SYLLABUS (PSYCHOLOGY) (RUSA)
B.A. PART-II: SEMESTER III
Session 2021 -2022, 2022-23 and 2023-24

EXPERIMENTAL PSYCHOLOGY - I

For Regular Students
Max. Marks: 50

For Distance Education Students
Max Marks : 70

Time Allowed: 3 hours
Pass Marks: 35% of the subject
Lectures to be delivered: 6 per week
(For Regular Students)

INSTRUCTIONS FOR THE PAPER-SETTER

For Regular Students: The question paper will consist of three sections A, B and C. Syllabus of each section (i.e. A&B) will have two subparts. Examiner will set two questions from Section A (each question having internal choice covering both parts of syllabus of section A) and two questions from section B (each question having internal choice covering the entire syllabus of section B). Each question will carry 8 marks. Section C is compulsory, and shall comprise nine short answer type questions carrying 2 marks each. The short type answer should be written in approximately 25-30 words..

For Distance Education Students: The question paper will consist of three sections A, B and C. Syllabus of each section (i.e. A&B) will have two subparts. Examiner will set two questions from Section A (each question having internal choice covering both parts of syllabus of section A) and two questions from section B (each question having internal choice covering the entire syllabus of section B). Each question will carry 8½ marks. Section C is compulsory, and shall comprise nine short answer type questions carrying 4 marks each. The short type answer should be written in approximately 25-30 words..

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions each from the sections A and B and the entire section C. The candidates are required to answer each short type question in 50 words i.e. in 5-7 lines. Each short answer type question will carry 2 marks.

SECTION-A

(i) Experimental Psychology: Nature, Types of Variables and Control of ExtraneousVariables.

(ii) Memory: Information Processing, Levels of Processing, Measures of Memory; Mnemonics; Forgetting: Causes of Forgetting: Decay, Interference, Retrieval failure, Motivated forgetting and Amnesia.

SECTION-B

(i) Learning: Classical Conditioning; Instrumental Conditioning, Types and Schedules of Reinforcement.

(ii) Statistics: Properties of Normal Probability Curve and its applications, Degrees of Freedom, Levels of Significance. Chi Square -Application to One Way and Two Way Classification.

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B.A. PART- II PSYCHOLOGY (Semester-III) (EXPERIMENTAL PSYCHOLOGY)
Unit - I
Department of Distance Education Punjabi University, Patiala (All Copyrights are Reserved) LESSON NO. :
1.1 NATURE AND SCOPE OF EXPERIMENTAL METHOD
1.2 EXPERIMENTAL METHOD : TYPES OF VARIABLES AND CONTROL OF EXTRANEOUS 1.3 MEMORY : NATURE, TYPES AND THEORIES
1.4 FORGETTING : NATURE AND CAUSES
NOTE : Students can download the syllabus from department's website www.pbidde.org
UNIT- 1 B.A. PART-II PSYCHOLOGY (Semester-III) EXPERIMENTAL PSYCHOLOGY
LESSON NO. 1.1 Last Updated January 2023
NATURE & SCOPE OF EXPERIMENTAL METHOD
Lesson Structure 1.1.0 Objectives 1.1.1 Introduction 1.1.2 The Four Principles of Science 1.1.2.1 Determinism 1.1.2.2 Empiricism 1.1.2.3 Parsimony 1.1.2.4 Testability
1.1.3 EXPERIMENT 1.1.1.1Psychological Laboratory 1.1.1.2 Experimenter 1.1.1.3Subject 1.1.1.4 Stimulus 1.1.1.5 Response 1.1.1.6Variables 1.1.4 Nature of Experimental Psychology 1.1.5 Scope of Experimental Psychology 1.1.6 Let us sum up 1.1.7 Keywords 1.1.8 Long questions 1.1.9 Short questions 1.1.8 Suggested Readings

B.A. PART- II PSYCHOLOGY
(Semester-III) (EXPERIMENTAL PSYCHOLOGY)

Unit - I

Department of Distance Education
Punjabi University, Patiala

LESSON NO. :

NOTE : Students can download the syllabus from department's website www.pbidde.org

UNIT- 1
B.A. PART-II **PSYCHOLOGY**
(Semester-III) **EXPERIMENTAL PSYCHOLOGY**

LESSON NO. 1.1 **Last Updated January 2023**

NATURE & SCOPE OF EXPERIMENTAL METHOD

Lesson Structure

1.1.0 OBJECTIVES:

The lesson aims at providing an introduction to the Experimental Psychology. The lesson would begin with the basis of Experimental Psychology, leading to origin of Experimental Method and therefore the basic nature of Experimental Psychology.

By the end of this lesson you should be able to define Experimental Psychology, differentiate it from general psychology, conceptualize different perspectives in psychology and understand basic nature and scope of experimental method.

1.1.1 INTRODUCTION

Experimental psychology first made its appearance about 100 years ago and challenged the old mental philosophy. No more psychology was known as:

---- the field that studies the unconscious or

---- even Hypnotism, Extra Sensory Perception (a layman's view of Psychology). No more there was that 'old battle' over what psychology should study i.e.

---- Structuralism- structure of mind

---- Functionalism - functions of mind

---- Behaviorism - study of behaviour

Instead a firm scientific footing happened. Psychology became the 'Science of Behaviour and Cognitive Processes'. There was no longer restraint of '**isms**'. Modern

psychology was a movable feast, it was struggling to establish a clear identity and a useful agenda for research. Collins and Drever had beautifully remarked "Psychology without experimental part is incomplete".

Psychology emerged as an independent branch of Science in 1860. In this year Helmhotz, Fechner, Wundt adopted scientific method and explained psychological events. The experimental method was first of all introduced by **Wilhelm Wundt in 1879.** He opened the first recognized psychology laboratory at Leipzig in Germany. In 1880, Ebbinghaus conducted many experiments related to memory and learning. Thorndike, Judd and Freeman conducted many experiments in various fields.

German Scholar E.H. Weber (1795-1878) made a significant contribution in making psychology as a science. He worked in the field of sensation, Psychology and psychophysics. His most memorable contribution is that sensory differences are relative and not absolute. Weber's law is considered the first quantitative law in the history of psychology.

Fechner (1801-1881) who was a physicist, modified th experiments of Weber. Fechner had devoted whole life in studying th relationship between physical stimulus and mental activity, he did excellent work in the field of psychophysics. Fechner published "Elemente der Psychophysik," which is considered as the first work of experimental psychology. Fechner's research focused on the measurement of psychophysical thresholds and just-noticeable differences, and he invented the psychophysical methods of limits, the method of constant stimuli and the method of adjustment, which are still in use. **Herman Helmholtz** (1821-1894) did most prestigious work in the field of physiological psychology of sensation. He did experiments to study nerve conduction, Reaction Time, Colour Vision, Auditory Sensation and discussed the anatomy of ear very scientifically. Herman Ebbinghaus (1850-1909) was the first social scientist to conduct experimental study on memory and learning process. He was the first social scientist to conduct experimental study on memory and learning process. He was the first to introduce nonsense syllables in experiments. Even today " Ebbinghaus curve of Retention" is greatly considered.

Sir Francis Galton (1822-1911) was the first psychologist who had constructed psychological tests for measuring intelligence and mental abilities. He was the first psychologist who applied questionnaire method for studying psychological traits. In order to understand the experimental method we need to discuss the four major principles/norms of science or scientific method.

1.1.2 The Four Principles of Science

In order to understand the scientific approach to experimental psychology as well as other areas of scientific research, it is useful to know the four fundamental principles that appear to be accepted by almost all scientists.

1.1.2.1 Determinism

One of the first canons of science is the assumption of determinism. This canon assumes that all events have meaningful, systematic causes. Scientists accept this principle largely on faith and also to the fact that theories wouldn't be very useful in the absence of determinism, because in the absence of determinism, orderly, systematic causes wouldn't exist.

1.1.2.2 Empiricism

The principle of empiricism simply means to make observations. This is the best method of figuring out orderly principles. This is a favorite tool among scientist and

psychologists because they assume that the best way to find out about the world is to make observations.

1.1.2.3 Parsimony

The third basic assumption of most scientific schools of thought is parsimony. The rule of parsimony says that we should be extremely careful in developing or choosing between theories by steering away from unnecessary concepts. Almost all scientist agree that if we are faced with two competing theories, that both do a great job at handling a set of empirical observations, we should prefer the simpler, or more parsimonious of the two. The central idea behind parsimony is that as long as we intend to keep simplifying and organizing, we should continue until we have made things as simple as possible.

1.1.2.4 Testability

The final and most important norm of science is the assumption that scientific theories should be testable using currently available research techniques. This canon is closely related to empiricism because the techniques that scientists typically use to test their theories are empirical techniques. In addition to being closely related to empiricism, the concept of testability is even more closely associated falsifiability. The idea of falsifiability is that scientists go an extra step by actively seeking out tests that could prove their theory wrong. Among psychologists, the concepts of testability and falsifiability are extremely important because many really theories like the work of Freud and other psychoanalysts were difficult to put to any kind of objective test.

Thus the experimental method is a scientific method and psychology has attained the status of science because of the "Experimental Method."

1.1.3 EXPERIMENT

"**Experiment consists of objective observation of actions performed under rigidly controlled or laboratory conditions**". In experimental method we proceed systematically and experimentally and not haphazardly.

The following are the requirements of an experiment.

1.1.3.1Psychological Laboratory

The psychological laboratory should be fully equipped with the latest scientific equipments and psychological tests.

1.1.3.2 Experimenter

There has to be an experimenter to conduct experiment in a scientific way. The experimenter is the researcher and is also referred to as 'E'.

1.1.3.3 Subject

There has to be a subject or subjects on whom the experiment is performed. In physical sciences experiments are performed on organic or dead objects whereas in psychology experiments are performed on living subjects. The subject may be a human being or an animal. The subject may also be written as 'O'.

1.1.3.4 Stimulus

By stimulus we mean any physical force in the environment which makes the organism behave, react and respond. The physical force can be any living being such as teacher in the class or snake in the courtyard ,non living thing such as words written on the blackboard, telephone or even physical environment such as trees, wind etc. It is usually referred to as 'S'.

1.1.3.5 Response

Response is the reaction to the stimulus by the organism. It can be defined as change in behaviour which can be observed. This change can be visible (observable) such as crying, studying or invisible (physiological) such as rise in blood pressure or even at the cognitive level such as thinking, imagining etc.

1.1.3.6 *Variables*

Anything which varies is a (vary + able) variable (to be dealt in detail separately).

Therefore, it can be said that Psychology's knowledge about human behaviour has expanded beyond psychology itself. Psychology has matured. Psychology is being exported to so many other fields. It has travelled its journey from theory to practice to deal with emotional and psychological problems or focus on motivation building, employee evaluation or de-stressing the stressed one.

It is true that even philosophy or age old wisdom has provided an insight into human behaviour. But, has, then psychology provided us with something different? The answer is, Yes! Absolutely! Because what psychologists say, they back it up with scientific studies and the most scientific method of psychology is the Experimental Method.

1.1.4 Nature of Experimental method.

Before we get on to the nature of experimental psychology we must outline the nature of experimental method- the scientific method.

Experiment-"observation under controlled conditions". In an experiment the experimenter observes the behavior or response of the subject to the stimulus. This is done in the controlled environment i.e. under controlled laboratory conditions. When observation is done under somewhat controlled conditions it becomes science. Therefore,

Experimental Method = Scientific Method

Now the primary question is "what is science?"

Science is neither getting into white coats and working on heavy instruments, nor physics, chemistry or biology. **Science** refers to a **SPECIAL METHODOLOGICAL APPROACH FOR ACQUIRING KNOWLEDGE** and it can be applied to the study of any aspect of the world around us. The scientific method is a set of principles and procedures that are used by researchers to develop questions, collect data, and reach conclusions. We as human beings are part of the natural world and thus the scientific method can certainly be applied to the study of our behaviour and cognition. It is this adoption of the scientific method that makes psychology a science and the information it acquires is so valuable .It is important to mention here that despite following strict methodological regime and other formalities of science, Psychology is not a pure science as physics, chemistry etc. Psychology is rather a positive science because it deals with the subject matter that is organism's behavior which is so dynamic and changing.

What are the goals of scientific research in psychology? Researchers seek not only to describe behaviors and explain why these behaviors occur; they also strive to create research that can be used to predict and even change human behavior. Thus,the goals of psychological studies are to describe, explain, predict, and perhaps influence mental processes or behavior.

In the most basic form, the experimental method in psychology involves three key steps.

- The presence or strength of some variable believed to affect behaviour which is systematically altered.
- The effects of such alterations (if any) are carefully observed and measured.
- The variables which are not allowed to vary or changed and are thus controlled.

The variable that is systematically varied is termed as **STIMULUS VARIABLE** or **INDEPENDENT VARIABLE (IV),** the aspect of behaviour studied is

termed as **RESPONSE VARIABLE** or **DEPENDENT VARIABLE (DV)** and the conditions which are kept under control are called **CONTROL VARIABLES** or **RELEVANT VARIABLES (RV)**.

In any simple experiment different groups of participants are exposed to contrasting levels of the stimulus or independent variable (such as zero, low, moderate and high).This procedure of varying independent variable by the experimenter is termed as **MANIPULATION**. The researcher then carefully measures the research participants behavior i.e. response or dependent variable to determine- 'whether it does in fact differ' depending on the level of the independent variable to which they are exposed. This process of response by the subject to various exposed independent variable is termed as **OBSERVATION**. The observation is then recorded and statistically analysed. It is important to understand that this whole process of manipulation and observation is done under controlled condition. As referred earlier, by controlled conditions is meant laboratory conditions which further means that all the RV's are controlled by the experimenter .The experimenter only allows the independent variable to vary or change, measures the dependent variable or response given by the subject and rest all other RV's are controlled by the experimenter by various methods of **CONTROL**. Without control of RV's it cannot be ascertained that the response or dependent variable given by the subject is due to various levels of stimulus or independent variable or some other variable that is not controlled. The reason for the unique importance of controlled experiments in psychology is that they are capable of providing firm evidence regarding cause-and-effect relationships, which no other research method can provide. In controlled experiments it can be scientifically proven that it is only independent variable i.e. cause or stimulus which has resulted in dependent variable i.e. effect or response. Finding the cause and effect relationship is the very basic need of doing an experiment.

Control	**Manipulation**	**Observation**
Relevant Variable	Independent Variable	Dependent Variable
Done by the 'E'	Done by the Experimenter	Done by the Experimental and given by the Organism
Variables are held constant controlled by various methods	Variables are allowed to vary	Responses are observed and measured

In a simple experiment, study participants are randomly assigned to one of two groups. Generally, one group is the control group and receives no treatment (IV), while the other group is the experimental group and receives the treatment (IV). **The control group** is made up of individuals who are randomly assigned to a group but do not receive the treatment (IV). The measures (DV) taken from the control group are then compared to those in the experimental group to determine if the treatment (IV) had an effect(DV).**The experimental group** is made up of individuals who are randomly assigned to the group

and then receive the treatment (IV). The scores of these participants are compared to those in the control group to determine if the treatment (IV) had an effect (DV).

EXAMPLE

Problem -To study the effects of magnets on muscular or joint pains.

IV	DV	RV
↓	↓	↓
Magnets	Pain	Age,Gender,Other physical problems

Experimenter will have a sample (research participants) with joint pain through ads in the local newspapers by referrals or in other ways. The sample would be called over to the lab.

Two groups will be made .

Experimental Group Real Magnets

Control Group Disks that look like magnets

After one hour both groups will be asked to rate their pain level as No Pain = 0, Mild Pain = 1, Moderate Pain = 2 and Heavy Pain = 3. Pain level is the dependent variable (DV).

If 'real magnet group' reported less pain Magnets are Effective. If experimental group reported same level of pain- Magnets are ineffective.

This is how IV is varied systematically and its effect is seen on the DV.

One More Example

Effect of KR (Knowledge of Result) on learning.

KR	Learning	Age, Intelligence, Gender
↓	↓	↓
IV	DV	RV

Manipulation of KR will be done.

0% KR group
25 % KR group
50% KR group
75% KR group
100% KR group

If 100% KR group learns the best- the conclusion would be that KR helps learning.

If 0% KR group performs the best-the conclusion would be that KR hinders learning.

1.1.5 SCOPE OF EXPERIMENTAL PSYCHOLOGY

The earliest experimental psychologists were physicists and physiologists and consequently a great amount of work in the psychological laboratory is concerned with the special senses of touch, temperature, taste, smell, vision, hearing and movement. Starting from psychological laboratory at Leipzig by Wilhelm Wundt (1879) the father and founder of Experimental Psychology. Psychology has come a long way. Wundt's laboratory became an early model for the first generation of experimental psychologists. The scope and application of experimental techniques to study the various processes of Psychology, has further given Psychology an independent and scientific status and a position of positive science.

The systematic study of sensation by laboratory methods by Fechner popularly called psychophysics led to real widening of psychological horizon and also upgraded psychology to an exact science like Physics. Gustav Theodor Fechner elaborately endeavoured to obtain exact quantitative statements of the relation between the intensity of a stimulus and of the sensation which it evokes. The actual methods of observation which he initiated have been developed in many ways and are the foundation of a large part of modern experimental procedure

In 1885, Hermann Ebbinghaus published the results of a long series of experiments which he had made upon himself in the memorizing of nonsense syllables. He claimed that the use of this kind of material (nonsense syllables) made it possible for the first time to experiment successfully on the "higher mental processes."The publication of his results settled the direction of flow of the main stream of experiments on memory from that day to this due to his great innovation in the use of nonsense syllables for memorizing.

During the same time Francis Galton gave Psychology a scientific status with his studies on individual differences and development of mental testing methods and increased its scope in day to day life.

Experimental psychology, as such professes a wide scope. Memory, training conditioning and the whole field of human and animal learning activities are accessible with the help of experimental methods. Thinking and problem solving have also yielded very impressive results .Experimental Psychology is fast catching on emotions and motivation also. Locus of control and "self efficacy" is being researched upon widely.

Experimental Psychology, along with experimental method also utilizes statistical methods like ANOVA, factor analysis and correlation. This has multiplied the scope of experimental psychology many fold giving it quantification advantage.

Experimental psychology, as such, however had taken challenge that comes from clinical counseling in dealing with personality development and maladjustments but slowly is picking up in these fields also. Experiments on anger reduction or prosocial and antisocial behaviour are being conducted across nations.

It is now recognized that experimental psychology has a position in the scheme of higher education and scientific research. A considerable number of well-established journals exist for the publication of the results of experimental research in psychology. Apart from university teaching there are, flourishing organizations for the practical application of experimental psychology in various directions, be it education, practice of medicine and law, industry (special tests for vocational aptitudes and their methods of vocational guidance and training) and even in the organization of a country's defensive and offensive services. In legal practice psychological experiments have been tentatively proposed and used in connection with the detection of crime. It would be easy to show that the development of this practical aspect of psychology has been made possible directly and almost entirely by the use of experimental methods.

The whole of this practical development has reacted strongly upon those methods of academic research without which it could itself never have grown to importance. In this way also the laboratory has been brought nearer to the problems of real life and the very great possibilities of experiment as contributing to a more complete understanding of man's multifarious activities is being explored with greater eagerness than ever before.

Thus Collins and Drever (1976) rightly remark "Psychology without the experimental part would be anachronism".

1.1.6 Let us sum up

Experimental psychology first made its appearance about 100 years ago and challenged the old mental philosophy. Psychology became the 'Science of Behaviour and Cognitive Processes'. Collins and Drever had beautifully remarked "Psychology without experimental part is incomplete". The experimental method was first of all introduced by **Wilhelm Wundt in 1879.** He opened the first recognized psychology laboratory at Leipzig in Germany. Psychology is being exported to so many other fields. It has travelled its journey from theory to practice to deal with emotional and psychological problems or focus on motivation building, employee evaluation or de-stressing the stressed one.

1.1.7 Keywords

1. Empiricism:
The principle of empiricism simply means to make observations. This is the best method of figuring out orderly principles. This is a favorite tool among scientist and psychologists because they assume that the best way to find out about the world is to make observations.

2. Stimulus:
By stimulus we mean any physical force in the environment which makes the organism behave, react and respond. The physical force can be any living being such as teacher in the class or snake in the courtyard ,non living thing such as words written on the blackboard, telephone or even physical environment such as trees, wind etc. It is usually referred to as 'S'.

3. **Subject:**
There has to be a subject or subjects on whom the experiment is performed. In physical sciences experiments are performed on organic or dead objects whereas in psychology experiments are performed on living subjects. The subject may be a human being or an animal. The subject may also be written as 'O'.

4. Manipulation:
In any simple experiment different groups of participants are exposed to contrasting levels of the stimulus or independent variable (such as zero, low, moderate and high).This procedure of varying independent variable by the experimenter is termed as manipulation.

1.1.8 Long questions

Q.1 Write in detail the scope of experimental psychology.
Q.2. What are the basic requirements of conducting an experiment?

1.1.9 Short questions

Define the following
1. Determinism
2. Experiment
3. Structuralism

1.1.8 Suggested Readings :

1. Morgan, C.T. King, R.A. Wesz, J.P. Schoper, J. (1987). Introduction to Psychology. MC Graw-Mill, New York.
2. Postman & Egan : Experimental Psychology.

B.A. PART-II **PSYCHOLOGY**
(Semester-III) **EXPERIMENTAL PSYCHOLOGY**

LESSON NO. 1.2 **Last Updated January 2023**

EXPERIMENTAL METHOD

Lesson Structure

1.2.8 Keywords
1.2.9 Long questions
1.2.10 Short questions
1.2.9 Suggested readings

1.2.0 OBJECTIVES:

The lesson provides the basics of experimental method i.e. its requirements, characteristics and types of designs used in an experimental method. We shall also take up the merits and demerits of experimental method.

By the end of this lesson, you should be able to:

- Explain the requirements of experimental method.
- Understand basic characteristics and steps of an experimental method.
- Variables and its types.
- Merits and demerits of experimental method.

EXPERIMENTAL METHOD

1.2.1 INTRODUCTION

An experiment is defined as "observation under controlled conditions". Experimental method, as it employs 'control', is therefore a "highly developed, most accurate and reliable of all methods used in psychology". The experimental method involves manipulating one variable to determine if changes in one variable cause changes in another variable. This method relies on controlled methods, random assignment and the manipulation of variables to test a hypothesis.

It is a procedure in which

↓

certain hypotheses are formed on the basis of previous findings.

↓

These assumptions or hypotheses are tested systematically

↑

by varying certain conditions and controlling others

↑

called prearranged conditions.

1.2.2 Therefore we can say that the Basic Requirements (steps) of an experiment are

↓	↓	↓	↓	↓
Well planned laboratory	Apparatus	Problem	Hypothesis	Well planned design

1.2.2.1 Well Planned Laboratory

This basic requirement of an experiment points to the physical factors. A well lit room, with proper seating arrangement, and apparatus availability for the experiments, is a well planned laboratory. Whenever psychological research is carried out utilization of laboratory is a prerequisite and it needs to be a well planned one.

1.2.2.2 Apparatus

Apparatus has a very important role to play in the experiment. An inaccurate apparatus used for 'reaction time' experiment can defeat the very purpose. Standardized tests or apparatus therefore must be installed in the laboratory to facilitate experiment and draw out valid and reliable results.

1.2.2.3 Problem

General problem exists when there is no available answer for a question. In psychology, however, by PROBLEM we mean the first link in the chain of thoughts necessary for the successful designing of the experiment.

1. The experimenter should be very clear about the problem or investigation that he wants to undertake.
2. Problem should be extremely precise and clear cut. Example- Effect of Drug on performance.
3. Problem must state the causal relationship between IV and DV.

According to Townsend – "A problem is a question proposed for solution".

On the basis of above definition, we can say that problem is in itself a question which is related to our inadequate knowledge and through experimentation we search solution.

Once the experimenter is clear about the problem his next step is to introduce it. The researchers must then conduct a thorough review of the existing literature on the subject. This review will provide valuable information about what has already been learnt about the topic and what questions remain to be answered. A literature review might involve looking at a considerable amount of written material from both books and academic journals dating back decades. The relevant information collected by the researcher becomes part of the introduction section. This background material will also help the researcher in formulating a hypothesis.

1.2.2.4 Hypothesis

Formation of hypothesis is a very important aspect of experimentation. Hypothesis is defined as '**the suggested and testable answer to the problem**'. Hypothesis is a mere assumption on the basis of past findings. A hypothesis can be defined as an educated guess about the relationship between two or more variables.

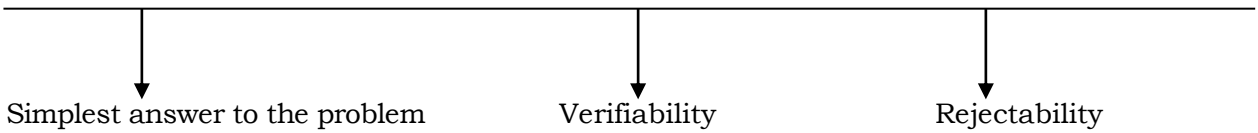
According to Townsend, J.C.(1953)- "It is a suggested answer to the problem under investigation."

