

# INTRODUCTION TO EXPERIMENTAL PSYCHOLOGY AND STATISTICS IN PSYCHOLOGICAL RESEARCH - I

## Unit Structure :

- 1.0 Objectives
- 1.1 Introduction
- 1.2 What is a complex design?
  - 1.2.1 Characteristics of complex design
  - 1.2.2 Example of complex (2 X 2) design
  - 1.2.3 Interaction and Main Effects
- 1.3 Mixed design
  - 1.3.1 Example of mixed design
  - 1.3.2 Advantages of mixed designs
- 1.4 Summary
- 1.5 Questions
- 1.6 References

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## 1.0 OBJECTIVES

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- i. To impart knowledge and understanding of complex design and its characteristics
- ii. To create an understanding of the effect of each independent variable alone (main effect)
- iii. To create an understanding of the effect of the independent variable in combination (interaction effect)
- iv. A foundation for an understanding of mixed designs

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## 1.1 INTRODUCTION

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Last semester our discussion was related to experiments involving only one independent variable because we wanted you to concentrate on the basics of experimental research. Experiments involving only one independent variable are not, however, the most common type of experiment in psychological research.

As we know, the manipulation of a single independent variable with all other variables held constant is a design that has been criticised for its extreme separation from reality. In normal life, we are affected by several influences together at any one time.

The two- factor design (complex design) moves that one step closer to reality by testing the effects of two independent variables ('factors') on a dependent variable simultaneously.

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## 1.2 WHAT IS A COMPLEX DESIGN?

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Researchers most often use complex designs in which two or more independent variables are studied simultaneously in one experiment. Factorial design is another name for complex designs because they involve factorial combination of independent variables. Factorial combination involves pairing each level of one independent variable with each level of a second independent variable. Because of this it possible to determine the effect of each independent variable alone and the effect of the independent variables in combination as well.

In the beginning complex designs may seem a little complicated, but the concepts will become clearer as you go through various examples which are given later in this section.

### 1.2.1 Characteristics of complex design

Researchers use complex designs to study the effects of two or more independent variables in one experiment.

- In this type of design, each independent variable can be studied with an independent groups design or with a repeated measures design
- 2 X 2 design is the simplest complex design where we have two independent variables, each with two levels.
- The number of different conditions in a complex design can be found by multiplying the number of levels for each independent variable (e.g.,  $2 \times 2 = 4$ ).
- In a complex design more levels of an independent variable and more independent variables can be included in the design. Each independent variable in a complex design must be implemented using either an independent groups design or a repeated measures design.

Complex designs are identified by specifying the number of levels of each of the independent variables in the experiment. A 2 X 2 (which is read "2 by 2") design, then, identifies the most basic complex design.

Regardless of the number of independent variables, the number of conditions in a complex design can be determined by multiplying the number of levels of the independent variables. For example, if there are two independent variables with each having two levels (a 2 X 2 design), there are four conditions. In a 3 X 3 design there are two independent variables with three levels each, so there are nine conditions. In a 3 X 4 X 2 design there are three independent variables with three, four, and two levels, respectively, and a total of 24 conditions.

Understanding the 2 X 2 design is very important in order to understand complex designs.

Complex designs can be extended beyond the 2 X 2 design in one of two ways. Researchers can add levels to one or both of the independent variables in the design, yielding designs such as the 3 X 2, the 3 X 3, the 4 X 2, the 4 X 3, and so on. Researchers can also build on the 2 X 2 design by increasing the number of independent variables in the same experiment. The number of levels of each variable can range from 2 to some unspecified upper limit.

### 1.2.2 Example of 2 X 2 design

E. Aron and A. Aron (1997) proposed that people differ on a basic, inherited tendency they called “sensory-processing sensitivity” that is found in about a fifth of humans and in many animal species. People with this trait process information especially thoroughly. To check the sensitivity of people Aaron and colleagues used 6-item Highly Sensitive Person Scale. If one scores high on most of the items, then the person is probably among the 20% of people who are “highly sensitive.”

One implication of being a highly sensitive person, according to this model, is that such people are more affected than others by success and failure. This is because they process all experiences more completely. So, one would expect highly sensitive people to feel especially good when they succeed and especially bad when they fail.

To test this prediction, E. Aron, A. Aron, and Davies (2005) conducted an experiment. In the experiment, students first completed the sensitivity questions. On the basis of the scores obtained by subjects, researchers when divided them into highly sensitive and not highly sensitive groups.

Later, as part of a series of tests on attitudes and other topics, everyone was given a timed test of their “applied reasoning ability,” something important to most students. Each subject was given a test which was either extremely easy or so difficult that some problems had no right answer (subjects did not know who was getting easy or difficult test).

The test questionnaires were handed out to subjects in alternate seats (it was randomly determined where this process began in each row); so if a subject had the hard version of the test, subjects on either side had an easy version and the subject was probably aware that they finished quickly while he was still struggling.

On the other hand, if a subject had the easy version, he was probably aware that he had finished easily while the others around him were still working on what he presumed to be the same test.

Right after the test, everyone was asked some items about their mood, how depressed, anxious, and sad they felt at the moment. (The mood items were from the other questionnaire, and it was not obvious that testing mood was the purpose of the study.) Responses to the mood items were averaged to create a measure of overall negative mood.

In sum, the study looked at the effect of two different factors on negative mood: (1) whether the students were highly sensitive or not highly sensitive and (2) whether the students had taken the easy test (which caused them to feel they had succeeded) or the hard test (which caused them to feel they had failed).

Aron and colleagues could have done two studies, one comparing highly sensitive versus not highly sensitive individuals and one comparing people who took the easy test versus people who took the hard test. Instead, they studied the effects of both sensitivity and test difficulty in a single study. With this setup there were four groups of participants:

- (a) those who are not highly sensitive and took the easy test,
- (b) those who are highly sensitive and took the easy test,
- (c) those who are not highly sensitive and took the hard test, and
- (d) those who are highly sensitive and took the hard test.

### 1.2.3 Interaction and Main Effects

When effect of each independent variable is studied alone it is known as main effect. When effect of independent variable is studied in combination it is known as interaction effect.

In a factorial design we can study the effects of combining two or more variables. In this example, sensitivity and test difficulty might affect negative mood in a simple additive way. (Here additive means their combined influence is the sum of their separate influences; if one subject is more sensitive and also got the difficult test, then the overall effect is the total of the two individual effects.)

For example, suppose being highly sensitive makes one more likely to experience a negative mood; similarly, suppose the test being hard makes one more likely to experience a negative mood. If these two effects are additive, then participants in the high sensitivity, hard test group will be most likely to experience a negative mood; participants who are not highly sensitive and take the easy test will be the least likely to experience a negative mood; and those in the other two conditions would have an intermediate likelihood of experiencing a negative mood. It could also be that one variable but not the other has an effect. Or perhaps neither variable has any effect. In the additive situation, or when only one variable or neither has an effect, looking at the two variables in combination does not give any interesting additional information.

However, it is also possible that the combination of the two variables changes the result. Aron and colleagues predicted that the effect of being highly sensitive would be especially strong in the hard test condition.

**Interaction effect:** A situation where the combination of variables has a special effect is called an interaction effect. In interaction effect the effect of one variable that divides the groups on the measured variable is different across the levels of the other variable that divides the groups.

**Main effect:** The effect of one factor over all levels of another factor taken together is known as a main effect (e.g., both highly sensitive and not highly sensitive experience a negative mood). In the above experiment there was a possibility of two main effects and one interaction effect. The two possible main effects are one for sensitivity and one for test difficulty.

The possible interaction effect is for the combination of sensitivity and test difficulty.

### 1.3 MIXED DESIGN

When we have a complex design which has both an independent groups variable and a repeated measures variable, it is called a mixed design. Main feature of mixed design is that there is one independent variable (Randomized design) and second independent variable has Repeated measures design. Generally, the repeated measures design is usually gender, personality etc – the one that are usually selected (not manipulated).

A mixed design involves two or more independent variables, of which at least one is a within-subjects (repeated measures) factor and at least one is a between-groups factor. If we consider the simplest case, there will be one between-groups factor and one within-subjects factor. The between-groups factor would need to be coded in a single column while the repeated measures variable would comprise as many columns as there are measures.

#### 1.3.1 Example of Mixed design

As an example, assume that an experiment is conducted in which researcher was interested in the extent to which visual distraction affects younger and older people's learning and remembering.

To do this, the researcher obtained a group of younger adults and a separate group of older adults and had them learn under three conditions

eyes closed,

eyes open looking at a blank field and

eyes open looking at a distracting field of pictures.

This is a 2 (age) x 3 (distraction condition) mixed factorial design.

Following table represents the number of words recalled out of ten under each distraction condition.

Age	Closed Eyes	Simple Distraction	Complex Distraction
Younger	8	5	3
Younger	7	6	6
Younger	8	7	6
Younger	7	5	4

Age	Closed Eyes	Simple Distraction	Complex Distraction
Older	6	5	2
Older	5	5	4
Older	5	4	3
Older	6	3	2

In the above example age is independent variable This is manipulated at two levels, that is, younger and older people.

Second independent variable is distraction condition which is manipulated at three levels. These three levels are: closed eyes (no distraction), simple distraction and complex distraction.

Dependent variable is number of words correctly recalled out of ten under each distraction condition by younger and older subjects.

As you know in mixed design, there is at least one within subject or repeated measures factor. In this example, both the groups of subjects were subjected to all the conditions (repeated measures, that is, eyes closed, simple distraction and complex distraction).

In mixed design, there also needs to be at least one between-groups factor. In the present example, younger group and older group is between groups/unrelated factor.

Between group: Where all factors use independent samples, is commonly known as a between groups factor.

Within group: Where factors are related (repeated measures) it is a within groups factor.

### **1.3.2 Advantages of mixed designs:**

The primary advantage of all complex designs is the opportunity they provide for identifying interactions between independent variables

In a factorial design two or more than two independent variables are simultaneously manipulated and in a single independent variable experiment, a separate experiment is designed to study the effect of independent variables. Thus, a factorial experiment provides economy of time, labour and money.

The factorial experiments also permit the evaluation of interaction upon the dependent variable. In a single independent variable, one cannot evaluate the effect of the interaction of the independent variables because only one independent variable is manipulated at a time.

The experimental results of a factorial/mixed experiment are more comprehensive and can be generalized to a wider range due to the manipulation of several independent variables in one experiment. From this

point of view, the single independent variable experiments suffer with major drawback.

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## 1.4 SUMMARY

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In this unit, we learned about complex design. Complex designs are those in which two or more independent variables are studied simultaneously in one experiment. Another name for complex design is Factorial design because they involve factorial combination of independent variables.

Complex designs are identified by specifying the number of levels of each of the independent variables in the experiment. A 2 X 2 (which is read “2 by 2”) design is the most basic complex design where there are two independent variables each having two levels.

In a factorial design, one can study the effects of combining two or more variables. When the effect of each independent variable is studied alone it is known as the main effect. When the effect of an independent variable is studied in combination it is known as the interaction effect.

When we have a complex design that has both an independent groups variable and a repeated measures variable, it is called a mixed design. The main feature of the mixed design is that there is one independent variable (Randomized design) and the second independent variable has a Repeated measures design.

The main advantage of all complex designs is the opportunity they provide for identifying interactions between independent variables

In a factorial design, two or more than two independent variables are simultaneously manipulated and hence it provides economy of time, labor, and money.

The factorial experiments also permit the evaluation of interaction upon the dependent variable. In a single independent variable, one cannot evaluate the effect of the interaction of the independent variables because only one independent variable is manipulated at a time.

The experimental results of a factorial/mixed experiment are more comprehensive and can be generalized to a wider range due to the manipulation of several independent variables in one experiment.

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## 1.5 QUESTIONS

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1. What is an IV and DV?

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2. Give one study with one IV and one DV

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3. Give an example where you have one independent variable with two levels/three levels.

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4. Explain complex design with two IV each having two levels (2 X 2)

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5. Explain mixed design.

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## 1.6 REFERENCES

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# **INTRODUCTION TO EXPERIMENTAL PSYCHOLOGY AND STATISTICS IN PSYCHOLOGICAL RESEARCH - II**

## **Unit Structure :**

- 2.0 Objectives
- 2.1 Introduction
  - 2.1.1 Descriptive statistics
  - 2.1.2 Inferential statistics
  - 2.1.3 Features of Inferential Statistics
  - 2.1.4 Importance of Inferential Statistics
  - 2.1.5 Example of Inferential Statistics
- 2.2 ANOVA – Analysis of Variance
  - 2.2.1 Features of ANOVA
  - 2.2.2 Types of ANOVA
- 2.3 One- way analysis of variance
  - 2.3.1 One Independent Variable with More Than Two Levels (Example # 1)
  - 2.3.2 When to use a one- way ANOVA
- 2.4 Two – way ANOVA
  - 2.4.1 More Than One Independent Variable (With Two or More Levels Each) and One Dependent Variable (Example # 2)
  - 2.4.2 When to use a two-way ANOVA
- 2.5 How does the ANOVA test work?
- 2.6 Chi-Square Test
  - 2.6.1 Features of Chi square Test
  - 2.6.2 Example of Chi Square Test
  - 2.6.3 Types of Chi-square tests
  - 2.6.4 When to use Goodness of Fit or Test of Independence
  - 2.6.5 How to perform a Chi-square test
- 2.7 Summary
- 2.8 Questions
- 2.9 References

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## 2.0 OBJECTIVES

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- To impart knowledge and understanding of the topic of inferential statistics
- To develop an understanding of ANOVA
- To create awareness about when to use one-way ANOVA and when two-way ANOVA
- To develop an understanding of Chi-square tests

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## 2.1 INTRODUCTION

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Statistics plays a big role in the field of psychological research. It helps us in the collection, analysis and interpretation of data either by numbers into a general understandable format. For the purpose of data analysis, we divide statistics into two main branches which are Descriptive Statistics and Inferential Statistics. In this section, we will discuss Inferential statistics in detail

### 2.1.1 Descriptive statistics:

By using mean, median, mode, variance etc., which are part of descriptive statistics, the important characteristics of data can be described. Data can be summarized with the help of numbers and graphs. It describes the basic features of the data in a study. Descriptive statistics provide simple summaries about the sample and the measures.

Descriptive statistics describe what the data shows. Descriptive Statistics are used to manage quantitative data which can be described in a manageable way. Descriptive statistics help us to simplify large amounts of data and it can be done in a sensible way. Each descriptive statistic reduces lots of data into a simpler summary.

### 2.1.2 Inferential statistics:

Inferential statistics is used to make judgments whether an observed difference between groups is a dependable one or one that might have occurred by chance. Thus, inferential statistics is used to make inferences from obtained data to more general conditions.

### 2.1.3 Features of Inferential Statistics

Inferential Statistics involves using sample data to draw conclusions about a population.

They are statistical tests which are used to analyze relationships between variables.

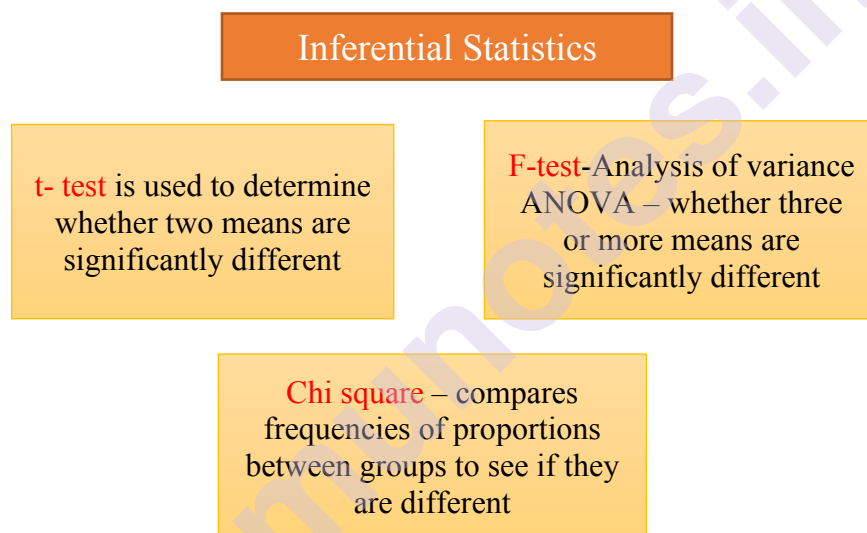
It allows to make inferences and assumptions about the data collected relative to a larger group that researcher wants to infer about.

In Inferential statistics, we make an inference from a sample about the population. The main aim of inferential statistics is to make conclusions from the sample and generalise them for the population data. e.g., if we want to find the average salary of a data analyst across India. There are two options.

The first option is to consider all the data analysts across India and ask them their salaries and take an average.

The second option is to select a sample of data analysts from some major cities in India and take their average and consider that for across India.

If you consider the first option, it is not only not possible but also very difficult to collect data of all data analysts across India. It is time-consuming as well as costly. Therefore, to overcome the problem, we can look into the second option to collect a small sample of salaries of data analysts and take their average as India average. This is called as inferential statistics where we make an inference from a sample about the population.



**Figure: Types of Inferential Statistics**

#### **2.1.4 Importance of Inferential Statistics**

Making conclusions from a sample about the population

To conclude if a sample selected is statistically significant to the whole population or not

Comparing two models to find which one is more statistically significant as compared to the other.

In feature selection, whether adding or removing a variable helps in improving the model or not.

### 2.1.5 Examples of inferential statistics

Now let us consider an example of inferential statistics to make the concept clear. Suppose you are performing a study in the USA. You might randomly select a sample of 11th graders in one state, for example, Florida, and collect data on their SAT scores and other characteristics.

Inferential statistics can be used to make estimates and test hypotheses about the whole population of 11th graders in the state of Florida based on your sample data.

Another example: You want to test the efficacy of a new drug meant for cancer patients. You can select your sample (cancer patients) and give this new drug. With inferential statistics you take sample data from a small number of people and try to determine if the data can predict whether the drug will work for everyone (i.e., the population).

Ordinarily, psychologists conduct research to test a theoretical principle or the effectiveness of a practical procedure. For example, heart rate can be measured by a psycho-physiologist from before to after solving a difficult problem. The measurements are then used to test a theory predicting that heart rate should change following successful problem solving.

An applied social psychologist might examine the effectiveness of a program of neighborhood meetings intended to promote water conservation. Such studies are carried out with a particular group of research participants. But researchers use inferential statistics to make more general conclusions about the theoretical principle or procedure being studied. These conclusions go beyond the particular group of research participants studied.

In this section we will discuss two types of inferential statistics which are as follows:

#### ANOVA

#### Chi-square

When we want to know whether the means of two groups (one independent variable (e.g., gender) with two levels (e.g., males and females) differ, a *t* test is appropriate. If we want to calculate a *t* test, we must know the mean, standard deviation, and number of subjects in each of the two groups.

Let us consider an example for *t* test research. A *t* test research question might be “*Is there a significant difference between the reading scores of boys and girls in sixth grade?*” But, when we have more than two groups then another statistic is used known as ANOVA or Analysis of variance.

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## 2.2 ANOVA (ANALYSIS OF VARIANCE) PARAMETRIC DATA ANALYSIS

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R. A. Fisher (1920) developed the analysis of variance (ANOVA). ANOVA test helps to find out if an experiment's results are significant or not. It is usually used when the experimenter has more than 2 groups and we have to test the hypothesis that the mean of multiple populations and variances of multiple populations are equal.

ANOVA is a powerful parametric procedure for testing the differences between several means and several independent variables.

In other words, if we have one independent variable (with three or more groups/levels) and one dependent variable, we do a one-way ANOVA.

- The significance of the difference in means is studied by variance analysis by analyzing variance.

### 2.2.1 Features of ANOVA

ANOVA measures two sources of variation: variation BETWEEN groups & variation WITHIN groups

ANOVA F-statistic is a ratio of the Between Group Variation divided by the Within Group Variation

- A large F is evidence against  $H_0$ , since it indicates that there is more difference between groups than within groups

ANOVA can be used to test differences among several means for significance without increasing the Type I error rate

### 2.2.2 Types of ANOVA

One-way ANOVA

Two-way ANOVA

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## 2.3 ONE -WAY ANOVA

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The one-way analysis of variance (ANOVA) is used when the researcher wants to determine whether there are any significant differences (statistically) between the means of three or more independent (unrelated) groups.

What does this test do?

The one-way ANOVA makes a comparison of the means between the groups, that you are interested in, and determines whether any of those means are statistically significantly different from each other. Specifically, it tests the null hypothesis:

$$H_0: \mu_1 = \mu_2 = \mu_3 = \dots = \mu_k$$

where  $\mu$  = group mean and  $k$  = number of groups. If, however, the one-way ANOVA returns a statistically significant result, we accept the alternative hypothesis ( $H_A$ ), which is that there are at least two group means that are statistically significantly different from each other.

### 2.3.1 One Independent Variable (With More Than Two Levels) and One Dependent Variable

Example # 1: Let us consider an example here. Suppose the independent variable (e.g., political party affiliation) has more than two levels (e.g., Democrats, Republicans, and Independents) to compare and we wish to know if they differ on a dependent variable (e.g., attitude about changing the gun possession rule), we need to do an ANOVA (Analysis of Variance).

ANOVA (analysis of variance) is introduced for the analysis of more than two conditions/levels.

*Our sample research question is, "Do Democrats, Republicans, and Independents differ on their opinion about a change in gun control rule?" A sample answer might be, "Democrats ( $M=3.56$ ,  $SD=.56$ ) are less likely to make a change in existing gun rule than Republicans ( $M=5.67$ ,  $SD=.60$ ) or Independents ( $M=5.34$ ,  $SD=.45$ ),  $F(2,120)=5.67$ ,  $p<.05$ ."*

*[Note: The (2,120) are the degrees of freedom for an ANOVA. The first number is the number of groups minus 1. Because we had three political parties it is 2,  $3-1=2$ .*

*The second number is the total number of subjects minus the number of groups. Because we had 123 subject and 3 groups, it is 120 ( $123-3$ ).*

*The one-way ANOVA has one independent variable (political party) with more than two groups/levels (Democrat, Republican, and Independent) and one dependent variable (attitude about changing the gun rule).*

### 2.3.2 When to use a one- way ANOVA

Situation 1: You have a group of individuals randomly split into smaller groups and completing different tasks. For example, you might be studying the effects of tea on weight loss and form three groups: green tea, black tea, and no tea.

Situation 2: Similar to situation 1, but in this case the individuals are split into groups based on an attribute they possess. For example, you might be studying leg strength of people according to weight. You could split participants into weight categories (obese, overweight and normal) and measure their leg strength on a weight machine.

#### Example # 2

A manager wants to raise the productivity at his company by increasing the speed at which his employees can use a particular spreadsheet program. As he does not have the skills in-house, he employs an external agency which provides training in this spreadsheet program. They offer 3 courses: a

beginner, intermediate and advanced course. He is unsure which course is needed for the type of work they do at his company, so he sends 10 employees on the beginner course, 10 on the intermediate and 10 on the advanced course. When they all return from the training, he gives them a problem to solve using the spreadsheet program, and times how long it takes them to complete the problem. He then compares the three courses (beginner, intermediate, advanced) to see if there are any differences in the average time it took to complete the problem.

### Example # 3

Suppose there is a pharmaceutical company which wants to conduct an experiment to test the efficacy of a new cholesterol medicine. The company does a random selection of 15 subjects from a larger population. Each subject is randomly assigned to one of three treatment groups. Subjects in each treatment group receive a different dose of the new medication.

In Group 1, subjects receive 20 mg/day; in Group 2, 60 mg/day; and in Group 3, 90 mg/day.

The treatment levels represent all the levels of interest to the experimenter.

Cholesterol level of each subject is again measured after 30 days. The results for all 15 subjects are given in the table below:

Dosage		
Group 1, 20 mg	Group 2, 60 mg	Group 3, 90 mg
210	210	180
240	240	210
270	240	210
270	270	210
300	270	240

Two research questions were there in front of the experimenters while conducting the experiment

- i) Does dosage level have a significant effect on cholesterol level?
- ii) How strong is the effect of dosage level on cholesterol level?

To answer above questions, the experimenter can use one-way analysis of variance.

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## 2.4 TWO- WAY ANOVA

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ANOVAs can have more than one independent variable. A two-way ANOVA has two independent variables (e.g., political party and gender), a three-way ANOVA has three independent variables (e.g., political party,

gender, and education status), etc. These ANOVA still have only one dependent variable (e.g., attitude about a tax cut).

There are three research questions in a two-way ANOVA: One for each of the two independent variables and one for the interaction of the two independent variables.

A two-way ANOVA is used to know how the mean of a variable changes according to the levels of two categorical variables.

Two-way ANOVA can be used when the researcher wants to know how two independent variables, in combination, affect a dependent variable.

#### Example # 1

Let us take another example. Suppose you want to research which type of fertilizer and planting density will produce the greatest crop yield in a field experiment. You can assign different plots in a field to a combination of fertilizer type (1, 2, or 3) and planting density (1=low density, 2=high density), and measure the final crop yield in kilogram per hectare at harvest time.

In this experiment two-way ANOVA can be used to find out if fertilizer type and planting density have an effect on average crop yield.

#### **2.4.1 More Than One Independent Variable (With Two or More Levels Each) and One Dependent Variable (Example # 2)**

Let us consider the following research Questions for a Two-Way ANOVA:  
*Do Democrats, Republicans, and Independents differ on their opinion about a change in the gun law?*  
*Do males and females differ on their opinion about a change in the gun law?*

*Is there an interaction between gender and political party affiliation regarding opinions about a change in the gun law?*

There are three null hypotheses and three alternate hypotheses in a two-way ANOVA.

#### **2.4.2 When to use a two-way ANOVA**

In any study if you have collected data on a quantitative dependent variable at multiple levels of two categorical independent variables you can use a two-way ANOVA.

A quantitative variable represents amounts or counts of things. It can be divided to find a group mean.

Kilogram per acre is a quantitative variable because it represents the amount of crop produced. It can be divided to find the average kilogram per hectare.

