BASICS OF PERCEPTION AND AWARENESS

Sensation and perception are two separate processes that are very closely related. Sensation is input about the physical world obtained by our sensory receptors, and perception is the process by which the brain selects, organizes, and interprets these sensations. In other words, senses are the physiological basis of perception. Perception of the same senses may vary from one person to another because each person's brain interprets stimuli differently based on that individual's learning, memory, emotions, and
expectations.

Sensation

What does it mean to sense something? Sensory receptors are specialized neurons that respond to specific types of stimuli. When sensory information is detected by a sensory receptor, **sensation** has occurred. For example, light that enters the eye causes chemical changes in cells that line the back of the eye. These cells relay messages, in the form of action potentials (as you learned when studying biopsychology), to the central nervous system. The conversion from sensory stimulus energy to action potential is known as **transduction**.

You have probably known since elementary school that we have five senses: vision, hearing (audition), smell (olfaction), taste (gustation), and touch (somatosensation). It turns out that this notion of five senses is oversimplified. We also have sensory systems that provide information about balance (the vestibular sense), body position and movement (proprioception and kinesthesia), pain (nociception), and temperature (thermoception).

The sensitivity of a given sensory system to the relevant stimuli can be expressed as an absolute threshold. **Absolute threshold** refers to the minimum amount of stimulus energy that must be present for the stimulus to be detected 50% of the time. Another way to think about this is by asking how dim can a light be or how soft can a sound be and still be detected half of the time. The sensitivity of our sensory receptors can be quite amazing. It has been estimated that on a clear night, the most sensitive sensory cells in the back of the eye can detect a candle flame 30 miles away (Okawa & Sampath, 2007). Under quiet conditions, the hair cells (the receptor cells of the inner ear) can detect the tick of a clock 20 feet away (Galanter, 1962).

It is also possible for us to get messages that are presented below the threshold for conscious awareness—these are called **subliminal messages**. A stimulus reaches a physiological threshold when it is strong enough to excite sensory receptors and send nerve impulses to the brain: this is an absolute threshold. A message below that threshold is said to be subliminal: we receive it, but we are not consciously aware of it. Therefore, the message is sensed, but for whatever reason, it has not been selected for processing in working or short-

term memory. Over the years there has been a great deal of speculation about the use of subliminal messages in advertising, rock music, and self-help audio programs.

Absolute thresholds are generally measured under incredibly controlled conditions in situations that are optimal for sensitivity. Sometimes, we are more interested in how much difference in stimuli is required to detect a difference between them. This is known as the **just noticeable difference (jnd)** or **difference threshold**. Unlike the absolute threshold, the difference threshold changes depending on the stimulus intensity. As an example, imagine yourself in a very dark movie theater. If an audience member were to receive a text message on her cell phone which caused her screen to light up, chances are that many people would notice the change in illumination in the theater. However, if the same thing happened in a brightly lit arena during a basketball game, very few people would notice. The cell phone brightness does not change, but its ability to be detected as a change in illumination varies dramatically between the two contexts. Ernst Weber proposed this theory of change in difference threshold in the 1830s, and it has become known as **Weber's law**: The difference threshold is a constant fraction of the original stimulus, as the example illustrates. It is the idea that bigger stimuli require larger differences to be noticed. For example, it will be much harder for your friend to reliably tell the difference between 10 and 11 lbs. (or 5 versus 5.5 kg) than it is for 1 and 2 lbs.

Perception

While our sensory receptors are constantly collecting information from the environment, it is ultimately how we interpret that information that affects how we interact with the world. **Perception** refers to the way sensory information is organized, interpreted, and consciously experienced. Perception involves both bottom-up and top-down processing. **Bottom-up processing** refers to the fact that perceptions are built from sensory input. On the other hand, how we interpret those sensations is influenced by our available knowledge, our experiences, and our thoughts. This is called **top-down processing**.

One way to think of this concept is that sensation is a physical process, whereas perception is psychological. For example, upon walking into a kitchen and smelling the scent of baking cinnamon rolls, the *sensation* is the scent receptors detecting the odor of cinnamon, but the *perception* may be "Mmm, this smells like the bread Grandma used to bake when the family gathered for holidays."

