SENSORY PROCESS

SENSATION

The process of collecting information through our sense organs from the environment is called as sensation.

CHARACTERISTICS OF SENSES:

1.ABSOLUTE THRESHOLD

The minimum physical energy necessary to activate a given sensory system is known as the absolute threshold.

On the basis of certain theoretical considerations, psychologists define the absolute threshold as that value at which the stimulus is perceived 50 percent of the time.

Some estimates of absolute thresholds for various sense modalities in terms of physical measures are presented in Table.

Some approximate values for Absolute Thresholds.

Sense Modality	Threshold
VISION	A candle flame seen at 30 miles on a dark, clear might
HEARING	The tick of a water under quiet conditions of 20 feet
TASTE	One teaspoon of sugar in 2 gallons of water
SMELL	One drop of perfume diffused into the entire volume of a 6 – room apartment
TOUCH	Wing of a fly falling on your check from a distance of 1 centimeter.

The absolute threshold values varies considerably from one individual to another. The threshold for a particular individual will also vary from time to time depending or his physical condition, motivational state and the conditions under which observations are made.

2. DIFFERENCE THRESHOLD

The minimum amount of stimulation necessary to tell two stimuli aprt is known as the difference threshold.

Like the absolute threshold, the difference threshold is defined as a statistical quantity. It is the amount of change in physical energy necessary to detect a difference between two stimulti 50 percent of the time. Psychologists use the term just noticeable differences (j.n.d.) to refer to this amount of change.

Difference threshold tends to be a constant fraction of the stimulus intensity. To illustrate, suppose we estimate the difference threshold for a subjects judging weights. If he is given a 100 gram weight, we note that his difference threshold is 2 grams. i.e., the 100 gram weight must be compared to a weight of at least 102 grams in order for him to detect a j.n.d. about 50 per cent of the time.

3. SENSORY ADAPTATIN

Sensory adaptation means that after a time our senses adjust to a stimulus and the, sensation produced by the stimulus, tends to disappear, through a new stimulus creates an immediate new response.

All the senses demonstrate adaptation in one way or another through a new stimulus will immediately produce a new response.

In practical terms, the principle of adaptation means that our sensory equipment is built to inform us of changes is the environment exactly the kind of information that is most valuable.

For example, if you hold salt water or a bitter fluid in your mouth, the taste goes away. The strong small that greets you in a fish market soon seems to disappear.

VISION

Physical Energy to Visual Sense

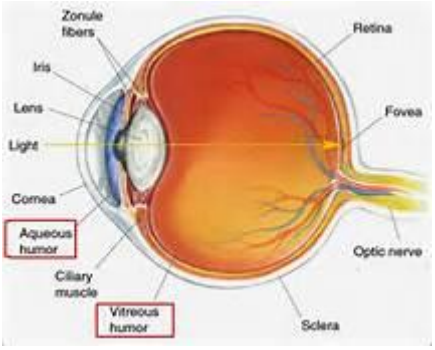
The EYE is sensitive to a portion of electromagnetic energy traveling through space that we call light. Electromagnetic energy is traveling in waves. The wavelengths vary from shorter cosmic rays to long radio waves. The wavelengths that the human eye perceives as LIGHT extend only from about 380 nanometers (nm) to about 780 nm.

The eye will respond to forms of stimulation other than light waves. Pressure on the eyeball or electrical stimulation on certain areas of the brain will produce the sensation of the light.

The experience of light is a quality produced in the visual system. The visible portion of the electromagnetic spectrum is called light because it is what usually produces that sensation.

THE HUMAN EYE

A CROSS SECTION OF THE HUMAN EYE



The main parts of the human eye are shown in the above fig. ,

Light enters the eye through the transparent cornea. The amount of light is being regulated by the pupil. The lens then focuses the light on the sensitive surface, the retina. Constriction and dilation of the pupil are controlled by the autonomic nervous system. The parasympathetic nervous system controls the change in pupil size as a function of change in illumination. The sympathetic nervous system acts to dilate the pupil under conditions of strong emotion, either pleasant or unpleasant. Even conditions of mild emotional arousal or interest will result in sympathetic changes in pupil size.

The Retina, the light sensitive surface at the back of the eye has three main layers

1. The rods and cones: The photosensitive calls that convert light energy into nerve impulses.

2. The bipolar cells: make sympathetic connections with rods and cones.

3. The ganglion cells: The fibers of which form the optic nerve.

The rods and cones form the rear layer of the retina. The light waves have not only pass through the lens and liquids that fill the eyeball but also have to penetrate the network of blood vassals and bipolar and ganglion cells before reaching the photoreceptors where light is converted into nervous impulses.