According to Mc Guigan, F.J.(1969)- A hypothesis is a testable statement of a potential relationship between two (or more) variables.

For example, a researcher might be interested in the relationship between drug intake and study performance. They would then propose a hypothesis about how these two variables (drug and performance) are related, such as "drug intake lowers study performance." A testable hypothesis predicts how the operationally defined variables are related.

It is a statement which must have the following qualities.

Qualities of a Hypothesis



→ Simplest answer to the problem - Hypothesis must be so clearly stated that it contains all the elements to make it the simplest answer to the problem. Simplest the

hypothesis, simpler the experiment, and simple it is to test it. A hypothesis stated in difficult and complex words defeats the very purpose and is worthless.

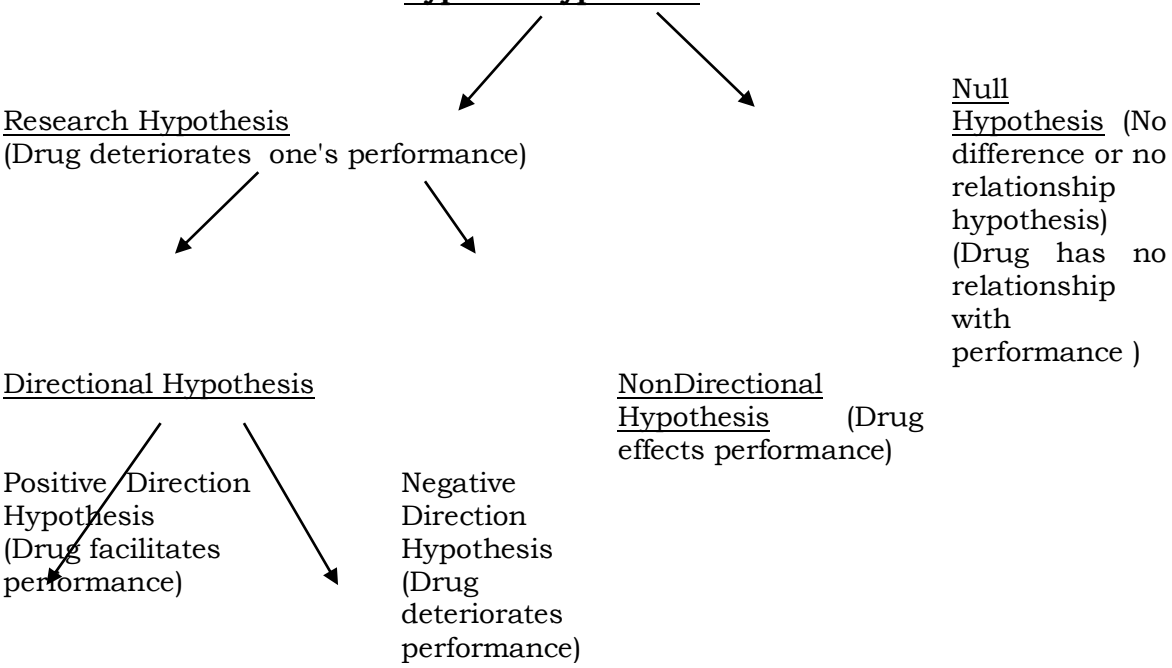
→ Verifiability- Hypothesis must have the quality of verifiability.

→ Rejectabilty- Hypothesis is not always to be accepted by the results. Thus it must be stated in such a way that it can also be rejected.

◄ Predictibility-Hypothesis must be predictive in nature i.e. it must state the direction of relationship between the variables involved.

- Scope - The apparent application of the hypothesis to multiple cases of phenomena.
- Fruitfulness -The prospect that a hypothesis may explain further phenomena in the future.

Example-Drugs deteriorate one's performance. The above said hypothesis is simple, verifiable, open to rejection and predicts the outcome of the study.



1.Experimental hypothesis/Research hypothesis: Hypothesis which are put to test and research. In this hypothesis it is predicted that the treatment causes an effect. It can be proven wrong. For e.g., drug deteriorates one's performance highlights the relationship between IV (drug) and DV(performance). Scientists generally base scientific hypotheses on previous observations that cannot be satisfactorily explained with the available scientific theories. It is of two types:

a) Directional Hypothesis-Any research hypothesis which states the direction of the relationship between IV and DV i.e. whether IV positively or negatively effect DV. This is further of two types:

→ Positive direction hypothesis states that IV improves/facilitates/increases DV. For e.g., Drug facilitates performance.

Negative direction hypothesis highlights that IV inhibits/decreases DV. For e.g.,Drug deteriorates performance.

b) Non Directional Hypothesis-Hypothesis which is a simple statement which indicate the direction of relationship between IV and DV. For e.g., drug effects performance.

2. Null hypothesis: "Null" is a german word which means zero. Other name of Null hypothesis is 'Statistical Hypothesis'. In this type of hypothesis, the experimenter presumes that there is no difference between the two variables. Null Hypothesis predicts that the treatment does not cause an effect. It also can be proven wrong. It cannot, however, be accepted. The null hypothesis is the prediction that one variable will have no association to the other variable. For e.g., drug has no relationship with performance .In other words, the null hypothesis assumes that there will be no difference in the effects of the two treatments in our experimental and control groups. The null hypothesis is assumed to be valid unless contradicted by the results. The experimenters can either reject the null hypothesis in favor of the alternative hypothesis or not reject the null hypothesis. It is important to remember that not rejecting the null hypothesis does not mean that you are accepting the null hypothesis.

Hypothesis, as above said, is either accepted or rejected. When the hypothesis is proved we must look for **Confirmation Bias** - "a tendency to notice only things that agree with our view of the world". This bias must be looked for before we accept our hypothesis.

Sources of hypothesis :-

Hypothesis is formulated on the basis of some existing theory, laws, personal experiences, analogy (cause and effect relationship).

1.2.2.5 Well Planned Design

Design of experimental method is the method of controlling RV's such as laboratory conditions or other variables which might hinder the results (DV). Design helps in making empirical observation of actions, thoughts and behaviour of humans or animals.

So the most important aspect of an experiment is the experimental design. The success and validity of an experiment depends mostly on the experimental design. **It contains the entire planning of the experiment.** It can be called the 'skeleton of the experiment'.

In an ideal design chiefly 3 points are note worthy.

- How many conditions are to be taken and in what order they are to be placed.
- Which variables are to be controlled and how to be controlled.
- How to manipulate experimental variable to get its maximum effect upon the results.

Ruch (1970) states about the experimental designs.

- It defines the experimental problem.
- States the conditions for observation to be made.
- Describes the instrument and apparatus to be used in making accurate observations and
- Outlines the procedures to be followed in interpreting the results.

1.2.2.6 Choosing Sample

When conducting experiment, the experimenter need not to test every individual in a group. Instead, he can select a random sample of participants from the larger population. When choosing subjects, there are a number of different techniques the experimenter can use. A *simple random sample* involves randomly selecting a number of participants from a group. A *stratified random sample* requires randomly selecting participants from different subsets of the population. These subsets might include characteristics such as geographic location, age, sex, race or socioeconomic status.

1.2.2.7 Conducting Test and Collecting Data

After selection of participants, the next steps are to conduct tests and collect the data. Prior to doing any testing, however, there are a few important concerns that need to be addressed. First, it is important to be sure that testing procedures are ethical and the permission is sought by the subjects beforehand. Once this step has been completed, the experimenter can begin administering testing procedures and collecting the data.

1.2.2.8 Examining Data and Reaching Conclusion

Once a researcher has designed the study and collected the data, it is time to examine this information and draw conclusions about what has been found. Using statistics, researchers can summarize the data, analyze the results, and draw conclusions based on this evidence. Statistical analysis can support (or refute) the researcher's hypothesis; it can also be used to determine if the findings are statistically significant. When results are said to be statistically significant, it means that it is unlikely that these results are due to chance. Statistical significance means that the results of the study are unlikely to have occurred simply by chance.

Experimenter should be very clear about the statistical technique, he wishes to use to analyze his results. Experiment conducted rightly till the last, but if a wrong statistical technique is applied, whole of the experiment is a waste of time, energy and money. Experimenter ought to be clear about, method he is going to adopt for analyzing his results. For this he should test reliability and validity of the method he is to use. Results or observations need to be organized in **'some clear and orderly arrangements'** such as tables, figures and curves on the graph paper.

1.2.2.9 Discussion of the Results

The purpose of this section is to evaluate and interpret the results, especially with respect to the original research question. The main findings and implications and importance/limitations of the results are discussed.

EXPERIMENTAL DESIGNS

1.2.3 CHARACTERISTICS OF EXPERIMENTAL DESIGN

1.2.3.1 *Order*

It is assumed that events follow a system or an order. Therefore design should be accordingly planned.

1.2.3.2 *Determinism*

It is assumed that all events have a cause. Finding the cause should be the aim of the experiment.

1.2.3.3 *Empiricism*

Observation must be looked into and measured by experimental design.

1.2.3.4 *Parsimony*

Design should be such that it promotes generalization.

1.2.4 TYPES O EXPERIMENTAL DESIGN

1.2.4.1 Designs According to Assignment of Participants

Within Subject Design
Between Subject Design

1) Within subject design (Counter balancing method)

Task - learning of 2 lists

List A - 10 words

List B - 20 words
No. of Subjects - 20
Design - All will learn both the lists (but)
10 Subjects proceed A to B (A → B)
10 Subject proceed B to A (B → A)
(This procedure is called counter balancing method).

Another Example
Effect of Drug on Performance

Subjects	**Variation of IV →**	**5 mg**	**10 mg**	**15 mg**	**20 mg**
A ↓		A	B	C	D
B ↓		B	C	D	A
C		C	D	A	B
D		D	A	B	C

2) Between subject design

In using 'Between Subject design, 10/20 subjects will be randomly assigned to learn list A (10 words) and 10 subjects would learn list B (10 words). Randomly means when all the subjects have equal chances of being selected in either of the group - Each subject will be given a number from 1 to 20 and then they will be divided in two groups randomly.

Gr. I - 1,3,4,7,8,10,12,14,18,19,
Gr. II - 2,5,6,9,11,13,15,16,17,20

1.2.4.2 Design According to Number of IV

Usually research is not with just one independent variable, it is with more than one independent variable. Simultaneous manipulation of several independent variables need to be done as it has many advantages in terms of time and energy. It is more efficient to run one experiment with three IVs than running three separate experiments. In such a case factorial designs are used.

1.2.4.3 Matched Pair Technique

In this design the subjects are examined one by one in pairs and assigned to the respective groups on the basis of their equal possession of relevant variables. One begins to decide on which factors or variable the groups will be matched.

For example

Group can be matched on		male	female
Academic Achievement percentage	Pair1	78%	78%
	Pair2	72%	72%
	Pair3	70%	70%
	Pair4	67%	67%

Thus, in this design an attempt is made to select subjects from larger group of subjects and dividing them into two equal groups.

1.2.4.4 Matched Group Technique

In this method the experimenter does not attempt to match each individual with other individual but tries to make sure that average possession and extent of distribution of the important characteristics in the group with respect to relevant variable is the same.

For example- If experimenter feels that 'IQ of the Subjects' is the relevant variable in his experiment, all his efforts should be guided by the principle that there is an even distribution of IQ for both the groups. Average IQ of both the groups should be same.

1.2.4.5 Randomized Group Technique

If experimenter thinks that he is unable to match his groups either because he cannot decide about the important factors upon which to equate them or cannot measure relevant variables, then the technique of randomization is used. This technique is based on the assumption that as more and more subjects are included in each group, there is every chance that the two groups, become similar. The subjects are selected at random and allotted to one of the groups. The larger the group the greater the chance that they will cancel their differences and become more similar.

1.2.5 VARIABLES

A variable is something that can be changed, such as a characteristic or value. Any thing which can be varied is a variable. Variables and their understanding is a very important part of experimental method. A variable is a factor or element that can be changed and manipulated in ways that are observable and measurable. There are 3 main types of variable.

TYPES OF VARIABLES

1.2.5.1 Stimulus Variables (Independent Variable (IV))

Stimulus or IV Variable is one which is systematically and independently varied or manipulated by experimenter. They serve the purpose of a stimulus.

Example - Effect of Drug on Performance

↓ ↓

IV DV

Drug - IV - can be manipulated or varied as:-

5mg to be given to Group I

10 mg to be given to Group II

15 mg to be given to Group III

20mg to be given to Group IV

Independent variable can be further classified as

- Environmental variables (noise, heat illumination)
- Instructional variable (Experimenter may or may not give instructions
- Task variables (Levels of difficulty, amount of work to be done)
- Subject variables (age, sex Intelligence)

1.2.5.2 Control Variables (Organismic Variables and Extraneous Variables)

A controlled (RELEVANT) variable is the thing that is kept consistent in between trials of doing an experiment. All the variables which might hinder or effect the results, apart from IV which the experimenter manipulates and DV which he observes, must be controlled .This will ensure that the change that has occurred in the DV or behavior is only because of IV. In a scientific experiment, the controlled variable never changes; it is the same for every setup. The experiment might select participants that are the same in background and temperament to ensure that these factors do not interfere with the results. If, however, a variable cannot be controlled for, it becomes what is known as a **confounding variable**. This type of variable can have an impact on the dependent

variable, which can make it difficult to determine if the results are due to the influence of the independent variable, the confounding variable or an interaction of the two. Control variables can either be Organismic or Extraneous.

Organismic Variables are those variables which are within the organism. Some of the organismic variables are:-

- Habit Strength
- Drive Hunger
- Incentives
- Individual differences due to, Sex, Intelligence, Interest, health, Organic State

Extraneous Variables are all those variables which are present in the physical environment outside the organism such as noise, temperature, time of the day etc.

If not taken up as independent variable, they also affect the results of the experiment. At times when they affect the results they become relevant variables but at other times they do not affect the present experiment and as such become irrelevant variables. Therefore, the same variable is relevant for one experiment but irrelevant for the other one.

1.2.5.3 Dependent Variables (Response Variables)

DV are those variables which cannot be manipulated but are dependent on independent variables. They are the consequences or responses given or behavior shown by the subject to the treatment or IV. These are those variables on which the effect is being studied.

Example - If we want to study the Effect of Reward on Learning

IV DV

All the variables are either qualitative or quantitative.

Qualitative Variable : When the observation is of kind rather than degree (how much can't be measured) are called qualitative variable. They often relate to aspects or properties of the organisms under study- religion, occupation, personality classification etc. The essential feature of qualitative variable is that they are composed of categories which do not bear a quantitative relationship (one of magnitude) to each other. These variables are called Unordered or Categorical Variable.

According to D'Amato :

"Qualitative variables are composed of categories which cannot be ordered with respect to magnitude."

Quantitative Variable :

When observations are measurable, we call them, quantitative variables. Observations of this variable are in numbers and this variable can be measured with a degree of fineness, may be by using precise instruments e.g. two point threshold can be quantitatively measured.

D'Amato,

"Any Variable that can be ordered with respect to magnitude is a quantitative variable." Thus age, intelligence, number of trials and intensity are all quantitative variables. There are preferred in scientific work for the simple reason that they lend themselves to much more precise and fruitful measurement than qualitative variable.There is little explanatory power in qualitative variable.

Quantitative variable is of two types –

(i) **Continuous Variable :** These are characterized by uninterrupted changes, without breaks or steps. Continuous variables are the quantitative which can be measured with an arbitrary degree of fineness. Reaction time is a continuous variable.

(ii) **Discrete or Discontinuous Variable :** These quantitative variables are those whose values are obtained by counting, e.g. number of children in a class, siblings. It cannot be measured with arbitrary degree of fineness because no amount of refinement of measuring instruments or techniques can produce a value of two and a half children.

Differences in Quantitative and Qualitative Variable

Quantitative Variable	Qualitative Variable
1 Any variable that can be ordered with respect to magnitude is a quantitative variable.	1 Qualitative variable are composed of categories which cannot be ordered with respect to magnitude.
1 They are preferred in scientific work for they lend themselves to much precise measurement.	2 They have little explanatory power.
2 There variables are observed in degree and number.	3 These variables are observed in king.
3 These can be measured in magnitude precisely.	4 They lack in fine measurement.
4 e.g. : Age is a quantitative variable.	5 Personality is a qualitative variable.

Controlling Techniques :

Experimental method intends to study the effect of independent variable on the dependent variable. To achieve this objective its essential to control all the confounding variables that may effect independent or dependent variable. This objective can be achieved by the following methods.

1. Method of Removal : This is one of the first step that the experimental takes before even starting with the experimentation. For example light and sound can effect the performance of the subject so in that regard the experimenter may use sound proof room with the backup provision for light.

2. Method of Consistency of Condition : In this method the experimentor can control the variable by providing uniformity of external variable qualitatively or quantitatively For example, Gender/Age is a relavant variable which affects the behavior of most dependent variable. We can control such variables through the consistency method, that is all the subjects have same gender or age (Mean age) then their effect on behavior on dependent variable will be controlled.

In case of experimental and control groups and subjects are randomly drawn from the same population then each element of the population has the best chance of selection in either control group or experimental group.

3. Method of Screening or Balancing : This is a good method of controlling the extraneous variable affecting independent or dependent variable. In this method the effect of related variable is removed by screening or balancing its effects. For example during the experiment some uncontrollable sound effect the measurement of the dependent variable. The influence of sound could be eliminated by producing more powerful sound in the

laboratory. Thus that louder sound would be constant as all the subjects will be affected by this louder sound. Mc Guigan (1969) has described two conditions of this controlling method:

(i) In the first condition, the experimenter doesn't take interest in controlling the external variables.

(ii) In second condition, the experimenter has to know external variables and also control them. In this condition be distributes the external variable in experimental and control group in a very balanced manner.

4. Counter-Balancing Method : In psychological experiments many a times practice, fatigue or anticipation may effect the final results of the experiment. This has been called the "apparent progressive" change in the subjects response. This effect needs to be controlled as these are labeled as constant error.The constant error can be controlled by the method of counter-balancing method. Suppose the experiment is to study the difference between reaction time of Red and Green lights. If the experimenter gives the trails in an order like RRGG then the results may be affected by fatigue and practice and there is a possibility that the experimenter may not get similar results if the trails are given like : green-green-red-red".

Successive Trials	A	B	B	A
Effect of Response	1	2	3	4

Total Effect of Condition A 1+4 = 5
Total Effect of Condition B 2+3 = 5 > Same

Successive Trails	A	A	B	B
Effect of Response	1	2	3	4

Total effect of condition A 1+2 = 3
Total effect of condition B 3+4 = 7 > Different

Underwood (1949) indicates that the assumption behind the counter balancing or abba sequence is "the progressive change in response which may take place as experimentation proceeds in a straight line function".

5. Method of Systematic Randomizations : Counter balancing can't be used effectively if we have five or six conditions.

In such a case systematic randomization is a more appropriate method. Mc- Guigan has pointed out two following conditions in which this method can be used.

1 When the experimenter knows the nature of external variables but unable to control them through other methods.

2 When external variables are unknown to the experimenter and he is unable to control them by other methods.

In this method "each condition proceeds and is followed by each other condition about equally."

The following figure indicates the conditions presented in a systematic randomized manner.

Presentation of Condition
(ABCDE)

Subject	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
1	A	D	B	E	C
2	C	B	D	A	A
3	E	E	A	D	E
4	B	C	C	B	B
5	D	A	E	C	D

systematic randomization table for five conditions and five trials.

1.2.6 MERITS and DEMERITS OF THE EXPERIMENTAL METHOD

1.2.6.1 MERITS OF THE EXPERIMENTAL METHOD

1.2.6.1.1 Superior to Folk Wisdom -Folk wisdom is inconsistent and contradictory. For example- Absence makes the heart grow fonder versus Out of sight out of mind. The example shows how common sense is a faulty guide to human behaviour. Common sense also leads us astray. Our thinking is subject to several forms of error. Therefore, only experimentation provides scientific bases to our intuitive ideas.

1.2.6.1.2 Cause and Effect Relationship- The ability to reveal cause and effect relationship is the most important underlying need and advantage of the experimental method. Cause and effect means establishing that one variable has caused a change in the other variable for example has an increase in stress levels caused illness. It is important to establish cause and effect, so that an undesirable effect can be changed or eliminated i.e. reducing illness by decreasing levels of stress. If the research is correlational or the variables are not controlled then the causal relationship between IV and DV cannot be ascertained. Psychologists look to identify the effect one variable has on other variable….Does one variable "cause" other variables to change. Establishing cause and effect is not easy and requires researchers to conduct studies that not only follow the scientific method, but also classify as true experiments."

1.2.6.1.3 Encourage Critical Thinking -Experimental method encourages critical thinking which is essential in today's world of facts and information.

1.2.6.1.4 Quantitative Knowledge-It is only with the help of experimental method that we are able to get quantitative results and therefore, we can show how important our results are for future studies. Without this method we have always been getting qualitative results which show no amount of surety that whether the two traits are significantly correlated or not.

1.2.6.1.5 Reliability-It is only with the help of experimental method that reliability of the results can be established. Reliability refers to the consistency of a measure. A test is considered reliable if we get the same result repeatedly. Reliability needs repetition and verification which is only possible in experimental method. Here the experimenter can repeat his observations under the same conditions for verifications.

1.2.6.1.6 Validity -Validity means **'whether the test or the experiment really measures what it intends to'**. Experimental method with its strong statistical techniques have many methods to test the validity of any test or equipment, thus making experimental method strong.

1.2.6.1.7 Replication and Repetition-Repetition and replication is also only possible in experimental method. The results can be replicated with the help of parallel tests made in a standard way. The experiment can be repeated any number of times to check the reliability of results. Replication of the experiment is possible due to due to standardised procedures (designs/instructions).

1.2.6.1.8 Wide Scope-Experimental method has a very wide scope. Many problems of psychology which hadn't been measured before experimental method, have been measured accurately and reliably with this method.

1.2.6.1.9 Varying of the conditions-Experimentalist can vary the conditions systematically and note the variation in the response.

1.2.6.1.10 Control over the situation-It is only with the help of experimental method that experimenter can control the situation under which the events occur whereas in other methods an observer simply watches the course of events without exerting any control.

1.2.6.1.11 Generalisation-The experimental method also makes us more confident about the generalisation of its results to a wider population.

Experimental method is considered superior to all other methods because like observation it does not give too much importance to the observer neither does it give importance to the subject as in introspective method. It is a method where the subject and the experimenter both have equal say and importance.

1.2.6.2 DEMERITS (DISADVANTAGES)

Experimental method with all its advantages and an upper hand over all other methods still has certain limitations.

1.2.6.2.1 Wastage of Time and Energy - It is a lengthy method which takes too much time of the experiments and expects too much time from the subject also. If any of them, the 'Subject' or the 'Experimenter ' is not in a mood to devote or give that much time, the very purpose of the method is defeated and it only remains to be a waste of time and energy.

1.2.6.2.2 The Expensive Method - Experimental method with all its merits still stands to be a very expensive method which requires a lot of equipments and laboratory facilities. It is not a method which can be conducted in an open air situation.

1.2.6.2.3 Controls - If relevant variables remain uncontrolled it can prove a disaster for the results. Thus the strength of the experiment becomes its weakness.

1.2.6.2.4 Artificiality - Psychology is the science of behaviour and behaviour is how we move about in natural surroundings. Experimental method stresses on study of behaviour under artificial conditions. Thus, it may be said that what we study in the laboratory may not be what actually is. This points out to problem of Ecological Validity.

1.2.6.2.5 Narrowness of Its Approach - Experimental method is limited to the laboratory but behaviour is a very vast phenomenon which cannot be limited to a four walled room. Thus, many aspects of behaviour are impossible to study in an artificial and limited field of laboratory such as crowd behaviour.

1.2.6.2.6 Human Bias and Prejudices – Since scientific method is a matter of human construction, it is subject to human error. Experimenter's bias and prejudices can ruin this method. However, scientifically, it may be, it still is in the hands of human being and any type of preconceived bias in the mind of experimenter can influence the participant's behavior and/or the interpretation of results-a Self Fulfilling Prophecy. TAT tests for example, have experimenter bias. To eliminate experimental bias experimenters use Double-blind Technique (an experimental procedure where neither the participants nor the experimenter knows who is in the control group and who is in the experimental group until results have been gathered).

1.2.6.2.7 Lack of Motivation on the part of Subject - Subject about whom sometimes even the experimenter is not aware can be very disastrous to experimental method and can make its results most unreliable.

