

Sensation

Nature

It is clear from the study of the structure and function of the nervous system that sensation makes a major contribution towards shaping behaviour and gathering information about the external world. Sensation is a simple process in which sense organs, in response to stimuli, collect information about the world with the help of the nervous system. Every sense organ consists of a delicate and complicated system. In this system, receptors which are located at the extreme external end of sense organs occupy a critical role. These receptors are stimulated at threshold and pass on message to the brain by generating electro-chemical neural impulses and then carry back the message from there to various parts of body. Thus they in collaboration with the nervous system carry out external and internal functions.

The basic unit of every sense organ is stimulus; each sense organ has its own specific stimulus. If stimulus acts on a sense organ, it makes no impact on the other, e.g. light waves act as a stimulus for the eye, and sound waves for the ear, pleasant and unpleasant smell gives stimulus to sensory receptors of nose whereas sweet, sour, salty or bland taste provides stimulus for the tongue. A stimulus is the physical force that affects internal or external sense organ and triggers off response.

Through sensation, the individual gathers comprehensive information about some event, situation or other affairs of the world. Since sensation involves several sense organs that collect information about environment together, it is called a complex cognitive process.

As apart from humans, animals also have senses but their level of sensitivity is different. Every sense of animals is individually sharper than that of humans.

For example, the visual sense in the eagle and vulture is very sharp; hearing and smell are far keener in dogs, cats, fish and beasts than in humans. If we assess the functioning of all senses put together, man rates far higher than all other animals. A marvelous brain and the faculty to speech give him a great advantage in this regard.

Sensation involves not only responding to stimuli but also interpreting them. Since each sensation reaches the brain, sensory function takes place instantly. Sensation gives us immediate external, internal and physiological awareness.

The principle function of the special sensory receptors is to detect environmental stimuli and transfer their energy into electrical impulses. These are then conveyed along sensory neurons to the central nervous system, where they are integrated and processed, and a response is produced.

There is no firm agreement amongst neurologists as to exactly how many senses there are. The disagreements stem from a lack of consensus as to what the definition of a sense should be. Although it is still routinely taught that there are five senses (sight, hearing, touch, smell, taste; a classification first devised by Aristotle, it is generally agreed that there are at least nine different senses in humans, and a minimum of two more observed in other organisms.

A broadly acceptable definition of a sense would be "**a system that consists of a sensory cell type (or group of cell types) that respond to a specific kind of physical energy, and that correspond to a defined region (or group of regions) within the brain where the signals are received and interpreted**". Where disputes arise is with regard to the exact classification of the various cell types and their mapping to regions of the brain. It can also be defined as:

- Sensation is a process that makes possible, and facilitates our contact with reality.
- Sense means to become aware of something.
- All living organisms have sense organs. Sensation is the process by which our sense organs respond to different stimuli.
- It is the mechanism through which stimuli from outside or inside the body are received and felt by different faculties e.g., hearing, sight, smell, touch, taste, and equilibrium.
- In the process of sensation the incoming (afferent) nerve impulse is registered in that part of the brain, which has a potential of such reception. The awareness of a stimulus results from the perception of the sensory receptors.

Characteristics of Sensation

- 1. Specific stimulus**
- 2. Intensity**
- 3. Duration**
- 4. Span**
- 5. Threshold**
 - i. Absolute Threshold
 - ii. Terminal Threshold
 - iii. Differential Threshold
- 6. Adaptation**
- 7. Sensory Acuity**

Specific Stimulus

Each type of sensation involves a specific sense organ that reacts to specific stimuli. Eye for sight, ear for hearing, nose for smelling, and tongue for taste are the sense organs. They respond only to the stimulus that is specific to them.

For example, light waves enable the eye to see whereas sound waves are not suitable for sight. Similarly, light waves serve no purpose in hearing. Each sense organ has its own specific location, nerves, receptors and stimuli.