The most sensitive portion of the eye in normal daylight vision is a part of the retina called the fovea. This area plays a major role in perception and yet it is so small that the projection of a thumbnail viewed and arms length will cover it. Near the fovea, there is an insensitive area called the blind spot where the nerve fibers from the ganglion cells of the retina come together to form the optic nerve.

Optic nerve fibers from each eye go to the cortical areas where vision is represented (the occipital lobes). Some of the fibers go from the right eye to the right cerebral hemisphere and from the left eye to the left hemisphere whereas other fibers cross over at a junction called the Optic Chiasma and go to the opposite hemisphere. Fibers from the right sides of both eyes go to the right hemisphere of the cerebral cortex and fibers from the left sides of both eyes go to the left hemisphere. Consequently damage to the occipital lobe of one hemisphere, will result in blind areas in both eyes. This fact is helpful in pinpointing the location of a cerebral tumor or injury.

RODS AND CONES

Rods are cylindrical and the cones are bulbous. The cones are active only in daylight vision. They permit us to see both achromatic colours (white, black and intermediate grays) and chromatic colours (red, green, blue etc). The rods function under reduced illumination (at twilight or night) and permit us to see only achromatic colours.

More then 6 million cones and 100 million rods are distributed, somewhat unevenly, throughout the retina. The fovea contains only cones. Our vision is more active when light waves strike the fovea, because the non-converging “private-line” does not mix signals. For this reason we turn our head to look directly at an object when we want to see it clearly. Although the rods will respond to a much dimmer stimulus than will the cones, the image they give is less clear.

DARK ADAPTATION

The transition from day to night vision takes place gradually as daylight diminishes. At twilight both the cones and rods are operating but neither with full effectiveness.

A sudden change from conditions of light to dark, or vice versa, is even more difficult to adjust to. It takes several minutes for the eye to shift from dim light to brightness, and even longer to adjust from bright light to darkness. This process is called dark adaptation.

Wearing red goggles or working in a room illuminated by red light greatly reduces the time required for dark adaptation. Since red light stimulates the cones but not rods, the rods remain in a state of dark adaptation.

COLOUR VISION

For the human subjects the colour spectrum fades into invisibility at the extreme ends red and violet. However we are able to see some vivid colours that do not exist in the spectrum at all.

COMPLEMENTARY COLOURS

An interesting relationship exists among colours. If the spectral colours are wrapped around the circumference of a circle, allowing room between the red and violet ends of the spectrum for the purples and reds not found on the spectrum, the colours opposite each other on the circle will be complementary. That is if lights of these colours are mixed in proper proportions, they disappear to a neutral gray. Blue-yellow and red-green are the main complementary pairs.

Red, yellow, green and blue are called psychological primaries. These colours appear on the colour circle as more elementary than others. That is they appear to be composed of a single hue.

Red, green and blue are called colour-mixture primaries. These colours can be used to produce all other colours by additive mixtures.

PSYCHOLOGICAL DIMENSIONS OF COLOUR

There are three psychological dimensions of colour
1. hue 2. brightness and 3. saturation.

Hue-refers to what we ordinarily think of as the name of the colour. For e. g. red, green, etc. ,
Brightness-The physical basis of brightness is primarily the energy of the light source.

Saturation refers to the apparent purity of the colour.

COLOURBLINDNESS

The normal eye can discriminate three systems of colour Black-white, yellow-blue, and red-green. All other combinations can be derived from these. The person with normal vision is called a TRICHROMAT.

Colour blindness results from a deficiency in one or two of these systems. A person lacking one system but with the use of the other system is called a DICHROMAT. He is particularly colourblind. A person with only the black-white system is a MONOCROMAT and totally colourblind.

The most common colour blindness is red-green colour blindness.

AFTERIMAGES

If we stare at a red circle and then look at a plain gray surface, we are likely to see a green circle on it. This experience is called a NEGATIVE AFTERIMAGE. It is negative because green is the complementary colour of red.

After staring at a very bright light we are likely to see a whole succession of colours. But seeing the complementary colour is very common.

COLOUR CONTRAST

When two complementary colours occur side by side, each colour appears more lightly saturated than it would when placed next to noncomplementary colour. This effect is termed as SIMULTANEOUS CONTRAST.