1.2.6.2.8 Non representative sample – The sample may not be representative of a population, because the researcher does not have an opportunity to ensure a representative sample by random assignment or randomization . For example, subjects

could be limited to one location, limited in number, studied under constrained conditions and for too short a time. This is called as Selection Bias when differences between experimental and control group are present from the beginning and random assignment (assigning participants through chance, guaranteeing that all participants have an equal probability of being placed in any groups) of subjects have not been undertaken.

Thus, it may be concluded that experimental method is a method with many merits if placed in the proper hands. On the other hand, if in wrong hands, all its demerits emerge.

1.2.7 Let us sum up :-

Experimental method has given psychology the status of science and with the help of this method only cause and effect relationship can be studied under controlled conditions. As psychology studies organisms (Animals or humans) so all the conditions can't be controlled and hence the results may not always be same due to organismic factors like motivation, mental set etc. Despite of certain limitations still experimental method is the most scientific method that has given psychology a pragmatic outlook.

1.2.8 Keywords

1. Hypothesis:

Formation of hypothesis is a very important aspect of experimentation. Hypothesis is defined as '**the suggested and testable answer to the problem**'. Hypothesis is a mere assumption on the basis of past findings. A hypothesis can be defined as an educated guess about the relationship between two or more variables.

2. Reliability:

It is only with the help of experimental method that reliability of the results can be established. Reliability refers to the consistency of a measure. A test is considered reliable if we get the same result repeatedly. Reliability needs repetition and verification which is only possible in experimental method. Here the experimenter can repeat his observations under the same conditions for verifications.

3. Continuous Variable:

These are characterized by uninterrupted changes, without breaks or steps. Continuous variables are the quantitative which can be measured with an arbitrary degree of fineness. Reaction time is a continuous variable.

4. Directional Hypothesis:

Any research hypothesis which states the direction of the relationship between IV and DV i.e. whether IV positively or negatively effect DV. This is further of two types: Positive direction hypothesis states that IV improves/facilitates/increases DV. For e.g., Drug facilitates performance. Negative direction hypothesis highlights that IV inhibits/decreases DV. For e.g., Drug deteriorates performance.

1.2.9 Long questions

Q1. What are the different types of variables?
Q2. How we can control extraneous variables?

1.2.10 Short questions

Define the following

Q1. Hypothesis
Q2. Validity

1.2.11 Suggested Readings

Morgan, C.T. King, R.A. Wesz. J.R. Schoper, J. (1987). Introduction to psychology. McGraw-Hill, New York.

B.A. PART - II **PSYCHOLOGY**

(Semester-III) **EXPERIMENTAL PSYCHOLOGY**

LESSON NO. 1.3 **Last Updated January 2023**

MEMORY : NATURE AND TYPES

LESSON STRUCTURE

1.3.0 Objective

The main objective of this lesson is to understand the nature and different types of memory. The lesson aims to familiarize students with the stages of memorization, the processes involved in memory, and the factors affecting memory. By the end of this lesson, students should be able to comprehend the various levels of memory - sensory memory, short-term memory (STM), and long-term memory (LTM). They will also understand the different methods used to measure retention, such as recall, relearning, recognition, and reconstruction.

1.3.1 Introduction :

Learning and memory are inseparable. They are so closely inter-related that it is difficult to define them separately. Broadly speaking, memory is doing what one has learnt to do, or memory is retaining what one has learnt. We think and reason largely from the remembered facts. The experimental aspect of human memory started in 1874 when a German psychologist Hermann Ebbinghaus started an experimental programme on memory, that brought about a number of changes in cognitive psychology. He wrote a book in 1885 entitled "on Memory" which included well designed experiments in the area of memory.

1.3.1.1 Definitions :

Stout has defined memory as "ideal revival" i.e., to revive the things, objects or experiences in the same order or form.

Morgan et al. (1974) have defined memory as the storage and revival of things learnt earlier.

Woodworth (1964) has defined memory as follows : "Memory consists inremembering what has been previously learnt."

Thus, memory is the reproduction of past personal perception in the same orderand form.

1.3.2 Stages of memorisation

There are four stages or process involved in memorisation. These are :

(i) Learning,
(ii) Retention
(iii) Recall, and
(iv) Recognition.

(1) Learning

Learning is the first step of remembering. It is a very active process during which impressions are registered in the brain. The more efficient the learning, the better is the scope for remembering. If we have learnt a thing nicely, we can retain, recognize and recall for long time. Learning depends upon active observation, active recitation, strong will or purpose, interests, constant repetition, and good health. Learning creates memory traces on the mind, on the basis of which recollection is effected. There are various methods of learning (i) Whole and part method, (ii) Spaced and Unspaced method, (iii) Part progressive method (iv) Recitation method.

(2) **Retention** :

It is demonstrated by trying to remember the impression made during the learning process. Memory traces are like pencil marks. Just as the pencil marks fade away with time, similarly memory traces fade away if not used. In retention, these memory traces or neural traces formed out of learning are consolidated. The amount of retention depends upon the consolidation of memory traces, which ultimately depends on the activities in which the individual is engaged during the retention interval. There are two types of Retention (i) STM and LTM. Forgetting in STM is caused by decay and lack of rehersal, while in LTM it is caused by interference.

(3) **Recall** :

Recall means trying to remember the impressions retained. In this, the previously learnt material is brought to the present consciousness in its absence. It is remerbering learned and retained association without the help of outside cues.It may involve a chain of associations and is often produced by partial stimuli. According to Ebbinghaus recall is Reproductive. There are two types of recall (i) Spontaneous recall i.e. one is able to recall memory traces one after the other without any effort. Second is deliberate recall i.e. consists in recalling the past impression with effort as solving a new problem, making new adjustments. Deliberate recall is of two types-Direct and Indirect recall.

Direct-It is to recall with more effort. Indirect-It is to recall with less efforts with the help of associations.

(4) **Recognition** :

According to Guilford, recognition means "knowing again". When one recognize an object or a stimulus, he behaves as if he has experienced it before. Thus, recognition simply means identification.

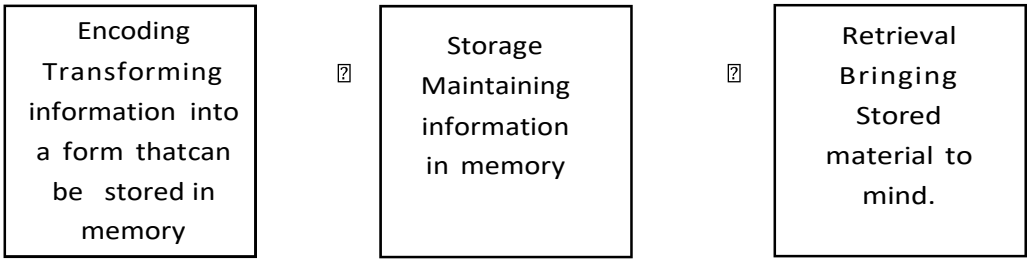
The recent approach to understand human memory is known as information- processing approach (Klatzky, 1984).

1.3.3 The Three Processes in Memory/Information Processing :-

The act of remembering requires the successful completion of three processes : encoding, storage and retrieval. The first process, encoding involves transforming information into a form that can be stored in memory. Sometimes, we store the information automatically but at times we need to do something with the information to store like making associations.

The second memory process, storage, involves keeping or maintaining information in memory. Encoded information is stored in the brain through certain physiological change in the brain - a process called consolidation.

The final process, retrieval, occurs when information stored in memory is brought to mind. To remember, we must perform all three processes-encode the information, store it and then retrieve it.



1.3.3.1 Levels of memory

So far, we have been discussing what is memory and what are the processes involved in memorisation. Now let us consider the types or levels of memory. Memory has been differentiated into three distinct levels:

(i) Sensory memory ;
(ii) Short-term memory ; and
(iii) Long-term memory.

Sensory memory :

Sensory memory is also known as the "sensory buffer" or "sensory register". It refers to the recorded or transcribed raw physical input. It consists of the impressions that

stimuli from the external world make on our senses. If the transfer of information of other memory stores is not virtually instantaneous, then the information gets lost.

Though the sensory store has a huge capacity for information, only a small proportion is processed from the raw sensory data and passed onto the next level. Sensory Memory could be either iconic (visual impressions) or Echoic (auditory) in nature.

Short-term memory (STM) :

After the information is processed from the sensory store and has been recognized and attended to, it moves into short-term memory. According to Broadbent (1958), "STM is interpreted as a bioelectric process in the form of a close neural circuit and is strongly susceptible to forgetting and interfering influences. Unlike sensory memory, short term memory is active and conscious. It is more selective and "more permanent" than sensory memory. When the sensory channels hold information for a brief duration, for about 30 seconds, it is called STM. STM has limited storage capacity. Miller (1956) pointed out that the range of STM is 5-9 objects. However, with the process of chunking, one can retain a larger numberof items.

STM has two important characteristics

a) Very limited capacity (only about seven digits can be remembered)
b) Fragility of storage, as any distraction usually causes forgetting.STM can be converted into LTM through the process of rehearsal.

Long-term memory (LTM):

It is also known as secondary memory. In contrast to STM, LTM has unlimited storage capacity. Information, knowledge and skills stored in LTM are relatively permanent as compared to STM, and hence remembered for a much longer period. It usually contains words, sentences, ideas, concepts and life experiences we have had. Organisations and imagery have an important role to play in storing information at the LTM level. Some experts believe that there are two main subsystems within long term memory i.e. Declarative memory and non declarative memory.

Declarative Memory (also called explicit memory) stores facts, information and personal life events that can be brought to mind verbally or in the form of imagesand then declared or stated. It holds information you can intentionally or consciously recollect.

There are two types of declarative memory - episodic memory and semantic memory.

Episodic Memory is the subpart of declarative memory that contains the memory of events as they have been subjectively experienced.

Semantic Memory is memory for general knowledge, or objective facts and information.

Non Declarative Memory (also called implicit memory) consists of motor skills, habits and simple classically conditioned responses.

1.3.4 Factors affecting memory

There are several factors affecting memory. These are as follows :

Mental set :

Without a readiness to learn, little or no learning takes place. Since retention varies with the degree of learning only those learners who practice under an adequate set will show

good retention. A specific set to recall will aid retention further.

Interest :

We remember things well in which we are interested. When we loose our interest in any activity, that activity is not retained for a long time. So, the greater thesubject's interest in the material to be learnt, the better would be his retention.

Attitudes :

Attitudes of acceptance and rejection of the content of the learning material are

significant determinants of the degree of retention. Retention tends to be poor forcontroversial material or items. So, the material which is experienced as hostile or threatening to established attitudes may be retained more poorly than the material which is acceptable to the subject or towards which he is indifferent.

Memory for completed and interrupted tasks (zeigarnikeffect) :

Interrupted tasks are generally retained better than completed ones. This is quantitatively expressed as I/C ratio. When no explanation or some very vague explanation is given, interruption in perceived as failure and the ratio is morethan 1. The reason for the better recall in interrupted task as compared to uninterrupted task is that tension or anxiety is built up for incomplete task and hence there is predominance of recall for interrupted tasks.

Age :

It is generally believed that memory depends on age. Benton (1963) states that memory increases from 8 to 14-15 years of age, then there is plateau which is maintained through thirties, and a decline occurs in forties.

Imagery :

Imagery too, is a facilitating factor in memory. Visual imagery strategy facilitates memory (Levin, 1978). Pictures given to six-years-old facilitates recall of the text they had read (Bender & Levin, 1978).

Nature of the learning task :

Meaningful material is retained better than nonsense items. The general content and meaning of a passage are retained better than the exact sentences. Thus, retention favours vivid and distinct experience that are rich in associative support. Items like nonsense syllables are retained with great difficulty, and there is greater scope for interference in recalling them.

Distribution of practice :

Retention is better after distributed than after massed practice. Distribution implies the interpolation of rest intervals during practice. Thus, when a criterion is reached by the distribution of practice, the associations are older than in the case of massed practice.

Influence of sleep during retention interval :

It has been experimentally proved that subjects who sleep after learning some material retain better than the subjects who don't sleep after learning. Spright conducted an experiment using two groups. The first group learnt in the morning session and recalled in the evening. Group II learnt in the evening, slept and recalledin the morning. It was found that group II showed 10% less forgetting than group I.

Retention and retroactive inhibition :

This factor is in reference to the type of activities that fill the interval between the end of practice and the test for recall. Retroactive inhibition can be defined as the adverse effect upon retention of an activity interpolated between learning and recall of a task. Here, retention is adversely affected because of the interference caused by the interpolated activity.

Retention and proactive inhibition :

When the original learning interferes with subsequent learning during the retention interval, it is called proactive inhibition. Forgetting occurs also when new learning is disturbed by old learning.

Serial position effect :

When you memorize formulas, terms or grocery items you are more likely to remember those items at the beginning and end of the list than those in middle. This is called Serial Position Effect.

Flash bulb memory :

It is vivid recall for earlier events associated with extreme emotions. Such memories are so vivid that it is as if our brains had recorded them like a scene in the sudden glare of a camera's flash bulb.

Constructive Memory :

It refers to the memory of an event that did not actually happened, but unconsciously constructed to fill a gap. Research has shown that memories are not always Fg. courtroom testimony of two witnesses differs significantly because constructive memory that one holds uses a variety of information (perceptions, beliefs, attitudes etc.) to fill in gaps and that the accuracy of our memory may be altered. The Misinformation effect says that we use newly acquired information (valid or not) to reconstruct our memory such as police or detective's leading questions about event. Hindsight Bias is the tendency to look at the past through our present perceptions such as if we see person cheating we state "He was probably cheating back then too."

1.3.5 Measurement of retention

During the process of memorisation, some of the material is retained by the learner but here the question is how much is retained and what is the extent of forgetting? The credit for the first systematic assessment of memory goes to Ebbinghaus (1900). Since then, several methods of assessing memory have evolved. Some of widely accepted methods for the measurement of retention have been described below. These are as follows :

(i) Recall ;
(ii) Relearning ;
(iii) Recognition ; and
(iv) Reconstruction.

1.3.5.1 Recall :

One of the most prevalent approaches of assessing memory is recall of a task learnt earlier. It is actually repetition of the learned material, i.e., verbatim or word for word recitation. Recall can be categorised into : Free recall, and

(i) Serial recall

(a) Free recall allows us to reproduce, pieces of information in any order. For example, we may listen to a lecture and afterwards, we may try to remember a few important quotes though not necessarily in the same order as presented during the class. On the other hand, in serial recall, we recall the material in the same order as it was at the time of learning. To obtain a quantitative measure of recall, the experimenter allows time of lapse after the subject has memorized the material usually by the serial method or the paired associates method or the prompting and anticipation method. The percentage of the correct responses denotes the recall score.

(b) Memory-span method :- In this method the subject is presented with a list of digits, alphabets or words and is required to reproduce it immediately after presentation. The number of items are successively increased until the subject fails in his attempt at reproduction. The memory span is defined as that length oflist which can be reproduced in 50 percent of the trials.

(c) Method of Prompting and Anticipation :- In this method the subject is presented with a list of words through the window of the memory drum. After the exposure trial the subject is shown the first word of the list and he has to anticipate the second word. Whenever the subject hesitates in responding he is prompted and if he makes an error he is

corrected. The retention score is calculated by adding the correct anticipations the subject has made.

(d) Method of paired association :- In this method one member of the pair becomes the specific stimulus for the reproduction of second member. The learning material may be meaningful words or nonsense syllables. In the exposure trial both the member are exposed through the window of the memory drum then only one member is presented and the subject has to recall the second member of the pair. The retention score is the number of correct paired items.

1.3.5.2 RELEARNING :

In this method, the subject is given a list to learn and after sometime, the same list is given for relearning, the criterion being the same. The measurement canbe in terms of the number of trials or the number of errors or time taken to learnthe list.

The greater the retention, faster the subject can re-establish his/her old level of performance. This method is also known as the *savings* method. The percentage of saving can be calculated by the following formula :

$$\text{Saving Score} : \frac{L_1 - L_2}{L_1} \times 100$$

Where L_1 stands for original learning,
and L_2 stands for relearning

For example, a subject takes 10 trials to learn a list to the criterion of one perfect recall. Next day, he relearns the same list in 4 trials to the same criterion. Then,

$$\% \text{ saving} = \frac{10-4}{10} \times 100$$

$$= 60\%$$

1.3.5.3 RECOGNITION :

It implies identification of the recalled material. In recognition, the past experience are presented to the senses. In this method, the object or stimuli are presented to the subject,but in recall method, the subject is to find or reproduce the stimuli.

In a typical experiment on recognition, the subject is confronted with a series of words containing both correct (old) and in correct (new) items. The subject is required to identify the correct ones. Scoring is done by the following formula :

$$\text{Recognition score} = \frac{\text{Right} - \text{Wrong}}{N} \times 100$$

Where N is the total number of stimuli 'right' is the number of correct responses, and'wrong' is the number of incorrect responses

For example, if no. of right responses =18

no. of wrong
responses =2N = 20.

Then, Recognition Score $= \frac{18-2}{20} \times 100 = 16 \times 5 = 80$

Recognition test may not be a successful test of retention if there is little or no similarity between old and new items. Retention of nonsense syllables (NSS) can be tested best by making the nonsense syllables with NSS only. Thus the condition for this method is that the new and old items should be similar.

1.3.5.4 RECONSTRUCTION :

This method involves the reproduction of the learned material. For example while writing an essay on World War II, we recall that the United States entered the war in 1941 after the attack on Pearl Harbour, and atomic bomb was dropped on Hiroshima in 1945. Hence, we are able to reconstruct the events that took place between these two time. In the laboratory set-up, the learning task consists of a series of items arranged in a definite

order. Some time after the end of practice, the subject is given the items he had learnt, but they are presented in a random order. The subject's task is to reconstruct the items in the original order.

The formula used is as follows:

$$\frac{\text{No. of items correctly reproduced}}{N} \times 100$$

Where, N is the total number of items.

There are two methods that are commonly used to measure short-term memory. These are :

(i) Probe technique ; and

(ii) Distractor technique

(1) PROBE TECHNIQUE :

In this, the subject is presented with a series of items but is tested for only one of them. At the time of presentation, the subject does not know which item will be called for lateron. For example, series of five digits can be presented to the subject. Later on, he may beasked to recall the fourth digit. On the next presentation, he may be asked to recall thesecond digit. In pair associate learning, any one of the two members of the pair is presented and the subject is required to recall the other member of the pair.

(2) DISTRACTOR TECHNIQUE :

In this technique, the subject is presented with a series of letters of digits which he has to recall later on. He is given some interpolated activity in order to prevent rehearsal during the retention interval. After this, he is asked to retrieve the original series. The interpolated activity is simply enough to occupy the subject, but it doesnot involve any new learning. Thus, it is different from retroactive inhibition test in which the interpolated activity involves some new learning.

These technique provides a point of reference from which we can inquire about the nature of forgetting in short-term memory.

1.3.6 THEORY OF LEVELS OF PROCESSING

While information-processing theories of memory view the memory process in discrete stages, each with its own characteristic features a contrasting model of memory has been given which is the "levels of processing" (Craik & Lockhart 1972) framework, with the idea of elaboration added to it more recently (Craik & Tulving, 1975).

According to the levels of processing framework, incoming information can be worked on at different levels of analysis; the deeper the analysis the better the memory. The first level is simply perception, which gives us our immediate awareness of the environment. At a somewhat deeper level, the structural features of the input are analyzed (such as what it looks or sounds or tastes). Finally, at the deepest level of processing the meaning of the input is analyzed. The more deep and elaborate the processing of the perceptual input, the better is the memory for that matter. Rehearsal plays a very important role in the processing of information. It refers to keeping the information "at the centre of attention", perhaps by repeating it over and over again. According to the levels of processing view, simply repeating the information, i.e., maintenance rehearsal is not enough. It must be elaborative, i.e., it must process the information to the meaningful level if the information is to be well retained.

The concept of elaboration has been added to the levels of processing theory. Elaboration refers to the degree to which coming information is processed so that it can be tied to, or integrated with, existing memories. The greater the degree of elaboration given to an item, the more likely it is to be remembered. The entire processing is based on how encoding is done.

1.3.6.1 ENCODING

Encoding or recording involves the preparation of information in a useful way so that it can be remembered. Encoding for long-term storage required special attention or strategies of some sort. Some of them are discussed as below :

Mnemonic : A mnemonic is a technique that enhances the storage and the recall of information in memory. It aids information retention and retrival (remembering) in the human memory. The word "mnemonic" is related to Ancient Greek word Mnemosyne ("rememberance") the name of the goddess of memory in Greek mythology. Mnemonic help us to use information already stored in long term memory to make memorisation an easier task,

Eg : To remember the name of planets by using first letters mnemonic technique

: "My very Educated Mother just served us Nachos" where Ist letter M stands for Mercury, V stands for Venus, E for earth and so on.

a) Role of Organization :- The term organization carries its usual meaning, referring to some systematic or functional arrangement. Organized material is most readily remembered. When the material doesn't have its own organization, the learner must create a Subjective Organization imposing an organizing scheme on the material by encoding it in terms of personal experience. One method to arrange the information is through 'peg-word' technique. For eg:- the letters in the word homes can be used as "pegs" on which to hang the names of the great lakes - Hurron, Ontario, Michigan, Erie and Superior. This technique rely on the linking or association, of to be remembered material with a systematic and organised set of images or words that are already firmly established in long-term memory and can therefore serve as reminder cues.

(b) Chunking Method :- Another method of storing information in STM is through chunking procedure. Chunking means grouping certain items together, forming subgroups. For eg:- You want to remember your credit card number 9743625 you can break it into groups and even associate it with some important dates or events.

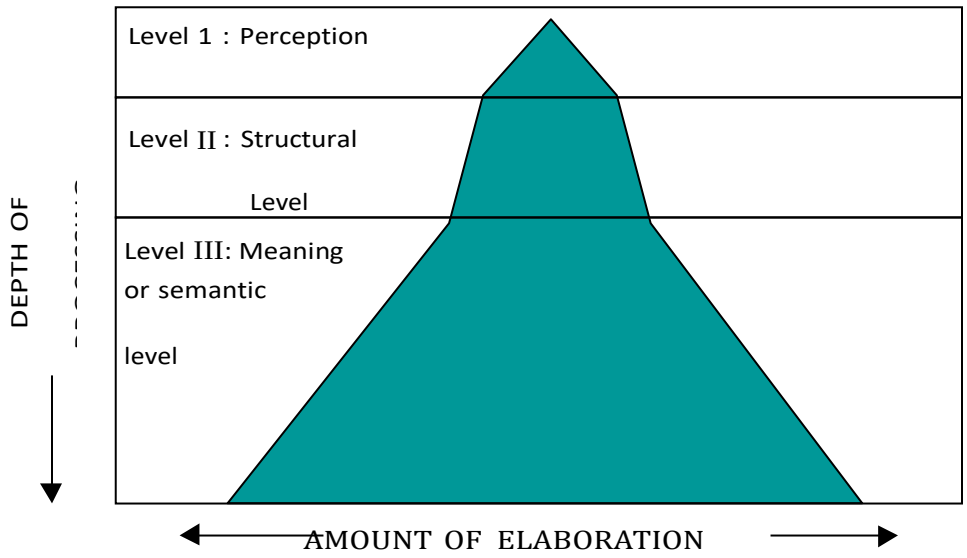
(c) Use of Imagery :- We remember the material better in visual terms than by verbal ones. The visual imagery is very effective as compared to other material. The effectiveness of visual imagery, or mental pictures, has been very well demonstrated (Postman, 1975). Pictures are recognized with very high degree of accuracy. When subjects were presentedwith three types of verbal materials to the memorized -pictures, concrete nouns and abstract nouns - the accuracy of recall appeared in that order. The apparent reason is that pictures and concrete nouns can be remembered in both visual and verbal terms, where as abstract nouns are generally remembered only by words.

(d) Constructive Processes :- During encoding, the to-be-remembered information especially if it is a complex life event or something you have read is modified. Certain details are accentuated, the material may be simplified, or it may be changed in many other ways so that what is encoded and stored is far from a literal copy of the input. These modification are called constructive

processes. For eg : You read some complex and long news in a newspaper but you construct a simplified version of the whole news.

The following figure shows that the amount remembered, indicated by the shading, depends on both the level of processing and the degree to which information is elaborated.

FIGURE : DIAGRAM OF THE RELATIONSHIPS AMONG LEVELS OF PROCESSING, ELABORATION OF INFORMATION AND MEMORY(SHADED PORTION IS THE AMOUNT OF INFORMATION



1.3.7 Summary

The present lesson explores the fundamental aspects of memory, including its definition, stages of memorization, and factors affecting memory. It begins by defining memory as the reproduction of past personal perceptions in the same order and form. The four stages of memorization, namely learning, retention, recall, and recognition, are discussed in detail. The importance of active observation, repetition, and good health in the learning process is highlighted. Different methods for measuring retention, such as recall, relearning, recognition, and reconstruction, are explained, along with their respective techniques and calculation procedures. The lesson also introduces the theory of levels of processing, emphasizing the depth of analysis and elaboration for better memory retention. Overall, this lesson provides a comprehensive understanding of memory and its underlying processes in the field of experimental psychology.