Intensity

Each sense organ has the capacity to receive and bear its specific stimulus to a certain extent. The intensity of light waves for human eye is 385 to 760 millimicron per millimeter. The light waves of lower intensity than this cannot stimulate the eye whereas higher intensity can harm the eye. The lowest and highest intensity of the stimulus is also involved in other senses.

Duration

Every sense organ has the capacity to hold a certain quantity of a specific stimulus for a specific time. For every sensation to take place, it is necessary that the stimulus should act on the sense organ for some time. In other words, the response to a stimulus entails the stimulation of the sense organ for some time.

Span

Every sensation has a certain span which relates to its expansion and its spatial aspect. Every sensation is characterized by the ability to distinguish between the stimulus acting on small area and the one acting on large area. The pressure of a finger is different from that of the full hand. The pain caused by the point of a needle will be different from that given by the cut of knife.

Threshold

Every sense organ is characterized by threshold which relates to stimulation. The minimum magnitude of a stimulus that can stimulate a sense organ is called threshold. It is divided into three types

Absolute Threshold

The minimum physical energy required to stimulate a sense organ is known as absolute threshold. The lowest level of the stimulus that can provoke a sensory reaction will be threshold. If the intensity of a stimulus is lower than the absolute threshold, human senses will not be able to detect it. The movement of the small hand of a watch is not detected though it does move. Two grains/pinches of sugar put in a glass of water cannot bring about any change in taste, though sugar is there. A hair placed on the palm cannot give sensation of weight. In all these examples, the intensity of the stimulus is so low that it fails to cause any stimulation.

Terminal Threshold

The maximum level of physical energy that a sense organ can bear is called terminal threshold. It is also known as the upper limit of a stimulus. If the magnitude of a stimulus exceeds the upper limit, it causes pain to the sense organ and it (sense organ) cannot detect it. That is why, X-rays though existent cannot be seen. The sound produced by a bat in flight cannot be detected by human ear. The bullet shot by a gun cannot be seen by the individual, though it is in motion. It is because the upper limit of the intensity of these stimuli exceeds the grasp of human senses.

Differential Threshold

The minimum magnitude of physical energy whereby two stimuli can be distinguished is called differential threshold. If the level of difference between two stimuli is too low, the sense organ cannot detect the difference. If 50 grams of sugar are mixed in one glass and 53 grams in the other, our tongue would not be able to detect differences in sweetness. If ten tube lights are on in a room and another tube light is switched on after some time, the individual will not be able to feel this difference.

Adaption

Every sense organ has the ability to adapt to the situation. Sensory and motor nerves stimulate the sense organ in accordance with the nature of a stimulus. The required chemical changes are brought about to enable the sense organ to adapt to the environment. The contraction of the pupil in bright light, its dilation in darkness, the turning of the ear to the low sound, bending forward to listen, the circulation of blood in subcutaneous skin during winter and in the epidermis during summer so that balance in temperature may be maintained, all these are examples of adaption.

Sensory Acuity

Sensitivity of sensation or for the process of sensation is that how we can interpret/understand the information which we perceive through specific organs of five sensations properly and accurately.

Human nature is very sensitive system. **Eugene Galanter** discovered the minimum rate of sensation. He conducted several experiments on sensory acuity.

According to him, the weakest detectable stimulus for **vision** is the candle flame that can be seen at 30 miles on a dark, clear night.

The weakest stimulus for **audition** is the tick of a watch that can be heard at 20 feet under quite conditions.

The weakest stimulus for **taste** is a small teaspoon of sugar that can be detectable in to gallons of water.

The weakest stimulus for **olfactory/smell** is one drop of perfume detectable in a three-room of apartment.

The weakest stimulus for tactile/touch is the wing of the bee that can be felt when it falls on the cheek from a height of 01 centimeter. If this wing falls on the palm, it will not be felt. In other words, the sensitivity to touch or pressure varies from one area of skin to the other.