Although our perceptions are built from sensations, not all sensations result in perception. In fact, we often don't perceive stimuli that remain relatively constant over prolonged periods of time. This is known as **sensory adaptation**. Imagine entering a classroom

with an old analog clock. Upon first entering the room, you can hear the ticking of the clock; as you begin to engage in conversation with classmates or listen to your professor greet the class, you are no longer aware of the ticking. The clock is still ticking, and that information is still affecting sensory receptors of the auditory system. The fact that you no longer perceive the sound demonstrates sensory adaptation and shows that while closely associated, sensation and perception are different.

BASIC ISSUES IN PERCEPTION

The central problem in the epistemology of perception is that of explaining how perception could give us knowledge or justified belief about an external world, about things outside of ourselves. This problem has traditionally been viewed in terms of a skeptical argument that purports to show that such knowledge and justification are impossible. Skepticism about the external world highlights a number of epistemological difficulties regarding the nature and epistemic role of experience, and the question of how perception might bring us into contact with a mind-independent reality. The issues that arise are of central importance for understanding knowledge and justification more generally, even aside from their connection to skepticism.

Two main types of response to the skeptical argument have traditionally been given: a metaphysical response that focuses on the nature of the world, perceptual experience, and/or the relation between them, in an effort to show that perceptual knowledge is indeed possible; and a more directly epistemological response that focuses on principles specifying what is required for knowledge and/or justification, in an effort to show that skepticism misstates the requirements for knowledge.

Much of the philosophical tradition has viewed the central epistemological problems concerning perception largely and sometimes exclusively in terms of the metaphysical responses to skepticism. For that reason, these will be addressed before moving on to the more explicitly epistemological concerns.

The Problem of the External World

The question of *how* our perceptual beliefs are justified or known can be approached by first considering the question of *whether* they are justified or known. A prominent skeptical argument is designed to show that our perceptual beliefs are not justified. Versions of this argument (or cluster of arguments) appear in René Descartes's *Meditations*, Augustine's *Against the Academicians*, and several of the ancient and modern skeptics (e.g., Sextus Empiricus, Michel de Montaigne). The argument introduces some type of skeptical scenario, in which things perceptually appear to us just as things normally do, but in which the

beliefs that we would naturally form are radically false. To take some standard examples: differences in the sense organs and/or situation of the perceiver might make her experience as cold things that we would experience as hot, or experience as bitter things that we would experience as sweet; a person might mistake a vivid dream for waking life; or a brain in a vat might have its sensory cortices stimulated in such a way that it has the very same perceptual experiences that I am currently having, etc.

It is usually not specified how one gets from here to the conclusion that our perceptual beliefs are unjustified. I offer one possible reconstruction of the skeptical argument, one which helps to illustrate the central problems in the epistemology of perception.

The skeptical scenarios (dreaming, brains in vats, differently situated sense organs, etc.) call our attention to a crucial distinction between appearance and reality: how things perceptually appear is not necessarily how things really are; things could appear the same though really be different, and they could appear to be some other, incompatible way and really be the same. Further reflection on the scenarios suggests that although I might know very little—perhaps nothing—about how things are in the external world, I can nevertheless know quite a lot about how it appears to me that things are. This engenders a shift from thinking about perceptual appearances as features of objects (e.g., "the appearance of the house was quite shabby"), to thinking of them as mental states—experiences—of the perceiving subject (e.g., "she had a visual appearance/experience as of a house"). Finally, it seems that if we are to know anything about the external world at all, that knowledge must be indirect, for what is directly before me is not the world itself, but only these perceptual appearances. I know and have justified beliefs about the external world only insofar as I know and have justified beliefs about appearances.

All this suggests a "veil of perception" between us and external objects: we do not have direct unvarnished access to the world, but instead have an access that is mediated by sensory appearances, the character of which might well depend on all kinds of factors (e.g., condition of sense organs, direct brain stimulation, etc.) besides those features of the external world that our perceptual judgments aim to capture. Paraphrasing David Hume (1739: I.2.vi, I.4.ii; 1748: sec 12.1; see also Locke 1690, Berkeley 1710, Russell 1912): nothing is ever directly present to the mind in perception except perceptual appearances.

But if our only access to the external world is mediated by potentially misleading perceptual appearances, we ought to have some assurance that the appearances we are relying on are *not* of the misleading variety. And here is where all the trouble arises, for it seems that there is no way we could have any evidence for the reliability of perception (i.e., perceptual appearances) without relying on other perceptions. We have empirical reason, for example, to think that

science is not yet capable of stimulating brains in a very precise way, but appealing to this to rebut the possibility of brain-in-a-vat scenarios seems blatantly question begging. At the heart of the problem of the external world is a skeptical argument I will refer to as "PEW" and which I reconstruct in what follows. I have named the premises, as we will want to discuss them individually.