1.3.8 Keywords

Retention

It is demonstrated by trying to remember the impression made during the learning process. Memory traces are like pencil marks. Just as the pencil marks fade away with time, similarly memory traces fade away if not used. In retention, these memory traces or neural traces formed out of learning are consolidated.

Recognition

According to Guilford, recognition means "knowing again". When one recognize an object or a stimulus, he behaves as if he has experienced it before. Thus, recognition simply means identification.

Sensory memory

Sensory memory is also known as the "sensory buffer" or "sensory register". It refers to

the recorded or transcribed raw physical input. It consists of the impressions that stimuli from the external world make on our senses. If the transfer of information of other memory stores is not virtually instantaneous, then the information gets lost.

Declarative memory

It is also called explicit memory stores facts, information and personal life events that can be brought to mind verbally or in the form of imagesand then declared or stated. It holds information you can intentionally or consciously recollect.

Flash bulb memory

It is vivid recall for eariler events associated with extreme emotions. Such memories are so vivid that it is as if our brains had recorded them like a scene in the sudden glare of a camera's flash bulb.

Constructive memory

It refers to the memory of an event that did not actually happened, but unconsciously constructed to fill a gap. Research has shown that memories are not always eg. courtroom testimony of two witnesses differs significantly because constructive memory that one holds uses a variety of information (perceptions, beliefs, attitudes etc.) to fill in gaps and that the accuracy of our memory may be altered.

1.3.9 Long questions

1. Explain the stages of memory processing with suitable examples.

2. Elaborate on the factors influencing memory.

1.3.10 Short questions

1. What are the main stages involved in the process of memory?

2. How does the "levels of processing" theory contribute to our understanding of memory?

1.3.11 Suggested Readings

1. Postman, L., & Egan, J.P. (1989). *Experimental Psychology :* An Introduction,Kalayni Publishers, New Delhi.
2. Woodworth, R.S., Schlosberg, A. (1965). *Experimental Psychology,* Methuen& Co. Ltd., London.

B.A. PART-II **PSYCHOLOGY**

(Semester-III) **EXPERIMENTAL PSYCHOLOGY**

LESSON NO.1. 4 **Last Updated January 2023**

FORGETTING : NATURE AND CAUSES

Lesson Structure :

1.4.0 OBJECTIVE

Various things and tasks are remembered by a person to reproduce later to perform various activities, duties and functions. But it is experienced that sometime a person find difficulty in recall of such learnt or experienced matters. So a lot of problem will be experienced in performing such tasks. For example a student is required to reproduce the matter learnt throughout the year during exams. If he fails to recall, it will make him to suffer the loss of marks. So memory helps an individual to perform better, forgetting add hindrance in performing such activities. Thus memory and forgetting both are two sides of a same coin. But interestingly forgetting does not always interfere in performance of a person but sometime it serves as a great relief and help the person by forgetting interfering memories. There are certain experiences or incidences or memories, which a person might also want to forget because remembering such things can make the life very miserable. A person does not have every experience as pleasant one. Some time bitter experiences like death of some one or embarrassing situation do give pain to a person as remembered, so individual will like to forget. To understand how such things take place in our mind, this chapter is created with the following objective :

1. What is forgetting?
2. How we forget?
3. What factors affect forgetting?

1. 4.1 INTRODUCTION

How we forget ? The answer of this question is the causes of forgetting. Time is an important factor in forgetting. What is learned or experienced is forgotten with laps of times, there are also several other factors or causes of forgetting. Different psychologists have given various theories of forgetting. In these theories, the causes of forgetting are automatically mentioned. To know the causes of forgetting, we should know the theories of forgetting.

1.4.2 NATURE OF FORGETTING

Memory and Forgetting are two important functions of mind, which cannot be separated from each other but still different with a distinct difference. Where memory in simple words is recall of some learnt material, forgetting is inability to recall some learnt material. So difference in memory and forgetting lies at the stage of recall. However different Psychologists had given different definitions of forgetting as follows:

Aristotle- Forgetting is fading away or paling of original experience with the passage of time.

Frank Geldard- Retention may be viewed in either positive or negative aspects, and forgetting is a negative Retention.

Norman Munn- Forgetting is failing to retain or to recall what has been acquired.

Woodworth- Forgetting is an active mental process.

English & English- The loss or losing, temporary or permanent of something earlier learnt, losing ability to recall or to recognize something.

Morris- Forgetting is slipping out of mind of something once learned or experienced.

Garret- Forgetting is a memory loss or failure.

Ebbinghaus- Forgetting is a passive mental process. It is a matter of passive decay of impression. Amount of forgetting keeps on increasing as the time between learning and recall increases.

Forgetting at Short term memory (STM) and Long term memory (LTM) is different in nature. STM is temporary in nature and here any information cannot be stored for more than 30 seconds. Some psychologists believe that forgetting from STM take place because of Displacement of information because the span of STM is only 7 units or chunks. If more information will be stored, it will displace already stored information. Other psychologists believe that the information stored in STM starts fading with the passage of time i.e. Decay of memory traces. This is clearly proved by Ebbinghaus in an experiment, where the forgetting keep on increasing with the passage of time. Another line of Psychologists like Decamp and Webb held the view that the information stored in STM forgets because of the interference of new information. It is very much clear that forgetting from STM takes place at faster speed.

However to store in LTM, it is necessary to transfer the information from STM to LTM. The way of encoding the information differs between STM and LTM. Information is usually encoded in Acoustic or Visual form in STM and in Semantic form in LTM. So if information is passed in acoustic or visual form from STM to LTM, there is more chance that forgetting will take place more

quickly. On the other side if it is transferred in semantic way, there will be slow forgetting in LTM. Further forgetting at LTM does not mean that information is lost. Usually information remains there in memory but we might be trying to

find in wrong way. For example in library, if a person has noted wrong number from catalogue and is unable to find the book, the book is very much present in the library,

but the person is searching at wrong place. Same thing can happen with LTM. Freud has this view that forgetting at LTM may be because of Repression of information, as we do not want to remember painful experience. So forgetting at STM and LTM differ in various respects in nature.

1. 4.3 TYPES OF FORGETTING:-

1. Permanent forgetting- that refers to actual loss of information. It is usually experienced in short term memory and sometime in long term memory.

2. Temporary forgetting- that refers to inability to recall information, which is present in memory store. It is commonly experienced in Long term memory.

1. 4.4 CAUSES OF FORGETTING

There are various perspectives of forgetting that states different causes of the process. These theories account the reasons of forgetting. Some of the most prevalent theories are as follows:

DISUSE OR DECAY THEORY

INTERFERENCE THEORY

RETRIEVAL FAILURE

REPRESSION THEORY

MOTIVATED FORGETTING

1.4.4.1 DISUSE OR DECAY THEORY

This theory was formulated by Ebbinghaus (1885) and was supported by Radosalvith' Finken & Luh. According to this theory when some material is retained in the Brain, with the passage of time it starts fainting and decaying continuously and ultimately forgets. It is derived from the Evolution theory of Spence. Evolution theory states that those body organs of certain organisms get extinct with the passage of time, which were not in use according to the changed conditions. For example the tail of human is extinct as it was not in use after the man started to live in society. Similarly the feet of snakes extinct as these started to live in burrows. In the same manner when some material is learnt and retained in the brain, if it is not used thereafter it starts to decay from the storehouse of brain and the individual forgets.

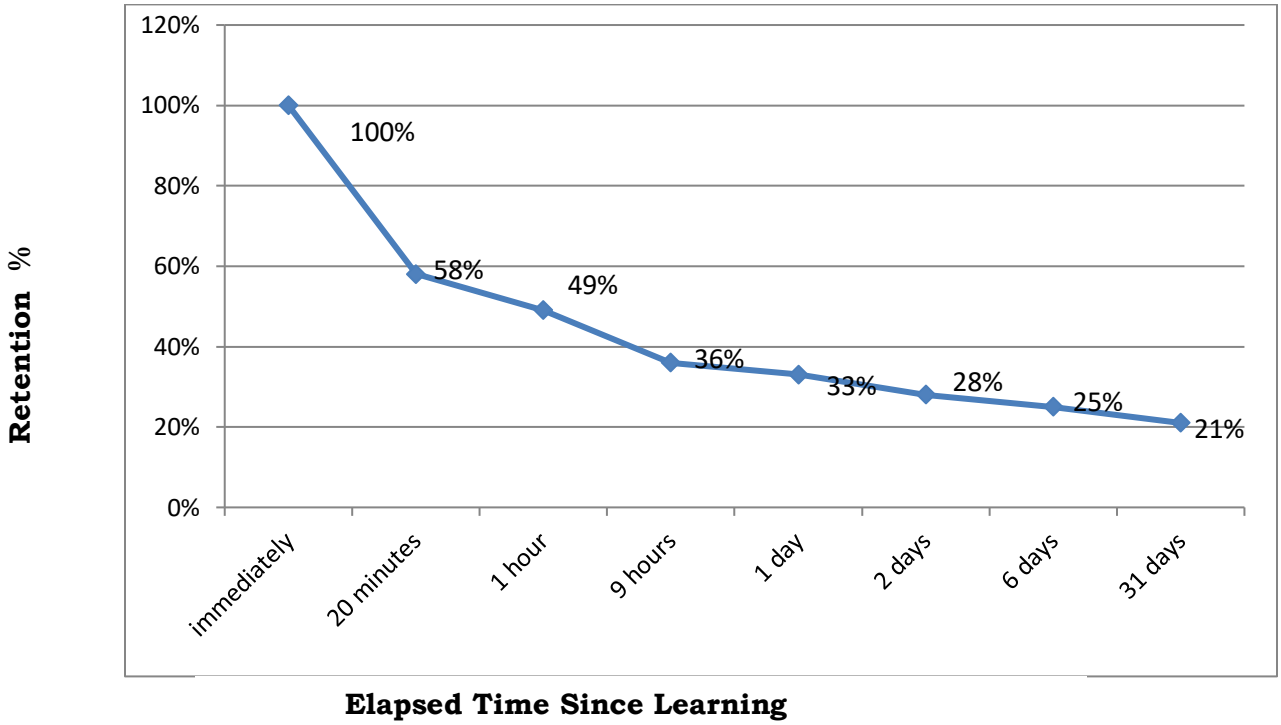
In the favour of this theory, Ebbinghaus has conducted an experiment on himself. He invented Nonsense syllables and learnt more than 1200 such

syllables. Then he recalled that at different intervals of time. It was found that with the passage of time there is a continuous rise in the forgetting of that list as shown below:

Time Elapsed	Forgetting %
20 minutes	47%
1 hour	53%
9 hour	56%
1 day	66%
2 days	72%
7 days	75%
1 month	79%

These results are also drawn in the form of graph as shown below. This curve is also called as **Curve of Forgetting.**

Ebbinghaus Forgetting Curve



Above results clearly show that with the passage of time there is a continuous loss of learnt material from the memory. However there is observed variance in the speed of forgetting. In initial stages there is a sharp rise in forgetting and in middle period the speed gets slower and in last stage it becomes almost constant.

Further experiments show that the shape of forgetting curves varies with the Material and Methods of learning. It is also found that nonsense syllables forget more early than meaningful words. Luh, Ormer (1930) and Boreas (1931) also found similar results. Conard (1960) in his studies found that forgetting in short term memory is based on decay of retained material. Miller (1936) compared the short-term memory with the Baking Bucket and found that the information retained in Short-term memory gets lost itself.

Limitations:

There are present different problems with this theory which are as follows:

1. This theory states that forgetting take place because of decay of learnt material. It means that once some information is lost, it can never be recalled. However in

Reminiscence the forgotten material in early stages, sometime successfully recalled in later stages. Nicholai (1922) has found such results even in controlled conditions.

2. Lashley (1929) conducted experiments to search out the location in brain where learnt material is retained in the form of traces. It was found that memory and forgetting depends upon the activity of whole brain. So forgetting is not a single process of decay, but it depends upon many processes.

3. There are certain learnt reactions, which are not forgotten, even in the absence of practice like swimming, driving etc.

4. It is also observed in the field of therapeutic work that Delirious patients can speak even that foreign language which they had left many years ago.

1.4.4.2 INTERFERENCE THEORY

Decamp and Webb gave this theory. According to this theory when two or more than two tasks are learnt, these interfere each other in the learning or recall of such tasks and individual forgets. This interference is explained in two different ways:

(a) Preservation-Consolidation of memory traces.
(b) Response competition

(a) Preservation-Consolidation of memory traces:

This view was given by Muller and Pilzecker (1900) against Disuse and Decay theory. It states that when some task is learnt it is retained in the form of traces. When learning of that task is stopped, the process of preservation and consolidation continues for a certain period of time. During that period if the learning of some other task begins, it interfere in the preservation and consolidation of already learnt task and the process of preservation-consolidation interfere in the learning of new task. As a result there occurs forgetting.

(b) Response competition:

McGeoch (1932) presented this view point. It states that once a task is learnt, the memory traces becomes consolidated at the same moment and no process continuous after stopping the learning of task. So if learning of some new task begins, there is no interference in retaining the memory traces of two tasks. Learning of both tasks remains independent from each other. However the interference develops during recall of such learnt tasks. When such tasks are recalled, then competition in the memory traces of both tasks interfere in the recall of a particular task and individual forgets such task partially or completely.

Any of these view points may be wrong or right but these explain very well that how interference can take place and individual forgets. Further this interference is of two types:

(1) Retroactive Inhibition

(2) Proactive Inhibition

(1) Retroactive Inhibition:

When a later learnt task produce interference in the recall of early learnt task, it is called Retroactive Inhibition. In other words Retroactive Inhibition means an adverse effect upon retention of an activity interpolated between learning and recall test. For example, a subject is given Task A to learn and afterward another Task B given. On recall of Task A, if task B interferes, it is Retroactive inhibition.

	Task	Task	Recall
	A	B	A

The experimental Design used to study Retroactive Inhibition is as follows:

	Task	*Task*	*Recall*
Experimental group	**A**	**B**	**A**
Control group	**A**	**no task**	**A**

As shown, two groups of subjects are taken. First of all Task A is given to both groups. Then Task B is given to Experimental group, however no task is given to control group. At last both groups are required to recall Task A. Muller and Pilzecker conducted a study using such experimental design and found that Forgetting % was higher in experimental group than Control group. Tulving and Psotka also found similar results. Ormer and Ekstrand suggested that if control group is not given any task, even then the mind never remains free. It keeps on thinking and doing something, which also can interfere in the recall of learnt task. In their experiment, they selected a second control group. During interpolated activity, the first control group was given no task and second control group was made to sleep. Results show that forgetting was less in second group then first group.

(2) Proactive Inhibition:

When earlier learnt task interferes in the recall of later learnt task is called Proactive Inhibition. For example, subject is given Task A to learn and thereafter another Task B is learnt. During recall of Task B, when earlier learnt Task A interferes, it is called Proactive Inhibition.

	Task	Task	Recall	A
	B	B		

The Experimental Design used in the study of Proactive Inhibition is as follows:

	TASK	TASK	RECALL
Experimental group	**A**	**B**	**B**

Control group	**no task**	**B**	**B**

Underwood conducted an experiment using above experimental design. Both groups were given a list of words to learn. Experimental group was given few more lists before learning the present list, whereas the control group was given no list earlier to present list. It was found that forgetting was more in experimental group than control group. These results prove that earlier learnt task interferes in the recall of later learnt task.

Limitation:

1. This theory does not explain the spontaneous recovery of forgotten material i.e. Reminiscence.
2. This theory does not give any consideration to the effect of similarity in learning of two tasks.
3. Non-Sense syllables are naturally forgotten after passage of time, when these face no competition from other words, because in our daily life we do not learn such meaningless words.
4. Preservation-Consolidation of memory traces is very short period process, however interference remains for long periods.
5. Every forgetting cannot be explained on the basis of competition words.

1.4.4.3 RETRIEVAL FAILURE

In the field of memory studies, the retrieval failure theory is a popular explanation for forgetting. According to this theory, the inability to recall information from memory is caused by the failure to retrieve the information at a given time rather than the loss of the memory trace itself. This means that the information remains in memory but cannot be accessed or brought to conscious awareness when needed. According to the principle, cues present at the time of encoding information become an integral part of the memory's representation. These cues help to connect the memory to the retrieval context. When the retrieval cues and the original encoding cues do not match, retrieval failure occurs.

Assume you studied for an exam in a specific room while chewing a specific flavour of gum. If you are not in the same room or chewing the same gum during the exam, the contextual cues are different, and you may find it difficult to recall the information. However, if you return to the same room or chew the same gum, information retrieval becomes easier due to the match in cues. This phenomenon of retrieval failure is

known as "cue-dependent forgetting." It emphasises the importance of context and the environment in which information is acquired. The retrieval cues will be more effective if they are similar to the encoding cues.

1.4.4.4 REPRESSION THEORY

This theory was formulated by Freud and it was explained in his book "Psychopathology of Everyday Life" in 1938. Forgetting is considered a Defense Mechanism, which protects the Self from painful memories of life. Every individual at certain moments of life experiences traumatic and bitter incidences in life. If all these memories will remain in the conscious, the life of a person will become miserable. To save from such painful memories, **there is a Defense Mechanism** called Repression. It is an unconscious process and very much different from Suppression. In Suppression, a person deliberately tends to keep such memories away from conscious, but in Repression such memories get buried in unconscious without any awareness of person. It means that such memories do not extinct from our mind. Actually these experiences remain in our mind, but we cannot bring them in our conscious. Freud suggested different phenomenon like 'Tip of Tongue', 'Slip of Tongue', Recall of forgotten memories through Hypnosis, Which proves that actually such painful experiences remain present in our mind but we are unable to recall them. According to Freud, we forget because we want to forget.

Experiences remain retained forever but we do not allow them to come in to our conscious experience. Luborsky and Spence (1978) in their study found that Emotional matters are less recalled than Neutral matters. Zeller (1950, 1951) in his study showed that when subjects were given some task to learn, during learning trials one group was made to experience Ego Deflation and Embarrassment and other group was given no such experience. Presence of Repression had been observed in the first group. These studies clearly proves Freud's version that we forget painful memories because of Repression.

Limitation

Most of the concepts given by Freud are not very scientific and are based on mythical stories. This theory of Repression faced major criticism in explaining Zeigarnik Effect. Zeigarnik (1927) showed that incomplete tasks are remembered better than completed tasks. As incomplete tasks produce stain on brain so a person do not forget and remember longer as long as not completed. It is totally against Freud's theory, which states that painful memories are difficult to be recalled. So this theory has no explanation for Zeigarnik Effect.

1.4.4.4.1 Motivated Forgetting

According to the repression theory of forgetting, motivated forgetting occurs when people deliberately block or suppress distressing or unwanted memories from entering their conscious awareness. According to Sigmund Freud's theory, certain memories are too painful, embarrassing, or dangerous to confront, so the mind actively pushes them into the unconscious realm as a defense mechanism. Freud believed that

repression, or motivated forgetting, served to protect the individual's psyche from psychological harm.

The social-cognitive perspective is another modern account of motivated forgetting. It implies that people may forget certain memories, particularly those associated with personal failures or inadequacies, in order to maintain a positive self-image and protect their self-esteem. This is referred to as self-serving motivated forgetting. Furthermore, motivated forgetting can occur as a result of intentional forgetting, in which individuals purposefully choose not to encode information into memory in the first place, resulting in its subsequent absence during retrieval. Finally, the theory of motivated forgetting, which is based on Freud's repression theory, proposes that certain memories are intentionally forgotten in order to protect oneself from psychological harm.

1.4.5 Amnesia :

Further forgetting of severe type can also take place as observed in the cases of Amnesia. Amnesia can be biogenic or psychogenic in nature. In biogenic cases some physical shock or injury at brain can result in to actual loss of information from memory and the individual can forget his identification, family and various other personal things. In psychogenic cases the person will forget only those informations which are the cause of his present stressful conditions of life. So in Psychogenic cases, there is not actual loss of information, it is just repression of such information in unconscious.

It is a condition in which memory is disturbed or lost. It is the inability to remember events for a period of time often due to brain injury, illness or effects of drugs. The memory can be either wholly or partially lost due to the extent of damage that was caused. In some cases already stored information is lost while in others there is difficulty in forming new memories.

Causes :

Organic damage to the brain

Use of certain drugs

Post-traumatic stress

Retrograde amnesia :

It involves the loss of memories that were created before the condition developed. With retrograde amnesia certain types of memories may be completely inaccessible. Victims forget events that occured in theis liver before they experienced the trauma.

Events that occured closest to the time of the accident are harder to recall. Episodic memory in this case is more severly affected.

Anterograde ammnesia :

This form of amnesia follows brain trauma and is characterized by the inability to remember new information. Recent experiences and short term memory disappear but victims recall events prior to the trauma with clarity. Anterograde amnesia involves an inability to form new memories after the condition develops. Victim is unable to learn new skills, may be unable to remember things did, heard, or saw earlier in the day. It is quite traumatic, as it hampers some of the simplest day-to-day tasks. Anterograde amnesia often occurs following an acute event such as concussion, a heart attack, oxygen deprivation or an epileptic attack.

1.4.6 FACTORS AFFECTING FORGETTING

There are present many factors that affect the forgetting in an individual. These are as follows:

1. **Unpleasant Experiences**- Some Psychologists like Freud believes that unpleasant experiences are forgotten at much fast speed, because no individual wants to keep such experiences in memory. So memory traces of such experiences are moved away from the conscious mind to repress in unconscious.

2. **Intoxication**- Intoxication of drugs produce disorder in the processes of brain. It creates trouble in the organization of learnt material. As a result a person experience great difficulty during recall of such material. So intoxication negatively affects the memory of a person.

3. **Lacking Interest**- It has been found that if a person has interest in learning of task, then not only the material is learnt at better speed but also such material is maintained in memory for longer period. However if the person has no interest then forgetting of such material take place at fast speed.

4. **Lapse of Time**- Ebbinghaus conducted experiment on himself by learning Non-Sense syllables. It was found that forgetting increases with the passage of time. It is faster at the initial period, but later on speed of forgetting get slow and at last becomes constant. Fiken and Luh have confirmed the results of Ebbinghaus. However Bellard and some other Psychologists rejected this viewpoint.

5. **Nature of material**- Non-sense material forgets at faster speed than Meaningful material. Reed (1946) found in his studies that after six weeks, there was only 10% loss in memory of meaningful material and 80% loss in non-sense material. Meaningful material in his experiment was a poem and meaningless material was a list of non-sense syllables. Various other psychologists also supported these results.

Length of material also effects forgetting. Studies show that loss of memory for long lessons is slower than short lessons. Ebbinghaus in his study found that long lists are forgotten at much slower speed than short lists. Hovland 1951) and Woodworth (1915) also found similar results. Vividness of material also affects the forgetting. Various studies show that forgetting of vague material takes place faster than vivid material. Other than this, there are many variables, which affect the forgetting like difficulty of material, intensity of material etc.

6. Level of learning- Results of some studies show that with the increase in learning of some material, there is less forgetting. However under learning of some task result in to faster forgetting. Sometime over learning can also result in to forgetting, but usually more learning leads to lesser forgetting. Ebbinghaus in his study found that if a subject is stopped to learn before reaching a set criterion, there is speedy forgetting. Underwood (1974) observed that if a subject is allowed to make more learning after the set criterion, there is comparatively less forgetting.

7. Mental Shock- Psychologists also held this view that mental shock is responsible for forgetting. Guilford has cited many such cases, where the persons experienced forgetting because of mental shock.

8. Nature of Practice- Practice can be of various types like Massed Practice and Spaced Practice. In massed practice subject practice a task without taking any rest, whereas in Spaced practice, the subject keep on taking rests at regular intervals. It has been found that massed practice is better than spaced practice.

9. Age- In the field of Development Psychology, it has been observed that the rate of forgetting declines with increase in age up to a particular stage, when all other conditions remain normal. There is more forgetting in childhood but as individual grows up to Adulthood, there is a continuous decline in forgetting and rise in retention ability. However in Old age, the individual find difficulty in retaining and recall and as a result experience increase in forgetting.

10. Intellectual level- Individuals having high intellectual level are able to retain information for longer durations. On other hand individuals with low level of intellectual ability forget things faster.

11. Mental Set- That material for which a person remains ever ready to retain is always retained for longer periods. So mental set affect the forgetting of a person.

12. Interference- If two tasks are learnt at different times, then on recall of one of them, other interferes and result into forgetting. Earlier learnt task interferes in the recall of later learnt task and later learnt task interferes in the recall of earlier learnt task.

13. Health- Individuals who are suffering from some health problems find difficulty in learning and retaining some material. Poor health also results in forgetting. In comparison to healthy persons, unhealthy persons show more forgetting.