According to **Neuro Linguistic Programme (NLP)**

Sensory acuity is about paying more attention to what's going on. In a general way sensory acuity means how good your senses are doing and what they should do. In the context of NLP, it refers to the ability to use our senses to make accurate observations about ourselves or other people.

Example,

With the strong and accurate sense acuity you can look at eye movements, changes in skin colour and breathing, and postures in order to get information about what is happening to other people. Because if you can use any one of your five senses more effectively, then you can become better at just about anything is happening which you do.

The essence of sensory acuity is the ability to recognize what is fact and making conclusion about things accurately that what is perceived.

When you are expert in your sensory acuity then you will be aware of the facts and start to notice changes in the facts at various points of the conversation interpreting key points and learning about your relevant situation.

Types of Sensation

- 1) **Eye/Visual Sensation**
- 2) **Hearing/Auditory Sensation**
- 3) **Skin/Tactile Sensation**
- 4) **Taste Sensation**
- 5) **Nose/Olfactory Sensation**

Eye/Visual Sensation

Visual sensation tops all types of sensation. Eighty percent of information gathered through sensation belongs to eyes. That is why; the eye is called the queen of sensation. The loss or impairment of sight is often compared to being engulfed in a pall of darkness. It is because the process of getting information about environment is very adversely affected.

The sense organ involved in visual sensation is the eye, and it is stimulated by light. Visual sensation is incomplete without light. Eyes are encased in orbital **orbital cavity** and each eye is attached to it with six nerves. The eye is very sensitive sense organ. Nature has created eyebrows, eyelids, and eyelashes to protect the eye from perspiration and dirt and keep it intact.

Orbit Cavity

The orbit is the cavity or socket of the skull in which the eyeballs and their associated structure (nerves, vessels and muscles) are situated.

Structure of the eye

Human eye consists of three layers or coats which are as follow:

- **Sclerotic Coat**
- **Choroid Coat**
- **Retinal Coat**

1. Sclerotic Coat

This is the outermost layer that is made of thick white fibrous material called sclera. It is a sort of protective layer the front of which is transparent.

The transparent of sclerotic coat is known as cornea. This part is a bit curved. The cornea itself is a delicate membrane; its curve is sustained by aqueous humour behind it. The cornea received light waves from external environment and lets them enter the eye. A very thin protective membrane covering the cornea is called conjunctiva. This membrane facilitates reflex movements of the cornea.

2. Choroid Coat

This is the middle layer of the eye that is black or very dark grey in color. The choroid coat contains pigments that absorb excess light. The choroid coat also contains thin blood vessels that supply blood to the eye.

a) Iris

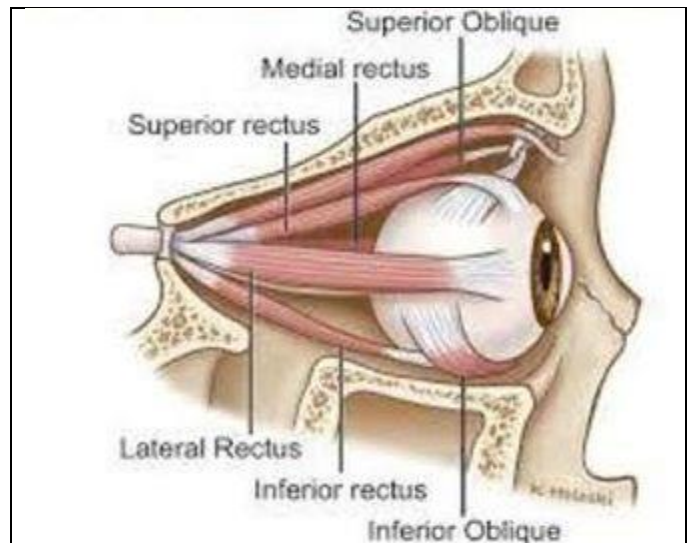
The iris is the front of the choroid coat. It is located exactly behind the cornea. It is the iris that gives the eye its characteristic color. The brown, black or blue color that we see in the centre of the eye is in fact the iris. It together with the pupil controls the light entering the eye.