NEURAL PROCESSING VISUAL INFORMATION

Much of the information transmitted to the brain is concerned with the differences and changes in the environment.

If a light is projected onto a single receptor, causing its fiber to begin firing, and a neighboring receptor is then stimulated the original fiber will begin to fire at a slower rate. The activation of the second receptor is inhibiting the first. This inhibitory effect is exerted mutually among the receptors so that each inhibits, and is inhibited by its neighbour. The impulse from each receptor flows out its horizontal nerve cells and flows to neibhouring retinal units to affect them negatively. This mechanism is called recurrent inhibition.

A system with recurrent inhibition will display a burst of neural impulses in the optic nerve when a light is first turned on, but after the light has been on for a while inhibition will gradually build up, and the nerve activity will drop back to approximately its resting level. When the light is turned off, the receptors will fire less rapidly, but the inhibitory effects still remain for a brief period, thus the neural activity in the optic fibers will drop for below the resting level and then gradually return to it as the inhibitory effects dissipate.

A system with recurrent inhibition has the ability to transmit the information about parts of the environment that are steady and changing. We can see that such a system has adaptive value for the organism. Attention to changing aspects of its surroundings is important for survival.

STABILIZED IMAGES

The eyes continually make minute oscillatory movements that cause light from the stimulus to strike different retinal receptors from the moment to the next. It is impossible to hold the eye steady, but several devices have been developed to eliminate the movement of the image on the retina.

Changes in illumination on receptors are necessary for us to see things. Without changes in intensity everything disappears. Our ability to see stationary objects depends on a visual system that responds to changes in illumination and an eye that transforms a fixed image into change stimulation on the retina.

THEORIES OF COLOR VISION

YONG – HELMHOLTZ THEORY

According to this theory there are three different kinds of colour receptors. One is sensitive to red, one to blue and one to green. All other colors are produced by a combined stimulation of these receptors.

This theory is based on the fact that three colours are sufficient to produce all colours in the spectrum. The modern form of this theory attempts to link three kinds of cones with three colours.

HERING THEORY

Hering proposed that there are three types of cones. One responds to degrees of brightness, the black –white continuum. And two colour cones, one provided the basis for red-green perception other for blue-yellow. Each receptor was assumed to function in two ways. Red-green and blue-yellow are pairs in the colour spectrum.

One colour of the pair is produced when the receptor is in a building-up phase (anabolic) and the other appears when the receptor is in a tearing-down phase (catabolic). The two phases cannot occur at the same time in a given receptor. Thus this is known as opponent-process theory.

In its modern form this theory assumes that the opponent processes takes place not in the cones but in coding mechanisms closer to the brain in the optic system.

TWO-STAGE PROCESS THEORY

According to this theory colour vision is a two- stage process.

1) The retina contains pigment that responds differentially to the light of three different colours.

2) These responses are encoded into two-colour, on-off signals by cells further along in the optic system for transmission to the higher visual centers.

HEARING

Physical Stimulus for the Ear

The ear is sensitive to mechanical energy to pressure changes among the molecules in the atmosphere. The sound waves generated by the vibration of molecules (in air, water, or some other medium) are the stimuli for hearing.

The two main characteristics of sound wave are

•frequency and
•amplitude

Frequency is measured in number of vibrations per second. That is the number of times per second that the complete cycle is repeated. The unit hertz (Hz) is used to denote cycles per second. That is, one cycle per second is one Hz.

Amplitude refers to the amount of compression and expansion, as represented by the amount by which the curve is displaced above or below the baseline.

Pitch and Loudness

The psychological correlate of frequency is pitch, the higher the vibration frequency, higher the perceived pitch. The amplitude of the sound wave determines the intensity with which sound pressure strikes the eardrum. The psychological correlate of intensity is loudness. The greater the intensity louder the tone.

We can hear frequencies that range from about 20 to 20,000 Hz. The intensity of sound is measured by the unit called decibel (db). At about 120 db sound intensity becomes painful. The loudness of normal conversation is about midway between these extremes at 20 db. Exposure to sound intensity of 90 db and above for an extended period of time can result in permanent deafness.

Complex tones and Noise

PURE TONESproduced by sound wave of a single frequency.

OVER TONESproduced by multiples of a frequency. Halves, thirds, quarters, fifths and so on.

TIMBERThe sound of one musical instrument differs from those of another.
Number of overtones produced and the construction of instrument enhance certain overtones and deaden others. This characteristics quality of a musical tone is called timbre.