14. Method of Learning- Experimental studies has proved that the method of learning also affects the forgetting of a person. Steffens and Meyers study show that there is more forgetting in Part Learning than Whole learning. Results show that Whole learning is better method.

Active and Passive Learning methods are also compared.Results show that if some material is learnt by reciting aloud, it is retained for long time. However reciting in mind result into faster forgetting than reciting aloud. It is

also observed that Mechanical rehearsing result in to faster forgetting than Elaborative rehearsing.

15 Intention- When we learn some material or task with an intention to produce or recall at particular place or time, it's forgetting is quite slow.

When we have such intentions then naturally we give some special attention and as a result retained strongly.

16. Motivation- It is known very well that motivation affect learning, retention and recall. So forgetting is also affected by motivation. In learning some task, if a person has high motivation, it is learnt better, retained better and recalled better, so forgetting is slow.

17. Emotion- When the emotional arousal level is optimum, then forgetting is found poor, however if emotional arousal level is very high or very low, it results into difficulty in recall and person suffer from a good loss of recall.

18. Retrieval Failure – Retrieval failure means the information in the long term memory is not accessible. This implies that information is still stored but cannot be retrieved. Due to the absence of retrieval cues. When ever the new memory is formed, information about the situation is also stored known as retrieval cue. It is more likely to retrieve information if appropriate cues are present. For eg. if you witnessed an accident while listening a song, you will be likely to remember the details of the accident when you hear the same song again.

1.4.7 Summary

What is learned or experienced is forgotten with laps of times, there are also several other factors or causes of forgetting. Memory and Forgetting are two important functions of mind. Where memory in simple words is recall of some learnt material, forgetting is inability to recall some learnt material. So difference in memory and forgetting lies at the stage of recall. In the current chapter we have learnt different causes and factors of forgetting.

1.4.8 Keywords

Conscious- Present state of mind related to awareness or knowing.

Control group- a group of subjects carefully selected so that they are equal in every respect to the members of the experimental group, except that the independent variable is not applied to the control group.

Decay- Perishing of some thing with the passage of time

Defense mechanism- Any behaviour that protects the ego or psyche of a person from anxiety, shame, or guilt.

Delirious- A state of delirium in which mental confusion is accompanied by delusions, illusions, and hallucinations.

Ego deflation- A loss of self-esteem or confidence of a person.

Elaborative rehearsal- Rehearsing some information by expanding its meaning and going deep into context.

Experimental group- A group of subjects selected to conduct an experiment by applying independent variable to them.

Extinct- Disappearance of some organ in the body, which is not usable in changed conditions from long time. Or disappearance of some learnt behaviour.

Non-Sense syllable- A pronounceable combination of letters that do not make meaningful words, such as ZOG, KIW.

Unconscious- A state of mind about which a person is totally unaware. Individual does not know information, & experiences stored and processes working.

1.4.9 Long Questions

1. Explain in detail the nature of forgetting.

2. What are the various causes of forgetting.

1.4.10 Short Questions

Define the following:-

1. Amnesia

2. Forgetting Curve

3. Non sense syllables

1.4.11 Suggested Readings

Singh, A. (1990) *Paryogatamak manovigyan.*

Atkinson, J., Berne, E., & Woodworth. (1988). *Dictionary of Psychology.*

Morgan, C. T., king, R. A Robinson, N. M. (1982). *Introduction to Psychology.*

B.A. PART- II PSYCHOLOGY
(Semester-III) (EXPERIMENTAL PSYCHOLOGY)

Unit II

Department of Distance Education
Punjabi University, Patiala

LESSON NO. :

2.1 LEARNING : CONCEPT AND TYPES OF CONDITIONING
2.2 NORMAL PROBABILITY DISTRIBUTION-PROPERTIES AND APPLICATIONS
2.3 HYPOTHESIS TESTING
2.4 CHI SQUARE AND ITS APPLICATIONS

NOTE : Students can download the syllabus from department's website www.pbidde.org

LEARNING

CHAPTER PLAN

2.1.0 OBJECTIVE

In this lesson the students will get acquainted with the nature of learning, types of learning and the various laws of learning.

2.1.1 INTRODUCTION

"Learning is a discipline of psychology that attempts to explain how an organism learns. It consists of many different theories of learning, including instincts, social facilitation and observation. Learning is one key process that many people take for granted . They just assume it happens and happens basically the same way for most people. Definition of learning is comprised of several different components:

The 4 factors that form the definition of learning:

1) Learning is inferred from a change in behavior/performance*
2) Learning results in an inferred change in memory
3) Learning is the result of experience
4) Learning is relatively permanent

This means that behavior changes that are temporary or due to things like drugs, alcohol, etc., are not "learned. It is the combination of these 4 factors that make definition of learning. “Learning is a relatively durable change in behavior, behavioural potential or knowledge that is due to experience” here Behavior Potential means that once something is learned, an organism can exhibit a behavior that indicates learning as occurred. Thus, once a behavior has been "learned", it can be exhibited by "performance" of a

corresponding behavior.

2.1.2 NATURE OF LEARNING

As learning always involves some kind of experience , the behavioural changes occurring because of it are relatively permanent e.g. suppression of orienting reflexes resulting in habituation . Habituation is a decrease in response to a stimulus after repeated presentations. For example a new mobile ring tone, may initially draw your attention or even become distracting. After you become accustomed to this sound, you pay less attention to the noise and your response to the sound will diminish. This diminished response is habituation. But if it occurs due to fatigue or drugs it is not learning. Habituation is an example of non-associative learning.

Learning may be both vertical and horizontal. It is vertical in so far precision in increased or information is added to that already learned. It is horizontal in so far as what is learned is integrated and organized as a part of a functioning unit of expanding experience. Thus the former means qualitative and latter is quantitative in nature.

Learning is expected to bring about more or less permanent change in the learner's behavior. This change may range from the acquisition of a relatively simple skill. item of information to the mastery of complicated mechanical performance and application of difficult and abstract reading material, change in response or behavior is caused partly or wholly by experience. It includes behavior change in the emotional sphere, refers to the acquisition of symbolic knowledge or motor. skills. it however does not include physiological changes like fatigue, temporary sensory resistance and hunger.

Learning should enable us to make the least use of the things in the world around us. For example, one has to learn the art of living harmoniously with others by learning how to establish good relations with his fellows. Learning not limited
to the school alone, it being earlier and continues even after the school days.

1. **Learning is growth :**

   The individual grows as he lives. This growth implies both physical as well as mental development of the learner. The individual gains experiences through various activities. These are all sources of learning. The individual grows through living and learning. Thus growth and learning are inter-related and even synonymous.

2. **Learning is adjustment :**

   Learning enables the individual to adjust himself properly, with the new situations. The individual faces new problems and new situations throughout his life and learning helps him to solve the problems encountered by him. That is why; many psychologists describe learning as “a process of progressive adjustment to the ever changing conditions which one encounters.” The society in which we live is so complex and so dynamic that any one type of adjustment will not be suitable for all of many situations and problems. It is through learning that one could achieve the ability to adjust adequately to all situations of life.

3. **Learning is purposeful :**

All kinds of learning is goal-oriented. The individual acts with some purpose. He learns through activities. He gets himself interested when he is aware of his objectives to be realized through these activities. Therefore all learning is purposive in nature.

4. **Learning is experience :**
   The individual learns through experiences. Human life is fall of experiences. All these experiences provide new knowledge, understanding, skills and attitudes. Learning is not mere acquisition of the knowledge, skills and attitudes. It is also the reorganization of experiences or the synthesis of the old experiences with the new.
5. **Learning is intelligent :**
   Mere cramming without proper understanding does not make learning. Thus meaningless efforts do not produce permanent result. Any work done mechanically cannot yield satisfactory learning outcomes. Learning therefore must be intelligent.
6. **Learning is active :**
   Learning is given more importance than teaching. it implies self-activity of the learning. Without adequate motivation he cannot work whole-heartedly and motivation is therefore at the root of self-activity. Learning by doing is thus and important principle of education, and the basis of all progressive methods of education like the project, the Dalton, the Montessori and basic system.
7. **Learning is both individual and Social :**
   Although learning is an individual activity, it is social also. Individual mind is consciously or un-consciously affected by the group activities. Individual is influenced by his peers, friends, relatives' parents and classmates and learns their ideas, feelings and attitudes in some way or others. The social agencies like family, church, markets and clubs exert immense, influence on the individual minds. As such, learning becomes both individual as well as social.
8. **Learning is-the product of the environment :**
   The individual lives in interaction of the society. Particularly, environment plays an important part in the growth and development of the individual. The physical, social, intellectual and emotional development of the child is molded and remolded by the objects and individuals in his environment. Therefore, emphasized that child's environment should be made free from unhealthy and vicious matters to make it more effective for learning.
9. **Learning affects the conduct of the learner :**
   Learning is called the modification of behavior. It affects the learner's behavior and conduct. Every learning experience brings about changes in the mental structure of the learner. therefore attempts are made to provide such learning experiences which can mould the desired conduct and habits in the learners.

The sequence of events and corresponding cognitive processes that are present in learning are:

(1) Gaining attention (reception)
(2) informing regarding objective (expectancy)
(3) recall of prior learning (retrieval)
(4) the stimulus (selective perception)
(5) learning guidance (semantic encoding)
(6) performance (responding)
(7) feedback (reinforcement)
(8) performance (retrieval)
(9) retention and transfer (generalization).

These events should satisfy or provide the necessary conditions for learning and as is clear from these that learning is an inferred process. Inference here means the act or process of deriving logical conclusions from premises known or assumed to be true. In other words it is the act of reasoning from factual knowledge or evidence.

2.1.3 TYPES OF LEARNING

Learning can take place in many ways depending upon simple or complex form of responses that needs to be learnt. The simplest form of learning is conditioning. Two types of conditioning has been identified

1. Classical conditioning
2. Instrumental / operant conditioning

2.1.3.1 CONDITIONING

The concept of conditioning can be better understood by explain some of its representative theories. The acquisition and modification of behaviour and their performance is dependent on learning. Learning is largely the outcome of an individuals experience with the environment. It has extensively been studied experimentally by Ivan Pavlov and BF Skinner as they proposed learning through conditioning.

Conditioning is a behavioural process whereby a response becomes more frequent or more predictable in a given environment as a result of reinforcement, with reinforcement typically being a stimulus or reward for a desired response. As sometimes change in the individual's behavior or mental state is in response to something in the environment and by controlling the environment, one's learning can be controlled.

In the present chapter we shall study two types of learning through conditioning..

(i) Classical Conditioning
(ii) Instrumental conditioning

2.1.4 CLASSICAL CONDITIONING

Classical Conditioning is one important type of learning Classical Conditioning, was actually discovered accidentally by Ivan Pavlov (1849-1936). Pavlov was a Russian physiologist who discovered this phenomenon while doing research on digestion. Classical conditioning was the first type of learning to be discovered and studied within the behaviorist tradition (hence the name classical). Pavlov was studying the digestive system of dogs and became intrigued with his observation that dogs deprived of food began to salivate when one of his assistants walked into the room. He began to investigate this phenomena and established the laws of classical conditioning.

Classical conditioning is a very simple form of learning. Classical conditioning happens when a stimulus that one can identify (such as an aroma in the air) is followed by a biologically significant event (such as the appearance of food). After several such pairings, one *learns this connection so that* the next time that stimulus occurs; one acts like it *expects* the same event. That is, it makes an *anticipatory response*.

Creatures do not need much of a nervous system to notice that when stimulus *A* happens, event *B* happens next. The rule is, "Whenever you notice A, prepare for B." That is classical conditioning: an *anticipatory biological response.*

Major concepts

Classical conditioning is Stimulus (S) elicits >Response (R) conditioning .this is because the antecedent stimulus (singular) causes (elicits) the reflexive or involuntary response to occur. Classical conditioning starts with a reflex. Reflex is an innate, involuntary behavior elicited or caused by an antecedent environmental event. For example, if air is blown into the eye, one blinks. There is no voluntary or conscious control over whether the blink occurs or not. This reflex blinking becomes conditioned when it becomes associated with any antecedent stimulus

The specific model for classical conditioning is:

1. Unconditioned Stimulus (US) elicits Unconditioned Response (UR): a stimulus will naturally (without learning) elicit or bring about a reflexive response
2. Neutral Stimulus (NS) does not elicit the response of interest: this stimulus (sometimes called an orienting stimulus as it elicits an orienting response) is a neutral stimulus since it does not elicit the Unconditioned (or reflexive) Response.
3. The Neutral or Orienting Stimulus (NS) is repeatedly paired with the Unconditioned or Natural Stimulus (US).
4. The NS is transformed into a Conditioned Stimulus (CS): when the CS is presented by itself, it elicits or causes the conditioned response(CR) CR is the same involuntary response as the UR but the name changes because it is elicited by a different stimulus. This is written CS elicits > CR.

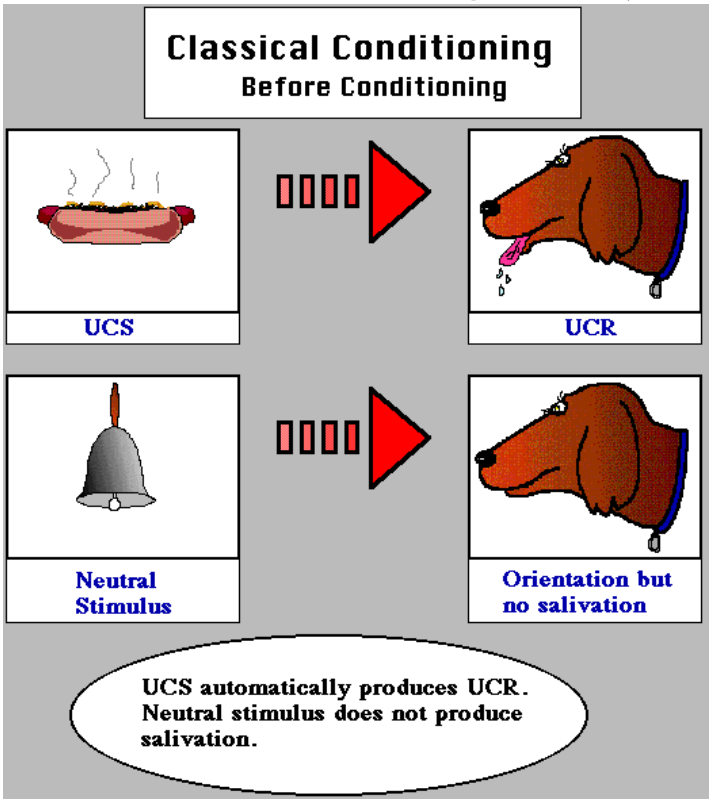
In classical conditioning no new behaviors are learned. Instead, an association is developed (through pairing) between the NS and the US so that the animal or person responds to both events or stimuli in the same way In other words, after conditioning, both the US and the CS will elicit the same involuntary or reflexive response ie the person or animal learns to respond reflexively to a new stimulus.

The following is a restatement of these basic principles using figures of Pavlov's original experiments as an example.

Before conditioning

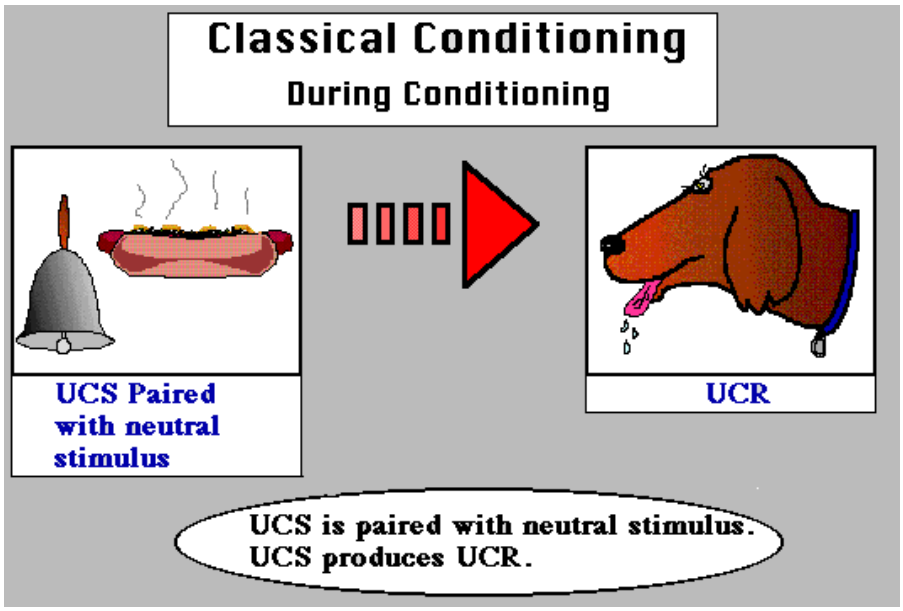
In order to have classical or respondent conditioning, there must exist a stimulus(food) that will automatically or reflexively elicit a specific response(salivation in dog). This stimulus is called the **Unconditioned Stimulus** or UCS because there is no learning involved in connecting this stimulus and response. There must also be a stimulus

that will not elicit this specific response, but will elicit an orienting response. This stimulus is called a **Neutral Stimulus** or an **Orienting Stimulus(the bell)**.



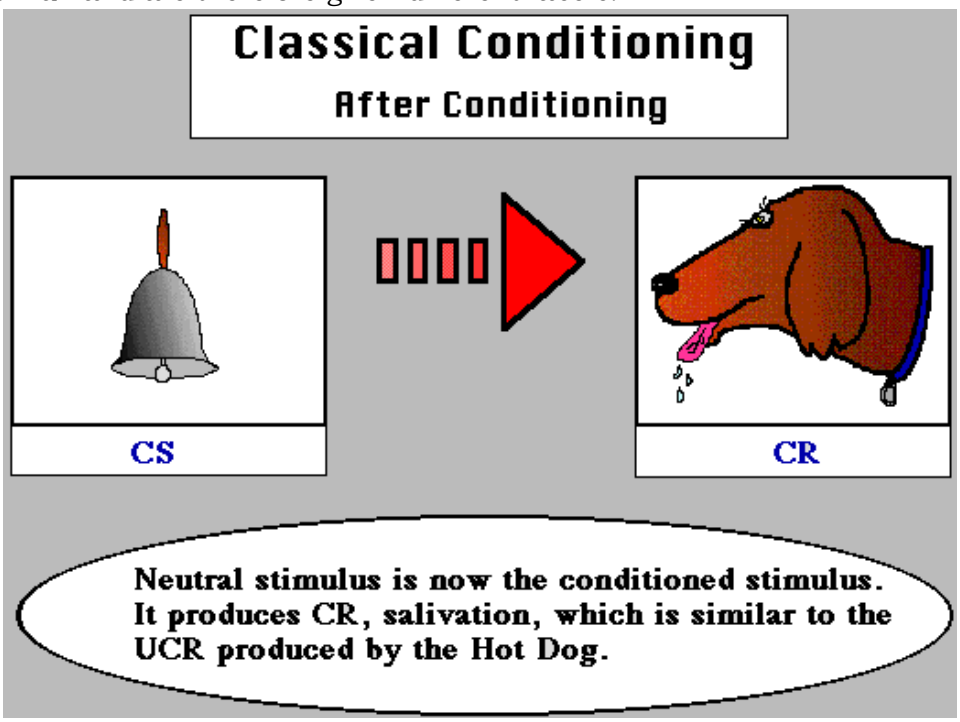
During conditioning

During conditioning, the neutral stimulus(bell) will first be presented, followed by the unconditioned stimulus(food). Over time, the learner(dog) will develop an association between these two stimuli i.e., will learn to make a connection between the two stimuli (bell and food)



After conditioning

After conditioning, the previously neutral or orienting stimulus (bell) will elicit the response (salivation) previously only elicited by the unconditioned stimulus (food). The stimulus (bell) is now called a **conditioned stimulus** because it will now elicit a different response as a result of conditioning or learning. The response (salivation) is now called a **conditioned response** because it is elicited by a stimulus (bell) as a result of learning. The two responses, unconditioned and conditioned, look the same, but they are elicited by different stimuli and are therefore given different labels.



Basically, Pavlov's findings support the idea that we develop responses to certain stimuli that are not naturally occurring. When a child touches a hot glass of milk, his reflex pulls his hand back. It he does this instinctually, no learning is involved. It is merely a survival instinct. But why kids, after getting burned, pull their hands back even when the milk glass is cold? Pavlov discovered that we make associations which cause us to generalize our response to one stimulus onto a neutral stimulus it is paired with. In other words, hot milk = ouch, glass = hot milk, therefore, glass = ouch. This will be learning through classical conditioning

Many of our behaviors today are shaped by the pairing of stimuli. Have you ever noticed that certain stimuli, such as a certain song, or smell of cooked rice results in fairly intense emotions? It's not that the smell or the song that are the cause of the emotion, but rather what that smell or song has been paired with... the death of a loved one, or maybe the day you met your husband or wife or just mothers cooking. We make these associations all the time and often don't realize the power that these connections or pairings have on us. But, in fact, we have been classically conditioned.

Additional Terminology

There are several terms associated with this behavioral approach that deserve further explanation.

Extinction refers to the breaking of the stimulus-stimulus or stimulus-response connection. When CS-US pairings are followed by presentations of the CS alone or by unpaired CS and US presentations, the CR decreases. In other words if the conditioned stimulus (CS)(eg: bell) is repeatedly presented by itself ,without pairing with the unconditioned stimulus [US](eg:food) the conditioning process is reversed, and the CS will become a NS again.

Spontaneous recovery: Sometimes, after extinction in classical conditioning, if the conditioned stimulus (CS) is again presented, it will "spontaneously" ie without any new learning,will elicit the conditioned response (CR). Presentation of the CS after some time after the subject stopped responding might yield renewed responding.

Higher (or second) order conditioning: Classical conditioning does not have to involve pairing a neutral stimulus (NS) with an unconditioned stimulus (US). If a NS is paired with an existing conditioned stimulus (CS), the NS will also become a CS.

Stimulus generalization and discrimination

- generalization -- behaviors learned in one context or situation are transferred to other similar context or situation (e.g., child may fear all white liquids in glass from earlier example) A CS2 elicits a CR when it shares some characteristics with a CS1 that has been paired with the US.
- discrimination – behaviors learned in one context or situation have a different response in another(eg:child does not fear orange juice in the same glass from the earlier example)

2.1.5 INSTRUMENTAL (operant) CONDITIONING

The classic study of instrumental Conditioning involved a cat who was placed in a box with only one way out; a specific area of the box()latch) had to be pressed in order for the door to open. The cat initially tries to get out of the box because freedom is reinforcing. In its attempt to escape, the area of the box is triggered and the door opens. The cat is now

free. Once placed in the box again, the cat will naturally try to remember what it did to escape the previous time and will once again find the area to press. The more the cat is placed back in the box, the quicker it will press that area for its freedom. It has learned, through natural consequences, how to gain the reinforcing freedom.

We learn this way every day in our lives. Imagine the last time you made a mistake; you most likely remember that mistake and do things differently when the situation comes up again. In that sense, you've learned to act differently based on the natural consequences of your previous actions. The same holds true for positive actions. If something you did results in a positive outcome, you are likely to do that same activity again.

The major theorists for the development of operant conditioning are B. F. Skinner and Edward Thorndike. This approach to behaviorism played a major role in the development of the science of psychology, especially in the United States. They proposed that learning is the result of the application of consequences; that is, learners begin to connect certain responses with certain stimuli. This connection causes the probability of the response to change (i.e., learning occurs.)

Thorndike labeled this type of learning instrumental. Using consequences, he taught kittens to manipulate a latch (e.g., an instrument). Skinner renamed instrumental as operant because it is more descriptive (i.e., in this learning, one is "operating" on, and is influenced by, the environment). Where classical conditioning illustrates **S-->R** learning, operant conditioning is often viewed as **R-->S** learning since it is the consequence that follows the response that influences whether the response is likely or unlikely to occur again. It is through operant conditioning that voluntary responses are learned.

The 3-term model of operant conditioning (**S--> R -->S**) incorporates the concept that responses cannot occur without an environmental event (e.g., an antecedent stimulus) preceding it. The antecedent stimulus in operant conditioning does not elicit or cause the response (as it does in classical), but it can influence it. When the antecedent does influence the likelihood of a response occurring, it is technically called a discriminative stimulus. It can be thought of as learning due to the natural consequences of our actions.

It is the stimulus that follows a voluntary response (i.e., the response's consequence) that changes the probability of whether the response is likely or unlikely to occur again. There are two types of consequences: positive (sometimes called pleasant) and negative (sometimes called aversive). These can be added to or taken away from the environment in order to change the probability of a given response occurring again.

General Principles

There are 4 major methods used in instrumental conditioning. They result from a) combining the two major purposes of instrumental conditioning (increasing or decreasing the probability that a specific behavior will occur in the future), b) the types of stimuli used (positive/pleasant or negative/aversive), and c) the action taken (adding or removing the stimulus).