A categorical variable represents types or categories of things. A level is an individual category within the categorical variable.



In our example, fertilizer types 1, 2, and 3 are levels within the categorical variable fertilizer type. Planting densities 1 and 2 are levels within the categorical variable planting density.

In any experiment/study there should be enough observations in the data set in order to find the mean of the quantitative dependent variable at each combination of levels of the independent variables.

Both the independent variables should be categorical.

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## 2.5 HOW DOES THE ANOVA TEST WORK?

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ANOVA tests for significance using the F-test for statistical significance. The F-test is a groupwise comparison test, which means it compares the variance in each group mean to the overall variance in the dependent variable.

If the variance within groups is smaller than the variance between groups, the F-test will find a higher F-value, and therefore a higher likelihood that the difference observed is real and not due to chance.

A two-way ANOVA with interaction tests three null hypotheses at the same time:

There is no difference in group means at any level of the first independent variable.

There is no difference in group means at any level of the second independent variable.

The effect of one independent variable does not depend on the effect of the other independent variable (a.k.a. no interaction effect).

A two-way ANOVA without interaction only tests the first two of these hypotheses.

### Check Your Progress

Read the following paragraph and answer questions given below.

Suppose students are interested in effects on driving (having just passed their tests) and have read in the literature that, when people are not over tired, caffeine (in a coffee drink) can reduce number of errors made during a driving task. They decide to use a computerized hazard perception task as a performance measure. Having carefully considered and provided for ethical issues, they decide that they should give some participants an acceptable dose of caffeine, some a placebo drink (decaffeinated coffee) which, the participants are informed, contains caffeine, some the same drink but with no information and finally a group given nothing at all. All participants perform the driving task.

1. What is the dependent variable in this experiment?

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2. What is the independent variable?

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3. How many levels does the independent variable contain?

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## 2.6 CHI-SQUARE TEST

CHI SQUARE TEST is a non- parametric test. We use a Chi-square test for hypothesis tests about whether our data is as expected. The basic idea behind the test is to compare the observed values in our data to the expected values that we would see if the null hypothesis is true.

Chi-square test is used to compare observed results with expected results. The purpose of chi square test is to determine if a difference between observed data and expected data is due to chance, or if it is due to a relationship between the variables which are being studied.

### 2.6.1 Features of Chi square Test

- Chi square test is used to measure the differences between what is observed and what is expected according to an assumed hypothesis.
- Chi square test tells the researcher about the presence or absence of an association between the events but doesn't measure the strength of association.
- This test doesn't indicate the cause and effect; it only tells the probability of occurrence of association.

The following conditions should be satisfied before test can be applied:

1. The data must be in the form of frequencies
2. The frequency data must have a precise numerical value and must be organized into categories or groups.
3. All the items in the sample must be independent. i.e., the occurrence of one individual observation (event) has no effect upon the occurrence of any other observation (event) in the sample under consideration.

Following is the formula to calculate chi square:

$$\chi^2 = \sum (O - E)^2 / E$$

Where,

O = Observed frequency

E = Expected frequency

$\sum$  = Summation

$\chi^2$  = Chi-Square value

#### Chi Square P-Values.

A chi square test gives a p-value. The p-value tells the researcher if test results are significant or not. In order to perform a chi square test and get the p-value, you need two pieces of information:

Degrees of freedom. That's the number of categories minus 1.

The alpha level ( $\alpha$ ). This is chosen by the researcher. The usual alpha level is 0.05 (5%), but you could also have other levels like 0.01

How do you interpret a chi-square test?

If the calculated chi square value is greater than the chi-square critical value, then the researcher rejects the null hypothesis. If chi-square calculated value is less than the chi-square critical value, then one "fails to reject" the null hypothesis.

### **2.6.2 Example of Chi Square Test**

Let us consider one example.

Suppose in a study 27 people were surveyed regarding whether they preferred red, blue, or yellow as a colour. If there were no preference, we would expect that 9 would select red, 9 would select blue, and 9 would select yellow. In this study chi-square test can be used to compare what we have observed (actual) with what we expected.

If results of our sample indicated that 2 liked red, 20 liked blue, and 5 liked yellow, we might be rather confident that more people prefer blue. If our

sample indicated that 8 liked red, 10 liked blue, and 9 liked yellow, we might not be very confident that blue is generally favored.

Chi-square test is important here because it helps us make decisions about whether the observed outcome differs significantly from the expected outcome. In this example, a sample research question might be, "*Is there a preference for the red, blue, and yellow colour?*" A sample answer is "There was not equal preference for the colours red, blue, or yellow. More people preferred blue than red or yellow."

Suppose the calculated value of  $X^2$  is more than chi square critical value then you can reject the null hypothesis and accept the alternate hypothesis (Note: critical value can be found in the table given in all statistics books. You need to know the degree of freedom {df} and significance level for example 5 % or .05 and then check chi square critical value in the appropriate box).

Just as t-tests tell the researcher how confident he/she can be about saying that there are differences between the means of two groups, the chi-square tells us how confident we can be about saying that our observed results differ from expected results.

In any study where we have to compare categorical data Chi-square test is used. Chi-square test is of two types. Both use chi-square statistics and distribution for different purposes.

### 2.6.3 Types of Chi-square tests

We use a Chi-square test for hypothesis tests about whether our data is as expected. The basic idea behind the test is to compare the observed values in your data to the expected values that you would see if the null hypothesis is true.

There are two commonly used Chi-square tests: the Chi-square goodness of fit test and the Chi-square test of independence. Both tests involve variables that divide data into categories. As a result, people can be confused about which test to use.

The table given below can be used to compare the two tests.

Goodness of fit: It determines if sample data of categorical variables matches with population or not.

Test of Independence: It compares two categorical variables to find whether they are related with each other or not.

## 2.6.4 When to use Goodness of Fit or Test of Independence

	Chi-Square Goodness of Fit Test	Chi-Square Test of Independence
Number of variables	One	Two
Purpose of test	Decide if one variable is likely to come from a given distribution or not	Decide if two variables might be related or not
Example	Decide if bags of candy have the same number of pieces of each flavor or not	Decide if movie goers' decision to buy snacks is related to the type of movie, they plan to watch
Hypotheses in example	H <sub>0</sub> : proportion of flavors of candy are the same H <sub>a</sub> : proportions of flavors are not the same	H <sub>0</sub> : proportion of people who buy snacks is independent of the movie type H <sub>a</sub> : proportion of people who buy snacks is different for different types of movies

## 2.6.5 How to perform a Chi-square test

For both the Chi-square goodness of fit test and the Chi-square test of independence, you perform the same analysis steps, listed below.

Define your null and alternative hypotheses before collecting your data.

Decide on the alpha value. This involves deciding the risk you are willing to take of drawing the wrong conclusion. For example, suppose you set  $\alpha=0.05$  when testing for independence. Here, you have decided on a 5% risk of concluding the two variables are independent when in reality they are not.

Check the data for errors.

Check the assumptions for the test.

Perform the test and draw your conclusion.

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## 2.7 SUMMARY

Statistics plays a very important role in the field of psychological research. It helps us in the collection, analysis and interpretation of data. For the purpose of data analysis, we divide statistics into two main branches which are Descriptive Statistics and Inferential Statistics. In this section, we discussed Inferential statistics in detail

Inferential statistics is used to make judgments whether an observed difference between groups is a dependable one or one that might have occurred by chance. Thus, inferential statistics is used to make inferences from obtained data to more general conditions.

In this section we discussed two types of inferential statistics: ANOVA and Chi square.

R. A. Fisher (1920) developed the analysis of variance (ANOVA). ANOVA test helps to find out if an experiment's results are significant or not. It is usually used when the experimenter has more than 2 groups and we have to test the hypothesis that the mean of multiple populations and variances of multiple populations are equal.

If we have one independent variable (with three or more groups/levels) and one dependent variable, we do a one-way ANOVA. The one-way analysis of variance (ANOVA) is used when the researcher wants to determine whether there are any significant differences (statistically) between the means of three or more independent (unrelated) groups.

The one-way ANOVA makes a comparison of the means between the groups that you are interested in, and determines whether any of those means are statistically significantly different from each other. Specifically, it tests the null hypothesis.

ANOVAs can have more than one independent variable. A two-way ANOVA has two independent variables (e.g., political party and gender), a three-way ANOVA has three independent variables (e.g., political party, gender, and education status), etc. These ANOVAs still have only one dependent variable (e.g., attitude about a tax cut).

CHI SQUARE TEST is a non-parametric test. We use a Chi-square test for hypothesis testing about whether our data is as expected. The basic idea behind the test is to compare the observed values in our data to the expected values that we would see if the null hypothesis is true.

Chi-square test is used to compare observed results with expected results. The purpose of chi square test is to determine if a difference between observed data and expected data is due to chance, or if it is due to a relationship between the variables which are being studied

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## 2.8 QUESTIONS

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1. Give one example where you will use chi square test.

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2. Explain the term goodness of fit

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3. Explain the term test of independence

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## 2.9 REFERENCES

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## REVIEWING A RESEARCH PAPER

### Unit Structure :

- 3.0 Objectives
- 3.1 Overview
  - 3.1.1 Writing a research paper
  - 3.1.2 Publishing a research paper
  - 3.1.3 Reviewing a research paper
  - 3.1.4 Difference between reviewing a research paper, writing a review paper, and writing a literature review
- 3.2 What is the APA Style format?
  - 3.2.1 Guidelines of the APA Style format to write a research paper
  - 3.2.2 Benefits of reviewing a research paper
  - 3.2.3 Brief introduction to the professional level of reviewing a research paper
  - 3.2.4 Exercise of reviewing a research paper considering the APA Style format
- 3.3 Summary
- 3.4 Questions
- 3.5 References

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### 3.0 OBJECTIVES

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- Familiarizing the students with the basic guidelines of APA Style format for writing a research paper.
- Familiarizing them with reviewing a research paper at the beginners' level.
- Differentiating between reviewing a research paper, writing a review paper, and writing a literature review.
- Introducing the professional level of reviewing a research paper in brief.

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### 3.1 OVERVIEW

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In this chapter, we are going to learn about how to review a research paper. Before that, we will need to know in brief about **research, writing a research paper, and research paper publication**. Kumar (2011, p. 1) defines **research** as an activity more than a set of skills that is a way of thinking, and it involves i) examining critically the various aspects of our



day to day professional work, ii) understanding and formulating guiding principles that govern a particular procedure; and iii) developing and testing new theories that contribute to the advancement of your practice and profession. Research offers us a scientific way to find out the answer to our questions or the solution to the existing problems that we want to work on for the betterment of society or its particular segment. Hence, research is a very important activity and is undertaken in every field to upgrade and contribute to the existing body of knowledge.

### 3.1.1 Writing a Research Paper

Writing a research paper or article is a process of documenting the research study that has been carried out right from the beginning to the end. A research paper narrates the following essential elements:

- **Abstract:** A summary of the research problem, method, result, and conclusion.
- **Introduction:** Which constructs/concepts did we study and what is their theoretical basis(such as, psycho-social models, theories proposed by the previous researchers)?
- **Rationale:** What drove us to carry out that particular research?
- **Significance:** What is the importance of our research study from any specific perspective or multiple perspectives(i.e., social, psychological)?
- **Research problem/s:** What problems/issues did we identify to study?
- **Hypotheses or research questions:** What questions did we address or what assumptions did we have?
- **Literature review:** What research has been carried out in the past relevant to the one we carried out?
- **Methodology/ method:** How was the research study carried out?
- **Variables (independent, dependent, control):** Which concepts did we study, and in what way?
- **Sample and sampling:** Which population segment was studied? How was the selected number of the target population approached?
- **Data collection procedure:** How were the data collected (e.g. using interview technique, observational technique, paper-pencil tools, etc.)?
- **Statistical analysis and data interpretation:** How were the data analyzed (i.e., which statistical tests were applied to treat the data), and how were they interpreted?

- **Results and discussion:** What did we find after analysis? Which previous research studies supported our research findings and which did not?
- **Conclusion:** What were the overall findings of our study to be highlighted?
- **Limitations and practical implications:** What were the restrictions followed while carrying out the research study? How can our research study be applied to day-to-day life?

Thus, writing a research paper aims to explain each segment of the research study carefully, minutely, in detail, and yet concisely and with precision. The same procedure applies to the documentation of the thesis to be submitted to accomplish a Ph. D. degree, often coupled with the structured format prescribed by any particular university where one is pursuing the course.

### 3.1.2 Publishing a Research Paper

Disseminating the knowledge that we derived from our accomplished research work is the next important step after writing a research paper. For this purpose, we need to publish research paper/s in good, quality scientific journals that promote this important scientific activity. There are several journals dedicated to many sub-fields of psychology. Therefore, we need to identify and narrow down the list of journals relevant to our research topic. We then need to acquire some basic information about those particular journals before sending our research paper for publication, such as i) how appropriate the journal is to publish our research paper considering our research topic, ii) the quality of the journal (whether it is a well-known/standard journal or fake), iii) the range of the journal for publishing the research articles in terms of topics, iv) whether the journal is peer-reviewed (as such journals are the most widely accepted for formal scholarly communication), v) the number of articles/ papers accepted in a single volume/ issue of that journal, vi) an impact factor of the journal (one of the very important aspects), vii) the preferred format of the journal (specifications about font, font size, language, etc.) for a research paper. This format informs us about a certain way we should send our manuscript of the research paper to the journal.

Acquiring basic information will help us make a wise decision about where (i.e. to which journal) and when to send our research paper for publication, which will make our publication process half done. In India, University Grant Commission (UGC) is the highest institution that governs all educational institutions with important rules, regulations, and guidelines. UGC has created a list of journals (known as “UGC Recognized Journals”) for each academic subject in the year 2019 and updates it after some interval. Following this, all students and academic professionals from the educational institutes from India require to get their research papers published in the journals preferably from this list for getting approved against the publication criterion set for the selection procedure for any academic competitive post in India.

Apart from this, two more important things that we should be always cautious about before submitting a research paper for publication are i) a publication in a fake journal and ii) plagiarism and self-plagiarism. Both of them can endanger us academically and/or professionally. That is, the effort and time that we invest in carrying out research will be wasted if we get our research paper/s published in a fake journal. Similarly, plagiarized content in our research manuscript/paper reflects academic theft, which leads to a bad impression of ourselves and our work. We will learn more about plagiarism in Section 2.2.

Many journals instruct the authors to follow the standard formats for submitting their research manuscripts. Three of such well-known, well-established, and widely accepted standard formats are i) APA format by the American Psychological Association, ii) MLA format by Modern Language Association, and iii) CMS format by Chicago Manual of Style. Each format publishes its new updated edition introducing some changes over some time. Currently, APA is running its seventh edition, MLA is running its ninth edition, and CMS is running its 17<sup>th</sup> edition. The writing style of these three formats differs from each other. Once we send our research paper for publication, it is either accepted or rejected by the journal based on the content of our research paper and the journal may suggest some important changes if needed to be implemented.

### 3.1.3 Reviewing a Research Paper

After having a glance at the three important scientific activities, that is, research, writing a research paper, and publishing a research paper, let's move to our main topic on writing a review on or reviewing a research paper. This work of reviewing a research paper can be considered taking place at two levels: i) basic level, that may be considered meant for students or beginners – which we are going to discuss in Section 2.2, and ii) higher or professional level where the experts on the review committee of the journals review the research papers before getting published (refer Section 2.3). Reviewing a research paper simply refers to the activity of evaluating a given research paper against the existing parameters set for a good or quality research paper.

As a student of psychology (or even any other field), we need to write several research papers, present them at various conferences, and publish them in some quality journals to disseminate the knowledge. For this reason, we must know the important details of the format preferred by most journals for accepting research manuscripts. The APA Style format is one of such most adopted formats. This chapter intends to help you gain the basic knowledge of the seventh edition of the APA style format and test it through the activity of reviewing a research paper at the students' or beginners' level. This activity will also help you understand how to evaluate a research paper against various basic and important parameters of research documentation.

### **3.1.4 Difference Between Reviewing A Research Paper and Writing A Review Paper or a Literature Review**

The term ‘review’ is very common in the research field and appears to be confounding when used in the research documentation context. As a result, reviewing a research paper and writing a review paper (or literature review) may be perceived as the same. And there are chances that they may be mixed up easily with each other. However, one must have a clear understanding that these three writing activities are different from each other. This chapter also attempts to rule out this misperception to avoid any further chaos in this regard. Here is a brief description provided of each of these three activities:

#### **a) Reviewing a research paper:**

As we have already discussed in the previous sections, reviewing a research paper deals with evaluating any research paper based on whether it has followed the guidelines of APA style format and whether the basic important elements of the research are specified appropriately (e.g. variables studied – independent, dependent, control, etc., literature emphasizing the relevant previous important studies, generalizability and replicability of the research study being evaluated).

#### **b) Writing a review paper/article:**

A review paper/article is the one that reviews or synthesizes the findings from primary research studies. This type of paper deals with literature reviews and meta-analyses (quantitative or qualitative) (APA, 2020). Thus, it is also called a literature review that presents an overview of the current thinking on the theme, but does not present new experimental results.

Though different, a similarity between reviewing a research paper and writing a review paper/ article or a literature review is that both activities do not produce any original findings. So, as a researcher, it is very important to be aware and clear of this basic difference between these three research-related concepts or terms to avoid any confusion in the future.

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## **3.2 WHAT IS THE APA STYLE FORMAT?**

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The previous section underlines the fact that knowing the different style formats (i.e., APA, MLA, and CMS) is one of the important requirements of research publication guiding the researchers on how to write research manuscripts. We need to understand such different Style formats with their guidelines to write research papers as well as the basic elements of the research papers in order to understand how to evaluate them. The APA Style format by American Psychological Association (APA) is widely used by various Indian as well as international journals. It is also adopted by many universities/academic institutes across the world for research documentation. The APA Style format provides a set of guidelines that help achieve excellence with clear and precise scientific writing in an organized way. It also assures uniformity and consistency for the readers to enable them to focus on the key points with ease. Let us understand the various guidelines offered by the APA Style format.

### 3.2.1 The Guidelines of the APA Style Format to write a Research Paper

For reviewing any research paper, we also need to know the format that is preferred by the journals. Therefore, we will discuss here the **seventh edition** of the APA Style format that is running currently. The APA Style format offers extensive guidelines for scientific writing with a wide coverage touching the areas like types of research papers, content from the printed media, website, or any other social media. Since this is the beginning for you on this research-related topic, we will focus only on the basic elements of this style format as much as possible and only for research papers. In general, APA specifies the guidelines for i) paper format, ii) in-text citations, iii) mechanics of style, iv) tables and figures, v) bias-free language, vi) references, vii) grammar, and viii) publication process. Here, we will focus on the first four of these categories that will be helpful to us in reviewing the paper at the beginners' level. The rest of the four categories can be focused on during your masters' course. Also, more details on the elements from each of these can be sought from the authentic "*Publication Manual of the American Psychological Association, Seventh Edition*" by the American Psychological Association (APA, 2020) or its official website/page <https://apastyle.apa.org>. Let's begin with understanding the first four categories.

#### A) Paper format:

The APA Style paper format follows the guidelines for the following sections:

- i) **Order of pages:** The basic elements of any research paper include the i) title page, ii) abstract, iii) main/bodytext, iv) references, v) footnotes, vi) tables, vii) figures, and viii) appendices. Each section should be started on a new page generally while writing research manuscripts. These sections usually do not appear on the separate pages in the already published or printed research articles in the journals. However, journals following the APA Style format are bound to follow the same order of the sections for any research paper.
- ii) **Title Page:** Here are the basic important elements of the title page for research papers along with their specification.
  - **Title:** A title should be focused and should include the key terms. It appears in bold font and capitalized major words (such as nouns, verbs, adjectives, adverbs, pronouns – excluding words like “on”, “of”, “and”, etc.) in the centre of page three or four lines down from the top of the title page. There is no limit for maximum length for the title. Subtitles, if any, should be placed on double-spaced lines if desired.

#### *Example 2.1:*

A Preliminary Study of Factors Affecting Adherence to Medication in Clinic Children with Attention-Deficit/Hyperactivity Disorder

- **Name/s of the author/s (the byline):** It appears in the centre of the page below the research title with one double-spaced blank line between the title and author names. Separate the names of the authors with the word “and”, when there are **two authors**.

*Example 2.2:*

Research Paper Title

Author, A. A. and Author B. B.

- Separate the names of the authors with a comma and use the word “and” before the last author’s name, when there are **three or more authors**.

*Example 2.3:*

A Preliminary Study of Factors Affecting Adherence to Medication in Clinic Children with Attention-Deficit/Hyperactivity Disorder

Shitoley, P., Agarwal, V., and Chamoli, S.

- Use **superscript numerals** after author names to connect the names to the appropriate affiliations when mentioning different authors with different affiliations. Do not use superscript numerals when mentioning all authors with the same affiliation.

*Example 2.4:*

Research Paper Title

Author, A. A.<sup>1</sup> and Author, B. B.<sup>2</sup>

- **Author affiliation:** It appears in the centre of the page right below the author/s name/s with double-spacing. The institution at which the research was conducted, including both the name of the department and the name of the college, university, or any other institution separated by a comma (e.g. IDOL, University of Mumbai).
- In the case of multiple affiliations, each affiliation is to be placed on its own line. Use **superscript numerals** before affiliation to connect the affiliation to the appropriate author/s when mentioning different authors with different affiliations (e.g. <sup>1</sup>IDOL, University of Mumbai, <sup>2</sup>Department of Applied Psychology, University of Mumbai). A detailed example of this is presented below:

*Example 2.5:*

A Preliminary Study of Factors Affecting Adherence to Medication in Clinic Children with Attention-Deficit/Hyperactivity Disorder

Shitoley, P.<sup>1</sup>, Agarwal, V.<sup>1</sup>, and Chamoli, S.<sup>2</sup>

<sup>1</sup>Department of Psychiatry, CMS (formerly King George's) Medical University UP, Lucknow

<sup>2</sup>Manning Mental Health Services, HNEAHS, NSW, Australia.

- Do not use superscript numerals when mentioning all authors with the same affiliation.
- **Author note:** It appears In the bottom half of the title page in the centre with the bold label “Author Note” and paragraphs in the note aligned to the left. It may include more such information as i) author/s ORCID iDs, if any; ii) presence or absence of conflicts of interest between the authors over the research topic; iii) study registration information.
- **Running head:** It is a short version of the research paper title (up to 50 characters only, including spaces and punctuation) in all capital letters, without any label as “Running head:”, aligned to the left margin in the page header (throughout the research paper), including the title page.No abbreviations should be used, except the ampersand symbol (&) for “and”.

*Example 2.6:*

FACTORS AFFECTING ADHERENCE TO  
MEDICATION  
IN-CLINIC CHILDREN WITH ADHD

A Preliminary Study of Factors Affecting Adherence to Medication in Clinic Children with Attention-Deficit/Hyperactivity Disorder

Shitoley, P.<sup>1</sup>, Agarwal, V.<sup>1</sup>, and Chamoli, S.<sup>2</sup>

<sup>1</sup>Department of Psychiatry, CMS (formerly King George's) Medical University UP, Lucknow

<sup>2</sup>Manning Mental Health Services, HNEAHS, NSW, Australia.

- **Page number:** It appears In the top right corner of the page header opposite the running head (throughout the research paper).The title page should be numbered as 1.



*Example 2.7:*

FACTORS AFFECTING ADHERENCE TO MEDICATION  
IN-CLINIC CHILDREN WITH ADHD

A Preliminary Study of Factors Affecting Adherence to Medication  
in Clinic Children with Attention-Deficit/ Hyperactivity Disorder

Shitoley, P.<sup>1</sup>, Agarwal, V.<sup>1</sup>, and Chamoli, S.<sup>2</sup>

<sup>1</sup>Department of Psychiatry, CMS (formerly King George's)  
Medical University UP, Lucknow

<sup>2</sup>Manning Mental Health Services, HNEAHS, NSW, Australia.

iii) **Font:** The seventh edition of the APA style format recommends specifically the following fonts because they are legible and widely available. Also, they include special characters, such as math symbols and Greek letters that are generally required to express the results in APA style after the statistical analysis. Here are the font specifications in detail considering the different parts of the research paper (font size of different fonts is mentioned in the parentheses):

- **Sans Serif fonts:** “Ariel” (11), “Calibri” (11), “Lucida Sans Unicode” (10); and
- **Serif fonts:** “Times New Roman” (12), “Georgia” (11), “Normal” (10), “Computer Modern” (the default font for LaTeX)
- **Font for figures/ images:** Sans Serif font with a type size between 8 and 14
- **Font for computer codes:** A monospace font such as “Lucida Console” (10) or “Courier New” (10)
- **Font for footnotes:** Default font settings of the footnote function from the word-processing program without any changes in the text font (i.e., slightly smaller than the general text body) and line spacing.

iv) **Page header:** It appears within the top margin of every page of the paper.

The page header consists of the page number and running head. The guidelines for the page numbers and running head as a part of page headers have already been specified in the sub-section of the “title page” of paper format (**Example 2.7**).

v) **Line spacing:** All parts of the research paper should be double-spaced, including the abstract, text, block quotations, table and figure numbers, titles, notes, and reference list. No extra space should be given before and after paragraphs.



vi) **Margins:** In general, the 1-inch margin on every side of the page of the research paper.

vii) **Paragraph alignment and indentation:** All body or main text should be aligned to the left margin, while the right margin should be left uneven. Fully justified alignment should not be used. Hyphens (“-“ manual breaks) should not be inserted in words at the end of the line unless they are automatically inserted by the word-processing program (e.g., in long hyperlinks, such as DOI or URL). The first line of each paragraph of text should be indented 0.5-inch from the left margin by using the tab key or the automatic paragraph-formatting function of the word-processing program for indentation with the default setting of the same measure. The space bar should not be used to create an indentation. Title page, section labels, abstract, block quotations, headings, tables and figures, reference list and appendices are some exceptions to paragraph-formatting requirements.

viii) **Headings:** Headings play an important role by helping us identify the content within the sections of a research paper. Therefore, headings should be descriptive and concise. They should be well formatted and worded so clearly to enable readers of all abilities. The APA Style format offers a more flexible, updated heading format in terms of hierarchy (**Table 2.1**), ranging from Level 1 as the highest or main level of heading to Level 5 as the lowest level of heading in the research paper. This heading format offers ease in reading the research papers that are lengthy and display the complex research work.