It is the timber of a tone that tells us whether it is being produced by a piano or a clarinet. If one compares the dimensions of tone with those of colour, the following correspondences hold approximately.

ColourTone

Hue ---------- pitch

Brightness ----------Loudness

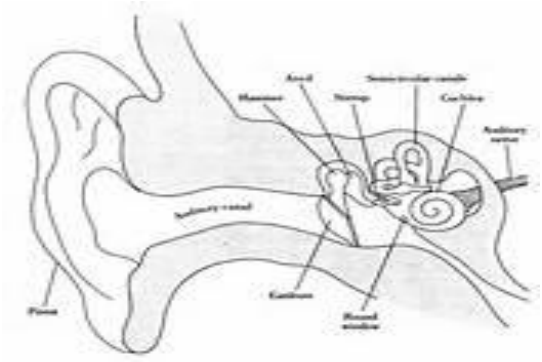
Saturation----------Timber

Hue and pitch are functions of wave frequency. Brightness and loudness are functions of amplitude. Saturation and timber are the results of mixture. When two tones are mixed together that is heard as consonant (pleasant or as dissonant unpleasant).

A noise is a sound composed of many frequencies not in harmonious relation to one another.

WHITE NOISE is composed of all frequencies in the sound spectrum at roughly the same energy level. (eg, The sound of a radio static or the bathroom shower).

THE HUMAN EAR



The human ear has three principal parts.

1. the external ear.

2. the middle ear and

3. the inner ear.

The external ear collects the energy. The middle ear transmits the energy and the inner ear convert the physical energy into nerve impulses. The pinna of the external ear collects energy, which travels through a small air-filled duct called the auditory canal to the eardrum. The eardrum is a thin membrane stretched tightly across the inner ear in the canal. Alterations in the pressure of the sound wave move this small membrane back and forth. The oscillation of the eardrum, in turn, moves three bones, the ossicles (hammer, anvil and stirrup) so that vibration is conducted through the middle ear to the entrance of the cochlea in the inner ear. The bones of the middle ear are connected like a series of levers. Hence energy is transmitted mechanically, and amplification takes place through the middle ear.

The inner ear sense organs for hearing are contained in a body structure that is spiraled like a snail and cochlea (from the Latin word meaning “snail-shell”). The cochlea has three fluid-filled canals spiraling around together and separated from one another by membranes.

The three canals of cochlea are 1. The vertibular canal2. The cochlear canal and 3. The tympanic canal.

As the ossicles move back and forth, one of them, the stapes, presses on a membrane called the oval windowwhich seals off the end of the vestibular canal ofthe cochlea. In this way when changes in the air pressure moves the ossicles back and forth, waves are set up in the fluid that fills the canals of the cochlea. The waves in the cochlea reach the organ of corti, which lies on the basilar membrane. The pressure waves in the cohlear canals produce bending movement of fine, hair like processes are bent, receptor potentials are initiated, thus starting the process by which nerve impulses are generating.

In summary, the bending of the hair cell fibers is the event that is responsible, in the auditory system, for the transduction of mechanical energy into nerve impulses. The nerve impulses initiated in the cochlea travel into the brain and then along certain nerve fibers within the brain. These fibers and the nerve cells, from which they originate, make up what is called the auditory pathway. Patterns of activity of nerve cells in this pathway and the cochlea itself comprise the afferent codes for what we hear.

AFFERENT CODES IN HEARING

Sense organs generate more and more impulses as the intensity of the stimulus increase. Pitch depends upon the fact that different portions of the organ of corti on the basilar membrane are maximally stimulated by different frequencies. The brain uses a place-code that is nerve impulses arising from a given region of the organ of corti are sensed as a particular pitch. This is sometimes called the pitch is which theory (for frequencies above 1500 Hz).

For lower frequencies (20-1500Hz) pattern of firing is established that is distinctive for a given frequency. It is this pattern which is the code for physical frequency in the brain and is correlated with the sensation of pitch.

THEORIES OF HEARING

PLACE THEORY

The place theory assumes that the frequency of a tone is indicated by the region of the basilar membrane that is maximally displaced by the sound wave. High frequency tones displace the narrow end of the basilar membrane near the oval window. Tones of intermediate frequency cause displacement further toward the other end of the basilar membrane. Low tones activate the entire membrane with roughly equal displacement.

FREQUENCY THEORY

According to this theory pitch is determined by the frequency of impulses traveling up the auditory nerve. The greater the frequency higher the pitch.