1. Nothing is ever directly present to the mind in perception except perceptual appearances. (**Indirectness Principle**) Thus:
2. Without a good reason for thinking perceptual appearances are veridical, we are not justified in our perceptual beliefs. (**Metaevidential Principle**)
3. We have no good reason for thinking perceptual appearances are veridical. (**Reasons Claim**)
4. Therefore, we are not justified in our perceptual beliefs.

The problem of the external world should be distinguished from what is typically called the problem of perception (see the entry on the problem of perception), even though they are motivated by similar considerations, in particular, by the Indirectness Principle. The problem of perception is the problem of how *perception* is possible—how it is possible, for example, to *see* mind-independent objects, rather than inferring them from awareness of sense-experiences, in light of the claim that only appearances are ever directly present to the mind. The problem of the external world is a distinctively epistemological problem, and it focuses on the normative status of perceptual judgments about external objects; it matters little for these purposes whether and how such judgments might amount to *seeing*. What matters is whether such judgments are or could be justified.

BASIC TASKS OF VISUAL PERCEPTION

What is Visual Perception?

Visual perception is the ability to perceive our surroundings through the light that enters our eyes. The visual perception of colors, patterns, and structures has been of particular interest in relation to graphical user interfaces (GUIs) because these are perceived *exclusively* through vision. An understanding of visual perception therefore enables designers to create more effective user interfaces.

Physiologically, visual perception happens when the eye focuses light on the *retina*. Within the retina, there is a layer of photoreceptor (light-receiving) cells which are designed to change light into a series of *electrochemical signals* to be transmitted to the brain. Visual perception

occurs in the brain's *cerebral cortex*; the electrochemical signals get there by traveling through the optic nerve and the thalamus.

Visual perception could be defined as the ability to interpret the information that our eyes receive. The result of this information being interpreted and received by the brain is what we call visual perception, vision, or sight. Visual perception is a process that starts in our eyes:

- **Photo-reception**: The light rays reach our pupils and activate the receptor cells in the retina.
- **Transmission and basic processing**: The signals made by these cells are transmitted through the optic nerve toward the brain. It first goes through the optic chiasma (where the optic nerves cross, making the information received from the right field of vision go to the left hemisphere, and information received from the left field of vision go to the right hemisphere), and is then relayed to the lateral geniculate nucleus of the thalamus.
- **Finally, the visual information that our eyes receive is sent to the visual cortex in the occipital lobe.**

To get an idea of the complexity of this cognitive function, try to think about your brain when you look at a soccer ball. What are the factors that you should identify?:

- **Lighting and contrast**: You can see the lines that are more or less illuminated, and have a parameter that is different than the rest of the objects around and behind it.
- **Size**: it's a circular object with a circumference of about 27 inches.
- **Shape:** it's round.
- **Position** It's about 10 feet from me, to my right. I could easily touch it.
- **Color**: It's white with black pentagons. If the light went away suddenly, we would still know that it is black and white.
- **Dimensions**: It's three dimensional, which means that it's a sphere.
- **Movement**: it's not moving now, but is susceptible to movement.
- **Units**: there is one, and it's different from the ground.
- **Use**: it's used to play soccer. It is kicked with the foot
- **Personal relationship with the object**: it's like the one that you use at soccer practice.
- **Name**: it's a soccer ball. This last process is called naming.

MULTISENSORY INTERACTION AND INTEGRATION

Multimodal (or multisensory) integration refers to the neural integration or combination of information from different sensory modalities (the classic five senses of vision, hearing, touch, taste, and smell, and, perhaps less obviously, proprioception, kinesthesis, pain, and the vestibular senses), which gives rise to changes in behavior associated with the perception of and reaction to those stimuli. Information is typically integrated across sensory modalities when the sensory inputs share certain common features. For example, although vision is concerned with a certain frequency band of the electromagnetic energy spectrum, and hearing is concerned with changes in pressure at the ears, stimulus features such as spatial location, movement, intensity, timing, and duration, as well as other higher-order features such as meaning and identity can apply equally to information from several (or all) sensory modalities. Crossmodal integration is often used synonymously with multimodal integration, however the latter term has various other associations in different disciplines, including in describing the use of more than one measuring system. The former term, crossmodal, may therefore be preferable.