b) Pupil

The pupil is an opening in the centre of the cornea. The iris is responsible for dilating or constructing the pupil. When the light level is low, the iris contracts and consequently the pupil widens. In bright light, the iris dilates and covers the pupil, which results in the constriction of the pupil that lets light enter the eye. The constriction of the pupil in bright light reduces the amount of light entering the eye whereas its dilation in low light lets more light enter the eye. Thus adequate light projects the exact image onto the retina.

c) Ciliary Muscles

Ciliary muscles are located beside the iris. They help the iris to move. When the iris has to contract or dilate to control the amount of light, ciliary muscles help it with this task.



d) Lens

Biconvex lens lies behind the iris. Its function is to adjust eye for long sight and short sight. The lens becomes thick in the middle and thin at corners for short sight. This form of the lens is called **convex** lens. For long sight, the lens changes its shape to focus exact and clear image of the stimulus on the retina. In this case the lens becomes thin in the middle and thick at the corners. This form of lens is called **concave** lens. If the lens does not change its shape to focus exact image on the retina, vision gets poor. This defect can be removed by wearing spectacles with convex or concave lenses. Now days, artificial lenses are also being used for this purpose. This lens is attached to ciliary muscles. It is the ciliary muscles that help the lens to change its shape for close-up or distant vision.

e) Aqueous Humour

The water liquid lying between the lens and the cornea of the eye is called aqueous humour. It keeps the eye wet and sustains the curve of the cornea.

3. Retinal Coat

This is the inner most layer of the eye that consists of numberless small cells and fibers. This part is very sensitive. A little excess light entering the eye can damage it. Optic nerves are located in this very cup-shaped part of the eye. The biconvex lens focuses the image from the external environment on the retina. This image is inverted and gets upright after the process of vision is complete. After this layer, there lies a chamber in the eye.

a) Vitreous Humour

The eyeball is empty inside and contains vitreous humour. It is a thick, sticky, transparent fluid which fills the eye chamber. Vitreous keeps the structure of the eye intact and protects it from being compressed.

b) Fovea

In the center of the retina there is an area which is filled with cones. This is the area of clearest vision for the detection of colours.

c) Blind Spot

It is a spot on the retina. It is at this point that the optic nerve converges to carry the image on the retina to the brain. There are no rods and cones at this point because of the convergence of the retina and optic nerve. Because of the absence of rods and cones, any light entering this spot goes undetected and no vision takes place. This is why; this spot is called blind spot.

The retina contains two types of cells which are the real photoreceptors. These very cells make vision possible. The light waves have to pass through the cornea, iris, lens, aqueous humour and vitreous humour to reach these sensitive cells.

These receptors are of two types:

- (i) Rods (ii) Cones

Rods

These receptors are straight and rod-shaped. They are located on the side of lower layers of the retina. They can function under conditions of low illumination. They have excellent capacity for receiving sensations of white, black flash and brightness. They are found in the greatest number at the angle of 20° from the centre. As we move away from the centre to the corners, they grow in number. Their special characteristic is that they can function in very low light. Hence they are also called cells of nocturnal vision. Without light, vision is not possible. Vision involves at least 300 millimicron wave length of light waves.

Cones

These receptors are cone-shaped. They can detect all types of colour. They are located in the lower part of the retina. They are most thickly packed in the lower part of the retinal coat. There is a spot near the retinal centre where their presence is 100%. This spot is called fovea or yellow spot. As we move further away from the fovea, rods begin to mix with cones. Away from the retinal centre, the upper part of the eye contains no cones. Cones can detect things in adequate light. Hence they are also called cells of diurnal vision.

