-cell bodies that process the information that the brain receives and sends. In contrast, the underlying white matter of the brain’s interior comprises mostly white, myelinated axons.

The cerebral cortex forms the outer layer of the two halves of the brain—the left and right cerebral hemispheres (Davidson & Hugdahl, 1995; Galaburda & Rosen, 2003; Gazzaniga & Hutsler, 1999; Levy, 2000). Although the two hemispheres appear to be quite similar, they function differently. The left cerebral hemisphere is specialized for some kinds of activity whereas the right cerebral hemisphere is specialized for other kinds. For example, receptors in the skin on the right side of the body generally send information through the medulla to areas in the left hemisphere in the brain. The receptors on the left side generally transmit information to the right hemisphere. Similarly, the left hemisphere of the brain directs the motor responses on the right side of the body. The right hemisphere directs responses on the left side of the body.

However, not all information transmission is contralateral—from one side to another (contra-, "opposite"; lateral, "side"). Some ipsilateral transmission—on the same side—occurs as well. For example, odor information from the right nostril goes primarily to the right side of the brain. About half the information from the right eye goes to the right side of the brain, the other half goes to the left side of the brain. In addition to this general tendency for contralateral specialization, the hemispheres also communicate directly with one another.

The corpus callosum is a dense aggregate of neural fibers connecting the two cerebral hemispheres (Witelson, Kigar, & Walter, 2003). It allows transmission of information back and forth. Once information has reached one hemisphere, the corpus callosum transfers it to the other hemisphere. If the corpus callosum is cut, the two cerebral hemispheres—the two halves of the brain—cannot communicate with each other (Glickstein & Berlucchi, 2008). Although some functioning, like language, is highly lateralized, most functioning—even language—depends in large part on integration of the two hemispheres of the brain.