**Table 2.1: Hierarchy APA Style Format guidelines for Different Heading Levels**

Level	Format of Heading (and when to use?)
1	Centred, Bold, Title Case Heading The text begins as a new paragraph. (Use it when only one level of heading is needed.)
2	Flush Left, Bold, Title Case Heading The text begins as a new paragraph. (Use it along with Level 1 heading when two levels of heading are needed.)
3	<i>Flush Left, Bold Italic, Title Case Heading</i> The text begins as a new paragraph. (Use it along with Level 1 and 2 of heading when three levels of heading are needed.)
4	Indented, Bold, Title Case Heading, Ending With a Period. The text begins on the same line and continues as a regular paragraph.

Level	Format of Heading (and when to use?)
	(Use it along with Level 1, 2, and 3 of heading when four levels of heading are needed.)
5	<i>Indented, Bold Italic, Title Case Heading, Ending With a Period.</i> The text begins on the same line and continues as a regular paragraph. (Use it along with Level 1, 2, 3, and 4 of heading when five levels of heading are needed.)

{**Source:** American Psychological Association. (2019, September). APA Style. Retrieved from <https://apastyle.apa.org/style-grammar-guidelines/paper-format/headings>.}

**Table 2.1** suggests that the use of the levels of heading will depend on the levels of headings required in the content. Short research papers may not require any headings. Here are a few guidelines for using the levels of headings appropriately:

- Use only the number of headings necessary to differentiate distinct sections in the research paper.
- Avoid having only one subsection heading within a section as shown in an outline, when there are multiple subsections.
- Do not label headings with numbers or letters in a research paper (such a numbering format is used while writing a book).
- Double-space headings and do not switch to single spacing within headings.
- Do not add blank lines above or below headings, even if a heading falls at the end of a page.

## **B) In-Text Citations:**

The APA Style in-text citations format imparts knowledge about the following eight sections:

### **i) Basic principles of citations:**

The in-text citation system used in APA Style includes a brief in-text author- date citation that directs readers to a full reference list entry. The in-text citation appears within the body of the research paper, or even in a table, figure, footnote, or appendix. It is briefly the cited work by its author/s and date of publication. Each work cited in the body text must appear in the reference list in alphabetical order, and each work in the reference list must be cited in the text (or in a table, figure, footnote, or appendix). Paraphrases and quotations both require citations. Here are a few guidelines for in-text citations:

- Ensure the spelling of author names and the publication dates in reference list entries match those in the corresponding in-text citations.
- Cite only works that have been read and ideas that have been incorporated into writing.
- Include only those citations needed to support the immediate point rather than including a long string of citations.
- Cite primary sources when possible, and cite secondary sources carefully.
- Cite sources to document all facts and figures that are mentioned and not a part of common knowledge (e.g., “sky is blue” is a part of common knowledge and does not require any sources”).
- Provide an author-date citation for the work as well as information about the specific part in order to cite a specific part of a source.
- Credit even the sources in the text that cannot be retrieved maybe because they are personal communications or other such reasons. Do not use online sources that are no longer recoverable.

**ii) Appropriate level of citation:**

The sources should be cited depending on the purpose of the research work.

Most papers require one or two of the most representative sources for each key point. On the other hand, literature review papers typically need an exhaustive list of references. While using an in-text citation to credit the sources appropriately, authors should follow the guidelines mentioned below:

- Paraphrasing the ideas of others, that is, stating them in own words.
- Directly quoting the words of others.
- Referring to data or data sets.
- Reprinting or adapting a table or figure, even images from the internet that are free or licensed in the “Creative Commons”.
- Reprinting a long text passage or commercially copyrighted test item.
- Avoiding under- and over-citation of the sources to avoid possible chances of plagiarism and/or self-plagiarism or unnecessary distraction.

### iii) **Plagiarism and Self-Plagiarism:**

**Plagiarism** refers to the act of presenting the content (i.e., words, ideas, or images) of another as one's own. It is a deliberate or unintentional way of i) denying the due credit of the authors for that particular content, ii) violating ethical standards in scholarship, iii) disrespecting and disregarding unfairly the efforts of original authors by failing to acknowledge their contributions, and iv) restraining further research by preventing readers from tracing ideas back to their original sources.

On the other hand, **self-plagiarism** is the presentation of one's own previously published work as original. Self-plagiarism can lead to i) deception of the readers by making it appear that more information is available on a topic than it exists, ii) an impression that findings are more replicable than it is in reality, or particular conclusions are more strongly supported than is warranted by the evidence, and iii) copyright violations if the same work is published with multiple publishers, which is known as duplicate publication.

Here are a few guidelines to avoid both plagiarism and self-plagiarism:

- Provide appropriate credit to the sources by adding author-date in-text citations for direct quotations and ideas (e.g. proponents of the original theories).
- Give credit to the authors of the original study after modelling a study based on that.
- Seek permission from the copyright holders whenever required to use the materials and provide more comprehensive credit in the form of copyright attribution for reprinting or adapting tables, figures, and images or reprinting long quotations or commercially copyrighted test items (e.g. even the images from the internet that are free or licensed in the Creative Commons).

Both plagiarism and self-plagiarism are considered unethical acts and academic theft which leads to a bad impression of ourselves and our work. However, the minor error which may be attributable to even an editorial oversight, rather than an intentional attempt to steal someone's ideas, may not be considered as plagiarism in case of incorrect in-text citations (e.g. misspelling an authors' name, forgetting or mistyping an element in a reference list entry, or citing a source in the text that does not have a corresponding reference list entry). Thus, as researchers, we must take care of even such minor mistakes not to occur. Any written material produced by us must be free of plagiarism and self-plagiarism as such activities are not acceptable practices in scientific writing.

#### iv) Paraphrasing:

Paraphrasing enables authors to i) restate another's idea (or even their own previously published idea) in their own words, ii) summarize and synthesize information from one or more sources, iii) focus on significant information, and iv) compare and contrast relevant details. Authors must cite the original work using either the narrative (such as using the sentences like, "According to Freud (publication year), .....", or "Freud (publication year) stated that....", etc.) or parenthetical (such as "..... (Freud, publication year)) citation format. We can also provide a page or paragraph number in the citation to help interested readers locate the relevant passage within a long or complex document. It is the best exercise to read and cite the primary source directly if possible, even after reading a paraphrase of that primary source instead of using the secondary source. In the case of long paraphrases that continue for several sentences, the work that is being paraphrased should be cited in the beginning. The citation should be reintroduced if the paraphrase continues into a new paragraph.

#### v) Quotations:

A direct quotation is a way to reproduce words verbatim from another work or one's own previously published work. Paraphrasing allows us to fit the material into the context of our paper and writing style. Therefore, it is best to paraphrase sources rather than quoting them. A direct quotation can be used when i) reproducing an exact definition, ii) an author has said something memorably or concisely, or iii) one wants to respond to the exact wording. There are two types of direct quotations mentioned below: i) short quotations that include fewer than 40 words, and ii) block quotations that include 40 words or more. Here are a few guidelines for formatting short quotations and block quotations:

- **Guidelines for short quotation:** Add quotation marks ("\_\_\_") around the words and incorporate the quote into own text with no additional formatting. Do not insert an ellipsis at the beginning and/or end of a quotation unless the original source includes an ellipsis. Always include a full citation (parenthetical or narrative) in the same sentence as the quotation, including the page number (or other location information, such as paragraph number). Place a parenthetical citation either immediately after the quotation or at the end of the sentence. Include the author and year in the sentence and then place the page number or other location information in parenthesis after the quotation while placing a narrative citation. Put the page number or location information after the year and a comma if the quotation precedes the narrative citation. Put the end punctuation after the closing parenthesis for the citation, if the citation appears at the end of a sentence. Place periods and commas within closing single or double quotation marks. Place other punctuation marks inside the quotation marks only when they are part of the quoted material.

- **Guidelines for block quotation:** Do not use quotation marks to enclose a block quotation. Start a block quotation on a new line and indent the whole block 0.5-inch from the left margin. Double-space the entire block quotation. Do not add extra space before or after it. Indent the first line of each subsequent paragraph an additional 0.5-inch if there are additional paragraphs within the quotation. Cite any one of these without adding a period after the closing parenthesis in either of the following cases:
  - the source in parentheses after the quotation's final punctuation or
  - the author and year in the narrative before the quotation and place only the page number in parentheses after the quotation's final punctuation.
- **Quotations from research participants** are part of the original research.

Therefore, neither there would be a reference list entry for them in the reference list, nor such quotations should be treated as personal communications. Here are a few guidelines for formatting them as for other quotations:

- Present a quotation of fewer than 40 words in quotation marks within the text, and
- Present a quotation of 40 words or more in a block quotation indented below the text.
- While presenting such quotations state that they are from participants. For example, Participants shared their experiences, ".....".
- Follow ethical agreements while quoting research participants regarding confidentiality and/or anonymity agreed to between you and your participants during the process of seeking their informed consent.
- Take care to obtain and respect participants' consent to have their information included in your report.
- Assign pseudonyms to participants, obscure identifying information, and/or present collective information to disguise participant information.

**vi) Personal communications:**

Personal communications are the cited works that cannot be recovered by readers. They include emails, text messages, online chats or direct messages, personal interviews, telephone conversations, live speeches, unrecorded webinars, unrecorded classroom lectures,

memos, letters, messages from non-archived discussion groups or online bulletin boards, etc. Here are a few guidelines to use personal communications as citations:

- Use personal communication citation only when the recoverable source is not available. For example, if a topic is learned via a classroom lecture, the lecture can be cited as a personal communication only if that lecture is not based on any research and its content is not published anywhere.
- Cite communications that are recoverable only in an archive as archival materials.
- Directly quote the information acquired by interviewing the research participants as a part of the original research. Do not use a personal communication citation.
- Cite the personal communications in the text only. Do not include them in the reference list, because readers cannot retrieve the information from personal communications.

**vii) Secondary sources:**

A primary source in scholarly work refers to the one that reports original content, while a secondary source refers to the content first reported in another source. Secondary sources should be cited concisely when i) the original work is out of print, ii) unavailable, or iii) available only in a language that we do not understand. As a good scholarly practice, whenever possible, we should find the primary source, read it, and cite it directly rather than citing a secondary source. Here are a few guidelines for citing a secondary source:

- Provide an entry in the reference list for the secondary source that is used.
- Identify the primary source from the text and write “as cited in” the secondary source that is used.
- Include the primary source in the text citation also if the year for the source is known.
- Omit the primary source from the in-text citation if its year of publication is unknown.

**viii) Classroom or intranet sources:**

The citations of some works are affected by the type of audiences as they are recoverable only by those audiences. For example, sources such as classroom websites or learning management systems that are recoverable only by the instructor and fellow students can be cited only by students who are writing a paper for a course assignment.



### C) Mechanics of Style:

Mechanics of style ensure clear, consistent communication and presentation in written works. The style guidelines enable to avoid inconsistencies among and within academic papers, journal articles, and book chapters. This section provides information and guidelines on the following seven sections:

- i) **Punctuation:** Punctuation enables the readers to understand where to pause, stop or take a diversion. It usually indicates a pause in thought when used in a sentence. Thus, different kinds of punctuation indicate different kinds and the length of pauses. For example, comma, semicolon, and colon indicate where to pause; period and question mark indicate where to stop; dash, parentheses, and square brackets indicate where to take a diversion. A few and important guidelines have been specified below:
  - Do not overuse or underuse various kinds of punctuation marks.
  - Reword the sentence or split the sentence into multiple shorter sentences, if the punctuation within a sentence makes it challenging and complex to read.
- ii) **Spelling and hyphenation:** Authors should use consistent **spellings** for terms within and across works. In general, spellings in APA Style papers should match those given in the Merriam-Webster.com Dictionary, while the spellings of psychological terms should match those given in the APA Dictionary of Psychology. Here are a few guidelines for using spellings and hyphenation:
  - Consult one of the above mentioned two dictionaries for proper spellings (including those of some common technology terms), hyphenation, capitalization, used in APA style.
  - Follow the spelling in the APA Dictionary of Psychology, if a word appears differently in these two dictionaries.
  - Consult an unabridged edition of Webster's dictionary if a word is not in either of these dictionaries.
  - Select one of the choices offered for spelling and use it consistently throughout the paper.
  - Follow the hyphenation, like spellings of the compound words, that may be written in different ways, as shown in the Merriam-Webster.com Dictionary and the APA Dictionary of Psychology to determine how to spell and hyphenate words in APA style papers.



The general rules for **hyphens** apply to two types of words: i) temporary compound words that do not appear in the dictionary, and ii) words with prefixes and suffixes. The rules are specified below:

- Use hyphens in temporary compound words to prevent misreading. For example, use a hyphen if a compound adjective appears before a noun (e.g., decision-making behaviour, high-anxiety group).
- Do not use a hyphen unnecessarily if the compound adjective appears after the noun (e.g., behaviour related to decision making, a group with high anxiety).
- Write words with prefixes and suffixes without a hyphen according to APA style. A few examples of this are antisocial, nonsignificant, prosocial, postgraduate, etc.

**iii) Capitalization:** As per the APA Style format, words are lowercase unless there is specific guidance to capitalize them. For example, capitalize the first word of a sentence, unless the sentence begins with the name of a person whose name starts with a lowercase letter. The APA Publication Manual guides on how to use capitalization in i) words beginning a sentence, ii) proper nouns and trade names, iii) job titles and positions, iv) diseases, disorders, therapies, theories, and related terms, v) titles of works and headings within works, vi) titles of tests and measures, vii) nouns followed by numerals or letters, viii) names of conditions or groups in an experiment, and ix) names of study factors, variables, and effects. Here are a few guidelines on capitalizing the words:

- **Proper nouns:** Capitalize proper nouns in APA Style that include –
  - the specific names of people, places, and things,
  - names of racial and ethnic groups, religions, castes, etc. (e.g., African American, Asian American, Black, White, Hispanic, Christian, Muslim),
  - trade names (e.g., brand names of medications),
  - job titles or positions (only when they precede a name of person, place, or thing, etc., such as “University of Mumbai” and “a university”, “Department of Psychology” and “a psychology department”, and so on).
- **Diseases, disorders, therapies, and more:**
  - Do not capitalize the names of diseases, disorders, therapies, treatments, theories, concepts, hypotheses, principles, models, and statistical procedures (e.g., autism spectrum disorder, anorexia nervosa, major depressive disorder, lung cancer, etc.)

- Do capitalize personal names that appear within these kinds of terms. For example, Alzheimer's disease, Rett syndrome, Maslow's hierarchy of needs, Freudian theory, etc.
- **Title and sentence case capitalization:**
  - Two types of capitalization used in APA Style include titles of works (e.g., paper titles) and headings within works (title case and sentence case).
  - In the title case, major words are capitalized, and most minor words are lowercase.
  - In sentence case, most major and minor words are lowercase. Proper nouns are an exception as they are always capitalized.
  - Major words include nouns, verbs (including linking verbs), adjectives, adverbs, pronouns, and all words of four letters or more.
  - Minor words include short (i.e. three letters or fewer) conjunctions, short prepositions, and all articles.
- **Title case capitalization:** Capitalize the following words in a title or heading:
  - the first word of the title or heading, even if it is a minor word, such as "The" or "A".
  - the first word of a subtitle.
  - the first word after a colon, em dash, or end punctuation in a heading
  - major words, including the second part of hyphenated major words (e.g., "Self-Report", not "Self-report")
  - words of four letters or more (e.g., "With", "Between", "From")
- Lowercase only minor words that are three letters or fewer in a title or heading (except the first word in a title or subtitle or the first word after a colon, em dash, or end punctuation in a heading):
  - short conjunctions (e.g., "and", "as", "but", "for", "if", "nor", "or", "so", "yet").
  - articles ("a", "an", "the")
  - short prepositions (e.g., "as", "at", "by", "for", "in", "of", "off", "on", "per", "to", "up", "via").

- **Use title case for:**
  - the titles of articles, books, reports, and other works appearing in the text
  - the titles of tests or measures, including subscales (e.g., Beck Depression Inventory-II)
  - all headings within a work (Levels 1 to 5 and they are bold or bold italic)
  - the title of your own paper and named sections and subsections within it.
  - the titles of periodicals, which are also italicized.
  - table titles, which are also italicized
  - figure titles (which are italicized), axis labels, and legends.
- **Sentence case capitalization:**
  - Lowercase most words in a title or heading.
  - Capitalize only i) the first word of the title or heading, ii) the first word of a subtitle, iii) the first word after a colon, em dash, or end punctuation in a heading, iv) nouns followed by numerals or letters, and v) proper nouns (such as the names of racial or ethnic groups).
  - Use sentence case for i) titles of articles, books, reports, webpages, and other works in reference list entries, even if title case was used in the original work, ii) table column headings, entries, and notes, and iii) figure notes.

**iv) Numbers:** Numbers in all sorts of scholarly works (whether empirical or non-empirical research) are used to report the numerical information, such as i) the number of participants, their demographic information (e.g., age), and ii) the results of statistical analyses. Even while conducting a literature review or writing a response paper one may need to report numerical information (e.g., the percentage of people diagnosed with a particular disease or disorder). Thus, the number usage help researchers make their papers more consistent and readable. In general, numbers are expressed in words and numerals. Here are the guidelines to use numbers in general and with exception:

- **Numbers in words:** Numbers zero through nine are expressed in words (e.g., five nurses, three conditions). In some cases, even numbers 10 and above are expressed in words. Here are a few examples:

i) numbers that begin a sentence, title, or heading (when possible, reword the sentence to avoid beginning with a number):

Example: Fifty percent of the patients received the intervention, and the other 50% were part of a control condition.

ii) common fractions:

Examples: One-fifth of the class, two-thirds majority

iii) certain universally accepted phrases:

Examples: Twelve Apostles, Five Pillars of Islam

- **Numbers in numerals:** Numbers 10 and above are expressed in numerals (e.g., students from 10<sup>th</sup> and 12<sup>th</sup> grade, the study had 40 participants). Some more cases in which even numbers zero through nine are expressed in numerals are mentioned below with examples in parentheses:

a) numbers that immediately precede a unit of measurement (e.g., 5-mg dose, 3 cm),

b) statistical or mathematical functions (e.g., multiplied by 2),

c) fractions or decimals (except common fractions) (e.g., 1.5, 2.27),

d) percentages (e.g., 50%, 75%-80%),

e) ratios (e.g., 4:1 ratio),

f) percentiles and quartiles (e.g., the 5<sup>th</sup> percentile, the 95<sup>th</sup> percentile, the 3<sup>rd</sup> quartile),

g) times and dates (including approximations of time) (e.g., 30 s, 10 min, 3 hr, 2 days, approximately 4 months, 2 years, about 6 years ago, 3 decades, 12:30 a.m., 6 p.m.),

h) ages (e.g., 5 years old/5-year-olds, 18 years old/18-year-olds),

i) scores and points on a scale (e.g., scored 3 on a 5-point scale),

j) exact sums of money (e.g., Rs. 10),

k) numerals as numerals (e.g., the numeral 2 on the keyboard),

l) numbers denoting a specific place in a numbered series when the number comes after the noun: Capitalize the

noun before the number even for books and tables (e.g., Step 1, Chapter 1),

m) numbers after a noun (e.g., Year 5, Grade 5, Step 1, Level 4, Item 3, Question 2),

n) **numbers before a noun** (e.g., the 5<sup>th</sup> year, the fifth grade, the first step, the fourth level, the third item, the second question).

**Do not capitalize the abbreviations for the page(s) or paragraph(s)** even when they are followed by a numeral (e.g., p.3, pp. 2-5, para. 0, paras. 1-4).

- v) **Italics and quotation marks:** **Italics** are used to draw attention to key terms and phrases when providing definitions and to format parts of reference list entries (e.g., titles of books). On the other hand, **quotation marks** are used to present linguistic examples and titles of book chapters and articles in the text. Thus, the use of italics and quotation marks makes the research paper appear more consistent and readable. We have seen before how to use quotation marks when presenting quotations (Section B In-Text Citation category).

- **Guidelines for when to use italics**(with examples):

i) first use of key terms or phrases often accompanied by a definition Example: *Mindfulness* is defined as “the act of.....”.

ii) titles of books, reports, webpages, and other stand-alone works Example: *Assessment and treatment of.....*

iii) titles of periodicals and periodical volume numbers (but not the comma between them) Example: *American Journal of Nursing*, 119(9), 47-53.

iv) English letters used as statistical symbols or algebraic variables Example: *M*, *SD*, *t*, Cohen’s *d*, etc.

v) anchors of a scale (but not the associated number)

Example: a Likert scale where 1 = *strongly disagree* to 5 = *strongly agree*,

vi) first use of words, phrases, or abbreviations from another language with which readers may not be familiar (however, do not italicize the term if it appears in a dictionary for the language in which you are writing)

Example: Their favourite term of endearment was *mon petit chou*.

- **Guidelines for when not to use italics** (with examples):

- i) Titles of book series (e.g., the Harry Potter series),
- ii) punctuation mark after an italicized word or phrase or between elements of a reference list entry. For example, the comma after a periodical title or issue number, the period after a book title (e.g., *Journal of Abnormal Psychology*, 128(6), 510-516),
- iii) words, phrases, and abbreviations of foreign origin that appear in a dictionary for the language in which you are writing (e.g., a posteriori, a priori, per se).

- **Guidelines for italics for emphasis:** In general, avoid using italics for emphasis and rewrite your sentence to provide emphasis. Place important words or phrases at the beginning or end of a sentence instead of in the middle, or break long sentences into several shorter sentences. Use italics if an emphasis might otherwise be lost or the material might be misread. Place the words “[emphasis added]” in square brackets after the words are italicized, if the emphasis is added to a direct quotation.
- **Guidelines for reverse italics:** It refers to the condition where words are to be set in standard (non-italic) type when they already appear within the text as italicized as they normally should appear. For example, use standard type for the symbol if an italic symbol appears in a table title (which is also italicized).
- **Guidelines for when to use the quotation marks** (with examples): Use double quotation marks in the text to—

- i) refer to a letter (e.g., the letter “j”), word (e.g., the singular “they”), phrase (e.g., answered “yes” to the question), or sentence as a linguistic example or as itself (e.g., Students wrote “I promise to uphold the honour code” at the top of the test page).
- ii) present stimuli in the text (long lists of stimuli may be better presented in a table, where quotation marks are not needed)  
  
Example: The stimulus words were “groceries”, “cleaning”.
- iii) reproduce material from a test item or verbatim instructions to participants (if instructions are long, present them in an appendix or set them off from the text in block quote format)  
  
Example: The first item “How often do you feel happy with your body?”

- **Guidelines for when not to use quotation marks**(with examples): **Do not** use double quotation marks in the text to:

- i) highlight a key term or phrase (e.g., around for which you are going to provide a definition). Use italics to highlight such a term or phrase

Example: *Mindfulness* is defined as .....

- ii) identify the anchors of a scale. Use italics to highlight such anchors

Example: A Likert scale where 1 = *strongly disagree* to 5 = *strongly agree*),

- iii) refer to a numeral as itself because the meaning is sufficiently clear without quotation marks

Example: The numeral 2 was displayed onscreen), and

- iv) hedge or downplay meaning (do not use any punctuation with these expressions)

Correct example: The teacher rewarded the class with tokens;

Incorrect example: The teacher “rewarded” the class with tokens.

- vi) **Abbreviations:** Abbreviations are shortened forms of a word or phrase that are often composed of the first letter of each word of the phrase (i.e., acronym). Most abbreviations must be defined (explained) in an APA Style paper upon first use. A few guidelines for using abbreviations are mentioned here:

- **General guidelines:** Use abbreviations concisely to maximize clarity. Consider readers’ familiarity with the abbreviations before using them in order to facilitate communication. Use an abbreviation if i) it is conventional and readers are likely to be more familiar with it, and ii) it is considerable space can be saved and cumbersome repetition avoided. Do not use periods with abbreviations in APA Style (e.g., write “FBI” and “PhD”, not “F.B.I.” and “Ph.D.”).
- **Guidelines for definitions of abbreviation:** Ensure neither too many nor too few abbreviations in a paper. Avoid both the overuse and underuse of abbreviations. Use the abbreviation at least three times in a paper when any term is abbreviated to help readers understand considering their difficulty remembering it. A clearer and concise standard abbreviation for a long, familiar term can be used fewer than three times as an exception to the general rule. Present both the full version of the term and the

abbreviation in all capital case in the parentheses after it when using a term to be abbreviated for the first time. For example, posttraumatic stress disorder (PTSD). Include the citation after the abbreviation, separated with a semicolon, if the citation accompanies an abbreviation. Do not use nested or back-to-back parentheses.

*Example 2.8:*

Narrative format: Clinician-Administered PTSD Scale for DSM-5 (CAPS-5; Weathers et al., 2018)

Parenthetical format: (Clinician-Administered PTSD Scale for DSM-5 [CAPS-5]; Weathers et al., 2018).

Do not define the abbreviation in the heading when the full version of a term appears for the first time in a heading. Define it when the full version next appears. Use abbreviations in headings only if the abbreviations have been previously defined in the text or if they are listed as terms in the dictionary. Define the abbreviation on first use in both places if it has appeared in the abstract as well as the text. Use only the abbreviation after you define it. Do not alternate between spelling out the term and abbreviating it. Do not define very common abbreviations in an APA Style paper which the readers are sure to be familiar with.

Here are some kinds of abbreviations which should not be defined:

- **Abbreviations listed as terms in the dictionary** (e.g., AIDS, IQ)
- **Measurement abbreviations** (e.g., kg, cm)
- **Time abbreviations used with numerical values** (e.g., 5 hr, 30 min)
- **Latin abbreviations** (et al., i.e., e.g., etc.)
- **Statistical abbreviations** (e.g., *M*, *SD*, *SE*, *t*, etc.)

