Course Material (E-Content) of Psychology

By – Dr. KHURSHID JAHAN

Deptt.of Psychology

MagadhMahila College

Top-down and Bottom-up approach of information processing

Psychologists often distinguish between top-down and bottom-up approaches to information-processing. In top-down approaches, knowledge or expectations are used to guide processing. Bottom-up approaches, however, are more like the structuralist approach, piecing together data until a bigger picture is arrived at. One of the strongest advocates of a bottom-up approach was J.J. Gibson (1904-1980), who articulated a theory of direct perception. This stated that the real world provided sufficient contextual information for our visual systems to directly perceive what was there, unmediated by the influence of higher cognitive processes. Gibson developed the notion of affordances, referring to those aspects of objects or environments that allow an individual to perform an action. Gibson's emphasis on the match between individual and environment led him to refer to his approach as ecological. Most psychologists now would argue that both bottom-up and top-down processes are involved in perception.

Top-down processing

Top-down processing refers to the use of background information in pattern recognition. It always begins with a person's previous knowledge, and makes predictions due to this already acquired knowledge. Psychologist Richard Gregory estimated that about 90% of the information is lost between the time it takes to go from the eye to the brain, which is why the brain must guess what the person sees based on past experiences. In other words, we construct our perception of reality, and these perceptions are hypotheses or propositions based on past experiences and stored information. The formation of incorrect propositions will lead to errors of perception such as visual illusions. Given a paragraph written with difficult handwriting, it is easier to understand what the writer wants to convey if one reads the whole paragraph rather than reading the

words in separate terms. The brain may be able to perceive and understand the gist of the paragraph due to the context supplied by the surrounding words.

Bottom-up processing

Bottom-up processing is also known as data-driven processing, because it originates with the stimulation of the sensory receptors. Psychologist James Gibson opposed the top-down model and argued that perception is direct, and not subject to hypothesis testing as Gregory proposed. He stated that sensation is perception and there is no need for extra interpretation, as there is enough information in our environment to make sense of the world in a direct way. His theory is sometimes known as the "ecological theory" because of the claim that perception can be explained solely in terms of the environment. An example of bottom up-processing involves presenting a flower at the center of a person's field. The sight of the flower and all the information about the stimulus are carried from the retina to the visual cortex in the brain. The signal travels in one direction.

Bottom-up theories

1.Template matching

Template matching theory describes the most basic approach to human pattern recognition. It is a theory that assumes every perceived object is stored as a "template" into long-term memory. Incoming information is compared to these templates to find an exact match. In other words, all sensory input is compared to multiple representations of an object to form one single conceptual understanding. The theory defines perception as a fundamentally recognition-based process. It assumes that everything we see, we understand only through past exposure, which then informs our future perception of the external world. For example, A, **A**, and *A* are all recognized as the letter A, but not B. This viewpoint is limited, however, in explaining how new experiences can be understood without being compared to an internal memory template.

2. Prototype matching

Unlike the exact, one-to-one, template matching theory, prototype matching instead compares incoming sensory input to one average prototype. This theory proposes that exposure to a series of related stimuli leads to the creation of a "typical" prototype based on their shared features. It reduces the number of stored templates by standardizing them into a single representation. The prototype supports perceptual flexibility, because unlike in template matching, it allows for variability in the recognition of novel stimuli. For instance, if a child had never seen a lawn chair before, they would still be able to recognize it as a chair because of their understanding of its essential characteristics as having four legs and a seat. This idea, however, limits the conceptualization of

objects that cannot necessarily be "averaged" into one, like types of canines, for instance. Even though dogs, wolves, and foxes are all typically furry, four-

legged, moderately sized animals with ears and a tail, they are not all the same, and thus cannot be strictly perceived with respect to the prototype matching theory.

3. Feature analysis

Multiple theories try to explain how humans are able to recognize patterns in their environment. Feature detection theory proposes that the nervous system sorts and filters incoming stimuli to allow the human (or animal) to make sense of the information. In the organism, this system is made up of feature detectors, which are individual neurons, or groups of neurons, that encode specific perceptual features. The theory proposes an increasing complexity in the relationship between detectors and the perceptual feature. The most basic feature detectors respond to simple properties of the stimuli. Further along the

perceptual pathway, higher organized feature detectors are able to respond to more complex and specific stimuli properties. When features repeat or occur in a meaningful sequence, we are able to identify these patterns because of our feature detection system.

One source of evidence for feature matching comes from Hubel and Wiesel's research, which found that the visual cortex of cats contains neurons that only respond to specific features (e.g. one type of neuron might fire when a vertical line is presented, another type of neuron might fire if a horizontal line moving in a particular direction is shown).

4. Recognition by components theory

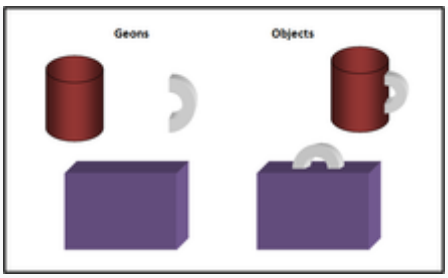

Image showing the breakdown of common geometric shapes (geons)

Similar to feature detection theory, recognition by components (RBC) focuses on the bottom-up features of the stimuli being processed. First proposed by Irving Biederman (1987), this theory states that humans recognize objects by breaking them down into their basic 3D geometric shapes called geons (i.e.

cylinders, cubes, cones, etc.). An example is how we break down a common item like a coffee cup: we recognize the hollow cylinder that holds the liquid

and a curved handle off the side that allows us to hold it. Even though not every coffee cup is exactly the same, these basic components helps us to recognize the consistency across examples (or pattern). RBC suggests that there are fewer than 36 unique geons that when combined can form a virtually unlimited number of objects. To parse and dissect an object, RBC proposes we attend to two specific features: edges and concavities. Edges enable the observer to maintain a consistent representation of the object regardless of the viewing angle and lighting conditions. Concavities are where two edges meet and enable the observer to perceive where one geon ends and another begins.

The RBC principles of visual object recognition can be applied to auditory language recognition as well. In place of geons, language researchers propose that spoken language can be broken down into basic components called phonemes. For example, there are 44 phonemes in the English language.