Multimodal integration is more often used to refer to integrative processes operating at the systems level, and studied most commonly using brain imaging techniques alongside behavioral and perceptual measurements. Multisensory integration on the other hand, tends to refer to the combinatorial effects of stimulation of two or more senses on the activity of single neurons, measured electrophysiologically in experimental animals. Since multisensory integration is more commonly used in the context of single-cell recordings, often made under anesthetised recording conditions, causal relationships to the behavioral outcomes of multisensory integration are less certain, although this is currently an area attracting considerable research interest.

- Having information from multiple senses converge onto the same neurons allows the neurons to work in concert so that their combined product can enhance the physiological salience of an event, increase the ability to render a judgment about its identity, and initiate responses faster than would otherwise be possible.
- This interactive synergy among the senses, or 'multisensory integration', is manifested in individual neurons, by enhancing or degrading their responses, and in behaviour, by producing corresponding alterations in performance.
- Multisensory integration is guided by principles that relate to the spatial and temporal relationship among cross-modal stimuli, as well as to the vigor of the neuron's responses to their individual component stimuli.

- The spatial principle of multisensory integration relies on faithful register among a neuron's different receptive fields and this register must be maintained in spite of independent movement of the sense organs (such as the eyes). Recent studies suggest that compensation for such movement is less than perfect, and occurs to varying degrees in different neurons and brain regions. Degradation in receptive-field register has strong implications for multisensory integration, but these remain to be examined empirically.
- Multisensory integration is crucial for high-level cognitive functions in which considerations such as semantic congruence might determine its neural products and the perceptions and behaviours that depend on them.

PERCEPTUAL PROCESSES AND ATTENTION

The process through which certain stimuli are selected from a group of others is generally referred to as attention. At this point it may be noted that besides selection, attention also refers to several other properties like alertness, concentration, and search. Alertness refers to an individual's readiness to deal with stimuli that appear before her/him. While participating in a race in your school, you might have seen the participants on the starting line in an alert state waiting for the whistle to blow in order to run. Concentration refers to focusing of awareness on certain specific objects while excluding others for the moment.

Attention has a focus as well as a fringe. When the field of awareness is centered on a particular object or event, it is called focus or the focal point of attention. On the contrary, when the objects or events are away from the center of awareness and one is only vaguely aware of them, they are said to be at the fringe of attention. Attention has been classified in a number of ways. A process-oriented view divides it into two types, namely selective and sustained. We will briefly discuss the main features of these types of attention. Sometimes we can also attend to two different things at the same time. When this happens, it is called divided attention.

Selective Attention Selective attention is concerned mainly with the selection of a limited number of stimuli or objects from a large number of stimuli. We have already indicated that our perceptual system has a limited capacity to receive and process information. This means that it can deal only with a few stimuli at a given moment of time. The question is, which of those stimuli will get selected and processed? Psychologists have identified a number of factors that determine the selection of stimuli. Factors Affecting Selective Attention Several factors influence selective attention. These generally relate to the characteristics of stimuli and the characteristics of individuals. They are generally classified as "external" and "internal" factors. External factors are related to the features of stimuli. Other things held constant, the size, intensity, and motion of stimuli appear to be important determinants of attention. Large, bright,

and moving stimuli easily catch our attention. Stimuli, which are novel and moderately complex, also easily get into our focus. Studies indicate that human photographs are more likely to be attended to than the photographs of inanimate objects. Similarly, rhythmic auditory stimuli are more readily attended to than verbal narrations. Sudden and intense stimuli have a wonderful capacity to draw attention.

Internal factors lie within the individual. These may be divided into two main categories, viz. motivational factors and cognitive factors. Motivational factors relate to our biological or social needs. When we are hungry, we notice even a faint smell of food. A student taking an examination is likely to focus on a teacher's instructions more than other students. Cognitive factors include factors like interest, attitude, and preparatory set. Objects or events, which appear interesting, are readily attended by individuals. Similarly we pay quick attention to certain objects or events to which we are favourably disposed. Preparatory set generates a mental state to act in a certain way and readiness of the individual to respond to one kind of stimuli and not to others.