Define all those abbreviations which some readers may be familiar with, while others may not (e.g., “RT” for reaction time or “ANOVA” for analysis of variance).

- **Guidelines for group author abbreviations:** The name of the group can sometimes be abbreviated if a reference has a group author and is well-known. For example, “American Psychological Association” can be abbreviated to “APA” to avoid cumbersome repetition. Provide the full name of the group on the first mention in the text, followed by the abbreviation. Include the abbreviation before the year in parentheses, separated with a comma if the group name first appears in a narrative citation.



**Example 2.9:**

The American Psychological Association (APA, 2017) provided information on overcoming opioid abuse.

Include the abbreviation in square brackets, followed by a comma and the year if the group name first appears in a parenthetical citation. Spell out the full name of the group as presented in the source. Do not abbreviate the group author name in the reference list entry. Introduce the abbreviation only once in the text if several references have the same group author. Spell out each name of the two different groups with the same abbreviation every time (e.g., the American Psychological Association and the American Psychiatric Association abbreviating to “APA”) if both the groups are cited in the paper. Do not use the abbreviation in such cases as it would be unclear which APA is meant within the context of the paper.

- **Guidelines for Latin abbreviations:** Use the standard Latin abbreviations only in parenthetical material. Use the translation of the Latin terms in the narrative. Punctuate as if the abbreviation were spelt out in the language in which paper is being written in both cases.

**Example 2.10:**

A few standard Latin abbreviations with their meanings in the parentheses:

cf. (compare), e.g., (for example), etc. (, and so forth), i.e., (that is,),

viz., (namely,), vs. (versus or against)

Use the abbreviation “e.g.,” including a comma before the examples while giving a list of examples within parentheses. Do not use the abbreviation “e.g.,” if the words “for example” appear outside the parentheses. Some **exceptions** to the use of Latin abbreviations:

- Use the abbreviation “v.” Instead of “vs.” In the title or name of a court case in the reference list and all in-text citations. For example, Brown v. Board of Education (not Brown vs. Board of Education).
- Use the Latin abbreviation “et al.” (which means “and others”) in both narrative parenthetical citations.
- Do not use the abbreviation “ibid.” as it is not used in APA Style.

**vii) Lists:** Lists help the authors make their research papers more consistent and readable. Like heading structure, they help readers understand a related set of key points within a sentence or paragraph. Most lists are simple lists. APA Style also supports the use of lettered lists, numbered lists, and bulleted lists. The general guideline for lists asks to ensure all items are synthetically and conceptually parallel. Here are guidelines for different types and other aspects of lists:

- **Guidelines for lettered lists:**

- Use a serial comma before the final item when a list within a sentence contains three or more items.

***Example 2.11:***

The information was gathered regarding participants' age, gender, and socioeconomic status.

- Use semicolons instead of commas between the items if the list of three or more items already contains commas

***Example 2.12:***

The participants were divided by age into categories of young adults, which included people between the ages of 18 and 40 years; middle-aged adults, which included people between the ages of 40 and 60 years; and older adults, which included people between the ages of 60 years and older.

- Use lowercase letters in parentheses before each item to draw more attention to the items and help readers understand the separate, parallel items in a complex list. Do not use numbers in parentheses.

***Example 2.13:***

Participants provided information about their (a) level of education; (b) income, specified at the family level; (c) occupation, including both specific role and industry; and (d) family size.

- Use a numbered list to display items in a numbered series. Use a bulleted list to draw visual attention to items without implying the certain orders that they follow.

- **Guidelines for numbered lists:** Use a numbered list to display complete sentences or paragraphs in a series (e.g., itemized conclusions, steps in a procedure). Use a lettered list or bulleted list rather than a numbered list if the items are phrases. Use the numbered list function of the word-processing program to create a numbered list and indent the list automatically. Select

the option for an Arabic numeral followed by a period, but not enclosed in or followed by parentheses. An example of a numbered list can be the several hypotheses in the research paper stated one below the other.

- **Guidelines for bulleted lists:** Use a bulleted list to draw visual attention to items in a list without implying a certain order that the items in the list follow. Use the bulleted list function of the word-processing program to create a bulleted list and indent it automatically with the help of symbols, such as small circles, squares, dashes, etc. Begin each item with a capital letter and finish it with a period or other appropriate punctuation if the bulleted items are complete sentences. Begin each item with a lowercase letter (except words such as proper nouns) when the bulleted items are words or phrases (but not complete sentences). Two options can be used for the punctuation of bulleted lists when the items are words or phrases:

- No punctuation after the bulleted items, including the final one when the items are shorter and simpler.

***Example 2.14:***

Poor sleep quality is associated with:

- higher levels of negative mood
- physical symptoms such as insomnia
- stress
- use of medications for persistent psychological distress (Glozier et al., 2010; Lund et al., 2010)

- To insert punctuation after the bulleted items as though the bullets were not there when the items are longer or more complex.

***Example 2.15:***

Young adults have the following motivations for texting on their smartphones:

- social connection, that is, texting as a way to connect with others;
- escapism, that is, texting to get away from dull or uncomfortable situations such as waiting in line;
- distraction, that is, texting to distract themselves while having a conversation with someone or being in a meeting;
- audacity, that is, texting to get a response from someone, such as to break up with them or ask them on a date;
- nurturing, that is, texting to foster relationships by saying things like “good morning”, etc.; and driving, that is, texting while in the vehicle (Schroeder & Sims, 2018).

## D) Tables and Figures:

A table usually shows numerical values (e.g., means and standard deviations)

and/or textual information (e.g., lists of stimulus words, responses from participants) arranged in columns and rows. On the other hand, a figure can be presented in any form, such as a chart, graph, photograph, drawing, plot, infographic, or any other illustration that is not a table.

Tables and figures enable authors to i) present a large amount of information efficiently, and ii) make their data more comprehensible. Consequently, they help readers understand the research work carried out by the researcher/s. Thus, the best tables and figures are those which are attractive and accessible to all users or readers. The APA Style guidelines for tables and figures mainly on the following elements help authors ensure clearly and consistently formatted visual displays that contribute to effective communication.

i) **Table setup:** Tables are visual displays composed of columns and rows in which numbers, texts, or a combination of numbers and text are presented. Many common kinds of tables include i) demographic characteristics tables, ii) correlation tables, iii) factor analysis tables, iv) analysis of variance tables, and v) regression tables. Here we will see the basics of the table setup:

- **Table components:** The basic components of the APA Style tables are mentioned below:
  - (a) **Number/ Table number:** It appears in bold font above the table title and body in the order in which they are mentioned in the research paper (e.g., Table 1).
  - (b) **Title:** It appears in one double-spaced line below the table number. Give each table a brief but descriptive title. Capitalize the table title in an italic title case.
  - (c) **Headings:** Tables may include a variety of headings depending on the nature and arrangement of the data. Include column headings, including a stub heading (heading for the leftmost, or stub, column). Often use the heading “Variable” for the stub column if no other heading is suitable. Capitalize the column headings in sentence case and align them to the centre of the respective column.
  - (d) **Body:** The table body includes all rows (including the headings row) and all columns of the table. A cell is the point of intersection between a row and a column. Here are a few guidelines for a body: i) Keep the table body single-spaced, one-and-a-half-spaced, or double-spaced; ii) Left-align the information in the leftmost column or

stub column of the table body (but centre the heading); and iii) In general, centre information in all other cells of the table. However, left-align the information if doing so would improve readability, particularly when cells contain lots of text.

- (e) **Note:** Note should appear below the table in three types – general, specific, and probability. Describe the contents of the table in the note that cannot be understood from the table title or body alone (e.g., definitions of the abbreviations, copyright attribution, explanations of asterisks used to indicate p values). Include table notes only as needed.
- **Principles of table construction:** Present information in a way that is easy for readers to understand. Provide sufficient information in the table itself to restrict the need for readers to read the text to understand it. Place entries that are to be compared next to each other. Place different indices (e.g., means and standard deviations) in different columns rather than in the same column. Use the same font in tables as in the rest of the research paper. Use the tables feature of the word-processing program to create tables in APA Style papers. Do not use the tab key or space bar to manually create the look of a table. A few other important guidelines are as follows:
  - **Guidelines for table borders:** Limit the use of borders or lines in a table to those needed for clarity. Use a border at the top and bottom of the table, beneath column headings, and above column spanners. Use a border to separate a row containing totals or other summary information from other rows in the table, if necessary. Do not use vertical borders to separate data. Do not use borders around every cell in a table. Use spacing between columns and rows and strict alignment to clarify relations among the elements in a table.
  - **Guidelines for long or wide tables:** Use the tables feature of the word-processing program to make the headings row repeat on the second and any subsequent pages if a table is longer than one page. Use landscape orientation to fit a too wide table on the page.
- **Placement of tables in a paper:** As mentioned in the first subsection (order of pages) of section A (page format), tables (and figures) can be placed in a paper either by embedding in the text after “called out”, or placing each table on a separate page after the reference list. Place the table at either the top or bottom of the page if the embedded table is short and is likely to take up the entire page and text may appear on the same page as the table. Do not place such tables in the middle of the page.

Add one blank-spaced line between the table and any text to improve the visual presentation.

ii) **Figure Setup:** Overall setup for both tables and figures are the same.

Figures in APA Style are all types of visual displays other than tables that include line graphs, bar graphs, charts (e.g., flowcharts, pie charts), drawings, maps, plots (e.g., scatterplots), photographs, infographics, and other illustrations. Here are the guidelines for the basics of figure setup which includes figure components, principles of figure construction, and placement of figures in a research paper:

- **Figure components:** The components of APA Style figures along with the guidelines for them are as follows:
  - (a) **Number:** Place the figure number (Eg., Figure 1) above the figure title and image in bold font. Number figures in the order in which they are mentioned in your research paper.
  - (b) **Title:** Place the figure title with one double-spaced line below the figure number. Give each figure a brief, but descriptive title. Capitalize the figure title in the italic title case.
  - (c) **Image:** Any graph, chart, photograph, drawing, or other illustration is itself the image portion. Use a sans serif font between 8 and 14 points when the text appears in the image of the figure (e.g., axis labels).
  - (d) **Legend:** Place the figure legend, or key within the borders of the figure, if used. It explains any symbols used in the figure image. Capitalize words in the figure legend in the title case.
  - (e) **Note:** It appears in three types (i.e., general, specific, and probability) below the figure to describe the contents of the figure that cannot be understood from the figure title, image, and/or legend alone (e.g., definitions of abbreviations, copyright attribution, explanations of asterisks used to indicate *p* values). Include figure notes only if required.
- **Principles of figure creation:** Presenting information in a way that is easy for readers to understand is the most important principle to follow when creating a figure. Therefore, always provide sufficient information in the figure. Ensure that some standards are followed when creating a figure, such as i) clear images; ii) smooth and sharp lines; iii) legible and simple font; iv) units of measurement provided; v) clearly labelled axes; and vi) clearly labelled or explained elements within the figure.
- **Placement of figures in a research paper:** Like tables, figures can be placed in a paper either by embedding in the text after

“called out”, or placing each table on a separate page after the reference list. Place each figure on a separate page after the reference list. An embedded figure may take up an entire page. In the case of short figures, the text may appear on the same page as the figure. In that case, place the figure at either the top or bottom of the page rather than in the middle. Also, add one blank double-spaced line between the figure and any text to improve the visual representation.

- iii) **Accessible use of colour in figures:** Though the use of colours can make the figures appear more communicative and decorative, authors seeking publication are suggested to avoid the use of colours unless needed for understanding the material. Thus, the colours can be used according to the preferences expressed by the journals, the need of understanding the material, and the media (i.e., printed or online) that is being used for publishing the research paper. Some other precautions that should be taken while using the colours in figures are i) ensuring plenty of contrast, considering people living with a colour-vision deficiency (often referred to as “colour blindness”) or people who do not see colour in a typical way, ii) using a pattern in a combination with colour to make the differentiation of elements independent of colour alone (e.g., using different colours and styles of lines in a line graph, such as solid, dashed, etc.), iii) labelling coloured areas directly in the image or using lines to connect the object to its labels.

### 3.2.2 Benefits of Reviewing a Research Paper

The scientific activity of reviewing a research paper has extensive benefits, especially when it takes place at the professional level. It is beneficial for all concerned parties: editors, authors, reviewers, and overall the researcher community as a reader. We can explore these benefits in detail in the masters’ course. At this beginners’ level, this activity has benefits that are restricted only up to you as the budding researchers. It is because, at this stage of your academic course, you may not be submitting your review to any journal as done at the professional level.

Some of the important benefits of this activity of reviewing a research paper can be listed down as follows:

- First and foremost, this activity boosts a scientific attitude in individuals.
- It boosts one’s interest in the research field by encouraging the person to know more about their interest area that they may be interested to explore as a researcher.
- It creates awareness in the individual about the development taking place in the particular area.
- It creates an opportunity for an individual to update knowledge and research skills.



- It provides an insight into the particular aspects that are neglected from the research point of view and required to study in that particular research area, which may be based on the limitations of the previously examined research paper/s.
- Thus, it increases the chances of the significant contribution/s by the individual in the research field as a researcher.

These and many other benefits at this beginners' level as well as the professional

level, that will be explored later, indicate the importance of this activity of reviewing a research paper and how it contributes to the research field.

### 3.2.3 Professional Level of Reviewing a Research Paper:

Writing a review of/ reviewing a research paper is one of the important scientific activities in the field of research for any subject, for example, psychology, political science. It is an important skill for offering service to the scientific community (Pain, 2016), and for contributing constructively to the field of research, when takes place at the professional or experts' level. At the professional level, researchers, as experts undergo these important three stages when reviewing a research paper:

- i) the stage before accepting the invitation for reviewing a research paper/ undertaking a review task,
- ii) the stage after accepting the invitation for reviewing a research paper/ working on a review task, and
- iii) the stage of submitting a review. Experts need to follow precautions at each of these stages.

We will know more about this professional level of reviewing a research paper at the masters level in detail along with the other remaining four categories (i.e., bias-free language, references, grammar, and publication process) of the APA Style format. Learning all this will be more relevant and beneficial in the masters' (M.A.) course, as you all will be moving towards the professional level of your academic course that will enable you to understand this topic more sensibly.

#### **IMPORTANT NOTE:**

1. The editions of the APA Style format and other formats keep being updated with changes. So, always refer to the current edition of such formats when engaging in writing, publishing, or reviewing a research paper.
2. Many examples mentioned in the chapter are borrowed from American Psychological Association. (2021). APA style. Available at <https://apastyle.apa.org/products/publication-manual-7th-edition>



### 3.2.4 Exercise of reviewing a research paper considering APA format

In Section 2.2.1, we learned the important details of this format. In this section, we will proceed with a small exercise in which you will be provided with a sample of the research paper to check your knowledge and clarity of that format. You have been provided with a (published) research paper for the review task as a sample. Your task is to examine the aspects of the research paper carefully based on a set of questions provided below and to see whether the elements of that paper match with the **APA style format (7<sup>th</sup> Edition)** guidelines.

**Title of the research paper:** A preliminary study of factors affecting adherence to medication in clinic children with attention-deficit/hyperactivity disorder

- By **Shitoley, P., Agarwal, V., and Chamoli, S.**

**Note:** The research paper is included in the appendix.

**Exercise 2.1:** Evaluate the given research article based on the following questions considering the **APA – 7<sup>th</sup> Edition Style Format** and other details of the research study based on the following sample questions.

Q.1 Is the research paper title appropriate as per the APA – 7<sup>th</sup> Edition Style format?

Q.2 Whether the research abstract is present in the paper and includes the keywords along with required details of the research study?

Q.3 Examine the relevance of the previous studies with the given research paper.

Q.4 Specify whether the problem studied and research objectives are mentioned.

Q.5 Specify the independent and dependent variables studied in the given research paper.

Q.6 Specify the control variables in the given research study, if any.

Q.7 Check whether all variables are operationally defined.

Q.8 Find out the procedure of selection of the participants, used in the research, if any.

Q.9 Describe the inclusion criteria for selecting the participants.

Q.10 Comment on the sample size of the research study.

Q.11 Describe the tools used to measure the variables studied in the research.

Q.12 Are the research hypothesis/es specified?

Q.13 Comment on the statistical analysis carried out in the research study.

Q.14 Are there any significant findings, based on statistical analysis?

Q.15 Comment on the generalizability and replicability of the findings from this particular research study.

Q.16 Specify the strengths and limitations of the research.

Q.17 What are the implications of this research?

Q.18 What could be other possible variables to be studied in relation to ADHD?

Remember, these are only the sample questions to give you direction on how to review the research papers. However, they provide a wide scope of learning how to review the research articles in a representative manner, irrespective of your academic course.

**Note:** The answers for these 18 questions have also been provided in the index to provide you with some basic ideas on how to review a research paper considering the important aspects.

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### 3.3 SUMMARY

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This chapter starts with understanding what is research and three important scientific activities, called research, writing a research paper, publishing a research paper, and reviewing a research paper. **Research** as an activity more than a set of skills that is a way of thinking, and it involves i) examining critically the various aspects of our day to day professional work, ii) understanding and formulating guiding principles that govern a particular procedure; and iii) developing and testing new theories that contribute to the advancement of your practice and profession (Kumar, 2011). It offers us a scientific way to find out the answer to our questions or the solution to the existing problems that we want to work on for the betterment of society or its particular segment. Thus, it is a very important activity and is undertaken in every field to upgrade and contribute to the existing body of knowledge.

**Writing a research paper or article** is a process of documenting the research study that has been carried out right from the beginning to the end. The essential elements of a research paper include abstract, introduction, a rationale and significance of the study, research problem/s, research hypotheses or questions, literature review, methodology/ method, Variables (independent, dependent, control), sample and sampling, a procedure of data collection, Statistical analysis and data interpretation, results and discussion, conclusion, limitations and practical implications. An activity of writing a research paper should be performed by explaining all these elements carefully, minutely, in detail, and yet concisely and with precision. **Publishing a research paper** is the next step that helps in disseminating the knowledge that we derived from our accomplished research work. To identify and narrow down the list of journals relevant to our research topic for publishing a research paper, some basic information should be acquired about the journals, such as i) appropriateness of the journal considering our research topic, ii) its quality, iii) its range for

publishing the research articles in terms of topics, iv) whether it is peer-reviewed, v) the number of articles/ papers accepted in a single volume/ issue of the journal, vi) its impact factor, vii) its preferred format for a research paper (whether APA, MLA, CMS). It is very important to be always cautious about a publication in a fake journal and plagiarism and self-plagiarism before submitting a research paper for publication as both can endanger us academically and/or professionally. The third important scientific activity is **reviewing a research paper** which refers to the activity of evaluating a given research paper against the existing parameters set for a good or quality research paper. This requires knowing the standard format to ensure the clarity of the content of the research paper along with its quality. Reviewing a research paper takes place at two levels, namely primary or beginners' and higher or professional level. Two other similar, yet different concepts or terms like reviewing a research paper are **writing a review paper or article** and **writing a literature review**. Writing a review paper/ article and a literature review indicate the same activity. Rather a review paper is also called a literature review. A similarity between reviewing a research paper and writing a review paper/ article or a literature review is that both activities do not produce any original findings.

Among the three standard style formats, the APA Style format by American Psychological Association (APA) is widely used by various Indian as well as international journals. It provides a set of guidelines that help achieve excellence with clear and precise scientific writing in an organized way. It also assures uniformity and consistency for the readers to enable them to focus on the key points with ease. For reviewing any research paper, we also need to know the format that is preferred by the journals. Therefore, we discussed the **seventh edition** of the APA Style format (in part) that is running currently. The APA Style format offers extensive guidelines for scientific writing. In general, APA specifies the guidelines for i) paper format, ii) in-text citations, iii) mechanics of style, iv) tables and figures, v) bias-free language, vi) references, vii) grammar, and viii) publication process. Out of these, we focused on the first four categories which are relevant at the beginners' level, while the rest of the four categories will be focused on during the masters' course, considering their relevance more with professional level.

The first category of the APA Style format called "paper format" includes seven sections or subcategories, namely, order of pages, title page, font, page header, line spacing, margins, paragraph alignment and indentation, and headings providing important guidelines for respective elements. The second category "in-text citation" includes the different sections, providing information and guidelines on the basic principles of citations, appropriate level of citation, plagiarism, paraphrasing, quotations, quotations from research participants, personal communications, secondary sources, and classroom or intranet sources. The third category "mechanics of style" specifies the guidelines for using punctuation, spelling and hyphenation, capitalization, numbers, italics and quotation marks, abbreviations, and lists. And finally, the fourth category "tables and figures" provides specifications on the table and figure setup with accessible use of colour in figures with important guidelines.

Reviewing a research paper at the beginners' level is beneficial for boosting a scientific attitude in individuals and one's interest in the research field by encouraging the person to know more about their interest area that they may be interested to explore as a researcher. It creates awareness in the individual about the development taking place in the particular area. It also creates an opportunity for an individual to update knowledge and research skills. It provides an insight into the particular aspects that are neglected from the research point of view and required to study in that particular research area, which may be based on the limitations of the previously examined research paper/s. Thus, overall it increases the chances of the significant contribution/s by the individual in the research field as a researcher.

Researchers, who review the research papers at the professional level, undergo the three stages, that is the stage before accepting the invitation for reviewing a research paper/ undertaking a review task, the stage after accepting the invitation for reviewing a research paper/ working on a review task, and the stage of submitting a review. We will learn more about these stages in detail at your masters' course.

### 3.4 QUESTIONS

Q.1 What is research? What are the different essential elements of any research paper?

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Q.2 Discuss on writing, publishing and reviewing a research paper as three important scientific activities.

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Q.3 Comment on the seventh edition of the APA Style format with reference to writing a research manuscript/ paper.

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Q.4 Write a short note on plagiarism and self-plagiarism.

Reviewing A Research Paper

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Q.5 What are the basic principles of citations?

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Q.6 Write a short note on the benefits of reviewing a research paper.

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Q.7 Considering the same research paper provided in this chapter, frame another possible set of questions based on what you learned about the APA Style format and the previous sample set of questions. You may exercise this activity by forming two groups in your classroom as a group activity, where one group will ask questions to the other group and the other group will answer those questions. The activity of questioning and answering can be interchanged between the groups. This exercise can be performed even individually.

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Q.8 Exercise the same activity with some other published research paper.

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## 3.5 REFERENCES

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### ***Exercise 2.1:*** Answers to questions for reviewing a research paper

(Note: Though some features of a research paper, such as line spacing, font or font size cannot be readily (e.g., in inch or point) estimated, you still can estimate it through observation.

1. Yes, to some extent. The research paper title appears to be three or four lines down from the top of the title page. It is not in the centre. However, it is in bold font. The title appears to be lengthy, but seems to be focused and includes the key terms. The major words in the title are not capitalized.

2. Yes. The research abstract is present in the paper. It includes the keywords and required details of research, such as background and objectives of the study, method and materials used for the research, results and conclusion.

3. Most of the previous studies referred are related to attention-deficit/hyperactivity disorder (ADHD), which is relevant to the research topic. Also, many studies referred are related to clinic children and adolescents.

4. Research problem is not specified separately. The research objective was to identify the factors affecting adherence to medication in clinic children and adolescents with ADHD.

5. This research study seems to be exploratory in nature. The dependent variable was adherence to medication in clinic children with ADHD. Independent variables are not specified, which were later examined from the results based on the proforma responded by the informants.

6. Control variables in this research study areas follows: i) the number of participants (only 24), ii) only the participants newly diagnosed with ADHD were included in the research sample. On the other hand, the children with mental age < 6 years and children with drug-induced hyperactivity and children on nonpharmacological management of ADHD were excluded from the sample.

7. Yes. Only the dependent variable was operationally defined. Since the independent variables were being explored, they were not operationally defined.

8. The sample studied was selected based on the informed consent given by the parents to participate showing their agreement for drug therapy to their children. The children with mental age < 6 years and children with drug-induced hyperactivity and children on nonpharmacological management of ADHD were excluded from the sample.

9. The inclusion criteria for selecting the participants was newly registered cases of children and adolescents from the psychiatric clinic who were diagnosed as suffering from ADHD based on DSM IV-TR criteria.

10. Sample size of 24 was very small to generalize the research findings. However, the possible reason for such a small sample size could be that only newly registered cases of ADHD from the psychiatric clinic were preferred as the selection criterion. Since this was a preliminary study as mentioned in the title, it may be replicated in future possibly with comparatively a large sample.

11. Kiddie Schedule for Affective Disorders and Schizophrenia – Present and Lifetime (K-SADS-PL) was used for the psychiatric assessment of the children. Hillside Behavior Rating Scale (HBRS) was used to obtain the ratings for a child's behaviour. The Clinical Global Impression Scale (CGI) was applied to assess the severity of the illness of the child. No specific tool is mentioned that was used for assessing the child's intelligence since it was routinely assessed by the clinical psychologist from the clinic.

12. No

13. Pearson's correlation and regression analysis were applied to the data. Apart from this, frequency percentages were also calculated.

14. The research findings showed that the nonadherence to medication was affected in 83.3% of the participants within the first month. The most common reasons for this given by parents included the side-effects of medication, lack of effectiveness of the medication, problems in hospital (such as long waiting time and procedural delay), fear that the child will

become addicted to medication, problems in accessing medication, careless attitude of caregivers, and high cost of medication.

15. Since the sample size of 24 was very small, the research findings cannot be generalized easily. However, it may be replicated in future possibly with comparatively a large sample.

16. The strength of the study can be considered to be the concern for studying the factors that affect nonadherence to medication in children with ADHD. The sample size of the research study was very small, which is one of the biggest limitations.

17. There is a scope for further research with replication of the study with comparatively a larger sample with the same population characteristics. This would be helpful for taking measures against nonadherence to medication in children with ADHD.

18. Parental education

**Note for students:** These answers are not final. You can also add your observations to them to improve your research skills.

