Chapter III: Human Perception

1. Definition

Perception is the set of processes by which we recognize, organize, and make sense of stimuli in our environment. The central problem of perception is explaining how we attach meaning to the sensory information we receive? And how we manage to accomplish these feats so rapidly and (usually) without error?

The vast topic of perception can be subdivided into **visual perception, auditory perception, olfactory perception, haptic (touch) perception, and gustatory (taste) perception**. We will concentrate on visual and auditory perception because those two are the kinds of perception psychologists study most.

For the present, we will adopt what might be called the "classic" approach to defining perception. Figure (1) illustrates this approach for visual perception. Out in the real world are objects and events—things to be perceived—such as this book or, trees and shrubs. Each such object is **a distal stimulus.** For a living organism to process information about these stimuli, it must first receive the information through one or more sensory systems—in this example, the visual system. The reception of information and its registration by a sense organ make up **the proximal stimulus**. In our earlier example, light waves reflect from the trees to your eyes, in particular to a surface at the back of each eye known as the retina. There, an image of the trees, called *the retinal image*, is formed. This image is two-dimensional, and its size depends on your distance from the window and the objects beyond (the closer you are, the larger the image). In addition, the image is upside down and is reversed with respect to left and right.

The meaningful interpretation of the proximal stimulus is **the percept**—your interpretation that the stimuli are trees, cars, people, and so forth. From the upside-down, backward, two-dimensional image, you quickly (almost instantaneously) "see" a set of objects you recognize.

Related to perception is a process called **pattern recognition**. This is the recognition of a particular object, event, and so on, as belonging to a class of objects, events, and so on.

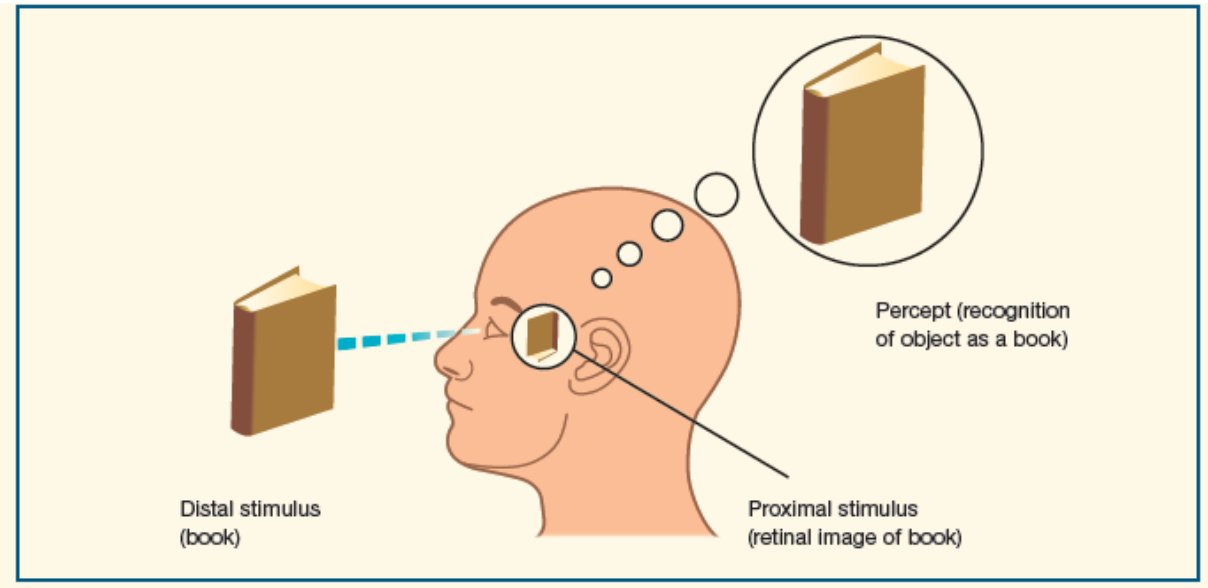

Figure (1): Visual perception (Sternberg, 1998)

2. Approaches to Perception

There are different views on how we perceive the world. These views can be summarized as bottom-up theories and top-down theories. Top-down and bottom-up approaches have been applied to virtually every aspect of cognition. Bottom-up and top-down approaches usually are presented as being in opposition to each other. But to some extent, they deal with different aspects of the same phenomenon. Ultimately, a complete theory of perception will need to encompass both bottom-up and top-down processes.

BOTTOM-UP PROCESSES

The term *bottom-up* (or *data-driven*) essentially means that the perceiver starts with small bits of information from the environment and combines them in various ways to form a percept (Gibson, 1979). The idea here is that the system works in one direction, starting from the input and proceeding to a final interpretation. In this section, four distinct examples of bottom-up models of perception will be illustrated: direct perception, template theories, feature theories, and recognition-by-components theory.