SENSORY PROCESSES – SMELL

Smell is one of the most primitive and most important of the senses. Smells trigger behavior and unpleasant smell arouses avoidance behaviour. Smells can also trigger memories of past emotional experiences.

There are four basic orders

1. Fragrant (musk)
2. Acid (vinegar)
3. Burnt (roast coffee)
4. Caprylic (goaty or sweaty)

SMELL RECEPTORS

Smell has a more direct route to the brain than any other sense. The receptors high in the nose, in the olfactory epithelium of each nasal cavity are connected without synapse directly to the olfactory bulbs of the brain, lying just below the frontal lobes. The olfactory bulbs are in turn connected with the olfactory cortex on the inside of the temporal lobes and extend to the neighbouring cortex.
Our sense of smell is little dull when we breath normally and quietly. That is animals and people sniff when they try to identify an odour.

SENSORY PROCESSES –TASTE

The primary taste qualities are
1. Sweet.
2. salt.
3. sour.
4. bitter.

Every other taste experience is composed of fusions of these qualities with other senses. Smell, texture, temperature and sometimes pain all contribute to the sensations we experience when we taste a food.

RECEPTORS FOR TASTE

The receptors for taste are specialized cells grouped together in little clusters known as taste buds. Most of these buds are located on the top and sides of the tongue, but a few of them are at the back of the mouth and in the throat. There are several bumps on the tongue. These bumps are called papillae. Papillae are richly populated with the taste buds. To stimulate the taste buds, substances must be in solutions that will wash around the papillae and penetrate to the taste buds in the clefts between them.

INPUT CODE FOR TASTE

The single fiber does not carry clear information regarding taste stimuli to the central nervous system. Because the fiber could be firing anyone of a number of stimuli has come in contact with the taste buds. However, it seems that afferent code for a particular taste consists of a pattern of firing in the nerve fibers from the taste buds. Thus one taste might be represented by high rates of firing in certain group of nerve fibers, intermediate rates in another group and low rates in others. Another taste would have a different pattern and so on.

REPRODUCTION OF CELLS

Taste cells are continuously reproducing themselves at the rate of a complete turnover for each taste bud every seven days. Sensitivity to sweet is greatest at the tip of the tongue, to salt on the tip and the sides, to sour on sides and to bitter on the back.

SENSORY PROCESSES-THE SKIN SENSES

The skin senses inform us about what is happening at the surface of our bodies. The skin can be thought of as a "giant sense organ" that covers the body. Skin sense are also be called as somatosenses.

Four skin senses are usually distinguished. They are

1) Pressure or Touch
2) Cold
3) Warmth and
4) Pain

The skin is not uniformly sensitive. The skin is sensitive at some points and not so sensitive at others. This is called "Punctuate sensitivity. The sensitive spots for the four basic skin senses are distributed differently over the patch of skin.

PRESSURE OF TOUCH

Receptors for touch

Meissner corpuscle serves the pressure sense in the hairless regions of the body. Basket nerve endings serves the pressure sense for the roots of hairs. Free nerve endings-endings not associated with any special structure-convey touch impulses where there are no other receptors. In addition to the sense of touch or pressure on the surface of the body, we are sensitive to deep pressure. The receptors for this sense seem to be small capsules called Pacinian corpuscles.

TEMPERATURE SENSATION-COLD AND WARMTH

Experiences of cold and warmth are elicited by changes in the normal gradient of skin temperature-that is, by changes in the difference between the temperature of the skin surface and the temperature of the blood circulating beneath it.

The temperature of the skin surface is usually about 32 or 33'C and that of the blood beneath it is about 37'C.

A stimulus of 28 to 30'C, which is definitely felt as cold, increases this gradient a little.

A stimulus of 34'C, which can be felt as warmth, decreases it a little. Thus it takes a change in skin temperature only 1 to 2'C to be experienced as warmth or cold.

RECEPTORS FOR COLD AND WARMTH

In skin maps, the cold spots and warm spots are found in different places.

Free nerve endings appear to be responsible for signaling information about temperature.

Increasing the temperature gradient by cooling the skin causes certain free-nerve-ending fibers to increase their rate of firing. These fibers might be called “cold fibers”.

Decreasing the temperature gradient by warming the skin causes an increase in the firing of certain fibers. These might be called “warm fibers”.

Thus the afferent code for the experiences of cold and warmth appears to be the rates of firing in cold and warm fibers.