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# EXPERIMENTS IN COGNITIVE PROCESSES – I

## Experiment No. 1 Anchoring Effect

### Unit Structure :

- 4.0 Objective
- 4.1 Introduction
- 4.2 Operational Definition Of Variables
- 4.3 Method
- 4.4 Analysis Of Data
- 4.5 Discussion
- 4.6 References

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### 4.0 OBJECTIVE

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- To understand about how to conduct experiments in psychology

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### 4.1 INTRODUCTION

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Mental math and calculations are important tasks of our everyday life. We are faced with several situations every day which require us to make quick calculations. And there is an innate human tendency to engage in shortcuts wherever possible to make the task at hand as easy as possible. People usually make use of information in their surroundings when the shortcuts are being used as well. When people calculate numeric estimates, they are often confronted with both relevant and irrelevant information. For example, in a shop when the consumer is trying to calculate the total cost of his groceries purchased might see that a frying pan is on sale for Rs. 999. Will the consumer's estimate be influenced by the irrelevant cost of the new frying pan? Or, more generally, are people influenced by irrelevant numeric values (i.e., anchors) when calculating numeric estimates?

Numerous studies have demonstrated that estimates tend to assimilate toward irrelevant anchors (for a review, see Chapman & Johnson, 2002). For example, anchoring effects have been observed with general knowledge questions like the length of the Mississippi River and the height of Mount Everest (Jacowitz & Kahneman, 1995), criminal sentences (Englich, Mussweiler, & Strack, 2006), and performance ratings of university professors (Thorsteinson, Breier, Atwell, Hamilton & Privette, 2008). A typical anchoring study requires that participants recruit information from memory and/or make a quantitative estimate from primarily non-quantitative information. In this experiment, we will attempt to

investigate the anchoring effects in a different context - One where participants needed to perform a calculation to generate their estimate. These instances are fairly common and occur regularly in our day-to-day lives. We need to understand how anchors influence our final evaluations or judgments.

A famous study is often taught to students of psychology which is a great example of the anchoring that takes place in calculations. This study was done by Tversky and Kahneman (1974). When participants were asked what the answer to the equation would be  $1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8$  they gave a lower estimate as compared to when they were asked to estimate the answer to the equation  $8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1$ . This is because the first equation begins with smaller numbers and moves in an ascending manner from 1, 2, 3, etc. because of which our brain provides a lower estimate as an answer to the equation. And the exact opposite takes place for the second equation which starts with a higher number like 8, 7, 6, etc. But we know that the answer to both the equations is the same. These exhibit the anchoring effect. The initial piece of information provides proves to be an “anchor” which makes us jump into quick but faulty judgments about the answer to the equation put forth.

For example, an individual must solve an equation like “ $256+781+446 = ?$ ” and they are exposed to an irrelevant number like 914. Would this randomly generated number, which is lower than the actual answer has any biasing influence on the individual’s final answer? This is what the current experiment aims to understand. There are four possible explanations as to why the anchors have an impact on the final answer. The first explanation is called *selective accessibility* (Mussweiler & Strack, 1999; Strack & Mussweiler, 1997; see also, Chapman & Johnson, 1999). Although it is not directly related to the anchoring effect while solving a math problem, it does relate to the anchoring effect in general. The *selective accessibility* explanation assumes that when one encounters an anchor of any kind, the individual will first test whether the target is equal to the anchor value. E.g., if someone is asked “is Mt. Everest taller or shorter than 2000 meters”, the anchor provided here is 2000 meters and the individual will use this value/anchor to make their estimate. They will attempt to test this hypothesis of whether Mt. Everest is taller or not. Because people will engage in hypothesis testing, they will use the information provided to make their judgments. Selective accessibility accounts assume that the activated information is semantically related to anchor value (Mussweiler&Strack, 2000,2001). When individuals generate their final estimate, they use this biased set of accessible information to inform their estimate. Selective accessibility can explain anchoring effects in many situations because the account relies on biased recruitment of information from memory. However, the selective accessibility explanation does not seem to apply to situations where people are performing a calculation based on available information. Furthermore, because selective accessibility accounts assume anchors increase the accessibility of semantically related information, they have difficulty explaining anchoring effects with purely numeric information.

The second explanation for the anchoring effect is *anchoring and insufficient adjustment* (Epley&Gilovich, 2001,2004, 2005, 2006; Tversky&Kahneman, 1974). This explanation states that individuals use the anchors as a starting point and then begin to adjust their estimate/answer based on that starting point. The limitation of anchoring and insufficient adjustment states that the adjustment aspect only works when the anchors are generated by the individual themselves (Mussweiler&Strack, 2000, 2001; Epley&Gilovich,2001, 2004, 2005, 2006).

A third and fourth explanation for the anchoring effect is called *numeric and magnitude priming*. E.g., when we read an arbitrary employee number on an ID card, we estimate that would represent the number of employees in that organization. Viewing the ID number increased the accessibility of similar numbers. When individuals generated their estimates, these primed numbers were more likely to come to mind, thereby influencing their final estimates. The magnitude priming explanation views the anchor to be priming a concept. (e.g., a high number will prime the individual to be primed for the term “higher/larger”). This primed concept will eventually influence the final estimate that the person makes (Oppenheimer, LeBoeuf, & Brewer, 2008). For example, in a study, when participants drew a long line on a sheet of paper, they estimated the Mississippi river to be longer as compared to when they were asked to draw a shorter line. The numeric and magnitude priming help us explain how irrelevant anchors will influence answers to a math equation.

In our experiment, we propose that the irrelevant anchors will have an influence on estimates that the participants make about the math equation (provided that the equations are not too simple). Thus, anchors will exert a biasing effect through the numeric/magnitude priming. Participants will provide estimates in line with the type of anchor presented to them

E.g., if we show the participants a high anchor (e.g., 3790), this number will increase the activation of numeric values near the anchor. That is, when the participant is shown an equation (e.g.,  $4637+7461+7164$ ), they are more likely to give a higher estimate as to the answer or estimate to this equation.

Even in our experiment, the participants will be exposed to an anchor (either low or high) to study its impact on the final answer that they will give to the math equation. We will be imposing a 5 second time limit to ensure that participants are not using other math techniques to solve the equation and that the anchor effect can be truly observed. With the time limit, the participants will be forced to make use of shortcuts to respond fast enough.

**Problem:** To understand the impact of irrelevant anchors on answers to math equations in a restrictive time-limited task.

**Alternative Hypothesis:** There will be a difference in the performance of the participant based on the three types of anchors provided to them i.e. low anchor, high anchor, and no anchor level respectively. The mean of the

estimates provided by the participants will be highest for the high anchor condition and lowest for the low anchor condition.

**Null Hypothesis:** There will be no difference in the performance of the participant based on the three types of anchors provided to them i.e. low anchor, high anchor, and no anchor level respectively.

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## 4.2 OPERATIONAL DEFINITION OF VARIABLES

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**Independent Variable (IV):** numeric anchors (exposure to an irrelevant number which may impact the estimate to the math equation posed). The IV has 3 levels:

**Level 1:** no anchor (control group)

**Level 2:** low anchor (randomly generated numbers between 500 and 999)

**Level 3:** high anchor (randomly generated numbers between 11001 and 11500) **Dependent Variable (DV):** mean of the estimates provided to the math equation posed.

### Controls:

1. The exposure time for each math equation will be kept constant at 5 seconds.
2. Participants will answer filler questions. The filler problems will be identical for all participants and have anchors that are near the actual answers to the math problems.
3. Between the presentation of the math equation and the anchor, a 3-second time gap will be maintained.
4. All math equations will be presented in an  $X1+X2+X3=Y$  format. E.g.,  $874+915+347=?$
5. To create these questions, three numbers (i.e.,  $X1$ ,  $X2$ , and  $X3$ ) were randomly generated for each trial between the range of 4000 to 8000
6. The anchor values were also randomly determined for each trial; low anchors were between 500 and 999 and high anchors were between 11001 and 11500. For example, a participant might be asked if the answer to " $4724+7811+5780=?$ " is more or less than 824 in the low anchor condition or 2192 in the high anchor condition.

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## 4.3 METHOD

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### Participant:

Initials of participant	Age	Sex

## Group data:

**Number of participants:** N =

## Apparatus/materials:

1. Demonstration flashcards with math equations
2. Actual trial flashcards with math equations
3. Stop-watch
4. Metronome
5. Scoring sheet
6. Screen
7. Stationery

## Design:

The design of the experiment is a repeated measures design with one independent variable having three levels namely low anchor, high anchor, and no anchor condition, and one dependent variable i.e. answer to the math equation.

## Procedure

The participants will be instructed that they would be answering math equations and would only have a short amount of time to view each equation. Therefore, they should work as quickly and accurately as possible. The participants first answered 10 practice math problems. For example, a participant might see the equation " $435 + 587 + 298 = ?$ " and will be asked to respond. After 4 sec, the flashcard with the equation will be removed and the experimenter must wait a response from the participant. Once the participant responds, the experimenter can proceed to the next problem.

After answering the practice problems, the participants will be told that they would be answering a few more math problems in two stages. Specifically, they will be told that they would first see an equation and compare the answer of the equation to a "randomly generated number." Second, they would be expected to provide the answer to the equation. The participants will then be shown an example to ensure they understood their task. Next, they would be told that they would have a short amount of time to view each equation, so they should work as quickly and accurately as possible. Finally, they will be told that, if they were unsure of the exact answer to the equation, they should provide their best estimate. The filler problems will be identical for all participants and will have anchors that are near the actual answers to the math problems

## Instructions

"This is a simple experiment surrounding math equations. You will first be presented with some practice equations to help you understand better.

(e.g., what is the answer to  $435 + 587 + 298 = ?$ ). We will now proceed with the actual task. You will be presented with an equation and your task is to compare the answer of the equation to a randomly generated number to solve the equation. Kindly respond as quickly and as accurately as possible. If you are unsure of the answer, kindly provide your best estimate and respond. You will not be provided any paper/pencil to do any rough calculation so you must mentally solve the equation. You must say your response out loud as soon as possible.”

Instructions for presentation of equations: Low/high anchor condition:

“Is the answer to the following equation smaller or larger than ?”

No anchor condition:

What is the answer to the following equation?

### Post Task Questions

1. What do you think was the purpose of this experiment?

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2. Did you notice any difference across the tasks presented to you?

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3. Did you notice a change in your responses across the tasks presented to you?

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4. Did you use any technique while responding to the equations? If yes, please elaborate.

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5. Did you feel some equations were easier than others? If yes, why?

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6. Did the randomly generated numbers presented to you when the equation was shown helpful while coming up with your answer?

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7. Do you have any comments or questions regarding the experiment?

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### Debriefing

The purpose of this experiment was to study the impact of irrelevant anchors on answers to math equations in a restrictive time-limited task. We presented you with three basic categories of tasks. In the first task you were exposed to irrelevant anchors/numbers before the math equation. This anchor was a low anchor. The second category of task used a high anchor, and the third category of task used no anchor at all. According to the anchoring effect, the type of anchor provided to you would have an impact on the estimate that you would give as the final answer to the math equation. We expected that your estimates would be influenced by the type of anchor given to you in the respective tasks i.e., in the low anchor condition you would give a low estimate and in a high anchor condition you would give a high estimate. \*Explain P's results to them\*. We have research evidence for this phenomenon occurring based on studies conducted by Tversky and Kahneman in 1974. The reason why anchoring effect occurs can be explained by numeric and magnitude priming. They state that, the magnitude priming explanation views the anchor to be priming a concept.

(e.g., a high number will prime the individual to be primed for the term “higher/larger”). This primed concept will eventually influence the final estimate that the person makes. Anchors will exert a biasing effect through the numeric/magnitude priming. Participants will provide estimates in line with the type of anchor presented to them. E.g., if we show the participants a high anchor (e.g., 3790), this number will increase the activation of numeric values near the anchor. That is, when the participant is shown an equation (e.g.,  $4637+7461+7164$ ), they are more likely to give a higher estimate as to the answer or estimate to this equation.

The practical implications of this effect can be seen in our day to day lives. For example, when we have to make quick mental calculation in a time pressure situation, we usually rely on information in our surrounding to help us come up with an answer. When we go shopping, the various price tags that we see can influence the way we perceive pricing in general. If we come across an item that is small but expensive, and later we see a large item but at a cheaper price, we may be deceived to think that we are getting a better deal. Or when we get a larger discount if we buy items worth more money, we assume that we are getting a better deal but instead we forget that we are spending a lot more money. Thus, companies can manipulate pricing or design their stores to their advantage using this anchoring effect. On the contrary we can make consumers more vigilant about this effect so that they can shop more mindfully.

#### **Solution sheet:**

#### **Low Anchor Condition Scoring Sheet:**

Sr. No.	EQUATION	LOW ANCHOR	P'S RESPONSE	P'S RESPONSE
1	$4724+7811+5780$	667		
2	$6956+5551+7806$	682		
3	$6358+6012+4007$	786		
4	$5059+5360+7543$	986		
5	$7176+4721+4325$	925		
6	$4411+4367+7606$	853		
7	$7337+4955+5237$	776		
8	$7511+7531+4586$	795		
9	$4905+5481+7277$	965		
10	$6138+6330+7157$	797		
11	$6219+7125+4206$	867		
12	$4383+4416+6713882$			



**High Anchor Condition Scoring Sheet:**

Experiments in  
Cognitive Processes – I  
Experiment No. 1  
Anchoring Effect

Sr. No.	EQUATION	HIGH ANCHOR	P'S RESPONSE
1	4425+5710+5986	7093	
2	5924+4770+7509	6351	
3	7097+6963+6242	8725	
4	7946+4388+4536	8270	
5	4637+7461+7164	10081	
6	6733+7359+6457	1193	
7	5452+4977+6079	3028	
8	4439+5104+6657	11044	
9	4583+5979+6309	2404	
10	4583+510710+6301	8518	
11	4297+6224+7279	10373	
12	6132+7924+7785	6571	

**No Anchor Condition Scoring Sheet:**

Sr. No.	EQUATION	P'S RESPONSE
1	6130+6869+6268	
2	6692+4948+4751	
3	7274+5310+6685	
4	4996+6120+5428	
5	4174+6713+4190	
6	6563+5515+6208	
7	6743+4797+5967	
8	4467+6392+7303	
9	5800+7016+7796	
10	5960+7823+4210	
11	7610+7095+7188	
12	6253+6743+6501	

## 4.4 ANALYSIS OF DATA

### Individual Data:

**Table 1:**

AVERAGE ESTIMATES	
Low Anchor Condition	
High Anchor Condition	
No Anchor Condition	

**Table 2: Group data of Ps (at least 20) on mean estimates in the 3 conditions.**

Participants condition	Low anchor	High anchor condition	No anchor condition
P1			
P2			
P3			
P4			
P5			
P6			
P7			
P8...			
P50			
Mean			
SD			
Range			

1. Mean of responses given in low anchor condition.
2. Mean of responses given in high anchor condition.
3. Mean of responses given in no anchor condition.
4. Comparison of means of the three groups.

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## 4.5 DISCUSSION

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### Individual data discussion:

1. Discuss the difference in the participant's performance between the three conditions i.e., low anchor condition, high anchor condition and no anchor condition.
2. Explain whether data is in line or contrary to the hypothesis.
3. Ancillary observations: whether the answers given were larger/smaller, non-verbal observations.
4. Incorporate PTQ's: strategy used if any.
5. Confounding factors if any.

### Group data discussion:

1. Referring to table 2 and Figure 2 describe the results obtained for the estimates.
2. Appropriate inferential statistic used, why?
3. Were the results statistically significant? Was hypothesis supported? Explain with reference to prior research and theoretical perspective.
4. Sources of confounding, limitations, suggestions for improvement.

### Practical applications:

1. Consumer psychology research: it will benefit consumers understand the tactics used by sellers. It will also help sellers understand how they can take advantage and make design/pricing/store layout decisions.
2. Social psychology research: it will help understanding priming of not just relevant but irrelevant information that humans received from their social environment.

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## 4.6 REFERENCES

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## EXPERIMENTS IN COGNITIVE PROCESSES – II

### Experiment No. 2

#### Homonyms and Synonyms as Retrieval Cues

##### Unit Structure :

- 5.0 Objective
- 5.1 Introduction
- 5.2 Operational Definition Of Variables
- 5.3 Method
- 5.4 Analysis Of Data
- 5.5 Discussion
- 5.6 Questions
- 5.7 References

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### 5.0 OBJECTIVE

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- To understand about how to conduct experiments in psychology

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### 5.1 INTRODUCTION

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Memory and learning are integral cognitive processes. There is extensive research done in the field of learning and memory exhibiting the role of learning in the subsequent storage and retrieval process. Thomson and Tulving (1970) have differentiated between two hypotheses regarding the nature of effective retrieval cues: *the encoding specificity hypothesis and the associative continuity hypothesis*. They proposed the idea that the context of the learning process is going to have a large impact on the learning. They denied the impact of the cue, and they insisted that context will have a superior effect. Contrary to the encoding specificity concept is the idea of associative continuity.

According to the associative continuity hypothesis, if a strong pre-experimental association exists between two words, then one word can serve as an effective retrieval cue for the other, and vice versa. This can occur simply due to the prior associations one may have, and it is regardless of the encoding phase. Past research has indicated that recall involves search and recognition. Retrieval cues initiate a search in long-term memory with recognition checks being performed on retrieved items; items passing the recognition test are produced as overt responses. Research shows that words are stored in long-term memory as lists or collections of units that specify their meaning, sound, and other attributes. Retrieval cues allow a search to be initiated based on one or more of these properties. The items specified

by a given cue may be called the search set (Shiffrin, 1970). Thus, when the cue is presented and the long-term memory begins its search process, it will search for the word associated with the cue. If the cue is similar to the to-be-remembered word concerning its meaning or sound or any other attribute it will help the search process.

Hence, the greater the similarity between the cue and the to-be-remembered word, the easier would be the search process. The only requirement is that there either be some previously established relationship between the to-be-remembered word and a cue or that participant establishes such a relationship through some process during storage. Here comes the role of cue specificity. The greater the effectiveness of the cue, the better will be the recall of the to-be-remembered word.

Thus, in our experiment, we attempt to understand the *search set specificity and recall accuracy*. Search set is the entire collection of words/information that our long-term memory holds regarding a particular category. So, for example, if a participant is shown the word car, they will have several other words that are associated with the word car and would all be part of the search set for the word car. The understanding from past research is that the larger the search set the longer it would take to complete the search. However, cues may help the process since they can aid the search process.

Shiffrin (1970) has identified a continuum for memory tasks. At the easiest end of the continuum is the recognition task, where the participant must simply recognize the word previously shown to them. In this stage, they have the most amount of information. On the other end of the continuum, there is free recall, where absolutely no information is provided to the participants. Between these two extremes is the cued recall task, where some cue is provided which can aid the search process for the participant.

In our experiment, we expose each one of the three groups of participants with homonym cues (homonyms are words that sound similar to one another but may have different meanings), synonym (synonyms are words that have a similar meaning) cues, and free recall task respectively. Given the search process, we expect that the best performance will be for the homonyms cues condition and the poorest performance will be for the free recall task. This is because the search set will be searched easily due to the presence of retrieval cues in the cued recall tasks, while in the free recall task, there is minimum information to aid the process of searching in the search set. For the homonym cued recall task, either one member of a homonym pair will be an effective retrieval cue for the other when a search is directed along with the acoustical properties of the cue. This is because the overlap in relevant properties i.e., the acoustical properties is high. The search process will be comparatively easier. For the synonym cued recall task, the search process will be based on meaning i.e., semantic properties. A single word may have several synonyms to it, so the search process may be comparatively less easy to the homonym cued recall task. Synonyms should ideally be less effective as retrieval cues than homonyms because the overlap in semantic properties of synonym pairs is less than perfect. The similarity may affect recall during either the retrieval or the recognition

stages in general. During retrieval, participants may limit the search to items that are highly similar in properties to the retrieval cues available to them; hence, to-be-remembered words which are less similar to retrieval cues may not be retrieved at all. (Bahrick, 1969, 1970). Because the search set for synonyms is large participants may find it difficult in discriminating alternatives which could lower their overall recall performance.

**Problem:** To study the impact of homonyms and synonyms as retrieval cues.

**Alternative Hypothesis:** There will be a difference in the mean recall score for the three groups where the mean recall will be highest for the homonym cues condition followed by the synonym cues condition and lowest for the free recall condition.

**Null Hypothesis:** There will be no difference in the mean recall scores of the three groups i.e., homonym cues condition, synonym cues condition, and free recall.

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## 5.2 OPERATIONAL DEFINITION OF VARIABLES

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**Independent Variable (IV):** The type of cues provided during the task were of three types:

Thus, the IV has three levels:

**Level 1:** homonym cues condition (homonyms are words with a similar sound but different meaning e.g., sign-sign/hair-hare)

**Level 2:** synonym cues condition (words with similar meaning e.g., aid/help/assist)

**Level 3:** free recall condition (participants were provided no cue)

**Dependent Variable (DV):** mean recall scores for the three conditions i.e., homonym cues condition, synonym cues condition, and free recall condition.

### Controls:

1. All participants will study a list of 45 homonyms.
2. Homonyms were selected from Homophones and Homographs: An American Dictionary (Hobbs., J.B., 2006) such that intralist acoustic and semantic similarity were judged to be low. One member of each pair was chosen to be the to-be-remembered word and the other served as its homonym cue.
3. The distractor items in the homonym cues and synonym cues were roughly matched with the to-be-remembered words in length and frequency of occurrence.

4. In the cued recall experiment, the participant will simply be given a list of retrieval cues at the time of recall and told that they may or may not help them to remember the to-be-remembered words.
5. Distractor words were roughly matched.
6. The participants were first shown a list of 45 words all together on a single sheet of paper and they were asked to study the given list.
7. Participants were given 5 mins to study the list of words.
8. Participants were given 10 mins to recall the words.

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### 5.3 METHOD

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#### Participant:

Initials of participant	Age	Sex

#### Group data:

Number of participants: N =

#### Apparatus/materials:

1. List of words
2. List of words for recall with cues
3. Blank sheet of paper for free recall condition
4. Stop-watch
5. Scoring sheet
6. Screen
7. Stationery

#### Design

The design of this experiment is a random group's measures design having one independent variable with three levels i.e., homonyms cues condition, synonyms cues condition, and free recall.

#### Procedure

The participants were first shown a list of 45 words all together on a single sheet of paper and they were asked to study the given list. They were given 5 mins to study the list of words, after which the sheet with the words was taken away. This was followed by their respective recall tasks. The first and second group was given a cued recall task where a list of retrieval cues was provided to them at the time of recall and told that they may or may not help him to remember the to-be-remembered words. The participants had were



told they had 10 mins to recall as many words as they could. The third group had a free recall condition where no retrieval cues were provided. They were simply asked to recall as many words as they could in 10 mins.

### Instructions

“This is a simple experiment on language. We will first begin by showing you a list of words that you must study for a subsequent recall task. You will be given 5 mins to study the list of words.”

Level 1 – homonym cues recall – “You will now be given a sheet of paper containing a list of words with blanks against it. Your task is to fill the blank with the word that sounds like the word provided. You have 10 mins to complete this task.”

Level 2 – synonym cues recall - “You will now be given a sheet of paper containing a list of words with blanks against it. Your task is to fill the blank with the word that has a similar meaning as the word provided. You have 10 mins to complete this task.”

Level 3 – free recall – “You will now be given a blank sheet of paper. Your task is to list down as many of the words that you studied in the first phase as possible. You have 10 mins to complete this task.”

### Post task questions:

1. What do you think was the purpose of this experiment?

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2. Did you notice any difference across the tasks presented to you?

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3. Did you use any technique while studying the words presented to you in phase 1? If yes, please elaborate.

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4. Did you use any technique while studying the words presented to you in phase 2? If yes, please elaborate.

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5. Do you have any comments or questions regarding the experiment?

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### Debriefing

This was a simple experiment based on the types of retrieval cues provided to the participants and their impact on their recall. You were exposed to 45 words in phase 1 and were asked to recall those words in phase 2. The experiment consisted of three different variations of the phase 2 task. You were presented with \_\_\_\_\_ and the remaining two participants will be exposed to \_\_\_\_\_ (fill in the blank in accordance with P1/2/3/4). The three variations of the phase 2 task were: 1. Homonym (words that have a similar sound but different meaning) cues recall task 2. Synonym (words with similar meaning) cues recall task 3. Free recall task. We expect that the highest number of words would be recalled in the homonyms cues condition followed by the synonyms cues condition, and the least number will be recalled in the free recall condition. This is due to the phenomenon called cue specificity. This phenomenon states that the kind of cue provided will aid memory. The more effective the cue, the better the recall. The effectiveness of the cues provided enhances performance. The homonym and synonym cues condition are easier as compared to the free recall condition which is more difficult since there is no cue provided.

The practical implications of this study could be with patients of any type of memory dysfunction. We can make sure we provide these patients with effective cues to aid their memory. It can also aid in academics while learning material. Students can use this to make cue cards with effective cues to study and remember their material better.