1) **Direct perception:** According to Gibson's theory of direct perception, the information in our sensory receptors, including the sensory context, is all we need to perceive anything. As the environment supplies us with all the information we need for perception, this view is sometimes also called ecological perception.

2) **Template matching:** It holds that patterns are recognized when perceivers match them to stored mental representations (Selfridge & Neisser,1960). In other words, Template theories suggest that we have stored in our minds myriad sets of templates. Templates are highly detailed models for patterns we potentially might recognize. We recognize a pattern by comparing it with our set of templates. We then choose the exact template that perfectly matches what we observe (Selfridge & Neisser, 1960). We see examples of template matching in our everyday lives. Fingerprints are matched in this way.
3) **Feature-Matching Theories:** Yet another alternative explanation of pattern and form perception may be found in feature-matching theories. According to these theories, we attempt to match features of a pattern to features stored in memory, rather than to match a whole pattern to a template or a prototype (Stankiewicz, 2003).
4) **Recognition-by-Components Theory:** it is about how do we form stable 3-D mental representations of objects? The recognition by-components theory explains our ability to perceive 3-D objects with the help of simple geometric shapes. Irving Biederman (1987) suggested that we achieve this by manipulating a number of simple 3-D geometric shapes called geons (for geometrical ions). They include objects such as bricks, cylinders, wedges, cones, and their curved axis counterparts. Biederman's RBC theory explains how we may recognize general instances of chairs, lamps, and faces, but it does not adequately explain how we recognize particular chairs or particular faces. Another problem with Biederman's approach, and the bottom-up approach in general, is how to account for the effects of prior expectations and environmental context on some phenomena of pattern perception.

TOP- DOWN PROCESSES

In contrast to the bottom-up approach to perception is the top-down, constructive approach (Bruner, 1957; Gregory, 1980). In constructive perception, the perceiver builds (constructs) a cognitive understanding (perception) of a stimulus. The concepts of the perceiver and his or her cognitive processes influence what he or she sees.

Top-down, or conceptually driven, processes are directed by expectations derived from context or past learning or both. All bottom-up models share a number of problems in explaining how viewers "make meaning"

of the stimuli they perceive. Top-down, or conceptually driven, processes are those directed by expectations derived from context or past learning or both.

According to constructivists, during perception we quickly form and test various hypotheses regarding percepts. The percepts are based on three things:

- What we sense (the sensory data),
- What we know (knowledge stored in memory), and
- What we can infer (using high-level cognitive processes).

According to constructivists, we usually make the correct attributions regarding our visual sensations. The reason is that we perform unconscious inference, the process by which we unconsciously assimilate information from a number of sources to create a perception (Snow & Mattingley, 2003). In other words, using more than one source of information, we make judgments that we are not even aware of making.

Perception of Objects and Forms

There are two common positions regarding the perception of objects and forms.

Viewer-centered representation

In this representation, the individual stores the way the object looks to him or her. Thus, what matters is the appearance of the object to the viewer, not the actual structure of the object. The shape of the object changes, depending on the angle from which we look at it. A number of views of the object are stored, and when we try to recognize an object, we have to rotate that object in our mind until it fits one of the stored images.

Object-centered representation

In this representation, the individual stores a representation of the object, independent of its appearance to the viewer. In this case, the shape of the object will stay stable across different orientations (McMullen & Farah, 1991). This stability can be achieved by means of establishing the major and minor axes of the object, which then serve as a basis for defining further properties of the object.

The Perception of Groups—Gestalt Laws

When stimuli occur close to one another in space and in time, they may group perceptually into coherent, salient patterns or wholes. Such Gestalts, as they are called, abound in our perceptual world, as when leaves and branches cluster into trees, and when trees merge into forests; when eyes, ears, noses and mouths configure into faces; when musical notes coalesce into chords and melodies; and when countless dots or pixels blend into a photograph.

Gestalt principles of perceptual organization

1) ***The principle of proximity,*** **or nearness:** Look at Figure 2.(A). Notice that you tend to perceive this as a set of rows rather than as a set of columns. This is because the elements within rows are closer than the elements within columns. Following the principle of proximity, we group together things that are nearer to each other.
2) **The *principle of similarity:*** Grouping together those elements that are similar. Notice that you perceive this display as formed in columns (rather than rows) .2(B).
3) **The *principle of good continuation***, depicted in Figure 2. (C), states that we group together objects whose contours form a continuous straight or curved line. Thus we typically perceive Figure2.(C) as two intersecting curved lines and not as other logically possible elements, such as those shown in Figure 2.(D).
4) **The *principle of closure***, when we look at subjective contour, Figure 2. (E) illustrates this principle more exactly. Note that we perceive this display as a rectangle, mentally filling in the gap to see a closed, complete, whole figure.
5) **The *principle of common fate***, is difficult to illustrate in a static drawing. The idea is that elements that move together will be grouped together, as depicted in Figure 2. (F)