Optic Nerve

The optic nerve passes near the nose at the back of the eye and then gets attached to the retina. It detects every image on the retina and then carries it to the occipital lobe at the back of the brain. The inverted image focused on the retina gets upright when the optic nerve carries it to the brain and thus the process of vision is completed.

Blood Vessels

In order to supply blood to the eye, a large blood vessel enters the eyeball and is further subdivided into thin vessels, ensuring blood supply to every part of the eye.

How we see and what we see

As for the question what we see, all the individuals having normal vision see or can see everything or stimulus that reflects light into our eyes. In other words, we can see anything when light reflected off it enters our eyes.

Visual Process

During visual process, light waves pass through the transparent cornea. Thereupon, these waves slowly travelling through the aqueous humour reach the pupil. With the help of the iris, the pupil adjusts to control the quantity of light. If there is too much light, the iris dilates so as to constrict the pupil. In case of low illumination, the iris contracts and thus the pupil dilates to project adequate light onto the lens.

The lens with the help of ciliary muscles increases or decreases its convexity according to how far or near the objects are. Then the light waves passing through the vitreous humour form inverted image on the retina. Having gone through chemical changes, this image gets upright with the help of optic nerve during the very process of reaching the occipital lobe. In this way, the visual process is completed when the image reaches the occipital lobe.

During the study of the nervous system, it has been explained that the messages from the right part of the body are received in the left hemisphere of the brain whereas the messages from the left part of the body end up in the right hemisphere of the brain.

In case of optic nerves, the process unfolds like this; the nerves extending from the outer parts of the eye carry messages to the same hemisphere whereas the nerves spreading out from the inner parts of the eye end up in the opposite hemisphere. In other words, the optic nerves of the left side extend to the right hemisphere and those of the right side of the eye extend to the left hemisphere of the brain and the spot where these optic nerves intersect each other is called optic chiasma.

Function of the Eye

The eye performs the following functions:

- **Conjugation**
- **Convergence**
- **Accommodation**

Conjugation

The moving together of both eyes to view distant objects is called conjugation. When we are looking at a thing lying at a distance or feasting eyes on a sprawling plain, etc. both of our eyes are parallel and move together in the same direction. Conjugation is subdivided into:

- a) Saccades
- b) Pursuit

Saccades

In this movement, both eyes are parallel to each other. They jump together from one point to the other in the visual process. For example, the movement of eyes during reading a book falls under saccades. If you are watching TV and look at the wall clock to know what time it is, it will also be called a saccade. To put it differently, any movement in which we suddenly shift eyes from one object to the other is known as saccades.

Pursuit

The eye movements that are continuous and uninterrupted are called pursuit, e.g. the sequence of eye movements when tracking a moving object is a pursuit. In this movement, the individual keeps watching the moving stimulus and continues tracking it whichever direction it may move.

Convergence

Convergence refers to the eye movements in which the eyes are focused on a distant object moving closer and remain fixed on it despite its movements; eyes also turn inward during this movement. For example, if we are looking at an individual or a vehicle coming closer from afar and keep our eyes fixed on in until he/it moves up to us then our eyes turn inward as the individual/vehicle draws closer. Similarly, hold a pencil in your hand and stretch your hand to its full length, then slowly draw your hand towards the forehead and keep looking at the pencil all the while. When the pencil comes closer to your eyes, your eyes will have turned inward. This is also an example of convergence.

Accommodation

The change in the size of the pupil in proportion to the intensity of light is termed accommodation. The dilation of the pupil in darkness and its constriction in light are due to accommodation. This process keeps the quantity of light entering the eye within proper limit. Thus vision gets clear in low light and the eye is protected from harm in case of too much light.

Factors Influencing the Eye

The eye is the sensory organ of vision. Hence when the eye is affected, our vision is also affected. The factors that influence our vision are as follow:

- i. Extra Bright or Dim Light
- ii. Duration of Light
- iii. Visual Disorder

Extra Bright or Dim Light

Correct vision involves adequate quantity of light. The limit of adequate quantity is from 385 to 740 millimicron. Both these limit are called lower and upper limits of light. Light is the stimulus for vision, namely vision is possible only in the presence of light. If light is more or less than these limits, vision does not take place.