**Solution sheet:**

Experiments in  
Cognitive Processes – II  
Experiment No. 2  
Homonyms and Synonyms  
as Retrieval Cues

Sr. No.	Phase 1 Words	Homonym Cue	Synonym Cues
1	weak	week	frail
2	Sun	son	daylight
3	See	sea	view
4	plane	plain	even
5	meet	meat	acquaint
6	Hare	hair	rabbit
7	fairy	ferry	elf
8	sweet	suite	sugary
9	Chic	sheik	stylish
10	allowed	aloud	permitted
11	manner	manor	way
12	fissure	fisher	crack
13	groan	grown	grunt
14	holy	wholly	divine
15	Know	no	aware
16	mail	male	letter
17	Right	write	good
18	scene	seen	display
19	altar	alter	shrine
20	cereal	serial	grain
21	doe	dough	bunny
22	Flee	flea	fly
23	great	grate	big
24	hole	whole	crack
25	night	knight	nocturnal
26	loan	lone	credit
27	maid	made	servant
28	Peddle	pedal	push
29	role	roll	act
30	soar	sore	rise
31	tail	tale	rear
32	vary	very	differ
33	wail	whale	sob
34	waste	waist	decay
35	weather	whether	climate
36	Wood	would	timber

Sr. No.	Phase 1 Words	Homonym Cue	Synonym Cues
37	sole	soul	lone
38	none	nun	nil
39	knead	knead	rub
40	heel	heal	obey
41	Flower	flour	blossom
42	dual	duel	double
43	break	brake	crack
44	Blew	blue	flow
45	ate	eight	bite

## 5.4 ANALYSIS OF DATA

### Individual Data:

**Table 1:**

<b>P1:</b> no. of words correctly reported on homonym cues recall task	<b>P2:</b> no. of words correctly reported on synonym cues recall task	<b>P3:</b> no. of words correctly reported on free recall task
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### Figure 1:

“Insert appropriate graph”

### Group Data:

**Table 2:**

Mean words recalled in homonym cues recall condition.	Mean words recalled in synonym cues recall condition.	Mean words recalled in free recall condition.
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## 5.5 DISCUSSION

### Individual data discussion:

1. Discuss the participants performance between on their respective tasks: homonym cues recall, synonym cues recall, free recall. Use table 1 and figure to compare and explain the data for all four participants.
2. Explain whether data is in line or contrary to the hypothesis.
3. Ancillary observations: whether the answers given were larger/smaller, non-verbal observations.

4. Incorporate PTQ's: strategy used if any.
5. Confounding factors if any.

**Group data discussion:**

1. Referring to table 2 describe the results obtained for the estimates.
2. Appropriate inferential statistic used, why?
3. Were the results statistically significant? Was hypothesis supported? Explain with reference to prior research and theoretical perspective.
4. Sources of confounding, limitations, suggestions for improvement.

**Practical applications:**

1. Aid to patients with memory deficit: the caregivers of people with memory deficit can provide patients with effective cues so that aid their memory deficit.
2. Students: students can use the concept of cue specificity to aid their learning.

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**5.6 QUESTIONS**

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1. What are the possible confounding variables for the homonyms and synonyms experiment? (proficiency with English language, unclear instructions, memory dysfunction, difference in the way words may be pronounced, etc.

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2. What is the associative continuity hypothesis?

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3. What is the encoding specificity hypothesis?

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4. What is search set specificity?

5. Explain the continuum of memory tasks identified by Shiffrin.

6. Describe the controls implemented in the experiment.

7. Explain the practical implications of this experiment.

8. State the independent/dependent variables of the experiment.

9. State what inferential statistical method should be employed to analyze the group data of this experiment and why?

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10. State the alternative/null hypothesis.

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## **PSYCHOLOGICAL TEST**

### **CATTELL'S CULTURE FAIR INTELLIGENCE TEST**

#### **Unit Structure :**

- 6.0 Objectives
- 6.1 Introduction
  - 6.1.1 Theories of Intelligence
- 6.2 Method
- 6.3 Data Analysis
- 6.4 Interpretation
- 6.5 Questions
- 6.6 References

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#### **6.0 OBJECTIVES**

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- The learner will be able to understand the scope nature of Intelligence testing
- The learner will be able to administer, score and interpret the Cattell's Culture Fair Test
- The learner will be able to communicate the test results of Cattell's Culture Fair Test to the test taker

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#### **6.1 INTRODUCTION:ADMINISTRATION, SCORING AND INTERPRETATION OF CATTELL'S CULTURE FAIR INTELLIGENCE TEST**

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Intelligence is the ability from one's experience, acquire knowledge and use resources effectively in adapting to new situations or solving problems. David Wechsler defined intelligence as the aggregate or global capacity of the individual to act purposefully, to think rationally and to deal effectively with his environment.

##### **6.1.1 Theories of Intelligence**

The theories of intelligence can be broadly classified factor theories and the information processing approach.

Spearman (1904) with a help if statistical technique of factor analysis, and identified common factor to perform well across different tests. This factor



he labeled the "general factor," or 'g' pervades performance on all tasks requiring intelligence. The second factor is specifically related to each particular test which was called as 's' factor or specific factor.

L.L. Thurstone rejected the idea of general intelligence, identified seven primary abilities, namely, verbal comprehension, word fluency, number, spatial visualization, inductive reasoning and memory.

A complex structure of intellect model was proposed by J.P. Guilford (1988). The intellect had three dimensions: operations, contents, and products. Operations referred to the cognitive processes required to do an activity. Contents referred to the nature of materials or information on which intellectual operations are performed. Products referred to the form in which information is processed by the respondent.

Raymond Cattell proposed two types of intelligences. Fluid intelligence (gf) which referred to the ability for abstract and logical thinking, and does not require any prior knowledge. Thus, it involves the ability to think and reason abstractly and solve any new task or problem independent of any past knowledge or experience in it. It helps one to analyze a novel problem, perceive the relationships and patterns that underlie the problem and solve it using logic. Crystallized intelligence (gc) referred to knowledge that one gained through learning, past experience, acculturation and the ability to use that acquired knowledge.

The Cattell Culture Fair IQ tests, The Raven's Progressive Matrices are the measures of fluid intelligence.

The information processing approach to intelligence was proposed by Sternberg. In the triarchic theory of intelligence given by Sternberg intelligence, he identified three components of intelligence, practical, creative and analytical.

### **Measurement of Intelligence**

The early work in the area of measurement was done by Francis Galton. Galton believed that psychophysical abilities were the basis of intelligence and, hence, that these tests were measures of intelligence.

Alfred Binet developed one of the first intelligence test which was periodically revised in 1937, 1960, 1973, 1986, and 2003. It consists of an age-graded series of problems whose solution involves arithmetical, memory, and vocabulary skills. The recent version of SB V meant to gauge intelligence through five factors of cognitive ability. These five factors include fluid reasoning, knowledge, quantitative reasoning, visual-spatial processing and working memory. Both verbal and nonverbal responses are measured.

Another widely used intelligence test was Wechsler's scales. Wechsler-Bellevue Intelligence scale were first published in 1939, the Wechsler Intelligence Scale for Children was developed in 1949. Since the tests were first published, they had several revisions. WISC V was developed in 2014

and WAIS IV in 2008. The WAIS-IV contains 10 subtests along with 5 supplemental tests. The test provides scores in four major areas of intelligence: a Verbal Comprehension Index, a Perceptual Reasoning Index, a Working Memory Index, and a Processing Speed Index. WAIS is scored by comparing the test taker's score to the scores of others in the same age group.

Apart from Stanford-Binet and Wechsler's scales there are a number of tests measuring intelligence. Kaufman Adolescent and Adult Intelligence Test the Kaufman Brief Intelligence Test (K-BIT; Kaufman & Kaufman, 1990), Kaufman Assessment Battery for Children (K-ABC; Kaufman & Kaufman, 1983), Cognitive Assessment System (Naglieri & Das, 1997). Differential Ability Scales (DAS) are intelligence tests used in various settings.

Measured intelligence may vary as a result of factors related to the measurement process. Few factors that may affect measured intelligence are a test author's definition of intelligence, the diligence of the examiner, the amount of feedback the examiner gives the examinee, the amount of previous practice or coaching the examinee has had, and the competence of the person interpreting the test data. Apart from these factors, personality, family environment, gender as well as culture affect the scores on intelligence tests. To reduce the cultural bias in an intelligence test culture fair or culture free tests are developed.

Culture-fair intelligence tests are tests or assessment processes designed to minimize the influence of culture with regard to various aspects of the evaluation procedures, such as administration instructions, item content, responses required of test takers, and interpretations made from the resulting data. The tests are designed to not be influenced by verbal ability, cultural climate, or educational level. The first culture-fair test, Army Examination Beta, was developed by the United States military during World War II to screen soldiers of average intelligence who were illiterate or for whom English was a second language. Another example of Culture Fair Test is Raven's Progressive Matrices.

The intelligence scales can be culturally biased based on the experiential and language influences included in the questions. Raymond B. Cattell developed the Cattell's Culture Fair Intelligence Test (CCFIT) with the intention of creating a test that was not influenced by these cultural elements. CCFIT was first published in 1930 with later revisions 1940, 1944 and 1961. The test can be administered either individually or in a group setting. There are three intelligence scales measured, with Scale I including eight subtests used for children aged between 4 to 8. Scale II was used for children aged 8-14. And scale III measured intelligence of children above 14 as well as adults.

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## 6.2 METHOD

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Tool Description:

Cattell's Culture Fair Intelligence Scale III.

Scale 3 consists of four subtests in all the number of items and time allotted in each of the subtest differ. The following table shows the items and time allotted to each subtest in Scale 3.

	<b>Sub tests</b>	<b>No. of Test Items</b>	<b>Time Allotted</b>
Test 1	Series	13	3 mins
Test 2	Classification	14	4 mins
Test 3	Matrices	13	3 mins
Test 4	Conditions (Topology)	10	2 ½ mins
Total		50 items	12 ½ mins

1. Series: In this subtest, the individual is presented with an incomplete, progressive series. His task is to select from among the choices provided, the answer which continues the series.
2. Classification: In the subtest, the individual has to correctly identify two figures which are in some way different from the three others.
3. Matrices: In the subtest, the task is to correctly complete the design or matrix presented at the left of each row.
4. Conditions (Topology): This subtest requires the individual to select, from the five choices provided, the one which duplicates the conditions given in the fair left box.

### **Reliability& Validity**

The test is reported to have a Spearman-Brown reliability coefficient of .79, a Cronbach's alpha of .77, and a KR21 of .81. The validity of the culture test has also been established. Its scores correlate in .80 with the general factor of intelligence and show a consistently high relationship with other mainstream intelligence tests such as WAIS, WISC, Raven Progressive Matrices, Stanford-Binet, Otis and General Aptitude Test Battery.

### **Materials:**

- 1) Cattell's Culture Fair test booklet & answer booklet
- 2) Stop watch
- 3) Stationery

### **Procedure:**

All the materials required for test administration were kept ready and the test taker was called into the laboratory. Rapport was established by asking few general questions. After ensuring that the test taker was comfortable and relaxed the following instructions were given.

### Instructions:

“Hello, in today’s practical, I will give you a psychological test, which is designed to measure the capacity to make abstractions and deal with novel situations. The test has four sub tests, the sub test comprises of a few questions which you have to answer. Instructions for each subtest will be given separately. Shall we proceed?”

After confirming the test taker has written down the demographic details. The test administrator started with the sub test 1. The instructions were read ‘verbatim’ that is, the instructions were readout as given in the test manual for each sub test.

Before starting each test, the test examples were explained and solved along with the test taker. Only after ensuring that the test taker had understood the test examples the test administrator asked the test taker to proceed to the actual test. The stop watch was switched on when the test taker started the test and it was stopped when the allotted time for the test was over as per the test manual. The same procedure was followed for all the sub tests.

The test taker was assured that the results of the results would be kept confidential and given a date for giving the test results. The test taker was thanked and escorted out of the laboratory.

### Post task questions:

1. What are your feelings while doing the test?

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2. Did you face any difficulty while doing the test?

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### 6.3 DATA ANALYSIS:

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#### Scoring:

The test taker had to mark the correct response out of the four options on the answer sheet provided. After all the four subtests were administered, the test takers right and wrong responses were marked after which a Raw Score

was derived. This raw score was further, using the appropriate norms, converted into an IQ score with the help of the CCFIT manual. The IQ scores were converted into Percentile scores with the help of the CCFIT manual.

**Table 1: Test taker's score on the CCFIT**

	Score
Raw Score	
IQ	
Percentile	

### Debriefing:

[Note for the Test Administrator: It is very important the manner in which test results are communicated to the test taker. Before debriefing the test taker, you need to be well versed with the nature of the test and the way test results are interpreted. The test results must be communicated in a very sensitive manner, especially if the test scores are low or below average. The test administrator must ensure that strengths of the test taker are to be emphasized rather than weaknesses. In case the test taker has scored low/below average kindly take the help of supervisor to interpret and communicate the results.]

“The test you took earlier was Cattell's Culture Fair Test. This test is a measure of intelligence. Intelligence is considered as ability to use one's experience, acquire knowledge and use resources effectively in adapting to new situations or solving problems. The scores on the test is not absolute and may vary due to many factors like your concentration while giving the test, previous practice etc.

Your total score was \_\_\_\_\_. From the total score, the Intelligence Quotient (IQ) was calculated which was \_\_\_\_\_. (Refer to the test manual for interpretation).

The IQ was further converted into a percentile score which was \_\_\_\_\_. Percentile score indicates that \_\_\_\_\_ percent of people fall below your score

Do you need any clarification about the results? Do you have any doubts?”

## 6.4 INTERPRETATION

1. Mention briefly about the CCFIT.
2. Mention the raw scores of each subtest.
3. Mention the total score, IQ and percentile score of the test taker.
4. Interpret the IQ and percentile score.
5. Discuss the test results with the help of the introspective report.

**Conclusion:** Mention the IQ and percentile score along with its interpretations.

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### 6.5 QUESTIONS

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1. Explain the term Psychological test.

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2. What are the characteristics of good psychological test, briefly explain characteristics.

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3. What is the scope or purpose of administering psychological tests.

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4. Explain the concept of Intelligence.

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5. Explain the various theories of Intelligence

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6. Enumerate the various measures of Intelligence.

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7. Explain briefly the nature of Culture Fair Test

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8. What are percentile ranks?

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## COMPUTER-BASED EXPERIMENTS (COGLAB)

### Unit Structure :

- 7.0 Objectives
- 7.1 Introduction To Computer-Based Experiments
- 7.2 Experiment 1 (Lexical Decision Task)
- 7.3 Questions
- 7.4 References

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### 7.0 OBJECTIVES

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After learning this unit, the learner should be able to –

- (1) Explain the meaning of Computer-based experiments
- (2) Evaluate the advantages and disadvantages of Computer-based experiments
- (3) Conduct computer-based experiments, analyse the results and write a report on it.

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### 7.1 INTRODUCTION TO COGLAB EXPERIMENTS (COMPUTER-BASED EXPERIMENTS)

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CogLab is a set of computer demonstrations of classic and current experiments and concepts of cognitive psychology. CogLab is **the program that runs cognitive experiments**. It allows students to experience variety of important psychological concepts and experimental studies which helps them to understand the design of the study and significance of the research.

#### **Advantages of computer based experiments:**

- Greater precision in stimulus presentation
- More accurate recording of responses, reaction time
- Faster and more accurate analysis of data
- Counterbalancing and randomization is easier to achieve, can be programmed.

#### **Disadvantages of computer based experiments:**

- Can be used only if a person is computer literate
- Technical problems possible during conduct



- Need special equipment/technical facilities/electrical, technical support
- It requires knowledge of computer programming and/ or how to use the software for designing and running one's own experiments (using one's own operational definitions and materials, how to incorporate randomization and/or counterbalancing and other controls etc.) or else one is restricted to the pre-prepared experiments available, with their respective limitations.

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## 7.2 EXPERIMENT NO. 1

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**Title:** Lexical decision task

**Problem:** To study the differences in the reaction time for the associated words and unassociated words on the lexical decision task.

### Introduction:

**Psycholinguistics** or **psychology of language** is the study of the interrelation between linguistic factors and psychological aspects (Jodai, 2011). It studies psychological and neurobiological factors that enable humans to acquire, use, comprehend and produce language. The discipline is mainly concerned with the mechanisms in which languages are processed and represented in the brain (Nordquist, 2017).

The term *psycholinguistics* was coined by Jacob Robert Kantor in his book '*An Objective Psychology of Grammar*' in 1936 but it was after the publication of the article "Language and psycholinguistics: a review," by his student Nicholas Henry Pronko (1946) followed which the use of the term finally became frequent.

Psycholinguistics has roots in education and philosophy. Modern researchers consider psycholinguistics to be an interdisciplinary field. According to them, it makes use of biology, neuroscience, cognitive science, linguistics, and information science to study how the brain processes language, and also social sciences, human development, communication theories and infant development theories, among others. Hence, it is studied from a variety of different backgrounds, such as psychology, cognitive science, linguistics, and speech and language pathology.

Psycholinguists study many different topics, but these topics can generally be divided into answering the following questions:

- (1) how do children acquire language (language acquisition)?;
- (2) how do people process and comprehend language (language comprehension)?;
- (3) how do people produce language (language production)?; and
- (4) how do people acquire a new language (second language acquisition)?

## Lexicon

Language production concerns how people produce language, either in written or spoken form, in a way that conveys meanings comprehensible to others. One of the most effective ways to understand this process is to understand one's mental dictionary or lexicon.

Theories of human language propose that lexicon exists and it contains a variety of information about words. This lexicon holds information about a word's meaning (its semantic content), its part of language (noun, verb, adjective, etc.), and its relationships to other words (What can it follow? What can follow it? How can it be modified?). Psychologists are interested in the organization of this lexicon.

The lexicon is similar to a dictionary in that it holds information about words and other components of language. Physical dictionaries generally organize words alphabetically. This arrangement makes it easy to find any word, provided the spelling is known or can be guessed. Because dictionaries usually are used to find the meanings of known words or to check if a word is spelled properly, this organization is useful.

In the mental lexicon, though, the most useful feature of a word may not be its spelling, but its meaning and its relationship to other words. If words are arranged in the lexicon by semantic relationships, words that are related to each other (e.g., chair, seat, table) would be close together in the lexicon, whereas words that are unrelated to each other (e.g., chair, dinosaur, broccoli) would be far apart.

### Lexical decision task (LDT)

For decades, the most commonly used laboratory tasks for studying the cognitive processes involved in printed word identification have been lexical decision and naming (e.g., Jastrzembksi&Stanners, 1975; Rubenstein, Garfield, & Millikan, 1970; Zevin& Seidenberg, 2006).

The lexical decision task (LDT) used in this experiment, is a procedure which is used in many psychology and psycholinguistics experiments. The basic procedure involves assessing how quickly people classify a stimulus as a word or a non-word.

The term *lexical decision task* was coined by David E. Meyer and Roger W. Schvaneveldt to study semantic memory and word recognition in the early 1970s (Meyer &Schvaneveldt, 1971;1973). Since then, the task has been used in thousands of studies, investigating semantic memory and lexical access in general. The different versions of the task had been used by researchers for a number of years.

In the LDT task, the subjects are presented with a mixture of words and logatomes or pseudowords (nonsense strings that respect the phonotactic rules of a language, like *trud* in English), either visually or auditory. Their task is to indicate whether the presented stimulus is a word or not.

The analysis is based on the reaction time, that is, how fast you are able to make your decision about each letter string and sometimes on the basis of the error rates for the various conditions for which the words (or the pseudowords) differ. A very common effect is that of frequency: words that are more frequent are recognized faster. In a cleverly designed experiment, one can draw theoretical inferences from differences like this. For instance, one might conclude that common words have a stronger mental representation than uncommon words.

## Rationale of the study

### Meyer and Schvaneveldt's study

Lexical decision tasks are often combined with other experimental techniques, such as priming, in which the subject is 'primed' with a certain stimulus before the actual lexical decision task has to be performed. Meyer and Schvaneveldt's (1971;1973) study demonstrated this phenomenon called **priming**, which occurs when the response to a visual stimulus (such as a word) is influenced by the stimuli that preceded it. They found that subjects are faster to respond to words when they are first shown a semantically related prime. For example, participants are faster to confirm "nurse" as a word when it is preceded by "doctor" than when it is preceded by "butter". This is one example of the phenomenon of semantic priming

Meyer and Schvaneveldt's study demonstrated that our **semantic memory**, which contains our general knowledge, is organized into **semantic networks**, which can be thought of as a network that contains word or concept meanings that are related. Semantic priming may occur because the prime partially activates related words or concepts, facilitating their later processing or recognition. Although this process is often automatic, priming can also be guided by the use of specific strategies to achieve a particular task goal. For example, seeing the word 'doctor', activates a node in a semantic network, which primes related words such as 'nurse,' thereby increasing the speed by which we can identify the word 'nurse'.

### Hoedemaker and Gordon (2014)

Even the study by Hoedemaker and Gordon (2014) found that the gaze duration for middle words was faster when the preceding word was semantically related vs. unrelated, indicating a semantic priming benefit in reading times. In their study, they tracked participants' eye movements while they read three words in sequence using a gaze-contingent viewing procedure where each word was only visible when it was fixated for the first time.

## Practical Implications

Lateralization of brain function is the tendency for some neural functions or cognitive processes to be more dominant in one hemisphere than the other. Studies in semantic processing have found that there is lateralization for semantic processing by investigating hemisphere deficits, which can either be lesions, damage or disease, in the medial temporal lobe (Kotz et.al.

2002). Tests like the LDT that use semantic priming have found that deficits in the left hemisphere preserve summation priming while deficits in the right hemisphere preserve direct or coarse priming (Beeman et.al.(1994)

Similarly, the LDT can be used to understanding the functioning of brain with respect to language acquisition, language usage, language comprehension and language production. Also the rationale of the study is useful to be applied as a teaching and learning aid. It demonstrates how using techniques that associate new knowledge with the existing knowledge in the brain can help in better retention for the same as an effect of semantic priming.

### **Prediction of the experiment**

Response times to the second word should be faster when the second item is a word that is semantically associated to the first item than when it is unrelated.

## **METHODOLOGY**

### **Hypothesis:**

The reaction time on the lexical decision task will be significantly less for the second word of the associated word pair as compared to the second word of the unassociated word pair.

### **Method**

**Design:** A repeated measures design with one IV having two levels (associated words and unassociated words). One participant will be exposed to both the levels of IV.

### **Operational Definition of Variables**

**Independent Variable:** Word association with two levels: associated words and unassociated words.

**Dependent Variable:** The reaction time (in milliseconds) taken to respond to the second word of the pair.

### **Control Variables:**

1. The participant should have a basic knowledge of English.
2. A small square was presented in the middle of the screen, after 1-4 seconds a word or non-word was presented. Again after 1-2 seconds, the second word or non-word appeared. This time was uniform for all trials.
3. 70 trials of associated word pairs, unassociated words and non-words were presented randomly.
4. The test screen was presented using the full-screen option.
5. The participants were from the age group of 17 to 21 years old.
6. Noise and distraction were kept minimal.

The data was gathered from \_\_ participants (males and females). The sample consisted of randomly selected participants from an educational institution.

## Materials

1. CogLab software
2. Laptop
3. PTQ sheets

## Procedure

The experimenter made sure that the participant was comfortable before beginning the lexical decision task. The basic demographic details of the participant were noted down after which the instructions (given below) were given to the participants. The participant completed the lexical decision task with at least 70 trials on the CogLab. Following this, the experimenter noted the reaction time (in milliseconds) for associated word pairs, unassociated word pairs, word non-word pairs, non-word word pairs and non-word pairs. The results and purpose of the experiment were conveyed to the participant.

**Instructions** – the following standard instructions were given to all the participants before starting with the lexical decision task:-

A window will appear that fills nearly the entire screen, and a smaller window will appear with abbreviated instructions. Close the instructions window. You can open it again later from the *Lab Info.* menu.

Press the spacebar to start a trial. A small fixation square will appear in the middle of the screen. Fix on this square. One to four seconds later, a word or non-word will appear above the fixation square. Decide if the item is a word or a non-word as quickly as possible. A word is the meaningful one (eg. train) and a non-word is the one that doesn't have a meaning (eg.nfp). Press the (/) key if the item is a word. Press the (z) key if the item is not a word. The item will disappear when you press either of these keys, so you will know your response has been recorded.

Two to three seconds later, the next word or non-word will appear. Again, decide if the item is a word or non-word by pressing the (/) key or (z) key as quickly as possible. You will receive feedback when you respond too quickly (before the item appears), too slowly, or incorrectly.

There are at least 70 total trials. You must classify the items correctly for the trial to count, so if you find that you are making many classification mistakes, slow down.

At the end of the experiment, the experiment window will close and a new window will appear that displays your data as a table and provides an explanation of the experiments and results. Have you understood? Any Questions?

### Post Task Questions (PTQs)

1. What would you say about your experience during the experiment? (Thoughts, feelings etc.)
2. Were some of the words more familiar to you in the experiment? (probe if the response is positive)
3. Did you have any difficulty while responding to words? (probe if the response is positive – in general or particular words)
4. Were there any factors that may have influenced your response? (For eg. Having greater personal association with some words/ Distraction?)
5. Any other question-

### Debriefing

The purpose of the experiment was to study the differences in the reaction time for the associated words and unassociated words on the lexical decision task. You were shown a series of words, which you were asked to classify as word and non-word, were actually word pairs. Associated words were those word pairs that were semantically related, i.e., meaningfully related, for instance, nurse and doctor - nurse is related to a doctor hence these two words are associated. And the Unassociated word were those word pairs that were semantically or meaningfully not related to each other, for instance, butter and doctor - butter is not related to a doctor hence these two words are unassociated.

We expected that the reaction time would be less for the second word of the associated word pair as compared to the second word of the unassociated word pair on this task. That is, the reaction times to the second word would be faster when the second word of the pair is semantically associated with the first word of the pair than when it is semantically unassociated.

This expectation is based on research conducted by Meyer and Schvaneveldt in which they demonstrated the phenomenon of priming, which occurs when the response to a visual stimulus (such as a word) is influenced by the stimuli that preceded it. They found that participants were faster to respond to words when they are first shown a semantically related prime as compared to a semantically unrelated prime. For example, they found that participants were faster to confirm "nurse" as a word when it is preceded by "doctor" than when it is preceded by "butter".

Meyer and Schvaneveldt's study demonstrated that our semantic memory, which contains our general knowledge, is organized into semantic networks, which can be thought of as a network that contains word or concept meanings that are related. Semantic priming may occur because the prime partially activates related words or concepts, facilitating their later processing or recognition. Although this process is often automatic, priming can also be guided by the use of specific strategies to achieve a particular task goal. For example, seeing the word 'doctor', activates a node in a



semantic network, which primes related words such as 'nurse,' thereby increasing the speed by which we can identify the word 'nurse'.