Theories of Selective Attention

A number of theories have been developed to explain the process of selective attention. We will briefly discuss three of these theories. Filter theory was developed by Broadbent (1956). According to this theory, many stimuli simultaneously enter our receptors creating a kind of "bottleneck" situation. Moving through the short-term memory system, they enter the selective filter, which allows only one stimulus to pass through for higher levels of processing. Other stimuli are screened out at that moment of time Thus, we become aware of only that stimulus, which gets access through the selective filter.

Filter-attenuation theory was developed by Triesman (1962) by modifying Broadbent's theory. This theory proposes that the stimuli not getting access to the selective filter at a given moment of time are not completely blocked. The filter only attenuates (weakens) their strength. Thus some stimuli manage to escape through the selective filter to reach higher levels of processing. It is indicated that personally relevant stimuli (e.g., one's name in a collective dinner) can be noticed even at a very low level of sound. Such stimuli, even though fairly weak, may also generate response occasionally by slipping through the selective filter.

Multimode theory was developed by Johnston and Heinz (1978). This theory believes that attention is a flexible system that allows selection of a stimulus over others at three stages. At stage one the sensory representations (e.g., visual images) of stimuli are constructed; at stage two the semantic representations (e.g., names of objects) are constructed; and at stage three the sensory and semantic representations enter the consciousness. It is also suggested that more

processing requires more mental effort. When the messages are selected on the basis of stage one processing (early selection), less mental effort is required than when the selection is based on stage three pr ocessing (late selection).

Sustained Attention

While selective attention is mainly concerned with the selection of stimuli, sustained attention is concerned with concentration. It refers to our ability to maintain attention on an object or event for longer durations. It is also known as “vigilance”. Sometimes people have to concentrate on a particular task for many hours. Air traffic controllers and radar readers provide us with good examples of this phenomenon. They have to constantly watch and monitor signals on screens. The occurrence of signals in such situations is usually unpredictable, and errors in detecting signals may be fatal. Hence, a great deal of vigilance is required in those situations.

Factors Influencing Sustained Attention

Several factors can facilitate or inhibit an individual’s performance on tasks of sustained attention. Sensory modality is one of them. Performance is found to be superior when the stimuli (called signals) are auditory than when they are visual.

Clarity of stimuli is another factor. Intense and long lasting stimuli facilitate sustained attention and result in better performance. Temporal uncertainty is a third factor. When stimuli appear at regular intervals of time they are attended better than when they appear at irregular intervals. Spatial uncertainty is a fourth factor. Stimuli that appear at a fixed place are readily attended, whereas those that appear at random locations are difficult to attend. Attention has several practical implications. The number of objects one can readily attend to in a single glance is used to design the number plates of motorbikes and cars so that the traffic police can easily notice them in the case of traffic rule violations.

PERCEPTUAL PROCESSES

The process by which we recognise, interpret or give meaning to the information provided by sense organs is called perception. In interpreting stimuli or events, individuals often construct them in their own ways. Thus perception is not merely an interpretation of objects or events of the external or internal world as they exist, instead it is also a construction of those objects and events from one’s own point of view. The process of meaning-making involves certain sub-processes.

Processing Approaches in Perception

How do we identify an object? Do we identify a dog because we have first recognised its furry coat, its four legs, its eyes, ears, and so on, or do we recognise these different parts because we have first identified a dog? The idea that recognition process begins from the parts,

which serve as the basis for the recognition of the whole is known as bottom-up processing. The notion that recognition process begins from the whole, which leads to identification of its various components is known as top-down processing. The bottom-up approach lays emphasis on the features of stimuli in perception, and considers perception as a process of mental construction. The top-down approach lays emphasis on the perceiver, and considers perception as a process of recognition or identification of stimuli. Studies show that in perception both the processes interact with each other to provide us with an understanding of the world.

THE PERCEIVER

Human beings are not just mechanical and passive recipients of stimuli from the external world. They are creative beings, and try to understand the external world in their own ways. In this process their motivations and expectations, cultural knowledge, past experiences, and memories as well as values, beliefs, and attitudes play an important role in giving meaning to the external world. Some of these factors are described here.

Motivation

The needs and desires of a perceiver strongly influence her/his perception. People want to fulfil their needs and desires through various means. One way to do this is to perceive objects in a picture as something that will satisfy their need. Experiments were conducted to examine the influence of hunger on perception. When hungry persons were shown ambiguous pictures, they were found to perceive them as pictures of food objects more often than satiated (non-hungry) persons.

