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***Lesson No.***

- 1.1 : Psychophysics and its methods**
- 1.2 : Sensation**
- 1.3 : Structure and Functions of Eye**
- 1.4 : Structure and Functions of Ear**
- 1.5 : Skin Sensation & Chemical Sensation**

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The objective of this chapter is to understand the concept of psychophysics and its various problems. We shall be covering basic concepts of psychophysics, Weber's law and Fechner's law in this lesson which is also known as Weber-Fechner's law.

By the end of this chapter you should be able to explain.

- Method of Limits
- Method of Average Error
- Method of Constant Stimuli

### 1.1.1 INTRODUCTION

One of the oldest problems in psychology is the study of the mind-body relationship, i.e., what has acted upon the body and what has been experienced by the individual. In simpler words, there may be difference between physical stimulation and its subsequent reported experience, and this comes within the domain of psychophysics. Psychophysics is that branch of Psychology which studies the quantitative relationship between stimulus and response in the context of the factors that affect this relationship. What are the lawful relationships between the measurable characteristics of the stimulus on one hand, and the reported attributes through sensory experience on the other hand? The answer to this question is dealt by psychophysics, one of the earliest branches of experimental psychology. According to Underwood (1965), "Methods used to study the stimulus-response relationships in the situations in which stimuli are varied along a physical dimension are commonly called psychophysical methods," These psychophysical methods are procedures by which the experimenter may quantify relations between a stimulus and the sensation or experiences that follows:

Defining the concept of Psychophysics is not an easy task when people have different views.

According to Andrews : Psychophysics is that branch of psychology, which is concerned with subjective measurements.

According to Guilford, "Psychophysics has been regarded as the science that investigates the quantitative relationships between physical events and corresponding psychological events.

According to Eysenck, "Psychophysics concerns the manner in which living organisms respond to the energetic configurations of the environment:

On the basis of above definitions it can be said that psychophysics is that branch of psychology that studies the quantitative relationship between stimulus and response in the context of the factor that effect this relationship.

### 1.1.2 BASIC PROBLEMS OF PSYCHOPHYSICS

Psychophysics is concerned with three basic problems :

- i) Detection of minimal stimulus;
- ii) Detection of minimal stimulus difference; and
- iii) Judgment of relations between stimuli,

#### 1.1.2.1 DETECTION OF MINIMAL STIMULUS :

This refers to what is the least amount of stimulation that is required for the detection of a stimulus. It is also known as Absolute Threshold, Lower Threshold and Reiz Limen and refers to "The value of a quantitative variable at which a stimulus is just detectable. In other words, how loud must the bell be so that it is audible or

how bright must a pinpoint of light be so that it is visible. So, this problem is concerned with what is the minimum of stimulation required for the detection of a stimulus. How intense must it be so that the subject can differentiate between its presence and absence. It is obvious that this will vary not only from person to person but also from one testing condition to another. For instance, a sound has to be less intense in a sound-proof room than a noisy room to be audible.

#### **1.1.2.2 DETECTION OF MINIMAL STIMULUS DIFFERENCE :**

This refers to what should be the least amount of difference between two stimuli so that they can be perceived as different by the subject. In simpler words, by how much minimum intensity should two bulbs differ so that they can be judged as different from one another by the subject. It is also known as Just Noticeable Difference and refers to the amount of Physical change necessary to bring about it and is just noticed. So, psychophysics is concerned with the question that what is the minimal difference, qualitative or quantitative, that is needed between two stimuli so that they can be perceived as different by the subject. Again, the minimum value of difference will vary from subject to subject, and from one testing condition to another.

#### **1.1.2.3 JUDGEMENT OF RELATIONS BETWEEN STIMULI :**

The experimental problems of psychophysics are not limited to the study of stimuli and stimulus differences that are detectable by the subject. The judgement of relations among stimuli is another important domain of investigation : For instance are two lines equal to each other, or is one shorter than the other? Similarly, are two light stimuli of equal intensity same or is one brighter than the other? What is the extent of error that the subject is liable to make when he tries to equate two stimuli with respect to quality or quantity. These are some of the problems in two stimuli with respect to quality or quantity. These are some of the problems in psychophysics which arise in connection with judgement of relations between stimuli.

### **1.1.3 BASIC CONCEPTS OF PSYCHOPHYSICS**

Let us next deal with the basic concepts of psychophysics, which are as follows :

- (i) sensitivity;
- (ii) threshold;
- (iii) point of subjective equality; and
- (iv) errors.

#### **1.1.3.1 SENSITIVITY :**

The organism is equipped with a number of receptor organs specialized to respond to particular energy changes in the environment. The receptors of the eye respond to light, that of the ears to sound waves, and so on. The capacity of the receptor organs and other reaction systems in the organism to respond selectively and differentially to physical stimulation is called sensitivity. It is of two types :

- (i) Absolute sensitivity; and
- (ii) Differential sensitivity.

**(i) Absolute Sensitivity :**

It defines the units of the organism's capacity to respond to stimulation. It is inversely related to the minimum stimulus which can be detected reliably by the subject.

**(ii) Differential Sensitivity :**

It defines the organism's capacity to respond to minimal differences, both qualitative and quantitative, between stimuli. It is inversely related to the minimum difference between stimuli needed for reliable discrimination (since the lesser the minimum difference required for differentiation, the more sensitivity).

**1.1.3.2 THRESHOLD :**

The word threshold means 'boundary'. In psychophysics, the term threshold is used to demarcate the boundary distinguishing two different types of response. These responses further depend on the type of threshold being considered. Threshold are of two types :

- (i) Absolute threshold; and
- (ii) Differential threshold

**(i) Absolute threshold :**

It distinguishes between two types of responses-the stimulus is present or it is absent. In a typical experiment, the experimenter begins with a sound that is inaudible. Slowly, its intensity is increased in small steps till the subject reports that he can hear that sound. Statistically speaking, absolute threshold is that stimulus value that is detected by the subject 50% of the times. Absolute threshold is an inverse measure of sensitivity since the lower the threshold, the more sensitive is the subject.

**(ii) Differential threshold :**

Differential threshold is that stimulus difference value that is detected by the subject estimation or under-estimation. In simple terms which gives rise to a judgment of difference 50% of the time. For instance, if we present the subject with two tones differing only very little in intensity, he will fail to report a difference most of the time. As we increase the intensity difference between the two sounds so as to obtain a judgment of difference on half the trials, this difference denotes the differential threshold for that particular subject. In D'Amato's words, "Difference Limen is the minimum amount of stimulus change required to produce a sensation difference."

**1.1.3.3 POINT OF SUBJECTIVE EQUALITY :**

In typical experiments of psychophysics, two types of stimulus are involved-the **standard stimulus** and the **comparison or variable stimulus**. The standard stimulus is kept constant (i.e., at a constant value) throughout the experiment, whereas the value of the variable stimulus varies across the experiment. For instance, the standard stimulus could be a 10 inch line and the variable stimulus would be a line whose length can be varied. The subject is asked to set the length of the variable stimulus so that it looks equal to that of the standard stimulus. So, point of subjective equality is that value of the variable stimulus, which on an average, looks equal to the standard stimulus to the subject.

**1.1.3.4 ERRORS :**

In psychophysical experiments, the subject is asked to make different types of judgements. These judgments may vary from trial to trial. So, the term error refers to the extent of error in judgment. There are two types of errors :

- (i) Variable error; and
- (ii) Constant error.

**(1) Variable error :**

The degree to which judgments differ from trial to trial provides an index of the amount of variable error. These variable errors could be due to conditions within the subject (such as fatigue, boredom, etc.) or those in the environment such as lack of light, lots of noise, etc.)

**(2) Constant error :**

This refers to the systematic tendency on the part of the subject towards over estimation or under-estimation. In simpler words, if the subject exhibits a systematic tendency to over estimate or under-estimate a particular stimulus out of two stimuli presented to him over a series of trials, we say that the subject is committing a constant error. There are different types of constant errors, and these are as follows :

- (a) Space Error;
- (b) Movement Error; and
- (c) Time Error.

**(a) Space Error :**

The subject's judgments may be influenced systematically by the spatial position of the stimuli, for instance, whether they are on the right or left of the object.

**(b) Movement Error :**

The subject's judgments may be influenced systematically by the kind of movements that he is making. For example, whether he is making inward or outward movement as in the case of Muller-Lyer illusion apparatus so that the variable line looks equal to the standard line to the subject.

**(c) Time Error :**

The subject's judgment may be influenced systematically by the presentation of the stimuli with respect to time. For instance, if two sounds are presented, one followed by the other, and if the subject shows a tendency to over-estimate or under estimate the second of the two successive stimuli, then it is indicative of time error.

**1.1.4 WEBER'S LAW**

For quantification of general principle, we have to know the consistent of systematic relation between the value of the standard and the amount of change in that standard necessary to produce a just noticeable difference. Weber's law states such a mathematical relationship. It states that the just noticeable increment to any stimulus bears a constant ratio to that stimulus, i.e.,

$$\frac{\text{Differential Threshold}}{\text{Standard Stimulus}} = \text{Constant}$$

Putting this fact in other words, it can be said that according to Weber's Law, if we vary the amount of the standard stimulus along a given dimension, the measure of the differential threshold at each point of change, the ratio of the size of the standard and the size of the differential threshold should remain about constant. Weber's law as such allow one to make no assumption concerning the increased variability of response as the magnitude of the standard stimulus goes from low to high. However, if we find that the variable error increases as the size of a standard increase along a given dimension, we can deduct Weber's law from the fact. Increased variability refers to less precision of response, suggesting that a greater change would be necessary to bring about a clear cut discriminable difference. This law suggests that the stronger or larger the standard stimulus, the greater increment is necessary to produce a perceived change. This relationship holds in general throughout the wide range of stimuli to which the organism is sensitive. Since Weber's law has been shown to be inaccurate in some instances, there have been several substitute laws attempting to state the relationship more precisely.

### 1.1.5 FECHNER'S LAW

Fechner believed that the stimulus and sensitivity can be measured directly but sensation needs to be measured indirectly by its differential increments. He assumed that the sensed differences being all just noticeably different are equal and constitute a proper unit. One has only to integrate to accomplish the mathematical counterpart of counting up units to perform a measurement. If we use this fundamental formula, we can certainly measure sensation. Therefore, Fechner integrated the equation arriving at :

$$S = K \log R$$

Where R is the German abbreviation for stimulus and S is the strength of Sensation or Response. Putting this fact in other words, it can be said that *the Strength of the sensation varies directly as the logarithm of the stimulus*, according to Fechner's Law. Fechner, himself did not actually generalize any law but only modified Weber's law. As such, it is also known as the Weber-Fechner law, which represents the functional relation between the measured magnitude of the stimulus and the measure magnitude of sensation.