PAIN

Pain is a skin sense. It motivates a multitude of behaviours. People will do many things to reduce it. Reduction of pain can swerve as a reinforcer in the promotion of learning. Pain may also trigger aggression against the source of the pain or even against neutral objects in the environment. Pain has immense biological importance because it may signal that something is wrong with the body.

PAIN STIMULI

Many different stimuli produce pain-a needle prick, scalding steam, a cut, a hard blow to the skin, inflammation and swelling, or strong chemical stimulation of the skin.

PAIN RECEPTORS

There is evidence that the receptors stimulated by this tissue damage are free nerve endings. The free nerve endings of the pain spots are specialized in some way to respond to painful stimuli and not to other stimuli.

AFFERENT CODES

The nerve fibers that carry information about pain into the spinal cord and brain are the smaller-diameter fibers in the sensory nerves form the skin and body organs. Rates of firing in these small nerve fibers constitute much of the afferent code for pain. But the central nervous system itself has much to say about how much pain is actually felt, or perceived.

PAIN GATES

As the pain inputs enter the spinal cord or brain, their transmission for further processing may be blocked. It is as if there are “gates” for pain input which can be closed.

Some pain-killing drugs, such as morphine and morphine-like compounds, seem to work because they are able to close these pain gates.

Increases in the activity of nerve cells in the brain-stem areas of midbrain and pons result in the blunting of human pain.

Body produces chemical substances which can act like morphine on the brain-stem cells of the pain gate. These self-produced opiates-known as enkephalins and endorphins-may be involved in closing the gates to lessen perceived pain.

Acupuncture procedures may stimulate the body to release its own opiates, which in turn activate the gate system.
A placebo is a pharmacologically inactive substance that a person is told will have a desired effect. Sugar pills are examples of commonly administered placebos. For those who believe in the effectiveness of the placebo, considerable pain relief is possible, and there is evidence linking the placebo effect with the opiate brain systems.
Hypnosis can also be used to relieve pain.

EQULIBRATORY SENSES

Equilibrioception or sense of balance is one of thephysiological senses. It helps prevent humans and animals from falling over when walking or standing still.

SENSE ORGANS FOR EQUILIBRATORY SENSE

The sense organs for equilibrium, located in the iner year, are a series of cavities extending from the cochlea. There are two systems.

1) Semicircular canals
2) Vestibular sacs

Semicircular canals:

There are 3 semicircular canals. They lie in planes, perpendicular to each others. The bodily rotation in any one of the planes will have maximum effect on one of the canals. Rotation at any angles to the planes will affect more than one.

The canals are filled with a fluid that moves when the head rotates and exerts pressure on hair cells similar to those of the organ of corti. Displacement of these hair cells by the movement of the fluid stimulates a nonauditory branch of the auditory nerve.

When rotation is slow and of moderate amount, the chief consequence is information that we are moving. When it is more extreme we experience dizziness and nausea.

Vestibular canals:

The vestibular sacs, between the base of the semicircular canals and the cochlea, provide for our perception of bodily position when the body is at rest. They respond to the till or position of the head and do not require rotation to be stimulated.

The receptors are hair cells that protrude into a gelatinous mass cantaining small crystals called otoliths ‘means, ‘ear stones’

The normal pressure of the otoliths on the hair cells gives us the sense of upright position. Any distortion tells us that the head is tilted.

KINESTHETIC SENSE (KINESTHESIS)

Kinesthesia is the sense which helps us detect weight, body position, or the relationship between movements in our body parts such as joints, muscles and tendons. In short, it is the muscle sense.

The muscle, tendon and joint sense make the sensory system called kinesthesis. This informs us of the position and movement of parts of the body.

Position and movements are detected by sense organs in the joints.

Sense organs in the muscles and tendons tell us whether a muscle is stretched or contracted and help to adjust muscular tension to the load upon it.

IMPORTANCE OF KINESTHESIS

Without kinesthesis we would have great difficulty in maintaining posture, walking, climbing, and controlling voluntary movements such as reaching, grasping and manipulating.

Whenever we cut, we first make somewhat tentative movements and then adjust them according to environmental effects. For example If something turnsout to be heavier than expected, we brace ourselves and lift with greater effect. The kinesthetic sense gives us a feedback from the environment that keeps telling us how things are going.

This sense deal with the body position in relation to gravity and with motion of the body as a whole.

The relation of bodily parts to one another and to external object is the responsibility of kinesthesis. The orientation of the body in space is the responsibility of the equilibratory senses.