Expectations or Perceptual Sets

The expectations about what we might perceive in a given situation also influence our perception. This phenomenon of perceptual familiarisation or perceptual generalisation reflects a strong tendency to see what we expect to see even when the results do not accurately reflect external reality. For example, if your milkman delivers you milk daily at about 5.30 A.M., any knocking at the door around that time is likely to be perceived as the presence of the milkman even if it is someone else.

Cognitive Styles

Cognitive style refers to a consistent way of dealing with our environment. It significantly affects the way we perceive the environment. There are several cognitive styles that people use in perceiving their environment. One most extensively used in studies is the "field dependent and field independent" cognitive style. Field dependent people perceive the external world in its totality, i.e. in a global or holistic manner. On the other hand, field

independent people perceive the external world by breaking it into smaller units, i.e. in an analytic or differentiated manner.

Cultural Background and Experiences

Different experiences and learning opportunities available to people in different cultural settings also influence their perception. People coming from a pictureless environment fail to recognise objects in pictures. Hudson studied the perception of pictures by African subjects, and noted several difficulties. Many of them were unable to identify objects depicted in pictures (e.g., antelope, spear). They also failed to perceive distance in pictures, and interpreted pictures incorrectly. Eskimos have been found to make fine distinction among a variety of snow that we may be unable to notice. Some aboriginal groups of Siberian region have been found to differentiate among dozens of skin colours of reindeers, which we would not be able to do.

People process and interpret stimuli in their own ways depending on their personal, social and cultural conditions. Due to these factors our perceptions are not only finely tuned, but also modified.

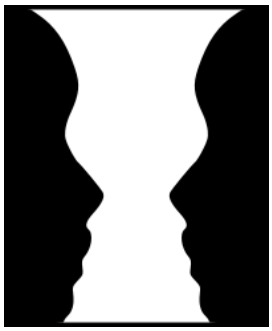
PRINCIPLES OF PERCEPTUAL ORGANIZATION

'Our visual field is a collection of different elements, such as points, lines, and colours. However, we perceive these elements as organised wholes or complete objects. For example, we see a bicycle as a complete object, not as a collection of different parts (e.g., saddle, wheel, handle). The process of organising visual field into meaningful wholes is known as form perception. You may wonder how different parts of an objects are organised into a meaningful whole. You may also ask if there are certain factors that facilitate or inhibit this process of organisation. Several scholars have tried to answer such questions, but the most widely accepted answer has been given by a group of researchers, called Gestalt psychologists. Prominent among them are Köhler, Koffka, and Wertheimer.

Gestalt means a regular figure or a form. According to Gestalt psychologists, we perceive different stimuli not as discrete elements, but as an organised "whole" that carries a definite form. They believe that the form of an object lies in its whole, which is different from the sum of their parts. For example, a flower pot with a bunch of flowers is a whole. If the flowers are removed, the flower pot still remains a whole. It is the configuration of the flower pot that has changed.

The Gestalt psychologists also indicate that our cerebral processes are always oriented towards the perception of a good figure or pragnanz. That is the reason why we perceive everything in an organised form. The most primitive organisation takes place in the form of figure-ground segregation. When we look at a surface, certain aspects of the surface clearly

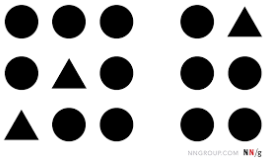
stand out as separate entities, whereas others do not. For example, when we see words on a page, or a painting on a wall, or birds flying in the sky, the words, the painting, and the birds stand out from the background, and are perceived as figures, while the page, wall, and sky stay behind the figure and are perceived as background.

To test this experience, look at the Fig.5.6 given below. You will see either the white part of the figure, which looks like a vase (flower pot), or the black part of the figure, which looks like two faces. Fig.5.6 :  Rubin's Vase

We distinguish figure from the ground on the basis of the following characteristics: 1. Figure has a definite form, while the background is relatively formless. 2. Figure is more organised as compared to its background. 3. Figure has a clear contour (outline), while the background is contourless. 4. Figure stands out from the background, while the background stays behind the figure. 5. Figure appears more clear, limited, and relatively nearer, while the background appears relatively unclear, unlimited, and away from us.

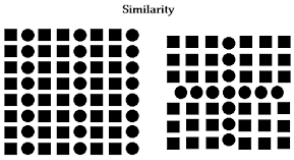
The discussion presented above indicates that human beings perceive the world in organised wholes rather than in discrete parts. The Gestalt psychologists have given us several laws to explain how and why different stimuli in our visual field are organised into meaningful whole objects. Let us look at some of these principles.