### 1.1.6 Introduction to Methods of Psychophysics

"Methods used to study the stimulus response relationships in the situations in which stimuli are varied along a physical dimension are commonly called psychophysical methods." (Underwood, 1965). These psychophysical methods are procedures by which the experimenter may quantify relations between a stimulus and the sensation or experiences that follows.

Psychophysical methods can be classified into three types :

- (i) Method of Limits;
- (ii) Method of Average Error; and
- (iii) Method of Constant Stimuli.

### 1.7 METHOD OF LIMITS

This method is also known as the Method of Minimal Changes or the method of Just Noticeable Difference. In this method, a series of stimuli, successively differing by small amounts, are used in order to make an estimate of the threshold value.

#### 1.1.7.1 Measurement of Absolute Threshold by the Method of Limits

The basic procedure consists of the presentation of a series of stimuli, each differing from the preceding one by a small amount, until a critical change in the subject's judgments offers. This involves two kinds of series :

- (i) ascending series; and
- (ii) descending series.

In an **ascending series**, we start with a stimulus value well below the threshold, and increase its magnitude on successive trials until the subject detects the presence of the stimulus. In a **descending series**, we start with a stimulus value well above the threshold, and then go on decreasing its magnitude on successive trials till the subject fails to detect the presence of the stimulus.

For example, let us consider the following data that the experimenter obtained by conducting a study using aesthesiometer for computing two-point threshold. The subject was asked to report whether he felt one or two points on his upper arm.

| Distance in (mm)  | A    | D    | A    | D    |
|-------------------|------|------|------|------|
| 21                | 2    | 2    | 2    | 2    |
| 20                | 2    | 2    | 2    | 2    |
| 19                | 2    | 2    | 2    | 2    |
| 18                | 2    | 2    | 2    | 2    |
| 17                | 2    | 2    | 2    | 2    |
| 16                | 1    | 2    | 2    | 1    |
| 15                | 1    | 1    | 1    | 1    |
| 14                | 1    | 1    | 1    | 1    |
| Transition Points | 16.5 | 15.5 | 15.5 | 16.5 |

Mean of the transition points are calculated according to the following formula:

$$\text{Mean} = \frac{\sum X}{N} = \frac{16.5 + 15.5 + 15.5 + 16.5}{4} = \frac{64}{4} = 16\text{mm}$$



The transition point in each series is indicated by the points where subject reports difference. Thus the mean of individual thresholds would define our accepted absolute threshold value that stimulus value which will elicit a response 50% of the time.

### 1.1.7.2 Measurement of Differential Threshold by the Method of Limits

This method is used to answer the problem of just how much change must take place in a stimulus before a subject is able to report accurately a change. In this method as well we take the ascending and descending series for accurate results. In this method one standard stimulus (the intensity of which will not vary) is compared with the variable stimulus and the subjects' experiences of "heavier", "equal" and "lighter" for the variable stimulus are noted down.

Let us consider the following data for the measurement of DL

| Weight (n gms.) | A     | D     | A     | D     | A     | D     | A     | D     | A     | D     |
|-----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 165             | +     | +     | +     | +     | +     | +     | +     | +     | +     | +     |
| 160             | +     | +     | +     | +     | +     | +     | +     | +     | +     | +     |
| 155             | +     | +     | +     | +     | +     | +     | +     | +     | +     | +     |
| 150             | +     | +     | +     | +     | +     | +     | +     | +     | +     | +     |
| 125             | =     | +     | =     | +     | +     | +     | +     | =     | +     | +     |
| 120 (st)        | =     | =     | =     | +     | =     | =     | +     | =     | =     | =     |
| 115             | =     | =     | -     | =     | -     | -     | =     | -     | -     | -     |
| 110             | =     | -     | -     | -     | -     | -     | -     | -     | -     | -     |
| 105             | -     | -     | -     | -     | -     | -     | -     | -     | -     | -     |
| 100             | -     | -     | -     | -     | -     | -     | -     | -     | -     | -     |
| 75              | -     | -     | -     | -     | -     | -     | -     | -     | -     | -     |
| T+              | 137.5 | 122.5 | 137.5 | 117.5 | 137.5 | 137.5 | 117.5 | 137.5 | 122.5 | 122.5 |
| T-              | 107.5 | 112.5 | 117.5 | 112.5 | 117.5 | 112.5 | 117.5 | 117.5 | 117.5 | 117.5 |

T+ is the transition point between + and = signs.

T- is the transition point between + and - signs.

$$\text{Mean T +} = \frac{\sum X}{N} = \frac{1290}{10} = 129$$

$$\text{Mean T -} = \frac{\sum X}{N} = \frac{1150}{10} = 115$$

$$\begin{aligned} \text{Upper D.L.} &= \text{Mean (T+) - Standard} \\ &= 129 - 120 = 9 \end{aligned}$$

$$\begin{aligned} \text{Lower D.L.} &= \text{Standard - [Mean T (-)]} \\ &= 120 - 115 = 5 \end{aligned}$$

$$\begin{aligned}
 \text{D.L.} &= \frac{\text{Upper D.L.} + \text{Lower D.L.}}{2} = \frac{9 + 5}{2} = \frac{14}{2} = 7 \text{gms} \\
 \text{P.S.E.} &= \frac{\text{Mean (T+)} + \text{Mean (T-)}}{2} \\
 &= \frac{129 + 115}{2} \\
 &= \frac{244}{2} \\
 &= 122 \text{ gms} \\
 \text{Interval of Uncertainty (IU)} &= \text{Mean (T+)} - \text{Mean (T-)} \\
 &= 129 - 115 = 14 \\
 \text{Constant Error (CE)} &= \text{P.S.E.} - \text{Standard} \\
 &= 122 - 120 \\
 &= 2 \text{ gms.}
 \end{aligned}$$

### 1.1.8 IMPORTANT TERMS

**IU**-Interval of uncertainty is calculated by the formula Upper Threshold-Lower Threshold. It is the point when the subject doesn't distinguish between the standard stimulus and the variable stimulus.

**PSE**-Point of Subjective Equality is another quantity of interest that can be calculated from the data. Subject does not always judge  $S_t$  and  $S_v$  to be equal when and only when they are in fact equal. The question therefore arises as to the value of  $S_v$  that subject perceives as equal to  $S_t$ , a value that carries the suggestive name, "the point of subjective equality." PSE is calculated by adding the mean of  $T^+$  and  $T^-$  and dividing it by 2.

**DL**-Difference Limen is a measure of differential sensitivity, i.e., the ability to discriminate differences between stimuli.

#### 1.1.8.1 METHOD OF AVERAGE ERROR

This method is designed to study the precision of observation or the precision of any matching procedure. As explained in chapter 1, the subject is presented with a standard stimulus. For example, if the experiment is on Muller-Lyre illusion, the standard stimulus is a 10 inch line. He has to adjust the length of the variable line so that it looks equal to the standard. Here, the subject can make movement from the left or right (by manipulating the apparatus). Also, he can make inward and outward movement. So, the data is collected and tabulated in the following form :

| Direction | Trials |   |   |   |   |   |   |   |   |    |
|-----------|--------|---|---|---|---|---|---|---|---|----|
|           | 1      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| RO        | -      | - | - | - | - | - | - | - | - | -  |
| LO        | -      | - | - | - | - | - | - | - | - | -  |
| RI        | -      | - | - | - | - | - | - | - | - | -  |
| LI        | -      | - | - | - | - | - | - | - | - | -  |

where RO      Stands for right outward

LO      Stands for left outward

RI      Stands for right inward

and LI      Stands for left inward experimental condition

$$\text{P.S.E.} = \frac{\text{Mean RO} + \text{Mean LO} + \text{Mean RI} + \text{Mean LI}}{4}$$

$$\text{Space Error} = \frac{\text{Mean Right} - \text{Mean Left}}{2}$$

$$\text{Movement Error} = \frac{\text{Mean Inward} - \text{Mean Outward}}{2}$$

$$\text{Constant Error} = \text{P.S.E.} - \text{Standard}$$

Constant Error gives the quantitative measure of the extent of the illusion.

So, with the help of this method, we can calculate P.S.E. as well as the constant error. We can also have an estimate of various systematic tendencies on the part of the subject such as space error and movement error.

#### 1.1.8.2 METHOD OF CONSTANT STIMULI

This method too, is used for the measurement of thresholds. In this, each trial consists of the presentation of an invariable stimulus and the subject is asked to report its presence or absence. Here, the stimuli are not presented in an ascending or descending order of magnitude (as in the method of limits), but rather in a random order.

#### 1.1.8.3 Measurement of Absolute Threshold with the Method of Constant Stimuli

Let us take an example (of two-point threshold) similar to the one taken earlier while discussing the method of limits. In a typical experiment, the subject is asked to report to the experimenter whether he experiences one stimulus point or two points of the aesthesiometer. The experiment, by means of preliminary work, determines the approximate value of the subject's AL. Then, a series of stimuli is chosen extending from well below to well above the threshold value, and presented in a random order, and the subject's responses are noted down by the experimenter.

| Distance (in mm) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------------------|---|---|---|---|---|---|---|---|---|----|
| 19               | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2  |
| 18               | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 2  |
| 17               | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2  |
| 16               | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 1  |
| 15               | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1  |
| 14               | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 2  |
| 13               | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1  |

| Distance (in mm) | One-Point Sensation | Two-Point Sensation | % of Two-point Sensation |
|------------------|---------------------|---------------------|--------------------------|
| 19               | 1                   | 9                   | 90                       |
| 18               | 2                   | 8                   | 80                       |
| 17               | 3                   | 7                   | 70                       |
| 16               | 4                   | 6                   | 60                       |
| 15               | 6                   | 4                   | 40                       |
| 14               | 6                   | 3                   | 30                       |
| 13               | 7                   | 2                   | 20                       |

The following formula is applied for calculating Riez Limen :

$$RL = \frac{Db(50 - a) + (b - 50)}{\frac{31}{2}} = 15.5 \text{ mm}$$

Where Db is stimulus value giving above 50% response.

b is the % value for Db

Da is stimulus value giving below 50% response

a is the % value for Da

$$RL = \frac{16(50 - 40) + (60 - 50)}{60 - 40}$$

#### 1.1.8.4 Measurement of Differential Threshold with the Method of Constant Stimuli

Let us consider an example in which the subject's task is the judgement of weights, i.e. whether the variable stimulus weighs equal to the standard stimulus

(70 gms) across a series of trails. Suppose the data tabulated is as follows :

| Weight<br>(in gms) | Heavier |     | Lighter |     | Euqual |    |
|--------------------|---------|-----|---------|-----|--------|----|
|                    | f       | %   | f       | %   | f      | %  |
| 78                 | 20      | 100 | 0       | 0   | 0      | 0  |
| 76                 | 17      | 85  | 0       | 0   | 3      | 15 |
| 74                 | 15      | 75  | 0       | 0   | 5      | 25 |
| 72                 | 7       | 35  | 5       | 25  | 8      | 40 |
| 70 (st)            | 4       | 20  | 8       | 40  | 8      | 40 |
| 68                 | 2       | 10  | 8       | 40  | 10     | 50 |
| 66                 | 1       | 5   | 15      | 75  | 4      | 20 |
| 64                 | 0       | 0   | 20      | 100 | 0      | 0  |
| 62                 | 0       | 0   | 20      | 100 | 0      | 0  |

$$\text{Upper Threshold (UT)} = \frac{Db(50 - a) + Da(b - 50)}{b - a}$$

where Db is stimulus value giving nearest % above standard and b is its % value.