	Outcome of Conditioning	
	Increase Behavior	**Decrease Behavior**
Positive Stimulus	**Positive Reinforcement (add stimulus)**	**Response Cost (remove stimulus)**

Negative Stimulus	**<u>Negative Reinforcement</u> (remove stimulus)**	**Punishment (add stimulus)**

2.1.6 Schedules of reinforcement

These are the base of instrumental conditioning. It has been experimentally studied that these consequences or reinforcers have different impact depending on how and when they are presented These are called the schedules of reinforcement Stimuli are presented in the environment according to a schedule of which there are two basic categories: continuous and intermittent. Continuous reinforcement simply means that the behavior is followed by a consequence each time it occurs. Intermittent schedules are based either on the passage of time (interval schedules) or the number of correct responses emitted (ratio schedules). The consequence can be delivered based on the same amount of passage of time or the same number of correct responses (fixed) or it could be based on a slightly different amount of time or different number of correct responses that vary around a particular number (variable). This results in four classes of intermittent schedules.

1. Fixed interval -- the first correct response after a set amount of time has passed is reinforced (i.e., a consequence is delivered). The time period required to receive the consequences is always the same.

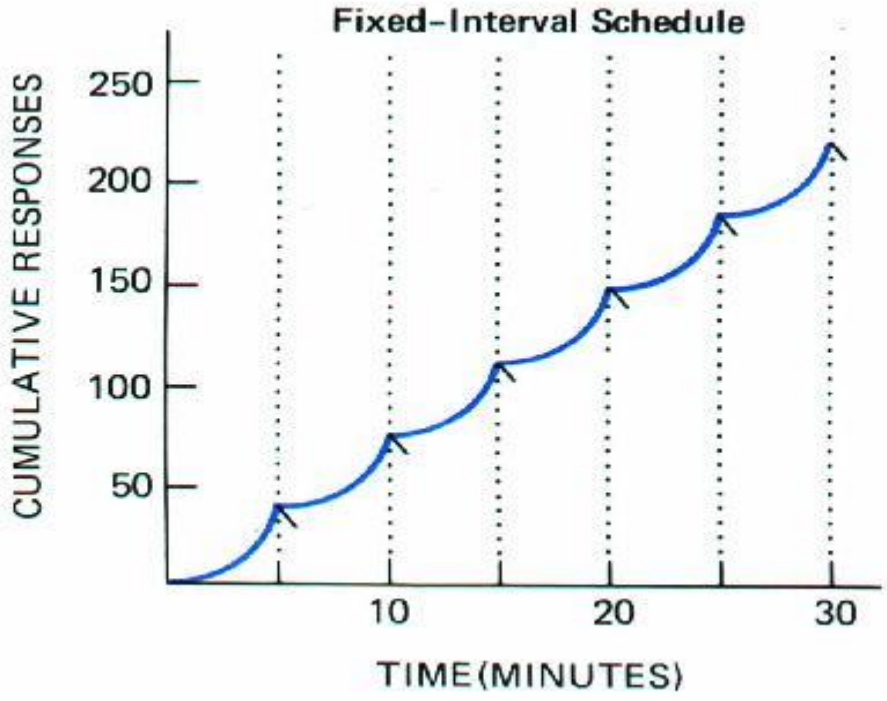


Figure a

As evident in figure a (where the dotted lines indicate the point of reinforcement) in the context of positive reinforcement, this schedule produces a scalloping effect during learning (a dramatic decrease in responding immediately after reinforcement.) Also notice

the number of behaviors observed in a 30 minute time period ie approximately 220 when when the consequence has been received every 10 mins

2. Variable interval -- the first correct response after a set amount of time has passed is reinforced. After the reinforcement, a new time period (shorter or longer) is set for the reinforcerer. As shown in figure b the time varies for every reinforcement. (the dotted line)

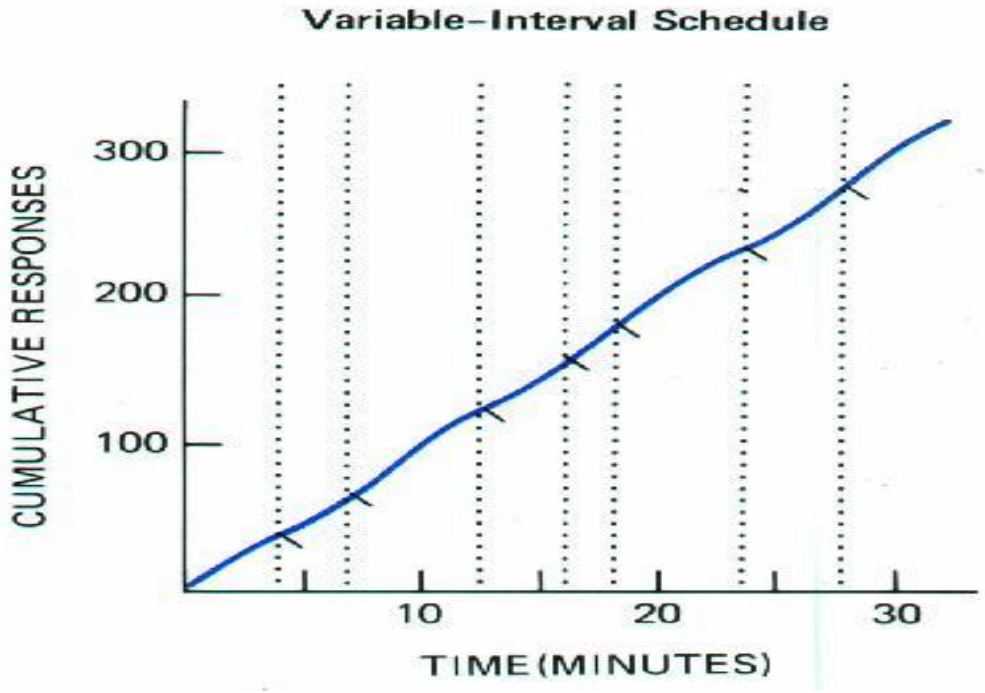


Figure b

Notice that this schedule reduces the scalloping effect and the number of behaviors observed in the 30-minute time period is slightly increased.ie approximately 300

3. Fixed ratio -- a reinforcer is given after a specified number of correct responses. This schedule is best for learning a new behavior

Notice that behavior is relatively stable between reinforcements, with a slight delay after a reinforcement is given. Also notice the number of behaviors observed during the 30 minute time period is larger than that seen under either of the interval schedules.

4. Variable ratio -- a reinforcer is given after a set number of correct responses. After reinforcement the number of correct responses necessary for reinforcement changes. This schedule is best for maintaining behavior, that has already been learnt i.e. it controls or prevents forgetting or the nonuse of learnt behaviour.

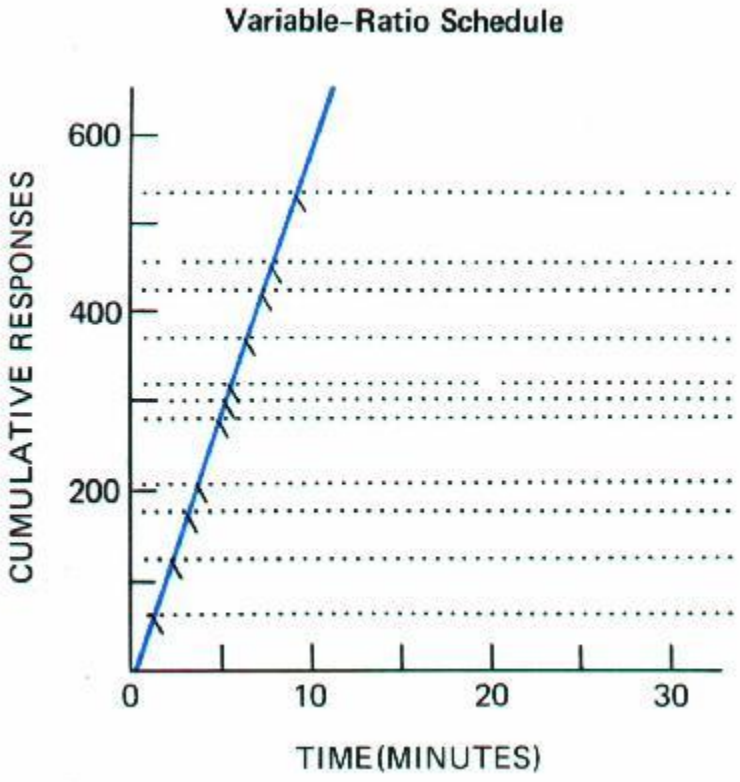
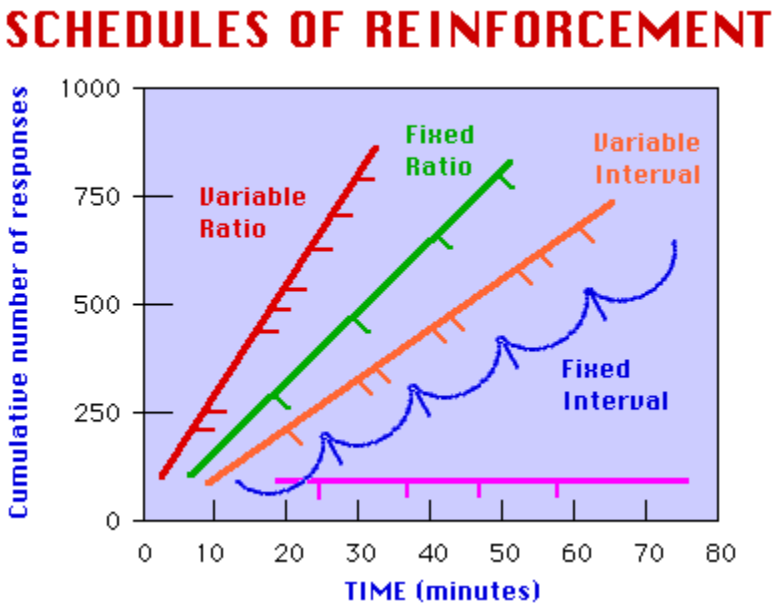


Figure c

As evident from figure c , within a small time large no. of responses have occurred. Notice that the number of responses per time period increases as the schedule of reinforcement is changed from fixed interval to variable interval and from fixed ratio to variable ratio.



In summary, the schedules of consequences are often called schedules of reinforcements because there is only one schedule that is appropriate for administering response cost and punishment: continuous or fixed ratio of one. In fact, certainty of the application of a consequence is the most important aspect of using response cost and punishment. Learners must know, without a doubt, that an undesired or inappropriate target behavior will be followed by removal of a positive/pleasant stimulus or the addition of a negative/aversive stimulus. Using an intermittent schedule when one is attempting to reduce a behavior may actually lead to a strengthening of the behavior, certainly an unwanted end result.

Premack Principle

The Premack Principle states that a high frequency activity can be used to reinforce low frequency behavior. Access to the preferred activity is contingent on completing the low-frequency behavior e.g. mother telling “You have to finish your VEGETABLES (Low Frequency) before you can eat any ICECREAM (High Frequency)"

Reinforcement

The term reinforce means to strengthen, and is used in psychology to refer to anything stimulus which strengthens or increases the probability of a specific response. For example, if you want your dog to sit on command, you may give him a biscuit every time he sits for you. The dog will eventually come to understand that sitting when told to will result in a biscuit. This biscuit is reinforcing because he likes it and will result in him sitting when instructed to do so.

This is a simple description of a reinforcer (Skinner, 1938), the biscuit, which increases the response, sitting. We all apply reinforcers everyday, most of the time without even realizing we are doing it. You may tell your child "good job" after he or she cleans their room; perhaps you tell your partner how good he or she look when they dress up; or maybe you got a pay raise at work after doing a great job on a project. All of these things increase the probability that the same response will be repeated.

There are five basic processes in operant conditioning: positive and negative reinforcement strengthen behavior; punishment, response cost, and extinction weaken behavior.

1. **Postive Reinforcement**--Think of it as adding something in order to increase a response. For example, adding a biscuit will increase the response of sitting in dog; adding praise will increase the chances of your child cleaning his or her room. The most common types of positive reinforcement or praise and rewards, and most of us have experienced this as both the giver and receiver.
2. **Negative Reinforcement**-- Think of negative reinforcement as taking something negative away in order to increase a response. Imagine a teenager who is nagged by his mother to help lay the table week after week. After complaining to his friends about the nagging, he finally one day performs the task and to his amazement, the nagging stops. The elimination of this negative stimulus is reinforcing and will likely increase the chances that he will help next week.
3. **Response Cost**--if positive reinforcement strengthens a response by adding a positive stimulus, then response cost has to weaken a behavior by subtracting a positive stimulus. After the unwanted response a positive reinforcer is removed which weakens the frequency of the response. Eg if the dog messes with the carpet then he does not gets usual biscuit or if wife takes too long to dress she is not appreciated for her attire.
4. **Punishment**-- Punishment refers to adding something aversive in order to decrease a behavior. The most common example of this is disciplining (e.g. spanking) a child for misbehaving. The reason we do this is because the child begins to associate being punished with the negative behavior. The punishment is not liked and therefore to avoid it, he or she will stop behaving in that manner.
5. **Extinction**--. When you remove something in order to decrease a behavior, this is called extinction. You are taking something away so that a response is decreased.

Examples. The following examples are provided to assist you in analyzing examples of operant conditioning.

a. Fateh likes to do gardening in the backyard. He worked on every Friday during the month of June. The last time he was working, some older kids snuck up while he was working and threw a bucket of cold water on him. Fateh has not done gardening for three weeks.

l. What behavior was changed? *gardening*
2. Was the behavior strengthened or weakened? *weakened* (eliminate positive and negative reinforcement)
3. What was the consequence? *having water thrown on him*
4. Was the consequence added or subtracted? *added*

Since a consequence was added and the behavior was weakened, the process was punishment.

b. Every time Noor raises her hand in class she is called on. She raised her hand 3 time during the first class, 3 times in the second and 4 times during the last class.

l. What behavior was changed? *handraising*
2. Was the behavior strengthened or weakened? *strengthened* (eliminates response cost, punishment, and extinction)
3. What was the consequence? *being called on*
4. Was the consequence added or subtracted? *added*

Since the consequence was added and the behavior was strengthened, the process is positive reinforcement.

c. Harry is being reinforced using a token economy. When he follows a direction / command he earns a point. At the end of each day, he can "buy" playtime, t.v. privileges, etc. with his points. When he misbehaves or doesn't follow a command, he loses points. Harry used to fight with his mom . Since he has been on the point system, his fighting has been reduced to almost zero.

l. What behavior was changed? *fighting*
2. Was the behavior strengthened or weakened? *weakened* (eliminate positive and negative reinforcement)
3. What was the consequence? *losing points*
4. Was the consequence added or subtracted? *subtracted*

Since the consequence was subtracted and the behavior was weakened, the process is response cost.

d. Teg used to avoid going to the dentist every 6-months for a checkup. Instead, he waited until a tooth really hurts, then go to the dentist. After two emergency trips to the dentist, teg now goes every 6-months.

1. What behavior was changed? *going to the dentist*
2. Was the behavior strengthened or weakened? *strengthened* (eliminate response cost and punishment)
3. What was the consequence? *tooth no longer hurting*
4. Was the consequence added or subtracted? *subtracted*

Since the consequence was subtracted and the behavior was strengthened, the process is negative reinforcement**.**

Comparison between classical and operant conditioning

	Classical Conditioning	Operant Conditioning
Response	Involuntary, automatic	"Voluntary," operates on environment
Acquisition	Associating events; CS announces UCS.	Associating response with a consequence (reinforcer or punisher).
Extinction	CR decreases when CS is repeatedly presented alone.	Responding decreases when reinforcement stops.
Cognitive processes	Subjects develop expectation that CS signals the arrival of UCS.	Subjects develop expectation that a response will be reinforced or punished; they also exhibit latent learning, without reinforcement.
Biological predispositions	Natural predispositions constrain what stimuli and responses can easily be associated.	Organisms best learn behaviors similar to their natural behaviors; unnatural behaviors instinctively drift back toward natural ones.

2.1.7 SUMMARY

Of all the creatures in this world humans are the most capable in changing behaviour through learning. Learning is any relatively permanent change in behaviours or behavioural potential produced by experience or practice. It is an inferred process and differs from performance which is the observed behaviour / response / action. The temporary change in behaviour due to continuous exposure to stimuli is called habituation. The main types of learning are: classical and operant conditioning, observational Learning, concept learning, and skill learning.

Pavlov first investigated classical conditioning in the course on studies on digestion in dogs. In this kind of learning an organism comes to associate stimuli. A neutral stimulus (CS) that signals an unconditioned stimulus (US) begins to produce a response (CR) that anticipates and prepares the organism for US. Using time relation involved in pairing CS and US jour major variations are noted: I simultaneous, delayed, trace and backward. US may be appetitive or aversive. The former elicits approach response while the later elicits avoidance responses.

Skinner first investigated operant or instrumental conditioning (OC). An operant is any response voluntarily emitted by an organism. OC is a type of learning in which, response is strengthened ,if followed by reinforcement. In observational learning, also known as imitation, modeling and social learning, one acquires knowledge by observing a model's behaviour. The performance depends on whether the model's behaviour is rewarded or punished. In verbal learning words get associated with one another on the basis of structural, phonetic, and semantic similarity and contrast. They are often organised in clusters.

2.1.8 KEYWORDS

1. Response Cost--if positive reinforcement strengthens a response by adding a positive stimulus, then response cost has to weaken a behavior by subtracting a positive stimulus. After the unwanted response a positive reinforcer is removed which weakens the frequency of the response.

2. Punishment-- Punishment refers to adding something aversive in order to decrease a behavior. The most common example of this is disciplining (e.g. spanking) a child for misbehaving. The reason we do this is because the child begins to associate being punished with the negative behavior. The punishment is not liked and therefore to avoid it, he or she will stop behaving in that manner.

3. Extinction refers to the breaking of the stimulus-stimulus or stimulus-response connection. When CS-US pairings are followed by presentations of the CS alone or by unpaired CS and US presentations, the CR decreases. In other words if the conditioned stimulus (CS)(eg: bell) is repeatedly presented by itself ,without pairing with the unconditioned stimulus [US](eg:food) the conditioning process is reversed, and the CS will become a NS again.

4. Fixed interval- the first correct response after a set amount of time has passed is reinforced (i.e., a consequence is delivered). The time period required to receive the consequences is always the same.

5. Conditioning- is a behavioural process whereby a response becomes more frequent or more predictable in a given environment as a result of reinforcement, with reinforcement typically being a stimulus or reward for a desired response. As sometimes change in the individual's behavior or mental state is in response to something in the environment and by controlling the environment, one's learning can be controlled.

2.1.9 LONG QUESTIONS

1. Describe contribution of Pavlov to psychology.
2. Compare classical and instrumental conditioning.
3. Describe the schedules of reinforcement.

2.1.10 SHORT QUESTIONS

Define the following

1. Neutral Conditioning
2. Schedules of Reinforcement

2.1.11 SUGGESTED READINGS

Hilgard, E.R. and Bower, G.H. (1975).Theories of Learning: Fourth Edition. Prentice-Hall, Inc. Englewood Cliffs, NewJersey

Morgan , C.T.King, R.A.Weisz et al (1986), introduction to psychology, McGraw Hill, New York

Lesson No. : 2.2 **LAST UPDATED JANUARY 2023**

Normal Probability Distribution- Properties and Applications, Areas under NPC (Normal Probability Curve)

2.2.0 Objective

The objective of this chapter is to understand the concept of Normal Probability Curve (NPC) and its applications. We shall be covering a brief introduction to what is meant by a NPC, characteristics of a NPC, divergence of NPC. Also, we shall focus on the application of NPC, while dealing with statistical problems encountered in Psychological research.

2.2.1 Introduction & History

The word probability or "chance" is very commonly used word in day to day conversation and generally people have a vague idea about it.

For example:

We come across statement like "Probably it may rain tomorrow." "It is likely that Mr. X may not come for taking his class today." All these – possibly probably, likely etc. convey the same sense i.e. the event is not certain to take place or in other words, there is uncertainty about happening of the event in question. In layman's terminology the word "probability" thus connotes that there are uncertainties about the happening of event. However, in mathematics and statistics we try to present conditions under which we can make sensible numerical statement about uncertainty and apply certain methods of calculating numerical values of probability and expectations. In statistical sense the term probability is thus established by definition and is not connected with beliefs or any form of wishful thinking.

The theory of probability has its origin in the games of chance related to gambling such as throwing a dice, tossing a coin, drawing cards form a pack of cards etc. **Terame Cardon (1501-76),** an Italian mathematician, was the first man to write a book on the subject entitled "Book on games of chance" which was published after his death in 1663.

Galileo (1564-1642), an Italian mathematician, was the first man to attempt quantitative measures of probability while dealing with some problems related to the theory of dice in gambling.

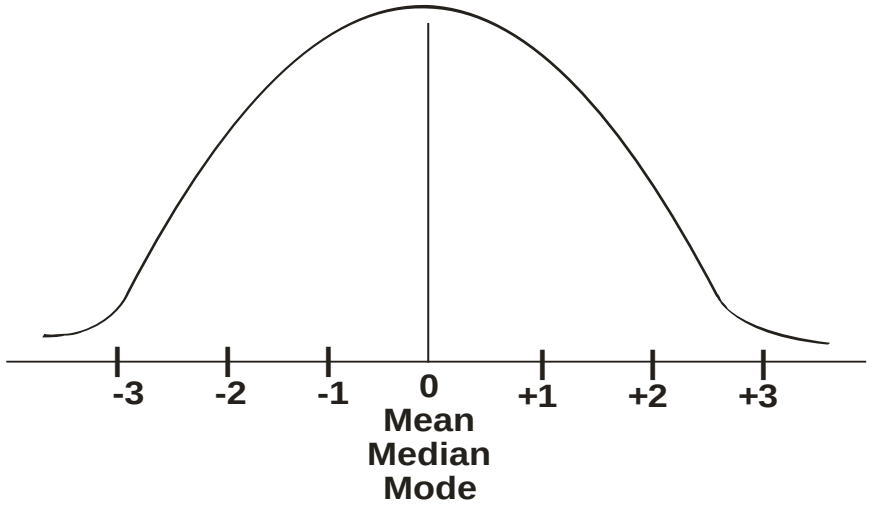
De Moivre (1773) was the first mathematician who developed a mathematical equation of the NPC. He was approached by gamblers to find out the chance of beating an opponent at different gambling games.

Gauss and Laplace (in 19th century) rediscovered the normal curve independent of De Moivre's work in the later half of 19th century and undertook the study of individual difference and during this systematic study, he found that most of the physical and psychological traits of human beings confirmed responsibly to the normal curve.

Today Normal curve is known by various names such as Gaussian curve, De Moivre's curve or bell-shaped curve.

2.2.2 Characteristic or Properties of Normal Probability Curve

Normal Probability curve is a graph representing a distribution of score. It is the ideal symmetrical frequency curve. In it the measures are concentrated closely around the centre and taper off from its central point or top to the left and right. There are few measures at the low score end of the scale; an increasing number up to a maximum at the middle position and a symmetrical falling off towards the high score end of the scale. The curve exhibits almost perfect bilateral symmetry. It is symmetrical about central altitude. This altitude divides it into two parts which will be similar in shape and equal area. The curve which is also called normal curve is a bell shaped figure. It is very useful in psychological and educational measurements. It is shown in figure.



The normal probability curves possess many important properties which are as follow;

1. All the three central tendencies - arithmetic average, median & mode coincide in it. They all lie at the same point.
2. It is symmetrical around its highest point.
3. It is equally divided into two parts by the perpendicular drawn from the highest point. The figure exhibits perfect bilateral symmetry.
4. The first and third quartiles are equidistant from median.
5. The ordinate at the mean is the highest ordinate. The heights of other ordinates at various sigma distances from the mean are also in a fixed relationship with the height of mean ordinate.
6. The curve is asymptotic to the base line. It means that it continues to approach but never reaches the base line. For practical purpose the curve may be taken to the end at points -3σ and +3σ distant from the mean.
7. The most important relationship in the normal curve is the area relationship. If we divide the range into six equal parts the cases between the two extremes are 99.73% and the cases between ± 2σ are 95.44% and the cases between ± 1σ are 68.26%.
8. On an NPC raw score can be converted into Z-scores. Z-score are raw scores expressed in terms of standard deviation units from the means. A z-score tells you how many deviations the corresponding raw- score lie about or below the mean.

$$Z = \frac{\text{Score} - \text{Mean}}{\text{----------}}$$

S.D. (σ)

(i) e.g. If raw score is 66, mean = 50, σ = 8

$$z = \frac{66-50}{8} = \frac{16}{8} = 2$$

(ii) If raw score = 34, mean = 50, σ = 8

$$z = \frac{34-50}{8} = \frac{-16}{8} = -2$$

Also, the percent of cases between

0 to +1σ = 34.13%

0 to -1σ = 34.13%

0 to +2σ = 47.72%

0 to -2σ = 47.72%

0 to +3σ = 49.87%

0 to -3σ = 49.87%

+1σ to +2σ = 13.59%

+1σ to +3σ = 15.74%

+2σ to +3σ = 2.15%

-1σ to +1σ = 68.26%

-1σ to +2σ = 81.85%

-1σ to +3σ= 84.00%

In terms of probability it can be said that in any normally distributed sample, chances are that 2/3 cases will fall within the area of –1 to +1. There are 68 chances in 100 that a case will lie with in ± 1 σ from the mean in a normal distribution.