The study by Hoedemaker and Gordon (2014) also found that the gaze duration for middle words was faster when the preceding word was semantically related vs. unrelated, indicating a semantic priming benefit in reading times.

As expected your response time for the second word of the associated word pairs was less as compared to the second word of the unassociated word pairs. Thus, the data is in trend with the hypothesis that 'The reaction time will be significantly less for the second word of the associated word pair as compared to the second word of the unassociated word pair on the lexical decision task.'

OR

Your response time for the second word of the associated word pairs was more than the reaction time for the second word of the unassociated word pairs. Thus data is not in trend with the hypothesis that, 'The reaction time will be significantly less for the second word of the associated word pair as compared to the second word of the unassociated word pair on the lexical decision task.' The reason for the contrary data could be The possibility of contrary data could be due to (state the reason reported by the P in the PTQ and/or the following reasons)

- Your personal association with the second word of unassociated word pairs
- Familiarity with the second word of unassociated word pairs
- Probably you were distracted while responding to the second word of associated word pairs
- You experienced a momentary lapse of attention by responding to the second word of associated word pairs.

OR

Your response time for the second word of the associated word pairs and for the second word of the unassociated word pairs was found to be the same. Thus data is not in trend with the hypothesis that, 'The reaction time will be significantly less for the second word of the associated word pair as compared to the second word of the unassociated word pair on the lexical decision task.' The reason for the contrary data could be The possibility of contrary data could be due to (state the reason reported by the P in the PTQ and/or the following reasons)

- Your personal association with the second word of unassociated word pairs
- Familiarity with the second word of unassociated word pairs
- Probably you were distracted while responding to the second word of associated word pairs

- You experienced a momentary lapse of attention by responding to the second word of associated word pairs.

This study has many practical implications. It can be used while learning new languages by associating new words with words that we are already familiar with. Associating new knowledge with existing knowledge in the brain can help in better retention. For example, the words 'Garten' in German can be associated with 'Garden' in English. or the French word "Pâtisseries" which means a pastry shop can be associated with the English word "pastry". Semantic networks can help in increasing vocabulary. We can utilise semantic priming as a teaching and learning aid by studying and grouping related concepts together.

If you are trying to memorise a long list of items on a list before going grocery shopping or if you were to memorise your content for a presentation, the use of this technique can facilitate better recall.

Have you understood? Do you have any questions?

And please do not reveal the purpose and procedure of this experiment to anyone outside as if they volunteer to participate in this study then the prior knowledge about the experiment might affect the result of the experiment.

### **Statistical Analysis (analysis of data)**

The performance of the two conditions was compared by finding out the mean, standard deviation and range.

t-test was conducted to know whether the difference between the performance under the two conditions was statistically significant or not.

A bar graph was drawn to show the graphical representation of the data.

### **Individual Data**

The present study was conducted to understand the process of Lexical decision making. This was done by presenting the Ps with pairs of items (associated words, unassociated words, word then non word, non word then word, non word then non word) in a random order. There were 70 trials in all and for each trial the pairs of items were presented one after the other. And the reaction time for the second item in the pair was recorded. For the present research, the reaction time of only associated words and unassociated words are considered i.e. Ps reaction time to the pairs of associated words was compared with the reaction time of unassociated words.

Then describe the data on Table no. 1 and Figure no. 1 and summarize the main trend obtained in the two main conditions - Associated words and Unassociated words. Describe the result in light with PTQs and E's observations. Then conclude whether the participant's data is in line with the hypothesis “



If the data is not in line with the hypothesis then state the reasons for obtaining contrary data (can be based on PTQs, E's Observation).

Thus, the data is not in trend with the hypothesis "The reaction time on the lexical decision task will be significantly less for the second word of the associated word pair as compared to the second word of the unassociated word pair."

Also state whether the data is in trend or not in trend with the Past research conducted by Meyer and Schvaneveldt (1971; 1973). They found that subjects are faster to respond to words when they are first shown a semantically related prime. For example, participants are faster to confirm "nurse" as a word when it is preceded by "doctor" than when it is preceded by "butter". This is one example of the phenomenon of semantic priming. Meyer and Schvaneveldt's study demonstrated that our **semantic memory**, which contains our general knowledge, is organized into **semantic networks**, which can be thought of as a network that contains word or concept meanings that are related. Semantic priming may occur because the prime partially activates related words or concepts, facilitating their later processing or recognition. Although this process is often automatic, priming can also be guided by the use of specific strategies to achieve a particular task goal. For example, seeing the word 'doctor', activates a node in a semantic network, which primes related words such as 'nurse,' thereby increasing the speed by which we can identify the word 'nurse'.

Also the research conducted by Hoedemaker and Gordon (2014) found that the gaze duration for middle words was faster when the preceding word was semantically related as compared to when they were unrelated, indicating a semantic priming benefit in reading times.

### **Ancillary Observations**

Describe the data on Table no. 2 and Figure no. 1 and summarize the reaction time of all the 5 conditions - Associated words, Unassociated words, Word - Non Word, Non word - Word and Non Word - Non Word. Describe the result in light with PTQs and E's observations.

Also mention P's overall experience and thought about the experiment.

### **Group Data**

Describe the data on Table no. 3 and Figure no. 2 and summarize the main trend obtained in the two main conditions - Associated words and Unassociated words - Compare the Mean, SD and Range of the two conditions. And State whether the data is in trend or not in trend with hypothesis "The reaction time on the lexical decision task will be significantly less for the second word of the associated word pair as compared to the second word of the unassociated word pair."

If data is not in trend with the hypothesis then state the reason for the same. Also state whether the data is in trend or not in trend with the Past research conducted by Meyer and Schvaneveldt (1971; 1973) and Hoedemaker and

Gordon (2014) - Refer to Individual data for the detail. Then describe and conclude the obtained t-value. And state whether the data validates the hypothesis "The reaction time on the lexical decision task will be significantly less for the second word of the associated word pair as compared to the second word of the unassociated word pair." and the past research by Meyer and Schvaneveldt (1971; 1973) and Hoedemaker and Gordon (2014) (no need to again write the whole explanation) Then state the practical application of the study - refer to the Debriefing

#### **State the limitations of the study**

- Sample size
- Only two conditions, Associated word pairs and Unassociated word pairs, are considered. Even other three conditions, Words - Non words, Non words
- Words and Non words - Non words, could have been considered to get an extensive understanding on the topic.

#### **Conclusion**

State whether the main trend in the Individual Data is in line or not in line with the hypothesis and past research.

And whether the main trend in the Individual Data validates or does not validate the hypothesis and past research.

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### **7.3 QUESTIONS**

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Q1. What is the hypothesis of the experiment? (refer to methodology)

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Q2. What is the Alternative directional hypothesis of the experiment?(refer to methodology)

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Q3. What is the Alternative non directional hypothesis of the experiment?

There is a difference in the reaction time for the second word of associated word pair and for the second word of the unassociated words on the lexical decision task

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Q4. What is the Null directional hypothesis of the experiment?  
The reaction time will not be significantly less for the second word of the associated word pair as compared to the second word of the unassociated word pair on the lexical decision task.

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Q5. What is the Null non directional hypothesis of the experiment?

There is no difference in the reaction time for the second word of associated word pair and for the second word of the unassociated words on the lexical decision task

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Q6. What is the design of the experiment? (refer to methodology)

Q7. What is the Independent Variable and Dependent Variable of the experiment? (refer to methodology)

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Q8. What are the levels of the Independent Variable? (refer to methodology)

Q9. State two important control variables of the experiment? And explain why it was controlled? (refer to methodology)

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Q10. State the reason for getting the contrary result in the lexical decision task? or State the reason why Participate reaction time was less for unassociated word pairs as compared to associated word pairs. (refer to debriefing)

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Q11. Which inferential statistics will you use to calculate the group data of this experiment and why?

A repeated measures t test as known as Dependent t test will be used as the design of the experiment is the Repeated measures design. There is One Independent Variable with two levels, that is there are two means to be compared and Dependent variable lies on the ratio scale.

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Q12. What is Lexicon? (refer to introduction)

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Q13. Describe the Past Research on which the Lexical Decision Task experiment is based on? (refer to introduction/debriefing)

Computer-Based Experiments  
(COGLAB)

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Q14. What is the rationale of the experiment? (refer to introduction)

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**Table 1: shows the comparative analysis of P's reaction time (R.T.) to associated and unassociated words.**

	Associated Words	Unassociated Words
R.T. (in msec.)		

**Table 2: shows the comparative analysis of P's reaction time (R.T.) to lexical decision task**

	Associated Words	Unassociated Words	Word – Nonword	Nonword – Word	Nonword – Nonword
R.T. (in msec.)					

**Table no. 3 show the comparative analysis of \_\_\_\_ participants' reaction time for the two conditions – the associated words and unassociated words.**

	Associated Words	Unassociated Words
1		
2		
3		
4		
5		
6		
7		
8		

	Associated Words	Unassociated Words
9		
,		
,		
20		
Total		
Mean		
Range		
SD		

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## USE OF EXCEL

### Unit Structure :

- 8.0 Objectives
- 8.1 Introduction
- 8.2 Why Use Excel?
  - 8.2.1 Advantages of Excel/Spreadsheet
  - 8.2.2 How Can Excel Help Students?
  - 8.2.3 How to Open Microsoft Excel?
  - 8.2.4 Important Excel Shortcuts
- 8.3 A Simple Introduction To Anova on Excel
  - 8.3.1 Introduction to Anova
  - 8.3.2 One Way Anova
  - 8.3.3 Anova on Excel
  - 8.3.4 Summary of All The Steps On Excel
  - 8.3.5 Limitations of One-Way Anova
- 8.4 Statistical Analysis of Experiment 1
- 8.5 Statistical Analysis of Experiment 2
- 8.6 Summary
- 8.7 Questions
- 8.8 References

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### 8.0 OBJECTIVES

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- i) To introduce Microsoft Excel to students
- ii) To familiarize students with various uses of excel
- iii) To develop an understanding to apply statistical tests and analyze the data collected
- iv) To explain the working of ANOVA on Microsoft Excel
- v) To apply statistical tests (ANOVA) and analyze the data collected

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### 8.1 INTRODUCTION

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**Microsoft Excel** is a spreadsheet program which is used to record numerical data and analyse it. This tool provides many features to perform various operations like calculations, pivot tables, graphs toolsetc.



In an Excel spreadsheet there are columns and rows that form a table. Alphabetical letters are usually assigned to columns, and numbers are usually assigned to rows. The point where a column and a row meet is called a cell. The address of a cell is given by the letter representing the column and the number representing a row.

Excel is a widely available computer program for students and managers and it is also an effective teaching and learning tool for quantitative analyses in education and psychology courses. Once you gain mastery over Excel, handling data becomes quite easy and many functions can be computed with the help of Excel.

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## 8.2 WHY USE EXCEL?

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Let us consider one example. Imagine that your company has organised a fundraiser event. Many people have made donations in this event. Now, you have to give a summary of the donations to your boss. He wants to know information like the minimum donation, maximum donation, the average donation, what amount was the most popular, etc.

Your boss is asking for a summary of the descriptive statistics related to the donations. Any statistical information that describes a set of data is descriptive statistics.

Now imagine for a second that you have to calculate manually and give all the required information to your boss. If there were five thousand donors, will it be even possible for you to do the job manually? If you decide to do it manually, it would be very time-consuming and could risk human error.

Instead of working manually, it will be a better idea is to use a strong mathematical tool to analyze the data.

Microsoft Excel is a spreadsheet software package that allows you to compute all kinds data and seek the answers what we are looking for. Descriptive statistics can be performed with ease in Excel.

Formulas in Excel are very easy to enter. You can very easily learn how to enter formulas to find the max, min, mean, mode, median, sum, range, and mean of a set of data. You can also learn how to identify items in exact positions without having to manually count out the positions (such as the 3rd largest, or 2nd smallest number in a series).

### 8.2.1 Advantages of Excel/spreadsheet

A spreadsheet is a powerful tool which is used to store, manipulate and analyze data. There are columns and rows in which data is organised and it can be sorted, calculated and used in a variety of charts and graphs.

With the help of spreadsheet one can easily perform mathematical calculations on statistical data and totaling long columns of numbers or determining percentages and averages.

Excel can help by automatically creating PivotTables, which are a very good way to summarize, analyze, explore, and present the data. A pivot

table may be used as an interactive data summarization tool to automatically condense large datasets into a separate, concise table.

Advantages can be summarized as follows:

- Formulae on Excel can be used to instantly recalculate totals.
- You can carry out "what if?" investigations.
- The information can be presented in different ways. ...
- It is easy to make these changes, save your work and print it out again.

### **8.2.2 How can Excel help students?**

Content can be understood in an easy manner and using Excel can enhance the presentation of data within a graphic presentation of the information. It provides a visual representation of data that makes it quite easy to analyze. Excel reduces the difficulty of plotting data and helps students to interpret the data.

What is Excel used for?

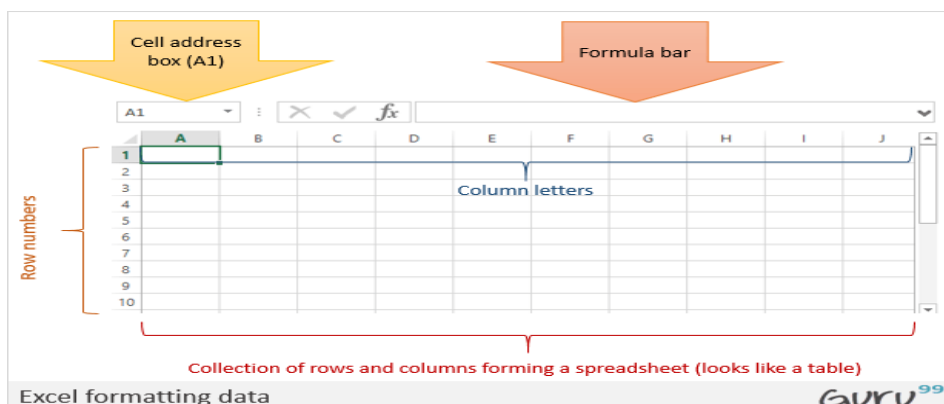
Financial analysis can be performed on Excel and it helps to organize data and perform various analysis. All organizations/companies use Excel whether they are small or large.

There are two most common general uses for spreadsheet software:

- i) to create and produce graphs and charts, and
- ii) for storing and sorting data.

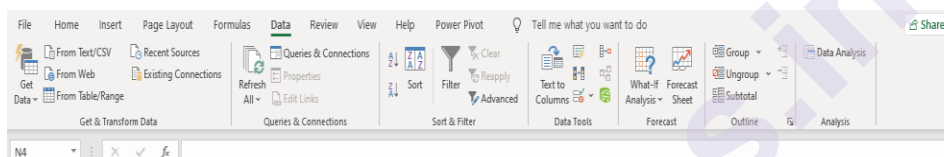
The main uses of Excel include:

- Data entry
- Data management
- Charting and graphing
- Programming
- Time management
- Task management
- Customer relationship management (CRM)
- Almost anything that needs to be organized!



### 8.2.3 How to Open Microsoft Excel?

- Click on start menu
- Search for Excel
- Click on Microsoft Excel
- The ribbon tabs look as follows:



### 8.2.4 Important Excel shortcuts

Ctrl + P	used to open the print dialogue window
Ctrl + N	creates a new workbook
Ctrl + S	saves the current workbook
Ctrl + C	copy contents of current select
Ctrl + V	paste data from the clipboard
SHIFT + F3	displays the function insert dialog window
SHIFT + F11	Creates a new worksheet
F2	Check formula and cell range covered

## 8.3 A SIMPLE INTRODUCTION TO ANOVA ON EXCEL

Analysis of variance (ANOVA) is a statistical technique that is used to check if the means of two or more groups are significantly different from each other. ANOVA checks the impact of one or more factors by comparing the means of different sample

Let us consider one example. Suppose we have three medical treatments to apply on patients with similar diseases. Once we get the test results, one approach might be to assume that the treatment which took the least time to cure the patients is the best among them. What if some of these patients had already been partially cured, or if any other medication was already working on them?

As a researcher you would want to make a confident and reliable decision, we will need evidence to support our approach. In this type of situation, the concept of ANOVA comes into play.

In this section, we will introduce you to the ANOVA techniques used for making the best decisions. We'll try to understand the techniques of ANOVA by way of considering an example. We will also make use of Excel to understand these concepts.

If you know basic statistics and you have knowledge of t-tests and hypothesis testing, it will help you to understand this topic. to understand this topic.

Let's begin!

### **8.3.1 Introduction to ANOVA**

Let us understand ANOVA with this example. A common approach to figure out a reliable treatment method would be to analyze the days it took the patients to be cured. We can use a statistical technique that can compare, for example, three treatment samples and depict how different these samples are from one another. Such a technique, which compares the samples on the basis of their means, is called ANOVA.

Analysis of variance (ANOVA) is a statistical technique that is used to check if the means of two or more groups are significantly different from each other. ANOVA checks the impact of one or more factors by comparing the means of different samples.

We can use ANOVA to prove/disprove if all the medication treatments were equally effective or not.

Another measure to compare the samples is called a t-test. When we have only two samples, t-test and ANOVA give the same results. However, using a t-test would not be reliable in cases where there are more than 2 samples.

### **Terminologies related to ANOVA you need to know**

#### **Grand Mean**

Mean is a simple or arithmetic average of a range of values. There are two kinds of means that we use in ANOVA calculations, which are separate sample means ( $\mu_1, \mu_2$  &  $\mu_3$ ) and the grand mean ( $\mu$ ). The grand mean is the mean of sample means or the mean of all observations combined, irrespective of the sample.

#### **Hypothesis**

A hypothesis is an educated guess about something in the world around us. It should be testable either by experiment or observation.

ANOVA also uses a Null hypothesis and an Alternate hypothesis. The Null hypothesis in ANOVA is valid when all the sample means are equal, or they

don't have any significant difference. Thus, they can be considered as a part of a larger set of the population.

On the other hand, the alternate hypothesis is valid when at least one of the sample means is different from the rest of the sample means. In mathematical form, they can be represented as:

$$H_0 : \mu_1 = \mu_2 = \dots = \mu_L \quad \text{Null hypothesis}$$

$$H_1 : \mu_l \neq \mu_m \quad \text{Alternate hypothesis}$$

where  $\mu_l$  and  $\mu_m$  belong to any two sample means out of all the samples considered for the test. In other words, the null hypothesis states that all the sample means are equal or the factor did not have any significant effect on the results. Whereas, the alternate hypothesis states that at least one of the sample means is different from another. But we still can't tell which one specifically.

### Between Group Variability

If the samples do not differ and overlap, their individual means won't differ by a great margin. Hence the difference between their individual means and grand mean won't be significant enough.

Now consider two sample distributions which differ from each other by a big margin, their individual means would also differ. The difference between the individual means and grand mean would therefore also be significant.

Such variability between the distributions called Between-group variability. It refers to variations between the distributions of individual groups (or levels) as the values within each group are different.

Each sample is looked at and the difference between its mean and grand mean is calculated to calculate the variability. If the distributions overlap or are close, the grand mean will be similar to the individual means whereas if the distributions are far apart, difference between means and grand mean would be large.

### Within Group Variability

Within-group variation refers to variations caused by differences within individual groups (or levels) as not all the values within each group are the same. Each sample is looked at on its own and variability between the individual points in the sample is calculated.

### F-Statistic

The statistic which measures if the means of different samples are significantly different or not is called the F-Ratio. Lower the F-Ratio, more similar are the sample means. In that case, we cannot reject the null hypothesis.

$F = \text{Between group variability} / \text{Within group variability}$

The numerator term in the F-statistic calculation defines the between-group variability. As we discussed earlier, as between group variability increases, sample means grow further apart from each other. In other words, the samples are more probable to be belonging to totally different populations.

This F-statistic calculated here is compared with the F-critical value for making a conclusion. In terms of our medication example, if the value of the calculated F-statistic is more than the F-critical value (for a specific  $\alpha$ /significance level, usually .05 level), then we reject the null hypothesis and can say that the treatment had a significant effect.

### 8.3.2 One Way ANOVA

As we now understand the basic terminologies behind ANOVA, let's now go into more details by using a few examples.

Let us begin with this example. A recent study claims that using music in a class enhances the concentration and consequently helps students absorb more information. As a teacher, you may find it difficult to accept.

What if it affected the results of the students in a negative way? Or what kind of music would be a good choice for this? Considering all this, it would be immensely helpful to have some proof that it actually works.

To figure this out, we can implement it on a smaller group of randomly selected students from three different classes. The idea is similar to conducting a survey. We take three different groups of ten randomly selected students (all of the same age) from three different classrooms. Each classroom was provided with a different environment for students to study. Classroom A had constant music being played in the background, classroom B had variable music being played and classroom C was a regular class with no music playing (control). After one month, we conducted a test for all the three groups and collected their test scores. The test scores that we obtained were as follows:

	Test scores of students (out of 10)									
Class A (constant sound)	7	9	5	8	6	8	6	10	7	4
Class B (variable sound)	4	3	6	2	7	5	5	4	1	3
Class C (no sound)	6	1	3	5	3	4	6	5	7	3

Now, we will calculate the means and the Grand mean.

So, in above case:  $M_1 = 7$ ;  $M_2 = 4$ ;  $M_3 = 4.3$  & Grand Mean = 5.1

	Test scores of students (out of 10)										Mean
Class A (constant sound)	7	9	5	8	6	8	6	10	7	4	7
Class B (variable sound)	4	3	6	2	7	5	5	4	1	3	4
Class C (no sound)	6	1	3	5	3	4	6	5	7	3	4.3
Grand mean ->											5.1

Looking at the above table, we might assume that the mean score of students from Group A is definitely greater than the other two groups, so the treatment must be helpful. Maybe it's true, but we cannot be sure until we perform some statistical tests to be sure. We may also want to answer a few questions, like:

1. How do we decide that these three groups performed differently because of the different situations and not merely by chance?
2. In a statistical sense, how different are these three samples from each other?

To answer above questions, we will do one way ANOVA on excel.

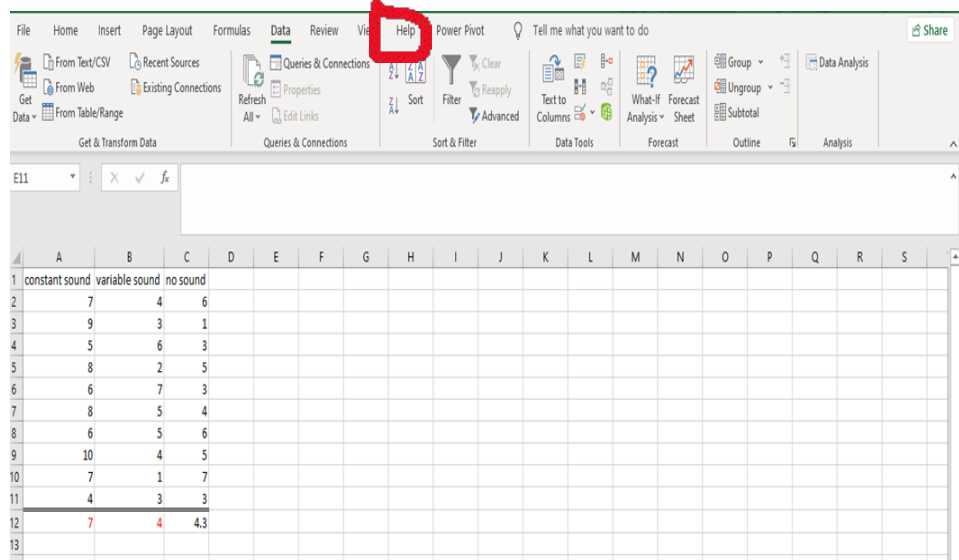
### 8.3.3 ANOVA on Excel

First you write all the scores (data) on a new excel sheet.

	constant sound	variable sound	no sound
1			
2	7	4	6
3	9	3	1
4	5	6	3
5	8	2	5
6	6	7	3
7	8	5	4
8	6	5	6
9	10	4	5
10	7	1	7
11	4	3	3
12	7	4	4.3
13			

Go to data

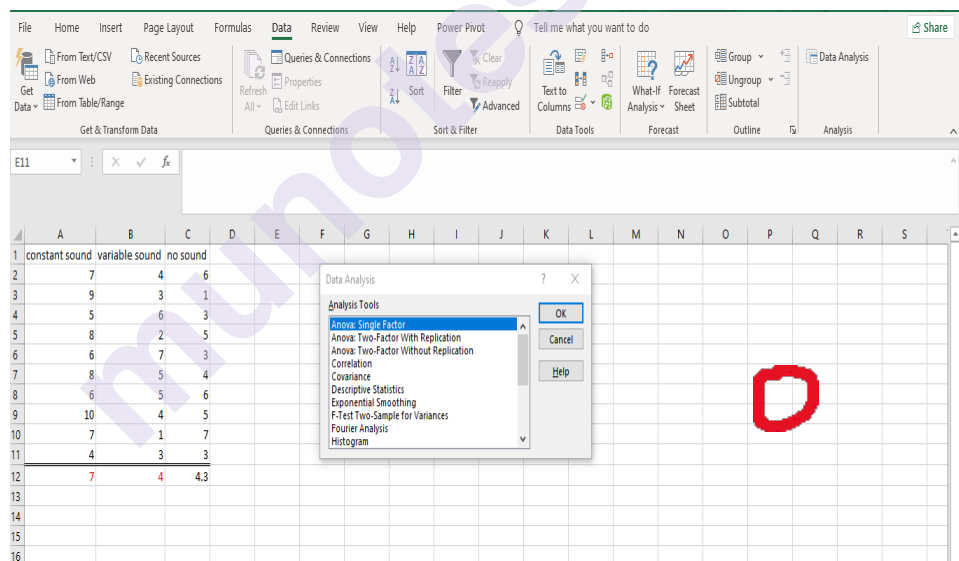
Go to data analysis



The screenshot shows the Excel interface with the 'Data' tab selected. A data table is visible in the worksheet, with columns labeled 'constant sound', 'variable sound', and 'no sound'. The data is as follows:

	constant sound	variable sound	no sound
2	7	4	6
3	9	3	1
4	5	6	3
5	8	2	5
6	6	7	3
7	8	5	4
8	6	5	6
9	10	4	5
10	7	1	7
11	4	3	3
12	7	4	4.3

Select ANOVA single factor



Click OK

Select input range A 2 C 11

Check the box labels in first row

Select output range E 1

Data is column wise, so select column

Click OK



The screenshot shows the 'Anova: Single Factor' dialog box in Excel. The 'Input Range' is set to \$A\$1:\$C\$11, 'Grouped By' is 'Columns', and 'Labels in first row' is checked. The 'Output Range' is set to \$E\$1. In the background, a red circle highlights cell O1 in the worksheet.