Da is stimulus value giving nearest % above standard and a is its % value.

$$\Gamma = \frac{72(50 - 10) + 68(35 - 50)}{35 - 10} = 74.4$$

$$\begin{aligned} \text{Lower Threshold} \\ \text{LT} &= \frac{Db(50 - a) + Da(b - 50)}{b - a} \\ &= \frac{68(50 - 25) + 72(40 - 50)}{40 - 25} \end{aligned}$$

$$= 65.33$$

$$\text{P.S.E.} = \frac{UT + LT}{2}$$

$$= 69.87$$

$$\begin{aligned} \text{IU} &= UT - LT \\ &= 74.4 - 65.33 \\ &= 9.07 \text{ gms.} \end{aligned}$$

$$\begin{aligned} \text{DL} &= \frac{UT + LT}{2} \\ &= \frac{74.4 - 65.33}{2} \\ &= \frac{9.07}{2} \end{aligned}$$

|    |   |                   |
|----|---|-------------------|
|    | = | 4.54 gms.         |
| CE | = | P.S.E. - Standard |
|    | = | 69.87 - 70.00     |
|    | = | 0.13 gms.         |

### 1.1.9 EXERCISE

- Q1 What are psychophysical methods discuss its types in short?  
Q2 Explain the Method of Limits in detail.  
Q3 State the meaning of the terms PSE, Constant Error, Space Error and Movement Error.

Write short notes on the following terms

- (a) Threshold
- (b) Point of subjective equality
- (c) Absolute Threshold
- (d) Differential threshold

### 1.1.10 REFERENCES

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**LESSON STRUCTURE****1.2.0 Objective****1.2.1 Introduction****1.2.2 Definition of Sensation****1.2.3 Characteristics of Sensations****1.2.4 Types of Sensations****1.2.4.1 Organic Sensations****1.2.4.2 Special Sensations****1.2.4.3 Kinesthetic or motor Sensations****1.2.5 Let us Sum it up****Check your progress****References****1.2.0 OBJECTIVE**

This lesson aims at providing an introduction to how we receive a stimulus from the environment and thereby interact with it. It will be done by defining sensation and giving its attributes.

By the end of this lesson you should be able to explain, what is sensation and what are its attributes.

**SENSATIONS****1.2.1 INTRODUCTION**

Behaviour as we know would be impossible without some way of knowing about the world around us. It is through our senses that we know about the world therefore we need to study sensation and sense organs.

Thus the study of sensation is concerned with the vital contact between organisms and their physical environment. It focuses on describing the relationship between various forms of sensory stimulation and how these inputs are registered by our sense organs i.e eyes, ears, nose, tongue, and skin.

Although, we are continually bombarded by various forms of physical energy, our brain responds only to intricate patterns of action potentials conducted by neurons special cells within our body that receive, move and process sensory information. Highly specialized cells known as **Sensory Receptors** located in our eyes, ears, nose, tongue and elsewhere, are responsible for accomplishing this task which is called **transduction**.

**TRANSDUCTION** - A process in which physical properties of stimuli are converted into neural signals that are then transmitted to our brain via specialized sensory nerves. It is also called encoding.

**ADEQUATE STIMULUS** - Any specific physical stimulus that alone can stimulate the sense organ is called its adequate stimulus. Light is adequate stimulus for the eye and sound waves for the ear.

**DECODING** - The incoming information is encoded by the receptors for transmission to the specialized area in the cerebral cortex. In the cortex the encoded information is decoded and interpreted.

### 1.2.2 DEFINITIONS OF SENSATIONS

According to Jalota, "Sensation is a primary cognitive experience."

According to James, "Sensation is the first thing in the way of consciousness"

According to Bootzin, "The activation of sensory receptors and processing and transmission of these signals to higher centres in the brain is called sensation".

Thus, in the light of the above definitions, sensation can best be described as elementary, abstract, cognitive process, caused by the stimulation of sense organs and giving knowledge of the work around either of qualities of outside object or of state at our own bodies.

### 1.2.3 CHARACTERISTICS OF SENSATION

Sensation is the simplest and the easiest mental process. The following characteristics or attributes which are present in every sensation will throw light on the nature of particular sensation.

1. **It is Relatively Passive State:** Sensation is relatively passive mental process because the sense organs receive the sensation or stimulation passively.
2. **Partly Subjective and Partly Objective:** Sensations form a part of individuals' personal experience and are subjective to some extent, on the other hand, they are also objective as they are answered by an external stimulus.



3. **Difference in Quality:** It differs in quality for there are different sense organs which produce different kind of sensations from different stimuli. The sensation of colour is different from the sensation of pain.
4. **Difference in Intensity:** It refers to the distinction in the intensity, duration and extensity. There shall be difference in sensation of hearing of loud sound as compared to hearing of low sound. Ex-buzzing of mosquito at a yards distance is not noticed. We feel difference between flash of lighting and the spark of a firefly.
5. **Related with other sensation:** No sensation is complete by itself, it has relationship with other sensations, it is very much dependent upon the nature of other sensations.
6. **Difference in trait:** The sensation related to colour have the different character than the sensation of voice.
7. **Special sensation can be distinguished:** We can easily distinguish various sensations for they are situated in the external parts of the body.
8. **Agents involved in sensation:** In the production of sensation, three agents are involved.
  - a) **An organ:** to receive the stimulus ( eyes)
  - b) **A sensory nerve:** to carry the impressions to the brain ( optic nerve)
  - c) **The centre in the brain :** To receive and convert the impression into the sensation [Central Nervous System (C.N.S.)]

**Key words****Stimulus Threshold**

It is the intensity of stimulus which is detected by the subject in 50 percent of the trials. It is the minimum intensity that can be detected by the subject.

**Subliminal Stimulus**

It is a stimulus of intensity less than the threshold value for that particular stimulus.

**Terminal Threshold**

It is the intensity above which the subject cannot detect the stimulus meaningfully and thus the sensation will not be able to produce any perception. Eg : Blinding effect of a bright light , deafening effect due to a loud sound.

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***Sensory Adaptation***

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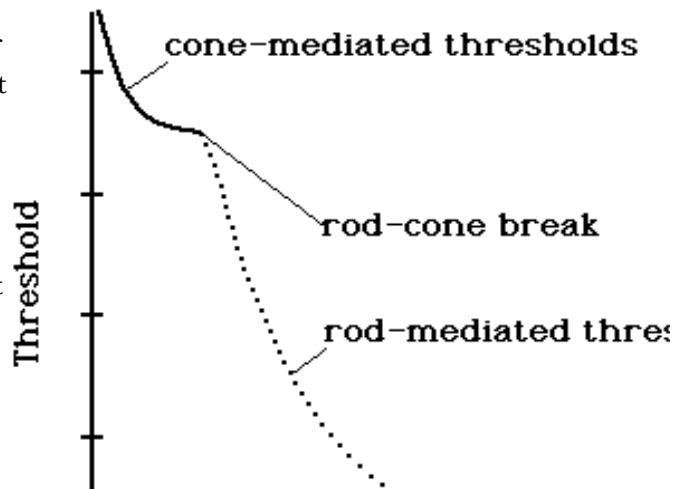
*Sensory Adaptation* occurs when sensory receptors change their sensitivity to the stimulus. This phenomenon occurs in all senses, with the possible exception of the sense of pain.

**Dark Adaptation**

Dark adaptation, or adaptation to reduced light intensity, involves three distinct changes in the visual system:

- Enlargement of the pupil -- takes place immediately. The larger pupil allows more of the available light to enter the eye and stimulate the retina.
  - Increased sensitivity of the cones (color receptors) of the eye -- In low levels of illumination, the light-sensitive chemical in the cones increases in concentration. This makes it more likely that molecules of the chemical will be struck by particles of light (photons), initiating a chemical cascade that signals the detection of light by the receptor. Cones become completely dark-adapted within about five to ten minutes, but at best remain unresponsive to the levels of light present at night or in a darkened theater, resulting in a loss of color vision under those conditions.
  - Increased sensitivity of the rods (night-vision receptors) of the eye -- As with the cones, the rods contain a light-sensitive chemical whose concentration increases under low light-levels, leading to increased sensitivity. Rods become fully dark-adapted after about 20-30 minutes.
-

The increased sensitivity produces a reduced threshold for detecting light. The figure to right shows the falling threshold values as a function of time spent in darkness. The left part of the curve is produced by adaptation of the cones, the right part by adaptation of the rods.



appear to be blue-green look brighter to the rods than they do to the cones, because rod sensitivity peaks in the blue-green region of the color spectrum. To make a scene shot in the daylight look like a moonlit scene, movie cameramen shoot the scene in black and white, with a filter over the lens that allows blue-green light to enter the camera better than other colors, making objects of that color appear relatively brighter, compared to other objects, than they do when seen in daylight. Rods are blind to red light. Thus, to view a map at night without disturbing the dark-adaptation of the rods ("night vision"), illuminate the map in red light. Because the rods do not "see" the red light, they remain fully dark adapted.

### Light Adaptation

As with dark adaptation, light adaptation involves (a) an immediate change in pupil size (it becomes smaller, admitting less light), (b) a change in the sensitivity of the cones to light (it decreases), and (c) a change in the sensitivity of rods to light (it also decreases). Because the large number of photons entering the eye rapidly destroy any excess light-sensitive chemical, light adaptation takes only a couple of seconds, rather than the many minutes required for dark adaptation.

**Other Examples of Sensory Adaptation**

Hearing -- loud sound causes a small muscle attached to one of the bones of the inner ear to contract, reducing the transmission of sound vibrations to the inner ear, where the vibrations are detected. (This protective mechanism does not work well for sudden very loud noises such as rifle shots, as the muscle does not have time to contract before the intense vibrations pass through.)