The Principle of Proximity

Objects that are close together in space or time are perceived as belonging together or as a group. 

The Principle of Similarity

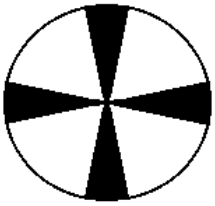
Objects that are similar to one another and have similar characteristics are perceived as a group. In Fig.5.8 the little circles and squares are evenly spaced both horizontally and

vertically so that the proximity does not come into play. Instead, we tend to see alternating columns of circles and squares. 

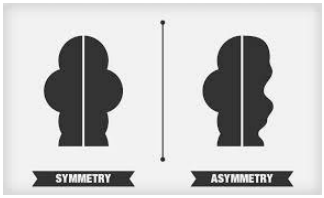
The Principle of Continuity

This principle states that we tend to perceive objects as belonging together if they appear to form a continuous pattern. 

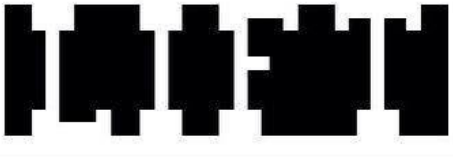
The Principle of Smallness

According to this principle, smaller areas tend to be seen as figures against a larger background.  In Fig.5.10 we are more likely to see a black cross rather than a white cross within the circle because of this principle.

The Principle of Symmetry

This principle suggests that symmetrical areas tend to be seen as figures against asymmetrical backgrounds. 

The Principle of Surroundedness

According to this principle, the areas surrounded by others tend to be perceived as figures.  For example, the image in Fig.5.12 looks like five figures against the white background rather than the word ‘LIFT’.

The Principle of Closure

We tend to fill the gaps in stimulation and perceive the objects as whole rather than their separate parts. For example, in Fig.5.13 the small angles are seen as a triangle due to our tendency to fill the gaps in the object provided by our sensory input.

IDENTIFICATION AND CLASSIFICATION

Identification involves describing an entity to a point where it will uniquely pick it out in a given context. Classification involves assigning the entity to a group according to given criteria, where all and only other entities also meet the criteria.

OBJECT RECOGNITION

Object recognition is the ability to recognize an object. This might be after the object has been previously seen or recognizing it from photographs or from verbal descriptions. It is the ability to perceive an object's physical properties (such as shape, color and texture) and apply semantic attributes to the object, which includes the understanding of its use, previous experience with the object and how it relates to others.

Object perception may involve seeing, recognition, preparation of actions, and emotional responses — functions that human brain imaging and neuropsychology suggest are localized separately. Perhaps because of this specialization, object perception is remarkably rapid and efficient. One of the fundamental goals of object recognition research is to understand how a cognitive representation produced from the output of filtered and transformed sensory information facilitates efficient viewer behavior. Given that mental imagery strongly resembles perceptual processes in both cortical regions and subjective visual qualities, it is reasonable to question whether mental imagery facilitates cognition in a manner similar to that of perceptual viewing: via the detection and recognition of distinguishing features. Categorizing the feature content of mental imagery holds potential as a reverse pathway by which to identify the components of a visual stimulus which are most critical for the creation and retrieval of a visual representation.

Object recognition is used for a variety of tasks: to recognize a particular type of object (a moose), a particular exemplar (this moose), to recognize it (the moose I saw yesterday) or to match it (the same as that moose). **Visual object recognition** refers to the ability to identify the objects in view based on visual input. One important signature of visual object recognition is "object invariance", or the ability to identify objects across changes in the detailed context

in which objects are viewed, including changes in illumination, object pose, and background context.

Basic stages of object recognition

Neuropsychological evidence affirms that there are four specific stages identified in the process of object recognition. These stages are:

Stage 1 Processing of basic object components, such as color, depth, and form.

Stage 2 These basic components are then grouped on the basis of similarity, providing information on distinct edges to the visual form. Subsequently, figure-ground segregation is able to take place.

Stage 3 The visual representation is matched with structural descriptions in memory.

Stage 4 Semantic attributes are applied to the visual representation, providing meaning, and thereby recognition.