2.2.3 Divergence from Normality

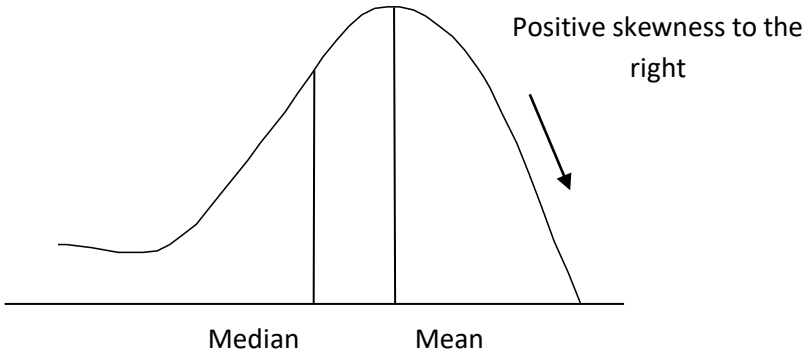
(i) Skewness

(ii) Kurtosis

(i) Skewness

In a normal curve model, the mean, median and mode all coincide and there is a perfect balance between the right and left halves of the figure. A distribution is said to be “skewed” when the mean and the median fall at different places between the distribution and the balance is shifted to one side or the other – to left or to right. Distribution is said to be skewed negatively or to the left when scores are massed at high end of the scale (the right end) and are spread out more gradually towards the low end (or left).

Distribution are skewed positively on the right when **scores** are massed at the low (or left) end of the scale and are spread out gradually toward the high or right. Moreover, when skewness is negative the mean lie to the left of the median and when skewness is positive, the mean lies to the right of the median.



The simple measure of skewness is

$$S_k = 3\left(\frac{\text{mean} - \text{median}}{\sigma}\right) = P_{50}$$

$$S_k = \frac{(P_{90} + P_{10})}{2} = P_{50}$$

P_{50} = 50th percentile

P_{90} = 90th percentile

P_{10} = 10th percentile

(ii) Kurtosis

The term "kurtosis" refers to the "peakedness" or flatness of a frequency distribution as compared with the normal. A frequency distribution more peaked than the normal is said to be letokurtic; one flatter than the normal, platykurtic. A normal curve is called mesokurtic.

$$Ku = \frac{Q}{(P_{90} - P_{10})}$$

Where Q = Quartile, P = Percentile

2.2.4 Application /Areas Under NPC.

(I) To find the limits in any normal distribution which include a given percentage of the cases. (Mean & S.D (σ) is given)

For example:-

(1) In a normal distribution of scores, with a mean of 50 and S.D of 10, what limit of scores will include the middle 50% of cases.

Solution

Middle 50% cases means 25% cases on the left side and 25% cases on the right side of the mean. 25% cases can be converted into number which is $\frac{25}{100} x 10000$ = 2500 (10000 is taken because total number of cases on a NPC is assumed to be 10000). Now we know that 2500 cases lie on the left side and 2500 cases lie on the right side of the mean in this particular case. Now see Table A (Garett and Woodworth, 1981). Roughly, it is clear that 2500 cases correspond to 0.675 value of *z*. For the positive side (right side), the sign would be + and for the left side the sign would be –.

$$\text{(Positive) } Z = \frac{\text{Score} - \text{Mean}}{\sigma}$$

0.675 x 10 = Score – 50

6.75 = Score – 50

6.75 + 50 = Score

56.75 = Score

(Negative) Z = $Z = \frac{S - M}{\sigma}$

- 0.675 = $\frac{Score - 50}{10}$

- 0.675 x 10 = Score – 50

- 6.75 + 50 = Score

43.25 = Score

Middle 50% of cases lie in the range of 43.25 to 56.75 score.

(2) If Mean = 15, S.D. = 3, find the range of scores where middle 60% cases lie

Solution

Middle 60% cases means 30% on left and 30% on right. Table A shows that the z value for 3000 cases $\left(\frac{30}{100} x 10000 = 3000\right)$ is 0.845. For positive side the sign is + for the negative side the sign is – .

(Positive) Z = $\frac{Score - Mean}{\sigma}$

0.845 = $\frac{Score - 15}{3}$

Score = 0.845 x 3 + 15

Score = 2.535 + 15

Score = 17.53

(Negative) = $\frac{Score - Mean}{\sigma}$

- 0.845 = $\frac{Score - 15}{3}$

Score = - 0.845 x 3 + 15

Score = - 2.535 + 15

Score = 12.46

Middle 60% of cases lie in the range of 12.46 to 17.53

(II) To determine the percentage of cases in the normal distribution within given limits.

For example;-

(1) Given a normal distribution with a mean of 100 and standard deviation of 20, find what percentage of cases lie between scores of 85 and 120

Z = $\frac{Score - Mean}{\sigma}$

(i) $Z_{120} = \frac{120-100}{20}$

$Z_{120} = 20/20 = +1$

(ii) $Z_{85} = \frac{85-100}{20}$

$Z_{85} = -0.75$

From Table A we see that 3413 cases lie till 1. So converting the number of cases into percentage we get 34.13 per cent cases till +1. From 0 to .75 we see that 2734 cases lie, which amount to 27.34 per cent cases.

Thus 0 to +1 = 34.13 percent

0 to -0.75 = 27.34 percent

Thus percentage of cases from -0.75 to +1 = 34.13 + 27.34 = 61.47

So, 61.47 percent cases lie between the raw scores of 85 and 120.

(ii) If the above scores were found on 3000 students, how many students score between 85 to 120

$\frac{61.47}{100} \times 3000 = 1844.1$

So, there are 1844 students who have got scores ranging from 85 to 120.

Q.2 If mean = 100, S.D. = 20 find out percentage of cases which lie above score of 120.

$Z = \frac{\text{Score} - \text{Mean}}{\sigma}$

$Z_{120} = \frac{120-100}{20} = 20/20 = +1$

Percentage of cases between 0 to +1 = 34.13.

Percentage of cases between 0 to +3 = 49.17% cases.

34.13 percent cases lie till +1.

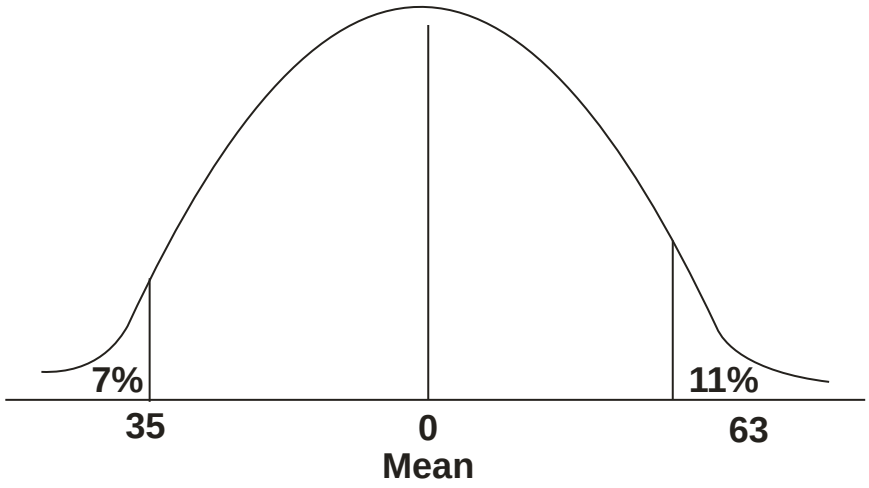
Thus percentage of cases above z score = +1

(i.e. between +1 and +3) = 49.17 – 34.13 = 15.04

So, 15.04% cases lie above raw score of 120.

(III) Calculating mean and S.D., when percentage of cases and limits are known.

Q.1. In a normal distribution 7% lie below a raw score of 35 and 11% are above a score of 63. What is the mean and S.D. of the distribution.



Solution

We know that 49.17 per cent cases lie from 0 to +3 and also from 0 to -3. We take this value to be roughly as 50%. As below 35 score, only 7% cases lie this score falls to the left side of the mean so from mean till point of 35 score,

50% – 7% = 43% cases lie.

43% cases means 4300 cases, and the z score for this is 1.48. Because this value is for left side we give – sign to 1.48.

$$Z = \frac{\text{Score} - \text{Mean}}{\sigma}$$

$$-1.48 = \frac{35 - \overline{X}}{\sigma} \qquad \text{-------} \ (1)$$

If 11% cases lie above 63 this score should be on the positive side. Similarly we also know that if 11% cases lie above this point so percentage of cases from mean to this point 50% – 11% = 39% cases.

39% cases means 3900 cases and the z value for 3900 is 1.23. Because this z value is on positive side, we give + sign to this value.

$z_{63} = \dfrac{\text{Score} - \text{Mean}}{\sigma}$

$1.23 = \dfrac{63 - \overline{X}}{\sigma}$ ----- (2)

$-1.48 = \dfrac{35 - \overline{X}}{\sigma}$ $+ 1.23 = \dfrac{63 - \overline{X}}{\sigma}$

Cross-multiplying Cross-multiplying

$-1.48\ \sigma = 35 - \overline{X}$ $+ 1.23\ \sigma = 63 - \overline{X}$

$-1.48\ \sigma = 35 - \overline{X}$ ---- (1)

$+1.23\ \sigma = 63 - \overline{X}$ --- (2)

- - +

---------- (simultaneous equations)

$-2.71\ \sigma = -28$

$\sigma = \dfrac{28}{2.71} = 10.33$

Putting the values of σ in equation (1)

$-1.48\ \sigma = 35. \overline{X}$ ---- (1)

$-1.48 \times 10.33 = 35 - \overline{X}$

$35 - \overline{X} = -1.48 \times 10.33$

$35 - \overline{X} = -15.28$

$-\overline{X} = -15.28 - 35$

$-\overline{X} = -50.28$

$\overline{X} = 50.28$

So, mean is 50.28 and σ is 10.33

(IV) To separate students given graph into sub-group, according to capacity, when the trait is normally distributed.

For example:-

(1) In a college, 10 grades are assigned to students, first is A+, A, A-, B+, B, B-, C+, C, C-, and D. If the ability in mathematics is normally distributed, how many students in a group of 500, receive each group to find the percentage of cases in A+, from mean to +3 these are 49.87 cases
0 to 2.4 → 49.18

(i) A = 49.87 – 49.18

= 0.69%

Converting into numbers

$\frac{0.69}{100} \times 500$ = 3.4 = 3 Approximately

So 3 students have score A+

(ii) A = 49.18 – 46.41 = 2.77

= $\frac{2.77}{100} \times 500$ = 13.85 = 14

So, 14 students who scored A

(1.8 – 1.2)

(iii) A^- = 46.41 – 38.49 = 7.92

$\frac{7.92}{100} \times 500$ = 39.6

40 students who score A^-

(iv) B^+ = 38.49 – 22.57 = 15.92

= $\frac{15.92}{100} \times 500$ = 79.6

= 80 students who scored B^+

(v) B = Mean → 0.6
= 0.6 = 22.57

$= \frac{22.57}{100} \times 500 = 112.85$

so 113 students who scored B.

(vi) B^- = (Mean to -0.6)
= -0.6 = 22.57

$= \frac{22.57}{100} \times 500 = 112.85$

so 113 students who scored B^-.

(vii) $C^+ = 38.49 - 22.57 = 15.92$

$= \frac{15.92}{100} \times 500 = 79.6$

= 80 students who scored C^+

(viii) $C = 46.41 - 38.49 = 7.92$

$= \frac{7.92}{100} \times 500 = 39.6$

so 40 students who scored C

(ix) $C^- = 49.18 - 46.41 = \frac{2.77}{100} \times 500 = 13.85$

So, 14 students who scored C^-

(x) $D = 49.87 - 49.18 = 0.69$

$\frac{0.69}{100} \times 500 = 3.4$

so 3, students who scored D

then all the students who scored A^+, A, A^-, B^+, B, B^-, C^+, C, C^-, D

$(A^+) + (A) + (A^-) + (B^+) + (B) + (B^-) + (C^+) + (C) + (C^-) + (D)$

3 + 14 + 40 + 80 + 113 + 113 + 80 + 40 + 14 + 3

= 500 students.

2.2.5 Summary

The chapter covered the introduction to Normal Probability Curve and its application in Psychology. The students were familiarized with the concept of

normality and the various properties of a Normal Probability Curve. We touched some very significant issues like skewness and kurtosis. Also, emphasis was laid upon the applications of NPC in Psychological research.

2.2.6 Keywords

1. Skewness

In a normal curve model, the mean, median and mode all coincide and there is a perfect balance between the right and left halves of the figure. A distribution is said to be "skewed" when the mean and the median fall at different places between the distribution and the balance is shifted to one side or the other – to left or to right.

2. Kurtosis

The term "kurtosis" refers to the "peakedness" or flatness of a frequency distribution as compared with the normal. A frequency distribution more peaked than the normal is said to be letokurtic; one flatter than the normal, platykurtic. A normal curve is called mesokurtic.

3. Normal Probability Curve-

The normal distribution is a continuous probability distribution that is symmetrical on both sides of the mean, so the right side of the center is a mirror image of the left side. The area under the normal distribution curve represents probability and the total area under the curve sums to one.

4. Median-

The median is the middle number in a sorted, ascending or descending, list of numbers and can be more descriptive of that data set than the average. It is sometimes used as opposed to the mean when there are outliers in the sequence that might skew the average of the values.

5. Mode-

The mode is the value that appears most often in a set of data values. Like the statistical mean and median, it is a way of expressing, in a (usually) single number, important information about a random variable or a population.

2.2.7 Long Questions

1. Given a normal distribution with a mean of 120 and SD of 15, and what percent

2. In a normal distribution, 8% lie below a raw score of 80, and 10% above a raw score of 100. What is the mean and SD of the distribution.

2.2.8 Short Questions

1. What is skewness?

2. What is a leptokurtic curve?

2.2.9 Suggested Readings :

1. Garrett : Statistics in Psychology and Education.

2. Guilford and Fruchter : Fundamental Statistics in Psychology and Education

Hypothesis Testing, One Tailed and Two Tailed Tests, Levels Of Significance, Degrees Of Freedom.

Lesson Structure

2.3.0 OBJECTIVE

The objective of this chapter is to familiarize the students of Psychology with some key issues in Statistics and Research. Here we shall be covering topics like hypothesis – its types, characteristics, sources, difficulties in formulating a hypothesis

etc. Also, we shall try to have a look on topics like one-tailed and two-tailed tests of significance, levels of significance, and degrees of freedom.

2.3.1 INTRODUCTION

The need for research arises when one finds a gap in knowledge, that is when the occurrence of an event fails to be explained by the existing body of knowledge, when the issue between conflicting findings is sought to be settled, or when some new facts have to be assimilated to the existing body of laws and theories. The awareness of a problem thus becomes the starting point of a research in any area of knowledge. **Mc Guigan** suggests that a scientific problem should be such that its answer is presently testable.

2.3.2 CONCEPT AND DEFINITIONS

The problem is the starting point of a research because every research activity is directed towards answering a problem. The next step is formulating a hypothesis. A conjectural statement about a relationship among two or more variables has been called a hypothesis. For example – How is A related to B? A hypothesis declares A is related to B.

Hypothesis simply means a mere assumption or some supposition to be tested. It is a guess or hunch, not haphazard guessing but based on facts.

According to G.A. Lundberg "An hypothesis is a tentative generalization, the validity of which remains to be tested. In its most elementary stage, the hypothesis may be any hunch, guess, imaginative idea, which becomes the basis for action or investigation."

According to Townsend, "Hypothesis is a suggested answer to a problem or it is a tentative solution to a problem."

Arthur S. Weber (1985) in his dictionary of Psychology quotes hypothesis as, 'In scientific work, any statement, proposition or assumption that serves as a tentative explanation of certain facts. A hypothesis is always presented so as to be amenable to empirical test and then either supported or rejected by the evidence'.

Clarke and Clarke remark, "Hypothesis is a statement tentatively accepted in the light of what is known about as the basis for action in the search for new truth".

According to Kerlinger, "A hypothesis is a conjectural statement of the relationship between two or more variables".

Kelleth D. Bailey, "Hypothesis is a tentative explanation for which the evidence necessary for testing is at least potentially available".

Hypothesis are always in declarative sentence form and they relate either generally or specifically, variables to variables. There is no hypothesis without facts- tentative or established, traditional or scientific. In essence, a hypothesis may be a preliminary tentative organization of facts in a meaningful way to be tested, accepted or discarded on the basis of critical observation or experimentation. Verified and repeatedly tested hypothesis give birth to theory and loss.

Prior to commencing experimentation or observation, the researcher states hypothesis so that with collection of data and subsequently its analysis, tenability of the

hypothesis would be tested. Hypothesis serves a sort of guiding light in research study precisely; it is not a haphazard guessing but an outcome of highly intellectual exercise; it is based on known facts or beliefs; it is to be tested or verified and accepted or rejected; it is a binding link between the unknown and yet to be known; it is a basis for action and it gives birth to theories and principles. There would be no science in any complete sense without hypothesis.

2.3.3 CHARACTERISTICS OF A GOOD HYPOTHESIS

Now the question arises, "what are the characteristics of a usable hypothesis?" The answer may be – a 'good" usable hypothesis is the one which satisfies many of the following criteria.

1) A hypothesis should be empirically testable. It should be so stable that it is possible to reduce logically certain inferences from it which in turn can be tested by observation in the field.
2) A good hypothesis is in agreement with the observed facts. A single unexplained conflict between fact and hypothesis is disastrous to the latter.
3) A hypothesis is entirely plausible and conceivable. It is based directly on existing data.
4) A good hypothesis does not conflict with any law of nature which is known to be true.
5) A good hypothesis is expert. It is stated in a scientific and research like language and is not an ordinary statement.
6) A hypothesis should be so designed that its test will provide an answer to the original problem which forms the primary purpose of the investigation. It should be related to available knowledge.
7) A hypothesis must be stated in final form early in the experiment before any attempt at verification is made.
8) The hypothesis must be conceptually clear. The concepts embodied in the hypothesis be defined in a manner commonly accepted and communicable.
9) The hypothesis must be specific. A hypothesis would include a clear statement of indexes which are to be used. For example, the concept of social class needs to be explicated in terms of indexes such, as income, occupation, education etc.
10) Hypothesis should be related to a body of theory or some theoretical orientation.
11) A hypothesis should be related to available techniques.
12) Hypothesis must actually explain what it claims to explain.
13) A hypothesis is never absolutely true or false but is probably true or probably false. They have a determinable degree of probability.

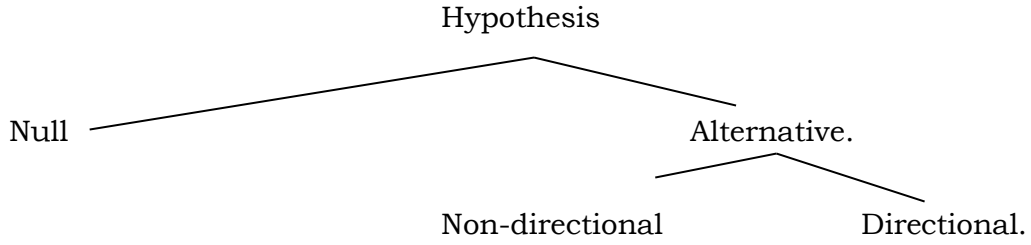
2.3.4 SOURCES OF HYPOTHESIS;

There are various sources of hypothesis. Some of them are as under:-

1. Reduction from theory.
2. Induced from direct observation.
3. Intuition.
4. Finding from previous experiments.
5. Serendipity (accidental discovery of relationship between two variables.)

6. Consultation with specialists.

2.3.5 TYPES OF HYPOTHESIS:-



Null hypothesis (H_O):-

This hypothesis proposed by Ronald Fisher. It is a statement of no relationship among the variables being tested, and that any relationship found may be attributed to sampling error. It is the simplest form of hypothesis and asserts that there is no actual difference between the sample and the population which is under consideration, or no difference between two groups on any variable. Null is a German word which means zero. It is also termed statistical hypothesis or zero hypothesis because it denies the existence of any difference or relationship. It is also known as chance hypothesis.

H_O: $\mu_1-\mu_2 = 0$

$\therefore \mu_1=\mu_2$

According to **Kerlinger**, the null hypothesis is a statistical proposition which states essentially that there is no relation between the variables of that problem.

e.g- Drugs have no effect on memory.

Alternate hypothesis(Ha)

It is opposite to null hypothesis or an alternate to null hypothesis. In statistics, a hypothesis that functions as an alternative to the null hypothesis and typically asserts that the independent variable has an effect upon the dependent variable, or there are differences between two groups that cannot be explained by chance alone is called on alternative or experimental hypothesis.

Ha: $\mu_1 \neq \mu_2$

$\mu_1 - \mu_2 \neq 0$

Alternative hypothesis further has two types.

(i) Non- directional:-

In this the researcher simply predicts that the two groups which have been compared will differ but does not predict the direction of that difference. The researcher does not predict which group will score higher or lower. Thus, a hypothesis that does not predict the direction of the difference is called the non-directional hypothesis.

(ii) Directional hypothesis:-

If the researcher predicts the direction of the difference, then it is a directional hypothesis. It gives an expected direction in relationship or difference between variables.

2.3.6 DIFFICULTIES IN FORMULATION OF HYPOTHESIS

There are a number of difficulties from which a beginner may suffer at the stage of formulating a good hypothesis:-

- Lack of knowledge and clarity of the theoretical framework of the area in which the investigator chooses to work.
- Lack of ability to make use of the theoretical framework logically.
- Lack of acquaintance with available research technique resulting in failure to be able to phrase the hypothesis properly.
- Vagueness of the statement: For example, a course of ethics will make a student a more ethical adult.

2.3.7 FUNCTIONS & IMPORTANCE OF HYPOTHESIS

Theories are relatively elaborate tools used to explain and predict events. The social scientist develops a theory to account for some social phenomenon and then he devices a means where the theory can be tested or subjected to verification or refutation. Seldom does the researcher test the theory directly. Most of the time he conduct tests of hypothesis that have been generated and derived from that theory.

All statements of theory in testable form are called hypothesis. Main functions of hypothesis are:-

(a) to test theories.
(b) to suggest theories.
(c) to describe social phenomenon.

Hypothesis has a very important place in research although it occupies a very small place in the body of thesis. The aimless collection of data is not likely to lead the investigator anywhere. The importance of hypothesis can be more specifically stated as under:-

1) By formulating hypothesis the researcher puts himself on the right track.
2) Hypothesis keeps the study within bounds or boundary.
3) Hypothesis delimits the problem to its specific objectives and goals to the choice of subjects to review of literature and to persue data collection techniques.
4) Hypothesis is the binding link between the known and yet to be known or unknown. In other words, an important bridge between theory and empirical inquiry.
5) Hypothesis based on others experiences and ones own to serve as a guiding light in the world of darkness.
6) Hypothesis provided infrastructure of facts on which the researcher builds up further.
7) Hypothesis provides a sort of framework on the basis of which the researcher draws conclusion from the result of his study.
8) Hypothesis are powerful tools for the advancement of knowledge because they enable scientists to get outside themselves.
9) It focuses research. Without it research would be like a random and aimless wondering.
10) Hypothesis is a prediction. It says if 'X' occurs 'Y' will also occur. 'Y' is predicted from 'X'.

11) It is a device which provokes the researcher to think and interpret his results in a meaningful way.

So these are some basic points of importance of hypothesis. These points are very important in the research process.

2.3.8 TWO- TAILED AND ONE- TAILED TEST OF HYPOTHESIS

TWO-TAILED TEST

A two tailed test of hypothesis is so called because in a two-tailed test the rejection region is located in both the tails of a Normal Probability Curve.

1) At 0.05 level of significance

If we are testing a hypothesis at 0.05 level of significance, the size of the acceptance region of the each side of the mean would be 0.475 (one-half of 0.95).

(a) If the sample mean fall into this area the hypothesis is accepted.

(b) If the sample mean fall into the area beyond 1.96 the hypothesis is rejected because it falls into the rejection region.