Touch -- We quickly adapt to hot and cold stimulation, if it is not too intense. The bath that was almost too hot to enter soon feels too cool; similarly, the cold lake we jump into for a summer swim feels freezing at first, but soon feels only refreshingly cool.

Smell -- We can detect amazingly low concentrations of some chemicals in the air (e.g., perfumes) but although the perfume is still in the air about us, we quickly cease to detect it.

Distorting goggles make an object that may be straight in front appear to be several degrees off to left or right. If you try to throw a ball to another person while wearing

to readjust the relationship between where you see the person standing and the feel of the motion of your arm as you throw, and are then able to throw the ball directly toward the person. However, take the goggles off and initially you will now throw wildly off in the opposite direction from your initially wild throws with goggles on. With a couple of practice throws you quickly readjust again.

**1.2.4 TYPES OF SENSATION****1.2.4.1 ORGANIC SENSATION**

The term organic sensation is used to cover a variety of sensations from the internal organs, such as hunger, thirst, nausea, heart burn, suffocation, and the vague bodily sensations that colour the emotional tone of any moment. The viscera include the stomach, intestines, internal sex structures and kidneys. Non visceral inner structures are the throat, lungs and heart. Activities of the internal organs excite sensory fibres, sending nerve impulses into the central nervous system. Reception of these impulses in the brain underlies organic sensitivity, Example: thirst is associated with the dryness in the throat and hunger with the stomach contractions.

**1.2.4.2 SPECIAL SENSATION**

There are as many kinds of sensations as there are sense organs. Each of the specialized sensory systems seeing, hearing, feeling, smelling, tasting- gathers information that humans must have to get along in this world. The sensation of colour, sound, smell, taste, temperature and pressure are the special sensations. They are produced by special kind of external stimuli like light waves and sound waves etc.

**1.2.4.3 KINESTHETIC OR MOTOR SENSATIONS**

Kinesthetic Sensations give us information about our body movements and position. It helps us to stand up, walk, and talk and to make any coordinated movement. Receptor cells for the kinesthetic sensation are found in nerve endings within and near the muscles, the tendons and more than 100 body joints. The kinesthetic sensation co-operates with the vestibular and visual senses to maintain the balance and equilibrium. As we walk along, our head never stops moving, yet we see a steady and solid world.

**1.2.5 LET US SUM UP**

Hence, it can be seen that sensation, which is caused due to the stimulation of the sense organs have certain characteristics and types which can best decide the type of sensation experienced.

## CHECK YOUR PROGRESS – I

Note: Space provided is for writing the answer.

**State in not more than 15 lines definition and characteristics of Sensation.**

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### References :

1. Hilgard, Atkinson and Atkinson : Introduction to Psychology.
2. Morgan, Ring Weisz & Schopler : Introduction to Psychology.
3. Woodworth & Schlosberg : Experimental Psychology.

**LESSON STRUCTURE****1.3.0 Objective****1.3.1 Introduction****1.3.2 Structure and Functions of the Eye****1.3.2.1 Structure of the Eye****Sockets****Eyelids and Eyelashes****Eyeball****1.3.2.2 Functioning of the Human Eye****1.3.3 Short Questions****1.3.3.1 Light****1.3.3.2 Physical Properties of Light****1.3.3.3 Colour Blindness****1.3.3.4 Visual Acuity****1.3.3.5 Visual Adaptation****1.3.3.6 Afterimages****1.3.3.7 Warm and Cool Colours****1.3.4 Summary****Check Your Progress****References****1.3.0 OBJECTIVE**

"This lesson aims at giving the details of visual sensation i.e. structure of the eye, functions of the eye, and other processes taking place in the course of vision phenomena.

After going through this lesson you should be able to comprehend the process of vision.

**1.3.1 VISUAL SENSATIONS**

For most people, sight is the most important way of gathering information about the world. In many ways, vision is our most important sense. It contributes enormously to our awareness of the surrounding environment and it provides

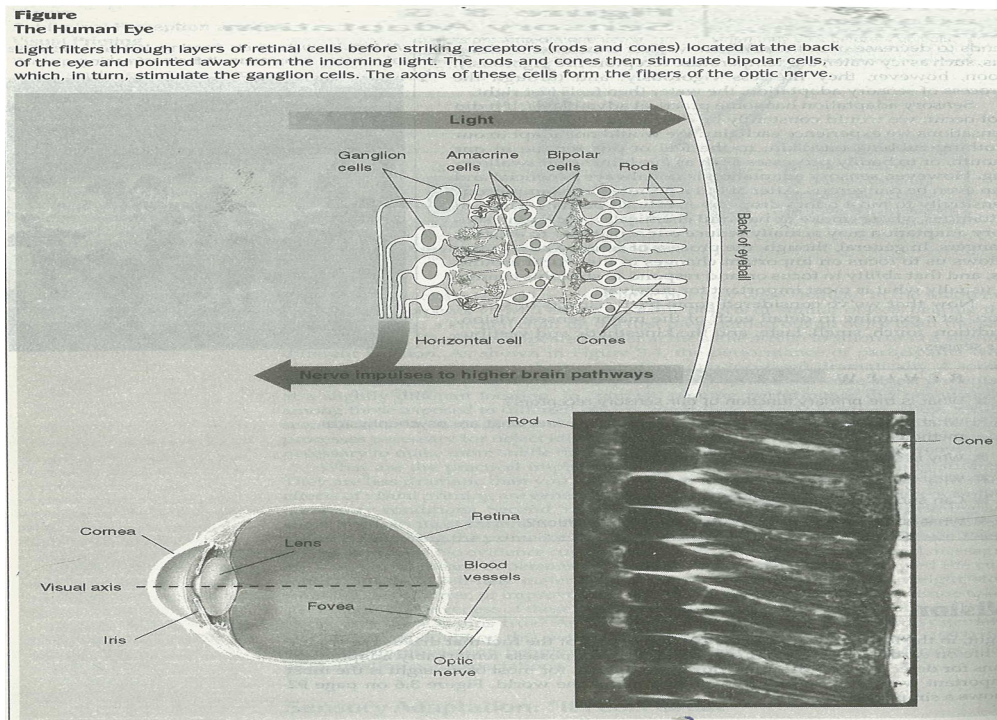
extremely valuable information that we can use to change our location or actions. Much of what we do, depends on an adequately functioning visual system.

Vision's primary importance is reflected in the fact that a greater portion of our brain is devoted to vision than to any of the other sensation. Our visual systems are composed of three major parts.

- a) The **Eyes** which capture and respond to light energy.
- b) The **Neural Circuits** that transmit signals from the eyes to the brain.
- c) The **Visual Centers** within the brain that interpret these messages.

### 1.3.2 STRUCTURE AND FUNCTIONING OF THE EYE

In visual sensation, light waves are the stimuli. Eye is the special sense organ which is responsible for the sensation of vision. It results from the stimuli of light waves that are located in the environment. Retina is the proper eye ball. Light waves act upon the retina and sensation is carried to the brain with the help of optic nerve. Eye is only sensitive to a small segment of spectrum known as 'visible spectrum'. Eyes are only able to receive the light waves whose length varies from 390 nm to 760





**1.3.2.1 STRUCTURE OF THE EYE:**

The structure of the eye looks like a camera, the light enters the eye through the cornea, the transparent protective coating over the front part of the eye.

The structure of the eye consists of the following parts.

1. **Sockets:** It is the case that lodges the eye. It is spherical in shape. It protects the eyeball from external injuries and blows. The socket is lined with tissues that are quite fatty in character. They provide cushion to the eyeball and allow its free movement.

2. **Eye Lids and Eye Lashes:** The eyelids are designed in order to protect the eye from any injury. The eye lids are the covers of the eyeball. They are made up of thin skin and nerve structures. At the end of the eye lids there are long hair called eye lashes.

3. **The Eyeball:** The eyeball is spherical in shape and hollow in structure. Its exact shape is oval, and its diameter is about an inch. It consists of three main coats.

a) Outer coat    b) Middle coat        c) Inner most coat.

**a) Outer coat:** It is also known as white of the eye. In front of it, there is a transparent part known as cornea. Its main function is to protect the eye ball and maintain its shape.

**b) Middle coat:** It is black in colour called the choroids coat. It is lined with thick black coating designed to absorb the surplus rays of light which could cause confused vision. The light passes through the pupil which has an opening in the centre of the lens. In front, there is a muscular curtain called the IRIS, which controls the amount of light reaching the receptors. In very bright light, the IRIS contracts to make the pupil smaller and protects the eye from damage while in the dim light, the IRIS extends to open the pupil wide. This pupil is a hole or opening in the iris. There is a transparent biconvex LENS just behind the pupil. Lens focuses light waves on to the retina. The space between the lens & the cornea is filled with clear watery fluid called **aqueous humour**. It focusses automatically by altering its surface or curvature by means of the contraction and expansion of the Ciliary Muscles. The ciliary muscles are attached to Sclerotic Coat just where it merges with the cornea.

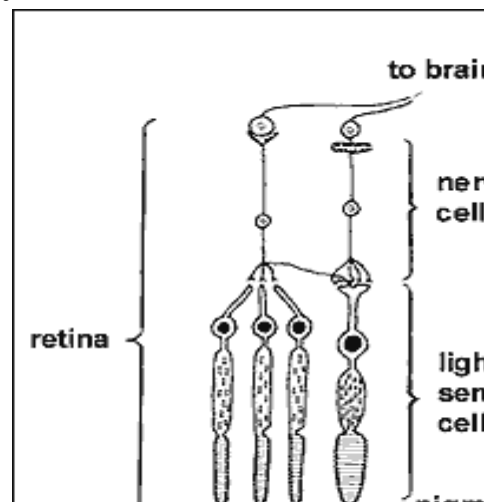
**c) Inner most coat (Retina):** This is the surface at the back of the eye where the receptor cells, the rods and cones are located. RETINA has the shape of a

cup and is also known as photo sensitive. The space enclosed by the retinal cup contains a transparent, jelly like fluid known as VITREOUS HUMOUR. It gives shape and firmness to the eye and keeps the retina in contact with the other two coats.

**Rods and Cones:** Rods and cones are the two visual receptors which respond or are responsible for the colour and light vision.

**Rods** assist in the light vision i.e. when the light is very dim. Their sensitivity increases with the decrease in the intensity of light. They convey information about brightness but not about colour. Rods are mainly responsible for the night vision. They are capable of even twilight or dim light vision. The changeover to rod vision due to fall in intensity of light is called Purkinje Phenomenon.