Within these stages, there are more specific processes that take place to complete the different processing components. In addition, other existing models have proposed integrative hierarchies (top-down and bottom-up), as well as parallel processing, as opposed to this general bottom-up hierarchy.

Object recognition is the fundamental aspect of cognition which has influence on

o Memory

o Decision-making

o Actions

- A failure to recognise something- to experience a failure of knowledge- is referred to as agnosia- when the disorder is limited to the visual modality this is visual agnosia
- This has provided a window into the processes that underlie object recognition. By analysing subtypes of visual agnosia and their deficits we can draw inferences about the processes that lead to object recognition
- There are four major concepts to keep in mind when thinking about object recognition:

o Need to be precise when using terms like perceive or recognise- may be able to see objects but not perceive or recognise them

o Although our sensory systems use a divide and conquer strategy, our perception is of unified objects- features like colour and motion are processed in distinct neural pathways however perception involves more than perceiving the features of object.

o Perceptual capabilities are enormously flexible and robust

CONCEPTS AND CATEGORIES

The mental representations we form of categories are called **concepts**. Concepts are at the core of intelligent behavior.The psychology of categories concerns how people learn, remember, and use informative categories. A **category** is a set of objects that can be treated as equivalent in some way. For example, consider the following categories: trucks, wireless devices, weddings, psychopaths, and trout. Although the objects in a given category are different from one another, they have many commonalities. When you know something is a truck, you know quite a bit about it. Remember, the psychology of categories concerns how people learn and use informative categories such as trucks or psychopaths. The mental representations we form of categories are called concepts. There is a category of trucks in the world, and you also have a concept of trucks in your head. We assume that people's concepts correspond more or less closely to the actual category, but it can be useful to distinguish the two, as when someone's concept is not really correct.

Concepts are categories or groupings of linguistic information, images, ideas, or memories, such as life experiences. Concepts are, in many ways, big ideas that are generated by observing details, and categorizing and combining these details into cognitive structures. You use concepts to see the relationships among the different elements of your experiences and to keep the information in your mind organized and accessible.

Concepts are informed by our semantic memory (you will learn more about this concept when you study memory) and are present in every aspect of our lives; however, one of the easiest places to notice concepts is inside a classroom, where they are discussed explicitly.

Natural and Artificial Concepts

In psychology, concepts can be divided into two categories, natural and artificial. **Natural concepts** are created "naturally" through your experiences and can be developed from either direct or indirect experiences.

An **artificial concept**, on the other hand, is a concept that is defined by a specific set of characteristics. Various properties of geometric shapes, like squares and triangles, serve as useful examples of artificial concepts. A triangle always has three angles and three sides. A square always has four equal sides and four right angles. Mathematical formulas, like the equation for area (length × width) are artificial concepts defined by specific sets of characteristics that are always the same. Artificial concepts can enhance the understanding of a topic by building on one another.

Schemata

A **schema** is a mental construct consisting of a cluster or collection of related concepts (Bartlett, 1932). There are many different types of schemata, and they all have one thing in common: schemata are a method of organizing information that allows the brain to work more efficiently. When a schema is activated, the brain makes immediate assumptions about the person or object being observed.

There are several types of schemata. A **role schema** makes assumptions about how individuals in certain roles will behave.

Schemata also help you fill in gaps in the information you receive from the world around you. While schemata allow for more efficient information processing, there can be problems with schemata, regardless of whether they are accurate: Perhaps this particular firefighter is not brave, he just works as a firefighter to pay the bills while studying to become a children's librarian.

An **event schema**, also known as a **cognitive script**, is a set of behaviors that can feel like a routine. Think about what you do when you walk into an elevator (Figure 4). First, the doors open and you wait to let exiting passengers leave the elevator car. Then, you step into the elevator and turn around to face the doors, looking for the correct button to push. You never face the back of the elevator, do you? And when you're riding in a crowded elevator and you can't face the front, it feels uncomfortable, doesn't it? Interestingly, event schemata can vary widely among different cultures and countries.

Nature of Categories

Traditionally, it has been assumed that categories are *well-defined*. This means that you can give a definition that specifies what is in and out of the category. Such a definition has two parts. First, it provides the *necessary features* for category membership: What must objects have in order to be in it? Second, those features must be *jointly sufficient* for membership: If an object has those features, then it is in the category. For example, if I defined a dog as a four-legged animal that barks, this would mean that every dog is four-legged, an animal, and barks, and also that anything that has all those properties is a dog.