Duration of Light

Dazzling lights blur vision. Besides, sudden change in the level of light also affects vision. If a person has to see in too bright or dim light for a long time, his vision will be affected.

Visual Disorder

The following visual disorders affect vision:

- | | | | | | |
|----|-------------------------|----|-----------------|-----|----------|
| i | Colour Blindness | ii | Night Blindness | iii | Myopia |
| iv | Hypermetropia/Hyperopia | v | Presbyopia | vi | Glaucoma |

Colour Blindness

The individual cannot distinguish colours in colour blindness. There are two types of this disorder:

- | | |
|------------------------|--------------------------|
| Total Colour Blindness | Partial Colour Blindness |
|------------------------|--------------------------|

Total Colour Blindness

This disorder arises when the retina contains no cones or if it has cons, they do not function. Since cones help in colour detection, their deficiency, disorder or malfunction causes colour blindness. It is called total colour blindness. In this case, a person cannot distinguish any colour. However, such a person can detect brightness or difference of brightness. A person suffering from total colour blindness finds everything grey, brown or black.

Partial Colour Blindness

When a person can distinguish only a few of basic colours, he is said to be suffering from partial colour blindness. According to **Helm Holtz**, red, green and blue are the basic colours. He asserts that cones of these basic colours are found on the retina. Partial colour blindness occurs when the receptors of any of these three colours malfunction. A partially colour blind may not be able to distinguish blue, red or green. A person who cannot detect a particular basic colour also cannot detect its secondary or complementary colours.

Night Blindness

As is clear from its nomenclature, the people suffering from this disorder are unable to see in low illumination after the fall of evening. It is caused by the malfunction of rods on the retinal coat. Cones function during daylight. As soon as light dims, they cease to function. However, rods continue working even in dim light; if they develop some defect, the individual cannot see under low-illumination conditions.

Myopia

We very well know that the projection of the image of a stimulus on the retina is necessary for correct vision. If the eyeball develops some defect and the image of stimuli falls in front of the retina, the individual cannot focus clearly on distant objects in such a case. Since such people can see near objects rather clearly, its alternative term is short sightedness.

Generally, this disease manifests itself during childhood. The school-going children who complain of inability to read the writing on the board suffer from this disorder. They face no difficulty in reading a book but cannot see distant objects clearly.

The ophthalmologist recommends such people to wear spectacles with lens of minus power. Spectacles help the image to focus on the retina. However, a myope has to wear spectacles or lenses all the time.

Hypermetropia/Hyperopia

If the image of stimuli begins to be focused behind the retina, such people cannot see near objects clearly but can see distant objects rather clearly. Hence this disorder is alternatively called long sightedness.

This defect can be corrected by wearing spectacles with lens of positive power. Such people have to wear spectacles or lenses all the time.

Presbyopia

This disorder occurs in people of more than forty years of age. As a person gets older, he loses eyes capacity for accommodation. Such people face no difficulty in detecting distant objects because they retain accommodation for distant things. However, they lose ability to focus on close objects and cannot clearly see what is close to them. Hence people above forty use spectacles for reading or closer examination of something.

Glaucoma

Normally, the vitreous humour in the eyeball keeps flowing out of the eye and being replaced by fresh humour. This process of losing vitreous humour continues through small pores in the eye. If this process is disrupted for some reason, poisonous substances are produced because of vitreous humour being retained too long in the eye. It leads to increased intraocular pressure. This increasing pressure of poisonous substances causes irreparable loss to the retina, and the affected person loses vision for ever.

The process of ejecting vitreous humour can be restored through an operation but the lost vision cannot be recovered. It is called glaucoma because of the gravity of the disease.