**Cones** are the receptor cells in the eye that are specialized for vision in bright light. They convey information about colour and fine details. These are yellow and hue area where the receptor cells are located. These are concentrated in the fovea, where only cones are present. A person may become blind if these cones are defective. In better light, more cones are stimulated and they lead to visual accuracy. In each eye, about 130 million rods and cones are present. Cones are capable of only day vision.



**DIFFERENCE BETWEEN RODS AND CONES**

1. **Structural:** Rods are lengthy and thin, cylindrical in shape whereas the cones are short and thick. Rods are found in groups whereas cones are found independently.
2. **Functional difference:** Cones are responsible for bright light and coloured vision whereas rods are responsible for dim light and black and white vision. Certain birds, like bats and owls do not possess cones and therefore can't see during the day time.
3. **Distributional difference:** In the human eye there are more rods than cones. In the central part of the retina, there are more cones than rods. On the yellow spot there are only cones.
4. **Content difference:** There is a photo sensitive pigment known as rhodopsin which is found only in rods and not in cones. It is complex reddish purple substance that changes when energized by light, causing a chemical reaction.

**Zones of Retina:**

- Central Zone: It is capable of differentiating between all the colour stimuli. In this zone, more cones are activated.
- Middle zone: It cannot respond to red and green colour stimuli and is mainly responsible for responding to yellow and blue colour. In this zone, both rods and cones are present.
- Extreme Zone: it is capable of responding to colorless stimuli.

Thus, we can say that these three zones respond to different colours and their sensitivity is governed by the intensity of light and thus the sensation of vision takes place by the help of optic nerve which carries the impression to the brain which gives rise to the sensation of sight.

**1.3.2.2 FUNCTIONING OF HUMAN EYE**

Light stimulation from external environment strikes the **eye** at the point of **cornea**. Since the cornea is transparent, it allows the light to pass on inside to the **lens** through the pupil. With the help of **ciliary muscles**, the lens is adjusted to get a good focus of this light i.e. if the light is very strong, the lens is contracted and if weak, the lens is expanded. The light is again passed inside to the **retina** through **vitreous humor** to excite the retina. The retina which acts like a thin film inside a camera, records this light. Now, the **sensory impulses** stimulated by light are

transmitted to **brain** by the **optic nerve**. **Fovea**, behind the lens, is a depressed spot on retina also known as **yellow spot**. It contains millions of **cones** but no **rods**. There is one spot in the retina, not far from fovea, called the **Blind spot**. This is an insensitive area and there are no light receptors. It occurs because the nerve fibre from the cell in the retina come together to form the bundle, making up the optic nerve.

Hence, the human eye is structured in such a way that it functions by capturing and responding to light energy, transmitting signals to the brain which in result, interprets these messages.

### 1.3.3 SHORT QUESTIONS

#### 1.3.3.1 LIGHT

We see things because they reflect light. For the receptors of vision, only a restricted band of radiant energy called light serves as a stimulus. The light that is visible to us is only a small portion of the electromagnetic spectrum. Visible light occupies only a narrow band in the entire spectrum.

#### 1.3.3.2 PHYSICAL PROPERTIES OF LIGHT

- **Wave length:** Eyes can sense the wave length of 390 nm to 760 nm
- **Hue:** It refers to the colour we perceive. Our sensation shifts from violet through blue, green, yellow, orange and finally red.
- **Brightness:** Intensity of light, measured by the number of particles of electromagnetic radiation, emitted by a light source.
- **Saturation:** It refers to the purity of the colour. Proportion of coloured chromatic light to non coloured or non chromatic light, which determines how colourful light appears. Example: deep red colour of an apple is highly saturated than a pale pink of an apple (low saturation).

#### 1.3.3.3 COLOUR BLINDNESS

- If one can discriminate the colours of the visible spectrum, one has normal colour vision and is labelled as TRICHROMAT. This means that one is sensitive to red green, blue, yellow and light & dark.
- People who are totally colour blind are called MONOCHROMATS and are sensitive to light and dark only. For them, world is only black and white.

- The partially colour blind, who are more common are called DICHROMATS. They can distinguish only two colours red and green or blue and yellow. A dichromat might put on one red sock and one green sock but not mix red and blue socks.

#### 1.3.3.4 VISUAL ACUITY

It is the ability to discriminate details and find differences in the field of vision. Rods and cones are found in varying densities in the retina. An individual's vision may range from poor or infocused to perfect, depending on the density of the cones in the area of the retina that is stimulated.

#### 1.3.3.5 VISUAL ADAPTATION

The eyes have to adopt itself according to increasing or decreasing amount of light

- **Dark Adaptation:** Adaptation due to slow chemical change within the cones and the rods as they gradually become more sensitive to minimal levels of light Eg. Walking out of the light into the dark.
- **Light Adaptation:** The rods, when become extremely sensitive in dark are over stimulated in light. After a few minutes, they lose their sensitivity and cones take over. Ex - coming out of the cinema hall, everything seems bright.

#### 1.3.3.6 AFTER IMAGES

The image appearing when the eyes shift from a particular image to a blank area. It occurs because activity in the retina continues even when the original stimulus is no longer present.

- **Positive after images:** If we stare at brightly illuminated stimulus and then look at an ordinary lighted surface, illuminated image on this ordinary surface is experienced for some time.
- **Negative after images:** If one concentrates at a red spot and then look at a plain grey board, a green spot is seen because green is a complementary colour of red. If stimulus is green, red after image is produced.

#### 1.3.3.7 WARM AND COOL COLOURS

- **Warm and cool colours**

The colours on the green blue side of the colour wheel are considered to be cool in temperature and those on yellow orange red side are considered to be warm.

- **Complementary colours**

The colour across from one another on the colour wheel. Example : Red-green, blue-yellow are major complementary. They dissolve into grey on mixing.

- **Primary, Secondary and Tertiary Colours**

The pigments of red, blue and yellow, those cannot be produced by mixing pigments of other hues are called primary colours. Secondary colours are created by mixing pigments of primary colours. Example - Orange (Red + Yellow), Green (Blue + Yellow) and Purple (Red + Blue).

- **Tertiary Colours** are created by mixing pigments of primary and adjoining secondary colours as in yellow green and bluish-purple.

### 1.3.4 Summary :

Vision is the most important sense and eyes are the specialized receptors for receiving visual sensation. The structure of the eye is just like camera and the retina of the eye has the receptor cells in the form of rods and cones.

## CHECK YOUR PROGRESS – II

**Note: Space provided is for writing the answer.**

**State in not more than 15 lines the structure of the eye with emphasis on rods and cones.**

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

**References :**

1. Woodworth and Schlosberg : Experimental Psychology.
2. Hilgard, Atkinson and Atkinson : Introduction to Psychology.

**LESSON STRUCTURE**

- 1.4.0 Objective**
- 1.4.1 Introduction**
- 1.4.2 Physical stimuli for hearing**
- 1.4.3 Physical Properties of Sound**
- 1.4.4 Types of Auditory Sensation**
  - 1.4.4.1 Sensation of Tone**
  - 1.4.4.2 Sensation of Noises**
- 1.4.5 Structure of Ear**
  - 1.4.5.1 Outer Ear**
    - 1.4.5.1.1 Pinna**
    - 1.4.5.1.2 Ear Canal**
    - 1.4.5.1.3 Ear Drum**
  - 1.4.5.2 Middle Ear**
  - 1.4.5.3 Inner Ear**
    - 1.4.5.3.1 Vestibule**
    - 1.4.5.3.2 Cochlea**
    - 1.4.5.3.3 Semi Circular Canal**
    - 1.4.5.3.4 Auditory Nerve**
- 1.4.6 Function of Ear**

**1.4.0 OBJECTIVE**

The objective of the chapter is to acquaint you about the properties of sound and the process of hearing. By the end of this chapter you should be able to write about different parts of ear, its structure and function.

**AUDITORY SENSATION****1.4.1 INTRODUCTION**

The sounds we hear are actually the patterns of successive pressure disturbances. Successive vibrations produce a pattern of periodic compression of the



surrounding air. The pressure vibrations generated by vibrating bodies travel in waves from within the media.

Auditory sensations are received by ears. Human ear is sensitive to sound waves within a certain limit. The sound waves between 20 to 20000 hertz are known as audible sensations and the sound wave below 20 hertz are infra sonic and above this limit are ultra sonic rays. Thus, the principle physical properties of sound waves may be characterized by:

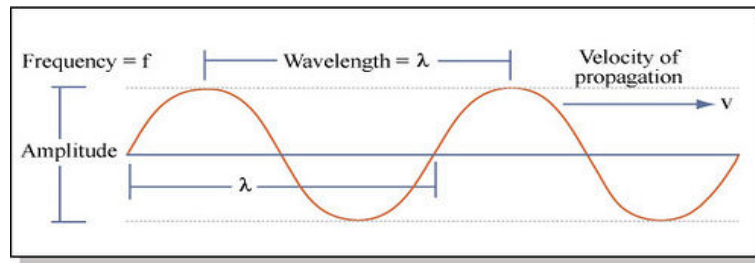
#### **1.4.2 THE PHYSICAL STIMULUS FOR HEARING**

When an object vibrates, the molecules of air around it are pushed together and thus are put under positive pressure. In turn, they push against the molecules close to them, and these molecules transmit the pressure to neighbouring molecules. A wave of pressure moves through the air in much the same way that ripples move on the water. However, sound waves travel much faster than waves of water.

Most objects do not move, or vibrate in only one direction when struck. A plucked violin string, for example, vibrates back and forth. As the string moves in one direction, a positive-pressure wave begins to move through the air. But when the string swings back to its original position and beyond, a little vacuum or negative pressure, is created just behind the wave of positive pressure. The vacuum moves with the speed of sound, just as the positive pressure wave does. The alterations in air pressure moving in all directions from the source are called sound waves, and such sound waves are the physical stimuli for everything we hear.

#### **1.4.3 PHYSICAL PROPERTIES OF SOUNDS**

- a) **FREQUENCY:** Number of waves, compressing, expansion, cycles that occur within 1 second. Pitch is a subjective interpretation of frequency as high or low, expressed in hertz (HZ.)
- b) **AMPLITUDE:** Intensity of vibrations as determined by wave height, expressed in decibels (db).
- c) **COMPLEXITY:** It means timber. It is on the basis of tonal complexity that we differentiate between musical instruments.



#### 1.4.4 TYPES OF AUDITORY SENSATION

##### 1.4.4.1 SENSATION OF TONE

These are musical sounds and they are produced by regular and periodic waves. They are of two types.