2) At 0.01 level of significance

The size of acceptance region on each side of the mean would be 0.495 (one-half of 0.99) the size of rejection region is 0.005 from table of NPC, an area of 0,495 corresponds to 2.58 standard error from μ_H mean. At 0.01 level of significance of the probability of rejection a hypothesis is 1%.

ONE-TAILED TEST

One tail test is so called because the rejection region is located in only one tail which may be either left or right depending upon the alternative hypothesis formulated.

2.3.9 LEVELS OF SIGNIFICANCE

Whether a difference is to be taken as statistically significant or not depends upon the probability that the given difference would have arisen "by chance". It also depends upon the purpose of the experiment. Usually a difference is marked "significant" when the gap between two sample mean point signifies a real difference between the parameters of the populations from which our samples are drawn.

A significance level is a statement of the probability that an observed difference is a chance difference. Significance level is usually determined in advance before testing the hypothesis. The most commonly used significance levels are 0.05 and 0.01. If 0.05 level of significance is to be used, this means we accept real difference so large that it could have occurred by chance only 5 times in 100. If 0.01 level, the difference can be expected to occur only one time in 100 by chance.

In simple words, there must be some guideline that determines how large a difference must be, to be considered real.

Only rarely can we be absolutely sure that the obtained difference between group means is not due to chance. Even very large differences would occur by chance except in rare cases with a restricted and finite population

The confidence with which an experimenter rejects or retains a null hypothesis depends upon the level of significance.

The 0.01 level of significance is more exacting than 0.05 level.

2.3.10 DEGREES OF FREEDOM

The concept of degrees of freedom is highly important in small sample statistics. It is crucial, too, in analysis of variance and in other procedures. When a statistic is used to estimate a parameter, the number of degrees of freedom (df) available depends upon the restriction placed upon the observations. One df is lost for each restriction imposed. If we have 5 score, 5, 6, 7, 8, 9. The mean is 7, and the deviations of individual scores (5,6,7,8,9) from 7 are –2,-1,0, 1, 2. Sum of these deviation, is zero. Of the 5 deviations, only 4 (N-1) can be selected freely.(i.e. one independent) as the condition that the sum equals zero restricts the value of 5th deviation. One df is lost in calculating mean.

The formula for calculating df is

df = N-1

The degree of freedom are not always (N-1) however, but will vary with the problem and restrictions imposed.

2.3.11 SUMMARY

The present chapter dealt with some very important and basic issues in statistics and research like hypothesis, its types, sources etc, difficulties in formulating a hypothesis. Also we covered areas like levels of significance, one-tailed and two-tailed test and degrees of freedom.

2.3.12 KEYWORDS

1. Level of significance

A significance level is a statement of the probability that an observed difference is a chance difference. Significance level is usually determined in advance before testing the hypothesis. The most commonly used significance levels are 0.05 and 0.01. If 0.05 level of significance is to be used, this means we accept real difference so large that it could have occurred by chance only 5 times in 100.

2. Degrees of freedom

In statistics the number of degrees of freedom (df) available depends upon the restriction placed upon the observations. One df is lost for each restriction imposed. If we have 5 score, 5, 6, 7, 8, 9. The mean is 7, and the deviations of individual scores (5,6,7,8,9) from 7 are –2,-1,0, 1, 2. Sum of these deviation, is zero. Of the 5 deviations, only 4 (N-1) can be selected freely.(i.e. one independent) as the condition that the sum equals zero restricts the value of 5th deviation. The degree of freedom are not always (N-1) however, but will vary with the problem and restrictions imposed.

3. Alternate hypothesis(H_a)

It is opposite to null hypothesis or an alternate to null hypothesis. In statistics, a hypothesis that functions as an alternative to the null hypothesis and typically asserts that the independent variable has an effect upon the dependent variable, or there are differences between two groups that cannot be explained by chance alone is called on alternative or experimental hypothesis.

4. One-tailed test

One tail test is so called because the rejection region is located in only one tail which may be either left or right depending upon the alternative hypothesis

formulated.

5. Null hypothesis(H_O):-

This hypothesis proposed by Ronald Fisher. It is a statement of no relationship among the variables being tested, and that any relationship found may be attributed to sampling error. It is the simplest form of hypothesis and asserts that there is no actual difference between the sample and the population which is under consideration, or no difference between two groups on any variable.

2.3.13 Long Questions

1. What are the commonly used levels of significance?

2. What are the characteristics of Hypothesis?

2.3.14 Short Questions

Define the following

1. Null Hypothesis
2. Directional Hypothesis

2.3.14

Garrett: Statistics in Psychology and Education

Lesson No. : 2.4 **Last Updated January 2023**

Chi Square and its Applications

Lesson Structure :

2.4.0 Objectives

The objectives of this lesson is to understand the concept of Chi Square and its applications. By end of this lesson you should be able to :

- Explain the meaning of Chi Square
- Focus on the application of Chi Square

2.4.1 Introduction : Chi Square

X^2 is one of the most important non-parametric statistics. It is used for a number of statistics.

It involves no assumptions regarding the normality of distribution or HOMOGENEITY OF VARIANCE. It is a non-parametric inferential procedure, which is used when the data is expressed in terms of frequencies. It applies to discrete data.

The scores indicate the category that the subjects fall in and total number of subjects in each category.

2.4.2 Uses of Chi Square ($x^{2)}$:-

2.4.2.1 When there is one sample or single variable case :- Here, it is referred to as a goodness of fit test. It permits us to determine whether there's a significant difference between the observed number of cases in each category and live expected number of cases based on the H_0. It is a way to answer to question that how well does an observed distribution corresponds to the theoretical distribution. Why it is called a good fit? because it indicates whether the observed frequencies are a good fit to expected frequency or not. The fit is good when the observed frequencies are within random functions of the expected frequencies and the computed X^2 value is small (i.e. it'll be insignificant when expected of observed frequencies will be close. When there's a lot of discrepancy between the two it'll get reflected in a significant X^2)

The larger the value of X^2 , the more the discrepancy between the observed and expected frequencies.

e.g. There are 100 subjects, who've been randomly selected and we want to see whether there's a significant difference in the proportion of individuals who prefer the taste of each of the 4 brands of a cold drink. So. N = 100

	A	B	C	D
Observed Frequency	20	31	28	21
Expected Frequency	25	25	25	25

Expected frequency $\frac{N}{k} = \frac{100}{4} = 25$

K-number of categories

An exp. freq. is the mean of the observed frequencies that would occur on infinite repetitions of an expected when sampling is random and the H_0 is true.

Here H_0 - There's no difference in preferences amongst the subjects for the 4 brands of cold - drinks.

To study the discrepancy between O & E frequencies, we use X^2 statistic. The use of X^2 tells whether the relative frequencies observed in the several categories of our sample frequencies distribution, are in accordance with the set of frequencies hypothesized to be characteristic of a population distribution.

df = k-1 where k - number of categories

= 4-1

= 3

Level of sig. at which we check our results = .01

$$X^2 = \sum_{i=1}^{r} \sum_{j=1}^{k} \frac{(fo - fe)^2}{fe}$$

where

i=1 to r means starting from the first row to the last row

j=k to r means starting from the first column to the last column

$$\therefore X^2 = \frac{(20-25)^2}{25} + \frac{(31-25)^2}{25} + \frac{(28-25)^2}{25} + \frac{(21-25)^2}{25}$$

$$= \frac{-5^2}{25} + \frac{6^2}{25} + \frac{3^2}{25} + \frac{4^2}{25}$$

$$= \frac{25}{25} + \frac{36}{25} + \frac{9}{25} + \frac{16}{25}$$

= 1 + 1.44 + 0.36 + 0.64

= 3.44

df = 3

$\alpha = .01$

The critical value at df = 3 and at α .01 is 11.34. The calculated value is 3.44, which is lesser than the critical value. So we fail to reject H_0 because the value is insignificant.

The discrepancy between the E & O frequencies are of a magnitude small enough to be reasonably expected if the H_0 is true therefore we fail to reject H_0.

A sig. X^2 (obt. X^2 is longer then labeled X^2) indicates that across all categories of the frequencies are described in. It is a non directional test. If on X^2 value had been significant, we would have rejected H_0 and conclusion would have been that there's a significant difference between the cold drinks but we can't say, which over one preferred.

X^2 can't be negative because all the frequencies are squared.

X^2=0 when each fo =fe .longer the discrepancy between fo & fe, longer the X^2 value.

It is the size of the discrepancy relative to magnitude of fe that account for the contribution to the value of X^2.

2.4.2 When we've 2 samples - Here, the use of the X^2 test is referred to as the testing the significance of the independence hypothesis. By independence hypothesis is meant that one variable is not related to or affected by another variable and so the 2 variables are independent. X^2 is not a measure of the degree of relationship. It just provides an estimate of some other factors other than chance, which account for the apparent relationship when we deal with data related to the individual hypothesis, we arrange the data in a contingency table. When observations are classified in a two way table then the data is called continous data and the table is referred to as contingency table.

e.g. 2 : You've data on 200 subjects, who are classified into 3 categories. On the basis of there educational qualifications : Masters, Bachelors, Intermediates their educational achievement in the cause of study is measured and they are classified into 3 -superior, Average & inferior.

	Superior	**Average**	**Inferior**	
Masters	30 (25)	15 (15)	5 (10)	50
Bachelors	25(25)	10 (15)	15(10)	50
Intermediate	45(50)	35 (30)	20(20)	100
	100	60	40	200

You've to see whether educational achievement is related to educational qualification.

H_0 : There is no relationship between the 2 variables.

H_A : The 2 variables are slightly related

$\alpha - 0.05$

First calculate row & columns Totals. Then calculate fe. If H_0 is true under the assumption of independence, the fo in each cell should be proportional to the distribution of row & column totals. fe is estimated and the product of the marginal totals (row & columns total) common to that cell and divided by N.

$$\frac{100x50}{200} \qquad \frac{100x50}{200} \qquad \frac{100x100}{200}$$

$$= 25$$

$$\frac{60x50}{200} \quad \frac{60x500}{200} \quad \frac{60x100}{200}$$
$$\frac{40x50}{200} \quad \frac{40x50}{200} \quad \frac{40x100}{200}$$

fo	**fe**	**fo-fe**	**$(fo-fe)^2$**	**$x^2=(fo-fe)^2/fe$**	
30	25	5	25	1	
25	25	0	0	0	
45	50	-5	25	0.5	
15	15	0	0	0	
10	15	-5	25	1.67	
35	30	5	25	0.83	
5	10	-5	25	2.5	
15	10	5	25	2.5	
20	20	0	0	0	$\therefore X^2 = 9$

df = (r-1) (c-1)

(3-1) (3-1)

2x2

= 4

For df = 4 at 0.5 level, the labeled value of X^2 is 9.48. Our obtained X^2 value is 9 ,m which is less so we fail to reject the H_0 so there is no significant relationship between 2 variables so they are independent.

When data is arranged in a 2x2 contingency table, there is another method. We needn't calculate fe.

A	B

The X^2 is calculated directly using the formula.

C	D

$$X^2 = \frac{N(AD - BC/)^2}{(A+B)(A+C)(B+D)(C+D)} - \text{Product of row f column totals}$$

Where A, B,C,D are the symbols for the frequency in the cells and N is the total no. indicate that when we subtract BC from AD, the sign is ignored.

e.g. 3 : Suppose we want to know whether 2 items in a test are independent or related, both the items are answered in yes or No. The total number of subjects are 400. Frequencies in each cell are:-

A B

180	120
90	10

C D

Substitute the values in 4 w

$X^2 = \frac{400(/180x10\text{-}120x90/)^2}{(300)(270)(130)(100)}$

$$= \frac{400(/1800-10800)^2}{1053000000}$$

$$= \frac{400(-9000)^2}{1053000000} = \frac{4w(81000000)^2}{1083000000}$$

$$= \frac{3.24x10^{10}}{1053000000}$$

= 30.77

df = (r-1) (c-1)

= (2-1) (2-1)

= 1x1

= 1

α = .05

The tabelled/critical value is 3.84 at df = 1 at .05. Our obtained X^2 value is 30.77, which greatly exceeds the critical value. So we reject the H_2. So our conclusion is that item no. 5 & item no. 10 are related.

e.g. 4 : We have 60 students - 50 boys & 10 girls, who have been administered an attitude scale and the answers are in yes & no. You're given the frequencies towards item no. 10. We've to see whether there's a significant difference between the opinions of the boys & the girls.

	Yes	No	
Boys	20	30	50
Girls	$\frac{3(3.83)}{23}$	$\frac{7}{37}$	$\frac{10}{60}$

fe = $\frac{23x10}{60} = 3.83$

X^2 = $\frac{N(/AD - BC/ - \frac{N}{2})^2}{(A+B)}$

= $\frac{60(/20x7 - 30x3/ - \frac{60}{2})^2}{50x10x23x37}$

= $\frac{60(/140 - 90/ - 30)^2}{425500}$

= $\frac{60(/50/ - 30)^2}{425500}$

= $\frac{60(20)^2}{425500} = \frac{60x400}{425500} = \frac{24000}{425500}$

= .056

df = (r-1) (c-1)

= (2-1) (2-1)

= 1x1

= 1

α = .05

The tabelled value is 3.84 at df = 1 and at α .05. Our obtained value of X^2 is .56 which is not significant so we reject the H_0.

Fortune to use this correction results in the probability of the given result to be underestimated and the chances of its being called signification considerably increased.

Another use of X^2 - It has been used in checking the significance for other statistics e.g. contingency coefficient, Phi coefficient and coefficient of concordance.

2.4.3 Summary :

The lesson covers the introduction to Chi Square and its application in Psychology. The students are familiarized with the application of Chi Square in case of one and two samples.

2.4.4 Keywords

1. Chi Square

X^2 is one of the most important non-parametric statistics. It is used for a number of statistics. It involves no assumptions regarding the normality of distribution or HOMOGENEITY OF VARIANCE. It is a non-parametric inferential procedure, which is used when the data is expressed in terms of frequencies. It applies to discrete data.

2. Homogeneity of variance

It is an assumption of the independent samples t-test and ANOVA stating that all comparison groups have the same variance. The independent samples t-test and ANOVA utilize the *t* and *F* statistics respectively, which are generally robust to violations of the assumption as long as group sizes are equal. Equal group sizes may be defined by the ratio of the largest to smallest group being less than 1.5. If group sizes are vastly unequal and homogeneity of variance is violated, then the *F* statistic will be biased when large sample variances are associated with small group sizes.

3. Parametric test

Parametric tests assume a normal distribution of values, or a "bell-shaped curve." For example, height is roughly a normal distribution in that if you were to graph height from a group of people, one would see a typical bell-shaped curve. This distribution is also called a Gaussian distribution. Parametric tests are in general more powerful (require a smaller sample size) than nonparametric tests.

4. Critical Value

In hypothesis testing, a critical value is a point on the test distribution that is compared to the test statistic to determine whether to reject the null hypothesis. If the absolute value of your test statistic is greater than the critical value, you can declare statistical significance and reject the null hypothesis.

5.Sample

A sample refers to a smaller, manageable version of a larger group. It is a subset containing the characteristics of a larger population. Samples are used in statistical testing when population sizes are too large for the test to include all possible members or observations.

2.4.5 Long questions

1. If mean=150, S.D.=20, find out percentage of cases which lie above score of 180.

2. In a normal distribution 7% lie below a raw score of 45 and 15% are above a raw score of 63. What is the mean and SD of the distribution.

2.4.6 Short questions

Write short notes on the following ;

1. Kurtosis
2. Leptokurtic Curve

2.4.7 Suggested Readings

1 Garrelt : Statistics in Psychology and Education

2 Guilford and Fruchter : Fundamental Statistics in Psychology and Education.

There are two methods that are commonly used to measure short-term memory. These are :

(iii) Probe technique ; and

(iv) Distractor technique

(3) PROBE TECHNIQUE :

In this, the subject is presented with a series of items but is tested for only one of them. At the time of presentation, the subject does not know which item will be called for lateron. For example, series of five digits can be presented to the subject. Later on, he may beasked to recall the fourth digit. On the next presentation, he may be asked to recall thesecond digit. In pair associate learning, any one of the two members of the pair is presented and the subject is required to recall the other member of the pair.

(4) DISTRACTOR TECHNIQUE :

In this technique, the subject is presented with a series of letters of digits which he has to recall later on. He is given some interpolated activity in order to prevent rehearsal during the retention interval. After this, he is asked to retrieve the original series. The interpolated activity is simply enough to occupy the subject, but it doesnot involve any new learning. Thus, it is different from retroactive inhibition test in which the interpolated activity involves some new learning.

These technique provides a point of reference from which we can inquire about the nature of forgetting in short-term memory.

1.3.6 THEORY OF LEVELS OF PROCESSING

While information-processing theories of memory view the memory process in discrete stages, each with its own characteristic features a contrasting model of memory has been given which is the "levels of processing" (Craik & Lockhart 1972) framework, with the idea of elaboration added to it more recently (Craik & Tulving, 1975).

According to the levels of processing framework, incoming information can be worked on at different levels of analysis; the deeper the analysis the better the memory. The first level is simply perception, which gives us our immediate awareness of the environment. At a somewhat deeper level, the structural features of the input are analyzed (such as what it looks or sounds or tastes). Finally, at the deepest level of processing the meaning of the input is analyzed. The more deep and elaborate the processing of the perceptual input, the better is the memory for that matter. Rehearsal plays a very important role in the processing of information. It refers to keeping the information "at the centre of attention", perhaps by repeating it over andover again. According to the levels of processing view, simply repeating the information, i.e.,

maintenance rehearsal is not enough. It must be elaborative, i.e., it must process the information to the meaningful level if the information is to be well retained.

The concept of elaboration has been added to the levels of processing theory. Elaboration refers to the degree to which coming information is processed so that it can be tied to, or integrated with, existing memories. The greater the degree of elaboration given to an item, the more likely it is to be remembered. The entire processing is based on how encoding is done.

1.3.6.1 ENCODING

Encoding or recording involves the preparation of information in a useful way so that it can be remembered. Encoding for long-term storage required special attention or strategies of some sort. Some of them are discussed as below :

Mnemonic : A mnemonic is a technique that enhances the storage and the recall of information in memory. It aids information retention and retrival (remembering) in the human memory. The word "mnemonic" is related to Ancient Greek word Mnemosyne ("rememberance") the name of the goddess of memory in Greek mythology. Mnemonic help us to use information already stored in long term memory to make memorisation an easier task,

Eg : To remember the name of planets by using first letters mnemonic technique

: "My very Educated Mother just served us Nachos" where Ist letter M stands for Mercury, V stands for Venus, E for earth and so on.

a) Role of Organization :- The term organization carries its usual meaning, referring to some systematic or functional arrangement. Organized material is most readily remembered. When the material doesn't have its own organization, the learner must create a Subjective Organization imposing an organizing scheme on the material by encoding it in terms of personal experience. One method to arrange the information is through 'peg-word' technique. For eg:- the letters in the word homes can be used as "pegs" on which to hang the names of the great lakes - Hurron, Ontario, Michigan, Erie and Superior. This technique rely on the linking or association, of to be remembered material with a systematic and organised set of images or words that are already firmly established in long-term memory and can therefore serve as reminder cues.

(e) Chunking Method :- Another method of storing information in STM is through chunking procedure. Chunking means grouping certain items together, forming subgroups. For eg:- You want to remember your credit card number 9743625 you can break it into groups and even associate it with some important dates or events.

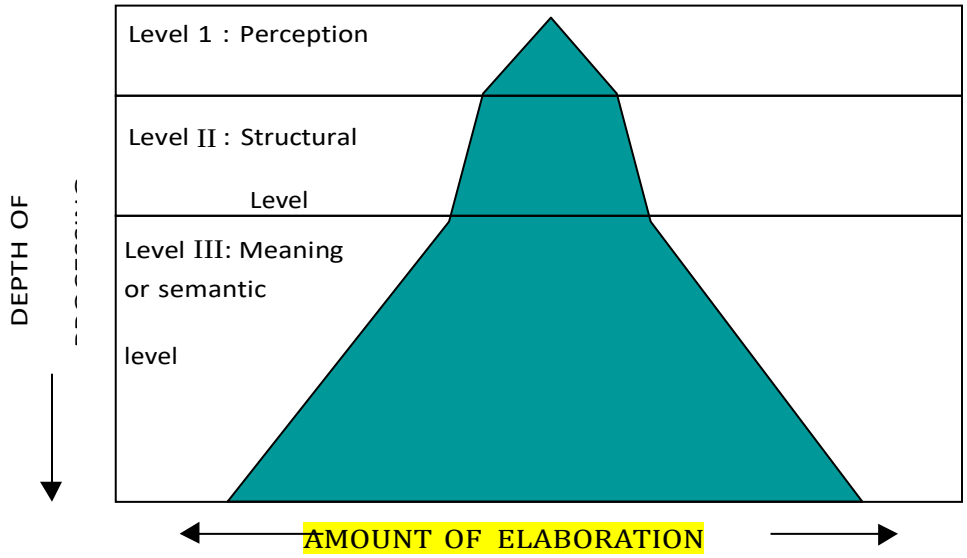
(f) Use of Imagery :- We remember the material better in visual terms than by verbal ones. The visual imagery is very effective as compared to other material. The

effectiveness of visual imagery, or mental pictures, has been very well demonstrated (Postman, 1975). Pictures are recognized with very high degree of accuracy. When subjects were presentedwith three types of verbal materials to the memorized -pictures, concrete nouns and abstract nouns - the accuracy of recall appeared in that order. The apparent reason is that pictures and concrete nouns can be remembered in both visual and verbal terms, where as abstract nouns are generally remembered only by words.

(g) Constructive Processes :- During encoding, the to-be-remembered information especially if it is a complex life event or something you have read is modified. Certain details are accentuated, the material may be simplified, or it may be changed in many other ways so that what is encoded and stored is far from a literal copy of the input. These modification are called constructive processes. For eg : You read some complex and long news in a newspaper but you construct a simplified version of the whole news.

The following figure shows that the amount remembered, indicated by the shading, depends on both the level of processing and the degree to which information is elaborated.

FIGURE : DIAGRAM OF THE RELATIONSHIPS AMONG LEVELS OF PROCESSING, ELABORATION OF INFORMATION AND MEMORY (SHADED PORTION IS THE AMOUNT OF INFORMATION



1.3.7 Summary

The present lesson explores the fundamental aspects of memory, including its definition, stages of memorization, and factors affecting memory. It begins by defining memory as the reproduction of past personal perceptions in the same order and form. The four stages of memorization, namely learning, retention, recall, and recognition, are discussed in detail. The importance of active observation, repetition, and good health in the learning process is highlighted. Different methods for measuring retention, such as recall, relearning, recognition, and reconstruction, are explained, along with their respective techniques and calculation procedures. The lesson also introduces the theory of levels of processing, emphasizing the depth of analysis and elaboration for better memory retention. Overall, this lesson provides a comprehensive understanding of memory and its underlying processes in the field of experimental psychology.

1.3.8 Keywords

Retention

It is demonstrated by trying to remember the impression made during the learning process. Memory traces are like pencil marks. Just as the pencil marks fade away with time, similarly memory traces fade away if not used. In retention, these memory traces or neural traces formed out of learning are consolidated.

Recognition

According to Guilford, recognition means "knowing again". When one recognize an object or a stimulus, he behaves as if he has experienced it before. Thus, recognition simply means identification.

Sensory memory

Sensory memory is also known as the "sensory buffer" or "sensory register". It refers to

the recorded or transcribed raw physical input. It consists of the impressions that stimuli from the external world make on our senses. If the transfer of information of other memory stores is not virtually instantaneous, then the information gets lost.

Declarative memory

It is also called explicit memory stores facts, information and personal life events that can be brought to mind verbally or in the form of imagesand then declared or stated. It holds information you can intentionally or consciously recollect.

Flash bulb memory

It is vivid recall for eariler events associated with extreme emotions. Such memories are so vivid that it is as if our brains had recorded them like a scene in the sudden glare of a camera's flash bulb.

Constructive memory

It refers to the memory of an event that did not actually happened, but unconsciously constructed to fill a gap. Research has shown that memories are not always eg. courtroom testimony of two witnesses differs significantly because constructive memory that one holds uses a variety of information (perceptions, beliefs, attitudes etc.) to fill in gaps and that the accuracy of our memory may be altered.

1.3.9 Long questions

1. Explain the stages of memory processing with suitable examples.

2. Elaborate on the factors influencing memory.

1.3.10 Short questions

1. What are the main stages involved in the process of memory?

2. How does the "levels of processing" theory contribute to our understanding of memory?

1.3.11 Suggested Readings

3. Postman, L., & Egan, J.P. (1989). *Experimental Psychology :* An Introduction,Kalayni Publishers, New Delhi.
4. Woodworth, R.S., Schlosberg, A. (1965). *Experimental Psychology,* Methuen& Co. Ltd., London.

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