	A	B	C	D	E
1	constant sound	variable sound	no sound		
2	7	4	6		
3	9	3	1		
4	5	6	3		
5	8	2	5		
6	6	7	3		
7	8	5	4		
8	6	5	6		
9	10	4	5		
10	7	1	7		
11	4	3	3		
12	7	4	4.3		

The screenshot shows the results of an ANOVA test in Excel. The 'SUMMARY' table shows the F-value (8.1809101) is greater than the F-critical value (3.354130829). The 'ANOVA' table shows the p-value (0.001669012) is less than the alpha level (0.05).

Groups	Count	Sum	Average	Variance
constant sound	10	70	7	3.333333333
variable sound	10	40	4	3.333333333
no sound	10	43	4.3	3.344444444

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	54.6	2	27.3	8.1809101	0.001669012	3.354130829
Within Groups	90.1	27	3.337037037			
Total	144.7	29				

Here, we can see that the F-value is greater than the F-critical value for the alpha level selected (0.05). Therefore, we have evidence to reject the null hypothesis and say that at least one of the three samples have significantly different means and thus belong to an entirely different population.

Another measure for ANOVA is the p-value. If the p-value is less than the alpha level selected (which is .05, in our case), we reject the Null Hypothesis.

### 8.3.4 Summary of all the steps on Excel

## Steps to perform one-way ANOVA with post-hoc test in Excel 2013

Step 1: Input your data into columns in Excel. For example, if three groups of students for music treatment are being tested, spread the data into three columns.

Click Data Click Data Analysis

Step 2: Click “ANOVA Single Factor” and then click “OK.”

Step 3: Type an input range into the Input Range box. For example, if the data is in cells A1 to C10, type “A1:C10” into the box. Check the “Labels in first row” if we have column headers.

Step 4: Select an output range. For example, E 2.

Step 5: Choose an alpha level. For most hypothesis tests, 0.05 is standard.

Step 6: Click “OK.” The results from ANOVA will appear in the worksheet.

Results for our example will look like this:

Class A	Class B	Class C	Anova: Single Factor				
7	4	6	SUMMARY				
9	3	1					
5	6	3					
8	2	5					
6	7	3	Groups	Count	Sum	Average	Variance
8	5	4	Class A	10	70	7	3.333333
6	5	6	Class B	10	40	4	3.333333
10	4	5	Class C	10	43	4.3	3.344444
7	1	7	ANOVA				
4	3	3					
			Source of Variation	SS	df	MS	F
			Between Groups	54.6	2	27.3	8.18091
			Within Groups	90.1	27	3.337037	0.001669
			Total	144.7	29		3.354131

Here, we can see that the F-value is greater than the F-critical value for the alpha level selected (0.05). Therefore, we have evidence to reject the null hypothesis and say that at least one of the three samples have significantly different means and thus belong to an entirely different population.

Another measure for ANOVA is the p-value. If the p-value is less than the alpha level selected (which is .05, in our case), we reject the Null Hypothesis.

### Post hoc test:

Now to check which samples had different means we will take the **Bonferroni approach** and perform the post hoc test in Excel.

Step 7: Again, click on “Data Analysis” in the “Data” tab and select “t-Test: Two-Sample Assuming Equal Variances” and click “OK.”

Step 8: Input the range of Class A column in Variable 1 Range box, and range of Class B column in Variable 2 Range box. Check the “Labels” if you have column headers in the first row.

Step 9: Select an output range. For example, click the “New Worksheet” radio button.

Step 10: Perform the same steps (Step 7 to step 9) for Columns of Class B – Class C and Class A – Class C.

The results will look like this:

A vs B			B vs C			A vs C		
	Class A	Class B		Class B	Class C		Class A	Class C
Mean	7	4	Mean	4	4.3	Mean	7	4.3
Variance	3.333333333	3.333333333	Variance	3.333333333	3.344444444	Variance	3.333333333	3.344444444
Observations	10	10	Observations	10	10	Observations	10	10
Pooled Variance	3.333333333		Pooled Variance	3.338888889		Pooled Variance	3.338888889	
Hypothesized Mean Difference	0		Hypothesized Mean Difference	0		Hypothesized Mean Difference	0	
df	18		df	18		df	18	
t Stat	3.674234614		t Stat	-0.367117657		t Stat	3.304058917	
P(T<=t) one-tail	0.000867715		P(T<=t) one-tail	0.358905891		P(T<=t) one-tail	0.001972897	
t Critical one-tail	1.734063607		t Critical one-tail	1.734063607		t Critical one-tail	1.734063607	
P(T<=t) two-tail	0.00173543		P(T<=t) two-tail	0.717811783		P(T<=t) two-tail	0.003945793	
t Critical two-tail	2.10092204		t Critical two-tail	2.10092204		t Critical two-tail	2.10092204	

Here, you can see that the p-value of (A vs B) and (A vs C) is less than the alpha level selected ( $\alpha = 0.05$ ). This means that groups A and B & groups A and C have less than 5% chance of belonging to the same population. Whereas for (B vs C) it is much greater than the significance level. This means that B and C belong to the same population. So, it is clear that A (constant music group) belongs to an entirely different population. Or we can say that the constant music had a significant effect on the performance of students.

### 8.3.5 Limitations of one-way ANOVA

A one-way ANOVA tells us that at least two groups are different from each other. But it won't tell us which groups are different. If our test returns a significant f-statistic, we may need to run a post-hoc test to tell us exactly which groups have a difference in means.

## 8.4 STATISTICAL ANALYSIS OF EXPERIMENT 1

Following is the dummy data for the experiment on Anchoring Effect.

Serial No	low anchor	high anchor	no anchor
1	755	750	7285
2	603	4891	5868
3	647	5625	8230
4	826	10548	2104
5	617	2276	3602
6	857	8159	5739
7	618	5055	9748

<b>Serial No</b>	<b>low anchor</b>	<b>high anchor</b>	<b>no anchor</b>
8	955	6825	7795
9	587	6477	11407
10	581	2127	3747
11	644	5310	4801
12	659	4686	6246
13	685	4261	3176
14	546	6611	10684
15	680	4294	1099
16	621	8584	9658
17	910	3877	4078
18	801	701	7746
19	558	2737	3753
20	812	2614	3618
21	985	9318	6635
22	575	4873	7243
23	868	6694	10645
24	723	9204	11387
25	794	1719	2144
26	929	622	2725
27	742	11187	3532
28	672	7640	9132
29	526	709	10691
30	595	6902	2604
31	602	3780	10108
32	847	10371	3341
33	556	5039	9718
34	707	4154	2470
35	610	6673	6757
36	841	9131	6022
37	667	7423	3262
38	967	1479	1098
39	565	1517	6203
40	941	511	7095

Serial No	low anchor	high anchor	no anchor
41	661	5185	3129
42	681	10315	2057
43	931	10192	10494
44	727	10961	7171
45	627	2753	4249
46	7238	607	8708
47	11349	541	7407
48	7951	629	1542
49	3102	839	1175
50	8842	542	7989
Mean	1415.66	4958.36	5942.34

Now let us see how to analyze the data on Microsoft Excel. As you already know if we have more than two means then we need to do ANOVA (analysis of variance). In the above experiment, there is **one IV with three levels**, namely,

- i) Low anchoring group
- ii) High anchoring group
- iii) No anchoring (control)

We have the following null and alternate hypotheses for our experiment:

**Null Hypothesis:** There will be no difference in the performance of the participant based on the three types of anchors provided to them i.e. low anchor, high anchor, and no anchor level respectively.

**Alternative Hypothesis:** There will be a difference in the performance of the participant based on the three types of anchors provided to them i.e. low anchor, high anchor, and no anchor level respectively.

**Dependent Variable:** Performance of the participants

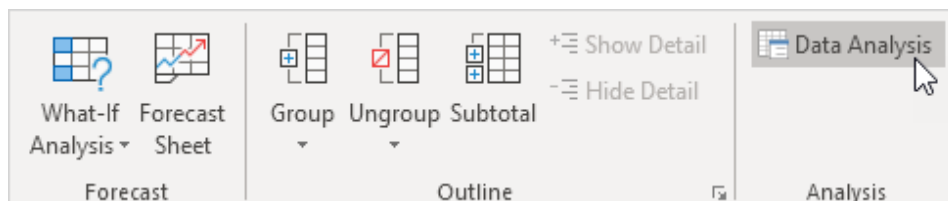
To know whether there is difference or not in the performance of three groups, we need to perform a one-way-ANOVA

Following steps, you need to perform:

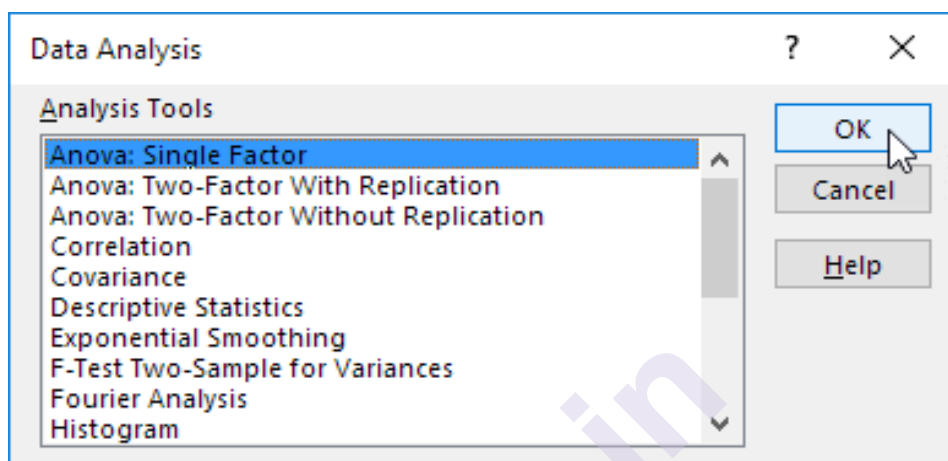
Step 1. Open the spreadsheet on your computer with data written in columns

Step 2. Click data

Step 3. Click on data analysis



Step 4. Select Anova: Single Factor and click OK.

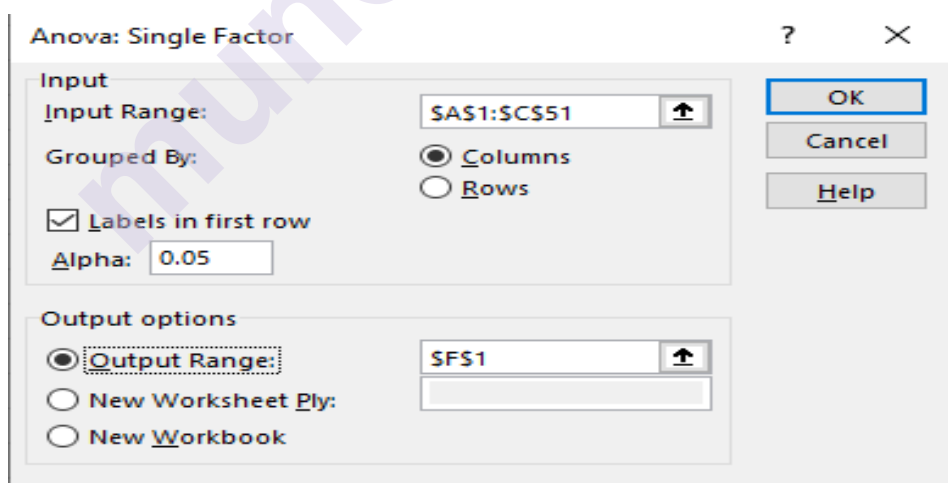


Step 5. Click in the Input Range box and select the range A1C51

Step 6. Click in the Output Range box and select cell F 1

Check in the box: Labels in First Row

Click on columns because data is in columns.



Step 7. Click OK

Anova: Single Factor						
SUMMARY						
Groups	Count	Sum	Average	Variance		
low anchor	50	70783	1415.66	5224109.984		
high anchor	50	247918	4958.36	11362129.75		
no anchor	50	297117	5942.34	9823004.882		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	566829529.2	2	283414764.6	32.19494939	2.53591E-12	3.057620652
Within Groups	1294052986	147	8803081.537			
Total	1860882515	149				

Conclusion: if  $F > F_{crit}$ , we reject the null hypothesis. This is the case,  $32.19 > 3.05$ . Therefore, we reject the null hypothesis. The means of the three groups are not all equal. At least one of the means is different. However, the ANOVA does not tell us where the difference lies. We need to perform post hoc test.

P value is less than .05 so null hypothesis is rejected

You can perform the post hoc test in the same manner as we did with our example of type of music and students' performance.

## 8.5 STATISTICAL ANALYSIS OF EXPERIMENT 2

Following is the dummy data for the experiment on Homonyms and Synonyms as Retrieval Cues

Sr. No.	homonym cues recall	synonym cues recall	free recall
1	36	24	12
2	35	28	26
3	38	24	10
4	38	23	14
5	34	18	19
6	37	18	15
7	37	18	13
8	37	20	7
9	32	23	6
10	30	26	15

<b>Sr. No.</b>	<b>homonym cues recall</b>	<b>synonym cues recall</b>	<b>free recall</b>
11	37	27	15
12	38	22	18
13	34	25	20
14	33	28	15
15	35	26	25
16	30	23	12
17	29	27	8
18	30	28	10
19	27	28	20
20	28	24	20
21	26	24	21
22	32	22	5
23	35	23	17
24	36	19	16
25	34	18	19
26	31	23	27
27	34	19	14
28	26	27	23
29	29	21	23
30	35	18	25
31	31	27	27
32	34	28	14
33	28	23	17
34	37	18	15
35	28	23	14
36	32	21	22
37	35	26	11
38	31	21	7
39	35	21	16
40	34	24	22
41	26	23	16
42	32	27	9
43	37	18	27
44	26	21	21
45	26	27	21
46	20	35	29



<b>Sr. No.</b>	<b>homonym cues recall</b>	<b>synonym cues recall</b>	<b>free recall</b>
47	25	32	30
48	22	15	32
49	21	14	4
50	30	10	26
<b>Mean</b>	<b>31.66</b>	<b>22.96</b>	<b>17.4</b>

Following is the solution sheet for the above experiment:

<b>Sr. No.</b>	<b>TBR</b>	<b>homonym cue</b>	<b>synonym cues</b>
1	weak	week	frail
2	sun	son	daylight
3	see	sea	view
4	plane	plain	even
5	meet	meat	acquaint
6	hare	hair	rabbit
7	fairy	ferry	elf
8	sweet	suite	sugary
9	chic	sheik	stylish
10	allowed	aloud	permitted
11	manner	manor	way
12	fissure	fisher	crack
13	groan	grown	grunt
14	holy	wholly	divine
15	know	no	aware
16	mail	male	letter
17	right	write	good
18	scene	seen	display
19	altar	alter	shrine
20	cereal	serial	grain
21	doe	dough	bunny
22	flee	flea	fly
23	great	grate	big
24	hole	whole	crack
25	night	knight	nocturnal
26	loan	lone	credit
27	maid	made	servant
28	peddle	pedal	push

Sr. No.	TBR	homonym cue	synonym cues
29	role	roll	act
30	soar	sore	rise
31	tail	tale	rear
32	vary	very	differ
33	wail	whale	sob
34	waste	waist	decay
35	weather	whether	climate
36	wood	would	timber
37	sole	soul	lone
38	none	nun	nil
39	knead	knead	rub
40	heel	heal	obey
41	flower	flour	blossom
42	dual	duel	double
43	break	brake	crack
44	blew	blue	flow
45	ate	eight	bite

**Problem:** To study the impact of homonyms and synonyms as retrieval cues.

**Null Hypothesis:** There will be no difference in the mean recall scores of the three groups i.e., homonym retrieval condition, synonym retrieval condition, and free recall.

**Alternative Hypothesis:** There will be a difference in the mean recall score for the three groups where the mean recall will be highest for the homonym retrieval cues, then the condition with the synonym retrieval cues and lowest for the free recall condition.

#### **Operational definition of variables:**

**Independent Variable (IV):** The type of cues provided during the task were of three types: Thus, the IV has 3 levels:

Level 1: homonym cues condition (homonyms are words with a similar sound but different meaning e.g., sign-sign/hair-hare)

Level 2: synonym cues condition (words with similar meaning e.g., aid/help/assist)

Level 3: free recall condition (participants were provided no cue)

Dependent Variable (DV): mean recall scores for the three conditions i.e., homonym cues condition, synonym cues condition, and free recall condition

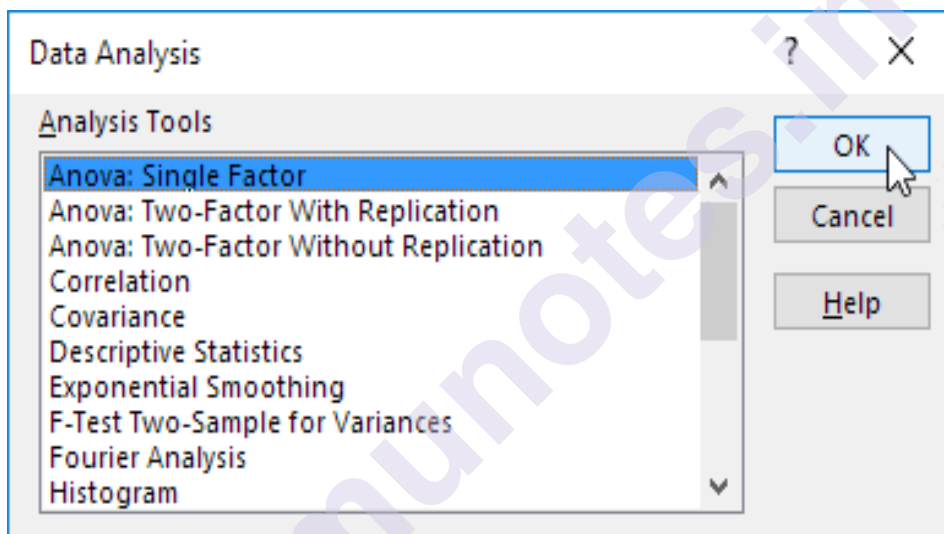
Step 1. Open the spreadsheet on your computer with data written in columns

Step 2. Click data

Step 3. Click on data analysis



Step 4. Select Anova: Single Factor and click OK.

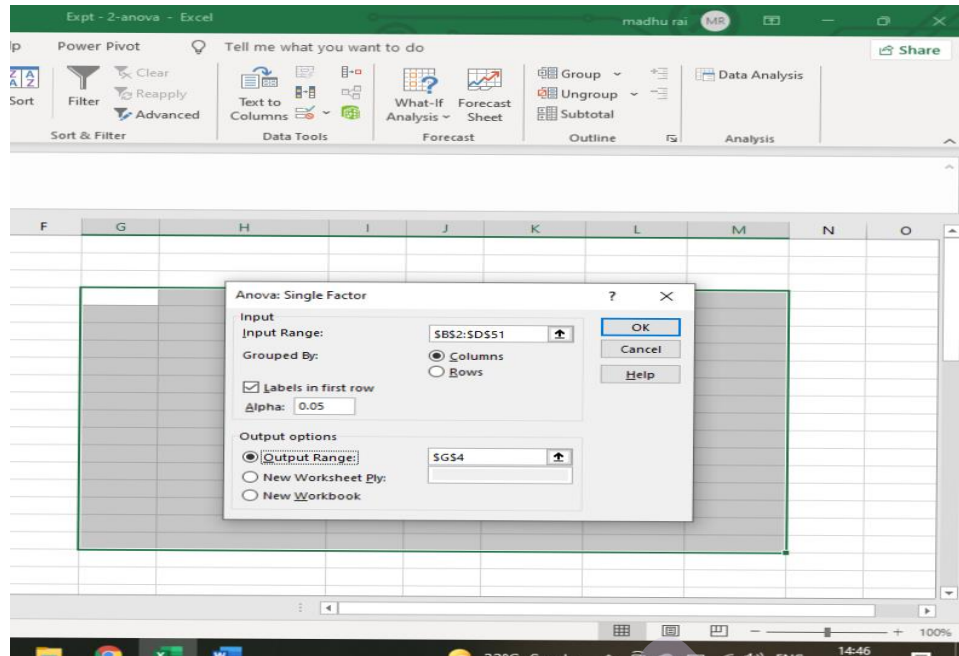


Step 5. Click in the Input Range box and select the range B 2D51

Step 6. Click in the Output Range box and select cell G4

Check in the box: Labels in First Row

Click on columns because data is in columns.



Step 7. Click OK

Anova: Single Factor						
SUMMARY						
Groups	Count	Sum	Average	Variance		
homonym cues recall	49	1547	31.57	21.83		
synonym cues recall	49	1124	22.93	21.51		
free recall	49	858	17.51	48.63		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	4927.931973	2	2463.965986	80.36	3.63455E-24	3.05
Within Groups	4415.061224	144	30.66014739			
<b>Total</b>	<b>9342.993197</b>	<b>146</b>				

Conclusion: if  $F > F_{crit}$ , we reject the null hypothesis. This is the case,  $80.36 > 3.05$ . Therefore, we reject the null hypothesis. The means of the three groups are not equal. Therefore, we have evidence to reject the null hypothesis and say that at least one of the three samples have significantly different means and thus belong to an entirely different population. The **ANOVA** does not tell us where the difference lies. We need to perform post hoc test.

You can perform the post hoc test in the same manner as we did with our example of type of music and students' performance.

**Microsoft Excel** is a spreadsheet program that is used to record numerical data and analyze it. This tool provides many features to perform various operations like calculations, pivot tables, graphs tools, etc. Microsoft Excel allows you to compute all kinds of data and seek the answers that you are looking for. Descriptive statistics can be performed with ease in Excel.

Formulas in Excel are very easy to enter. You can very easily learn how to enter formulas to find the maximum, minimum, mean, mode, median, sum, range, and mean of a set of data. You can also learn how to identify items in exact positions without having to manually count out the positions (such as the 3rd largest, or 2nd smallest number in a series).

The calculation of ANOVA can be done very easily using Microsoft Excel. Suppose you want to find out, out of three treatment methods which one is better. A common approach to figure out a reliable treatment method would be to analyse the days it took the patients to be cured. You can use a statistical technique that can compare, for example, three treatment samples and depict how different these samples are from one another. Such a technique, which compares the samples on the basis of their means, is called ANOVA.

Analysis of variance (ANOVA) is a statistical technique that is used to check if the means of two or more groups are significantly different from each other. ANOVA checks the impact of one or more factors by comparing the means of different samples.

We can use ANOVA to prove/disprove if all the medication treatments were equally effective or not. Microsoft Excel is a good and reliable tool to conduct ANOVA.

In this section, we learned how to compute ANOVA when we have more than two means in an experiment. As you already know if we have more than two means then we need to do ANOVA (analysis of variance).

In the first experiment, there is one IV with three levels, namely,

- iv) Low anchoring group
- v) High anchoring group
- vi) No anchoring (control)

We have the following null and alternate hypotheses for our experiment:

**Null Hypothesis:** There will be no difference in the performance of the participant based on the three types of anchors provided to them i.e. low anchor, high anchor, and no anchor level respectively.

**Alternative Hypothesis:** There will be a difference in the performance of the participant based on the three types of anchors provided to them i.e. low anchor, high anchor, and no anchor level respectively.

### Dependent Variable: Performance of the participants

To know whether there is a difference or not in the performance of the three groups, we need to perform a one-way ANOVA.

As you did the analysis of the data you saw that the null hypothesis was rejected. The means of the three groups are not all equal. At least one of the means is different. However, the **ANOVA** does not tell us where the difference lies. To know this, we needed to perform a post hoc test.

In a similar manner second experiment, too, was analyzed.

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## 8.7 QUESTIONS

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1. Explain what are the main uses of Microsoft Excel?

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2. i) Compute ANOVA from the following data for the experiment on the Effect of type of study/tuition on students' academic performance. In the following sum, three types of tuition are personal tuition, regular tuition, and no tuition. In the columns, marks (academic performance) of students over 100 are given in the subject of mathematics.

Serial No	Personal Tuition	Regular tuition	No tuition
1	76	76	70
2	67	67	32
3	45	56	65
4	62	50	54
5	67	44	44
6	70	68	66
7	80	80	32
8	82	59	22
9	45	76	32
10	22	45	12
11	56	60	36
12	46	79	57
13	47	69	76
14	60	72	55

Serial No	Personal Tuition	Regular tuition	No tuition
15	79	22	39
16	63	21	40
17	29	40	42
18	38	54	33
19	59	67	49
20	76	53	38

- ii) In the above experiment identify IV and DV.
- iii) In the above experiment how many levels of IV are there? Name them.

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## 8.8 REFERENCES

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Anastasi, A. & Urbina, S. (1997). *Psychological Testing*. (7<sup>th</sup> ed.). Pearson Education, New Delhi, first Indian reprint 2002

Aaron, A., Aaron, E. N., & Coups, E. J. (2006). *Statistics for Psychology*. (4<sup>th</sup> ed.). Pearson Education, Indian reprint 2007

Cohen, J. R., & Swerdlik, M. E., (2018). *Psychological Testing and Assessment: An introduction to Tests and Measurement*. (9<sup>th</sup> ed.). New York. McGraw-Hill International edition. (Indian reprint 2018)

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