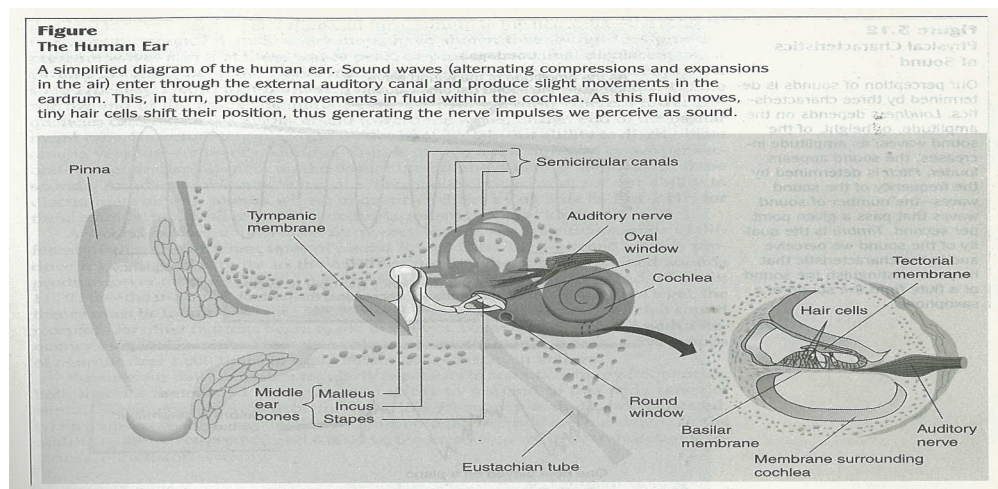
Smoothed (Example: Sitar) and Harmonious (Example: Flute)

##### 1.4.4.2 SENSATION OF NOISE

These are non musical produced at irregular intervals. They are of medleys noises (Example: Typewriter).

##### 1.4.5 STRUCTURE OF EAR

Ear is located on both sides of the head below the temples. The structure of human ear is divided into three parts Outer Ear, Middle Ear and Inner Ear. The outer ear is visible from outside while the middle and internal ear is located inside the head(skull).



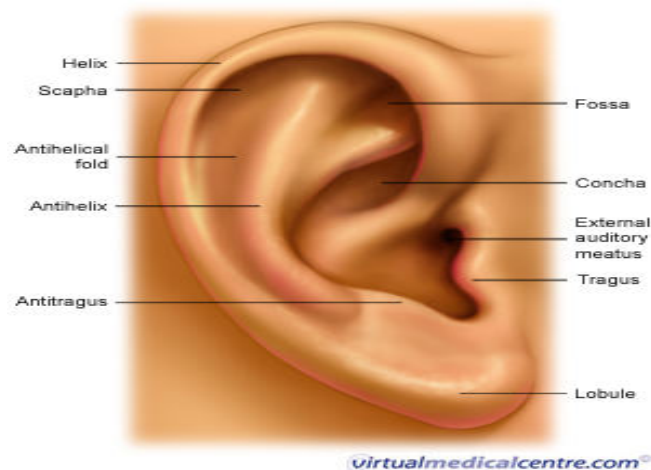
### 1.4.5.1 OUTER EAR

It includes all that we can see from outside even the opening and the thin membrane known as the ear drum, that separates the external ear from the middle ear. Outer ear is divided into 3 parts.

**1.4.5.1.1 Pinna:** All mammals consist of an ear flap called the pinna. It is wrinkled flap that lies on either side of the head. Pinna serves to turn the sound waves bumping up towards the inner canal. Its another function is to protect the sensitive and the delicate inner structure by preventing foreign bodies from entering the ear passage. It has been reported that pinna may slightly aid in the localization of sound. Although man normally does not have control over the muscular system that controls the pinna, many mammals possess highly mobile over; it is common to observe that many lower mammals erect their pinna towards the direction of a soundwave.

**1.4.5.1.2 Ear canal:** It is cylindrical in shape, about 2.5 to 3 cm long and 7 mm is diameter, open on the outside. Its main function is to conduct the vibrations to the ear drum and acts as a protective device against the foreign bodies and help in controlling the temperature in the vicinity of the ear drum.

**1.4.5.1.3 Ear drum:** It is also known as TYMPANIC MEMBRANE, a thick membrane pulled slightly inward at its centre, is stretched across the inner end of the auditory canal and seals off the cavity of the middle ear. The ear drum vibrates in response to the pressure waves of sound.



### 1.4.5.2 MIDDLE EAR

The main function of the middle ear is to transmit the vibratory motions of the ear drum to the inner ear. The vibrations of ear drum make, three little bones in the middle ear i.e. Hammer, Anvil and Stirrup, vibrate. The chain of these bones is called OSSICLES, which convert pressure into 'mechanical movement'. These bones, are, in turn, connected to the OVAL WINDOW, that divides the middle ear from the inner ear. The ossicles transmit the vibrations to the oval window. The middle ear helps in reducing the amplitude of sound waves before sending them to internal ear causing a remarkable increase in the pressure of sound waves. The middle ear is linked to the throat through the EUSTACHIAN TUBE. Just below the oval window, there lies another membrane called the ROUND WINDOW, which helps to equalize the pressure in the inner ear, when the 'stirrup' hits against the oval window. When the mount is open, ear pressure on both sides of the ear drum is equalized.

### 1.4.5.3 INNER EAR

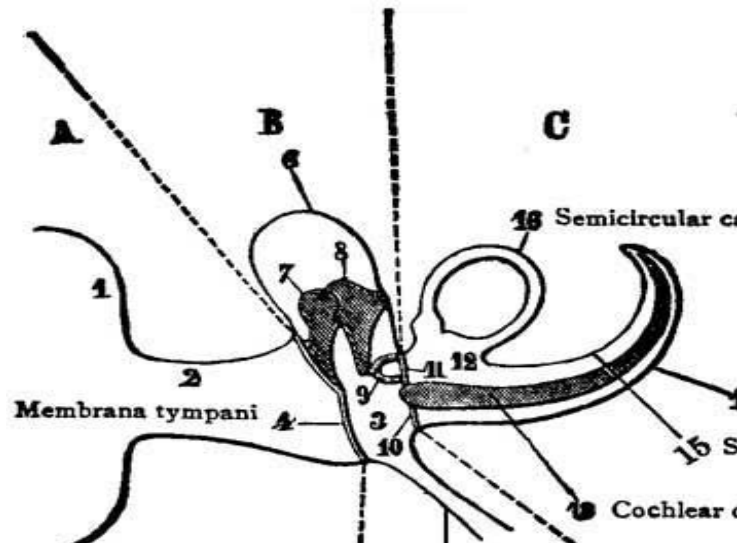
The inner ear is divided into three parts.

**1.4.5.3.1 Vestibule:** The vacant space surrounding these parts is filled with a fluid known as PERILYMPH. At one end of vestibule, there is another opening covered by a membrane connected with the stirrup of middle ear. The tube of cochlea is connected with the vestibule.

**1.4.5.3.2 Cochlea:** It is spiral, fluid filled chamber in the inner ear. It is small, tubular structure about 25 to 35 mm is length, resembling a snail shell and for this reason, it is called COCHLEA. The COCHLEAR DUCT divides the cochlea into two chambers; the 'upper canal' called the Scala Vestibuli and the 'lower canal' called the Scale Tympani. It is inside the cochlear duct that the specialized sensory structure, nerves and the supporting tissues for transducing vibrations to nerve impulses are found. In the Cochlea, there is an 'Organ of Corti' are hair cells in the Organ of Corti, which are connected to the auditory nerve fibres. These hair cells are sensory receptors attached to the basilar membrane the semi circular canals and the olfactory epithelium. Basilar membrane runs like a long tongue through the cochlea. It is a thick sheet of tissue in the cochlea to which hair cells are attached.

**1.4.5.3.3 Semi circular canal:** These are meant more for the balance of the body rather than for hearing. They are part of inner ear containing fluid that moves, when the body moves, to control balance.

**1.4.5.3.3 Auditory Nerve :** Carries signals from internal ear to the brain.



#### 1.4.6 FUNCTIONS OF EAR

The act of hearing includes all the three parts of ear. The 'sound waves' of the external world excite the auditory cells of the external ear. The 'external ear' acts as a collection of sound waves. First step in hearing is the 'vibration of the ear drum'. The sound waves go inside from pinna to 'auditory canal' and after reaching at the 'ear drum' that make it move back and forth. The function of external ear is to protect the ear drum from (1) external injuries, (2) to maintain the temperature, humidity and (3) to transmit the sound waves to the middle ear.

In the middle ear, the 'hammer' is put in motion by the vibration of the 'tympanic membrane' and this motion is transmitted through anvil to stirrup. Thus, these three bones in the middle ear act as a mechanical transformer of the sound waves. Due to the articulation of these three bones, there is a series of movement with the transmitting of sound waves and finally 'stirrup' applies pressure to the oval

window and this procedure is transmitted in the Cochlea Fluid leading to the vibration of the fluid.

Activities of the basilar membrane move the organ of Corti, the hair cells of which are induced to bend, when these hair like process are bend, receptor potential is initiated. The 'nerve impulse' initiated in the 'cochlea' thus travel to the brain. The nerve cells and the fibres from which they originate is called the auditory path way.

Thus, the physical movements in the cochlea are changed into 'electrical energy, which leads to changes in the auditory nerves and in turn these nerves are changed into the messages which the brain interprets in terms of pitch and loudness. This leads to the process of hearing.

#### **1.4.6 Summary**

Auditory sensations are received by ears. The structure of the ear can be divided into three parts. Outer Ear, Middle Ear and Inner Ear. The act of hearing includes all the three parts of the ear. Cochlea is the most important structure for changing the physical energy into electrical energy.

### CHECK YOUR PROGRESS – III

Note: Space provided is for writing the answer.