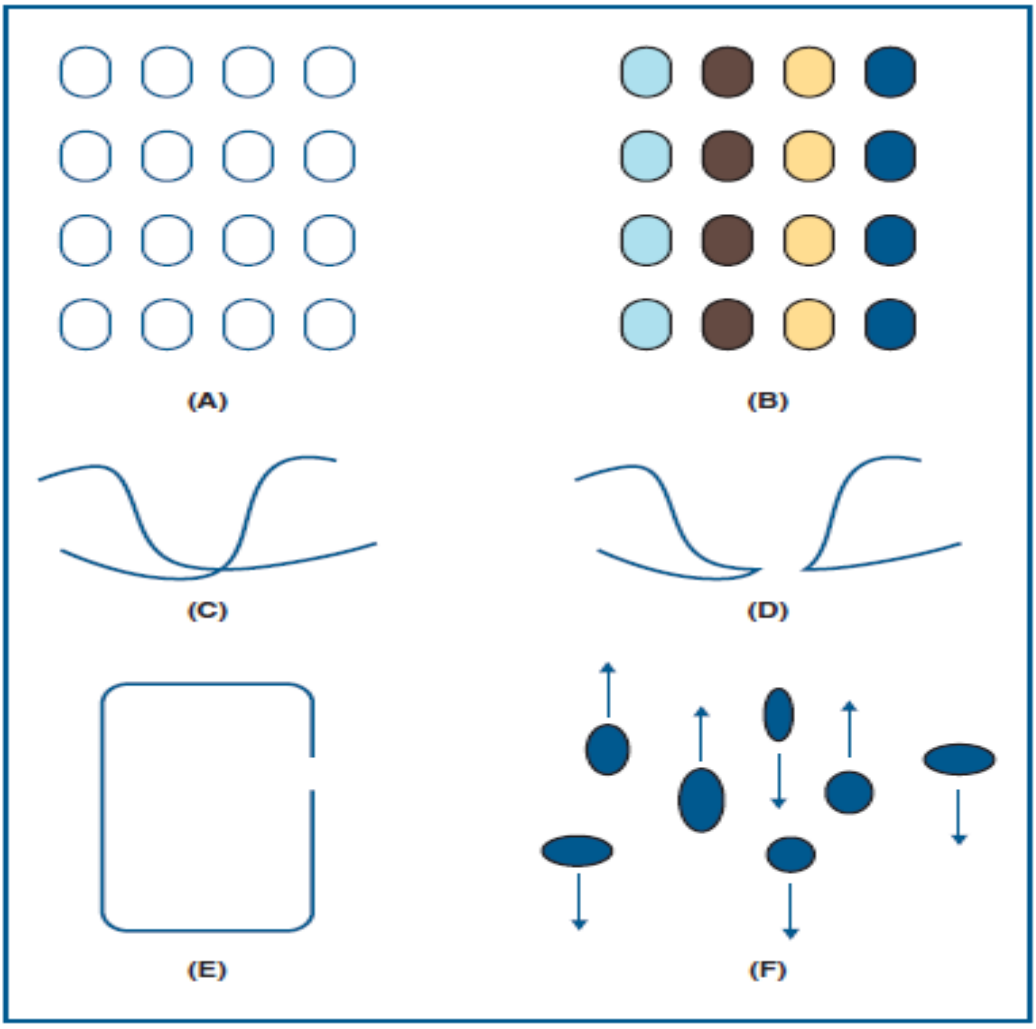

Figure 2: Gestalt principles of perceptual organization: (A) the principle of proximity; (B) the principle of similarity; (C) and (D) the principle of good continuation; (E) the principle of closure; and (F) the principle of common fate (Sternberg, 1998)

The Gestalt principles provide valuable descriptive insights into form and pattern perception. But they offer few or no explanations of these phenomena. To understand how or why we perceive forms and patterns, we need to consider explanatory theories of perception.

Perception deficits

Cognitive psychologists learn a great deal about normal perceptual processes by studying perception in normal participants. However, they also often gain understanding of perception by studying people whose perceptual processes differ from the norm (Farah, 1990).

What happens when people with normal visual sensations cannot perceive visual stimuli? **Agnosias**, which are usually associated with brain lesions, are deficits of form and pattern perception. They cause afflicted people to be insufficiently able to recognize objects that are in their visual fields, despite normal sensory abilities. People who suffer from **visual-object agnosia** can sense all parts of the visual field. But the objects they see do not mean anything to them. Individuals with **simultagnosia** are unable to pay attention to more than one object at a time. People with **spatial agnosia** have severe difficulty in comprehending and handling the relationship between their bodies and the spatial configurations of the world around them. People with **prosopagnosia** have severe impairment in their ability to recognize human faces, including their own. **Color blindness** is another type of perceptual deficit.