**State in not more than 15 lines the structure and function of ear.**

[illegible]

### References :

1. Woodworth and Schlosberg : Experimental Psychology.
2. Hilgard, Atkinson and Atkinson : Introduction to Psychology.

**LESSON STRUCTURE**

- 1.5.0 Objective**
- 1.5.1 Introduction**
- 1.5.2 Layers of Skin**
  - 1.5.2.1 The Outer Layer (Epidermis)**
  - 1.5.2.1 The Inner Layer (Dermis)**
- 1.5.3 Functions of Skin**
- 1.5.4 Types of Skin Sensation**
  - 1.5.4.1 Pressure of Touch**
  - 1.5.4.2 Pain Sensation**
  - 1.5.4.3 Temperature Sensation**
- 1.5.5 Introduction**
- 1.5.6 Functions of Smell**
- 1.5.7 Structure of Nose**
- 1.5.8 Sensitivity of Smell Receptors**
- 1.5.9 Types of Odour**
- 1.5.10 Gustatory Sensation**
  - 1.5.10.1 Sensitivity**
  - 1.5.10.2 Types of Tastes**
    - 1.5.10.2.1 Primary Tastes**
    - 1.5.10.2.2 Compound Tastes**
    - 1.5.10.2.3 Blend of Tastes**
- 1.5.11 Summary**
  - Check your Progress**
  - References**



**1.5.0 OBJECTIVE**

**To illustrate the layers of the skin and explain pressure, pain and temperature sensation**

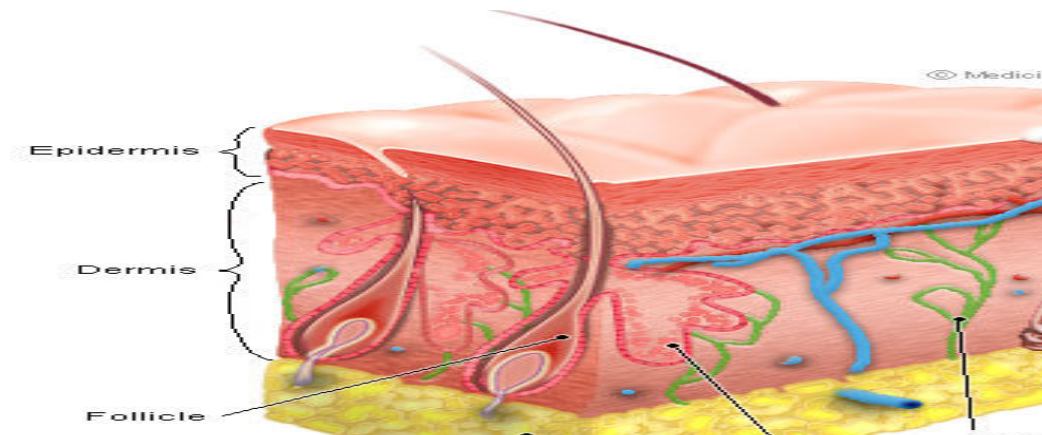
**To illustrate the structure and functions of the olfactory organ (nose) and the gustatory organ(tongue).**

**1.5.1 SKIN SENSATION- TOUCH (Cutaneous Sensation)**

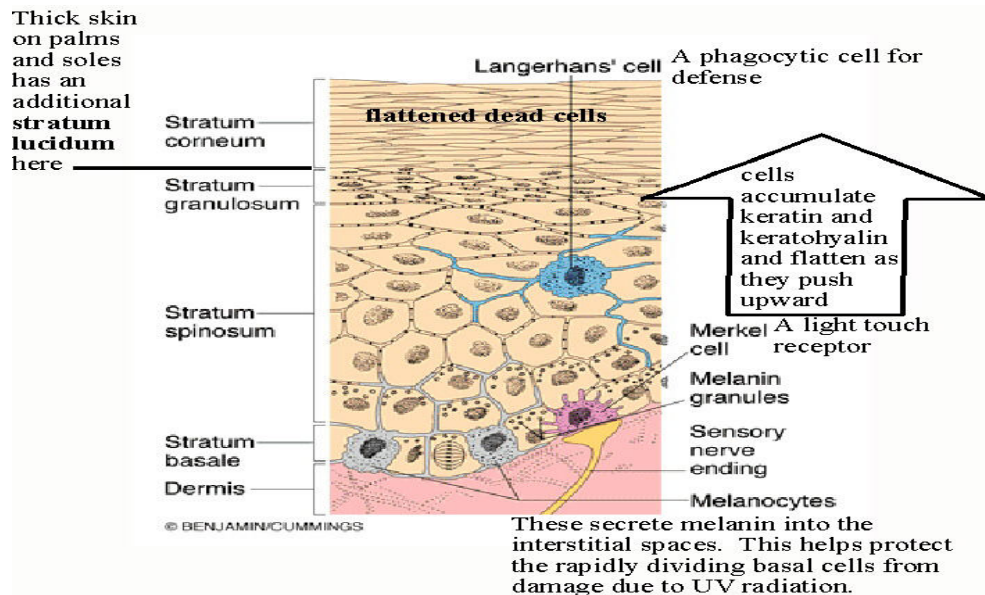
In order to adapt to the environment, we need to know what is happening at the surface of our bodies. The skin sensation gives us the information and the skin can be thought of as a giant sense organ that covers the body. There are a number of receptors deep within the skin that connect with neurons to inform the brain about environmental stimulation. These receptors transmit information about three different kinds of skin sensation:

- (i) pressure,
- (ii) pain and
- (iii) temperature.

All the receptors are not in the skin. Receptor for 'pressure' and 'pain' are found in muscles and internal organs. The skin of man, viewed as a sensory organ is very remarkable and most versatile organ in the body. It consists of two layers.

**1.5.2 LAYERS OF SKIN**

### 1.5.2.1 THE OUTER LAYER (EPIDERMIS)



### 1.5.2.2 THE INNER LAYER (DERMIS)

The outer layer of the skin is thin and is not sensitive and thus it is only a protective covering, whereas the inner layer contains the blood vessels as well as nerves. It thus contains the receptors which are responsible for various types of cutaneous sensations. The inner layer is called the dermis and is shaped into various folds called the papillae. On the surface there are touch corpuscles which are egg shaped. When the skin is touched the excitation is produced from the touch corpuscles from the nerve endings to the brain.

### 1.5.3 FUNCTIONS OF SKIN

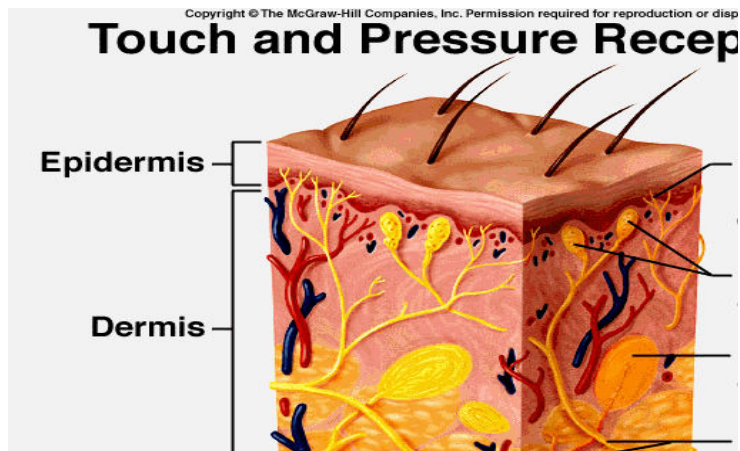
- Our skin is a pliable shield that keeps out bacteria.
- It holds in body fluids.
- Skin wards off harmful sun rays.

- It regulates the temperature of the body.
- It takes part in the production of vitamin D using UV rays in sunlight.

#### **1.5.4 TYPES OF SKIN SENSATION**

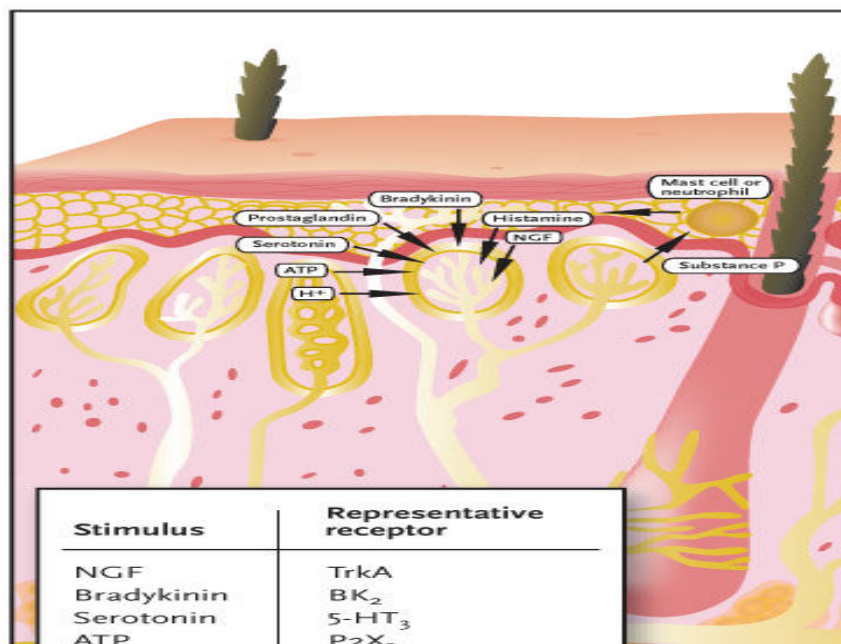
##### **1.5.4.1 PRESSURE OR TOUCH**

It gives us the qualitative difference of softness, toughness and hardness. It also contributes to the knowledge of extension, size and the position passive varies enormously over different portion of the body. Our finger and lips are extremely sensitive to any degree of pressure but portions of the back are relatively insensitive.



##### **1.5.4.2 PAIN SENSATION**

Pain spots are aroused by a variety of stimulus such as pricking, cutting, excessive heat and cold. This sensation starts from the surface of the skin. It can be felt through mechanical chemical and thermal stimuli. Sensation of pain has greater value for the survival of our organism because it protects us from the source of possible injury. In the localization of pain sensation, some portions are competitively more sensitive than the others. Pain sensation is felt at many places.



#### 1.5.4.3 TEMPERATURE SENSATION

It consists of sensation of warmth and cold. Warm spots are present in great number in cheeks, eye lids and eye brows whereas the cold spots are present in great number in cheeks, eye lids and eyes brows whereas the cold spots are present in upper lip and back. Hilgard (1962) described that the experience of warmth and cold depends up a level of adaptation. This level provides a kind of zero point. Whenever the stimulus is below 33°C, we feel sensation of cold and when above 35°C, we feel the sensation of heat or warmth. Weber (1946) formulated a theory of adequate stimuli for temperature sensation according to this theory, sensation of warmth is the result of rise in temperature of the skin and the sensation of cold is the result of fall in temperature of the skin.

Hence, the skin sensations are capable of feeling us much more than simple sensation. Much of heat received from the skin senses is the result of the above mentioned sensation. The skin is thus, the largest sense organ covering the entire body absorbing information from outside world.

**CHEMICAL SENSATIONS- SMELL, TASTE****1.5.5 OLFACTORY SENSATION INTRODUCTION**

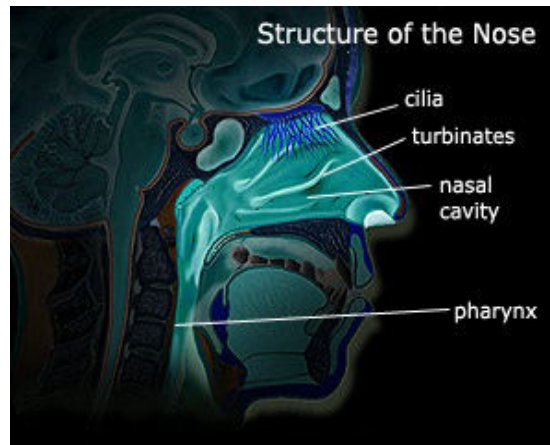
It is through smell, of course, that we detect and experience many of the events in the chemical world that surrounds us.

**1.5.6 FUNCTIONS/IMPORTANCE OF SMELL**

- (1) Smell seems to trigger behaviour
- (2) Smell judged as pleasant may set off **approach behaviour**, while smell judged as unpleasant may arouse **avoidance behaviour**,
- (3) Smell can also serve to trigger memories of past emotional experience.

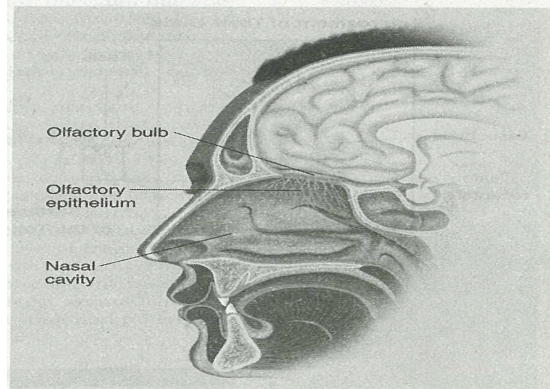
**1.5.7 STRUCTURE OF NOSE**

The receptor for smell i.e. nose responds to chemical substances, especially if those substances are volatile. These substances enter the nasal passage where they dissolve in moist nasal tissues. This brings them in contact with receptor cells contained in the olfactory epithelium. Smell receptors are located high up in the nasal passages leading from the nostrils to the throat. They lie in two small patches, one on the left and one on the right, in the roofs of these nostrils. Since, they are a little off the main route of air as it moves through the nose in normal breathing, our sense of smell is relatively dull when we are breathing normally and quietly. A sudden sniff or vigorous intake of air, however, stirs up the air in the nasal passage and brings more of it to the receptors. We smell something when air carried molecules of a substance reach a tiny cluster of 5 million receptor cells at the top of each nasal cavity. These olfactory receptor cells, warning like sea anemones on a reef, respond selectively to the aroma of brownies baking, to a wisp of smoke, to a rose fragrance and instantly alert the brain.



**Figure**  
**The Receptors for Smell**

Receptors for our sense of smell are located in the olfactory epithelium, at the top of the nasal cavity. Molecules of odorous substances are dissolved in moisture present in the nasal passages. This brings them into contact with *receptor cells*, whose neural activity gives rise to sensations of smell.



### 1.5.8 SENSITIVITY OF SMELL RECEPTORS

It is impressive that people can detect incredibly small amounts of odorous substances. Ex. Artificial musk can be sensed by human beings in concentration of 0.0004 mg in a litre of air. Human beings possess 10 million of these receptor cells. Our olfactory receptors can detect substances with the molecular weight 15-300 only (Carlson, 1994). This explains why we can smell the alcohol contained in a mixed drink

with molecular weight of 46, but not sugar, with molecular wt. of 342. Odor molecules come in many shapes and sizes that it takes lots of different receptors to detect them. A large family of genes design receptor proteins that recognize particular molecules.

### 1.5.9 TYPES OF ODOUR

Odours have many shades and qualities. Scientists have raised the question of whether such a multitude of sensations might not result from mixtures of a relatively few primary qualities. Perhaps, there are a few unique odours which mixed in different proportions, might account for the various discriminable odours. A number of basic odor systems have been proposed. One system says that there are four basic odours- Fragrant (musk), Acid (vinegar), Burnt (roast coffee) and Caprylic (goaty or sweaty) [Crocker & Henderson]. Another theory known as **Stereo Chemical Theory** suggests that substances differ in smell because they have different molecular shape (Amoore, 1982).

### 1.5.10 GUSTATORY SENSATION-TASTE

Taste is a chemical sense. The **tongue** is a muscle on the floor of the mouth that manipulates food for chewing and swallowing (deglutition). It is the primary organ of taste, as much of the upper surface of the tongue is covered in papillae and taste buds. A secondary function of the tongue is speech, in which the organ assists. It is sensitive and kept moist by saliva, and is richly supplied with nerves and blood vessels to help it move. Inside the little lumps on the top and side of your tongue are 200 or more taste buds. Each contains a pore that catches food chemicals. These molecules are sensed by 50 taste receptor cells that project antennalike hairs into the pore.

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. Tongue contains a number of **bumps** on it, some large and some small. These bumps, called **papillae**, are richly populated with taste buds. These **fungiform papillae** contain taste buds and others surrounding them, i.e. filiform papillae, do not contain taste buds. To stimulate the taste buds, substances must be in solutions that will wash around the papillae and

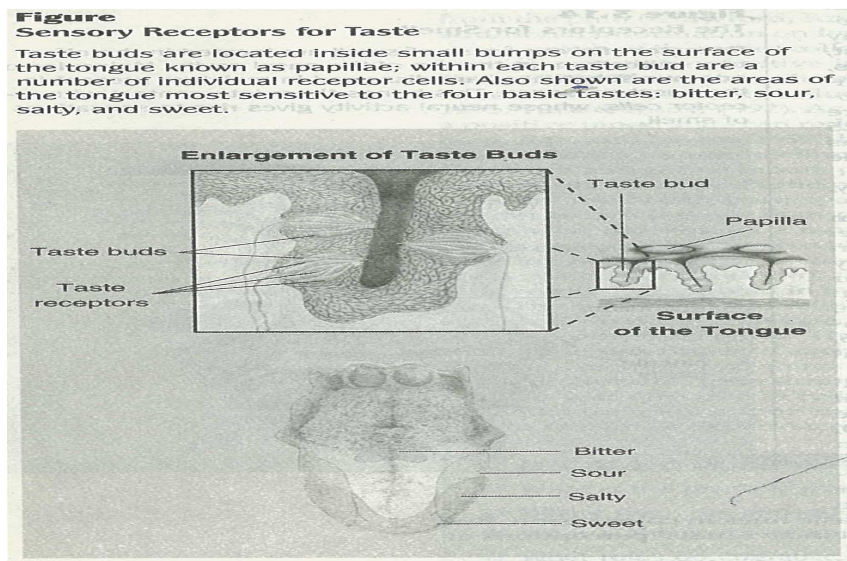


penetrate into the taste buds in the clefts between them. There are no taste buds in the middle of the tongue. So, this portion is insensitive to taste.

#### 1.5.10.1 SENSITIVITY

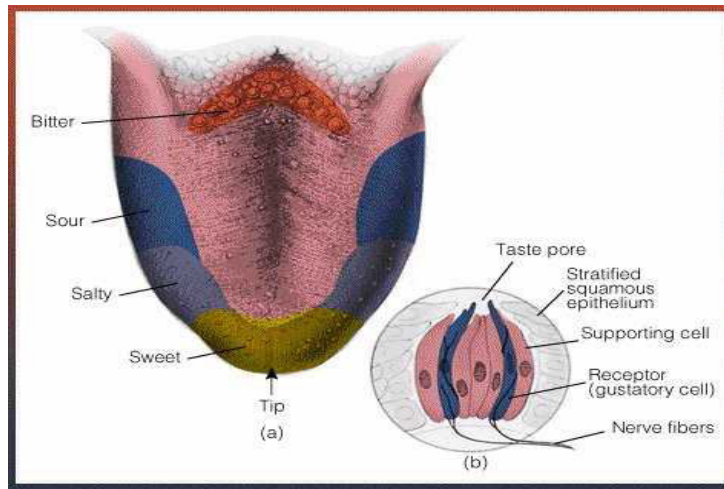
Taste sensitivity is not nearly so keen as smell sensitivity.

- It takes 1 part in 25 to 1 part in 2000 before it can be detected.
- People are more sensitive to acids and bitter substances than they are to sweet and salty.
- Human beings possess about 10,000 taste buds.
- Taste buds decline with age.





### 1.5.10.2 TYPES OF TASTES



**1.5.10.2.1 Primary Taste:** Several lines of evidence point to four basic taste qualities **salty, sour, sweet** and **bitter**. Different parts of the tongue respond to different taste qualities.

Bitter: Back of the tongue.

Sweet: Tip of the tongue.

Sour: Sides of the tongue.

Salt: Tip and part of the sides.

**1.5.10.2.2 Compound taste:** Combination of tastes is known as compound taste. Ex. Grapes is the combination of bitter/sour/sweet taste.

**1.5.10.2.3 Blend of taste:** Blend of taste occurs when the taste is mixed with smell. Ex. Flavour of food is a combination of taste and smell.

### 1.5.11 Summary :

Skin is the giant sense organ which gives the information of the environment to the body. There are number of receptors deep within the skin that connect with neurons to inform the brain about environmental stimulation. The skin responds to different kinds of stimulation like Pressure or touch, Pain and temperature sensation.

The receptor for smell i.e. nose responds to chemical substances. Small receptors are located high up in the nasal passage.

Tongue is the receptor for taste sensation. Birds present in the tongue are responsible for different kinds of taste sensation.

## CHECK YOUR PROGRESS –VI

**Note: Space provided is for writing the answer.**

**State in not more than 15 lines structure of tongue as well as types of taste and smell sensations.**

This image shows a full page of primary-ruled paper. It features multiple horizontal rows of small, evenly spaced dots, designed to guide young learners in writing their letters and words. The paper is otherwise completely blank, with no margins, text, or illustrations.

**CHECK YOUR PROGRESS – VI**

**Note: Space provided is for writing the answer.**

**State in not more than 15 lines different types of touch sensations.**

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**Questions for Practice**

**Q 1. Attempt any two questions from this section**

1. Explain the nature of Sensation.
2. Discuss the various types of sensation.
3. Explain the structure and function of an Eye.
4. Write a detailed note on "Chemical Sensation".
5. Explain the structure and function of Ear.

**SECTION-B**

**Q 2. This section is compulsory.**

**Write Short notes on**

- |                 |                         |
|-----------------|-------------------------|
| (a) Sensation   | (d) Gustatory Sensation |
| (b) Cornea      | (e) Cochlea             |
| (c) Wave Length |                         |

**References :**

1. Morgan, C.T. King, R.A. Werz, J.R. Schoper, J. (1987). Introduction to Psychology.
2. Hilgard, Atkinson and Atkinson : Introduction to Psychology.
3. Woodworth and Schlosberg : Experimental Psychology.